T H E

W O N D E R S   O F   T H E   H E A V E N S

B Y

C A M I L L E   F L A M M A R I O N

FROM THE FRENCH BY MRS. NORMAN LOCKYER

WITH
VARIOUS PUBLICATIONS BY OTHER AUTHORS

C O N T E N T S

THE WONDERS OF THE HEAVENS.

BY

CAMILLE FLAMMARION.

FROM THE FRENCH BY MRS. NORMAN LOCKYER.

WITH THIRTY-TWO ACTINOGLYPH ILLUSTRATIONS.

BOOK FIRST.

I.

NIGHT.

"O nuit ! que ton langage est sublime pour moi !"*

O NIGHT, how sublime is thy language to me ! . . . Where are the souls to whom the spectacle of starry night is not an eloquent discourse ? Where are those who have not been sometimes arrested in the presence of the bright worlds which hover over our heads, and who have not sought for the key of the great enigma of creation ? The solitary hours of night are in truth the most beautiful of all our hours, those in which we have the faculty of placing ourselves in intimate communication with great and holy Nature. Far from spreading a veil over the universe, as is sometimes said, they only efface those which the sun produces in the atmosphere. The orb of day conceals from us the splendors of the firmament ; it is during the night that the panoramas of the sky are open to us. "At the hour of midnight the heavenly vault is strewn with stars, like isles of light in the midst of an ocean extending over our heads. Who can contemplate them and bring back his looks to the earth without feeling sad regrets, and without longing for wings in order to take flight and be blended with them, or be lost amid their immortal light ?"

In the midst of darkness our eyes gaze freely on the sky, piercing the deep azure of the apparent vault, above which the stars shine. They traverse the white constellated regions, visiting distant regions of space, where the most brilliant stars lose their brightness by distance ; they go beyond this unexplored expanse, and mount still higher, as far as those faint nebulæ whose diffused brightness seems to mark the limits of the visible. In this immense passage of sight, thought with rapid wings accompanies the forerunning visual ray, carried away by its flight and wonderingly contemplating these distant splendors. The purity of the heavenly prospect awakens that eternal predisposition to melancholy which dwells in the depths of our souls, and soon the spectacle absorbs us in a vague and indefinable reverie. It is then that thousands of questions spring up in our minds, and that a thousand points of interrogation rise to our sight. The problem of creation is a great problem ! The science of the stars is an immense science ; its mission is to embrace the universality of created things !

At the remembrance of these impressions, does it not appear that the man who does not feel any sentiment of admiration before the picture of the starry splendor, is not yet worthy of receiving on his brow the crown of intelligence?

Night is, in truth, the hour of solitude, in which the contemplative soul is regenerated in the universal peace. We become ourselves; we are separated from the factitious life of the world, and placed in the closest communion with nature and with truth.

Of all the sciences, Astronomy is the one which can enlighten us best on our relative value, and make us understand the relation which connects the Earth with the rest of creation. Without it, as the history of past centuries testifies, it is impossible for us to know where we are or who we are, or to establish an instructive comparison between the place which we occupy in space and the whole of the universe: without it we should be both ignorant of the actual extent of our country, its nature, and the order to which it belongs. Inclosed in the dark meshes of ignorance, we cannot form the slightest idea of the general arrangement of the world; a thick fog covers the narrow horizon which contains us, and our mind remains incapable of soaring above the daily theatre of life, and of going beyond the narrow sphere traced by the limits of the action of our senses. On the other hand, when the torch of the Science of the Worlds enlightens us, the scene changes, the vapors which darkened the horizon fade away, our mistaken eyes contemplate in the serenity of a pure sky the immense work of the Creator. The Earth appears like a globe poised under our steps; thousands of similar globes are rocked in ether; the world enlarges in proportion as the power of our examination increases, and from that time universal creation develops itself before us in its reality, establishing both our rank and our relation with the numerous similar worlds which constitute the universe.

The silence and profound peace of a starry night present an appropriate scene to our contemplative faculty, and no time is more propitious to the elevation of the soul toward the beauties of the heavens. But the poetry of the sight of these appearances will be soon surpassed by the magnificence of the reality. And it is on this point that we must first insist, in order to get rid of all delusions caused by the senses. It seems to me right to remove the causes of error which may leave false impressions on our minds; it is completely useless, if not dangerous, to devote the first part of an astronomical discourse to describing apparent phenomena, which will afterward have to be proved false. Let us not follow this troublesome road; let us keep away from the ordinary path, and begin, on the contrary, by raising the veil, in order to allow the reality to shine. Poetry, whose harmonious breath has just hushed our suspended souls, will not vanish on that account; it will rather regain a fresh aspect and new life, and, above all, a greater energy. Fiction can never be superior to truth; the latter is a source of inspiration to us, richer and more fruitful than the former.

II.

THE HEAVENS.

The shade which spreads over the hemisphere in the absence of the Sun, from its setting to its rising, is only a partial phenomenon, circumscribed by the Earth, and in which the remainder of the universe does not participate. When we are enveloped in the calm silence of profound night, we are inclined to extend the scene which surrounds us to the entire universe, as if our world were the centre and pivot of creation. A few moments' reflection will suffice to prove how great this illusion is, and to prepare us for the conception of the whole world. It is, indeed, evident that the Sun cannot illuminate all sides of the same object at once, but only those which are turned toward it, only lighting up half the terrestrial globe at one time; hence it follows that night is nothing more than the state of the non-luminous part. If we imagine the terrestrial globe suspended in space, we shall understand that the side turned toward the Sun is alone illuminated, while the opposite hemisphere remains in shadow, and that this shadow presents the aspect of a cone. Moreover, as the Earth turns on itself, all its portions are presented successively to the Sun and pass successively into this shadow, and it is this which constitutes the succession of day and night in every country of the world. This simple *coup d'œil* suffices to show that the phenomenon to which we give the name of night belongs really to the Earth, and that the heavens and the rest of the universe are independent of it.

This is the reason why, if at any hour of the night we let our minds soar above the terrestrial surface, it will follow that, far from remaining always in the night, we shall again find the Sun pouring forth his floods of light through space. If we carry ourselves away as far as one of the planets which, like the Earth, revolves in the region of space where we are, we shall understand that the night of the Earth does not extend to those other worlds, and that the period which with us is consecrated to repose does not extend its influence there. When all beings are buried in the stillness of silent night here—above, the forces of nature continue the exercise of their brilliant functions—the Sun shines, life radiates, movement is not suspended, and the reign of light pursues its dominant action in the heavens (as on the opposite hemisphere to ours), at the same hour when sleep overcomes all beings on the hemisphere we inhabit.

It is important that we should know, first of all, how to habituate ourselves to this idea of the isolation of the Earth in space, and to believe that all the phenomena which we observe upon this globe are peculiar to it and foreign to the rest of the universe. Thousands and thousands of similar globes revolve like it in space. I do not now prove the truth of my assertions, but my readers will not doubt them, and will be willing to take my word, reminding me later to justify all that I shall have stated. Moreover, I promise them to do this as soon as possible; but I shall ask their permission to develop at once, in outline, a general idea of the universe.

One of the most fatal delusions which it is important we should get rid of at once, is that which presents the Earth as the lower half of the universe, and the heavens as its upper

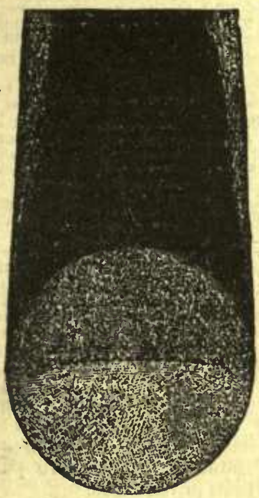

Fig. 1.—Night and Day.

half. There is nothing in the world more false than this. The heavens and the Earth are not two separate creations, as we have had repeated to us thousands and thousands of times. They are only one. The Earth is in the heavens. The heavens are infinite space, indefinite expanse, a void without limits; no frontier circumscribes them, they have neither beginning nor end, neither top nor bottom, right nor left; there is an infinity of spaces which succeed each other in every direction. The Earth is a little material globe, placed in this space without support of any kind, like a bullet which sustains itself alone in the air, like the little captive balloons which rise and float in the atmosphere when the thin cord which retains them is cut. The Earth is a star in the heavens; it forms part of them; it, in company with a great many other globes similar to it, peoples them; it is isolated in them; and all these other globes also float isolated in space. This conception of the universe is not only very important, but it is also a truth which it is absolutely necessary should be well fixed in the mind, otherwise three quarters of the astronomical discoveries would remain incomprehensible. Here, then, is this first point well understood and thoroughly established in our thoughts. The heavens surround us on every side. In this space the Earth is a globe suspended; but the Earth is not alone in space. All those stars which sparkle in the heavens are isolated globes, suns shining by their own light; they are very distant from us; but there are stars nearer which resemble much more the one we inhabit, in the sense that they are not suns, but dark earths receiving, like ours, light from our Sun. These worlds called "planets" are grouped in a family; ours is one member of this family. At the centre of this group shines our Sun, a source of light which illuminates it, and of heat which warms it. Floating in the bosom of the space which surrounds it on every side, this group is like a fleet of many boats rocked in the ocean of the heavens.

A multitude of suns, surrounded like ours with a family of which they are the foci and the light-givers, float likewise in all parts of the expanse. These suns are the stars with which the fields of heaven are scattered. In spite of the appearance caused by perspective, immense spaces separate all these systems from ours, spaces so great that the highest figures of our great numeration can scarcely number the smallest among them. A distance that our figures can scarcely express also separates these stars from each other, extending from depths unto depths.

Notwithstanding these prodigious intervals, these suns are in number so considerable that their numeration as yet exceeds all our means; millions joined to millions are inadequate to enumerate the multitude! . . . Let the mind try if it is possible to represent to itself at one time this considerable number of systems and the distances which separate them one from the other! Confused and soon humbled at the aspect of this infinite richness, it will only learn to admire in silence this indescribable wonder. Continually rising on the other side of the heavens, going beyond the distant shores of this ocean without limits, it will endlessly discover fresh new space, and new worlds will reveal themselves to our eagerness; heavens will succeed to heavens, spheres to spheres; after deserts of expanse will open other deserts, after immensities other immensities; and even when carried away without rest, during centuries, with the rapidity of thought, the soul would continue its flight beyond the most inaccessible limits that imagination could conceive—there even the infinite of an unexplored expanse would remain still open before it; the infinite of space would oppose itself to the infinite of time; endlessly rivalling, without our ever being able to take away from the other; and the spirit will be arrested, overcome with fatigue, at the entrance of infinite creation, as if it had not advanced a single step in space.

Imagination suspends its flight and is stopped humbled.

"Ye stars! bright legions that, before all time,
Camped on yon plain of sapphire, what shall tell
Your burning myriads but the eye of Him
Who bade through heaven your golden chariots wheel?
Yet who, earth-born, can see your hosts, nor feel
Immortal impulses—eternity?
What wonder if the o'erwrought soul should reel
With its own weight of thought, and the wild eye
See fate within your tracks of deepest glory lie?"*

The immensity of the heavens has been sung on many lyres; but how can the song of man express such a reality? Poets have tried to render it in verse, when one feels the insufficiency of speech to note the immense thoughts which this wonderful contemplation develops in us.

Had I not reason for stating, as I did, that reality is superior to fiction, even from the point of view poetical sentiments, and that the contemplation of actual nature incloses a richer and more fruitful source of inspiration than the illusions of the spectacle offered by our senses? Instead of an immense night stretching itself to the azure vaults, instead of a robe worked with gold embroideries, or a veil covered with brilliant ornaments, we are in the bosom of life and universal brightness. Night is but an accident, a happy accident, which enables our looks to extend themselves beyond the limits which the day marks for us; we are like a traveller reclining in the shadow of a hill, who contemplates the illuminated landscape which is unfolded as far as the distant horizon. Instead of the immobility of dead silence, we are present at the spectacle of life on worlds. With the light of truth the arbitrary vaults disappear and heaven opens its depths to us; the infinite of creation is revealed with the infinite of space, and our Earth, losing the preponderance which our pretensions had accorded to it, gives way under our feet and disappears in the shade, losing itself in the midst of a multitude of similar little worlds. In the freedom of our flight we go beyond the solar regions and take our first sketch of the universe. It is thus that, disabusing ourselves of the first step of the ancient rror too long established by appearances, we place ourselves in good condition for study, and prepare ourselves to receive easily the fresh truths which nature will reveal to us.

Allow me, in concluding this chapter, to relate an episode worthy of being more known than it has yet been, because it shows how much more power the real world has than the empire of fiction. It is taken from the life of the great mathematician, Euler, and it was Arago himself who related it to the Chambre des Députés at the meeting of the 23d of March, 1837.

"Euler, the great Euler, was very devout; one of his friends, a minister of one of the Berlin churches, came to him one day and said, 'Religion is lost, faith has no longer any basis, the heart is no longer moved, even by the sight of the beauties—the wonders of creation. Can you believe it? I have represented this creation as everything that is beautiful, poetical, and wonderful; I have quoted ancient philosophers and the Bible itself; half the audience did not listen to me, the other half went to sleep or left the church.'

"'Make the experiments which Truth points out to you,' replied Euler. 'Instead of giving the description of the world from Greek philosophers or the Bible, take the astronomical world, unveil the world such as astronomical research has constituted it. In the sermon which has been so little attended to, you have probably, according to Anaxagoras, made the Sun equal to the Peloponnesus. Very well! say to your audience that, according to exact incontestable measurements, our Sun is 1,200,000 times larger than the Earth.

"'You have, doubtless, spoken of the fixed crystal heavens; say that they do not exist, that comets break through them, in your explanations planets were only distinguished from stars by movement; tell them they are worlds, that Jupiter is 1400 times larger than the Earth, and Saturn 900 times; describe the wonders of the ring; speak of the multiple moons of these distant worlds.

"'Arriving at the stars, their distances, do not state miles; the numbers will be too great, they will not appreciate them; take as a scale the velocity of light; say that it travels 186,000 miles per second; afterward, add that there is no star whose light reaches us under three years; that there are some of them with respect to which no special means of observation has been used, and whose light does not reach us under thirty years.

"'On passing from certain results to those which have only great probability, show that, according to all appearance, certain stars could be visible several millions of years after having been destroyed; for the light which is emitted by them takes many millions of years to traverse the space which separates them from the Earth.'

"Such was, gentlemen, shortened, and only with few modifications in figures, the counsel given by Euler. The advice was followed; instead of the world of fable, the minister presented the world of science. Euler waited for his friend with impatience. He arrived at last, with dull eye and in a manner which appeared to indicate despair. The geometer, very astonished, cried out, 'What has happened?'

"'Ah! Monsieur Euler,' replied the minister, 'I am very unhappy; they have forgotten the respect which they owed to the sacred temple, they have applauded me.'"

The scientific world was a hundred orbits greater than the world which the most ardent imaginations had dreamed of. There was a thousand times more poetry in the reality than in the fable.

III.

INFINITE SPACE.

There are truths before which human thought feels itself humiliated and perplexed, which it contemplates with fear, and without the power to face them, although it understands their existence and necessity: such are those of the infinity of space and eternity of duration. Impossible to define, for all definition could only darken the first idea which is in us, these truths command and rule us. To try and explain them would be a barren hope; it suffices to keep them before our attention in order that they may reveal to us, at every instant, the immensity of their value. A thousand definitions have been given; we will, however, neither quote nor recall one of them. But we wish to open space before us and employ ourselves there, in trying to penetrate its depth. The velocity of a cannon-ball from the mouth of the cannon makes swift way, 437 yards per second. But this would be still too slow for our journey through space, as our velocity would scarcely be 900 miles an hour. This is too little. In nature there are movements incomparably more rapid, for instance, the velocity of light. This velocity is 186,000 miles per second. This will do better: thus we will take this means of transport. Allow me, then, by a figure of speech, to tell you that we will place ourselves on a ray of light and be carried away on its rapid course.

Taking the Earth as our starting-point, we will go in a straight line to any point of the heavens. We start. At the end of the first second we have already traversed 186,000 miles; at the end of the second, 372,000. We continue. Ten seconds, a minute, ten minutes have elapsed—111,600,000 miles have been passed. Passing, during an hour, a day, a week, without ever slackening our pace, during whole months, and even a year, the time which we have traversed is already so long that, expressed in miles, the number of measurement exceeds our faculty of comprehension, and indicates nothing to our mind: they would be trillions, and millions of millions. But we will not interrupt our flight. Carried on without stopping by this same rapidity of 186,000 miles each second, let us penetrate the expanse in a straight line for whole years, fifty years, even a century. . . . Where are we? For a long time we have gone beyond the last starry regions which are seen from the Earth, the last that the telescope has visited; for a long time we travel in other regions, unknown and unexplored. No mind is capable of following the road passed over; thousands of millions joined to thousands of millions express nothing: at the sight of this prodigious expanse the imagination is arrested, humbled. Well! this is the wonderful point of the problem: we have not advanced a single step in space. We are no nearer a limit than if we had remained in the same place; we should be able again to begin the same course starting from the point where we are, and add to our voyage a voyage of the same extent; we should be able to join centuries on centuries in the same itinerary, with the same velocity, to continue the voyage without end and without rest; we should be able to guide ourselves in any part of space, left, right, forward, backward, above, below, in every direction; and when, after centuries employed in this giddy course, we should stop ourselves, fascinated, or in despair before the immensity eternally open, eternally renewed, we should again understand that our secular flights had not measured for us the smallest part of space, and that we were not more advanced than at our starting-point. In truth, it is the infinite which surrounds us, as we before expressed it, or the infinite number of worlds. We should be able to float for eternity without ever finding anything before us but an eternally open infinite.

Hence it follows that all our ideas on space have but a purely relative value. When we say, for instance, to ascend to the sky, to descend under the earth, these expressions are false in themselves, for being situated in the bosom of the infinite, we can neither ascend nor descend: there is no above or below; these words have only an acceptation relative to the terrestrial surface on which we live.

The universe must, therefore, be represented as an expanse without limits, without shores, illimited, infinite, in the bosom of which float suns like that which lights us, and earths like that which poises under our steps. Neither dome, nor vaults, nor limits of any kind; void in every direction, and in this infinite void an immense quantity of worlds, which we will soon describe.

IV.

GENERAL ARRANGEMENT OF THE UNIVERSE.

Stars are Distributed in Clusters.

In the bosom of infinite space, the unfathomable extent of which we have tried to comprehend, float rich clusters of stars, each separated by immense intervals. We shall soon show that all the stars are suns like ours, shining with their own light, and foci of as many systems of worlds. Now the stars are not scattered in all parts of space at hazard: they are grouped as the members of many families. If we compared the ocean of the heavens with the oceans of the Earth, we should say that the isles which sprinkle this ocean do not rise separately in all parts of the sea, but that they are united here and there in archipelagoes more or less rich. A Power as ancient as the existence of matter presided at the creation of these isles, each archipelago of which contains a great number; not one among them has risen spontaneously in an isolated region; they are all collected in tribes, most of which count their members by millions.

These rich groupings of stars have received the name of "Nebulæ." This name was given at the time of the invention of astronomical lenses, when these starry tribes were distinguished only under a diffused, cloudy aspect, which did not enable the eye to distinguish the composing stars. This appearance not revealing in any way the idea of solar clusters, it was thought that they were only phosphorescent, cosmical vapors, whirlwinds of luminous substance, or possibly primitive fluids, whose progressive condensation would in the future effect the formation of new stars. They were thought to assist at the creation of distant worlds, and sometimes, in remarking their different degrees of luminosity, people thought they could infer their relative ages, as in a forest the age of trees of the same species may be known on approach according to their size or the concentric circles which are formed each year under the bark. Thus the first nebula observed by the aid of the telescope and pointed out as an object of particular nature, the nebula of Andromeda, was considered for three centuries and a half as entirely deprived of stars. Simon Marius of Franconia, who from a musician became an astronomer—very compatible tastes, moreover—describing this oval and whitish appearance, which, more brilliant at the centre, became fainter at the edges, said that it resembled "the light of a candle (*candela*) seen at a distance through a sheet of horn." Only a few years ago a Cambridge astronomer counted within the limits of this nebula 1500 little stars, notwithstanding which, the centre still keeps the aspect of a diffused light, in spite of the best instruments. Later, the astronomer Halley thought no more of the star-clusters. "In reality," he states, these spots are nothing more than light coming from an immense space situated in the regions of ether, filled with a diffused and luminous medium by itself." Others, again, imagined that at that spot the brightness of empyrean heaven was seen through an opening in the firmament. Derham said this, the author of astro-theology. But when optical instruments were perfected, this appearance of diffused light was transformed into a brilliant dotting; in proportion as the power of the telescope became more searching, the number of apparent nebulæ diminished, and at present many of those which in Galileo's time were regarded as cosmical clouds are resolved into stars. To be just, it must be added that in revealing the stellar composition of the first nebulæ, the telescope showed others whose nature has only quite recently been found out; these nebulæ remain in an indistinct state, not only on account of their prodigious distance, but because they are composed of vast cloud-masses of glowing gas.

Thus, infinite space must be represented as an immense void in the bosom of which are suspended archipelagoes of stars. These archipelagoes are themselves of infinite number, the stars which compose them can be counted by millions, and from one to the other the distance is incalculable. They are distributed in space in every direction, in every sense, following every imaginable course, and themselves invested with every possible form, as we shall soon see.

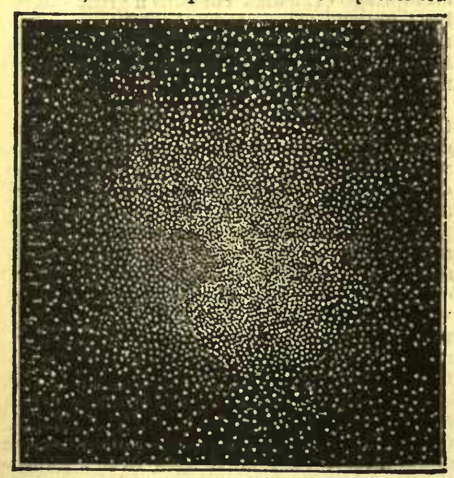

Fig. 2.—Cluster in the Centaur.

One of the most remarkable and regular nebulæ, and the one that may at the same time serve best for illustrating the arguments which precede, is the nebula in the Centaur. We shall study farther on the aspect of the constellations and the most simple method of finding celestial objects most worthy of our attention. This nebula is presented under the following aspect in the field of a good telescope.

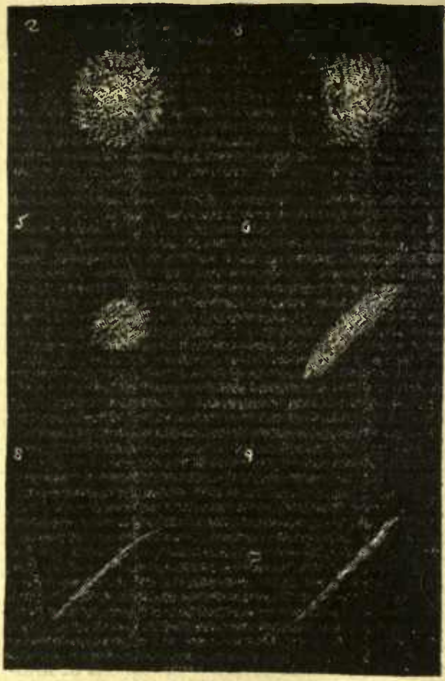

Fig. 3.—Globular Clusters.

With the naked eye it is with difficulty distinguished as a point of faint light; in the telescope it is seen as a prodigious number of stars strongly condensed toward the centre. This condensation is a manifest proof that the cluster of stars is not only circular, but also spherical. One instant of attention suffices indeed to show that if we look at a sphere of stars at a distance, the visual ray will pass through less if it look at the edges of the sphere than if it look at the centre, and will meet with fewer stars on its passage toward the borders than toward the centre. In proportion as this visual ray gets nearer the centre its part comprised in the sphere will become longer, and the number of stars which it will meet goes on increasing. The maximum will be at the very centre. It was this optical effect which induced the belief in a condensation of nebulous matter. Halley discovered this cluster in 1679, while he was working at the catalogue of objects visible in the Southern heavens.

The limits of this cluster are not so clearly defined as in those which have particularly received the name of globular. Fig. 3 represents some types chosen from the latter.

Of those star-clusters the first are certainly

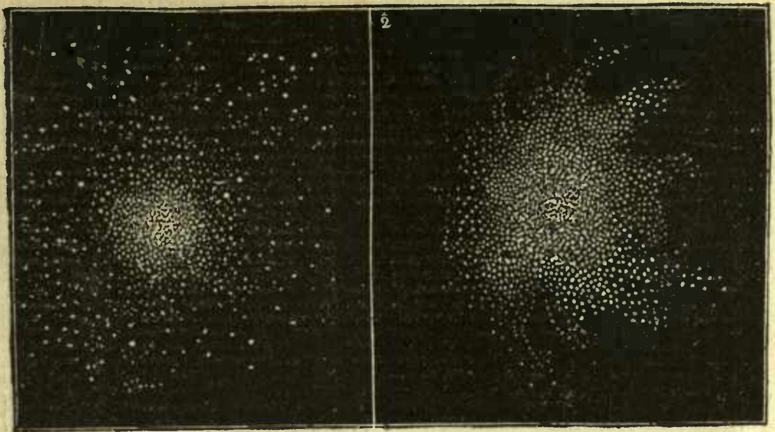

Fig. 4.—Stellar Clusters.

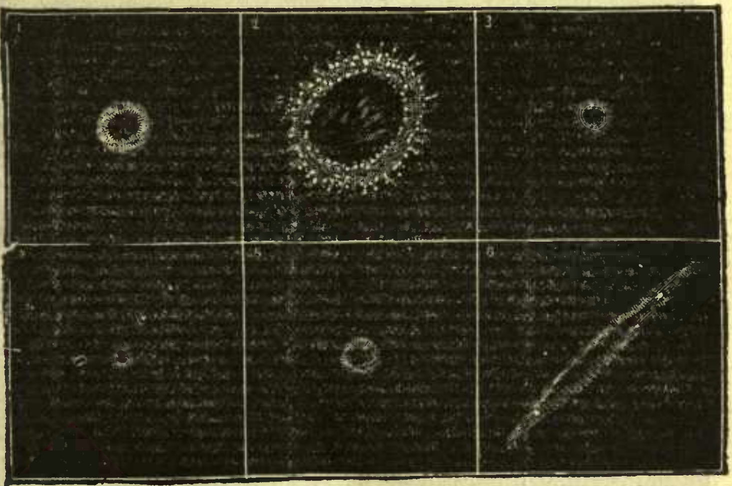

Fig. 5.—Annular Nebulæ.

spherical; others elongated, the thickness of which we see gradually diminished. These are probably also circular, but flattened in the form of lenses; instead of being presented to us in front they are seen edgeways.

At the sight of these globular masses one may ask with Arago, What is the number of stars contained in some of these clusters? The astronomer himself replied to his question. It would be impossible to count in detail and accurately the total number of stars of which certain globular nebulæ are composed; but one may be able to arrive at limits. In calculating the angular space of the stars situated near the edges, that is to say, in the region where they do not project on each other, and comparing them with the total diameter of the group, it is certain that a nebula, whose apparent superficial extent is scarcely equal to the tenth of that of the lunar disk, does not contain less than 20,000 stars; this is the minimum. The dynamic conditions proper to insure the indefinite preservation of a similar multitude of stars does not seem easy to imagine, adds the celebrated astronomer. Supposing the system at rest, the stars in time will fall on each other. Giving it a rotatory movement round a single axis, shocks will inevitably take place. After all, is it certain *à priori* that the globular systems of stars must be preserved indefinitely in the state in which we now see them?

The examination of changes which have taken place in other systems led to the belief, on the contrary, that there is nothing infinitely stable there, and that movement governs these clusters of suns, as well as it gov-

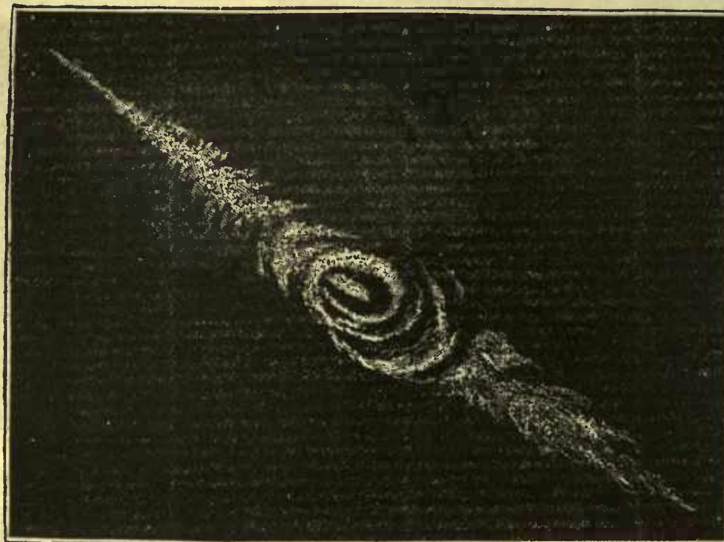

Fig. 6.—Nebula in the Lion.

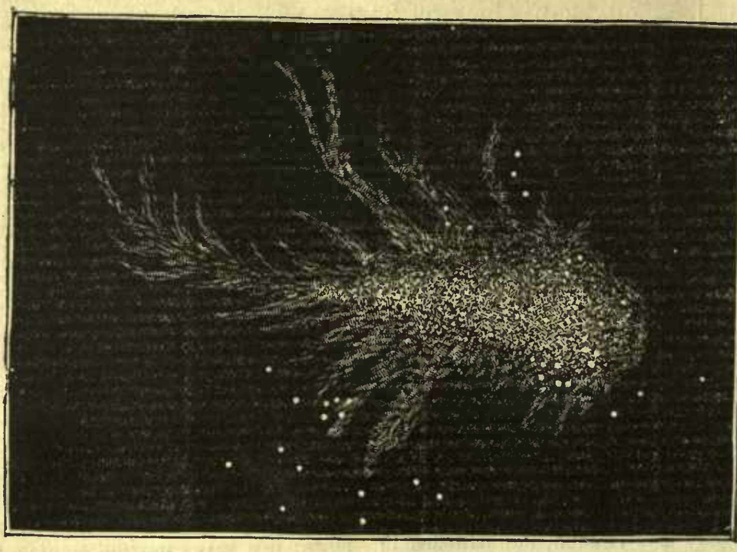

Fig. 7.—Crab Cluster in the Bull

erns each of the stars, and each of the little worlds which revolve round them.

The most regular nebulæ are not the most curious; notwithstanding, the aspect of some of them leaves a certain wonder in the mind. There are star-clusters which, instead of being condensed in an immense globe, are distributed in a crown, presenting the appearance of a circular or oval nebula, but hollow at its centre. Two types of this kind are represented in Figs. 5 and 6.

The first is the perforated nebula of *Lyra*; the second is that of Andromeda. In the one, the magnificent telescope of Lord Rosse shows dazzling borders of stars close together, and luminous fringes notching the outer edge; in the other, two suns, symmetrically placed on one side and the other of the ellipse, appear destined to the government of this system in its passage through space. Perforated nebulæ, says A. de Humboldt, are one of the rarest curiosities. That of Lyra is the most celebrated; it was discovered in 1779, at Toulouse, by Arquier, at the time when the comet pointed out by Bode approached the region that it occupied. It is about the apparent size of the disk of Jupiter, and forms an ellipse, its two diameters being in the ratio of four to five. The interior of the ring is not dark, but slightly luminous. The hollow space is, however, of a very deep black in the beautiful perforated nebulæ of the Southern hemisphere. All are probably star-clusters in form of rings.

The interesting nebula sketched on 58th page (Fig. 6) will serve us as a transition between the regular and irregular nebulæ; it is the elliptic annular cluster in the Lion. It appears to possess a central nucleus of great condensation. This nucleus is enveloped with concentric spheres, more or less filled with stars, separated from each other by spaces, and these envelops succeed each other along a great axis, getting farther from the centre, diminishing in extent equally on all sides, as far as the point where they fade away in a cone.

Fig. 8.—The Ship Argo.

V.

CLUSTERS AND NEBULÆ—(CONTINUED).

In proportion as the magnifying power of telescopes is increased, the contour of these star-clusters, like their interior aspect, presents itself under a more and more irregular form. Such of these objects which formerly appeared purely circular or elliptical have since showed great irregularlity in their form as well as in the degree of their luminosity. In the place where pale and whitish clouds gave out a calm and uniform light, the giant eye of the telescope has discovered alternately dark and luminous regions. The figures we are about to give all tend to support this remark; others confirm it in a still more striking manner. For instance, there is in the zodiacal constellation of the Bull a uniform and oval nebula, which does not present the least singularity in instruments of small power; but when Lord Rosse pointed his telescope to it for the first time, he could not resist immediately giving it the singular name of the Crab nebula, which its form alone suggested. The ellipse was changed into a fish; the antennæ, claws, and tail were depicted on the black sky by a white outline, formed by long trains of stars.

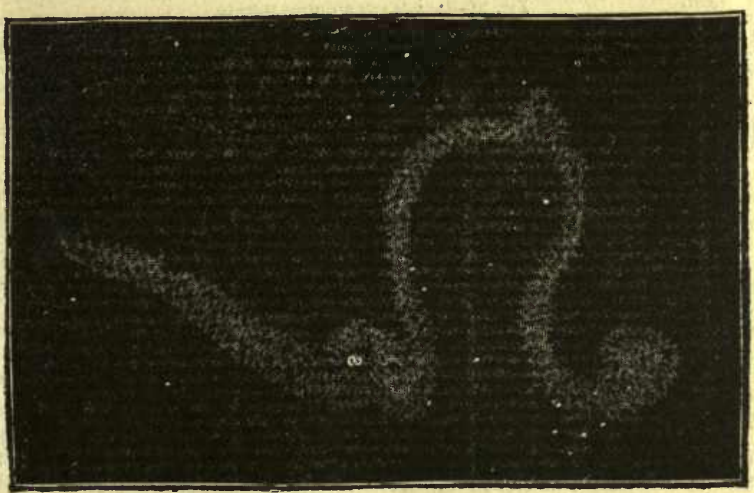

Fig. 9.—Sobieski's Crown.

There are irregular clusters and nebulæ of every possible shape, and of the thousands which have been already observed, described, and sketched, no two of them have been found to resemble each other. They take the most extraordinary forms. Some present the aspect of real comets; the nucleus is accompanied with a large tail and long luminous train: these are in the Unicorn, the River Eridanus, and the Great Bear; and especially that in the Ship Argo, in which is again found the classical type of the most regular comets. Others, like that in Orion, most celebrated by the study which has distinguished it, or like that of the Magellanic

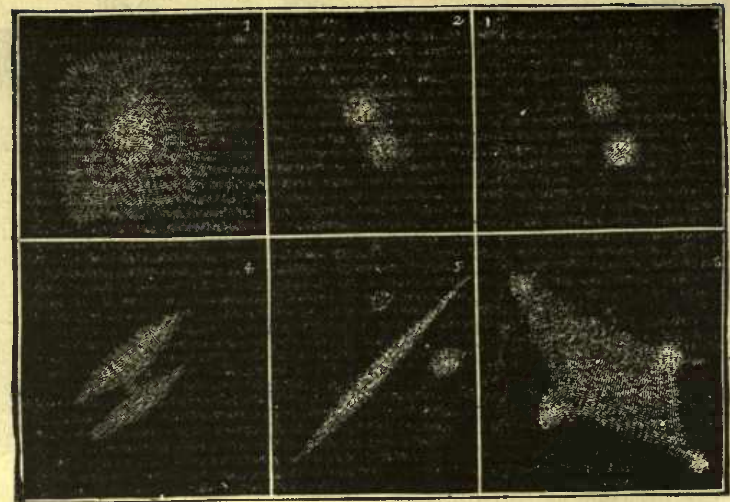

Fig. 10.—Double and Multiple Nebulæ.

Clouds and in the Ship (η). appear like immense vaporous clouds tossed about by some rough winds, pierced with deep rents, and broken in jagged portions. Another, again (that in the Fox), resembles the dumb-bells which gymnasts lift up to exercise the power of the arms; that in Sobieski's Crown describes on the page of heaven the last capital of the Greek alphabet, Ω.

Other nebulæ are grouped together, as if two or three of these vast systems had united their destinies. Many are double; we see two spherical masses united by the diffused glow which envelopes them, or they may be separated by a slight angular distance, or sometimes even inclosed in luminous concentric strata, like two eggs of snow in the midst of a nest of light. Again, elsewhere, in the Magellanic Clouds in the Southern hemisphere, we see four circular nebulæ arranged at the four angles of a lozenge, itself illuminated with fine star-dust; at one of the extreme angles the nebula is itself divided into four globes, so that in reality we have before us an immense cluster of stars, of which the extreme limits present seven principal condensations. But this is not all. Not only do these distant systems, some of them peopled with myriads of suns, take the most varied forms, not only do they present a diversity of aspect greater than it is possible to imagine; but some of them also unfold to the astonished eye which contemplates them varied shades and real colors. One is of a beautiful indigo blue; another is rose-colored at its centre with a white border, another again emits magnificent sky-blue rays. This coloring is produced by the actual color of the stars which compose it.* Others have been seen whose luminous intensity has perceptibly varied; the brightness of one of them has faded to such a degree as to be rendered completely invisible.

It is difficult to describe the impression which the sight of these distant universes makes on the mind when one sees them through the wonderful telescopes of modern times. The rays of light which reach us from so far place us for the time in communication with these strange creations, and the sentiment of terrestrial life hushed in the silence of night seems governed by the influence which celestial contemplation so easily exercises on the captivated soul. Earthly things lose their value, and one joins willingly with the voice of the poet of the Irish Melodies:

> "There's nothing bright but heaven,
> And false the light on glory's plume,
> As fading hues of even;
> And Love and Hope and Beauty's bloom,
> Are blossoms gathered for the tomb;
> There's nothing bright but heaven."

One feels that, in spite of the unfathomable distance which separates our abode from these far-off dwellings, there are there luminous foci and centres of movement: it is not a void, it is not a desert; it is "something," and this something suffices to attract our attention and awaken our reverie. An indefinable impression is communicated to us by the stellar rays which descends silently from unexplored abysses; one feels it without analyzing it, and the traces of it remain ineffaceable, like those felt by a traveller when he steps on strange lands, and sees new skies above his head. This is described by the illustrious author of "Cosmos," when he presents the Magellanic Clouds, vast nebulæ close to the Southern pole, as a unique object in the world of celestial phenomena. "The magnificent zones of the Southern heavens, comprised between the parallels from fifty and eighty degrees, are the richest in nebulous stars and irreducible nebulous clusters. Of the two Magellanic Clouds which lie near the Southern pole, this pole so poor in stars that it might be called a waste country, the largest especially appears, according to re-

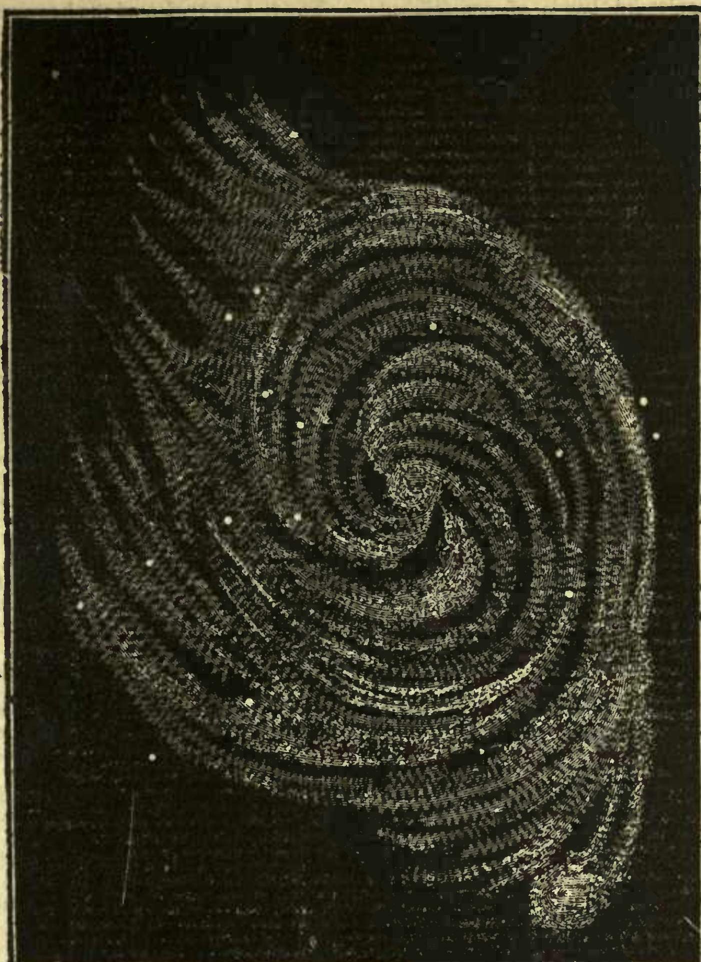

Fig. 11.—Spiral Nebula in the Constellation of the Hunting Dogs.

cent researches, to be a wonderful agglomeration of spherical clusters of large and small stars, and irreducible nebulæ, whose general brightness lights up the field of sight and forms the background of the picture. The aspect of these Clouds, the brilliant constellation of the Ship Argo, the Milky Way, which extends between the Scorpion, Centaur, and Cross, and the picturesque aspect of the whole Southern sky, have produced on my mind an ineffaceable impression." Nevertheless, the most magnificent and eloquent aspect of the nebulæ has not yet been revealed to us by those which precede. To form an idea of the importance of these objects, and to appreciate their value, from the space which they occupy, also from the time which has been necessary for their formation, we must see the splendid spiral nebulæ which the powerful telescope at Parsonstown unveils to us, and which in ordinary instruments only present appearances similar to those we have already noticed.

Lord Rosse, indeed, was the first to discover that the vast systems of suns were clustered, not only simply round a centre of condensation, not only in masses more or less regular, but according to a distribution which reveals the existence of gigantic forces in action among them. He observed some immense agglomerations of which the composing stars were distributed in long lines in a general system of spiral curves.

From the principal centre springs a multitude of luminous spirals, formed of a numberless quantity of suns or nebulous masses, shaping the resplendent nucleus, whence they issue to be lost in the distance, imperceptibly parting with their brightness, and dying away as trains of phosphorescent vapors. A secondary nucleus brings up on one side the extremities of the longest spirals.

There are splendid bands of constellated light, terminated with two rounded nodes. This rich spiral nebula belongs to the constellation of the Hunting Dogs. Before the discovery due to the powerful telescope which removed the veil with which it was enveloped, the best instruments only showed it as a single ring, one half of its contour surrounding a very bright globular nebula at its centre. Beyond the ring was noticed a second very small round nebula. Never was change of form more manifested between the aspects revealed by telescopes of different powers. To imagine the myriads of centuries necessary to the formation of these immense systems would be a vain undertaking. It is with slowness that nature accomplishes its most tremendous operations. In order that cosmical matter or the prodigious assemblage of so many stars could be distributed according to the curves revealed by the telescope, and winding round each other in gigantic spirals under the governing action of the combined attraction of all parts which compose this universe, it would require an incalculable series of accumulated years to pass away. Here especially it is truth to say that the luminous rays which descend from those distant creations are to us the most ancient testimony of the existence of matter.

The spiral nebula of the Hunting Dogs is not the only one of this form. In the constellation of the Virgin, Lion, and Pegasus, we also admire similar systems. That in the Virgin, situated in the central ring of Fig. 12, is presented under the aspect of the "wheels" that we see in fireworks; from the luminous centre white trains of light wind round, all guided and curved in the same direction; dark spaces separate them and give more clearness to the sketching of their direction. That in the Lion presents a series of oval concentric zones enveloping the centre, also more luminous; numerous stars shine out in the centre. The spiral nebula of Pegasus, marked with a beautiful star at its central point, is circular, and composed of circles alternately dark and luminous; on one side the circumference is cut by a tangent, a wide line of light longer than the nebula itself to which this appears to be attached, like the little silken nests of insects on branches. In writing these lines I am reminded of the year 1702, in which a maker of systems wrote a large book proving that the universe is a large spiral. According to him, God was placed at the centre of the heavens; from this centre He would communicate with all other created beings by an infinity of spiral lines directed toward the circumference. Sun and worlds, bodies and spirits, all would move in a spiral. If this singular author were again born in our day, with what delight would he seize our spiral nebulæ to illustrate his thesis!

Nebulæ are not uniformly spread in all regions of the sky. On the starry sphere vast localities may be observed where no nebula is visible, while, in other parts, they appear really heaped up.

The richest region of the heavens is in the following group of constellations, which will soon be recognized: the Great Bear, Cassiopea, Berenice's Hair, the Virgin. In the zodiacal region, near the Virgin, in an hour may be seen more than three hundred nebulæ; while, in the opposite region, a hundred would not be met with. The spaces which precede or follow nebulæ contain few stars. Herschel found this rule constant—so constant, in fact, that each time during a certain period no star was brought in the field of his immovable telescope by the movement of the heavens, he used to say to his secretary who assisted him, "Get ready to write; nebulæ are coming."

From this fact, namely, that the spaces poorest in stars are near the richest nebulæ, and from the other, that stars are generally more condensed toward the centre of nebulæ, follows a confirmation of what we said before on the incessant work of many centuries which would be required to elaborate these systems. There is nothing astonishing that these powerful unions were formed either at the expense of the surrounding cosmical matter, destined to be condensed in stars, or at the expense of the stars themselves, and that the spaces which surround them resemble vast deserts or regions laid waste.

VI.

THE MILKY WAY.

We have seen that the universe is formed of clusters and nebulæ, spread in the immensity of space, at every imaginable depth and in every possible direction. But then, if there are only nebulæ in space, and if no heavenly body is isolated from these clusters, our Earth, then, forms part of a nebula. The inhabitant of the terrestrial globe, then, finds himself also in the bosom of one of those immense clusters of stars which constitute the archipelagoes of the celestial ocean. And we do not, therefore live, as appearances lead us to suppose, beyond this starry creation which shines over our heads. In a word, if all the celestial bodies are united in groups, the Earth, then, also belongs to a group of stars, and a cluster.

Yes. The Earth, like all the stars, forms part of a cluster! It is not isolated in the deserts of the infinite; it is not an exception to the general law. The Earth, like the planets which are near it, belongs to the Sun. This Sun represents them in the universal numbering of the stars, for neither Earth nor planets count in the number of these splendors, and this Sun is one of the stars composing an immense nebula.

The Sun is but a star! This assertion seems astonishing at first sight, on account of the illusions produced by the senses. The torch of our light, the focus of heat, the ruler of terrestrial life, appears to us under the legitimate prestige of its own power, and we bow to it as the prince of stars, as the first among the great ones of the heavens. And for us, indeed, it supremely deserves these titles, and all those which our just

Fig. 12.—Spiral Nebula in the Virgin.

knowledge pleases to attribute to it. But if we consider it superior to the stars, if we find it more important, more magnificent, and more necessary, it is only because we are nearer to it, because in reality we are its tenants, its subjects, and that, contrary to that which happens on Earth, we recognize with delight the superiority of our master in the celestial realm. Belonging to him, we live at his expense, real parasites, and without him we should fall at once into the shades of death. To thank him and recognize his power is only just. Nevertheless, to judge things from an absolute point of view, we must rise above any particular dependence which may oppose the justice of our judgment, like him who, placed in the interior of an edifice and wishing to ascertain the rank of this edifice in the town, goes to a distance from it, and, placing himself on high ground, compares the various edifices with each other. We must, in the same way, put aside solar rule, and transport ourselves in spirit to a distant point in space, whence we should be able to determine the rank occupied by our Sun in the sidereal world.

Now, on getting farther from the Sun toward any point in space, we shall see the Sun diminish in size and lose the importance which appeared to be his privilege. When we reach the limits of his system, he will then only present the aspect of a large star. On getting still farther away, we shall see it descend to a simple star. Lastly, if we go toward any star in the heavens and continue to watch the decrease of the Sun which sinks behind us in the depths of space, it will become a small star soon lost in the multitude of others; the one we are approaching will lose, on the contrary, its small aspect, will increase, shine out, and get larger in proportion as we approach it, and will become a real sun, not less important than ours by its luminous and calorific power, and by the gifts its distributes to the planets of its domain.

Passing beyond this new sun and continuing our path, we shall behold an analogous transformation of others stars into suns; all those toward which we shall pass successively will appear to us under this aspect, thus showing that they shine with their own light and are so many planetary foci. Lastly, when we shall have crossed these starry plains, we shall reach shores where the suns are more scarce, and soon, a desert void of stars.

To the thousand millions and thousand millions of miles we have just traversed, let us again add a certain quantity of thousands of millions, and we shall soon arrive at a favorable point for estimating the absolute rank of our Sun. Let us then suppose that we at last reach the point from which we see the suns constituting our cluster, and then returning by the way we came, we

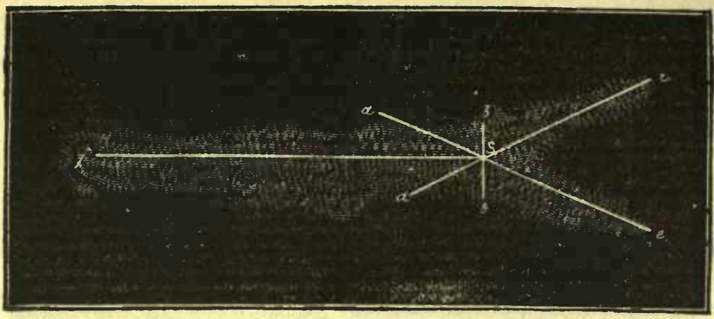

Fig. 13.—The Milky Way.

should find out what place our Sun occupies in the army of stars that we have left behind us.

It is there only that we can judge well of things. Now, this is what appears to us. All the stars which people our starry nights are inclosed in a narrow space, and we notice—now that we are beyond them—that they form a cluster of small bright points, and that they resemble an isle of lights suspended in space. In a word—and this is the point to which we wished to arrive—they form a cluster. This cluster is isolated; its limits are clearly enough defined, and no group, no star, shines in the space which surrounds it. It is marked out in the darkness in Fig. 13.

This is the nebula in which we live; this is the abode of our solar world. In what part of it are *we?* The question is at least curious, and, from the spot, where we are placed to observe the star-cluster of which we form part under its true aspect, the best instruments would not succeed in distinguishing our little Sun. But it is not always necessary to see people in order to guess where they are. This is why we are able to travel toward the centre of the nebula, and, not far from the line which separates the zone into two layers, to observe a little point. This point is the place occupied by our Sun. The Earth and planets are with him; but, since it is impossible to distinguish the Sun in the midst of this multitude, *à fortiori*, the utter impossibility of perceiving the slightest vestige of the existence of our planetary system will be manifest.

If we live thus in the middle region of a rich nebula, how is it, it may be asked by curious minds, how is it that we cannot distinguish it, and that our clear nights present around us a sky purely and splendidly starry? Is it then necessary to go away so many thousand millions of leagues from the Earth to know where it is placed? And if that is necessary, how has it been known?

No: this is not necessary, as the position is known. From the surface of our sphere we observe the sky, and we see that all around us a large nebulous circle envelopes our globe. We are ourselves near the centre of this circle, and each night displays over our heads a whitish band of dense stars continually surrounding us. This collection of stars, it has already been guessed, is the Milky Way.

The Milky Way, this wide irregular ribbon of stellar clouds which crosses the sky in all its width, is indeed nothing more than the greatest length of this immense lens of stars to which we belong. If the whole sky does not appear nebulous in every direction, it is precisely because the nebula to which we belong is not spherical, but of a lenticular form, and that in the thickness of the lens there is less depth and fewer stars than in the direction of the diameter. From the spot on which we are placed, if our sight pass through the greatest length, it meets stars on stars indefinitely, because there is an immense expanse from the point where we are to the edges of the flattened nebula. But if our sight turn aside from the equatorial plane toward the sides, it meets with fewer stars as it gets farther distant, and on reaching the polar diameter, scarcely any more will be met with. There are thirty times less stars in these regions than in those near the equatorial plane of the cluster.

All the stars which sparkle in the sky during a dark night belong to a single cluster, to a single nebula, the Milky Way marking its longitudinal direction. The stars are not isolated in an absolute manner, at random, in the deserts of space; they form part of a whole; the Sun which lights us is one of them; and they are counted by millions in a gigantic group, analogous to the distant clusters of which we have already spoken. Instead of only seeing a diffused glimmer, an indistinct light in the Milky Way, the telescope separates the stars which compose it and shows that it is formed of an innumerable multitude of stars very irregularly connected.

The idea which we must form of the Milky Way is then very different from that which appearances present to us, and from that with which the ancients contented themselves. From the beginning of ages, from the first observations of an elementary astronomy, this semi-luminous train which crosses the sky was noticed, and the ruling mythology adorned it with images.

William Herschel, with the powerful telescope made with his own hands, resolved, toward the end of the last century, to count the stars comprised in this zone : he addressed himself to his task and divided his work into portions. His long perseverance was crowned with success. By a careful comparison of the parts where the condensation of stars attains its maximum with those where it attains its minimum, and by an examination of the extent occupied by these immense rings, the great observer found that the Milky Way did not inclose less than eighteen millions of stars!

Eighteen millions of stars in the equatorial stratum of the lenticular nebula to which we belong : this is not the total number of which it is composed, as this does not refer to the lateral portions of this gigantic mass, and all the stars of the heavens situated on one side and on the other of the plane of greatest condensation are not included in this enumeration. We shall see farther on, in the chapter devoted to the study of the stars, that the total number of the members of this populous tribe is much greater still than eighteen millions. What is the real extent occupied by this collection of suns? The number of stars which compose it, and the relative distances from each other, comprises for this extent a number which the mind cannot well receive without being prepared for it, a number which it cannot appreciate without making great efforts to grapple it. I will not give the distance in leagues, because an immense continuation of leagues exceeds the limits of even the vision of the mind ; it is better to take the measure used constantly for astronomical units. Now, the extent of the Milky Way, at its greatest length, would be measured by a ray of light which, travelling 186,000 miles per second, would travel in a straight line and without stopping for fifteen thousand years.

Thus, as we are ourselves near the centre of this nebula, when in the field of a powerful telescope we observe the little distant stars situated in the depths of the Milky Way, our retina receives the impression of a luminous ray, which started seven or eight thousand years ago from a sun analogous to ours, and forming part of the same group.

If such be the extent of the nebula of which we are an infinitesimal constituent part, are not the other nebulæ scattered in space also as rich and vast ; or rather, is our nation privileged, and does it exceed the others in richness or in extent?

There is no reason to stop at this last idea, as a remnant of vanity would be perhaps able still to suggest to us, to make up a little for the mediocrity of the natural rank which we hold. The Milky Way is not unique ; many of the nebulæ of the universe are so many Milky Ways, more or less similar to our own. Some may be less vast ; others may possibly be vaster still, seeing that, in the domain of the infinite, space goes for nothing. It is best for us, then, to take the middle course, and to think that the pale and diffused nebulæ which seem to tremble in the distance in unfathomable immensities, are Milky Ways peopled with as many suns as our own. But then as they appear so small to us, they must necessarily be distant from us. More distant, indeed ; for if we find out at what distance we must remove our Milky Way in order to reduce it to the limit of a medium nebula, we find that we must remove it to 334 times its length, a distance which our agile messenger, a ray of light, takes a little more than five millions of years to accomplish. Such is the distance which may separate the gigantic clusters of suns, with which the sidereal universe is composed, and which hover in space suspended at all depths of unfathomable immensity from each other.

BOOK SECOND.

I.

THE SIDEREAL WORLD.

According to what has been previously stated, we inhabit the midst of a vast nebula ; its equatorial stratum, projecting itself on our sky, describes that cloudy zone known under the name of the Milky Way. Our Sun is one of the stars composing this gigantic cluster, and all the stars which sparkle during our silent nights form part, like him, of this same tribe. This is, properly speaking, our universe. The other nebulæ may be considered by us as other universes, foreign to this one, and which we have only contemplated in order to give us a more distinct notion of the grandeur of creation, but which we will henceforth leave in the unexplored immensity which they inhabit in the midst of space. Descending from the great to the small, proceeding from the whole to a part, we will now embrace less vast proportions ; we will pause at our sidereal universe, or, in other words, at the general description of the isles which constitute our celestial archipelago.

We will not yet speak of the nature of the stars, their distances, movements, or their particular history ; before pursuing the reality, it will be well for us to make a digression on appearances. We are, however, averse to appearances, and much prefer reality ; but there are some of which we cannot avoid speaking, seeing that they form in a certain way the surface of the things that must be searched into, and it is necessary to pass this surface before reaching the interior. But when we agree that such and such a phenomenon is only an appearance, there will be no harm in our studying it ; the important points to be understood and to avoid confusion.

The stars appear scattered at random in the heavens. In a fine starry night, when our sight rises to these heights, a great diversity in their brightness is noticed, and at the same time an apparent disorder in their general arrangement. This irregularity and the number of the stars have prevented the pos-

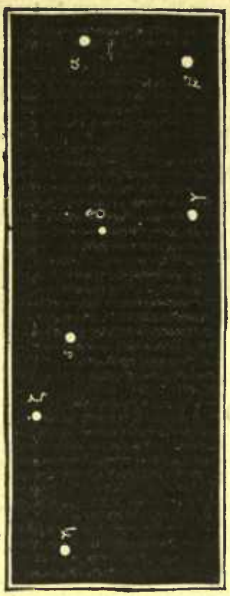

Fig. 14.—Constellation of the Great Bear.

sibility of giving to each of them a particular name; to recognize them and facilitate study, the heavenly sphere is divided into sections. The astronomy of the ancients, says Francœur, was confined to a few rough distinctions; they were at first contented to name the planets and most beautiful stars, and we have preserved this custom; but when they wished to study more carefully, and wished to describe stars of less brilliancy, they could only follow a method, the imperfection of which they acknowledged. They were led like the naturalists who, to name the species of the three kingdoms, unite under a common name a certain number of creatures which they afterward distinguish from each other by a qualification. Astronomers have united the stars in different groups, on which they have drawn an animal or fabulous being. To these groups or constellations they gave names from fables, history, or the animal kingdom. These denominations, consecrated by antiquity, are quite arbitrary; and unless imagination itself creates images, as it sees pictures in the ever-changing contours of the clouds, we must not endeavor to find in the groups of stars anything which might recall the figure or imitate the image of the objects whose name the constellation bears. The necessity of being guided on the seas obliged man to choose in the heavens invariable signs by which he could direct his course, and this is the historical origin of the constellations.

The ancients formed representative maps of the heavens, and from the time of Hipparchus, the Greek astronomer, they were able to class the stars, distinguishing them according to their brightness, in the positions occupied by each of them on these figures.

It was necessary to fix on a method to find a particular star easily, in the midst of such a great number (four to five thousand) as is distinguished with the naked eye. The first origin of the constellations is unknown; but it is imagined that they were established successively. The Centaur Chiron, Jason's preceptor, has the reputation of having first divided the heavens on the sphere of the Argonauts; but Job lived before the time when the precedent is placed, and this prophet then spoke of Orion, the Pleiades, and Hyades, three thousand three hundred years ago. Homer also speaks of these constellations when describing Vulcan's shield:

> "And on its surface many a rare design
> Of curious art his practiced skill had wrought,
> Thereon were figured earth, and sky, and sea,
> The ever-circling sun, and full-orbed moon,
> And all the signs that crown the vault of heav'n;
> Pleiads and Hyads, and Orion's might.
> And Arctos, call'd the Wain, who wheels on high
> His circling course, and on Orion waits;
> Sole star that never bathes in th' ocean wave."

The same mythological divisions are used in the present day. Since the establishment of Christianity there have been many efforts to reform this pagan system, and to replace it by Christian denominations. In the planisphere of Bede, St. Peter is substituted for the Ram, St. Andrew for the Bull, etc. From these attempts, no name escapes; David's chariot, Solomon's seal, the three Magi kings, or Jacob's rod, etc., date the highest. Later still, a German proposed to give to the twelve signs of the Zodiac the heraldry of the twelve most illustrious houses of Europe. These singular efforts remained sterile, and the mythological reign has continued until the present day.

As great diversity has been noticed in the brightness of stars, in order to facilitate their indication, they have been classed in order of magnitude. This word "magnitude" is improper, seeing that it has no relation to the dimensions of the stars, these dimensions being still unknown to us; it dates from a period when it was believed that the brightest stars were the largest, and this is the origin of the denomination; but it is important to know that this is not its real sense. It simply corresponds to the apparent brightness of the stars. Thus, stars of the first magnitude are those which shine with the greatest brightness in dark nights; those of the second magnitude shine less, etc. Now this apparent brightness belongs both to the real size of the star, its intrinsic light, and its distance from the Earth; consequently, it only possesses an essentially relative meaning. Nevertheless it may be said generally that the brightest stars are nearest, that those whose pale glimmer is scarcely distinguished in the field of the telescope are more distant.

Thus, when we shall speak of the magnitude of stars, it is to be understood that we refer simply to their apparent brightness; this brightness greatly facilitates the means of distinguishing them among the constellations. There is now another fact which is not less important to consider as relative, and not as absolute ; this is the arrangement of the stars or forms of the constellations. We know already that the sky is not a concave sphere in which bright nails are fastened, and that there is no kind of vault—only immense, infinite void surrounding the Earth on all parts, and in every direction. We know, also, that the stars, suns in space, are scattered at every distance in the vast immensity. When, then, we notice two stars close together in the sky, their apparent proximity does not in any way prove their real proximity : they may be very distant from each other, in the direction of vision, at a distance equal to or greater than that which separates us from the nearest one. In a similar way, when four, or five, or more stars are united in the same group, this does not imply that these stars, forming the same constellation, are on the same plane and at and equal distance from the Earth. By no means. Dispersed at all depths of space, all around the terrestrial atom, the arrangement which they display to our eyes is only an appearance caused by the position of the Earth with regard to them. This is purely a matter of perspective. When we find ourselves during the night in the midst of a large open space (for instance, the Place de la Concorde) in which numerous gaslights are dispersed, it is difficult for us to distinguish, at a certain distance, the most remote lights from those which are less so : they all appear to be projected on the dark ground ; moreover, their general arrangement depends purely on our point of view, and varies according as we ourselves walk away or across. This simple comparison may make us understand why the stars, lights in the dark space, do not reveal to us the distances which may really separate them, and why their arrangement on the apparent vault of the sky depends only on the spot where we place ourselves to examine them. On quitting the Earth's surface and transporting ourselves to a spot sufficiently distant, we should witness, in the apparent arrangement of the stars, a variation as much greater as our station of observation would be more distant from our previous one. For this it would be necessary to transport ourselves, not only to the last planets of our system, but beyond this system entirely, and to go to distances at least equal to those of the nearest stars. Indeed, from Neptune, the last planet of our system, the stars are seen in the same arrangement as from here. The change is only seen in quitting one star for another. One moment's reflection suffices to convince us of this fact, and to relieve us from further explanation on the subject.

These illusions once appreciated at their right value, we may, without fear, begin the description of the figures with which old fables have constellated the spheres. The knowledge of the constellations is necessary for the observation of the heavens and for researches which love of science or curiosity may inspire ; without it one finds one's self in an unknown country without any geography or possibility of discovering our where abouts. Let us, then, form the geography of the heavens. The innumerable figures of animals, men, or objects, with which the sphere is adorned, will not, however, be drawn here, seeing that they would only serve to confuse the mind with imaginary lines. Formerly they printed celestial atlases, where the figures were represented with exquisite care, so much so, indeed, that they ended by forgetting the stars, and the sky was nothing more than a menagerie. In spite of the interest of the images, I will not follow this example. I will only give farther on, on a special map, the drawing of the constellations visible in our hemisphere. At present, let us see how to direct our course for reading correctly the great book of the heavens.

There is one constellation known to every one ; for greater simplicity we will begin with it, as it will serve us as a starting-point to go toward the others, and as a sign to find its companions. This constellation is the Great Bear, which has also been called David's Chariot, or Charles's Wain ; which the ancients called *Septem triones* (whence came the word *septentrion*), or again, *Helix Plaustrum ;* which the Greeks addressed under the name of Ἄρκτος μεγάλη, ἑλική, etc., which the Arabs called *Aldebb al Akbar*, and the Chinese, three thousand years ago, addressed as the *Tcheou-pey*, the god of the north. Thus it can boast of a high celebrity. If, however, in spite of its universal notoriety, some have not yet had occasion to make its acquaintance, the following is the sign by which it may always be recognized. Turn toward the north, that is to say, opposite the spot where the Sun is at noon. Whatever may be the season of the year, the day of the month, or hour of the night, you will always see there a large constellation formed of seven stars, four of which are quadrilateral, and at an angle with the side ; the whole arranged as in Fig. 14.

Have you not all seen it ? It never sets. Night and day it watches above the northern horizon, turning slowly in four-and-twenty hours around a star of which we shall speak presently. In the figure of the Great Bear the three stars of the extremity form the tail, and the quadrilateral forms the body. In the Chariot the four stars form the wheels, and the three the car. Above the second, between these latter, good sights distinguish a very small star called Alcor, which is also called the Cavalier. The Arabs called it Saidak, which means the proof, because they used it to test a good eye. Greek letters are used to denote each star ; they are the first of the alphabet ; α and β mark the two first stars, γ and δ the two others, ϵ, ζ, η, the three of the car ; Arab names have also been given to them, but I shall pass over them in silence, as they are not generally used.

This brilliant septentrional constellation, composed (with the exception of δ*) of stars of the second magnitude, has received from

Fig. 15.—Great Bear, Little Bear, Pole Star.

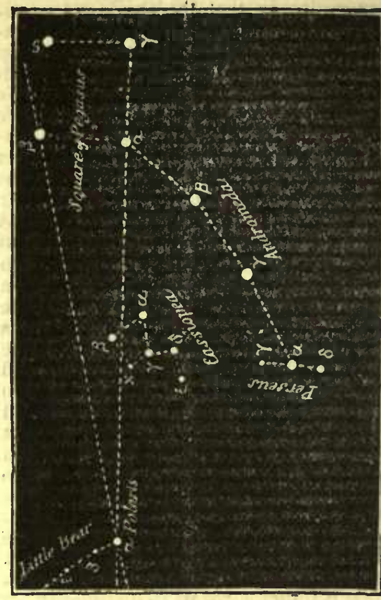

Fig. 16.—Cassiopea, Andromeda, Pegasus.

olden times the gift of captivating the attention of observers, and personating the stars of the north. Many poets have sung its praises; we will only repeat in prose one—the words being worthy of the majesty of the heavens—that of Ware, the American poet:

"With what grand and majestic steps this northern constellation advances in its eternal circle, following its royal path amidst the stars with a slow and silent light! Mighty creation, I worship thee! I love to see thee wandering in the brilliant avenues like a splendid giant with a strong belt—severe, indefatigable, and resolute, whose feet never pause on their road. Other kingdoms abandon their nocturnal path nnd rest their wearied orbs under the waves; but thou, thou never closest thy fiery eye, and never stoppest thy determined step. Forward, always forward! whilst systems change, suns set, worlds sleep and awaken, thou followest thy endless way. The adjacent horizon endeavors to arrest thee, but in vain. A vigilant sentinel, thou never quittest thy secular path, but, without allowing thyself to be overtaken by sleep, thou preservest the fixed lights of the universe, always preventing the north from forgetting its place.

"Seven stars people this bright kingdom; the sight embraces the whole; their respective distances are not inferior to their distance from the earth. And here again we see the tremendous distance between the celestial orbs. From the depths of the heavens, unexplored by the mind, the piercing rays dart through space, revealing to the senses numberless systems and worlds. Our sight must arm itself with the telescope, and explore the heavens. The heavens are opened, a rain of sparkling fire falls on our heads, stars appear close together, are condensed in such far-off regions that their rapid rays (more rapid than any other thing) have travelled for centuries in order to reach the earth. Earth, Sun, and nearest constellations, what are you amidst this infinite immensity and the multitude of divine infinite works?

These thoughts, inspired by scientific truth are superior to those of ancient mythology. Without speaking of the name of Bear, given to this constellation and the followins one, not only by the Greeks and Latins, but again by other people who did not appear to have had any communication with them, like the Iroquois, who gave to them the same name, we shall state that, generally, the Great and Little Bear were considered as Callisto and her Dog. Jupiter had a son by this nymph, the cow-herd (Boötes), of whom we shall speak farther on; he had them both placed in the sky. But the official wife of the king of gods, Madame Juno, as Virgil has said, was greatly incensed, and obtained from Thetis, the ruler of tne waves, that these perfidious constellations should never bathe in the ocean. Thus their continued presence above the horizon is explained. Callisto, whose car fears the wave of Thetis, near the ice of the north, shines out near her son. The Dragon embraces them like an immense wave. According to others, the two Bears are nymphs who fed Jupiter on Mount Ida; according to others again, they represented the oxen of Icarus; but these fabulous fancies do not interest us more than they ought to do, and now that we recognize the Great Bear we must make him useful in our celestial voyages among the stars in his neighborhood and our uranographic researches generally.

Let us return to the figure before traced. If a straight line be carried through the two stars, marked α and β, which form the extremity of the square, and prolonged beyond α to an extent equal to five times the distance from β to α, or, in other words, to an extent equal to the distance of α to the extremity of the tail η, a star less brilliant than the preceding ones is found, which forms the extremity of a figure like the Great Bear, but smaller and directed in a contrary direction. This is the Little Bear, or Little Chariot, also formed of seven stars. The star to which our line brings us, that which is at the extremity of the Bear's tail, or at the end of the shaft of the Chariot, is the Pole Star.

The Pole Star has a certain renown, like all personages who distinguish themselves from others, because, among all the stars which twinkle in our starry nights, it remains immovable in the heavens. At any moment of the year, day or night, if you observe the sky you will always find it occupying the same place. All the other stars, on the contrary, revolve round it every twenty-four hours, a hold for the centre of this immense whirlpool! The Pole Star remains immovable over one pole of the world, whence it is used as a fixed point by navigators of the pathless ocean, as well as by travellers in an unexplored desert.

Of the thousand facts which I could quote to show how many times the Pole Star, and its constellation, always visible in the north, have saved the lives of travellers lost in darkness, I shall content myself with the following, in which Albert Montemont honors the star of the north.

On the 4th of April, 1799, the English general, Baird, then at war against Tippoo Saib, received orders to march in the night, to observe a height on which it was supposed the enemy had placed an advanced post; Captain Lambton accompanied him as aide-de-camp. After having crossed this height several times, without meeting with any one, the general resolved to return to the camp, and he turned back, as it appeared to him, to the general quarters. But as the night was light and the constellation of the Great Bear was near the meridian, Captain Lambton remarked that, instead of returning south, as he must do to return to the camp, the division had advanced to the north, that is to say, toward the body of the enemy's army; and he instantly made the general aware of this mistake. But this officer, who troubled himself very little about astronomy, replied that he knew well enough what he was doing without consulting the stars. At the same instant the detachments fell in with the enemy's advanced post. This surprise having confirmed the captain's observation too well, they at first hastened to disperse the soldiers of the advanced post and then to turn back on their road. They procured a light, consulted a compass, and found, as the astronomical officer said laughingly, that the stars were right.

The immobility of the Polar Star at the north, and the movement of the entire heavens round it, are appearances caused by the movement of the Earth on its axis. We will give the evidence farther on; but, while we are visiting the country of the stars, we must not leave such a beautiful sight to descend to the Earth. Let us then continue our mode of surveying, and make ample acquaintance with the population of the starry heavens

II.

THE NORTHERN CONSTELLATIONS.

LOOKING at the Pole Star, stationary in the midst of the northern region, we have the south behind us, the east to the right, the west to the left. All the stars revolving round the Pole Star, from right to left, ought to be recognized according to their mutual relations rather than according to the cardinal points. On the other side of the Pole Star, relating to the Great Bear is another constellation easily recognized. If a line be brought to the pole, from the star in the middle (δ), by prolonging this line to an equal extent, the figure of Cassiopea is crossed, which is formed of five stars of the third magnitude arranged somewhat like the slanting strokes of the letter M. The little star κ, which ends the square, also gives it the form of a chair. This group takes every possible position, going round the pole; sometimes being above, sometimes below, sometimes to the left, and sometimes to the right: but it is always easy to find, seeing that, like the preceding constellation, it never sets and is always opposite to the Great Bear. The Pole Star is the axle around which these two constellations revolve.

If we now draw from the stars α and δ of the Great Bear, two lines joining the pole, and we prolong these lines beyond Cassiopea, they will lead to Pegasus, which is terminated on one side by a row of three stars similar to those of the Great Bear. These three stars belong to Andromeda, and themselves lead to another constellation, Perseus. The last star of the square of Pegasus is, as we have seen, α Andromedæ; the three others are called, γ, Algenib, α, Markab, and β, Scheat. To the north of β Andromedæ is found near a little star, ν, the oblong nebula which has been compared to the light of a candle seen through a horn plate, the first nebula of which mention is made in the annals of astronomy. In Perseus, α, the most brilliant star in the prolongation of the three principal stars of Andromeda, is seen between two others less brilliant, which with it forms a concave arc very easily distinguished. This arc will now serve us as a new starting-point. By continuing it from δ, a very brilliant star of the first magnitude . met with; this is the Capella. Forming a right angle with this prolongation to the south, we arrive at the Pleiades, a brilliant cluster of stars. On one side is a variable star, Algol, or the Head of Medusa.

The star Algol or β Persei, which is seen above α, belongs to a class of variable stars, the singular character of which we shall consider farther on. Instead of having a fixed light, as other stars, it is sometimes very brilliant and sometimes very faint; it passes from the second to the fourth magnitude. It was at the end of the seventeenth century that this variability was first perceived. Observations made since that time have proved that it is periodical and regular, and that this period is of astonishing rapidity. Thus, to pass from its minimum to its maximum brilliancy, it only requires one hour and three quarters, so that in three hours and a half it has accomplished its entire cycle, has passed through all the intermediate degrees of light from the fourth to the second magnitude, and from the second to the fourth. The star ζ of Perseus is double.

Fig. 17.—The Goat, Pleiades.

These are the principal stars which people the circumpolar regions, on the one side; presently we shall make better acquaintance with them. While we are tracing lines of indication, let us have patience and finish our short examination of this part of the sky. Take now the opposite side to the one we have just considered, still near the pole. Let us return to the Great Bear. Prolonging the curve of the tail we shall find at some distance from it a star of the first magnitude; this is Arcturus, or *α* of the Cow-herd (Boötes). A small circle of stars that we see to the left of Boötes forms the Northern Crown.

The constellation of Boötes is traced in a pentagonal form. The stars which compose it are of the third magnitude, with the exception of *α*, which is of the first. This is the one nearest the Earth, for it is of the small number of those whose distance has been measured. It is situated at 1,622,800 times the radius of the Earth's orbit from us. It is, moreover, a colored star; seen with a telescope, it is red. The star *ε*, which is seen above it, is double, that is to say, the telescope separates it into two distinct stars: one being yellow, the other blue.

By bringing a line from the Pole Star to Arcturus, and erecting a perpendicular on the middle of this line, opposite to the Great Bear, we find one of the most brilliant stars of the heavens, Vega, or *α* of the Lyre, near the Milky Way. It forms with the two just mentioned a large equilateral triangle. The line from Arcturus to Vega cuts the constellation of Hercules. Between the Great and Little Bear, a long series of little stars is seen passing round each other in rings and directing themselves toward Vega: these are the stars of the Dragon.

The stars bordering on the pole, and which have therefore received the name of Circumpolar Stars, are distributed into the groups we have just described. Now that we easily know how to find them in the sky, we may speak a little of their ancient renown. In this group there is one of the greatest dramas of ancient mythology. To repeat this famous episode in a few words, I will mention that Cassiopea, wife of Cepheus, King of Ethiopia, one day had the vanity to believe herself more beautiful than the Nereides, in spite of the African color of her complexion. These sensitive nymphs, piqued to the quick by such pretensions, prayed Neptune to avenge them of such a gigantic affront; the god allowed fearful ravages to be made by a sea-monster on the coasts of Syria. To stay the plague, Cepheus chained his daughter, Andromeda, to a rock and offered her in sacrifice to the terrible monster. But young Perseus, touched with so much misfortune, quickly bestrode the horse Pegasus, a model of coursers, took in his hand the Medusa's head, which froze the beholder with fright, and started for the fatal rock. He arrived naturally just at the moment when the monster was going to devour

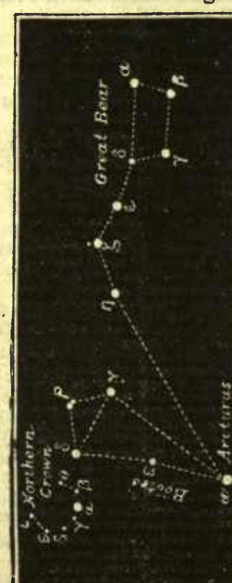

Fig. 18.—Northern Crown, Boötes, Arcturus

his prey, and nothing was more easily done than to petrify the monster by presenting Medusa's head to him, and to liberate the fainting Andromeda. This is a scenic effect from which painting has derived advantage in every sense; there are perhaps as many Andromedas as Ledas, and these are innumerable. It must be owned also that the painter has not often so captivating a subject.

In commemoration of these exploits, and not to give one an advantage over the other, all the family were placed in the heavens, and still remain there. With a little inclination, and knowing pretty well the conventional figures which divide our celestial atlas, we can see under the starry dome Cepheus enthroned, crown on head and sceptre in hand; at his side his wife Cassiopea, seated on a chair ornamented with palms; a little farther on Andromeda, chained to a rock in the midst of an abyss; an immense fish attacks her on one side; Pegasus flying in the air a little in front; and, lastly, the hero of the piece, Perseus, holding in the right hand a curved sword, and in the left the head with the hideous serpents. This is what the mythological eye may still contemplate at midnight during the beautiful season of summer.

Boötes is seen above the Virgin on the zodiacal map. He was called Arcas, and was the son of Jupiter and Callisto. He was also called Atlas, who carries the world, because, formerly, his head was close to the pole. As the Pleiades rise when Boötes sets, it has also been said that they were his daughters. In its vicinity shines like golden rain Berenice's Hair. It will be remembered that 246 years before Christ, Queen Berenice, who made a vow to cut off her hair if Ptolemy Euergetes, her husband, returned victorious, consecrated it to the gods in the temple of Venus, after the victory of the prince. Her husband was very displeased with this unlucky idea, and it was feared that he would not be able to calm his passion, the more so as the queen's hair was stolen the following night; but the astronomer Conon assured him that the regretted hair had been transported to the sky by order of Venus, and actually shone as a constellation.

The Hunting Dogs, or Greyhounds, are not distinguished by any remarkable star, but they possess the most beautiful nebula in the sky: that which I have before described and pictured (p. 6). It is situated in the left ear of Asterion, the northern Hunting Dog. As this left ear touches the tail of the Great Bear, it is easy to find it under the last star of the tail. To discern its form a good telescope is required. This is the nebula which resembles the Milky Way at a distance, and which was for some time considered as a globular cluster surrounded with a ring, until the day when Lord Rosse's great telescope showed it as the most magnificent spiral nebula in the heavens.

III.

THE ZODIAC.

It is known that the Sun in its apparent path above our heads follows a regular and permanent course; that each year, at the same periods, it passes at the same height in the sky, and that it is not so high in the month of December as in the month of June; the path it pursues is not less regular on that account, as it rises and falls in its circuit, and at the same periods it always returns to the same points in the heavens. It is also known that the stars remain perpetually around the Earth, and if they disappear in the morning, to shine again in the evening, it is only because the daylight effaces them. Now, the term *zodiac* is given to the starry zone through which the Sun passes during the entire course of the year. This word comes from ζώδιον, *animal*, an etymology taken from the character of the figures traced on this band of stars. Animals, indeed, predominate in these figures. The entire circumference of the heavens has been divided into twelve parts, which have been named the twelve signs of the zodiac, and our forefathers called them the "houses of the Sun," and again "the monthly residences of Apollo," because the Sun visits one each month, and returns each spring to the commencement of the zodiacal cortege. Two Latin verses give these twelve signs in the order in which the Sun crosses them:

"Sunt: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libraque, Scorpius, Arcitenens, Caper, Amphora, Pisces."

Or rather in English: the Ram ♈, the Bull ♉, the Twins ♊, the Crab ♋, the Lion ♑, the Virgin ♏, the Scales ♎, the Scorpion ♍, the Archer ♐, the He-goat ♄, Aquarius ♒, and the Fishes ♓. The signs placed by these names are the primitive indications which bring them to mind: ♈ represents the horns of a ram; ♉ the head of a bull; ♒ is a stream of water.

If we have now become acquainted with our northern heavens, if its most important stars are sufficiently marked in our mind and their reciprocal relations with each other, we need no longer fear confusion, and it will be easy to recognize the zodiacal constellations. We must note especially that they all belong to one zone, to one belt of the sky, which may serve us as a line of division between the north and south. An easy method of finding this zone in a fine starry night, and to avoid useless search, is to take the Pole Star as the centre of a large circle, and to describe this circle by taking a radius equal to the half of the sky. The line thus described will extend beyond the zenith to the south, and will descend below the horizon to the north; it will mark therefore the celestial equator. Now the ecliptic, on the meridian line of the zodiac, is slightly inclined to the equator, but it only goes beyond it a little, so that our circle will give us, with sufficient exactitude, the line toward which we must look for our constellations.

These summary indications once given, the first signs will be easy to find. To have a complete and lasting knowledge of them, it is necessary to follow the description I am going to give on the accompanying maps, and afterward in the evening to study the originals directly, of which the maps are only copies. These same maps will again serve us, in the following chapter, in studying the southern constellations visible in England.

The Ram is situated between Andromeda and the Pleiades, which we already know. By drawing a line from Andromeda to this group of stars, the head of the Ram is traversed, formed by two stars of the third magnitude, arranged in a north-east direction. The Ram is the first sign of the zodiac, because, at the time when this principal part of the celestial sphere was established, the Sun entered this sign at the spring equinox. In the fable, it represents the Ram with the golden fleece of the Argonaut expedition, because at the moment when the Sun rises in this sign, guarded by a monster (the Whale) and by a Bull which vomits flames, the constellation Ophiuchus or Jason, comes out in the evening at the same point, and thus subjugates the vanished Ram. The Ram was also the symbol of Spring and the opening of the year. These two causes were indicated by the translator of Plutarch. The Bull comes afterward. We go from west to east. We shall easily recognize it by the group of the Pleiades which sparkle on its shoulder, by that of the Hyades which glimmer on its forehead, and by the magnificent star which marks it right eye, the star Aldebaran, α, of the first magnitude. It is, moreover, situated just above the splendid constellation of Orion, which we shall meet again and make acquaintance with soon; Aldebaran shines along the line of the Belt to the north-west. (To follow our map.)

The Pleiades, which are seen trembling at the north-west of Aldebaran, are a group of about 80 stars, resolved by the telescope.

The ancients counted in the Pleiades seven stars more brilliant than the ground sprinkled with golden dust. At the present time only six can be counted with the naked eye, which are called, Alcyone or η in the neck of the Bull of the third magnitude; Electra and Atlas, of the fourth; Merope, Maïa, and Taygeta, of the fifth. If we are to believe

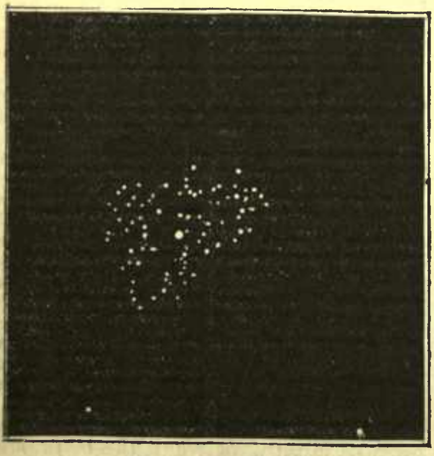

Fig. 19.—The Pleiades.

Ovid, the seventh hid itself with grief at the taking of Troy. But the author of the "Metamorphoses" suspected nothing of the distance of stars and the length of passage of the rays in reaching us. If even one of the Pleiades hid itself at the taking of Troy, Ovid would still have seen it in the place which it formerly occupied, and perhaps even now we should have still seen it there. The Hyades form a V with Aldebaran, which occupies the southern extremity. Like the Pleiades, they announce rain; their name signifies *to rain*, and that of their companions signifies *navigator*.

The Twins are easy to recognize to the east of the preceding stars, their heads being formed of two beautiful stars, Castor and Pollux. We shall also reach them by a diagonal, crossing the Great Bear. Again, Castor, of the first magnitude, forms a triangle with the Goat and Aldebaran. Therefore, nothing is more easily found. Descending toward the Bull, eight or ten stars terminate the constellation, and lower down, Procyon is met with, a star of the second magnitude. This region, marked with Orion, Sirius, the Twins, the Goat, Aldebaran, and the Pleiades, is the most magnificent region of the celestial sphere. It is toward the end of autumn that it shines in our hemisphere in the evening. The Twins are, in the fable, Castor and Pollux, sons of Jupiter, celebrated for their indissoluble friendship, for which they were rewarded by immortality. The Greeks also gave the name of Castor and Pollux to those lights which appear round vessels after storms, electrical phenomena now called the fires of Saint Elmo.

The Crab or Cancer may be distinguished at the bottom of the line of Castor and Pollux, in five stars of the fourth or fifth magnitude. It is the least important body of the zodiac.

The Lion is a large trapezium of four beautiful stars, situated to the east of the Twins. They may readily be found by continuing in the opposite direction the line, from α, β of the Great Bear, which served us to find the Pole Star. The most brilliant of these stars, α, is of the first magnitude and is called Regulus, the heart of the Lion; the three others, β, γ, and δ are of the second magnitude. The Sun enters the Lion at the summer solstice, and causes it to disappear by covering it with his fires; this is the victory of Hercules over the Lion of Nemea. It was also for the same cause the symbol of strength and power. Being the abode of the Sun during the month of July, it was again the sign of burning heats and of plagues which they sometimes brought with them. In the eyes of astrologers of the middle ages, this was its terrible aspect. The Virgin comes after the Lion, still to the east, as will be seen on the map. If we again use the very accommodating constellation which has until now been so useful to us, we must continue toward the south the great diagonal α, γ from the square of the Great Bear, and we shall meet with a beautiful star of the first magnitude placed just to the left of our figure; this is the Virgin's ear of corn, or Spica, a star known from all antiquity. Now that we can distinguish Arcturus, or Boötes, and α of the Lion, we may also remark that these two stars and Spica form together an equilateral triangle. The star β, situated in the right arm of the Virgin, is called the Vintager. It forms a triangle with β of the Lion and Berenice's Hair.

Emblem of justice and law, the Virgin represents Themis, with the scales at her feet. Why has she wings? Perhaps because Justice, formerly on the earth, abandoned it for heaven. She is also Astrea, daughter of Jupiter, and Themis, men's crimes having forced her to return to heaven at the end of the golden age. She has the privliege of representing a great number of persons; the entire list would be too long, the following being only a few of them: Ceres, symbol of harvests; Diana of Ephesus; Isis of Egypt, goddess of Syria; Atergatis or Fortune; Cybele drawn by lions; Minerva, mother of Bacchus; Medusa; Erigona, daughter of the Cow-herd; lastly, in the time of Virgil, she was the Sybil, who, with branch in hand, descended to the infernal regions. With so large a choice, she seems to have preferred the title of Daughter of Justice, exiled to the celestial regions by man's crimes.

The Scales is the seventh sign of the zodiac. To the east of Spica, two stars of the second magnitude are seen; these are α and β, marking the top of the Scales. With two other less brilliant stars, they form an oblique square on the ecliptic. Two thousand years ago, the Sun passed them at the autumnal equinox, and this is the origin of that sign which "equals the day to night, work to sleep."

The Scorpion, with its heart marked by the brilliant Antares, a star of the first magnitude, is easily recognized. It is not that the form can be distinguished; for this form is not better sketched out by the stars which compose it, than the preceding figures, the Scales, the Virgin, etc., have been. But it is well understood that, when we speak of recognizing a constellation, we refer simply to the groups of stars which bear its name, and not to its mythological figure. Antares, α of the Scorpion, is on the continuation of the line which would join Regulus (α of the Lion) to Spica; these are three stars of the first magnitude placed in a straight line, in a west-east direction. Antares also forms with Lyra and Arcturus a large isosceles triangle, the latter star being at the vertex. The second star of the Scorpion, β, of the second magnitude, marks the head. A string of stars of the third magnitude traces out the curved tail.

The Scales and Scorpion only formed one sign with the Latins before Augustus: the Scales were then the claws of the Scorpion. As Augustus was born on the 23d of September, flattery leagued itself with astrology to celebrate the happiness promised to the Earth by the birth of this emperor; the Scales, which the Egyptians had formerly instituted in the original sphere, were replaced in the heavens as a symbol of Justice.

The verses of the Eneid may now be easily interpreted. As a sign of misfortune and fear, the Scorpion was cursed among all the constellations. It was said, especially, that it had an invincible hatred toward Orion, because this figure sets when the former rises, and *vice versâ*. It was not only the terror of the stars, but also the terror of the Sun himself, that Ovid has described it to us.

Sagittarius (the Archer), forming an oblique trapezium, is a little to the east of Antares, still following the direction of the ecliptic. It only contains stars of the third and less magnitudes; α, δ, γ, form the arrow; the last, γ, is called Nushaba by the Arabs. The star π marks the head.

Capricornus (the He-goat) is not rich in bright stars. Those which sparkle on his forehead, α and β, are the only ones which can be distinguished by the naked eye. They are on the continuation of the line which passes from Lyra to the Eagle. The region of the Zodiac which we are now visiting is the poorest in the heavens; it presents a striking contrast with the opposite region, where we admired Aldebaran, Castor and Pollux, the Goat, etc.

Above Capricornus shines Altair, or α of the Eagle: the stars of Antinoüs form a trapezium on the path from Capricornus to the Eagle. In some authors this sign represents the goat Amalthea, which nursed Jupiter on Mount Ida, and received a place in heaven as a reward. According to others, it represents the return of the Sun to the winter solstice through the gates of the tropics. Again according to others, it was a he-goat which was brought up with the king of the gods, and which discovered and sounded the marine trumpet, and produced fear among the Titans in their war with Olympus. The frightened gods hid themselves in the forms of different animals; Apollo changed into a crane, Mercury into an ibis, Diana into a cat. Such a metamorphosis was never seen. Lastly, Pan into Capricornus, having a goat's body and the tail of a fish. He appeared, also, to wish to steal away with the giants who scaled heaven.

Aquarius forms with his three tertiary stars a very obtuse triangle. The base is prolonged in a string of stars from the side of Capricornus and toward the left to the Urn. Thence begins a sinuous line of very small stars descending to the horizon. This is the water poured out by Aquarius. Aquarius appears to personify Ganymede, who was raised by Jupiter's eagle to serve as cup-bearer to the gods after the fall of Hebe.

The Fishes, the last sign of the Zodiac, lie to the south of Andromeda and Pegasus. The northern fish is that which wished to devour Andromeda; the western fish advances in the square of Pegasus; they are bound together by a band. Not so apparent as the preceding, this constellation is composed of two rows of very small stars, which start from α of the third magnitude, the knot of the band, and diverge one toward α of Andromeda, the other toward α of Aquarius. Ovid tells how Venus and Love, wishing to steal away at the pursuit of the giants, crossed the Euphrates on two fishes, which were for this placed in heaven. It is related that two fishes having found an egg of a very beautiful shape, drew it to shore, that a dove sat on it, and Venus came forth. It was from this time that the Syrians abstained from feeding themselves on fish. This sign is the last abode of the Sun before the renewing of the year, in the month of February; this was the time of the inundation of Egypt and that of fishing with us. It closes the circle of the zodiacal constellations.

If our descriptions have been well followed on our map, the zodiacal constellations will be as well known as those of the north. Little now remains before we become familiar with the whole heavens, yet there is an indispensable complement to the preceding. The circumpolar stars are always visible above the London horizon; at any time of the year that we wish to observe them, they may always be found, either above, below, or on one side or the other of the Pole Star, which has served us to find them, and always preserving the same relation one with the other. The zodiacal stars do not resemble them in this point of view; for they are sometimes above the horizon and sometimes below it. We must, therefore, know at what time they are visible. For this it will be sufficient to remember the constellation which is at the centre of the heavens at nine o'clock in the evening, on the first day of every month, that, for instance, which at that hour crosses a line drawn from the Pole Star, from north to south, dividing the sky into two parts. This line is called the meridian, and all our figures cross it, passing from east to west. Marking each of the constellations which pass at the indicated hour, we thus give the centre of the visible constellations. Looking for the northern ones at the north; to its left those which precede the indicated constellation in the order of the signs; to its right those which follow it, all will be found without difficulty. On the first of January the Bull passes the meridian. Notice Aldebaran and the Pleiades. 1st of February: the Twins have not yet reached there; they are seen a little to the right. 1st of March: Castor and Pollux have passed, Procyon at the south; the little stars of the Crab to the right. 1st of April: the Lion, Regulus. 1st of May: β of the Lion, Berenice's Hair. 1st of June: Spica of the Virgin, Arcturus. 1st of July: the Scales, the Scorpion. 1st of August: Antares, Ophiuchus. 1st of September: Sagittarius, the Eagle. 1st of October: Capricornus, Aquarius. 1st of November: the Fishes, Algenib or ψ of Pegasus. 1st of December: the Ram.

Our general revision of the starry heavens ought now to be completed by the stars of the Southern sky.

I have only given a rapid summary of the mythological explanation of the signs of the Zodiac; the uncertainty which reigns over their origin has allowed many to be suggested. I shall only recount here, that which supposed them to be the twelve labors of Hercules, a suggestion which does not lack a certain ingenuity. Hercules would be no other than the Sun himself considered in his attributes relatively to the different times of the year. Francœur, in his *Uranographie*, according to Lalande and the philosopher Dupuis, charged himself with supporting this curious system.

The entrance of the Sun into the solstitial Lion which he made to disappear by covering it with his fires, is the victory over the Lion of Nemea. In proportion as the Sun advances he crosses Cancer, the Lion, and the Virgin; the different parts of the Hydra are eclipsed by turn; first the head, then the body, and lastly the tail; but then the head reappears in its heliacal rising. This is the triumph over the Hydra rising again from the Lake Lerna, which Hercules burned, after having crushed the Crab which aided it. The Sun crossing the Scales at the time of the vintages covers the Centaur with his fires. The fable states that the Centaur Chiron, having received Hercules, taught him the art of making wine. It adds that, in a drunken dispute, the people of the Centaurs wished to kill Hercules' host, which forced the hero to fight with them; this appears to relate to the setting of Sagittarius in the evening. Lastly, in hunting, he conquered a monster, called the wild boar of Erymanthus, which was believed to refer to the rising of the Great Bear in the evening.

Cassiopea, who is represented also by a hind, in the morning sets in the waves when the Sun is in Scorpion, which happens at the autumnal equinox; it is this hind with golden horns which, in spite of its wonderful velocity, Hercules tired out in a race, and caught at the water's edge when she reposed.

At the rising of the Sun in Sagittarius, the Eagle, Lyra (or the Vulture), and the Swan, situated in the Milky Way, disappear at once; these are the birds of the Lake Stymphalis, driven out of Arcadia by Hercules, whose arrow is placed among them. Capricornus, or the celestial He-goat, is bathed in front by the water of Aquarius; these are the stables of Augias cleansed by a river passing through them.

The Sun in Aquarius, or the winter solstice, was near Pegasus; in the evening the Vulture was seen to set, while the Bull passed the meridian; it was said that Hercules, on his arrival in Elis, to fight the Bull of Crete and the Vulture of Prometheus, mounted the horse Arion and instituted the Olympic Games, which are celebrated at full moon of the summer solstice; the moon is then exactly in Aquarius, that is to say, in the region opposite to the Lion. The carrying off of the mares of Diomedes, son of Aristes, relates to the heliacal rising of Pegasus and the Little Horse, the Sun being in the Fishes. These two Horses are placed above Aquarius, which is Aristes.

Hercules afterward starts for the conquest of the Golden Fleece, Aquarius and Serpentarius rise in the evening, while at the same time the Ram, Cassiopea, Andromeda, the Pleiades, and Pegasus set. Hence the victory of Hercules over Hippolyte, queen of the Amazons, whose belt (Mirach) shines with a bright light. Many of these warriors had the names of the Pleiades.

At the rising of the Bull, the Cow-herd (Boötes) sets, and the Great Bear (the oxen of Icarus) rises. This is the defeat of Geryon and the carrying off of his oxen. Hercules kills Busiris, persecutor of the Atlantides: the fable which alludes to Orion pursuing the Hyades, and who is then hidden in the solar beams. The return of spring is moreover explained by the destruction of the venomous reptiles of Crete and by the defeat of the brigand Cacus; that of the river Achelaüs, changed into a bull, relates to Eridanus, which is situated below.

After having founded Thebes in Egypt, Hercules went to the infernal regions, delivered Theseus and carried off Cerberus. The Sun has arrived in the northern hemisphere; the Great Dog, whose heliacal setting took place in the preceding sign, is now absorbed in the Sun's brightness; he is taken from the infernal regions, and brought to the light. The river of Aquarius, which rises in the evening with the Swan, when the Sun has traversed the constellation of the Twins, is Cycnus conquered at the borders of Penea.

The Northern Dragon and Cepheus, or the garden of Hesperides, rise at the setting of the Sun under Cancer; hence the voyage of Hercules in Hesperia. The time of the heliacal rising of the constellation of Hercules is in autumn; the apples of the Hesperides are an allusion to this season.

Returned to the summer solstice, the Sun recommences its revolution: this is the apotheosis of Hercules. Fable relates that Dejanira, seeking for a love-potion to keep her husband, sent him a shirt soaked in the blood of the Centaur Nessus. Hercules put it on to sacrifice to the gods, and to ask of them the immortality promised for his exploits; but, devoured by the poison in the garment, the hero burned himself on the funeral pile. This is the sense of this fable. The Sun has entered the Lion and rises, while the constellations Hercules and Aquarius are about to set. The Centaur sets a little after the Lion; this one then causes Hercules to die, and Aquarius, Ganymede, is carried off to pour out nectar to the gods, in the place of Hebe, given to the hero. The reconciliation of Hercules and Juno relates to Aquarius, who is dedicated to the goddess.

Hercules lived 52 years, had 52 wives, and accorded the Nemean honors to 360 of his companions who died for him: this alludes to the 52 weeks of the year and to the 360 degrees of the Zodiac. The Pillars of Hercules were the western limits of the known Earth, where the Sun seemed each day to set in the sea.

However vague many of the interpretations just put forth may seem to be, adds Francœur, there are some so remarkable that they cannot be supposed to be altogether the effect of chance: thus Hercules was not a hero whose good actions excited men to erect altars to him; but the Sun, considered in his attributes relative to the different epochs of the year; an opinion agreeing with the most revered testimonies of the ancients.

IV.

THE SOUTHERN CONSTELLATIONS.

"A TOUT seigneur tout honneur." Orion is the most beautiful constellation; we must not pass it without doing homage to it, and the best way of rendering homage to persons of worth is to learn how to understand them.

Let us observe our map: below the Bull and the Twins, to the south of the Zodiac, you will notice this giant who raises his club toward the forehead of the Bull. Seven bright stars are distinguished; two of them,

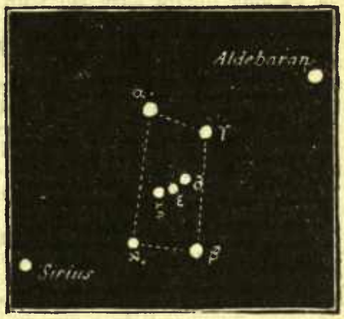

Fig. 20.—Orion, Aldebaran, Sirius.

α and β, are of the first magnitude; the other five are of the second; α and γ mark the shoulders, χ the right knee, β the left foot; δ, ϵ, ζ mark the belt; below this line is a luminous train of three stars close together, this is the Sword. Between the western shoulder, γ, and the Bull, is seen the Shield composed of a curved string of little stars. The head is marked by a little star, λ of the fourth magnitude; μ and ν denote the raised arm.

For more clearness, we give the arrangement of the principal stars of this magnificent asterism.

Orion is on the continuation of the line which joins the Pole Star to Capella. The four stars, α, γ, β, κ, occupy the angles of a great quadrilateral; the three others δ, ϵ, ζ, are close together in an oblique line in the middle of this quadrilateral; α, in the north-east angle, is called Betelgeuse (not Beteigeuse, as generally printed), β, of the south-west angle, is called Rigel.

The line of the Belt, prolonged on both sides, passes on the north-west by the star Aldebaran in the eye of the Bull, which we already know, and on the south-east by Sirius, the most beautiful star in the heavens, with which we shall soon occupy ourselves. It is during fine winter nights that this constellation shines over our heads. No other season is so magnificently constellated as the winter months. While nature deprives us of certain enjoyments on the one hand, it presents us with others no less precious. The wonders of the heavens present themselves to amateurs from the Bull and Orion at the east as far as the Virgin and Boötes at the west; of eighteen stars of the first magnitude, which may be counted in the whole extent of the firmament, a dozen are visible at nine o'clock in the evening, not counting many beautiful stars of the second order and the remarkable nebulæ and heavenly objects very worthy of the attention of mortals. These twelve stars are: Sirius, Procyon, Capella, Aldebaran, Spica, the heart of the Hydra, Rigel, Betelgeuse, Castor and Pollux, Regulus, and β of the Lion.

Thus it is that nature establishes everywhere harmonious compensation, and while it darkens our short and frosty winter days, it gives us long nights enriched with the wealthiest creations of the heavens.

The constellation of Orion is not only the richest in bright stars, but it conceals also treasures for the initiated which no other can present. We might almost call it the California of the heavens. We will enumerate its riches, and shall then find greater delight in contemplating it in the heavens.

Let us speak first of its nebula, situated below the second star of the Belt. The first time that Huygens, its discoverer, admired this cosmical beauty, in 1656, he was sufficiently astonished to say, that it seemed an opening in the sky which threw light on a more brilliant region. "Astronomers," he states, "have counted in the sword of Orion three stars very near each other. In 1656, I accidentally observed that, in place of one of these stars which occupy the centre of the group, there was a dozen of them, a result which is not rare to obtain with telescopes. Of these stars there were three which, like the first, nearly touched each other, and four others seemed to shine through a cloud in such a manner that the space which surrounded them appeared much more luminous than the rest."

Since that period this nebula has been studied with a kind of predilection; it has been minutely examined and the different regions of its cluster have been studied and described in all their details. In proportion as the instruments have become more powerful, the stars, which constellate it, appear more numerous, which has happened in all telescopic observations of nebulæ; and, while in early days it was asked with great uncertainty if there was only a phosphorescent cloud, a vaporous mass—astronomers afterward arrived at the conviction that it was formed of an immense number of heaped-up suns, and then again that it was a true cosmical cloud. At the centre is seen a brighter part of singular form; Sir J. Herschel compared it to the head of a monstrous animal, with gaping mouth, the nose being prolonged like the trunk of an elephant.

It occupies a large space in the sky, its apparent dimension being equal to that of the lunar disk. When we think of the distance which separates us from this agglomeration, we are dismayed at the real extent which it embraces in the midst of the boundless void.

But the strangest phenomena which are attached to this nebula are the changes which are observed in it. The drawings which are now taken differ from those which were taken half a century ago. Again this year (1867), there has been noticed in England an indication of brightness, through a dark portion, which did not exist ten years ago. Astronomers agree that there is no possible delusion in some of these observations, and that this distant agglomeration is the seat of formidable disturbances.

"The general impression that I have received from these observations," said the director of the Russian Observatory not long ago, "is that the central part of the nebula is in a state of continual agitation, like the surface of the sea."

Orion possesses many other riches. The star of the left foot, Rigel, is one of the most beautiful double stars. (We shall soon commence this chapter of Sidereal Astronomy.) This double star is composed of a white and a blue sun. In calm and clear nights which we sometimes have in the winter, it appeared to me sometimes that the reflection of the blue star tinted the brightness of the white sufficiently to cause this to seem slightly tinted with blue, especially when it is compared with the golden points which sprinkle the surrounding sky.

Two other binary systems are met with in the two stars at the extremities of the Belt. The first to the right is composed of a white and a purple sun; the second, of a yellow and a blue sun. Thus here are three systems of the most dissimilar worlds united in the same constellation. In each of these systems two suns instead of one; not only two suns like ours, but two differently colored suns; in the planets which belong to the first, a white and a blue body dispute the empire of the day with each other, giving rise, by the numberless combinations of their heat, light, and electrical power, to a variety of actions incomparable and unimaginable by us, who are devoted to one sun. In the planets which belong to the second, it is a purple sun which diversifies the white light of its compeer. In that of the third the number of colors is essentially different from ours, as there is no white light the generator of every tint: and presents an unknown series of shades the result of the combinations of gold and sapphire. These planets are doubtless green, and the color of the objects on their surface must probably oscillate round this medium either as yellow or blue.

But this wealth of stellar systems does not yet constitute all the patrimony of this beautiful constellation of Orion. It contains, besides, the most complex of multiple systems which have ever been met with in the heavens. In the nebula of which I have just spoken an extraordinary star is met with, the star marked θ in the catalogues, a little below the Sword. This star, divided by the telescope, presents to our admiration six suns collected in one point of the heavens. Four principal stars of the fourth, sixth, and seventh magnitudes are arranged at the four angles of a trapezium ; the two stars at the base have each a very feeble companion. That these six stars form in reality a physical system, and that they are connected together, like the binary systems, by the law of attraction, is a statement I do not wish to affirm. It may be that this is only an optical effect—that these six stars are in reality completely independent of each other, situated at immense distances and depths, but, being on the line of sight very near together, they appear to us collected on one plane. Nevertheless, there are probabilities in favor of the opinion which considers this sextuple star as an actual system, especially when we see that the movement belonging to the principal star is shared by the five others.

Another star in Orion, the twenty-third, is equally remarkable, being double, and instead of having its principal white and its small one blue, as in the generality of cases, it is the contrary that is noticed.

This is a great deal for one constellation ; but for this beautiful and ancient figure, about which Job sang three thousand years ago, I have a sympathy for which I cannot and will not defend myself. Between the Pleiades and the beautiful Sirius, it presents to me a magnificent celestial region, enriched with varied worlds, which makes one dream of distant life. Between ourselves, I read an astrological treatise of the middle ages ; its title was "Flamma Orionis." Since that time this name is dear to me : I love it ! Now, you know what happiness it is to lovers to speak continually of the object of their devotions. Following its course, like the Sun, and the planets, and zodiacal constellations, the moon sometimes passes near Orion. It then hides the stars over which its path conducts it.

In the fable, Orion, the handsomest man of his time, was of such high stature that, when he walked on the bottom of the sea, his head exceeded the height of the waves ; which means that this constellation is half beneath the equator and half above.

I have forgotten to add, that the three oblique stars which form his belt have been named the Three Magi Kings, Jacob's staff, and that in France we simply distinguish them under the name of the Rake.

To the south-east of Orion, on the line of the Three Kings, shines the most magnificent of all stars, Sirius, or a of the constellation of the Great Dog. This star of the first magnitude marks the upper eastern angle of a great quadrilateral, whose base reaches the London horizon, and is adjacent to a triangle. The stars of the quadrilateral and the triangle are all of the second magnitude. This constellation rises in the evening, at the end of November, passes the meridian at the end of January, and sets at the end of March.

Sirius being the most brilliant star of the heavens, and astronomers daring to attempt operations relative to the study of the distances of stars, this attracted their attention. After long and minute study, they succeeded in determining its distance ; 1,375,000 times the distance of the Sun. To traverse the distance from the Earth to this star, light takes nearly twenty-two years. Hence, it follows that, when we see it, it is not the Sirius of to-day which is before our eyes, but rather the Sirius of twenty-two years ago ; the ray of light which reaches our eye now left Sirius during the year 1848.

The name we now give to a of the Great Dog formerly belonged to the whole constellation, and not a single Egyptian monument is found where this figure is indicated without its representing Sirius, a name derived from Osiris, the Sun. At the time the constellation was formed, the summer solstice happened when the Sun crossed Capricornus ; the rising of Sirius announced to Egypt the time of the overflowing of the Nile, and like a faithful dog warned men to be on their guard. The *rôle* of Sirius did not stop here. The civil year of the Egyptians being exactly 365 days, and their kings swearing never to allow the intercalation of supplementary days, this year advanced a day every four years on the solar year, and again coincided with it at the end of 365 times four years—in 1460 years ; but during this time the civil periods, agricultural labors, fêtes, and the different parts of the calendar, could not be fixed by unchangeable dates. They therefore chose a sign in the heavens which announced the period of the solstice ; the rising of Sirius in the morning, which was then called Sothis, announced the desired epoch. The heliacal (solar) rising of this star only happened on the same day after 1461 years.

Since those ancient days, a movement of the Earth which slowly modifies the path of the Sun among the constellations, which is called "the precession of the equinoxes," has deprived Sirius of its faculty of predicting the inundation and the solstice ; its heliacal rising happens in Egypt now on the 10th of August instead of the 20th of June. But at the beginning of our era, it took place in July, in the midst of the great heats and the diseases they engender. Hence, this constellation was accused of a malignant influence, as may be seen in Sophocles and a hundred other more modern authors ; it gives fever to men and madness to dogs. The term dog days is derived from this. In order to conciliate Sirius, they raised altars on which were sacrificed the quail and the goat. They dreaded the star of the south.

Sirius, or the Dog-star, was also called the Dog of Procris, wife of Cephalus, who pierced her with an arrow shot accidentally, as Ovid relates at great length.

Sirius has a long and good reputation as a dog. After all the services which he had rendered to the Egyptians, Jupiter charged him with the care of his dear Europa; after the carrying off, he passed through the hands of Minos, Procris, Cephalus, and Aurora. Well-known authors even think that, in spite of all that precedes, he was Cerberus, the dog with three heads; their opinion is supported by this coincidence, that the Great Dog guards at the equator the lower hemisphere of the Egyptians, in the same manner as Cerberus watched the region of Tartarus. It is seen that this dog claims a very ancient nobility. No heraldic title can boast of such antiquity.

The Little Dog, or Procyon, which we have already seen on our zodiacal maps, is above Sirius and below the twins, Castor and Pollux, to the east of Orion. No bright star distinguishes it, unless it be α. From a mythological point of view, it shares with the Great Dog most of the fables attributed to the latter.

The Hydra is a long constellation which occupies that quarter of the horizon under the Crab, Lion, and Virgin. The head, formed by four stars of the fourth magnitude, is to the left of Procyon, on a line drawn by this star and Betelgeuse. The western side of the great trapezium of the Lion, like the line joining Castor and Pollux, is directed to α, of the second magnitude: it is the heart of the Hydra. On the back of the Hydra, stars of the second order may be noticed, the Raven and the Cup. Being like a river in its meanderings, the Hydra has been regarded as an inhabitant of the Nile and its representative. As the ship Argo is not far from here, some have even gone so far as to explain by certain aspects the deluge of Deucalion, who escapes in a vessel, and who, forty days after, makes certain that the waters have retired by sending forth a raven.

Eridanus, the Whale, the Southern Fish, and the Centaur are the only important constellations we still have to describe. They will be found in the order indicated, to the right of Orion. Eridanus is a river composed of a series of stars of the third and fourth magnitude, which descends and winds from Orion's left foot to Rigel, being lost under the horizon. After having followed long windings, invisible to us, it is terminated by a beautiful star of the first magnitude, α or Achernar. This was the river into which Phaëton, who awkwardly conducted the car of the Sun, fell: it was placed in heaven to console Apollo for the loss of his son.

Below the Ram, a star of the second magnitude is met with, which forms an equilateral triangle with the Ram and the Pleiades: this is α, or the jawbone of the Whale; α, μ, ξ and γ form a parallelogram—this is the head. The base, α, γ, is prolonged to a star of the third magnitude, δ, and to a star of the Neck marked o. This star is one of the most curious in the heavens; it is called the Marvellous, Miro Ceti. It belongs to the class of variable stars. Sometimes it equals in brightness stars of the first order, at others it becomes completely invisible. Its variations have been watched since the end of the sixteenth century, and it has been noticed that the period of increase and decrease is in the mean 331 days, but always irregular, being sometimes 25 days behind or 25 days in advance. The study of these variable stars will present curious phenomena to us.

The Whale was sent by Neptune to devour Andromeda. I shall not return to the history of this poor princess.

Four stars of the third magnitude form the tail of this cetacean and descend toward Fomalhaut, or α of the Southern Fish, which receives water from Aquarius. This asterism rises very little above the horizon of London.

Lastly, the constellation of the Centaur is situated below Spica of the Virgin. The star θ, of the second magnitude, and the star ι, of the third, mark the head and shoulder: this is the only part of the figure which rises above the horizon of London. The Centaur contains the star nearest to the Earth, α, of the first magnitude. It is also in this constellation that the beautiful regular nebula is found, which we have already admired, the globular cluster Omega of the Centaur. The feet of the latter touch the Southern Cross, formed of four stars of the second magnitude, always hidden below our horizon. A little farther south is the south pole.

V.

THE NUMBER OF THE STARS—THEIR DISTANCES.

In order that the mind may be less confused in the midst of these thousands of sparkling points it has been agreed from the highest antiquity to class the stars according to their apparent brightness, besides the divisions we have just mentioned. We have seen that the brightest stars have been called stars of the first order or magnitude, although this term does not imply anything relative to the actual size or brightness of the stars; those which follow, still in the order of their apparent brightness, have been called stars of the second magnitude; then come those of the third, fourth, and fifth magnitude, according as they appear smaller; lastly, stars of the sixth magnitude are the last stars visible to the naked eye.

The stars of the first magnitude are eighteen in number. In reality, the eighteenth, that is to say, the least brilliant of the series, might as well be inscribed in the first rank of the stars of the second magnitude, and the first of this second series might, in the same way, be added to the stars of the first magnitude. There is nothing in the nature of these separations which necessitates our classification; but as we must stop at one star, and a series is to be made, it has been agreed to make the list of stars of the first magnitude as follows:

List of Stars of the First Magnitude in the order of their decreasing brightness.

1. Sirius, or α of the Great Dog.
2. η of Argo (variable star).
3. Canopus, or α of the Vessel.
4. α of the Centaur.
5. Arcturus, or α of the Cowherd (Boötes).
6. Rigel, or β of Orion.
7. Papella, or α of Auriga.
8. Vega, or α of Lyra.
9. Procyon, or α of the Little Dog.
10. Betelgense, or α of Orion.
11. Achernar, or α of Eridan.
12. Aldebaran, or α of the Bull.
13. β of the Centaur.
14. α of the Cross.
15. Antares, or α of the Scorpion.
16. Atair, or α of the Eagle.
17. Spica, or α of the Virgin.
18. Fomalhaut, or α of the Southern Fish.

It is generally thought that the brightest are the nearest, and that the stars appear to us smaller the more distant they are from us. Hence it follows that the number of the stars must increase in the inverse ratio of each magnitude: that the stars which form the second series, for instance, being on a more distant, and consequently larger, visual circle than that of the first series, are more numerous: that the third series is richer than the second, and so on. This is precisely what is observed. The stars of the second magnitude number about 55; of the third, 170; of the fourth, 500, etc. The following is, indeed, an easy method of knowing approximately the number of stars of each order. It has been remarked that each class is generally three times more numerous than that which precedes it; so that by multiplying the number of stars which compose any series by three, we have nearly the number of those which compose the following series. By this calculation the number of the stars of the six first magnitudes—in other words, that of the whole of the stars visible to the naked eye—would give a total of about 6000. Generally it is thought that more may be seen; we think we can count them by myriads, by millions: in this as in everything else, we are always given to exaggeration! Yet, in fact, the number of stars visible to the naked eye, in both hemispheres, does not exceed this figure, and even then there are few eyes good enough to see more than 4000 or 5000.

But here, when our feeble sight gives way, the telescope, that giant eye which increases from century to century, piercing the depths of the heavens, constantly discovers new stars. After the sixth magnitude, the first glasses revealed the seventh. Then they reached the eighth, the ninth. It is thus that thousands have increased to tens of thousands, and that tens of thousands have become hundreds of thousands. More perfect instruments have cleared these distances, and have found stars of the tenth and eleventh magnitudes. From this period they began to count by millions. The number of the stars of the twelfth magnitude is 9,556,000; added to the eleven preceding magnitudes, the total exceeds fourteen millions. By the aid of still greater magnifying power, these limits are again surpassed. At the present time, the total number of stars, from the first to the thirteenth magnitude, inclusive, is calculated at 43,000,000. The sky is truly transformed. In the field of the telescope, neither constellations nor divisions are distinguished; but a fine dust shines in the place where the eye, left to its own power, only sees darkness on which stand out two or three stars. In proportion as the wonderful discoveries in optics will increase the visual power, all regions of the sky will be covered with this fine golden sand; and a day will come when the astonished eye, raised toward these unknown depths, will be startled by the accumulation of stars which succeed each other in an endless manner, and will only discover a delicate tissue of light.

What is the extent occupied by these myriads of stars which succeed each other eternally in space? This question has always attracted the attention of astronomers as well as that of simple thinkers; but they were not able to commence any researches relative to its solution until lately, when delicate means have become accessible to us.

The ancients did not form the slightest idea of the distance or nature of the heavenly bodies: they were thought to be emanations from the Earth, rising like the *ignes fatui* over marshy places. This would be a long and curious story, and, like that of all primitive ideas, but little in harmony with the grandeur of creation. To possess the power of measuring the distance of the nearest star, it is necessary to measure the thickness of a hair. A long time elapsed before this was accomplished. I shall give at the end of this chapter an idea of the method employed, in order to succeed in these exact determinations; we will first satisfy our curiosity, and learn at what distance the nearest stars are from us.

The nearest star is in the southern constellation of the Centaur; it is the star a. According to the most recent researches, it is distant from us 211,300 times the distance from here to the Sun. A few years ago, it was believed to be farther, but more exact determinations have definitely established that it is not beyond the distance just mentioned.

It is very difficult, if not impossible, to figure to one's self such distances, and to comprehend them, it is necessary for our mind to associate with the idea of space the idea of time; to travel in some way along this line, and to estimate its length by time. For small distances, we do the same on the Earth. If, for example, it is said that it is 310 miles from Paris to Strasburg, we with difficulty figure this distance at first sight; but by associating the idea of the time necessary to pass through it with a given velocity, by learning that an express train going at

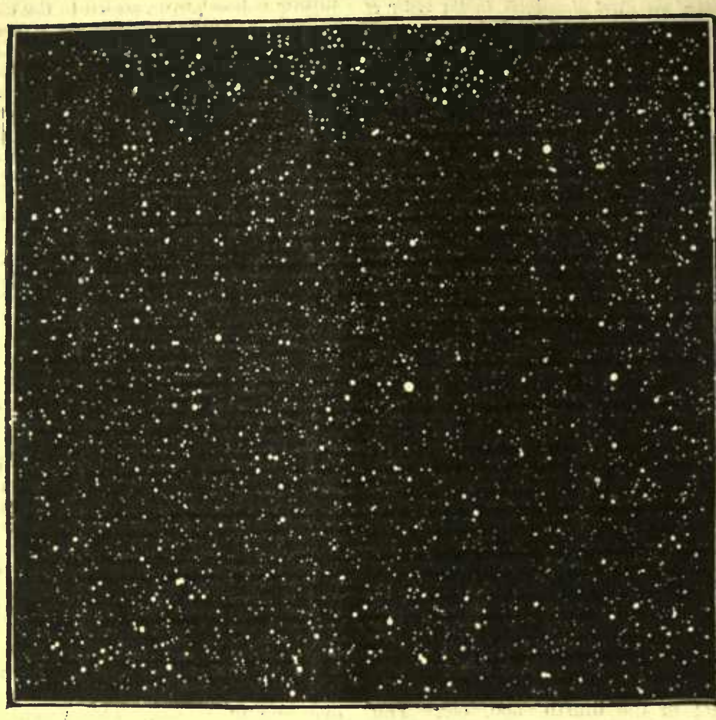

Fig. 21.—A part of the constellation of the Swan, as seen through the telescope.

the rate of 44 miles per hour, arrives there in seven hours, we represent to ourselves the road traversed. This method, useful for terrestrial distances, is necessary for celestial ones: we shall also measure space by time; only, instead of the velocity of a train, we shall take that of light, which travels at the rate of 186,000 miles per second.

Well, to traverse the distance which separates us from our neighbor *α* of the Centaur, our courier takes three years and eight months. If the mind wishes to follow it, it must not jump with the twinkling of an eye from the departure to the arrival, otherwise it would no longer have the slightest idea of the distance; it is necessary to represent to itself the direct path of the luminous ray, and not associate itself with this path, which it must imagine to travel 186,000 miles during the first second of route, dating from its departure; then 186,000 miles for the second second, which makes 372,000 miles; then again 186,000 miles during the third, and so on without stopping for three years and eight months.

If we give ourselves this trouble, it will enable us to understand the enormous value of the number; otherwise, as it exceeds every number which the mind is accustomed to use, it will not have any meaning and will remain uncomprehended.

Our nearest star is *α* of the Centaur. The one whose distance places it immediately after is a star situated in another region of the sky, in the constellation of the Swan. This is our second nearest; which does not prevent it being nearly three times more distant from us than the first. The distances of ten stars have been calculated. The following are the nearest: The first column of numbers represents the number of radii of the terrestrial orbit (distance from the Earth to the Sun) which must be laid out in line, one from the other, to reach the star; the second column indicates the number of years light takes to traverse the distance:

α of the Centaur	211,330	3 years 8 months
α of the Swan	550,920	9½ years.
Vega, α of Lyra	1,330.700	21 "
Sirius, α of the Great Dog	1,375,000	22 "
α of the Great Bear ..	1,550,800	25 "
Arcturus, α of Boötes..	1,622,800	26 "
Pole Star	3,078,600	50 "
The Goat, α of Auriga.	4,484,000	72 "

These are the nearest stars. Most of the stars whose distances have been calculated are some of the brightest in the heavens, and are among those of the first and second magnitude. It may be asked if it be possible, by comparison, to determine the probable distance of the regions where the least magnitudes shine. This is a curious question, which Arago tried to solve and on which he reasoned as follows:

We take, for instance, from the foregoing list a mean star of the first magnitude, not Sirius, which exceeds all the others by its brilliancy, but Arcturus or Vega; we ask ourselves to what distance must this star be transported in order that it may diminish in apparent brightness to the fourth magnitude, and we see that it is necessary to transport it to a distance four times greater than its present distance; by withdrawing it to eight times the original distance, it would become from the fifth to the sixth order: in the mean, a star of the first magnitude, transported to twelve times its actual distance, would still be visible to the naked eye, and its light would not fall below the sixth magnitude.

William Herschel tried to extend the scale of visibility which he had formed for the naked eye to telescopic observations. He prepared a series of telescopes of gradually increasing power, and for the subject of his observations he took the nebula of Perseus. There the eye could not distinguish any star. If there were any, they were necessarily more feeble than the stars of the first magnitude would be, transported to twelve times their actual distance; the small instrument showed a great number. Let us admit that, in this great number, there are, which is probable, as bright stars as Arcturus, Vega, etc., these stars, in order to become just visible after their intensity was quadrupled, must be twice as far as the last stars visible to the naked eye, that is to say, twenty-four times farther than Arcturus, Vega, etc.

The second instrument, which increased the light in the proportion of nine to one, and brought the objects three times nearer, discovered stars the traces of which were not to be found in the first; the intensities of the stars were such as Arcturus, Vega, etc., would become at thirty-six times their distance.

By coming gradually to the telescope of nine feet focal length, the observer perceived stars of intensity similar to what the stars of the first magnitude would appear at 344 times the distance which now separates them from us.

The eighteen-foot telescope extended its power to 900 times the distance of the stars of the first magnitude; and it was evident that a more powerful telescope would have showed stars still more distant. To escape the numerical consequences that I am going to deduce from Herschel's results, it must be supposed that, among the immense number of stars that each telescope of smaller power

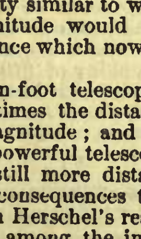

Fig. 22.—The same seen with the naked eye.

discovers, there does not exist one as brilliant as Arcturus or Vega of Lyra; in a word, it must be admitted that stars of the first magnitude only lie near our solar system. Such a supposition does not certainly deserve refutation.

There is no star of the first magnitude whose light reaches us in less than three years.

According to that, adds Arago, in conclusion, the light of the stars of different orders, in reality as large as Arcturus, Vega in Lyra, etc., arrives from such distances from the Earth that light could not pass through them—

For stars of the second magnitude in less than	6	years
" fourth magnitude . . .	12	"
" sixth magnitude . . .	36	"
For the last stars visible with the nine-foot telescope	1042	"
For the last stars visible with the eighteen-foot telescope	2700	"

The luminous rays which reach us from the stars relate to us then, if we may so express it, the ancient history of these bodies. But by what power did man arrive at the knowledge of the distances of the nearest stars? In astronomy there are facts which surprise us by their grandeur, and which exceed the sphere of the habitual conceptions of man of such a way that one is tempted to question them with doubt in spite of the affirmation of astronomers, and even to banish them to the rank of the deceitful pretensions with which science is sometimes surrounded, to impose on the vulgar. Of this number are the principal conquests of stellar astronomy, and particularly the determinations relative to the distance of the stars.

I shall endeavor to give an idea of the method which is employed to determine these distances, and by this explanation to remove the unfavorable idea still entertained by many of these perfectly established facts of modern astronomy.

A few instants' reflection will suffice to show, that if the Earth moves in space, during its annual course round the Sun, there must follow an apparent displacement of the other bodies in the sky. No one has looked from the window of a railway-carriage without seeing that the trees, houses, hills, and other objects which sprinkle the country, appear to move in an opposite direction to the path of the train, and that the nearest objects are those which appear to undergo the greatest displacement, while the most distant move more slowly, as far as the horizon, which remains nearly immovable. It must then follow from the movement of the Earth in space, that the stars, situated in the region of the heavens which the Earth leaves behind at a certain time of the year, will appear nearer together, while the stars which the Earth approaches will appear to get farther apart. This effect will be necessarily less as the distances of the stars become greater. If it were possible to measure the displacement undergone by a star in consequence of the movement of the Earth, we should have the distance of this star. For let the ellipse in Fig. 23 be the curve followed by the Earth in its annual path round the Sun, and let S be the Sun, T S T′ a diameter of the terrestrial orbit, and T and T′ the position of the Earth at the two extremities of this diameter, that is to say, at six months' interval (as the Earth makes

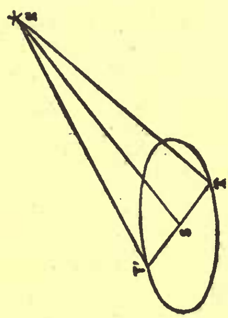

Fig. 23.—Measure of celestial distances.

the entire passage in a year); lastly, let E be the star whose distance is to be measured.

When the Earth is situated at the point T, the angle S T E is measured, formed by the Sun, the Earth, and the star; when the Earth is at T′, the angle S T′ E is measured. It is known that in every triangle the total of the three angles is equal to two right angles, that is, to 180°; therefore, if the total of the two observed angles, S T E and S T′ E, is found, and this total is deducted from 180°, the value of the angle at E will be obtained, the angle subtended at the star by the diameter of the terrestrial orbit. And this value will be as exact as if we could have been transported to the star to measure it directly. The half of this angle, that is, the angle S E T, is what is called "the annual parallax" of the star E. Thus the annual parallax of a star is the angle under which an observer placed on the star would see the radius of the terrestrial orbit

By always taking corresponding observations at two diametrically opposite points of the Earth's orbit in the course of the year, a great number of measures of the annual parallax will be obtained in this manner. In our example, and in our figure, the star is situated near the pole of the ecliptic; the operation is the same, although rather more simple for the other positions of the heavens. In practice, the measures of the angles S T E, S T′ E, are obtained, in an exact way, by comparing the successive positions of the star observed with that of a relatively fixed star which has no parallax. The great majority of stars are among the latter. Astronomical resaerches have proved that there is not a single star with its parallax equal to 1″. They are all below it. To form an idea of this value, it must be understood that, the circumference of astronomical circles used in observation is divided into 360 parts, called degrees, each degree into 60 minutes, each minute into 60 seconds. This value of a second is so small that a spider's thread, placed in the field of view of the telescope, entirely hides the portion of the celestial sphere where the apparent movements of the stars are effected, a portion at most equal to 1″.

The star which these observations have proved to be the nearest, is the star α of the Centaur; its parallax is equal to 97 hundredths of a second (0′·97). From the star α of the Centaur, the radius of the terrestrial orbit is then reduced to 0″·97. Now, in order that the length of any straight line seen be reduced as to appear only under the small angle of 1 second, it is necessary that this line be at a distance of 206,000 times its length, and in order to reduce it to 0″·97 it must be still farther removed to 211,330 times its length. These are mathematical data. Therefore the distance from us of the star α of the Centaur is 211,330 times the radius of the terrestrial orbit, that is to say, 211,330 times 91 millions of miles.

This is the nearest star. Light travels for three years and eight months to come from it to the Earth. The other near stars succeed each other, as we have seen, at greater distances.

From the preceding it will be seen that these results, however prodigious they may appear at first sight, are due to mathematical methods of great simplicity. All the difficulty in this sort of determination consists in the extremely minute, long, and laborious observation of the slight displacement of the star in the heavens.

All these stars, vast as our Sun, separated from each other by such distances, succeeding each other in an endless manner in the immensity of space, are in motion in the heavens. Nothing is stationary in the universe: there is not a single atom of matter in absolute repose. The formidable forces with which matter is animated universally regulate its action. These movements of the suns of space are imperceptible to our eyes, because they are performed at too great a distance; but they are more rapid than any velocity we can observe on the Earth; there are some stars which are carried away in space with a rapidity of fifty miles per second. To the eye which knew how to make abstraction of time as of space, the sky would be a moving swarm of stars.

VI.

VARIABLE STARS—TEMPORARY STARS—STARS SUDDENLY VISIBLE OR INVISIBLE.

Of all the wonders which the telescope has revealed in the fields of space, not one has perhaps more right to the astonishment of mortals than the existence of changing stars, periodically variable, whose light and color undergo a periodicity of brightness; at least, observers have not been more surprised at any telescopic revelation. Stars which, far from remaining fixed in an unchangeable light, see their brightness periodically die away and again revive!—stars shining to-day with a splendid light will be invisible to-morrow, and after to-morrow again revived! The most daring imagination could scarcely invent such creatures; and now even, when their existence has been well proved, the mind can scarcely accustom itself to realize it.

These are stars whose light undergoes a periodical variation, bringing it by turns to its maximum and its minimum intensity. To figure to ourselves well in what this singular change consists, let us call to mind our Sun, and let us suppose it subjected to these variations. To-day it radiates the most transcendent flames, and pours down into the heated atmosphere floods of dazzling light; for some days it preserves this same intensity; but behold, the sky remaining clear as formerly, the light of the Sun gradually dies away from day to day: at the end of a week it has lost half its light; at the end of fifteen days it can be looked at steadfastly, and then it still fades, becomes pale and dull, only sending a wan light to the Earth.

But it revives, and with it hope. The first progress in its extinguished light is noticed; it becomes whiter and more brilliant. The torch is relighted and increases from day to day; a week after its minimum intensity it already sends forth a light and heat which bring to mind the solar focus. Its increase continues. And when a period equal to that of its decline has passed, the dazzling Sun will have regained all its power and grandeur. The Earth is inundated with the rays of its brilliant light and its fertilizing heat. But it does not enjoy this splendor long, for already the Sun recommences its decreasing curve. And so on, continually. The nature of this new Sun is periodical, while the virtue of our preceding one was to preserve a permanent light and heat.

It may be imagined that these variations of light astonish the observer who contemplates them in the field of the telescope. The periods are of all lengths. For some stars, the thirtieth of the Hydra of Hevelius, for instance, the period is more than 1 year, being 494 days. It varies between the fourth magnitude and complete disappearance. The star χ of the neck of the Swan varies from the fifth to the eleventh magnitude in a period of 404 days. Another star of which we have already spoken in the chapter on the constellations, o of the Whale, also called the Marvellous (Mira Ceti), varies in 334 days from the second magnitude to total disappearance. Other stars are regulated by more rapid variations. The star which passes most rapidly from its maximum to its minimum is Algol in Medusa's Head, which we already know (β of Perseus). For in 1 day 10 hours and 24 minutes it has finished its decrease; in the same lapse of time it has reached its maximum: its period is only 2 days 20 hours 48 minutes. The star δ of Cepheus varies in a period of 5 days 8 hours and 37 minutes, from the third to the fifth magnitude. It will be seen that these variations are themselves very variable, and that there are suns which pass with strange rapidity from their greatest to their smallest light. What are the prodigious forces which regulate these gigantic changes? Science has not yet been able to determine this. Maupertuis said that variable stars were of the form of lenses, that they turned perpendicularly on themselves, and that they presented to us successively their edge and front. At the period when they presented the edge, their light was at the minimum; and at the time when they presented their entire front, it was at their maximum. But do lens-like suns exist? If the thing is possible, it is not proved. Not only are there stars whose light changes periodically, sometimes diminishing until they become completely invisible, although, in reality, they are not quite extinguished; but there are again others whose light is weakened never to be revived, and which forever have disappeared from the sky. These are the extinguished stars of which the list is rather long. The astronomer Ulugh-Beigh stated, in the year 1437, that one star of Auriga, the eleventh of the Wolf, six stars, among which four of the third magnitude near the Southern Fish, all marked in the catalogues of Ptolemy and Abdurrahman-Suphi, were no longer visible in his time. In the seventeenth century, J. D. Cassini, and at the end of the eighteenth, W. Herschel, pointed out a great number of other stars which had completely disappeared. These were systems for which the hour of the end of the world had struck.

Speaking of the end of the world, this dread is awakened in the inhabitants of the Earth, not when stars disappear from the firmament, for this is mostly noticed by astronomers, but rather when a new body is suddenly lighted up in the heavens. Indeed there are stars which suddenly appear. In the same year as the massacre of Saint Bartholomew, on the 11th of November, 1572, a magnificent star of the first magnitude suddenly appeared in the constellation of Cassiopea, effacing by its brilliancy the most beautiful stars in the sky. It remained for eighteen months, and disappeared never to return.

Astrologers said that this appearance was the same as that to the Magi at the birth of Jesus Christ, and concluded from it that the last judgment was near. Thirty-two years later another new star appeared in the constellation of Serpentarius. From the day of its appearance, the 10th of October, 1604, according to Arago, it was white; it surpassed stars of the first magnitude in brightness, also Mars, Jupiter, and Saturn, which were near it. Many compared it to Venus. Those who had seen the star in 1572 found that the new one exceeded it in brightness. It did not appear to become fainter in the second half of the month of October; on the 9th of November, the twilight which effaced Jupiter did not prevent this star from being visible. On the 16th of November Kepler perceived it for the last time, but at Turin, when it reappeared in the east, at the end of

December and at the beginning of January, its light was fainter; it certainly surpassed Antares, but was not equal to Arcturus. On the 20th of March, 1605, it was smaller in appearance than Saturn, but it exceeded in brightness the stars of the third magnitude in Ophiuchus. On the 21st of April it seemed equal to the shining star of the third magnitude in the knee of Ophiuchus. It diminished imperceptibly; on the 8th of October it was still seen, but with difficulty on account of the twilight. In March, 1606, it had become completely invisible.

These appearances, like all extraordinary phenomena, excited terror and awakened ideas, not to be stifled, of the conflagration of the world, the fall of the stars, and the end of time. One of the most memorable predictions is that in 1588, announced in emphatic Latin verse, of which the following is a translation:

"After one thousand five hundred years, dating from the conception of the Virgin, this eighty-eighth year will be strange and full of dread; it will bring with it sad destinies. If, in this terrible year, the perverse world does not fall into dust, if the earth and seas are not annihilated, all the empires of the world will be overthrown, and affliction will oppress the human race."

This prediction was later renewed in favor or disfavor of the seventeenth century, and the *Mercure de France* announced the greatest revolutions for the year 1788. It then passed for having been found in the tomb of Regiomontanus. Authors did not think how right they were to describe this memorable epoch under the title of revolution.

But while considering these predictions, the list of which would be longer than at first imagined, I cannot help relating the curious mystifications worked in 1524 by the German astrologer Stoffler. According to him, on the 20th of February of that year, the conjunction of the planets in the Fishes must produce a universal deluge. Astrologers gave faith to it like the common herd: the sinister news soon traversed the world, and they prepared themselves to see the universe pass from time into eternity. "All the provinces of Gaul," says an author of that period, "were in strange fright and doubt of a universal inundation, and such that our fathers had not seen, or was known by historians or others, by means of which men and women were in great fear. And many removed from their low dwelling-places, and found higher spots, made provision of meal and other matters, and had processions and general and public prayers, that it might please God to have pity on his people."

Fear seized on a great many minds. Those who lived near the sea or rivers left their abodes, and sold, at immense losses, doubtless to unbelievers, their properties and goods. At Toulouse, another Noah constructed a ship to serve as an ark to his family and friends, and, probably, also to a few couples of animals. This was not the only case. According to the account of the historian Bodin, "There were many infidels who made arks to save themselves, although God's promise and oath, never again to drown man by a deluge, was preached to them." Many and many a time the prediction was given out, and, sad to say, it always found the same number of believers, although each time the event gave it a positive denial. In 1584 the fear caused by an announcement of this kind was so great that the churches were unable to contain those who sought refuge in them; a great number made their wills without reflecting that it was useless if all the world was to perish; and others gave their goods to the priests, in the hope that their prayers would delay this day of judgment. I believe that as long as the world remains it will fear its dissolution.

These singular stars which are suddenly lighted up in the heavens, to be extinguished soon after—these variable suns which pass through all degrees of light, and seem, like Castor and Pollux, to have received as a destiny an everlasting transitory movement from life to death and death to life, little suspect the terrors which they so innocently cause to spring up among men. What unknown power presides over these variations of light and heat? What influence on the planetary worlds which circulate round these bodies of so strange a nature? What thought regulates these movements, and what hand constructs beings born to live in harmony with such systems? What distance separates terrestrial nature, where years follow each other by a permanent law, and bring back successively the same phenomena, from those worlds where such prodigious variations take place? The mind is astonished with these questions and cannot answer them.

VII.

DISTANT UNIVERSES—DOUBLE, MULTIPLE, AND COLORED SUNS.

The wonders we have just reviewed become insignificant before those which we approach. Here, what we call natural is quite overthrown. Our observation, ideas formed by experience, classification, and judgment in that which concerns the works of nature, have no longer the least application. We are really in another world, strange, improbable, and unnatural to us. Life, the forces which sustain it, light, heat, electricity, the periods of days and nights, seasons, years, the visible and invisible world, all are transformed. Here we are on the surface of celestial globes, illuminated by many suns, of all magnitudes, lights, colors, and by moons with many-colored disks. Nothing like it has been seen on the earth: are these truly our worlds? are these not other universes?

Let us, then, sum up the studies we have made on the nature of these worlds in our panorama, and let us observe the essential types of the astonishing diversity which contrasts them from ours.

The white light of our Sun pours its dazzling rays from the azure height, and, thanks to the transparent atmosphere in which a thousand reflections form a real reservoir of light, all the objects which clothe or people the surface of the globe are enveloped in this light. Nevertheless, this white light is not simple. It contains in its rays all possible colors; and bodies, instead of appearing to us clothed with a uniform whiteness, absorb certain colors of this complex ray and reflect others; it is this reflection which constitutes the coloration of these bodies. This depends, then, on the molecular agency of the reflecting surface, on its power of receiving certain rays of the spectrum, and of repelling others. But all these colors constitute the original white—the one source of these various appearances.

It is now well to remember that this theory, applicable to the organic world, receives still more considerable importance when we consider the mode of coloration of organic substances. The beauty of plants, the diversity of the meadows, the gold of the fields, the whiteness of the lily, the scarlet, orange, azure, and the charming shades which form the richness of the flowers, the brilliancy of plumage of little tropical birds, the snowlike doves, the yellow fur of the desert lion, like the radiancy of flaxen hair: it is to the white light of our Sun that we must go for the explanation of these visible beauties—in him resides the source of the infinite shades which decorate the forms of nature.

Now let us, for an instant, suppose that, instead of a white sun, the source of all the light which inundates us, we had a dark blue sun. What a change is soon worked in nature! The clouds lose their silvery whiteness and gold from their flakes, and spreading a darker vault under the heavens, all nature is covered with a colored penumbra, while the beautiful stars remain in the noonday sky; the flowers lose the light of their brilliant dress; the fields succeed each other in the mist as far as the invisible horizon; a new day shines under the heavens.

The carnation of fresh cheeks loses its budding bloom, faces appear to be aged, and astonished humanity asks for the explanation of such a strange phenomenon. We know the rudiments of things so little, and we hold so much to appearances, that the whole universe seems to us renewed by this slight modification of solar light.

How would it be if, instead of an indigo sun, following its apparent course with regularity, making the years and days certain by its own rule, a second sun suddenly arrived in addition to it, a scarlet sun continually disputing the empire of the world of colors with its partner? Imagine at noon, at the moment when our blue sun spreads that shadowy light over nature which we have just described, the conflagration of a resplendent orb kindling its flames in the east. Greenish silhouettes suddenly rise through the diffused light, and opposite each object a dark shadow cuts the blue light which spreads over the world. Later the red sun rises as the other sinks, and the objects are colored, to the east with the red rays, to the west with the blue. Later still, as a fresh mid-day lights up the earth, the first sun vanishes, and from that time nature is clothed with a scarlet fire. If we pass to the night, scarcely have the last rays of the purple sun faded away in the west, like distant Bengal fires, than a new sunrise appears opposite the azured glimmer of the cyclops with the blue eye.

Is it possible for the imagination of poets or the caprice of painters to create on the palette of fancy a more daring world of light than this one? The foolish hand of chimera, throwing on its impressible sheet the odd colors of its will, can it erect at hazard a more wonderful edifice this this? Hegel said that "all which is real is rational," and "all which is rational is real." Yet this bold thought does not express the whole truth. There are many things which do not appear to us rational, and which, nevertheless, exist in reality in the numberless creations of space which surround us.

What we have just said respecting an earth lighted up by two suns of different colors, one being dark blue and the other scarlet, is not imaginary. In a beautiful calm, clear night, take your glass and look at Perseus, this hero walking in the midst of the Milky Way, holding Medusa's head in his hand; look at the star η, this is a world such as that of which we have just spoken. The large star is of a beautiful red, the other of a dark blue. At what distance is this strange system situated? No one can tell. It can only be stated that, at the rate of 186,000 miles per second, light takes more than a hundred years to reach us from thence.

But this is not the only system of the kind. That of γ of Ophiuchus resembles it so much that they may be easily mistaken one for the other (at such a distance it would indeed be excusable) only in the system of Ophiuchus the blue sun is not so dark as in the others. One star of the Dragon very much resembles the preceding, but then the large sun is of a deeper red, its small one bluish; another again, η Argo, has its large sun blue and its less brilliant one dark red.

Thus we have our imaginary world realized in many parts of space. And perhaps there are human eyes who thus contemplate those wonders each day. Who knows?—and the thing is very probable—perhaps they pay no attention to it, and from their cradle accustomed like us to the same sight, they do not appreciate the picturesque value of their abode. Thus are men constituted. The novel and unexpected alone affect them; as to the natural, this seems but an eternal, necessary, and fortuitous state of blind nature, which does not deserve the trouble of being observed. If the people came thence to us, though acknowledging the simplicity of our little universe, they would not fail to observe it with surprise, and be astonished at our indifference.

The suns which constitute these multiple systems differ therefore from ours by their coloration; and, among the whole of the bodies, a fresh variety again manifests itself. Colored binary systems are not composed solely of the red and blue suns to which we have just alluded; the means have not been at fault; it is the same here as in the universality of the productions of nature; it is from an inexhaustible source that it has drawn the richness and sumptuousness with which it has decorated its works.

For instance, the following is the beautiful system of γ of Andromeda. The large central sun is orange, the small one which gravitates near it is emerald green. What follows from the union of these two colors, the orange and the emerald? Is not this an assortment full of youth, if this metaphor be permitted? A large and magnificent orange sun in the midst of the heavens; then a bright emerald which gracefully joins its green radiations to the gold!

Then, again, in Hercules, we have two suns, red and green; in Berenice's Hair, one pale red, the other a clear green; in Cassiopea, a red and a green sun; a fresh series of soft and charming shades.

Let us change the prospect: to do this, it is only necessary to consider other systems. There is more variety among them than in all the changes which an optician can produce on the screen of a magic-lantern. Certain planetary universes lighted up by two suns have all the series of colors included under blue, and the brilliant shades of gold and purple which throw so much vivacity on this world are there unknown It is in this category that are placed certain systems situated in the constellations of Andromeda, the Serpent, Ophiuchus, Berenice's Hair, etc. Others, again, only know red suns, like a double star of the Lion, for instance. Some other systems are devoted to the blue and yellow, or at least are lighted up by a blue sun and a yellow sun, which only give them a limited series of shades comprised in the combinations of these primitive colors; such are the systems of the Whale, of Eridanus, one of which is straw color and the other blue, the Giraffe, Orion, Unicorn, the Twins, Boötes, the large yellow and the greenish-blue of the Swan; the small one is of an intense blue. We have, on the other hand, assortments of red and green, as is seen in Cassiopea, Berenice's Hair, and Hercules.

Other stellar systems are nearer ours, in the sense that one of the suns which illuminates them has, like ours, a white light, the source of all colors, while its neighbor throws a simple radiation on everything. For instance, in the worlds which revolve round the great sun a of the Ram, the large sun is white; but we constantly see in the heavens another smaller sun, whose blue reflection covers the objects exposed to its rays, as with a veil. The 26th of the Whale is in the same condition, and it is the same with a great number among the brightest stars. Such is the star χ in the Swan's neck, which is besides one of the most remarkable of the variable stars, for in a period of 404 days the large white sun diminishes from the fifth to the eleventh magnitude and returns to its primitive state. To the worlds which gravitate round the principal sun in these binary systems, the original white light appears to give rise to the infinite varieties which we observe on the Earth, with the addition of a blue light constantly coming from the other sun; but to the planets which gravitate round this one, it is the blue coloration which predominates, while the action of the more distant white sun is only secondary.

In the same way as there are white suns, accompanied with blue suns, some are also accompanied with red or yellow suns. But I must not dwell on this enumeration if I wish to review the whole host of the sky.

What a variety of light with two suns, one red and the other green, or one yellow and the other blue, must be experienced on a planet which revolves round one or the other; and what charming contrasts, and what magnificent alternations must arise from a red day and a green day, succeeded in turn with a white day and with darkness! What nature is there! What unimaginable beauty clothes with unknown splendor these distant lands scattered in endless space?

If like our moon which gravitates round the globe, or like those of Jupiter and Saturn, which unite their mirrors on the dark hemisphere of these worlds, the invisible planets which are there poised are surrounded with satellites which constantly accompany them, what is the aspect of these moons, lighted by many suns? That moon which rises from the luminous mountains is divided into differently-colored quarters, one red, another blue; this other only presents an increasing yellow; that one is at its full: it is green, and appears suspended in the heavens like an immense fruit. A ruby moon, an emerald moon, an opal moon—what heavenly jewelry! O night of the Earth, which modestly silvers our solitary moon, thou art very beautiful when the calm and pensive mind contemplates thee! But what art thou beside nights illuminated by these wonderful moons?

And what are eclipses of the sun on these worlds? Multiply suns and multiply moons, to what endless changes must your mutually-eclipsed lights give rise? The blue sun and the yellow sun stand near each other; their combined light produces green on the surfaces illuminated by both of them, yellow or blue on those which receive only one light. Soon the yellow approaches the blue; already it enters on its disk, and the green spread over the world fades, and fades, until the moment when it expires, melted into the gold which pours in space its beautifying rays. A total eclipse colors the world with yellow. An annular eclipse presents a blue ring round a gold-piece. By degrees, imperceptibly, the green revives and holds its empire.

Let us add to this phenomenon another which would be produced if a moon came over the beautiful middle of this gold eclipse, to cover the yellow sun itself and to plunge the world in obscurity, then follow the relations existing between its movement and that of the Sun, continuing to hide it after its departure from the blue disk, and then to leave nature again fallen under the veil of a new azure. Let us again add—but no, this is Nature's inexhaustible treasure; however much we take from it, it will not be impoverished.

BOOK THIRD.

I.

THE PLANETARY SYSTEM.

WE will now descend from the stars as a whole to a particular one; from the general contemplation of our universe to the study of a limited region. After having embraced the extent of this vast and imposing domain explored by science, we shall concentrate our attention on a single point, like the observer who, wishing to give an account of the position of a house in a landscape, after having first examined the neighborhood and places which surround it, concentrates his attention on the house itself. If the immensity of the numbers or the infinity of this expanse no longer present themselves in this new contemplation in a way to astonish our mind and confuse our faculties, the inalienable characteristics which universally distinguish the works of nature will reveal to us more sensible and touching beauties, not less worthy of our attention. In nature's perfect work, the most modest of its creations present the divine sign of their origin, and the most simple unfold a hidden splendor, not less wonderful than the most brilliant manifestations. Thus the splendid coruscations of the Aurora Borealis, which the gigantic shadow of an invisible hand lifts up on the icy pole, are produced in a brighter color, and in a still more charming aspect, on the perfumed corolla of each little flower.

Nevertheless, it must not be imagined that we are going to descend to small objects. They have still colossal forms, at the sight of which the imagination is confused. We are going to occupy ourselves with the system of worlds to which the Earth belongs, and which is commanded by the Sun. Perhaps even we shall feel greater interest in studying things which relate to us more closely, than in those whose distance makes us strangers to their most precious riches.

Here were are at length, arrived nearly at our own abode in space. Descended from the heights of sidereal creation, after having commenced our study with the imaginary circumference which the limits of our sight extended by instruments describe round the point we inhabit, we have gradually approached the centre. Is not the observation of our celestial position more interesting than that of the other cities of space?

The Sun which lights us is one of the stars of the Milky Way, a unit lost in the millions which constitute this nebula. But it is no longer as a star that we must now examine it, but as the centre of a system of worlds grouped around it. Around this luminous body are collected opaque bodies, dark in themselves, and which receive their light and heat from it. These dark bodies are called Planets. To render the study of them more easy, and to help to distinguish them better, they may first be divided into two very distinct groups. The first, near the Sun, is formed of four planets, of small dimensions relatively to those of the second group. These four planets are, in the order of their distances from the Sun, Mercury, Venus, the Earth, and Mars.

The second group, more distant from the Sun, is also formed of four planets; but they are large as compared with the preceding. These four worlds are in the order of their distances from the radiant body, Jupiter, Saturn, Uranus, and Neptune. These bodies are so bulky that the first four united into one would not form one globe of the size of the smallest among them.

Now, between these two distinct groups there is a third, formed of a considerable number of small bodies, of which 109 are already known. These little planets occupy the space which extends from the first to the second group. Compared with the other globes of the system, they are very small bodies indeed, for most of them measure less than a hundred leagues in diameter; and in some even the diameter is only a few miles.

These planets, great and small, are the principal members of the family. We must now add to them some secondary members, satellites which belong to some of them, and are grouped round the planets, like these are round the Sun. Of these satellites, the Earth possesses one, the Moon; Jupiter four, Saturn eight, Uranus four and Neptune probably two.

At what distances are these planetary bodies situated round the central body? Mercury, the nearest, is 35,000,000 miles from the Sun; Venus, which comes next, at 66,000,000; the Earth, 91,000,000; and Mars, 139,000,000. The group of the small planets occupies a more distant zone, in the mean 266,000,000 miles from the central orb. Then come the four large planets: Jupiter nearly 476,000,000 miles; Saturn, 872,000,000; Uranus, 1,754,000,000; and Neptune, the last, 2,746,000,000 miles. All revolve round the Sun at the respective distances which have been stated, and revolve in more or less time, according as they are more or less distant from that body. The nearest having a shorter path to travel, and being more strongly attracted, revolve more rapidly; the more distant travel slowly, compared to the preceding. The Earth takes 365 days to accomplish its revolution; Mercury only 88 while Neptune takes more than 164 years. These movements are regulated by an admirable and very simple law discovered by the illustrious Kepler, after thirty years of study. Expressed in astronomical terms, this law is thus announced: "The squares of the time of the revolutions of the planets are as the cubes of their distances from the Sun." In other words, by multiplying the number which represents the distance of a planet from the Sun thrice into itself, we have double the time of its revolution multiplied by itself. A little attention shows how simple this formidable law, which directs all the celestial movements in space, is. Thus, for instance, Jupiter is five times farther from the Sun than the Earth. I multiply this number three times by itself, $5 \times 5 \times 5 = 125$. Well, this number 125 is precisely double the time of the revolution of Jupiter, multiplied by itself. It is the same for all planets, satellites, and celestial bodies. I must add, for the use of those who wish to go further into astronomy, that these bearings are not rigorously exact, and that if they were, the system of the world would be soon overthrown.

These movements, the formula of which was discovered by Kepler, are caused by attraction or universal gravitation, this law having been discovered by Newton. All bodies in nature attract each other; the Sun attracts the Earth, the Earth attracts the Moon, and in the infinitely small, as in the infinitely great, the elementary molecules are seen to attract each other by the law of affinity, and to constitute visible matter, which is only an assemblage of atoms in juxtaposition. It is in virtue of this universal force that the worlds launched in space describe a curve round the Sun; from this rapidly travelled curve would follow a force which, like that with which a stone is animated when it starts from a sling, would throw the planets out of their orbits, if the attraction of the Sun did not hold them captive.

To complete this sketch of the Empire of the Sun, we must add to the preceding, certain bodies which, without departing from his kingdom, are always journeying. From time to time they pay a visit to the capital, then return to the provinces, at every imaginable distance. These are comets, wandering beings, if ever there were any, indefatigable travellers, but which the powerful attraction of the solar body always retains in the limits of his domain.

Such is the little group of worlds of which our Sun is the sovereign.

Imagine a magnificent vessel, the Great Eastern for example, sailing in the open sea. Around it move a quantity of little boats, which are insignificant in comparison, and around some of these boats children's little boats, like those we see in the ponds in our squares. The boats placed at different distances move round the large vessel, and the toy-boats revolve round these boats. Lastly, a quantity of canoes alternately recede from and approach the large vessel, moving in ellipses.

This fleet of various small vessels is not immovable on the ocean: and this is the most wonderful point. Besides all the circular movements of which I have just spoken, we must see the collective movement of the fleet, carried away on the liquid plain by the master vessel. Fixed in the middle of the boats which revolve round it, the brilliant great ship sails on the ocean, drawing with it all its little satellites without their perceiving it, occupied as they are in faithfully revolving round the centre. So the Sun which it represents sails in space, drawing with it the Earth, Moon, planets, comets, and all its system. Where is it going? Toward what point are we all directed? Which is the point in space which sees our great fleet advancing toward it?

It would be difficult for me to tell you if we are going to strike against a rock or to cast anchor in a gulf; I rather believe that we shall continue our path indefinitely, describing a gigantic orbit in the heavens. We are actually approaching an imposing constellation, the constellation of Hercules, situated between Lyra and Boötes. One day a small star will be seen to arrive in this constellation, between the stars μ and π at a quarter of the distance from the second to the first. At this period the general aspect of the constellation will begin to change to us, seeing that the stars which we approach will get farther from each other, as those which we leave behind will draw nearer together, and those on each side of us seem to fall back; but this period is so distant from us that the best eyes cannot reach it. It is true the Sun carries us away with a velocity of about two leagues per second, but there is such a distance between each star that this progress is almost insignificant. It must be remembered that there are stars whose movement is still more rapid.

Such is the aspect under which it is proper to comprehend the Sun in passing from its *rôle* of star to that of the head of a system. Now this last *rôle* will be the only one that we shall study. The stars being suns, it is more than probable that to study and completely understand their history they must also be considered under the same aspect, and be equally surrounded by their respective families; but these families are unknown to us, and man's mind is so constituted that it is difficult for him to entirely comprehend the sphere of known things, and he would be easily lost did he try to go beyond. Moreover, we always preserve, whatever we do, a little background of egotism, and we gladly reserve our attention for persons or things which touch us nearest. We have now passed definitely from sidereal to planetary astronomy.

II.

THE SUN.

THE resplendent body which shines over our heads occupies the centre of the group of worlds to which the Earth belongs. Our planetary system owes its existence and life to it. It is truly the heart of this gigantic organism, as expressed in olden times by a happy metaphor of Theon of Smyrna, and its reviving pulsations sustain its long existence. Placed in the midst of a family as father, over which it ceaselessly has watched from unknown ages when the worlds left their cradles, it governs and directs, both in the maintenance of its interior economy and in the individual *rôle* which it fills amid the universality of the sidereal creation. Under the impulses of the forces which emanate from it, or of which it is the pivot, the Earth and our companions the planets gravitate round it, imbibing in their eternal courses the elements of light, heat, and magnetism, which constantly renew the activity of their life. This magnificent body is, at the same time, their support in space, the fire which warms them, the lamp which lights them, and the fertile source which pours out on them the treasures of existence. It is he who permits the Earth to float in the heavens, held by the invisible network of the planetary attractions ; it is he who guides it in its way and distributes to it years, seasons, and days. It is he who prepares a new clothing for the sphere yet frozen in the nakedness of winter, and who invests it with a luxuriant dress when it inclines its pole covered with snows toward him ; it is he who gilds the harvests in the plains and ripens the heavy grape on the warm hills. It is this glorious body which, in the morning, spreads the splendor of the day over the transparent atmosphere, or rises from the sleeping ocean, which he will transform into charitable dew for the thirsty plains ; it is he who forms the winds in the air, the twilight breeze on the shore, the ocean currents which traverse the waters. It is again, he who sustains the vital principles of the air we breathe, the circulation of life in the organic kingdoms, in a word, the regular stability of the world. Lastly, it is to him who we owe our intellectual life and the collective life of entire humanity, the perpetual food of our industry ; and more than this, the activity of the brain which allows us to clothe our thoughts with a form, and mutually transmit them in the brilliant intercourse of intelligence.

What imagination is powerful enough to comprehend the extent of the Sun's action on all the bodies subjected to its influences? A million and a half times larger than the Earth, and seven hundred times larger than all the planets together, he represents the whole planetary system ; and this system, which is a mere nothing compared with the stars, he draws through the deserts of space ; and these worlds follow him at his will like dark passengers carried away by a splendid vessel on an endless sea. He makes them revolve round him, that they themselves may imbibe in their course the support of their existence ; he governs them with his royal power, and regulates their formidable movements.

From these striking manifestations of his power, let us now descend to his hidden actions. Let us see his light and heat act on the organism of the planets which regard him with love and take long draughts of his fertile rays, on the electricity of minerals and on the diurnal variations of the magnetic needle, on the formation of clouds and the coloration of meteors ; let us see them, these occult influences of light and heat, descending through the pure air even to our very souls, so eminently accessible to exterior impressions, and communicating to them joy or sadness, and perhaps we shall begin to form an idea of what a ray of sunlight is, in the infinitely small of terrestrial nature as in the infinitely great of sidereal phenomena.

But what is the nature of this powerful body whose action is so universal, which he burns in this vast censer, what are the fragments which constitute this splendid globe? Does it contain in itself the conditions of an infinite duration or is the Earth rather destined one day to see this lamp of life extinguished, and revolving henceforth in the darkness of an eternal winter? These questions belong to a lawful curiosity, and we wish that a satisfactory answer could be made to them. When we wish to appreciate the nature and greatness of a high person, we do not generally seek to prove his defects, to study the blemishes in his character ; this would be a singular way of judging his value ; and even were this so, we owe it to human imperfection, from which the greatest of us are not free. But if referred to a being whose distinctive character lay precisely in being not only of a magnificent purity, but also the source of all light and purity, people would not seek for spots to understand him. Indeed, the learned were very astonished 260 years ago, when King Sun, the god of day, was accused by the telescope of being constantly covered with spots ; and would it not be still more astonished if it discovered that these spots were precisely the only means that the Sun gives us to penetrate his nature? They almost believed on this occasion that pride is in the inverse ratio of worth. The official *savants* of that time, the theologians and disciples of the school of Aristotle, were not willing to believe anything. The provincial father of the order of the Jesuits at Ingolstadt, replied to Scheiner, one of the first after Galileo who had seen the Sun and its spots through a glass, that Aristotle had proved that, in general, all stars were incorruptible, and that the Sun in particular was the purest light possible, consequently that the pretended spots of the Sun were in the glasses of his telescopes or in his eyes. When Galileo made the same observation, the Peripatetics exerted themselves to prove to him, books in hand, that the purity of the Sun was invincible, and that he had seen badly. And, indeed, who would have suspected such a thing! Spots on the Sun! This must be an error, and an evident delusion!

However, the Sun has spots, and the most curious fact is that these spots have enabled us to know its nature and physical constitution, while without them we should not have been able to acquire the slightest notion of the disposition of this great body.

Let us see, then, in what the spots of the Sun consist.

Generally, this is the aspect which they present to us in the field of the telescope. (See Fig. 24.) Two very distant portions are noticed. At the centre a well-defined black region. Around it a region not so black or

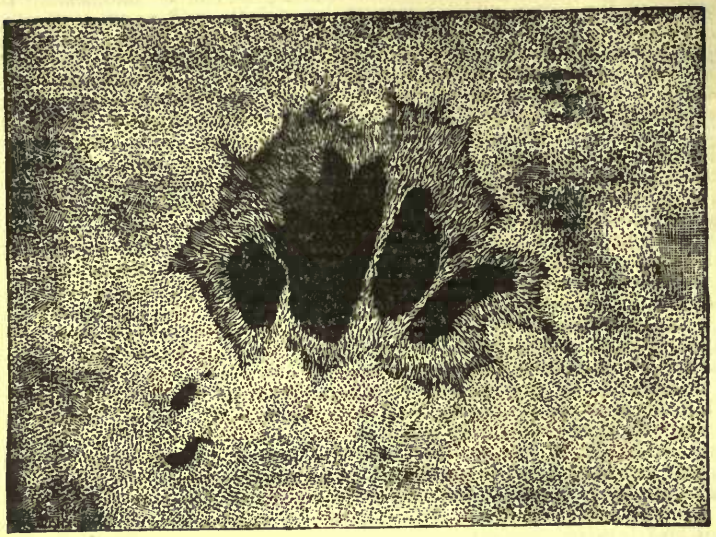

Fig. 24.—A Sun Spot.

grayish compared with the surface of the Sun which surrounds it. The central part has received the name of umbra; sometimes at the centre of this part is noticed a more intense dark spot, which is called "the nucleus." The exterior region of the spot has received the name of "penumbra." When it is stated that the centre of the spot is black, this expression must be understood as relative to the general surface of the Sun; for this centre, however dark it may appear by contrast, has been found of a light equal to two thousand times that of the full Moon.

We may be led to the belief that these spots, generally invisible to the naked eye, are insignificant movements carried on on the Sun's surface, and of small extent. It is not so. They are daily and very important phenomena. Some of them have been known to measure 80,000 miles; that is to say, they are ten times larger than the Earth. Our globe falling into most of them would be lost as in a well. Besides being of this size, they are also the seat of various actions and prodigious phenomena. They are not formed suddenly as a whole, but increase to the limit they attain, and afterward diminish. Some only last a few weeks, others months. Now the movements with which they are animated, either for their increase or diminution, or in their internal action, are sometimes of unheard-of rapidity. Lately astronomers have followed a dazzling meteor passing through a group of spots with a velocity of two thousand French leagues per minute. In other parts they have watched circular whirlwinds, dragging into their commotion large spots like the Earth, and swallowing them up in abysses with fearful velocity. Sometimes are seen the crests of stormy waves extending over parts of the penumbra, and rising on the white surface of the Sun as a still whiter and brighter substance, doubtless projected in their ebullition by interior forces. There have, besides, been seen immense bridges of fiery substances cast suddenly over a black spot, crossing it from one end to the other, like an arch of luminous striæ, which sometimes is dissipated, and falls down into the abysses of lower whirlpools. This body, which each day pours out over our heads such a pure and calm light, is the seat of powerful actions and prodigious movements, of which our tempests, hurricanes, and waterspouts give us but a slight idea; for these gigantic disturbances are not performed, as here, in an atmosphere of a few leagues thickness and over a few leagues area, but in proportions as vast as its atmosphere, which rises thousands of leagues above its surface,* and as its volume, which exceeds 1,450,000 times that of our globe. One of the first results of the observation of solar spots was to discover that the Sun turns on its axis in about twenty-five of our days.

Indeed, if we watch for several consecutive days any of the spots visible on the solar surface, or a group of spots, or even the whole Sun, we shall not be long in remarking that the spots are all animated with the same movement from one edge to the other of the solar disk. If, for instance, we begin to follow a spot from its appearance at the eastern edge, we observe that it advances slowly toward the middle of the body, which it reaches about seven days after its appearance; then it passes it, and continues its course toward the west, and seven days

* The recent spectrum observations tend to disprove this.—Tr.

after it reaches the edge and disappears.

After a period of fourteen days, employed in travelling over the opposite hemisphere, it reappears at the same place, and follows the path previously pointed out. These observations evidently show that the Sun turns on an axis. This rotation of the Sun shows its spots in the following manner:

If the period of the reappearance of the spots is from twenty-seven to twenty-eight days, this does not refute the number of twenty-five days before mentioned. The difference proceeds from the Earth not remaining immovable in space, but turning round the Sun. In order that we might observe directly the duration of rotation, it would be evidently necessary, as a first condition, that we should remain at the same place; for otherwise, if we turn round the body in the direction of its movement, we should still see the spots after the moment when they are invisible at the point where we were at first; and if we go in the contrary direction, we shall cease to see them before they cease to be visible at the same point. Now, in its translatory movement round the Sun, the Earth, advancing in the direction of its rotation, sees the spots two days and a half after they have disappeared at the point where the Earth was at the commencement of the observation.

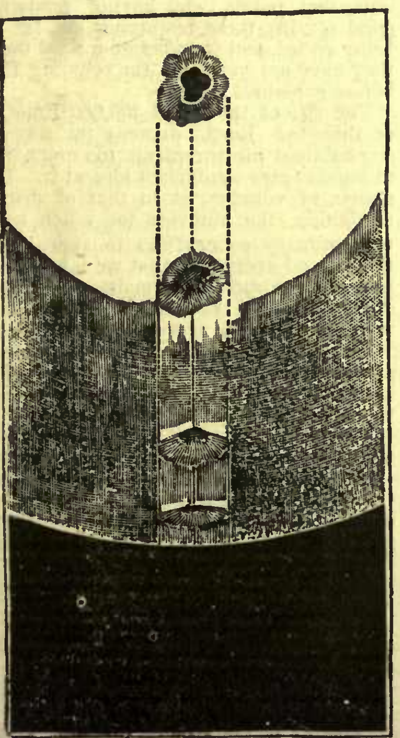

Fig. 25—The Sun's Rotation.

This rotatory movement takes place from west to east, like that of the Earth and all planets of the system. Thus by telescopic examination, this body declared fixed and incorruptible in antiquity, is stripped of its two distinctive qualities. The diurnal rotation of the Sun is twenty-five times longer than that of the Earth; but it differs essentially in its immediate consequences, because it does not produce on the surface the alternate day and night which we derive from this movement. It cannot, then, be stated that this is the length of the solar day, for it is not the sign of a succession of light and darkness: the Sun's day does not go out, and the twilight of evening does not pale it. This world lives in a permanent light.

It neither knows our seasons nor years, and the elements of our calendar cannot be applied to its astronomical *rôle*. It seems that the rapid succession of things which constitute our time, and the changing series of phenomena which we experience, do not fall to his lot; continuance and endless duration are his appanage; and he is freed from counting for his individual personal life these successive ages which measure life and overwhelm it with their number. The great variety of nature separates it from the rank of the planetary world; and it would be a profound subject of astonishment to an inhabitant of the Earth if he were to visit a country so essentially distinct from ours, and to be able to establish a comparison between this strange world and his own.

III.

THE SUN (CONTINUED).

Whatever may have been the preconceived idea by which opinions were regulated in favor of this beautiful Sun, this radiant body, so venerated that the idea of accusing it of spots was a blasphemy, it is nevertheless from observation and study of these spots that the knowledge we have of it has been acquired; so true is it that Science, superior to all prejudices, is the real ruler of the mind. The examination of these spots—their form, and the changing aspects which they reveal in consequence of the rotation of the Sun (Fig. 25), has served as a basis to a theory of its physical constitution which many astronomers have successively adopted and established, from Wilson and Herschel to Humboldt and Arago. According to this theory, the Sun is essentially composed of a nucleus and an atmosphere. The nucleus is dark, and the atmosphere is enveloped with a luminous stratum, to which has been given the name of "photosphere." The light and heat which it sends out to us does not come from the nucleus, but from this calorific and bright envelope. The spots are explained by supposing that they are openings formed in this outer envelope, either by gaseous eruptions issuing from volcanoes, or by powerful currents rising from the lower to the upper atmosphere, similar to vertical hurricanes, or by quite another cause dependent on the nature of the body. The penumbræ of the spots are formed on this theory by the lower atmosphere being endowed with the property of reflecting the light and heat of the photosphere and keeping it from the body of the Sun. The dark centre of the spots is nothing else but the body of the Sun itself, rendered visible by the aperture of the lower atmosphere corresponding to the opening of the photosphere. The spots are in this manner sufficiently explained, and also the different appearances observed on the solar surface, such as the pores with which it appears separated, faculæ or white spots, or ridges, phenomena caused by chemical movements carried on in the atmosphere in which various gases are mixed in the most varied combinations.

This theory has appeared much better established since the funnel-like aperture which forms the spots becomes still more perceptible by the perspective views afforded by the rotatory movement of the Sun. In virtue of this movement a round spot appears, and narrows in proportion as it travels farther from the centre; and when the portion of the sphere where it is situated disappears while it keeps its entire length, its width diminishes until it presents only the appearance of a line. Moreover, the portion of the penumbra, or, in other words, of the funnel which is on the side of the spectator, will diminish in width, and will disappear before the rest. Lastly, when a large spot arrives at the edge of the disk, if this spot is large enough, it ought to be seen slightly hollowing the part of the solar disk which it occupies. Now these appearances, regulated by perspective in the case of the spots being openings, are precisely those which are observed.

Astronomers are then generally of opinion that the solar nucleus is an opaque body, dark, like the Earth; that it is surrounded with a fluid atmosphere; and beyond this fluid lies a layer of substance endowed with the property of emitting light and heat; it is this outer stratum which is called the photosphere.

I say astronomers are generally of that opinion, for they are not all unanimous. A few years ago the physical sciences were enriched by a wonderful discovery, of which I shall speak farther on, by which light may be analyzed—that is to say, the elements whence it comes may be known. Now, the English and Germans, to whom we owe this discovery, having examined the nature of the solar light, found that there were in the Sun's atmosphere iron, sodium, potassium, barium, etc., while there was no gold, silver, copper, or zinc. This would have been in opposition to the alchemists of past times, Nicolas Flamel in particular: the Sun was to them a golden body *par excellence.* All these materials, proved to exist in the body by spectrum analysis, were also revealed as being in a state of incandescence. So much, then, for the experimenters and theorists of whom I speak—the orb of day returned to what it was to our fathers—a body of fire. Indeed, not only did they again state that the torch of day, far from being dark, is an incandescent globe: that the light we receive from it comes from its fiery nucleus, and not from its atmosphere; but they again sought to explain the spots on this new hypothesis, and they proposed to admit that these spots were simply clouds, combining with each other in the solar atmosphere under the influence of a partial fall of temperature, and becoming opaque enough to intercept the light of the incandescent globe almost entirely. Other *savants*, sharing the same ideas on the physical constitution of the Sun, threw out the idea that spots were not clouds, but partial solidifications of the surface—scoriæ, such as we see form on the surface of boiling metals treated in a crucible. They explained even how the umbra of the spots is the thickest central part of these partial solidifications, which intercepts the rays emitted by the solar body more effectually as it is more solid, and that the penumbra would correspond to the pellicle which, in every formation of this kind, is observed on the surface of melting metals, to be produced invariably round the scoriæ. But although, having cleared science on some important points, and having rendered it good service, these researches are far from being ended, and founded on a solid theory; they have not yet upset the reigning theory before explained.

The size of the Sun, 1,400,000 times larger than the Earth, exceeds the degree of our habitual measurements too much for us to hope to give a sufficient idea of it. In the matter of volumes, as in that of distances and times, the numbers too much surpass our ordinary conceptions to appeal to our minds, and every care that we take to represent them to ourselves remains almost sterile. Nevertheless, a comparison will be able to inspire at least a nearer idea of the size to which we refer. If we placed the terrestrial globe in the centre of the solar globe, like a kernel in the middle of a fruit, the distance of the Moon would be included in the interior of the solar body; the Moon itself would be absorbed in it, and beyond the Moon to the surface of the Sun, following the same radius, we should still have to traverse a distance of 160,000 miles. From the Earth to the Sun are reckoned 91 millions of miles. It is on account of this great distance that this immense body only appears to measure a foot in diameter; and this explains why the ancients, and Epicurus in particular, did not believe it larger than that measure. This distance equally explains why it does not appear to us larger than the Moon, which is only 240,000 miles away. From this it may reasonably be asked, how this distance from the Sun to the Earth could possibly be determined. The method is too complicated for me to explain it here in detail; but an idea may be given of it without exceeding the limits of this chapter.

Between the Sun and the Earth there are two planets, Mercury and Venus; the latter has rendered the greatest service in the study of the distance which separates us fom the Sun. As its orbit (the circumference which it describes round the central body) is nearly on the same plane as the Earth's orbit, it happens from time to time that it passes between the Sun and ourselves, and appears like a black spot crossing the luminous disk. This passage takes place at the singular intervals of eight years, 113½ years—8 years, 113½ + 8 years. At these valuable periods astronomers of all countries forget their nationality, and listening to each other like brothers, place themselves so as to observe the passage of Venus in different countries. Two observers situated in the stations most distant from each other note the two points where the planet, seen from each of their stations, seems to be projected at the same moment on the solar disk. This measure gives them the angle formed by two lines starting from their stations, and crossing each other on Venus, and passing on to the Sun. It is the measure of this angle, made by observers placed on all parts of the globe, which gives what is named the parallax of the Sun.

At the last transit of Venus, a French astronomer, Le Gentil—his name should have preserved him from such disappointments on the part of Venus—was curiously requited for his love of science and his disinterestedness. Sent to India by the Académie des Sciences, he embarked with arms and baggage to observe the passage of the planet in 1761 at Pondicherry. His great activity and ardor could not conquer the chances of the sea voyage; he landed a few days after the phenomenon had taken place. . . . The obstacles irritated him and increased his courage. He took the heroic resolution of remaining for eight years in the midst of that unknown country, in order to compensate himself for his lost observation; he waited for the passage of 1769, and then took all desired arrangements to make a perfect observation. The year and the day at length arrived! The sky was pure, no obstacle hindered his long resolution from at last receiving its reward. But alas! exactly at the moment when the black spot was about to enter on the solar disk, a small cloud formed in the atmosphere and remained before the Sun until the momet when Venus left the disk, putting an end to the possibility of all observation. The astronomer again took the voyage to France with a stormy sea, which brought his days to a close. Le Gentil, of Galaisière, died in 1792, after having written an account of his travels.

From considerations based on the magnetic action of the Sun, we may be led to believe that its light is of the same nature as the electric light, only incomparably more powerful, seeing that the elements which we have at command are infinitely inferior to those commanded by nature. However bright our electric foci may be, however dazzling their light, the whiteness of which astonishes us when it is projected on the solar disk, the electric light has the appearance of a black spot.

The intensity of solar heat is not less difficult to conceive; the most intense of our furnaces, which rise to the temperature of white heat, does not give us a faint idea of it.

However, the following few comparisons will indicate its value. If we represent the Sun under the form of an enormous globe built up of a million four hundred thousand terrestrial globes, and covered entirely with a stratum of coal fourteen miles thick, the heat which it pours out annually in space is equal to that which would be furnished by this stratum of flaming coal. This solar heat would also be capable of melting in one second a column of ice which would measure 1590 square miles at its base, and 192,000 miles high.

Lastly, it is curious to inquire how much this gigantic body weighs. It is a good weight:

2,154,106,580.000,000,000,000,000,000 tons!

If this globe were in the present day, as in that of Apollo, drawn by four horses, it would be necessary that the coursers had exceptional strength, especially to be able to go round the globe in twenty-four hours. Now, following the Sun's weight, that of our Earth, expressed like the preceding in tons, is 6,069,000,000,000,000,000,000.

When astronomers place the Sun in one of the pans of the immense scales with which they determine the weight of the stars, it is necessary for them to put in the other one 350,000 terrestrial globes to restore equilibrium.

We need not fear that this gigantic body will one day be extinguished, leaving the Earth in icy darkness. It possesses in its colossal reservoir a sufficient number of degrees of heat for us to have before us millions of centuries, during which it would be impossible for us, even if this heat should decrease, to perceive it.

Yes, the resplendent star of day remains to us the most beautiful and the best of stars. We have observed its size and its power: no power is capable of rivalling it, science has not lessened its venerated image in our mind, and, as in our preceding studies, reality here is superior to fiction. Our homage remains, better understood and justified than ever.

IV.

MERCURY.

Above the Sun, in the west, when that radiant body sets, or again before its rising in the east, is seen sometimes a small white star, slightly tinged with red. The Greeks called it Apollo, god of day, and Mercury, the god of thieves, who take advantage of night to commit their misdeeds, for they saw in it two different planets, one a morning and the other an evening one, as they did also for a long time in the case of Venus, the Egyptians and Indians doing the same. The first gave it the names of Set and Horus; the second those of Boudda and Rauhineya; names which bring to mind, like the preceding, the divinities of day and night. The Latins, who, however, employed themselves very little with astronomy, in this respect remained in doubt. It has been only in later times that the identity of these two stars which, like Castor and Pollux, to which they are assimilated, never appear together,

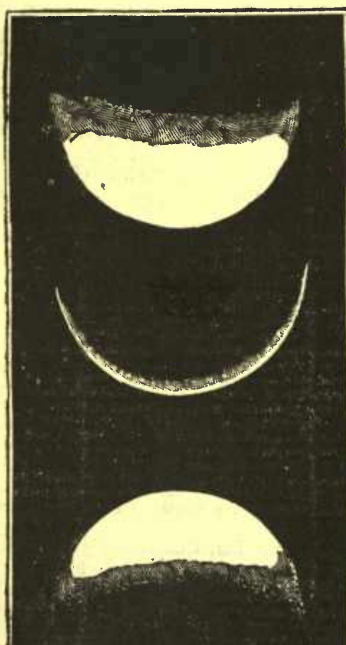

Fig. 26.—Phases of Mercury.

has been proved: its evening name, Mercury, was the one retained.

Being the first planet of the system, Mercury always remains absorbed in the royal radiation of the prince of day; also, like a courtier, it is deprived of its individuality, and blended in the personality of the ruling star. It gains nothing and loses much, seeing that it had not the honor of being known to the founders of astronomy. Copernicus despaired of ever seeing it. "I fear," said this great man, "that I shall descend to the tomb without having seen the planet." And, indeed, he who had transformed the system of the world, and taken in hand each of the planets to place them round the Sun, died without having seen the first among them. Galileo was able to observe it, thanks to the glasses which he had invented, but it could not be said he understood it sufficiently, as it was impossible for him ever to distinguish its phases. The adversaries of the new system opposed the first astronomers. Copernicus, Galileo, and Kepler, on account of the absence of phases in the planets Mercury and Venus. "For," said they, "if these planets revolved round the Sun, they would change their aspect to our eyes, as the Moon does, according as we see in front, in profile, or in rear, the illumined part, the side in fact which they turn toward the sun."

Copernicus and his colleagues replied: "We do not distinguish any phases, it is true; but if it only requires them in order that you should adopt our system, God will cause that there may be some." Indeed there were some, and here (Fig. 26) are those of Mercury. By the observation of the irregularities visible in the interior of the crescent or quarter, it has been observed that Mercury is rugged with high mountains, higher than those of the Earth, although Mercury is a much smaller globe than ours. The existence of a denser and higher atmosphere than ours has been suspected. In the middle of the last century, one of the numerous romancers who feigned voyages to the planets pretended to know that the mountains of Mercury were all crowned with beautiful gardens, in which grew naturally not only the most succulent fruits, which served as food to the Mercurians, but also the greatest variety of dishes. It would appear that in this happy world it is not necessary to prepare, as with us, things for food; fowls, hams, beefsteaks, cutlets, entremets, small side-dishes, etc., were raised there in the same manner as the apples on our apple-trees, and when a repast was wished for, it was sufficient to spread the cloth; then arrived bird-waiters for your orders, who knowingly flew away, and in the twinkling of an eye, from the mountains, where the desired dishes were to be found, brought you them with the greatest haste. It is better, perhaps, to believe that the vegetables of Mercury possess these precious gifts, and that its birds are of such delightful intelligence, than to think, with Fontenelle, that the inhabitants of Mercury are all mad, and that their brains are burned with the violent heat which the Sun pours upon their heads. But until an authentic voyager has made us sufficiently acquainted on this head, we will confine ourselves to the astronomical elements of the planet. It revolves at a distance of 35 millions of miles from the Sun; its diameter is 2960 miles; its day is 24 hours 3 minutes 28 seconds long; its year, 87 days 23 hours 14 minutes; and its seasons, 22 days only; its mass, compared to that of the Earth, is only $\frac{1}{16}$; its density is three times more than ours, and bodies which fall on its surface travel 7·45 feet during the first second of fall; and, lastly, it receives six times and a half more light and heat than the Earth does. Its orbit is very eccentric.

Eccentric means that in its movement of

revolution round the Sun it does not always remain at the same distance from it: that it describes an ellipse rather than a circle. As a result, at certain epochs of its year it receives twice as much heat as at the opposite epochs. It will be seen that the word excentric is not badly chosen, as it represents a want of regularity in the circular movement of the planet. While we are speaking of this singularity, let us also add that of all bodies Comets are the most eccentric. At certain times they approach so near the Sun that it is thought that they will be melted in his flames; in the opposite part of their path, on the contrary, they go to such distances that they are lost to sight, and wander in the darkness and cold of solitary space.

V.

VENUS.

Some ill-disposed minds have asserted that although Venus is beautiful afar, it is frightful on a nearer view. I fancy I see my young and amiable readers; and I am sure that not one among them is of this opinion.

Indeed, all the magnificence of light and day which we enjoy on the Earth, Venus possesses in a higher degree. Like our globe, it is surrounded by a transparent atmosphere, in the midst of which are combined thousands and thousands of shades of light. Clouds rise from the stormy ocean, and transport into the sky, snowy, silvery, golden and purple tints. At morning and evening, when the dazzling orb of day, twice as large as it appears from the Earth, lifts its enormous disk at the east, or inclines toward the west, the twilight unfolds its splendors and charms. From here we can be spectators of this distant spectacle; for we distinctly see the daybreak and the close of day in the plains of Venus. Day and night are of nearly the same duration as on the Earth; the diurnal period of rotation of the planet is twenty-three hours twenty-one minutes seven seconds; it is consequently thirty-five minutes less than ours. But between winter and summer there is a still greater difference than with us between the intervals which elapse from the rising to the setting of the Sun and that which separates its setting from its rising; for this globe is more inclined to the plane of its orbit than ours. It is this inclination which constitutes on this planet, as on the Earth, the variation of seasons, their duration and intensity. Venus being still more inclined than the Earth to the plane in which it moves, its seasons are more characteristic than ours, and its climate much more marked. Between the cold of winter and heat of summer there is a much greater difference than here; it is almost as cold in winter and very much warmer in summer. From the equator to the poles there is also a more decided variation of climates than on the terrestrial sphere; our temperate zones are imperceptible on Venus, and do not exist even. The torrid and glacial zones constantly encroach on each other; and as the year only occupies two hundred and twenty-four days instead of three hundred and sixty-five, the rapidity of this succession adds to its intensity. The snows, also, have not time to accumulate at the poles as on the Earth, Mars, and Saturn; and the atmospheric variations cause a continual disturbance on the surface of the planet. Its mountains are much higher than ours. They have been measured at the period when Venus presents itself to us as a crescent. The inequalities which are noticed in the interior of the crescent are the highest points of the surface, which still receive the Sun's rays after these have left the plain. The height can be concluded from the time that these light-points take to disappear. We have just spoken of

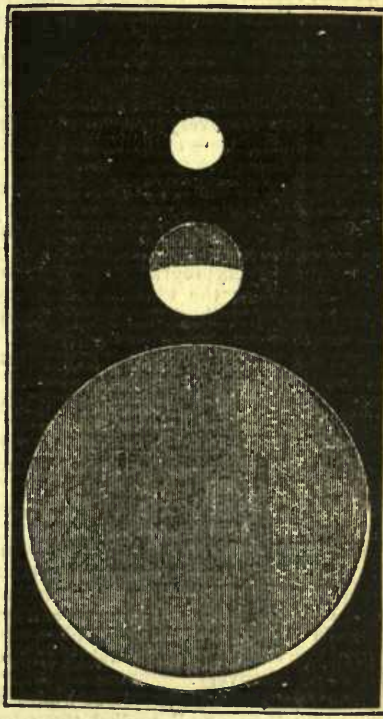

Fig. 27.—Variations of the apparent disk of Venus.

Venus as a crescent. Like Mercury, this planet is situated between the Earth and the Sun; and the circle which it describes during its year is comprised in the circle which the Earth describes round the same body. Hence it follows that at certain epochs the planet Venus is exactly between us and the Sun; and then it presents its dark part to us, as its illuminated portion is naturally on the side of the Sun. At other times, when it is to the right or left of the Sun, it presents only a quarter. Lastly, when Venus is on the other side of the Sun, it presents its entire illuminated portion to us.

As Venus revolves in an orbit, there are periods when it is only about twenty millions of miles from us (when it is between us and the sun), and contrary periods when it is 157 millions of miles distant from us. Its apparent dimensions then vary very perceptibly with its distance. Fig. 27 shows these variations.

The phases of Venus were seen for the first time by Galileo in the month of September, 1610, who beheld this spectacle with a joy impossible to describe, seeing that it eloquently testified in favor of the system of Copernicus, showing that, like the Earth and Moon, the planets receive their light from the Sun. When I say that these phases were for the first time seen in the month of September, 1610, you must not conclude that they did not exist before that epoch, but you must understand that before that year no one had turned the telescope to the planet, and that with the naked eye these phases are imperceptible.

According to the custom of the period, the illustrious astronomer disguised his discovery under an anagram, to maintain the authenticity of this discovery in case of rivalry, and to give himself time to continue his observations and to perfect them. He finished a letter with this phrase : "Hæc immatura a me jam frustra leguntur, d. y." which means, "These things, unripened and as yet hidden to others, are at length read by me."

Under this cryptogram it would be difficult to discover the idea of the phases of Venus. Our fathers were very ingenious, and in the present time certain discoveries would not have been so greatly contested, if astronomers had sometimes used the same ruse. In this phrase there are thirty-four letters. By placing them in another order we get these words, in which the whole discovery is elegantly inscribed : "Cynthiæ figuras emulatur mater Amorum." "The mother of the Loves puts on the phases of the Moon."

Galileo was very cunning. Two months later, Father Castelli, asking if Venus had phases, he replied, "My state of health is very bad, and I find it better to be in my bed than in the dew." It was only two days before the end of the year that he announced the above discovery.

Has Venus a satellite? "It would rather have two than one," replied the friend of Cassini to the enemies of this astronomer. Many hold the firm belief of having seen it, but the question remains undecided. In the middle of the last century it was so strongly believed in that Frederick the Great, of Prussia, proposed to give it the name of his friend Alembert, from which the illustrious geometer excused himself in this little note: "Your Majesty does me too much honor in wishing to baptize this new planet with my name. I am neither great enough to become the satellite of Venus in the heavens, nor well enough to be so on the Earth; and I know too well how small a place I occupy in this lower world to covet one in the sky." This globe presents the greatest resemblance to our own; and it has nearly the same astronomical elements, size, volume, weight, and density; only it is much nearer to the Sun than we are. From the ... of ancient poetry, its position near the Sun, which causes it to appear at sunrise and sunset, attracted contemplative minds toward it, and Venus became the star of all those who love to dream in the evening, from the shepherd returning from the fields to bosom friends whose souls commune with each other during the night. In the middle ages a worthy father took an ecstatic voyage in the heavens, and in Venus saw only young people of ravishing beauty, living in the midst of perfect happiness; in his sight these were the guiding spirits of the planet Venus, for in olden times it was believed that a legion of angels or genii presided over the direction of each of the heavenly spheres. Later, the author of "Paul and Virginia" gave the most wonderful description of Venus; it was a real terrestrial paradise.

VI.

MARS.

ALL the maledictions of mortals have fallen on Saturn and Mars. Beginning with war, that scourge of humanity, of which it will have great trouble to rid itself, all public misfortunes caused by power have been attributed to Mars, who, if it knew what the Earth thought of it, ought to regard us with an evil eye. It is, nevertheless, innocent of all these calumnies, and we ought not to speak ill of it, presenting, as it does, most resemblance to ourselves. Indeed the world of Mars resembles the Earth so much that if we happened one day to be travelling there and lost our way, it would be almost impossible to recognize which of the two were our planet. Without the Moon, which would charitably remove our uncertainty, we should run a great risk of arriving among the inhabitants of Mars, expecting to descend into Europe or some other terrestrial quarter. Indeed the planet Mars in our telescopes presents the same aspect as the Earth must do to the inhabitants of Venus—a circular disk, rather flattened, turning on itself in about twenty-four hours, furrowed from time to time by fleeting clouds, diversified with here dark and there light plains; revolving obliquely on an axis enveloped with an atmosphere and with snow-covered poles. On this planet the seasons are nearly of the same intensity as our own, but their duration is twice as long; for Mars only accomplishes its annual revolution round the Sun in 1 year 321 days and 22 hours, or 1 year 10 months and 21 days. The masses of ice at its poles partly melt in the spring of each hemisphere, and again form in the autumn, as occurs on our globe; and as the seasons are complementary on both hemispheres, the southern pole diminishes while the northern pole increases, and alternately. From this melting of snows result the changes of temperature and the cloud movements which are observed; one part of the water is evaporated into clouds, the other part swells the rivers and descends to the sea. Thus the fundamental characteristics of the terrestrial seasons are again found on the neighboring planet.

We may, nevertheless, notice certain differences between the aspect of Mars and our own world. Whereas the Earth seen at a distance must appear tinted with green, on account of the color of its atmosphere, its vegetation, and waters, Mars is shaded with red, and it is this shade which gives it the reddish light with which it is seen to shine. Doubtless this characteristic color is produced by the dominant coloring of its surface; either its soil is thus colored like that of our deserts, or its seas, its vegetation, or the vapors rising into its atmosphere are chiefly clothed with this shade. Nevertheless, the poles always preserve their brilliant light. An ancient philosopher, Anaxagoras, stated that snow was black: his paradox had been somewhat smoothed or cleared if the snows of Mars, each time that we were able to perceive them distinctly, had been red; but they are white also. "The color of the polar markings," said Beer and Mädler, two astronomers whose lives have been devoted to the study of Mars and the Moon, "is always of a bright and pure white, in no way similar to the color of the other parts of the planet. In 1837 it once happened that Mars was, during the observations, completely darkened by a cloud, with the exception of the poles which stood out distinctly."

Moreover, is the water of Mars the same as the water on the Earth? Father Kircher was asked if that of Venus would be good for baptizing; and it was not doubted. We ask ourselves whether there are the same chemical elements as there are here, and we doubt it. That the polar markings of Mars are masses of ice and snow seems proved by observation, as the changes which they undergo annually are occasioned, as with us, by the apparent movement of the Sun. This fact has been abundantly proved. When a snow zone is of large extent, it is after the long winter of the pole to which it belongs; when the same spot is very small, it is after a summer which has melted and successively contracted it. But from this it must not be concluded that the term snow signifies anything but an appearance, and there is no plausible proof to be relied on that the substance that we know under the name of snow is actually seen there—that is to say, water (chemically, an equivalent of hydrogen and oxygen: H_2O) frozen into small needles. It is, on the other hand, possible that the constituent elements of the globe of Mars are very different from those with which the Earth is formed, and their chemical combinations having been from the beginning submitted to other influences than those which are at work on our globe, there may exist but a remote analogy between the nature of this world and our own, and not an identity of matter.

Removed from the Sun to a mean distance of 139 millions of miles, and encircling the Earth's orbit in that which it describes round the central body, there are certain periods when these two planets are very near together; that is, when they are both on the same side of their path with regard to the Sun. Sometimes they are not more than 48 millions of miles distant from each other. It is this which makes Mars, after the Moon, best known to us, so that Kepler was able to say: "It is from the knowledge of Mars that astronomy will reach us, and it is from the study of this planet that the future progress of our science will advance."

The conjunction of two planets is the point of their orbits where they are on the same side of the Sun, and are the nearest possible to each other; the term opposition is given to the opposite point of their paths, when they are on opposite sides of the Sun, except in the case of Mercury and Venus. In olden times these positions greatly exercised the sagacity of horoscope-seekers, and Heaven knows how many destinies have received fancied predictions, according as the god of war was in conjunction in such and such sign of the zodiac. The conjunction in the Bull was not at all the same as that which happened in the Virgin; and when by chance it had the misfortune to occur in the Goat, the most learned were lost in conjectures on the bad fortune predicted to the new-born. The interior planets, Venus and Mercury, whose orbits are inclosed in that of the Earth, have no opposition, but they have two conjunctions; the superior, when the planet is beyond the Sun and in one right line; the inferior, when it is situated between the Sun and the Earth. The exterior planets, those which inclose the terrestrial orbit, and of which Mars is the first, have only the superior conjunction.

At about 80 millions of miles, beyond the planet Mars, between the orbit of this planet and that of Jupiter, we meet with the group of small planets, of which we have already spoken. These are very little worlds, if even they deserve this name, which have scarcely the extent of a province, or even a department. They gravitate in his zone in considerable numbers, for there may exist several thousands. Already 109 have been discovered: the first in 1801 and the last in 1870. Perhaps they are *débris* of a larger world, shattered by some catastrophe; perhaps they have been formed in this region of space in the fragmentary state in which we now see them. This is not decided, seeing that science now, as in the time of Virgil, is not yet able to determine on the origin of things.

"Felix qui potuit rerum cognoscere causas."

Putting aside the title of original greatness of these asteroids, and the fate which attends them, let us traverse their colony, and beyond it get near the most magnificent of the worlds of our system.

VII.

JUPITER.

THE orb of Jupiter is more bulky than all the other planets of our system: it is only a thousand times smaller than the Sun, which makes it, if we remember the volume of that radiant body, from fourteen to fifteen hundred times larger than the terrestrial globe. Also, although it revolves in an orbit nearly 475 millions of miles distant from the Sun, and receives a much fainter light than that received by the Earth, its size is evidenced by the light with which it shines during our starry nights, equal and often superior to that with which Venus shines. Jupiter is therefore reckoned among the most beautiful objects of the heavens. As it is always in the zodiac, and when Venus is visible in the evening it is always in the west, it is easily recognized. At whatever period of the year, therefore, you see a very bright star, either in the east or high up among the zodiacal constellations, you may be certain that it is Jupiter.

This planet is a charming one, so far at least as we are able to judge from afar and without going there. To begin with, a continual spring rejoices its surface. If it is ornamented with flowers, which we do not doubt, though we know not of what these flowers consist, they do not only survive "the span of a morning" as our roses do, but live much longer. Scarcely have the oldest begun to dry up and fade but they are replaced by lovely buds, opening before the first have died away. Not only is the Jovian year equal to twelve of ours, but it is scarcely known when the yearly period begins or ends. No winters, no summers, always spring.

Then Jupiter, as I have stated, presents a surface 126 times more extensive than the terrestrial surface. I speak of surface, not volume. Now, a hundred and twenty-six Earths placed side by side, and on which the human race would be able to spread itself at will, would constitute a very fine country. We ought, then, not to doubt that such an empire has been formed to serve as an abode for a human family, venerable and worthy of our respect. We reason thus *apropos* of Jupiter because we have had the necessary means to measure and appreciate it at its just value. But it is necessary to add something to complete the comparison between this world and our own.

Because we find, by observation of the Jovian planet, excellent reasons for believing that its inhabitants are very favored, it does not follow that the aforesaid inhabitants make similar reflections on us. There is a very good reason why they do not occupy themselves with us—they are probably not acquainted with our existence. And, indeed, if ever, at a future time, more or less distant, you should happen to inhabit Jupiter, you would have great trouble to discover your old country. To do so you would have to rise a little before the Sun (and mark, there are only five hours from the setting to the rising of this body on Jupiter) and five or six minutes before the rising look to the east for a very small white star. With good eyes you perhaps would perceive it. In this case you would know that our Earth exists. Again, you would make the same search six months later, at the west, a few moments after the setting of the Sun. Such is the condition of the inhabitants of Jupiter with regard to us. They can never see the Earth during the night, although it is precisely in the middle of clear nights that we are best able to observe this magnificent planet.

No. Jupiter is an earth, a splendid earth, compared to which ours is only a moon.

If we were allowed to observe Jupiter closely and to accustom ourselves to its nature, to live for some time in the midst of its train, and to appreciate all its importance, we should think our globe very small after such a stay. We should be like the good villagers who came once in their life to see Paris, and who, if they had the misfortune to remain there only a month, could not even think of their village; it became eclipsed by the single remembrance of the splendor they had glanced at.

VIII.

SATURN.

If you happen one day to take a little journey to the planet Saturn, which is scarcely more than 900 millions of miles from us, you would feel on approaching it an unspeakable astonishment, to which certainly no sentiment of surprise felt on the Earth can be compared. Imagine an immense globe, not only of the size of the Earth, but as large as 734 Earths put together. It revolves on an axis with such rapidity that, in spite of its size, it accomplishes its diurnal rotatory movement in about ten hours. Around it, at 20,000 miles distance, above its equator, an immense ring, flat and relatively very thin, surrounds it on all sides. This ring is followed by a second, and this one by a third. Now this system of multiple rings is only a few miles thick, while its diameter is 166,000 miles. They do not remain immovable, but are carried along with a circular movement round the planet, this movement being of still greater rapidity than that of the planet itself. The domain of the Saturnine world is not confined to this. Beyond the ring eight moons are seen revolving in the heavens around this strange system; the nearest of these satellites is separated from the planet's centre by a distance of 120,000 miles; the most remote has an orbit of 2,293,-

Fig. 28 —Saturn and its Satellites.

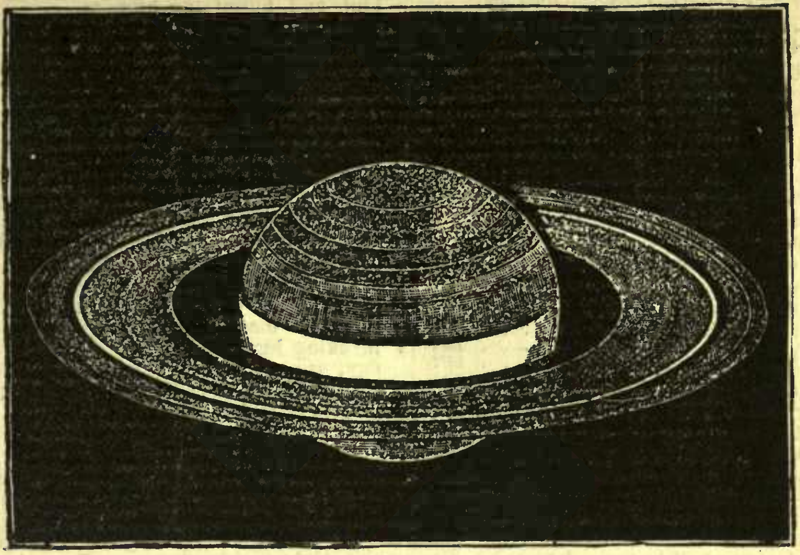

Fig. 29.—Saturn.

000 miles from the centre of the planet. Saturn, then, governs a system which measures not less than four and a half millions of miles in diameter.

By the side of this world the Earth makes but a poor figure, and Micromegas was to be pardoned when, on coming out of Saturn, he mistook the Earth for a molehill. Its years are thirty times longer than ours; of its seasons each lasts seven years and four months; a change remarkably like that which distinguishes our own diversifies them; a regenerating spring succeeds the rigor of winter; summer and autumn pour forth their alternate fruits. But the phenomenon which draws most attention to this world is that gigantic ring which surrounds it. It was long before astronomers were able to give any account of this singular appendage in the planetary system.

Galileo, who first saw on each side of Saturn something bright of which he could not distinguish the form, was greatly astonished with such an aspect. He first announced it under an anagram, in which Kepler himself could not discover anything, and, as he had done with Venus, disguising his discovery, he gave himself time to bring it to perfection. He called it three-bodied, for want of better knowledge. "When I observe Saturn," he wrote later to the ambassador of the Grand Duke of Tuscany, "the central star appears the largest; two others, situated, one to the east, the other to the west, and on a line which does not coincide with the ecliptic, seem to touch it. They are like two servants who enable old Saturn to continue his road, and they remain always at his side. With a glass of small power the star appears lengthened and of an olive form."

The laborious astronomer sought in vain; he was not favored in his researches as in the preceding ones. At the period when the edges of Saturn's rings are presented to us, they disappear on account of their thinness. Galileo, finding on a certain night the absolute impossibility of distinguishing anything on either side of the planet, where, a few weeks before, he still observed the two luminous objects, was completely in despair; he came to the belief that his glasses had misled him. Being entirely discouraged, he no longer observed Saturn, and died without knowing that the ring existed. In the same way, later, Hevelius declared he was puzzled, and it was not until 1659 that Huygens, the real author of the discovery of the ring, made the first satisfactory observation and explained its structure. With the contemporaries of Galileo, Saturn was considered to be a bowl with handles, or a cardinal's hat. In the middle of the eighteenth century Maupertuis conjectured that the ring was only a comet's tail, wound like a turban round the Saturnian globe. Toward the end of the same century Du Séjour wrote his "Essai sur les phénomènes relatifs aux disparitions périodiques de l'anneau de Saturne," in which he found, theoretically, the time of rotation of the ring; he presented his work to Voltaire with the following graceful dedication:

"Monsieur, accept, I pray you, the history of a respectable old man, with whom they will busy themselves on the earth, whilst to know him will be an honor among men; his forehead is wreathed with an immortal crown; he shines on us, and presents one of the most singular phenomena of nature. This aged person is Saturn. I hasten to name him lest he have another given him, which your modesty would prevent you from recognizing. May this analogy gain for my work a favorable reception from you!"

Without the last remark, Voltaire himself, and sooner than any one else, might have thought that Saturn had very little to do with the dedication. At this time Saturn's system included, besides its rings, five satellites revolving round it. Since that time three others have been added, and the cortége is composed of eight members. The following table shows the order of their distances from the planet, their names, the order of their discovery, the discoverers, and date of the discoveries:

1. Mimas	Herschel	1789
2. Enceladus	Herschel	1789
3. Thetis	Cassini	1684
4. Dione	Cassini	1684
5. Rhea	Cassini	1672
6. Titan	Huygens	1655
7. Hyperian	Bond and Lasseli	1848
8. Japhet	Cassini	1671

Saturn has not been favored by ancient poets, who did not guess at its grandeur and richness. Situated at the extreme limit of the planetary system, and marking the frontier until the period of the discovery of Uranus, he was considered as the coldest and slowest of all bodies. It was the god of Time, dethroned and banished in a sort of exile. Misfortune to those who were born under its influence! If, at the moment of birth, it was in the zodiacal sign of the month, the newly-born had nothing more to ask than to go again into nothingness. For a thousand years a considerable number of serious men had full and entire faith in horoscopy, themselves deceived through ignorance and often in sincerity. These ideas, happily having given way before the light of science, are too curious for me not to give a slight specimen. Hear, for example, an astrologer, who wrote, in 1574, the following absurdities:*

"Saturn is in the seventh heaven. He makes rustics; signifies peasants, laborers, and mercenaries; makes thin, solitary, and dreamy people, who, when walking, keep their eyes to the ground; it also signifies stooping, old people, Jews and beggars, mechanics and people of low condition, and causes death, ice, and epidemics; in short, it has no light except that which others impart to it." So much for the conditions; but this is as nothing to the influence of this unfortunate on diseases.

"Saturn," says La Martinière, "is a dull, dry, nocturnal, and malevolent planet, to whom are attributed long, quartan, or daily fevers, indispositions of the tongue, arms, and bladder, general paralysis, gouts, abscesses, obstructions of the heart and spleen, the black jaundice, polypus, diseases of the intestines—such as windy colics, piles, hemorrhoids, hernia, corns on the feet, spitting of blood, canine appetite, difficulty of breathing, stones in the loins and bladder, epilepsy, cachexy, dropsy, melancholy, leprosy, and other diseases proceeding from foul and putrefying humors . . . (all cannot be quoted). Those who are born in its season are melancholy and phlegmatic." Saturn has no idea of having caused such misfortunes to the inhabitants of the earth. Let us hope, for our reputation there, that astrologers in Saturn will not have used reprisals; for, then, of what sorcery will they not accuse us? But we have good reason for believing that we are not viewed ill by the Saturnians; for this reason (which, however, does not do us great honor), that from Saturn they do not see the Earth, as our globe is too small, and is hidden by the Sun.

According to a still more singular author, the devil may be made to appear to us, by invoking him, on the Sabbath-day. Saturday, consecrated to Saturn by a cabalistic formula, extremely long and difficult to pronounce, and by presenting to Saturn a perfume composed as follows: "Mix the seed of poppy and henbane, mandrake-root, powdered loadstone, and good myrrh; reduce these drugs to fine powder, and mix them with some blood of bats and brain of black cats," etc. I will not give the whole, lest you might try the recipe.

Each planet influenced the destinies of men, according to the date of their birth. Thus in the first sign of the zodiac, "Jupiter made bishops, prelates, nobles, powerful people, judges, philosophers, wise men, merchants, and bankers. Mars signified warriors, firebrands, murderers, doctors, barbers, butchers, goldsmiths, cooks, bakers, and all trades having to do with fire. Venus produces queens and beautiful women, apothecaries (how well that follows!), tailors, workers in jewels and ornaments, cloth-merchants, gamesters, those who frequent public-houses, those who play with thimbles, libertines, and brigands. Mercury produces clerks, philosophers, astrologers, geometers, arithmeticians, Latin authors, painters, ingenious and cunning workmen, both men and women, and their arts."

Mars may be compared to Saturn for the bad reputation given to it by astrologers. The following sentence will suffice to show this: "People over whom Mars presides are rough, rude, and invincible, and can be prevailed upon by no reason; they are obstinate, quarrelsome, rash, daring, violent, and accustomed to be deceived by report; gluttons, digesting various meats; strong, robust, imperious; with bloodshot eyes, red hair, not possessing affection toward their friends, but exercising the arts of fire and sword; in short, Mars generally produces furious, quarrelsome, dissolute, self-conceited and choleric men."

As to Venus, no star has had such a favorable influence. It is useless to state in what its action chiefly consisted; but it appeared that those over whom it presided were most happy mortals. These odd and erroneous ideas on a pretended influence of the planets, and all those which constituted the vast astrological domain, arose from man's super-

* La Taille de Boudaroy, *Géomancie abrégée.*

stition, which is always attracted toward the wonderful, and his pride, which represented the universe as formed expressly for him. As long as the old system of the world, founded on appearances, reigned, man was a prey to this morbid error. The torch of true science—of science founded on discussed observations and calculation—was alone capable of bringing light into the midst of this darkness, and dissipating it in proportion as man shall rise more in true knowledge. It will be a more glorious title of honor for the centuries which are to come, to have delivered the human mind from these illusions, and forever to have triumphed over them. Often, in those times when man's life was so easily sacrificed, astrologers, alchemists, and sorcerers were burned alive, hung, broken on the wheel, beheaded, quartered, or executed by long tortures, for having predicted badly. I could point out hundreds of sorcerers burned for pretended witchcraft, or for profanations which arose rather from their credulity than their wickedness; astrologers hung or drowned according to the good pleasure of princes; seekers of the philosopher's stone executed for having made a compact with the devil; but this is not the place; and in speaking of astrology in this chapter on Saturn, I have only wished to profit by the circumstance to show once again what benefits we owe to science, and to what depths man could again fall if ever the torch of science were extinguished. Saturn's world deserves something better from our hands. Not only do we deny the sinister influences of which he is the supposed author, but again we admire in him a magnificent abode of life, in the midst of which the forces of nature continue under aspects which are still unknown to us. Amid his splendid rings, and rich system of eight moons, he reigns peacefully in the heavens; and we love to contemplate his venerable figure, in those distant regions, as the type of a creation already advanced in that era of perfection to which all beings aspire. This disquieting Saturn has not always been treated with more respect by the moderns than by the ancients; has it, in its turn, a bad star? Some people still regard it with an evil eye—for instance, the author of the "Contemplations" made it the place of chastisement of wicked souls, while the happy ones passed from sphere to sphere.

This would be hateful! Let us hope that there are in this picture reminiscences of the ancient ideas on Saturn, and that this globe is less frightful than it looks to the prejudiced. This strange world does not want for riches; and if we were able one day to visit it, doubtless we should find it much more beautiful than the Earth, and we should vow henceforth to reside in such a royal and majestic domain.

Saturn, in the eyes of the ancients, kept the frontier of the solar empire, of which the composing Seven would not see their number increased. Science, daring and independent, which despises opinions and prejudices, has without scruple passed this barrier and discovered two new worlds, which extended the ramparts of the solar domain three times beyond their old position.

IX.

URANUS.

ON the 13th of March, 1781, between ten and eleven in the evening, a quondam organist of Halifax, who had himself made the best telescope then in existence, observed the small stars of the constellation of the Twins, with a telescope of nine feet focal length, and a magnifying power of 227. During his observation he perceived that one of the stars presented an unusual diameter. Astonished, and desiring to prove the fact, he took an eyepiece magnifying double, and found that the diameter of the star increased while that of the others remained the same. More and more surprised, he fetched his magnifying power of 932, being quadruple that of the first, and again observed it. The mysterious star was still larger. From that time he no longer doubted; this was a new body, not a star. He continued the following days, and noticed that it slowly moved among the others. It was, then, a comet. Herschel described it to the Royal Society in a paper entitled, "Account of a Comet;" and the scientific world of all countries registered this new cometary body, and set about observing it in order to determine its orbit.*

The name of the astronomer was then so little known that it is found written in every way: Mersthel, Herthel, Hermstel, Horochelle, etc. Nevertheless, the discovery of a new comet was an event important enough to induce a study of the new body. Laplace, Méchain, Boscowich, and Lexell endeavored to determine the orbit along which it moved. Many months elapsed before they guessed that it was a real planet, and it was not until after having observed that all the imagined orbits for the pretended comet were soon contradicted by observation, and that it probably had a circular orbit, much more distant from the Sun than Saturn, until then the boundary of the system, that they agreed to regard it as a planet. Still this was but a provisional agreement.

It was, indeed, more difficult than was thought thus to increase unscrupulously the family of the Sun. Many reasons of propriety were opposed to it. Old ideas are tyrannical. It had been the custom for so long to regard the venerable Saturn as keeper of the frontiers, that it required a great effort to determine upon withdrawing these frontiers and guarding them by a new world. It happened in this as in the discov-

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* "If Herschel had directed his telescope toward the constellation of the Twins eleven days sooner," said Arago, "the real movement of Uranus would have escaped him, for this planet was on the second at one of its stationary points." It may be seen by this remark on what the greatest astronomical discoveries depend.

ery of the small planets situated between Mars and Jupiter. Two years before this discovery was made, Kepler imagined, for the harmony of the world, a large planet in this space, and the most frivolous and senseless considerations were urged against it. For instance, they reasoned: "There are only seven openings in the head, the two eyes, the two ears, the two nostrils, and the mouth; there are only seven metals; there are but seven days in the week; therefore there are but seven planets," etc. Considerations like these, and others no less imaginary, often hinder the progress of astronomy.

When William Herschel, having been present as a spectator at the debates created by his discovery, came to the belief that his comet was a planet, situated at the confines of our system, he claimed the right, which was indisputably his, of christening the new star. Animated by a lawful motive of gratitude toward George III., who had appreciated his astronomical worth and given him an annual pension, he at first proposed the name of Georgium Sidus, George's star, as Galileo had called the satellites of Jupiter discovered by him, the Medici's stars, and as Horace had said, Julium Sidus. Others proposed the name of Neptune, in order to preserve the mythological character; Saturn would be thus found between his two sons, Jupiter and Neptune. Others added to Neptune the name of George III.; others again proposed Astræa, considering the goddess of Justice was as far as possible from the Earth; Cybele, mother of the gods; Uranus, the most ancient of all to whom reparation was due after so many hundred years of neglect. Lalande suggested Herschel's name, to immortalize the discoverer. These two denominations prevailed. For a long time the planet bore the name of Herschel, but custom has since declared for the mythological appellation of Uranus.

The discovery of Uranus has increased the radius of the solar system from 872 millions of miles to 1753 millions.

Compared with the preceding, this planet is not very large, for it is scarcely eighty-two times more bulky than the Earth. Its seasons last twenty-one years, and its years eighty-four years and a quarter. Around it revolve eight satellites, six of which Herschel himself discovered. These eight moons are rather curious, for instead of revolving from west to east like all moons and planets of the system, they go from east to west, and, moreover, travel at a singularly decided inclination. The reason of this no one can tell.

It was thus, at the period when European society felt the first miseries of the Revolution which was near, that Science with peaceful conquests saw its glory increase, and visited new skies.

X.

NEPTUNE.

THE world which here marks the frontiers of the system is situated at such a distance from the Sun that the light and heat which it receives from it are thirteen hundred times less than that with which the Earth is enriched, so that no great difference can be noticed between the day and night of this distant planet, and to it the solar disk is nearly reduced to the smallness of the stars. Hence it follows that at its surface the stars of the heavens remain visible in the day as well as in the night, and that the Sun is only a more brilliant star than the others. From Neptune, then, the eye, situated between the planetary world and the starry heavens, is in a region where it must be much more sensitive and endowed with peculiar properties, which permit it to especially appreciate the sidereal world and its riches.

2746 millions of miles is the distance which separates this world from the Sun. Until the time of its discovery, the frontiers of the planetary system, already augmented by the addition of Uranus, were confined to an orbit of 1753 millions of miles in radius. Does this, then, imply that these are the utmost limits, and that analysis will not be able to go farther and add fresh members to the already increasing family of the Sun? No. When observations spreading over a long series of years shall have been made, and compared with each other, the universal law of gravitation by which the existence of this planet was known before ever being perceived in the field of the telescope, will prove the existence of others, if others exist, which is probable; and the progress of optics following equally the progress of astronomy will give to the visual power, again magnified, the power to discover such distant planets, which will, doubtless, be of the sixteenth or seventeenth magnitude.

Imagine a body a hundred times larger than the Earth carried into the gloomy deserts of space to the distance of the Neptuian orbit. It floats isolated, in the obscurity of space, following an immense but purely ideal curve, and which exists only in theory in the decree of eternal laws. It follows this curve, and revolves on itself without ever deviating from its path. To finish its immense route and return to its starting point, it requires 164 years. It will return and again pass through this mysterious point of space, which it passed nearly two centuries before. What power moves it? What hand guides this blind body through the night of the distant regions, and what causes it to describe this harmonious curve? It is universal attraction.

Instead of following a regular ellipse round the Sun, the planet Uranus underwent, from some unknown cause, a perturbation, which retarded its theoretical path, and extended its circular curve toward a certain point, as if an attractive cause had seduced the traveller from its path, and had made it deviate from its proposed route. It was calculated that, in order to produce at this point an attraction of such intensity, it was necessary that there should be on that side of the system beyond Uranus, a planet of a certain mass, and at a certain distance. Two astronomers, the one French, the other English, set to work at the same time in this research. They discovered the disturbing cause theoretically, and observers directed their telescopes to the spot thus indicated by theory. They were not long in actually discovering the body near the spot pointed out, and they were able to announce to the world the most brilliant confirmation of universal gravitation.

The distance of this planet had been theoretically deduced from a well-known empirical law called "Bode's Law," which, however, was first given out by Titius. It is as follows. Starting from 0 put down the number 3, and double successively, thus :

0 3 6 12 24 48 96 192 384

Add four to each of these numbers :

4 7 10 16 28 52 100 196 388

Now, it happens that these numbers represent the successive distances of the planets from the Sun, even of the small planets, which were not known at the time this law was promulgated for the first time. The orbit of Mercury is expressed by the number 4 ; that of Venus by 7 ; the Earth by 10 ; Mars by 16 ; 28 describes the mean orbit of the asteroids. Jupiter's is expressed by 52 ; Saturn's by 100 ; and Uranus' by 196. According to this there seemed a legitimate right to place the new planet at the distance of 388. Now the real distance of Neptune is only 300 ; and it is to this irregularity of the series starting from Uranus that we must attribute the disagreement which exists in reality between the elements of the theoretical prediction of Neptune and those given by ulterior observation.

It must be remembered that this formula is not, like that of attraction, the expression of the intimate force which governs the spheres. After Kepler had recognized the three fundamental laws which we have before announced, Newton discovered the mode of action of this universal force, to which we owe the stability of the world. "Bodies attract each other according to their masses, and in the inverse ratio of the square of their distances." In the immensity of the vast heavens, the gigantic suns of space obey this formula, and in the littleness of the actions which are performed on the surface of the Earth, the mechanical functions of small beings do not escape its rule. It is the law of creation, sustaining the life of the edifice in the invisible as in the vast. "Attraction," says the author of "Paul and Virginia," "is a harmonious lyre, which resounds under divine fingers."

When we contemplate these harmonious movements of the spheres in their orbits, in the system confided to the keeping of the Sun ; when we have seen that these formidable laws regulate the movements of stellar systems with the same sovereignty as they direct those which are executed around us, and when to this marvellous grandeur of the laws of nature we compare human weakness and our insignificance in the midst of this sublime creation, we sincerely admire the genius of the men which rose to the idea of these causes : it seems that their power spreads itself to other men, and one feels proud of belonging to humanity.

XI.

COMETS.

These tailed bodies, which suddenly come to light up the heavens, were for long regarded with terror, like so many warning signs of divine wrath. Men have always thought themselves much more important than they really are in the universal order ; they have had the vanity to pretend that the whole creation was made for them, while in reality the whole creation does not suspect their existence. The Earth we inhabit is only one of the smallest worlds ; and therefore it can scarcely be for it alone that all the wonders of the heavens, of which the immense majority remain hidden from it, were created. In this disposition of man to see in himself the centre and the end of everything, it was easy indeed to consider the steps of nature as unfolded in his favor ; and if some unusual phenomenon presented itself, it was considered to be without doubt a warning from Heaven. If these illusions had had no other result than the amelioration of the more timorous of the community, one would regret those ages of ignorance ; but not only were these fancied warnings of no use, seeing that, once the danger passed, man returned to his former state ; but they also kept up among people imaginary terrors, and revived the fatal resolutions caused by the fear of the end of the world.

When one fancies the world is about to end—and this has been believed for more than a thousand years—no solicitude is felt in the work of improving this world ; and, by the indifference or disdain into which one falls, periods of famine and general misery are induced which at certain times have overtaken our community. Why use the wealth of a world which is going to perish ? Why work, be instructed, or rise in the progress of the sciences or arts ? Much better to forget the world, and absorb one's self in the barren contemplation of an unknown life. It is thus that ages of ignorance weigh on man, and thrust him farther and farther into darkness, while Science makes known, by its influence on the whole community, its great value, and the magnitude of its aim.

The history of a comet would be an instructive episode of the great history of the heavens. In it could be brought together the description of the progressive movement of human thought, as well as the astronomical theory of these extraordinary bodies. Let us take, for example, one of the most memorable and best-known comets, and give an outline of its successive passages near the Earth. Like the planetary worlds, Comets belong to the solar system, and are subject to the rule of the Star King. It is the universal law of gravitation which guides their path ; solar attraction governs them, as it governs the movement of the planets and the small satellites. The chief point of difference between them and the planets is that their orbits are very elongated ; and, instead of being nearly circular, they take the elliptical form. In consequence of the nature of these orbits, the same comet may approach very near the Sun, and afterward travel from it to immense distances. Thus, the period of the Comet of 1680 has been estimated at 3000 years. It approaches the Sun, so as to be nearer to it than our Moon is to us, while it recedes to a distance 853 times greater than the distance of the Earth from the Sun. On the 17th of December, 1680, it was at its perihelion—that is, at its greatest proximity to the Sun ; it is now continuing its path beyond the Neptunian orbit. Its velocity varies according to its distance from the solar body. At its perihelion it travels thousands of leagues per minute ; at its aphelion it does not pass over more than a few yards. Its proximity to the Sun in its passage near that body caused Newton to think that it received a heat 28,000 greater than that we experience at the summer solstice ; and that this heat, being 2000 times greater than that of red-hot iron, an iron globe of the same dimensions would be 50,000 years entirely losing its heat. Newton added that in the end comets will approach so near the Sun that they will not be able to escape the preponderance of its attraction, and that they will fall one after the other into this brilliant body, thus keeping up the heat which it perpetually pours out into space. Such is the deplorable end assigned to comets by the author of the "Principia," an end which makes De la Bretonne say to Rétif : "An immense comet, already larger than Jupiter, was again increased in its path by being blended with six other dying comets. Thus displaced from its ordinary route by these slight shocks, it did not pursue its true elliptical orbit ; so that the unfortunate thing was precipitated into the devouring centre of the Sun." "It is said," added he, "that the poor comet, thus burned alive, sent forth dreadful cries !" It will be interesting, then, in a double point of view, to follow a comet in its different passages in sight of the Earth. Let us take the most important in astronomical history —the one whose orbit has been calculated by Edmund Halley, and which was named after him. It was in 1682 that this comet appeared in its greatest brilliancy, accompanied with a tail which did not measure less than 32 millions of miles. By the observation of the path which it described in the heavens, and the time it occupied in describing it, this astronomer calculated its orbit, and recognized that the comet was the same as that which was admired in 1531 and 1607, and which ought to have reappeared in 1759. Never did scientific prediction excite a more lively interest. The comet returned at the appointed time ; and on the 12th of March, 1759, reached its perihelion. Since the year 12 before the Christian era, it had presented itself twenty-four times to the Earth. It was principally from the astronomical annals of China that it was possible to follow it up to this period.

Its first memorable appearance in the history of France is that of 837, in the reign of Louis le Débonnaire. An anonymous writer of chronicles of that time, named "The Astronomer," gave the following details of this appearance, relative to the influence of the comet on the imperial imagination :

"During the holy days of the solemnization of Easter, a phenomenon ever fatal, and of gloomy foreboding, appeared in the heavens. As soon as the Emperor, who paid attention to these phenomena, received the first announcement of it, he gave himself no rest until he had called a certain learned man and myself before him. As soon as I arrived, he anxiously asked me what I thought of such a sign. I asked time of him, in order to consider the aspect of the stars, and to discover the truth by their means, promising to acquaint him on the morrow ; but the Emperor, persuaded that I wished to gain time, which was true, in order not to be obliged to announce anything fatal to him, said to me. 'Go on the terrace of the palace and return at once to tell me what you have seen, for I did not see this star last evening, and you did not point it out to me ; but I know that it is a comet ; tell me what you think it announces to me.' Then scarcely allowing me time to say a word, he added : 'There is still another thing you keep back : it is that a change of reign and the death of a prince are announced by this sign.' And as I advanced the testimony of the prophet who said, 'Fear not the signs of the heavens as the nations fear them,' the prince, with his grand nature, and the wisdom which never forsook him, said, 'We must only fear Him who has created both us and this star. But as this phenomenon may refer to us, let us acknowledge it as a warning from Heaven.'"

Louis le Débonnaire gave himself and his court to fasting and prayer, and built churches and monasteries. He died three years later, in 840, and historians have profited by this slight coincidence to prove that the appearance of the comet was a harbinger of death. The historian, Raoul Glaber, added later : "These phenomena of the universe are never presented to man without surely announcing some wonderful and terrible event."

Halley's comet again appeared in April, 1066, at the moment when William the Conqueror invaded England. It was pretended that it had the greatest influence on the fate of the battle of Hastings, which delivered over the country to the Normans.

A contemporary poet, alluding probably to the English diadem with which William was crowned, had proclaimed in one place, "that the comet had been more favorable to William than nature had been to Cæsar ; the latter had no hair, but William had received some from the comet." A monk of Malmesbury apostrophized the comet in these terms : "Here thou art again, thou cause of the tears of many mothers ! It is long since I have seen thee, but I see thee now, more terrible than ever ; thou threatenest my country with complete ruin !"

In 1455 the same comet made a more memorable appearance still. The Turks and Christians were at war, the West and the East seemed armed from head to foot—on the point of annihilating each other. The crusade undertaken by Pope Calixtus III. against the invading Saracens was waged with redoubled ardor on the sudden appearance of the star with the flaming tail. Mahomet II. took Constantinople by storm, and raised the siege of Belgrade. But the Pope having put aside both the curse of the comet and the abominable designs of the Mussulmans, the Christians gained the battle, and vanquished their enemies in a bloody fight. The *Angelus* to the sound of bells dates from these ordinances of Calixtus III. referring to the comet.

This ancient comet witnessed many revolutions in human history, at each of its appearances, even in its later ones; in 1682, 1759, 1835, it was also presented to the Earth under the most diverse aspects, passing through a great variety of forms, from the appearance of a curved sabre, as in 1456, to that of a misty head, as in its last visit. Moreover, this is not an exception to the general rule, for these mysterious stars have had the gift of exercising a power on the imagination which plunged it in ecstasy or trouble. Swords of fire, bloody crosses, flaming daggers, spears, dragons, fish, and other appearances of the same kind, were given to them in the middle ages and the Renaissance.

Comets like those of 1577 appear, moreover, to justify by their strange form the titles with which they are generally greeted. The most serious writer were not free from this terror. Thus, in a chapter on celestial monsters, the celebrated surgeon Ambroise Paré described the comet of 1528 under the most vivid and frightful colors: "This comet was so horrible and dreadful that it engendered such great terror to the people that they died, some with fear, others with illness. It appeared to be of immense length, and of blood color; at its head was seen the figure of a curved arm, holding a large sword in the hand, as if it wished to strike. At the point of the sword there were three stars, and on either side were seen a great number of hatchets, knives, and swords covered with blood, among which were numerous hideous human faces, with bristling beards and hair." The imagination has good eyes when it exerts itself. The great and strange variety of cometary aspects is described with exactitude by Father Souciet in his Latin poem on comets. "Most of them," says he, "shine with fires interlaced like thick hair, and from this they have taken the name of comets. One draws after it the twisted folds of a long tail; another appears to have a white and bushy beard; this one throws a glimmer similar to that of a lamp burning during the night; that one, O Titan! represents thy resplendent face; and this other, O Phebe! the form of thy nascent horns. There are some which bristle with twisted serpents. Shall I speak of those armies which have sometimes appeared in the air? of those clouds which follow as it were along a circle, or which resembled the head of Medusa? Have there not often been seen figures of men or savage animals?

"Often, in the gloom of night, lighted up by these sad fires, the horrible sound of arms is heard, the clashing of swords which meet in the clouds, the ether furiously resounding with fearful din which crush the people with terror. All comets have a melancholy light, but they have not all the same color. Some have a leaden color; others that of flame or brass. The fires of some have the redness of blood; others resemble the brightness of silver. Some again are azure; others have the dark and pale color of iron. These differences come from the diversity of the vapors which surround them, or from the different manner in which they receive the Sun's rays. Do you not see in our fires, that various kinds of wood produce different colors? Pines and firs give a flame mixed with thick smoke, and throw out little light. That which rises from sulphur and thick bitumen is bluish. Lighted straw gives out sparks of a reddish color. The large olive, laurel, ash of Parnassus, etc., trees which always retain their sap, throw a whitish light similar to that of a lamp. Thus, comets whose fires are formed of different materials, each take and preserve a color which is peculiar to them."

Instead of being a cause of fear and terror, the variety and variability of the aspect of comets ought rather to indicate to us the harmlessness of their nature.

XII.

COMETS (CONTINUED).

THE following are some of the ideas put forth by Maupertuis in his "Lettres sur la Comete de 1742":

In the present day it will not be believed that such distant bodies as comets can have any influence on things here below, nor can they be signs of what is to happen. What connection should these bodies have with that which goes on in the councils and armies of kings?

It would be necessary that their influence should be made known, either by revelation, reason, or experience; and it may be said that we have not met with it in any of these sources of our knowledge. It is very true that there is an universal connection between everything in nature, as much in the physical as in the moral world; each event, bound to that which precedes it, and to that which follows it, is only one link of the chain which forms the order and succession of things; if it were not placed as it is, the chain would be different, and would belong to another universe.

Reasoning thus, the astronomer doubts the non-influence of comets as well as he does their influence; to confirm his ideas, he recalls those of others, and soon comes to the belief that comets cause many other events besides simple colds.

Kepler, to whom astronomy owes so much, thought it reasonable that, as the sea has its whales and its monsters, the air possesses them also. These monsters are comets, and he explains how they are produced.

Some people have believed that comets were expressly created every time it was necessary to announce the design of God to men, and that the angels had the care of them. They added that this explanation solved all the difficulties which could arise in the matter. Lastly, in order that all the absurdities with regard to them may be stated, there were some people who denied that comets existed, and who considered them as false appearances, caused by the reflection or refraction of light. They alone understood how the reflection or refraction was caused, without bodies to cause it. According to Aristotle, comets were meteors formed by exhalations from the earth and sea, and this was, as may be imagined, the decision of the crowd of philosophers who believed and thought only as he did. In older times still, people possessed more correct ideas of comets. The Chaldeans knew that they were material bodies and a species of planet, the courses of which they succeeded in calculating. Seneca embraced this opinion; he speaks to us of comets in a manner so conformable with all that is known of them in the present day, that it may be said that he guessed what the experience and observations of moderns have discovered.

It was after having spoken of the opinions of the ancients that Maupertuis explained his own. "The regular course of comets no longer allows them to be considered as warnings, or as lighted torches to terrify the Earth. But although a more perfect knowledge than that which the ancients had prevents us from regarding them as supernatural warnings, it teaches us that they may be the physical causes of great events." He dreads the approach of the tailed bodies to the Earth. In the variety of their movements he sees the possibility o an encounter with some planets, and, consequently, with the Earth. It cannot then be doubted, says he, that terrible accidents will happen from the simple approach of these two bodies, for such approach would make great changes in their movements, either because of the attraction which they exercise over each other, or because of some fluid confined between them. The least of these movements would do nothing less than change the situation of the axis and poles of the Earth. That part of the globe which was formerly toward the equator would be found, after such an event, near the poles, and that which was near the poles would be found toward the equator. "The approach of a comet," he adds, "might have other still more frightful consequences. I have not yet spoken to you of the tails of comets. On these, as on comets, strange opinions have been held; but the most probable is that they are principally composed of immense torrents of exhalations and vapors, which the Sun's heat draws from their nuclei. A comet, accompanied by a tail, may pass so near the Earth that we may find ourselves immersed in the torrent which it carries with it."

Such is the perspective to which we are by degrees conducted by this physicist; but he gives us a singular consolation. As the human race would all perish together in this catastrophe, being swallowed up by boiling water, or poisoned by mephitic gases, and as no one would remain to weep over the agony of the Earth, he tells us it is easy to console ourselves. "A universal misfortune is scarcely a misfortune. It would be he whose unfortunately too-robust temperament would make him survive alone in an accident which had destroyed the whole human race except himself, who would have to lament! King of the whole Earth, possessor of all its treasures, he would perish of sadness and ennui: his whole life would not be worth the last moment of him who dies with those he loves."

Thus, in the last century, people still believed in the terrible power of these unhappy stars. In the present day, and especially since the famous comet of 1811, country people have imagined rather that they predicted excellent vintages. These ideas are as void of proof as the former. Although these bodies have greatly lost their prestige, they have not been entirely despoiled of it. Moreover, who could efface the impression produced by some of their aspects? Often they have been considered as signs of curses hovering over men and empires.

Nevertheless, nothing proves that comets are gifted with any influence whatever, I do not say on the morals of men, but on the physics of the world. Their lightness, the extreme diffusion of their substance, induces us to believe rather that they possess no kind of action on the planets. Let us imagine that they are harmless. Like atmospheric clouds, whose magnitude, form, and shade vary with the caprice of the winds and according to the fortuitous play of solar rays, the vaporous agglomerations which form comets take every possible form under the impulsion of cosmical forces more or less intense. At their approach to the fiery body, their substance distends itself, assumes a wonderful size, and develops itself over an expanse f many million leagues. They are of such lightness and suppleness that a ray of heat may, at its will, cause them to take any shape: you have an instance of this lightness in the comet recently observed in 1862; the form and position of the luminous appendages changed from day to day; and observers might have believed that even a portion of the substance of the nucleus flowed into space. On the other hand, their rarity is such that out of the tails of certain comets we should be able to cut a piece the size of Notre Dame, and inhale it as a homœopathic inspiration. Comets have been seen several million leagues long, whose mass was nevertheless so small that it would have been possible, without fatigue, to carry it on one's shoulder. Thus, the extreme variability of the cometary forms ought to proclaim these terrible bodies harmless.

And, indeed, these celestial bodies are not exceptional phenomena; they are subjected, like others, to the inexorable laws of nature. Two thousand years ago Seneca wrote, "A day will come when the course of these bodies will be known, and submitted to rules, like that of the planets." The prophecy of the philosopher is realized. It is now known that, like the planets, comets gravitate round the Sun, and depend equally on its central attraction. Only, instead of moving in orbits, circular, or nearly so, they describe oval curves—very long ellipses. This is the great distinction established between them and planets. Instead of being opaque, heavy, and important bodies like our planets, they are of great lightness, and extreme tenuity. One day, a comet carried away by its rapid march, traversed the system of Jupiter; the satellites and the planet were for some hours surrounded by the comet; and when the body had passed over them they had not undergone the slightest deviation in their path. When Maupertuis, wishing to explain the origin of Saturn's ring, thought he had conceived an ingenious idea in attributing this appendage to the tail of a comet which was wound round the planet, he did not dream of the extreme rarity of these impotent vapors.

The distinctive character of comets lies especially in the length of their course, and in the immense duration of their journeys round the Sun, through the celestial regions.

BOOK FOURTH.

I.

THE TERRESTRIAL GLOBE.

WHILE reviewing the worlds belonging to solar rule, we passed over the space which separates Venus from Mars without noticing a body which occupies the mid-distance. This body, moreover, ought to interest us somewhat, for it relates to us more nearly than all the others.

The Earth, isolated in space like all the other planets that we have seen, is situated some 91 millions of miles from the Sun, and journeys along an orbit which it traverses in 365¼ days. Like some of its companions, it has a faithful attendant—a satellite revolving round it. This is its little system, and the Moon accompanies it humbly in all its voyages through space.

Like the other planets, also, it rotates on an axis with great rapidity, for at some parts of its surface bodies travel at the rate of 1000 miles an hour. It is spheroidal, and rather flattened at its poles, which proves its primitive state of fluidity. Of this state, a proof more easy to recognize still remains in its volcanoes, with their open craters, from which are ejected the interior substances of the Earth in the state of fusion, and at the high temperature in which they exist at the present time. Correctly speaking, the whole Earth is still a globe of liquid substances, melted by the intense heat which glows under our feet; for the solid stratum of this globe—the crust which surrounds it, and on which we live—is not, it has been estimated, a hundred miles in thickness. The Earth resembles a thin glass globe, a yard in diameter, filled with metals in a state of fusion. If there were not some apertures—that is to say, some volcanoes, to allow the vapors to escape, it might happen that the globe would burst. What is the real size of this globe? Imagine a gigantic die, each side of which would measure one mile in length; you would have then a volume of one cubic mile. To form a volume equal to that of the Earth, it would be necessary to heap up 260,613 millions of these cubic miles.

What is its weight? We have already glanced at it in speaking of the Sun's weight. To express it in tons, it requires a row of twenty-two figures.

The weight of the atmosphere which surrounds the Earth is not the millionth part of the weight of the whole Earth; yet each of us carries on our shoulders a pressure of about 8000 pounds. Let us add, in passing, that this pressure, although not to be despised, is not perceptible to us, because it is counterbalanced by an equal pressure exercised in the opposite direction by the fluids within our body.

The surface of the Earth is about 197,000,000 square miles. Of this surface the ocean occupies 145,000,000 square miles; only 52,000,000 therefore remain for *terra firma*. There is then only about a quarter of the Earth's surface which is habitable; the remainder lies hidden in the bosom of the waves.

By retreating into space we should be better able to judge of the Earth as a star. At the distance of the Moon, that is, about 240,000 miles, the Earth would appear to us as the Moon does, being not less luminous and much larger. At ten times this distance the Earth would still present to the naked eye a perceptible disk, and its light would be intermediate between that of the Moon and that of the stars. Again, at ten times farther, that is to say, at the distance of the orbit of Venus, the Earth would be seen under the form of a beautiful star of the first magnitude, without any appreciable disk, as a brilliant point, similar to Jupiter. But if we go farther still, the Earth, already promoted from the rank of a planet to that of a star of the first magnitude, will afterward fall from magnitude to magnitude to the last order of visibility, and would be finally lost in the depths of the invisible. It is scarcely necessary to add that the light with which it shines and with which it is radiant in space is no other than the light received by us from the Sun, and it would be seen under every possible phase, according as it would be observed fully lighted up, or from one side, or obliquely, or when turning round its opposite hemisphere to the Sun.

The Earth revolves round the Sun, with a

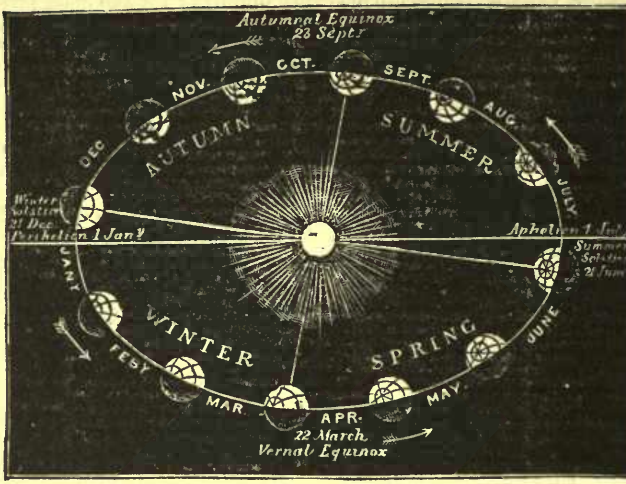

Fig. 30.—Orbit of the Earth.

movement of translation similar to that which we have noticed in the case of all the planets. It is this movement which constitutes its year. Its rotatory movement on its axis, which may be compared to that of a spinning top, constitutes its diurnal period, its day. It is to this second movement that we owe the illusion of the apparent movement of all the stars.

All that has been said on the diurnal movement of the stars round the Pole Star will be easily understood if we reflect that this star lies in the continuation of the axis of the Earth. The Earth turning, suppose, from left to right in our northern hemisphere, all the objects situated outside it, that is to say, the stars, appear to turn from right to left, in the direction contrary to the movement which carries us on. When you are in a railway carriage, if you forget the movement of the train, the objects you pass will appear to fly behind you, and if you did not know for certain that it was you who were moving, believing yourself stationary, you would have the conviction that it was the trees and hills which are travelling. A similar delusion presents itself when we find ourselves on the top of a high tower, and the clouds pass rapidly above us. It seems as if the tower advances and moves under our feet. One morning I was at the top of the steeple of Strasburg Cathedral; the sun had scarcely risen, and some clouds coming from the Rhine had entirely hidden the town and the whole lower space from me. These cloud-bands were driven by an east wind and passed below me. In spite of the complete certainty that I naturally had of the stability of the high cathedral, it was impossible to keep in my mind the feeling of reality, but the delusion carrying it away, I believed myself again in the train—the cathedral certainly moved toward Germany. I closed my eyes, but the movement continued its action in my mind, and it was not until ten minutes after, when the Sun had lighted up the scene and cleared away the vapors, that the roofs of Strasburg restored me to the reality. The apparent movement of revolution of the Sun round the Earth, which seems to be effected from east to west—the opposite of the real movement of the Earth, from west to east—constitutes our day and night. The moment at which the Sun attains the middle of its course, the culminating point, is that which divides the day into two equal parts. The opposite moment, when the Sun is diametrically under our feet, marks the middle of the night. From this it is evident that our noon is the midnight of the people who live in the countries situated on the opposite side of the Earth, and that, conversely, when they have noon we have midnight. The Sun then regulates time by passing over the heads of each of the nations which inhabit the globe. The civil day commences at midnight, and is composed of two periods: the morning, from midnight to noon; the afternoon, from noon to midnight. Astronomers do not follow this custom; they reckon their day from noon, and make of it one period, from 0 hour to 24 hours, which they count from noon to the following noon. Let us now see how the Earth is studied, and by what means its different parts are recognized.

As the Earth is a sphere, the two points at the opposite extremities of the ideal axis around which it rotates are called the poles. If we trace, perpendicularly to this axis, a large circle at an equal distance from the two poles, which would cut the sphere into two equal portions, this circle is the equator. Now the distance from the equator to the poles on each side of it is divided into ninety equal distances; these are degrees of latitude. Lastly, the great equatorial circle itself, or the entire circumference of the globe, is divided into 360 equal parts by other great circles passing through the poles arranged on the sphere, like the slices of a melon; these are the meridians of longitude. There are, consequently, 180 in each half of the sphere, and ninety in each quarter. These names, longitude and latitude, date from a time when the terrestrial region, which had alone been measured, was supposed to be an oblong figure, the length of which extended in the direction of the equator, and the width in that of the meridians.

Degrees of latitude then are counted starting from the equator; either north or south, as far as the north pole or the south pole. The degrees of longitude cut them, and are counted from any point, being reckoned toward the east entirely round the globe. The line of the poles goes from north to south, or south to north, indifferently; the line of the equator goes from east to west, or from west to east. When we advance from the eastern to the western side we do not change

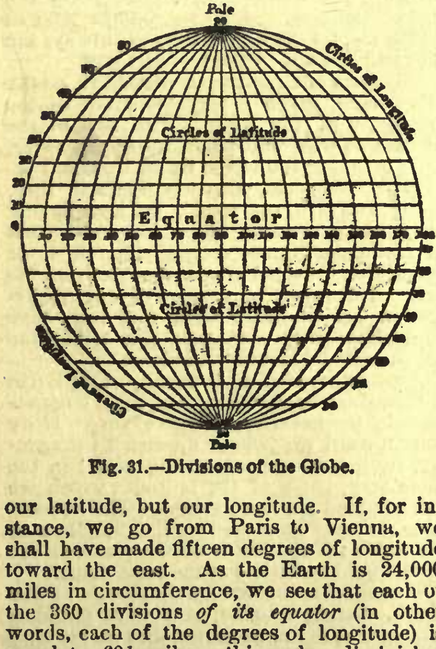

Fig. 31.—Divisions of the Globe.

our latitude, but our longitude. If, for instance, we go from Paris to Vienna, we shall have made fifteen degrees of longitude toward the east. As the Earth is 24,000 miles in circumference, we see that each of the 360 divisions *of its equator* (in other words, each of the degrees of longitude) is equal to 69½ miles; this value diminishes toward the poles. Moreover, as the sun employs twenty-four hours for the journey it seems to make, it appears to travel 15 degrees an hour, 180 in twelve hours, and 360 in twenty-four hours; each hour being equivalent to 15 degrees. Thus, at Vienna, noon is an hour earlier than at Paris. Going on toward the east, the traveller will gain an hour every fifteen degrees, and if he keeps his watch according to London time it will be on hour slow for every fifteen degrees. If he goes round the world travelling east, and if he sets his watch by the time of the countries through which he travels, it will advance on London time, in proportion as he continues his journey; when he arrives in London after having thus made the tour of the world easterly, he will have gained twenty-four hours, and will reckon a day more than we do: it will be Monday with him while with us it is Sunday.

It is on account of this difference in the time that if, on visiting the borders of the Rhine, you take the train at Kehl for Strasburg, as the Kehl station is regulated by the Baden time, and that of Strasburg by Paris time, you will arrive at Strasburg ten minutes before the time of your departure from Kehl.

For the same reason, when the Emperor of the French delivers his speech at the opening of the Chambers, this speech flying to London by telegraph, the conclusion may be read by us before it has left the lips of the Emperor, reckoning merely by time. The watch of another traveller, going west, will be too fast, unlike our preceding one; and if he sets it by the time of the countries through which he passes, on returning to London, after having gone round the world with him, it will only be Saturday, while with us it is Sunday. This singularity in the way of reckoning would be experienced every time a vessel arrived which had been round the world, if it had counted the days without conforming to the time of the countries through which it passed.

For the same reason, says Lalande ("Astronomie des Dames"), the inhabitants of the South Sea Islands, which are twelve hours distant from our meridian, must see that travellers who come from the Indies and those from America count the days of the week differently, the first being one day in advance of the others; for, supposing that it is Sunday at noon at London, those who are in India say that Sunday noon has already passed six or seven hours; and in America it will still be Saturday evening. This fact appeared very singular to our old travellers, who were accused at first of having made a mistake in their almanac, and of having lost the thread of their calculation. Dampier, on going westward to Mendanao, found that there they were a day in advance of him. Varenius said the same at Macao, a maritime town in China. The Portuguese always reckon a day in advance of the Spaniards at the Philippines, although not so distant; the former have Sunday, while the latter only count Saturday. The reason of this is, that the Portuguese who settled at Macao went there by the Cape of Good Hope, travelling from the west—that is to say, starting from America and crossing the South Sea.

It will be seen from this sketch that the Earth is a planet, and is regulated by planetary movements; that there is nothing absolute in any of these data of time and space; that all is relative to the condition of each planet; and that on each of the planets these elements differ according to their magnitude, as do the movements which give rise to them. But, it may be asked, on what grounds are these theoretical rules established, and what proves to us that, on the other hand, the Earth is not the absolute fixed world, established as the base of the heavens, and that all these movements are not real as they appear? How can it be proved that this is delusion of our senses; and, since it has been discovered only through observation, how has it been known that these are only simple appearances?

If you will listen to me for a few moments you will be as convinced on this subject as I am.

II.

PROOFS THAT THE EARTH IS ROUND—THAT IT TURNS ON AN AXIS, AND REVOLVES ROUND THE SUN.

I have known people who were never so eager as when addressing a thousand astronomical questions to me, and who had no sooner received my answers than they ridiculed all with the greatest ingenuity. Without noticing their really primitive rudeness, it was astonishing to see them, at the same time, so curious and yet so difficult to please. In their eyes scientific men were dreamers, who fancied they understood, but who, in reality, were as unable as the rest of the world to discover the secrets of nature.

I have known others, a little more intelligent than the former, but who, considering the different phases of the history of the science, its successes and its reverses, thought that we turn in a vicious circle, that we do not possess the true knowledge of things, and that our systems, however solidly based they may appear, must never be received but as hypotheses.

The cosmographical question which touches us most nearly, that of the isolation and movement of the Earth in space, especially dissipates the doubts of which I speak. For those who have heard these doubts stated, and who have not always undeniable proofs ready to hand, I shall give here the fundamental points on which this element of the new system of the world rests. We state, first, that the Earth is round; that it has the form of a sphere rather flattened at the poles. The first fact which bears testimony to this is the convexity of the immense expanse of water which covers the greater part of the globe. The mere sight of a ship at sea suffices to prove this curvature. On reaching the blue line which seems to form the separation of the sky and the water, the receding ship appears for a moment to rest on the horizon. A little later it disappears, not the upper, but the lower part. The sea rises at first between the hull and the observer; afterward it hides the lower sails; the tops of the masts are the last to disappear. A similar phenomenon is visible to an observer placed on the ship; the lower coasts vanish first; the buildings, high towers, and lighthouses being the objects which remain longest visible. This double fact proves, in an evident manner, the convexity of the sea. If it were a plane surface, the distance alone would hide a vessel, and in this case all would disappear together, the upper as soon as the lower sails.

It follows, moreover, from this same kind of observation, that the curvature of the ocean is the same in every direction; now this property belongs only to the sphere.

The convexity of the sea extends itself to the solid land. In spite of the inequalities of the ground, the surface of the continents does not differ essentially from the seas; for it is known that the highest chains of mountains are far from producing, on the general surface of the Earth, protuberances comparable to the corrugations of the skin of an orange. Now, the rivers which divide the solid Earth in every direction, to be again united in the ocean, are scarcely higher than its level, and may be considered as the continued surface of the sea throughout the whole extent of the continents. The barometric measures of the heights of mountains have confirmed this fact. The land of the continents deviates little from this level, and presents, as a whole, a curvature entirely like that of the seas. Moreover, on the land as on the sea, the highest objects are always the first and last which the traveller sees.

Voyagers of circumnavigation have, on the other hand, given a palpable proof of the sphericity of the Earth. The first of the navigators who undertook the daring enterprise of going round the world was the Portuguese, Magellan, who left Spain in 1519, going always to the west. Without having changed its direction, one of his vessels (that of Lieutenant Cano) reached Europe three years afterward, as if it had come from the east. The numerous voyages of circumnavigation accomplished since that time have superabundantly confirmed this truth—the Earth is round in every direction.

Another proof of the convexity of the Earth is furnished by the change of aspect undergone by the heavens during voyages. If we steer toward the pole or approach the equator, fresh stars are continually seen; in the same way, those of the latitudes which we leave behind are lost to sight. This appearance can only be caused by the roundness of the Earth; if the Earth were a plane, all the stars would be visible at the same time.

The shadow thrown by the Earth on the Moon, during eclipses, is always circular, whatever side the terrestrial disk at the time presents to the lunar disk. This conical shadow, invariably observed, is a fresh proof in favor of the sphericity of the Earth.

Such are the common facts which prove, in a positive way, the truth we have put forward. If we desired to enter into questions of geodesy or mechanics, I could present more rigorous considerations still; but the preceding proofs are sufficient for us here.

Let us now see what basis of truth they have who assert that the Earth is isolated and in motion through space. The difficulty which certain minds have in believing that the Earth can be suspended like a balfoon in space, and completely isolated from every kind of support, proceeds from a false notion of gravity. The history of ancient astronomy shows us the profound perplexity of the first observers who began to conceive the reality of this isolation, but could not understand what hindered this heavy globe, on which we live, from falling. The early Chaldeans supposed the Earth hollow, and similar to a boat; it could then float on the abyss of the ether. Some ancients fancied that it rested on pivots placed at the two poles. Others supposed that it stretched indefinitely below our feet. All these systems were conceived under the impression of a false idea of gravity. To rid ourselves of this old delusion, it is necessary to know that gravity is only an effect produced by the attraction of a centre. A body never falls but when the attraction of another more important body solicits it. The expressions "from above" and "from below" can only be applied to a determined material system, in which the attractive centre may be considered as the bottom; beyond this they signify nothing. When, then, we suppose our globe isolated in space, we do nothing which can give rise to the objection before mentioned—namely, that the Earth will fall.

The Earth may be isolated in space. But not only may it, but it is so in reality. If it were supported by a neighboring body at some point of its surface, this support, which would necessarily be of very great dimensions, would certainly be perceived when it was approached. It would be seen projecting from the Earth and losing itself in space. There is no necessity to state that travellers who have gone round the world in every direction have never perceived anything like this; the terrestrial surface is entirely detached from everything which exists around it. We now come to the third point of this chapter, to the positive proofs of the Earth's motion.

Let us notice, first, that the appearances of exterior objects will be identically the same to us whether the Earth being in repose these objects are in motion, or these objects being in repose the Earth itself is in motion. If the Earth carries in its movement everything which belongs to it—seas, atmosphere, clouds, etc.—we should only be conscious of this movement, in which we participate, by the changing aspect of the immovable sky. Now as, in both cases, the appearances are the same, we are going to show that the hypothesis of the Earth's movement explains everything, while without it we fall into an inacceptable complication of systems.

If the Earth turns on its axis in twenty-four hours, we see directly that its mean radius being some 8000 miles, and its circumference 24,000, a point situated on the equator would travel 1000 miles an hour. This velocity, which seems considerable, has been thought to be an objection against the movement of the Earth. But we shall see with what tremendous velocity it would be necessary to animate the heavenly spheres to cause them each to traverse the circumference of the heavens in the same lapse of twenty-four hours.

In the first place, the Sun being distant from the Earth 23,000 times the terrestrial radius, on the hypothesis of the immobility of the Earth, the Sun would describe a circumference 23,000 times greater than the equator, that is, it would travel 23,000 times 1000 miles an hour!

Jupiter is about five times farther away; its velocity would be more rapid still; Neptune, thirty times; it would travel still faster. Such would be the different velocities with which the planets would be animated if they revolved round our globe in twenty-four hours, at they appear to do. It shows that the objection against the movement of the Earth on the ground of rapid motion is untenable. What would this motion be if we should consider the fixed stars? Our neighbor, the star α of the Centaur, must travel more than a million times faster than 1000 miles an hour, and so on with all the stars, until with the more distant ones we should fail to find a number to express the velocity of their motion in revolving around this invisible point which we call the Earth.

Let us add to this that these bodies are, one, 1400 times larger than the earth, another, 1,400,000 times, and others more bulky still; that they are not united one to the other by any solid tie which connects them with the movement of the heavenly vault; and that they are all situated at the most diverse distances; and this fearful complication of the system of the heavens will itself bear witness of its non-existence—we might say of its mechanical impossibility.

But not only is it impossible for the diurnal movement of the celestial sphere to be understood except by the admission of the movement of the Earth on its axis, but the movements of the planets in the zodiac, their stations and retrogradations, demand it as imperatively. To explain the planetary appearances, supposing the Earth immovable, the ancients imagined as many as seventy circles placed one within the other, solid circles or crystal heavens, which nothing could surpass in complication, and which if they could exist for an instant would have soon been dashed to pieces by wandering comets or aerolites which we meet in space.

Again, on the other hand, analogy singularly confirms the hypothesis of the movement of the Earth, and changes into certainty its great likelihood. The telescope shows in the planets, globes analogous to our own, which have a rotatory movement on their axes, a rotatory movement of twenty-four hours' duration in the case of the nearest planets, and of a less duration still in the case of the more distant ones. Thus, simplicity and analogy are in favor of the Earth's movement. Let us now add, that this movement is rigorously required and determined by all the laws of celestial mechanics. The great difficulty which has been advanced against the movement of the Earth, and which was in favor for some time, was this: if the Earth turns under our feet, if we raise ourselves up into space, and find the means of supporting ourselves for a few seconds or more, we ought to fall after this length of time on a spot more to the west than the starting-point. For instance, at the equator, he who could find means to support himself immovable in the atmosphere for half a minute, must fall some miles to the west of the place whence he started. This would be an excellent way of travelling, and Cyrano de Bergerac claimed to have used it when, having raised himself in the atmosphere by a balloon of his own, he fell, a few hours after his departure, in Canada instead of coming down again into France. Some sentimentalists, Buchanan among the rest, have given to the objection a more tender form, saying that if the Earth revolved, the turtle-dove would never dare to rise from her nest, for soon she would inevitably lose sight of her young ones.

The reader has already replied to this objection by considering that all that belongs to the Earth participates, as we have stated, in its rotatory movement, and that to the last limits of the atmosphere our globe draws all in its course.

Direct observation of different phenomena has confirmed the theory of the movement of the Earth, and has confirmed it by undeniable material proofs.

If the globe turns, it develops a certain centrifugal force; this force will be *nil* at the poles, will have its maximum at the equator, and will be greater in proportion as the object to which it is applied is at a greater distance from the axis of rotation. This is, on a large scale, similar to that which exists on a smaller one in the case of a string, or wheel in rapid movement. Now, let us suppose that we fix a plumb-line to the top of a tower, and allow the weight which stretches it to descend to the ground; the direction of this plumb-line toward the centre of the Earth, that is to say, the perpendicular to the water level, will be slightly modified by the effect of the centrifugal force, resulting from the rotation of the globe, measured at the foot of the tower. If we fix also at the top of the tower, a little to the east of the first, a second very short plumb-line, so that its weight is situated a little below the point of joining, this second line will not have quite the direction of the first, for the centrifugal force due to the movement of the Earth being greater at the top of the tower than at the foot, will cause the line to deviate a little to the east. This minute observation has been made and repeated with the greatest care; it is, in its way, a proof of the rotation of the Earth.

The oscillations of the seconds pendulum support the foregoing fact. Not only are they slower at the equator than at the poles, because the equatorial radius is greater than the polar radius, but the difference is too great to be attributed to this cause alone. At the equator the centrifugal force partly counterbalances the effect of the weight. A curious remark to be made here is, that at the equator this force is $\frac{1}{289}$ of the weight. Now, as the force increases in proportion to the square of the velocity of rotation, and as 289 is the square of 17, if the Earth turned 17 times quicker, bodies at the equator would no longer weigh anything; a stone thrown into space would not fall.

Here is another fact no less positive than the preceding, and more easy to appreciate, as another proof in favor of the movement of the Earth. If the Earth were immovable, and the starry sphere revolved round it in twenty-four hours, the stars would never pass the meridian, would never rise or set, at the time predicted from their longitudes in the heavens. The luminous rays which they send to us, taking unequal intervals to reach us according to their relative distances, would cause an extreme confusion in the hours of their apparent passages. A star, for instance, which, in reality, passes now at the meridian, but is situated at such a distance that its light takes six hours to reach us, will only appear to pass it six hours later, that is to say, at the time of its setting. Another will be twelve hours late; another months or years, and so on. This is another material proof that it is not the heavenly spheres which move, but the Earth itself. The real annual movements of the stars in the heavens, of which we have spoken when stating the method used to determine the distances of the stars, furnish an equally positive proof of the movement of the Earth round the Sun. It is the same with the phenomenon of the aberration of light. The physics of the globe also furnish their contingent of proofs to the theory of the movement of the Earth; and it may be said that all branches of the sciences, nearly or distantly connected with cosmography, are united in the unanimous confirmation of this theory. The very form of the terrestrial spheroid shows that this planet was a fluid mass animated with a certain velocity of rotation, a conclusion to which geologists have arrived in their researches. Other facts, as the currents of the atmosphere and the ocean, the polar currents and the trade-winds, equally find their cause in the rotation of the globe; but these facts have less value than the preceding ones, seeing that they might agree with the hypothesis of the movement of the Sun.

We shall conclude by recalling M. Foucault's brilliant experiment at the Pantheon, in Paris. Unless we deny the evidence, this experiment proves indubitably the movement of the Earth. It consists in fixing a steel wire by its upper end into a metallic plate, solidly fitted into a ceiling. The wire is then stretched at its lower end by a rather heavy copper ball. A pointer is attached below the ball, and fine sand spread on the ground to receive the trace of this point. We have a long pendulum; and when the pendulum is in motion it happens that the point does not always trace the same line in the sand. Successive traces which cross at the centre follow each other, and show a deviation in the plane of the oscillations from east to west. In reality, the plane of the oscillations remains fixed; the Earth turns underneath from west to east. This last experiment has placed the seal on the positive proofs of the movement of the Earth.

Thus, like all the heavenly bodies, the Earth revolves. Absolute repose does not exist in the universe; all is in motion; and it is on this universal law of movement that the stability of the world rests.

But a question presents itself here: the Earth turns; we grant it! But is it possible for it to stop? Or what would happen if, by any chance, it ceased suddenly or by degrees, to revolve in its rapid motion? Let us see: the subject is worth the inquiry, as it is very curious. In trying to reply to this strange question, I wish to give it more importance than it really possesses. That our globe will one day cease to revolve is what we may fearlessly declare impossible; and that with all the authority which belongs to the principles of celestial mechanics. On the part of our world, we have nothing to expect or to fear from this chimera. I say, to fear! For here are the inevitable consequences which would follow from the simple arresting of the Earth in its course.

Let us first call to mind that the motion of a body situated on the surface of the Earth is composed of two portions—the movement of diurnal rotation of the globe on its axis, and its movement of translation round the Sun. In virtue of the first, the bodies placed on the terrestrial equator travel 1000 miles an hour. This velocity diminishes from the equator, where it is a maximum, to the poles, where it is *nil*, as bodies have naturally so much longer a path to travel as their latitude is less. In consequence of the second movement of the Earth—its revolution in space round the Sun—each particle of its mass travels 68,000 miles an hour.

An idea may be formed of this velocity if we reflect that an express train at full speed does not go more than sixty miles an hour, and that a 24-pounder ball has only, on its leaving the cannon, a velocity of some 300 yards a second.

As every part belonging to a material system in movement is animated with the same motion, if by an abrupt stoppage this system is suddenly brought to repose, the portions which can be displaced at its surface will continue, in virtue of the acquired velocity, to move in their original direction. It is on account of this principle that when your horse suddenly falls under the pole of your rapid chariot, you find yourself unfortunately thrown over the head of your Pegasus. It is also in virtue of the same principle that you must take certain precautions in descending from an omnibus in motion, since your feet being suddenly placed on the immovable ground while your body is still animated with the acquired velocity, you are inclined to tumble forward.

The Earth is, as we have seen, a more rapid conveyance than omnibuses, carriages, or trains. If it were to stop suddenly, all precautions would, without doubt, be unavailing to avoid instantaneous death. All objects which are not implanted and fixed in the ground, all which only adhere to the surface by the law of gravity, would be immediately, and all together, projected into space with a tremendous velocity—with the velocity, in fact, of the Earth in its orbit. Peaceful pedestrians, laborers, and quiet people, domestic and wild animals, the birds of the air, our carriages and machinery—all would be sent forth at a single bound in the direction of the movement of the Earth. As to the ocean, which covers two thirds of the globe, its liquid mass, rushing over the shores would submerge in the twinkling of an eye the islands and continents in its impetuous course, crowning the edifice of death. Soon it would reach above the highest mountains, and would cause our globe to undergo a transformation of surface, such as the ancient revolutions which have disturbed it have never equalled. Theorists who occupy themselves in finding a natural cause for the biblical deluge have not omitted to bring forward this powerful one, and to suggest that the shock of a comet would easily effect this arrest and its sad consequences. We now know that a comet could pass over the Earth without our perceiving it.

Another very curious fact which would follow the annihilation of the velocity of the Earth is this: the centripetal force which attracts the planets toward the Sun being no longer counterbalanced by the centrifugal force, the Earth would fall in a straight line into the Sun. If there were any other beings on the globe besides the fishes to see it, the Sun would be seen to increase visibly, and to swell out gigantically. The Earth would reach it sixty-four days after the shock, and would disappear in its surface as an aerolite does on the surface of the Earth.

Of course our globe is not an exception to the general rule; the same end would happen to the other planets if they found themselves in the same case. Thus, if the motion of Mercury, Venus, Jupiter, or Saturn were stopped, these planets would fall into the Sun—the first in fifteen, the second in forty, the third in seven hundred and sixty-seven, the last in nineteen hundred days.

But here is another consequence, still more curious, which would immediately follow from the sudden stopping of the Earth in its course.

It is acknowledged that motion can no more be annihilated than any atom of matter; it may be communicated, divided, or hidden in a certain quantity of other forces, but not annihilated. It may—and this is the important point here—it may be transformed into heat; and it is actually so transformed every time it appears to be lost as motive power. Thus you strike a nail, firmly driven in and immovable, several times: the movement of the hammer not being communicated to the nail, is transformed into heat—you can easily perceive it by the touch. It is needless to multiply examples: every one has proved by experiment this mechanical transformation of heat.

Now, if by any cause the motion which animates our globe should be instantaneously suspended, this motion would unerdgo this transformation of which we have spoken. The Earth would be all at once heated; and do we wish to know to what degree? The quantity of heat engendered by the arrest of the terrestrial globe due to a colossal shock would not only suffice to melt the whole Earth, but also to convert the greater part of it to a state of vapor.

This consequence crowns and absorbs all the preceding ones. The Earth would no longer be a planet; its volume and density would be changed entirely, and what we have just pointed out as to the inordinate movement of the bodies on its surface, the overflowing of the seas, and its fall into the Sun, would no longer be applicable; all these consequences suggested by mechanics would be modified according to the force which impeded the movement of the Earth. If this stoppage were only a progressive slackening, the accomplishment of which would require a length of time instead of being instantaneous, the Earth would still become hot enough to cause all living beings on its surface to perish suddenly.

Let us conclude these reflections as we began them, by stating that the question is more curious than important; and that it is very certain we may rest in peace without allowing the slightest trace of imaginary fears, which might at first sight spring up in our minds, to trouble us.

III.

THE MOON.

THE orb of reverie and mystery, the torch destined for the lighting-up of our terrestrial nights, has always been privileged to attract our sight and occupy our thoughts. Reigning over the empire of silence and peace, it seems more mysterious and solitary than any other; its white and frosted light also adds to the first impressions; and it remains in the mind as representing night itself. In olden times the ancients named the sovereign of the silent nights Diana with the silver crescent, or Phœbus with the fair hair.

Attached by indissoluble ties by means of attraction to the Earth from which it is descended, the Moon gravitates round us like a faithful satellite. At the time of its greatest brightness, when it is at its phase of full Moon on rising, it introduces the time of the appearance of the stars, and perceptily following their course from east to west, it appears their heavenly guide.

Nevertheless, as it makes the circuit of our globe from west to east in about twenty-seven days, it is soon remarked that each day it falls behind the stars which it seems to conduct, and that it possesses a movement independent to that of the celestial sphere. Indeed, it is the nearest heavenly body to us, and it belongs to us as a satellite.

Of all bodies, this is the one we understood the first and best. Since the invention of the first telescopes—scarcely 250 years ago—these primitive instruments whose power was far from attaining the stellar regions, and could only be effectually applied to this nearest body, astronomers, astrologers, alchemists, and all those who were occupied with science, felt themselves urged by a desire to penetrate into the mysteries of this celestial land. The first observations of Galileo did not make less noise than the discovery of America; many saw in them another discovery of a new world much more interesting than America, as it was beyond the Earth. It is one of the most curious episodes in history, that of the prodigious excitement which was caused by the unveiling of the world of the Moon. "*Ce n'est que le premier pas qui coute,*" says the old proverb; at the time of which I speak, only the first step in optics had been taken; scarcely was it made, but a second was claimed with avidity, then the third; and as science did not advance as quickly as was desired, as many years passed without the kingdoms of the Moon and the cities of its inhabitants being discovered, exalted imagination without waiting longer took flight to the new celestial world. Very curious voyages to the Moon then appeared, astonishing excursions, unpardonable fancies; and serious studies were soon eclipsed by the visions of impatient minds. Notwithstanding all this, astronomical discovery rapidly advanced. Encouraged by the first revelations of the telescope, astronomers undertook the complete study of the lunar surface. The aspect of the Moon to the naked eye, that rude face that was seen with little good-will on its pale disk, was transformed in the field of the telescope, and at first very bright portions and very dark portions were alone distinguished. Examining it more attentively, and increasing the magnifying power of the instrument, it was discovered that the aspect of the details changed according as the Sun was on one side or the other of the Moon; that on the days when the Sun was at the left of the bright portion dark lines were seen to the right, while in the opposite case, the dark shadow appeared to the left. It was then easy to prove that the bright portions were mountains, that the dark portions which were close to them were valleys, or low countries; and lastly, that the large plains were lands which reflected the solar light less perfectly.

It was already known that the phases of the Moon were produced by the illumination of the Sun, because when we see entirely the lighted-up portion of the Moon, at the time of full Moon, it is when we are between the Sun and the Moon, and that the side that the

Sun entirely lights up is turned toward us; that at the time of the new Moon, the Sun is behind the Moon, and lights up the side that we do not see, and that at the two quarters, we make a right angle with the Moon and Sun, and can see only one half of the portion which the Sun lights up. Observations made with the telescope confirm this explanation by showing that the path of the shadows on the surface is opposed to the direction of the Sun. Later, indeed only a few years ago, this was again confirmed by spectrum analysis, of which I have before spoken, for, on analyzing the rays sent us by the Moon, astronomers found indication of identically the same elements as in the light emitted directly by the Sun.

We have then before our eyes a globe, opaque like the Earth, lighted like it by the Sun, and its surface marked with mountains and valleys. This was more than was necessary to incite curiosity. Astronomers then employed themselves specially with our neighbor, and planned a geographical, or more properly, selenographical, map of it, since, as the reader may know, Γῆ means the Earth, while Σέληνη means the Moon.

As astrological ideas on the physical and metaphysical, moral or immoral influences of the Moon were still in full vigor, and man could not, but with the greatest difficulty, free himself from error, even when he wished, which is unfortunately but seldom the case, astrologers continued to interpret the language of the Moon according to the rules of the horoscope, and astronomers gave a description which agreed with the reigning opinions. To the large spots they gave the name of seas, to the small ones lakes or marshes; then they christened the seas, lakes, marshes, mountains, valleys, gulfs, peninsulas, etc., with names connected with the remembrance of virtues more or less legitimately attributed to the orb of night. Thus there were, and are still at the present time on the Moon, the Sea of Plenty, Lake of Dreams, Sea of Serenity, Marsh of Fogs, Ocean of Tempests, Lake of Death, Sea of Humors, Marshes of Putrefaction, Peninsula of Reveries, Sea of Tranquillity, etc., etc., and other names which are not all, as you see by the preceding, in exquisite taste or of graceful sentiment. When it was necessary to name the mountains, the first idea was to name them after the astronomers whose works had been most useful in the advancement of our knowledge of the Moon, and had most brilliantly illustrated this ornament of space. But a consideration of prudence deterred Hevelius, the author of the "Selenographia," and one which it will not take long to guess—he feared to excite sentiments of jealousy. An astronomer who did not possess a plot of land here was honored to receive a small heritage in the lunar world; but another, a rich proprietor, was (as it always happens with people of this kind) very angry not to increase his wealth by some part of the Moon. Then the names of the mountains of the Earth were given. There were the Alps, Apennines, Carpathians, etc.; but the vocabulary of our mountains was not sufficient, so they returned to the learned men, but to those who were dead. Aristotle, Plato, Hipparchus, Ptolemy, Copernicus, each had their property in the Moon. Certain travellers, like the author of the "Voyage au monde de Descartes," have found, on visiting these different lunar countries, that the great men whose names they had arbitrarily received, took possession of them in the course of the sixteenth century, and there fixed their residence. These immortal souls, it seems, continued their works and systems inaugurated on Earth. Thus it is that on Mount Aristotle a real Greek city has risen, peopled with Peripatetic philosophers, and guarded by sentinels armed with propositions, antitheses, and sophisms, the master himself living in the centre of the town in a magnificent palace. Thus also in Plato's circle live souls continually occupied in the study of the prototype of ideas. Two years ago a fresh division of lunar property was made, some astronomers being generously enriched.

Without taking up our time at present with the inhabitants of the Moon, the souls of those whose illustrious names have served to point out the kingdoms of the Earth, we can continue our narrative by saying that the satisfactory knowledge which people rapidly acquired of our satellite was due to its great proximity to the Earth, and to the facility with which we see all that passes on its surface. It is indeed so near to us, that after the celestial distances to which we must have familiarized ourselves in the preceding chapters, the distance which separates it from us is but trifling. Even to those whose minds have not visited the ultra-terrestrial regions, the path from here to the Moon is not very long. Navigators of long service who have made four or five voyages round the globe have travelled an equal distance, for in going round the world the irregularities of the route double the geometric circumference. A body allowed to fall from the lunar orbit would arrive here in 3 days 1 hour 45 minutes, and 13 seconds. To go from here to the Moon it would take rather more time; but if we availed ourselves of steam, one could arrive there in less than a year. At its minimum distance it is only twenty-eight times and a half the diameter of the Earth, or about 225,719 miles. This is really an insignificant distance.

It is doubtless this proximity which has caused the great reputation of the lunar orb among us. No celestial body, except the Sun, has ever had a similar influence. The whole world was accessible to the lunar influences—men, animals, plants, minerals. I have before stated that the astrological opinions with regard to this body were most singular. I must quote some to you: they are really too curious to be passed over in silence. Let us choose one or two good astrologers, learned on the Moon, and let us question them. First regarding the general action of the satellite on the Earth.

Cornelius Agrippa, a famous geomancer, thus expresses himself: "The Moon is called Phœbe, Diana, Lucinus, Proserpine, Hecate, who govern the months, half-formed; who illuminates the nights, wandering, in silence, with two horns; queen of divinities, queen of heaven, queen of *manes*, who rules over all the elements, to whom respond the stars, to whom return the seasons, and whom the elements obey: at whose direction the thunders sound, the seeds germinate, the germs increase; the primordial mother of fruits, heart of Phœbus, shining and brilliant, carrying light from one planet to another, illuminating by her light all the divinities, stopping various intercourses with the stars, distributing the light rendered uncertain on account of meetings with the Sun; queen of beauty, mistress of shores and winds, giver of riches, nurse of men, governor of all states good and unhappy; protecting men by sea and land moderating the reverses of fortune; dispensing with destiny, nourishing all which comes out of the Earth, arresting the insults of phantoms, holding the cloisters of the Earth closed, the heights of Heaven luminous, the currents of the sea salutary, and ruling at will the deplorable silence of the lower regions, governing the world, treading Tartarus under foot; of whom the majesty causes the birds which fly in the sky, savage beasts in the mountains, the serpents hidden under the Earth, and the fish in the sea, to tremble."

According to La Martinière, "This lunar planet is damp of itself; but, by the radiation of the Sun, is of various temperaments, as follows: in its first quadrant it is warm and damp, at which time it is good to let the blood of sanguine persons; in its second it is warm and dry, at which time it is good to bleed the choleric; in its third quadrant it is cold and moist, and phlegmatic people may be bled; and in its fourth it is cold and dry, at which time it is well to bleed the melancholic. It is a thing quite necessary to those who meddle with medicine to understand the movement of this planet, in order to discern the causes of sickness. And as the Moon is often in conjunction with Saturn, many attribute to it apoplexy, paralysis, epilepsy, jaundice, hydropsy, lethargy, catapory, catalepsy, colds, convulsions, trembling of the limbs, etc., etc. I have noticed that this planet has such enormous power over living creatures that children born at the first quarter of the declining Moon are more subject to illness, so that children born when there is no Moon, if they live, are weak, delicate, and sickly, or are of little mind, or idiots. Those who are born under the house of the Moon, which is Cancer, are of a phlegmatic disposition."

According to Eteilla, the Moon "governs comedians, butchers, tallow and wax chandlers, ropemakers, lemonade-venders, publicans, playwrights of all kinds, masters of great works, menageries of animals; and, on the other hand, professional gamblers, spies, sharpers, cheats, bankrupts, false money-coiners, and madhouses; that is to say, the Moon rules over all those whose business it is to work during the night until sun-rising, or to sell provisions for the night; and it also rules over all which people would be ashamed to commit in full day, in sight of those who have manners. Thus each reader, on reading, may easily find out of what denomination he is, etc. It is well to mention, that the Moon also governs all small merchants, who merely distribute imports, all usurers, courtiers, horse-dealers, place-hunters, men without employment, feeding on clients, and placing by their craft honest people in peril of losing. . . . It is not without a cause, one would say, with regard to these accusations that the Moon is so near us; if it were as far off as Saturn, it would not be able to answer to all of them."

But intelligent and animated beings alone were not subjected to these pernicious influences; all terrestrial nature, including vegetables and minerals, was under its rule.

Cucumbers increase at full Moon, as well as radishes, turnips, leeks, lilies, horse-radish, saffron, etc.; but onions, on the contrary, are much larger and better nourished during the decline and old age of the Moon than at its increase; and during its youth and fulness, which is the reason the Egyptians abstained from onions, on account of their antipathy to the Moon. Herbs gathered while the Moon increases are of great efficacy. "If vines are trimmed at night when the Moon is in the sign of the Lion, Sagittarius, the Scorpion, or the Bull, it will save them from field-rats, moles, snails, flies, and other animals. Pliny asserts that *aulx* sown or transplanted, the Moon being below the horizon, and gathered the day that it is new, will have no bad odor, and will not cause the breath of those who partake of them to be either offensive or disagreeable."

IV.

THE MOON (CONTINUED.)

On approaching the Moon, nothing is seen of the physical causes which make the Eartha vast laboratory wherein a thousand elements contend or unite with each other. There are none of those tumultuous tempests which sometimes sweep over our inundated plains; none of those hurricanes which descend in waterspouts to be swallowed up in the depth of the sea; no wind blows, no cloud rises to the heavens. There white trains of cloud vapors are not seen, nor those leaden masses with heavy cohorts: the rain never falls; and neither snow, nor hail, nor any of the meteorological phenomena are manifested there.

But, on the other hand, the magnificent tints which color our sky at sunrise and twilight, the radiation of the heated atmosphere, are never seen there; if winds and tempests never blow, neither is there the balmy breeze which descends upon our coasts. In this kingdom of sovereign immobility the lightest zephyr never comes to caress the hill-tops; the sky remains eternally asleep in a calm incomparably more complete than that of our hottest days when not a leaf moves in the air. This is because on the surface of this strange world there is no atmosphere. From this privation results a state of things difficult to realize. In the first place, the absence of air implies also the absence of water and every liquid, for water and liquids can only exist under atmospheric pressure: if this pressure is taken away they evaporate, and their beds are dried up. Thus, for instance, if you place a vessel filled with water under the receiver of an air-pump, and then, by pumping out the air, which is in the receiver, you make a vacuum, you will soon see the water boil, even when the place where the experiment takes place is frozen with the most intense cold. The boiling disengages vapors, and, finally, the water is evaporated. Now let us suppose that, at a certain period of its past existence, the Moon had, like the Earth, seas and rivers, and that by the aid of any apparatus, its seas and rivers were made to boil and to fall into vapor again; by continuing this operation long enough the Moon would be made completely dry: this is precisely what has happened. Since the distant period of its formation in a fluid state, it has lost all its liquids and vapors, and now a linnet would die of thirst in the midst of the seas of the Moon. These seas do not contain a drop of water. These, it will be said, are singular seas. And, indeed, no one will hold that their title is logical. But we have seen that they were named at a time when people did not know the lunar surface sufficiently well to guess that it existed without air and water. From the absence of air follows another very curious fact—the absence of sky. On the surface of the Moon, when the looks are directed toward the sky, there is none to be seen. An immensity without depth is traversed by the sight without resting on any kind of form, and in the day as in the night are seen the stars, planets, comets, and all the bodies of our universe. The Sun passes among them without extinguishing them, as it does to us. Not only does the Moon not possess this perpetual diversity which the movements of the air produce on our world, but it has not the azure vault which covers the Earth with such a magnificent dome; space is a black and a perpetually black abyss.

While on high there reigns darkness, below there is silence. Not the least sound is ever heard; the sigh of the wind in the woods, the rustling of foliage, the song of the morning lark, or the sweet warbling of the nightingale never awakens the eternally dumb echoes of this world. No voice, no speech has ever disturbed the intense solitude with which it is overspread. Unchangeable silence reigns there in sovereignty. Tall perpendicular mountains divide its surface. Here and there are seen worn-out craters rising toward the sky, white rocks heaped up like the ruins of some long-passed revolution, crevasses crossing the surface as in lands dried by the burning rays of long summer days. That which renders the spectacle more strange is that the absence of vapors causes the absence of perspective as well as the absence of all tints, and we see only white or black according as the object is in the Sun's light or in shadow, the objects succeeding each other as far as the horizon without losing brightness or contour. In the vicinity of the Southern pole, that is to say, at the lower part of the Moon as seen wit the naked eye, are the highest mountains of the satellite: Doerfel, whose top attains a height of 26,691 feet above the level of the neighboring plain; Casatus and Curtius, 7600 and 7318 yards; Newton, 23,853 feet in depth; this word depth may justly be questioned when it refers to the elevation of a mountain; but the Moon is such a singular world that its mountains may be measured as well by depth as height. This paradox, rather difficult to understand, arises from the fact that the mountains of the Moon are not like those of the Earth, but are hollow. When we arrive at the top there is a ring, the interior of which often descends below the surrounding plain: so that if one did not wish to make the round of the slopes which sometimes measures 310 miles (Ptolemy), and even 403 miles in circumference (like the circle of Clavius), it would be necessary to descend three or four miles to cross the bottom of the crater, and afterward to ascend on the opposite side of the ring, to return at last into the plain.

Among the annular mountains may be mentioned that of Aristillus, situated in the Sea of Rains, not far from the Caucasus, between the Marshes of Fogs and Putrefaction. It is a curious fact that the surface of the lunar hemisphere was known before that of our own Earth, and the heights of all its mountains were measured before the same thing was done for our own. The volcano of Aristillus in particular was one of the first and best known. Lecouturier, the author of a very good map of the Moon gave a long description of it, and this description may be applied to most of the lunar mountains. It is composed of a crater about twenty-four miles across, from the centre of which rise two cones, the highest of which attains nearly 984 yards; the whole is surrounded by a circular rampart, the highest part being 3608 yards high. When the bottom of the crater is examined with a powerful telescope and under favorable circumstances, numerous rough portions are noticed which seem to indicate hardened lava and blocks of rock heaped together. From this mountain, taken as a centre, start five or six lines and rocky ramifications directed toward the east and south. These ramifications give rise to the radiation of Aristillus. They are surmounted by an enormous quantity of peaks or basaltic columns which rise from their summits, and make them resemble from afar the multitude of bell towers that are seen on some Gothic cathedrals. Aristillus presents the general aspect of most of the mountains of our satellite.

Thus the Moon would appear very inhospitable to us. The sense of speech, like the sense of hearing, would be lost, and, consequently, would not exist. To the privation of these two senses, perhaps, must be added an inferiority in the pleasures which sight gives to us, seeing that, wherever the eye would be directed, it would only meet with white, rugged and sterile mountains, and lofty and deserted craters. These solitary and dried-up landscapes show how true were the lines of Alfred de Musset:

> "Va, Lune moribonde,
> Le beau corps de Phœbé
> La blonde
> Dans la mer est trombé
> Tu n'en es que la face,
> Et, déjà tout ridé,
> S'efface
> Ton front dépossédé."

This reminds me of what Fontenelle said regarding the changes at work on the surface of our satellite, caused, not by the movements of life, like those which regulate terrestrial nature, but by the simple falling down of lands. "Everything is in perpetual motion," he says; "even including a certain young lady, who was seen in the Moon with a telescope about forty years ago, everything has considerably aged. She had a pretty good face, but her cheeks are now sunken, her nose is lengthened, her forehead and chin are now prominent to such an extent that all her charms have vanished, and I fear for her days."

"What are you relating to me now?" interrupted the marchioness.

"This is no jest," returned the author. "Astronomers perceived in the Moon a particular figure which had the aspect of a woman's head, which came forth from between the rocks, and then occurred some changes in this region. Some pieces of mountain fell, and disclosed three points which could only serve to compose a forehead, a nose, and an old woman's chin." I do not know whether the face, of which the ingenious writer speaks, existed anywhere but in his imagination; but changes, even caused by simple fallings, are extremely rare, if even they are still produced. For a hundred years, for instance, during which period a day has not elapsed in which the Moon has been visible, without it being observed by the telescope, the slightest movement has never been noticed. At the commencement of the century, it is true, people fancied they observed active volcanoes, but they have since discovered that very probably what were then taken for volcanoes were nothing more than the white crests of certain mountains, their form or their structure being more favorably adapted to reflect light. Thus the orb of night remains dumb and silent, revolving in the heavens like a deserted planet.

Now that I have pointed out how the Moon is an inhospitable world, poor and destitute of nature's gifts, it is necessary to retrace my steps, and show it to you as a magnificent world, worthy our admiration and esteem. I do not wish to contradict my foregoing words; but in order not to leave a bad impression with regard to our faithful friend, I wish to remind you that nature, even when it appears to disgrace some of its works from some points of view, favors them with very desirable riches when regarded under other aspects.

To an astronomer the Moon would be a magnificent observatory. In the daytime he could observe the stars at noon, and thus discover, without trouble, that they reside eternally in the heavens. With us, on the contrary, among the ancients, were a great number who imagined that they were lighted up in the evening and extinguished in the morning. If, then, people make astronomical observations on the Moon, the Sun is not a tyrant who governs the heavens absolutely; it allows the stars to be enthroned peaceably with it in space; and studies commenced during the night can be carried on without difficulty during the day until the following night. On our satellite the nights are fifteen times 24 hours long, and the days are of the same length; but there is an essential difference to remark between the nights of the lunar hemisphere, which faces us, and those of the hemisphere which we do not see.

You must have noticed that the Moon always presents the same side to us. From the beginning of the world it has never shown but this side. We read in Plutarch, who wrote nearly two thousand years ago, a thousand conjectures relative to the side of the Moon forever turned toward us. Some said it was a large mirror, well polished and excellent, which sent back from afar the image of the Earth: the dark portions represented the oceans and seas, while the bright portions represented the continents. Others believed that the spots were forests, where some placed the hunts of Diana, and that the most brilliant parts were the plains. Others, again, saw in it a very light, celestial Earth; they stated that its inhabitants must pity the Earth which is below them, and which is only a mass of mud. Others, again, and their singular opinion was widely spread, added that the beings who peopled it were fifteen times larger than those of our Earth, and by the side of the lunar trees our oaks would only be small bushes. All this to explain the nature of the lunar face eternally turned toward us.

Now, if we never see but one side of the Moon, it follows that there is only one side of this body which sees us; so that half of the Moon has a moon—namely, our Earth—and the other half is deprived of one. If there are any inhabitants on the hemisphere turned from us, they do not guess that the Moon is only a body placed for the illumination of our nights, and they must be greatly astonished when the narratives of travellers relate to them the existence of our Earth in the heavens. If the travellers there resemble those here, what tales must they spread with regard to us! But, also, how useful must the Earth be to the lunar nights, and how beautiful we are—from afar! Fancy to yourself fourteen moons like that which gives us light, or, more properly speaking, a moon with fourteen times the extent of surface, and you will have an idea of the Earth as seen from the Moon. Sometimes it only presents a fringed crescent, a few days after the new Earth; sometimes it presents the first quarter; sometimes it shines out with its full disk, spreading its silvered light in floods. The most fortunate thing is, that it begins to shine precisely in the evening, that its brightest light, its full disk, is precisely at midnight, and that it fades away in the morning, at the time when it is no longer required. And it is known that from the evening to the morning is fifteen times twenty-four hours with our neighbors the Selenites. How much more reasonable are these inhabitants than we are in believing that the Moon was created and placed in the world expressly for them, and that we are only their very humble servants!

In some aspects, then, the Moon appears much more favored than the Earth. But not in planetary importance, for it measures scarcely the quarter the diameter of the Earth, 2,153 miles; its total surface is 14,568,000 square miles, including both hemispheres, that is to say, nearly the thirteenth part of the terrestrial surface; its volume is one forty-ninth of the volume of the terrestrial globe. This would probably not prevent its inhabitants (if there are any) from fancying themselves superior to us, and believing us to be their servants rather than their masters; for it is generally known that the smaller people are, the more vanity they possess. The inhabitants of the invisible hemisphere have the most beautiful nights imaginable, and those who live on the visible hemisphere one of the most beautiful moons. Only the inhabitants of the first moons of Jupiter and Saturn would be able to claim the superiority of their respective planets. Never any clouds, never any tempests, come to disturb these lonely and silent nights; profound calm, unalterable peace, occupy these regions. Moreover, while we only know a portion of their world, ours, turning on its axis in twenty-four hours, is entirely unveiled to them, so that with good eyes or with optical instruments they are able to contemplate our Earth revolving over their heads, presenting to them in turn the different countries of our abode. There, the new world stained with cruel battles; further on, gloomy isles, where they sacrifice human heads to the serpent Vaudoux; here, Russia crushing Poland, who resists strongly; and to the left a small verdant spot, where thirty-eight millions of French regard in various ways a throne which rises up in the midst of a great city. And ourselves, we contemplate the pensive Moon in the stillness of night, hoping that its people and those of other worlds are more united than our family. Yes, beloved light of the solitary nights, we think that nature has given thee some compensation for the things of which thou art deprived, and that the unknown riches of thy abode would strangely surprise those who for thee would escape from our world. We have seen that thou hast no air, and that thou hast not a drop of water to quench thy thirst; but that does not prevent us from returning to our old sympathy for thy beauty. If thou hast not the elements which suit us, if water and land, air and fire, do not reside in thy midst, thy nature is different, and thou art not less complete in thy creation.

Remain in the heavens of our reveries, renew those phases which form our months, pour out thy dew of light into the limpid air; the traveller will always love to choose thee as his guide in the midnight hours, in the paths of the sea, or in desert countries.

V.

ECLIPSES.

In the circle which it describes round the Earth, the Moon passes every fifteen days between the Sun and us—at the time of new moon—and every fifteen days it is on the opposite side of the Sun (the Earth being between it and the Sun); this is at the time of full moon. Now it happens, sometimes, that it passes exactly between us and the Sun, instead of passing a little above or below it, as it does in most cases. When this occurs, the light of the radiant body naturally finds itself stopped, in part or altogether, according as the lunar disk hides from us a part or the whole of the solar disk. There is, then, an eclipse of the Sun, either partial or total.

On the other hand, it happens sometimes that the Moon, passing behind the Earth, arrives just in the shadow which the Earth throws behind it, as every illuminated object does. When it is in this shadow it no longer receives the light of the Sun, and, as it only shines by this light, it loses its brightness. Its whole disk completely loses its light if it is wholly within the cone of the Earth's shadow; it remains half illuminated if, passing by the edge of the cone, it only half enters it. In these circumstances there is an eclipse of the Moon, either total or partial. Nothing, therefore, is so simple as an eclipse. When you have a lamp with a radiant globe before you, if you pass your hand before your eyes, you momentarily intercept the light which illumines you; to you it is an eclipse of the lamp by your hand. The same thing is produced when there happens on the Earth an eclipse of the Sun by the Moon. If, now, you turn round, leaving the lamp behind you, and again pass your illuminated hand before your face, it will be momentarily in the shadow of your body. This gives an idea of what happens in an eclipse of the Moon, when it passes into the shadow of the Earth.

If the movements of the Moon were performed exactly in a plane, the prolongation of which passed through the Sun and Earth, there would be an eclipse of the Sun every new moon, and an eclipse of the Moon every full moon. But the orbit in which the Moon moves is inclined a little to this plane, and oscillates from one side to the other, so that eclipses are very variable in their number and magnitude. Nevertheless, this variety has its limits. There cannot be less than two eclipses a year, and not more than seven. When there are only two, they are both eclipses of the Moon. These phenomena return nearly in the same order at the end of eighteen years and ten days ; a period known to the Greeks under the name of the Metonic Cycle, and which the Chinese themselves used more than three thousand years ago, to predict their eclipses.

However simple the cause of this phenomenon may be, now that it is known—and known causes are always so simple that one asks why they were never known before—however easy this explanation appears, for a long time the human race was astonished at the passing absence of the Sun's light during the day ; for a long time it felt full of fear and disquietude before this unexplained wonder. The light of day was rapidly diminished, and suddenly disappeared without the sky being darkened by any cloud. Darkness instead of light, stars shining in the sky, nature seeming surprised and astonished ; the combination of these unusual events is more than sufficient to explain the momentary terror with which individuals, and, indeed, whole nations, allowed themselves to be carried away in these solemn moments. By reason of the Moon's rapid motion, a total eclipse never lasts longer than five minutes ; but this short period is sufficient to allow a thousand sentiments to succeed each other in the terrified mind. The disappearance of the light of the Moon sometimes caused great trouble to ignorant minds ; with how much more reason would the disappearance of the orb of day cause inquietude and fear !

"History is full of the examples of fear caused by eclipses," says Francœur, "and dangers caused through ignorance and superstition." Nicias had resolved to leave Sicily with his army ; but, frightened by an eclipse of the Moon, and wishing to delay several days, to assure himself if our satellite had lost nothing after this event, he missed the opportunity of retreat : his army was destroyed, he himself perished, and this misfortune commenced the ruin of Athens.

Often it has been seen that clever men have taken advantage of people's terror during eclipses, either of the Sun or the Moon, to gain their wishes. Christopher Columbus, reduced to sustaining his soldiers on the voluntary gifts of a savage and poor nation, and nearly losing this resource and perishing with hunger, gave out that he was about to deprive the world of the Moon's light. The eclipse began, terror seized the Indians, and they returned, bringing to the feet of Columbus the accustomed tribute.

Drusus appeased a sedition in his army by predicting an eclipse of the Moon ; and, according to Livy, Sulpitius Gallus, in the war of Paulus Emilius against Perseus, used the same stratagem. Pericles, Agathocles, King of Syracuse, and Dionysius, King of Sicily, nearly fell victims to the ignorance of their soldiers. Alexander, near Arbella, was obliged to use all his skill to calm the terror that an eclipse had cast over his troops. Thus it is that superior men, rather than sink under the circumstances which oppress them, exert their art to turn them to their profit.

How many fables were built on the idea that eclipses were the effect of Divine wrath, which avenged the iniquities of man by depriving him of light ! Sometimes Diana sought Endymion in the mountains of Caria ; sometimes the magicians of Thessaly caused the Moon to fall on the herbs destined for enchantment.

Now it is a dragon which devours the Sun, and whole nations seek to frighten it away by cries ; or it is supposed that God holds the Sun inclosed in a tube, and hides or shows us the light by means of a shutter, etc. The progress of science has proved the absurdity of these opinions and fears, since it is known to be possible to calculate by astronomical tables, and to predict a long time beforehand, the instant when the wrath of Heaven will burst forth. Nevertheless, not long ago this terror caused misfortunes in the army of Louis XIV. near Barcelona, at the time of the total eclipse of 1706 ; and the device of this monarch, *Nec pluribus impar*, has given rise to injurious allusions.

Biot gives us, in his "Etudes sur l'Astronomie Indienne et Chinoise," very curious details on the rites which presided and which still preside over the observation of the eclipses in the Celestial Empire. The emperor is considered to be the son of Heaven ; and with this title his government ought to present the picture of the immutable order which governs the celestial movements. When the two great luminaries—the Sun and the Moon—instead of following their own routes separately, cross each other's paths, the regularity of the order of the heavens appears to be upset, and the disturbance which is there manifested must have its likeness, as well as the cause, in the disorders of the government of the emperor. An eclipse of the Sun was then considered as a warning given by Heaven to the emperor to examine his faults and correct them. When this phenomenon was announced beforehand by the appointed astronomer, the emperor and grandees of his court prepared themselves by fasting, and dressing themselves in garments of the greatest simplicity. On the appointed day the mandarins attended at the palace with bows and arrows. When the eclipse commenced, the emperor himself beat on the drum of thunder the "*roulement du prodige*," to give the alarm; and at the same time the mandarins let fly their arrows toward the sky to aid the eclipsed body. Gaubil quotes these particulars from the ancient Book of Rites, and the principles are announced in the Tcheou-li. After this, the discontent that would be caused by an eclipse not taking place at the time predicted may be imagined; and likewise if one suddenly appeared without being predicted. In the first case, the whole ceremonial was found to have been uselessly prepared; and the desperate efforts which, in consequence of the want of preparation, were made in the second case, inevitably produced a disorderly scene compromising to the imperial majesty. Such errors, although so easily made, placed the poor astronomers in danger of losing their goods, their office, their honor, and sometimes their life. Such a disgrace happened in the year 721 of our era: the Emperor Hiouen-Tsong sent for a bonze Chinese, called Y-Hang, renowned for his knowledge of astronomy. After having shown himself very learned, he had the misfortune to predict two eclipses of the Sun, which were ordered to be observed throughout the whole empire. But no one saw anywhere on the appointed days any trace of an eclipse, although the sky was almost everywhere serene. To clear himself he published a work, in which he pretended that his calculation was exact, but that Heaven had changed its rules of movement—doubtless in consideration of the high virtues of the emperor. Thanks to his reputation, otherwise deserved—perhaps, also, to his flattery—he was pardoned.

The same ideas on the importance and signification of the Moon and Sun which existed with the Chinese more than four thousand years ago, remain at the present day, and are still powerful, causing the same demands; but they have become less perilous for astronomers, as these phenomena are now predicted several years in advance, with a mathematical certainty, in the great ephemerides of Europe and America, which can easily be procured. M. Stanislas Julien found in the *Recueil des Lois de Chine* the complete description of the ceremonies still prescribed and practised at the present day on this occasion. The following is a specimen:

"Every time that an eclipse of the sun occurs pieces of silk are attached to the door of the minister of the rites, called I-men; and in the great hall they place a table to burn the perfumes at the top of the tower called Lou-thaï (tower of the Dew). The imperial guard places twenty-four drums on both sides, inside the door I-men; the Kiaofan-sse places musicians at the base of the tower Lou-thaï; he places also each magistrate in a part of the tower, at the spot where they must bow down to salute. All are turned toward the sun. When the president of astronomy has announced that the eclipse has begun, all the magistrates, in court garments, arrange themselves and stand up. At a given signal they fall on their knees, and then the music begins.

"Each magistrate makes three prostrations and nine bows, after which the music stops. When the magistrates of the tribunal of the rites have finished offering the perfumes, all the others kneel down. The Kiaosse-Koran advances with a drum, which he strikes to release the sun. The president of the ministry of rites gives three beats of his drum, and then they all skrike theirs together. When the president of the astronomical office has announced that the sun has recovered its circular form, the drums stop. Each magistrate kneels three times, and touches his head nine times on the earth. The music recommences; when these ceremonies are over, the music stops; then all the magistrates return each to his own side.

"When the moon is eclipsed they assemble in the office of the Taï-tch'ang (president of the ceremonies), and they observe the same rites for the deliverance of the moon as for the sun."

In civilized countries people no longer fear the arrival of eclipses, or think that eternal night is spreading over the Earth. It is known that these are celestial phenomena, studied and understood like many others, resulting from known movements and determined beforehand. They have entirely lost their supernatural character, and belong to a purely physical order of things. At the present time astronomers predict the eclipses of the Sun and Moon in the same manner as they have discovered past eclipses, by calculation, and have thus been able to assign more exactly certain dates in history. They know at what time the Moon will pass before the Sun, and will rob us of a portion, more or less great, of its light; and the proof is, that I can even now (in 1865) give you the times at which all the eclipses which will happen to the end of this century will occur. I will not give the list, and cover these pages with dates, but to convince you I will point out the total eclipses of the Sun, which will be visible at the places indicated until the year 1900. They are not numerous, as you see.

December 22, 1870, a total eclipse of the Sun at the Azores Islands, in the south of Spain and Italy, in Algeria and Turkey; August 19, 1889, a total eclipse of the Sun at the north-east of Spain, southern Russia, and central Asia; August 9, 1896, a total eclipse of the Sun in Siberia, Lapland, and Greenland; lastly, May 28, 1900 a total eclipse in the United States, Spain, Algeria, and Egypt.

I do not doubt but you will be a witness with me at the last one, and will thus be in a position to prove the truth of this prediction. Unfortunately, not one of them will be visible at London; but if our inventions with steam and electricity continue, and others come to their aid, the Earth will soon be but one country, and we shall travel from here to Pekin, as we did last century from Paris to St. Cloud.

In stating that the eclipses of the Sun and Moon are no longer a terror to us, I do not mean that they no longer make any impression. No; the sudden impressions caused by the spectacle of the rarest phenomena of nature are independent of our reflection, and the sudden absence of the solar light in the middle of the day produces in all beings an emotion from which they cannot free themselves. The narrative of the effect produced by eclipses on man, and even on animals, is too interesting not to be presented to you in concluding this chapter. I shall choose as narrator an eye-witness of the total eclipse of July, 1842, whose talent is too well known for it to be praised ; I refer to Arago, who thus gives us his impressions, enriched with other proofs, to which he attributes such high value as to place them with his own. (See "Popular Astronomy," Vol. III.)

"Riccioli relates, 'that during the total eclipse of 1415 birds were seen in Bohemia to fall down dead with fright.' The same is said relative to the eclipse of 1560 ; some eye-witnesses say, 'The birds, strange to say, fell to the ground, seized with fear.' In 1706, at Montpellier, the observer said, 'Bats flitted about as at the beginning of night. Fowls and pigeons ran precipitately to their roosts. The small birds that had been singing in their cages became silent, and put their heads under their wings. The animals employed in the labors of the field all at once halted.'

"The alarm occasioned among beasts of burden by the sudden transition from day to night is registered also in Louville's memoir relative to the eclipse of 1715, thus : 'Horses that were laboring or employed on the high roads lay down. They refused to advance.'

"Fontenelle relates that in the year 1654, at the mere announcement of a total eclipse, a multitude of the inhabitants of Paris hid themselves in deep cellars.

"Thanks to the progress of science, the total eclipse of 1842 found the public in a very different disposition from that which they manifested during the eclipse of 1654. A lively and legitimate curiosity had taken the place of puerile fears. The poorest villagers of the Alps and Pyrenees repaired in crowds to the places whence the phenomenon could be best seen ; they did not doubt, with some rare exceptions, that the eclipse had been correctly announced : they regarded it as a natural, regular, and calculable event, about which good sense taught them not to be uneasy.

"At Perpignan, only persons who were confined to their chambers by ill-health remained at home. Early in the morning the terraces, the ramparts of the town, the hills outside, whence the sunrise could be best seen, were crowded. In the citadel, beside the numerous groups of citizens seated on the glacis, we had beneath us all the soldiers collected in a vast square to be reviewed. The time for the commencement of the eclipse was approaching. Nearly twenty thousand people, with smoked glasses in their hands, were examining the radiant orb projected on the azure sky. We had scarcely, though provided with powerful telescopes, begun to perceive a slight indentation in the Sun's western limb, when an immense shout, the commingling of twenty thousand different voices, proved that we had only anticipated by a few seconds the naked-eye observation of twenty thousand astronomers equipped for the occasion, and exulting in this their first trial. A curiosity, animated by the desire of not being outdone, seemed to have inspired the natural sight with an unusual degree of penetration and power.

"Between this time and that which just preceded the entire disappearance of the Sun, we did not remark anything in the countenances of the spectators deserving of mention. But when the Sun, being reduced to a narrow filament, began to throw only a faint light on our horizon, a sort of uneasiness took possession of the mind, each person felt an urgent desire to communicate his emotions to those around him. Then followed a hollow moan resembling that of a distant sea after a storm, which increased as the slender crescent diminished. At last the crescent disappeared, darkness instantly followed, and this phase of the eclipse was marked by absolute silence, as distinctly as it was by the pendulum of the astronomical clock. The magnificence of the phenomenon had triumphed over the petulance of youth, over the levity affected by some of the spectators as indicative of mental superiority, over the noisy indifference usually professed by soldiers. A profound calm also reigned throughout the air ; the birds had ceased to sing.

"After a solemn expectation for two minutes, transports of joy and frenzied applause spontaneously and unanimously saluted the return of the solar rays. The sadness produced by feelings of an undefinable nature was now succeeded by a lively satisfaction, which no one attempted to moderate or conceal. For the majority of the public the phenomenon had come to a close. The remaining phases of the eclipse had no longer any attentive spectators beyond those devoted to the study of astronomy.

"Even those who appeared to be most deeply moved at the instant of the sudden disappearance of the Sun, amused themselves the very next day, and to my mind unreasonably, with recounting the state of alarm into which many country people had been thrown. Such people, at any rate, made no secret of their feelings. As for myself, I thought it very natural that illiterate persons, who had not been informed by anybody that an eclipse would occur on the morning of the 8th of July, should feel great uneasiness on seeing utter darkness so instantly follow daylight. Let it not be supposed that the idea of a convulsion of nature, the idea that the world was immediately coming to an end, is what would most generally disturb the minds of a rude and simple people. When I questioned them as to the true cause of the despair which had taken possession of them on the 8th of July, they immediately replied, "The sky was serene, and yet the light of day diminished, and every object grew shadowy, and then all at once we were in the dark. We thought that we had become blind.""

We extract from the *Journal des Basses Alpes*, of July 9, 1842, the following anecdote, which seems to me to be worthy of preservation :

"A poor child in the commune of Sièges was watching his flock, entirely ignorant of the approaching event; he became uneasy on seeing the sun gradually become dark; for no cloud, no vapor, accounted for the change. When the light suddenly disappeared, the poor child, overcome with fright, took to crying and called for help! His tears were still falling when the sun again sent forth a ray of light. Reassured by the commencement, the boy crossed his hands, exclaiming in the *patois* of the district, 'O beautiful sun!'" (O beou souleou!)

Arago afterward points out several curious facts on the influence of eclipses on animals:

"An inhabitant of Perpignan purposely kept his dog without food from the evening of the 7th of July. The next morning, at the instant when the total eclipse was going to take place, he threw a piece of bread to the poor animal, which had begun to devour it when the sun's last rays disappeared. Instantly the dog let the bread fall, nor did he take it up again for two minutes, that is, until the total obscuration had ceased, and then he ate it with great avidity.

"Another dog sought refuge between his master's legs when the sun became eclipsed. In a farm, some fowls at the instant of total obscuration, suddenly left the millet that had just been given them, and sought refuge in a stable. At the Mas de l'Asparron, the fowls being far from any habitation, went and grouped themselves under a horse's belly. A hen attended by a brood of chickens hastily called them to her, and covered them with her wings. Some ducks which were swimming about in a pool at the instant of the sun's disappearance, did not attempt to regain the farm which they had left two hours before, but huddled together in a corner.

"At La Tour, chief town of the canton, in the Eastern Pyrenees, an inhabitant had three hen linnets. On the 8th of July, very early in the morning, on hanging the cage up in the drawing-room, he remarked that the birds looked very well; after the eclipse one of them was found to be dead. Are we to suppose that the linnet in its fright hit itself violently against the bars of the cage? Some facts observed elsewhere tended to render this supposition probable."

Even insects did not escape a like impression.

M. Lentherie, professor at Montpellier, also gave some details concerning the effects of the total eclipse upon several species of animals. The bats, thinking night had come, quitted their retreats; an owl came out of St. Peter's tower, and flew across the square of the Peyrou; the swallows disappeared; the fowls went to roost; some oxen who were feeding freely near the church of Maguelonne arranged themselves in a circle with their backs toward each other, and their horns outward, as if to resist an attack.

Some observers at Cremona say that an immense number of birds fell to the ground; and M. Zamboni, the author of the "Piles Sèches," is quoted as having seen a sparrow fall beside him. M. Piola, who was under a tree near Lodi, remarked that the birds ceased tossing during the moments of darkness, but none fell.

In a narrative that Father Zantedeschi addressed to Arago from Venice he said that

"Some birds wishing to escape and not being able to see, knocked up against the chimneys and the walls with such violence as to fall down stupefied on the roofs, in the streets, and into the lagoons. Among the birds that met with these accidents may be specified some swallows and a pigeon. Other swallows were seized in the streets, their fright having scarcely left them the power of fluttering.

"Some bees which had left their hive in great numbers at sunrise, returned to it even before the instant of total darkness; and they waited till the sun had entirely resumed its brightness before they ventured forth again."

These narratives give a sufficient idea of the effect produced by unusual phenomena on the faculties of men and animals. The necessity of order is so deeply attached to creation that an appearance of trouble throws us out of our normal security, and fills us with fear.

BOOK FIFTH.

I.

THE PLURALITY OF INHABITED WORLDS.

THE astronomical truths which have been the subject of our conversation, doubtless prove the high character of the human mind, which aspires to them, and which, scrutinizing the organized laws of the universe, has been able to determine the causes which regulate the harmony of the cosmos and secure its perpetuity. No doubt, it is good for man, this spiritual atom inhabiting a material atom, to have penetrated the mysteries of creation, and to have been exalted to the knowledge of these sublime heights, the contemplation of which alone overwhelms and annihilates him. But if the universe remains to man only a great material mechanism, moved by physical forces, if nature is nothing in his eyes but a gigantic laboratory, where the elements are mingled blindly under the most various and casual forms; in a word, if this admirable and magnificent science of the heavens confines the efforts of the human mind eternally to the geometry of the heavenly bodies, the science would never attain its real end, and it would stop at the moment of reaping the fruit of its immense labors. It would remain supremely incomplete if the universe were never anything to it but an assemblage of inert bodies floating in space under the action of material forces.

The philosopher must go farther. He must not confine himself to seeing under a more or less distinct form the great body of nature. But, stretching forth the hand, he must feel, under the material envelope, the life which circulates in great waves. God's empire is not the empire of death; it is the empire of life.

We live on a world which is no exception among the heavenly bodies, and which has not received the least privilege. It is the third of the planets which revolve round the Sun and one of the smallest among them without going beyond our system, other planets are much more important than it; Jupiter, for instance, is 1414 times greater, and Saturn 734 times. While it appears to us the most important of the universe, it is in reality lost in the immensity of the worlds which people the heavens, and the whole creation does not guess at its existence.

Of the planets of our own system there are only four, the inhabitants of which can know that the Earth exists; these are, Mercury, Venus, Mars, and Jupiter; and even to this last one it is most of the time invisible in the solar aureola. Now, while the

Earth is thus lost amid worlds more important than itself, the other worlds are in the same conditions of habitability as those that we observe on the Earth. On these planets, as on our own, the generous rays of the Sun pour forth heat and light; on them, as here, years, months, and days succeed each other, drawing with them the seasons which, from time to time, support the conditions of existence; on them as here, a transparent atmosphere envelopes the inhabited surface with a protecting climate, gives rise to meteoric movements, and develops those ravishing beauties which celebrate sunrise and sunset. On them as here, vaporous clouds rise from the ocean with the deep waves, and spreading themselves under the heaven, carry dew to the parched-up regions. This great movement of life which circulates over the Earth is not confined to this little planet; the same causes develop elsewhere the same effects, and on many among these strange worlds, far from noticing the absence of the riches with which the Earth is endowed, an abundance of wealth of which our abode only possesses the first-fruits is observed. By the side of these bodies, the Earth is essentially an inferior world in many respects; from the unsatisfactory conditions of geological stability of which the terrestrial spheroid reminds us, its surface being only a thin pellicle, to the fatal laws which govern life on this Earth where death reigns supreme.

If, on the one hand, the other worlds have conditions of habitability quite as powerful, if not more so, as the terrestrial conditions, on the other hand, the Earth, considered in itself, appears to us like an overflowing cup whence life issues on all sides. It seems that to create is so necessary to the order of nature, that the smallest piece of matter of suitable properties does not exist without serving as an abode of living beings. While the telescope discovered in the heavens fresh fields for creation, the microscope showed us below the range of visibility the field of invisible life, and that, not content with spreading life everywhere where there is matter to receive it, from the primitive period when this globe had scarcely left its fiery cradle, to our days, nature still heaps up existence, to the detriment of existence itself.

Leaves of plants are fields of microscopical flocks of which certain species, although invisible to the naked eye, are real elephants beside other beings, whose extreme diminutiveness has not prevented an admirable system of organization for the carrying on of their ephemeral life. Animals themselves serve as an abode to races of parasites which, in their turn, are themselves the abode of parasites still smaller. Under another aspect the infinity of life presents a correlative character in its diversity. Its force is so powerful that no element appears capable of struggling advantageously against it, and tending to spread itself in every place, nothing can stop its action. From the high regions of the air, where the winds carry the germs, to the oceanic depths, where they undergo a pressure equal to several hundred atmospheres, and where the most complete night extends its eternal sovereignty; from the burning climate of the equator and the hot sources of volcanic regions to the icy regions and the solid seas of the polar circle, life extends its empire like an immense network, surrounding the whole Earth, amusing itself with all obstacles, and passing over all abysses, so that there is not in the world any district which can pretend to be beyond its absolute sovereignty.

It is by studies founded on this double consideration, the insignificance of the Earth in creation, and the abundance of life on its surface, that we are able to raise ourselves to the first real principles on which the demonstration of the universal habitation of the heavenly bodies must be fixed. For a long time man could confine himself to the study of phenomena; for a long time he must still keep to the direct and simple observation of physical appearances, in order that science may acquire the precision which constitutes its value. But now this entrance of truth can be passed, and thought, outstripping matter, may rise to the idea of intellectual things. In the bosom of these distant worlds, it sees universal life plunging its immense roots; and at their surface it sees this life spreading itself, and intelligence establishing its throne.

Founded on the astronomical basis, the only possible foundation, researches made in the domain of the physical sciences, from celestial mechanism to biology, and in that of the philosophical science from ontology to morals, the old idea of the plurality of worlds has risen to the rank of a doctrine. The evidence of this truth has been revealed to the eyes of all those who are impartially and entirely given up to the study of nature. It does not come within the bounds of this discourse to enter fully on this philosophical aspect of creation; but if I consider it in itself as the logical conclusion of astronomical studies, I owe it to my readers at least to offer them as a modest conclusion of the narratives which they have followed up to this time, the principal results to which we have arrived on this great and beautiful question of the existence of life on the surface of the heavenly bodies.

In the first place, the following is the first consideration established on the astronomical character of the world and its history: If the reader follow the philosophical march of modern astronomy, he will discover that from the moment when the movement of the Earth and the volume of the Sun were known, astronomers and philosophers found it strange that a body so magnificent was solely employed to light up and warm a little imperceptible world, arranged in company with many others under a supreme rule. The absurdity of such an opinion was still more striking, when they found that Venus was a planet of the same dimensions as the Earth, with mountains and plains, seasons and years, days and nights, similar to our own; the analogy was extended to the conclusion that these two worlds, similar in their formation, were also similar in their *rôle* in the universe; if Venus was without population, the Earth ought to be equally so; and conversely, if the Earth was peopled Venus must be so also. But afterward, when the gigantic worlds of Jupiter and Saturn were observed, surrounded with their splendid retinues, they were compelled to refuse living beings to the preceding little planets, if they did not equally endow these, and moreover give to Jupiter and Saturn men much superior to those of Venus and the Earth. And indeed, it is not evident that the absurdity of the immovability of the Earth has been perpetuated a thousand times more extravagantly in this ill-conceived final causation, the object of which is to place our globe in the first rank of celestial bodies? Is it not evident that this world has been thrown without any distinction into the planetary cluster, and that it is not better adapted than the others to be the exclusive seat of life and intelligence? How little founded is the sentiment which animates us when we fancy that the universe is created for us, poor beings lost on a world, and that if we should disappear from the scene, this vast universe would be marred, like an assemblage of inert bodies, and deprived of light! If on the morrow not one of us was to awake, and if the night which, in each diurnal period enwraps the world, forever sealed the closed eyelids of all living beings, is it to be believed that henceforth the Sun would no longer pour out its light and heat, and that the powers of nature would cease their eternal movements? No; these distant worlds that we have just reviewed, would continue the cycle of their existence, rocked on the permanent forces of gravitation, and bathed in the luminous aureola that the orb of day produces round its brilliant focus. The Earth that we inhabit is only one of the smallest bodies grouped round this focus, and its degree of habitation has nothing which distinguishes it amid its companions. For an instant place yourself at a distance in space whence you can embrace the whole solar system, and suppose that the planet in which you saw light is unknown to you. For to give yourself freely to the present study you must no longer consider the Earth as your country, or prefer it to other abodes; and then contemplate without pretension and with an ultra-terrestrial eye the planetary worlds which circulate round the focus of our life! If you suspect the phenomena of existence, if you imagine that certain planets are inhabited, if you are taught that life has chosen certain worlds in which to spread the germs of its productions, do you intend to people this small globe of the Earth, before having established in superior worlds the wonders of living creation? Or if you have the intention of settling yourself on a body whence you can embrace the splendor of the heavens, and on which you can enjoy the benefits of a rich and fertile nature, shall you choose as an abode this mean Earth, which is eclipsed by so many resplendent spheres? In reply, reader, and it is the least strong and most rigorous conclusion that we can draw from the preceding considerations, let us agree that "the Earth has no marked pre-eminence in the solar system to entitle it to be the only inhabited world, and that, astronomically speaking, the other planets are arranged as well as it is as abodes of life."

A second consideration, founded on the varieties of living beings on the surface of the terrestrial globe, on the infinite power of nature, that no obstacle has ever stopped. and on the eloquent spectacle of the infinity of life itself in the terrestrial world, conducts the argument into a new order of ideas: "Nature knows the secret of all things, puts into action the most feeble as well as the most powerful forces, renders all its creations answerable, and constitutes beings according to the worlds and ages, without the one or the other being able to place any obstacle in the way of the manifestation of its power. Hence it follows that the habitability and habitation of the planets are a necessary complement to their existence, and that of all the conditions enumerated, not one can stop the manifestation of life on each of these worlds. But let us add another observation which will complete the preceding; let us think for an instant of our forced ignorance in this little isle of the great archipelago where destiny has bound us, and of the difficulty we experience in searching into the secrets and power of nature. Let us prove that, on the one hand, we do not know all the causes which have been able to influence, and which still influence, the manifestation of life, its support and propagation on the surface of the Earth; and that, on the other hand, we are still far from knowing all the principles of existence which propagate in other worlds very dissimilar creations. Scarcely have we penetrated those which regulate the daily functions of life; scarcely have we been able to study the physical properties of the media, the action of light and electricity, the effects of heat and magnetism. There exist others which go on constantly under our eyes, and which have not yet been studied nor even discovered. How vain then would it be to wish to oppose to the possibility of planetary existences the superficial and narrow principles of what we call our sciences? What cause would be able to struggle with advantage against the effective power of nature, and to place obstacles to the existence of beings on all these magnificent globes which revolve round the Sun! What extravagance to regard the little world where we first saw light as the only temple, or as the model of nature!"

Impressed with the value of the providential design of creation, these considerations become more imperious still. "That our planet was made to be lived in, is incontestable, not only because the beings which people it are here under our eyes, but again because the connection which exists between these beings and the regions in which they live brings the inevitable conclusion that the idea of habitation is immediately connected with the idea of habitability. Now this fact is an argument in our favor; for, unless we consider the creative power as illogical, or as inconsistent with its real manner of acting, it must be understood that the habitability of the planets imperiously demands their habitation. To what end have they received years, seasons, months, days; and why does not life come forth on the surface of these worlds which enjoy, like ours, the benefits of nature, and which receive, like ours, the rays of the same sun? Why these snows of Mars, which melt each spring, and descend to water its continents? Why these clouds of Jupiter, which spread shade and freshness over its immense plains? Why this atmosphere of Venus, which bathes its valleys and mountains? O splendid worlds, which float afar from us in the heavens! Would it be possible that cold sterility was ever the immutable sovereign of yonder desolate regions? Would it be possible that this magnificence, which seems to be your appanage, was given to solitary and bare worlds, where the lonely rocks eternally regard each other in sullen silence? Fearful spectacle in its immense immutability; and more incomprehensible than if Death had passed over the Earth in fury, and with a single stroke mowed down the living population which enlightens its surface, thus enveloping in one ruin all the children of life, and leaving it to roll in space like a corpse in an eternal tomb!"

Thus it is that, under whatever aspect we regard creation, the doctrine of the plurality of inhabited worlds is formed and presented as the only explanation of the final end—as the justification of the existence of material forms—as the crowning of astronomical truths. The summary conclusions which we have just quoted are established, logically and without difficulty, by observed facts; and when, having contemplated the universe under its different aspects, the mind is astonished at not having sooner conceived this striking truth, it feels within itself that the demonstration of such evidence is no longer necessary, and that it ought to accept it, even with no other reasons in its favor than the condition of the terrestrial atom compared with the rest of the immense universe. Humbled by this spectacle, one can but proclaim the luminous truth in a transport, disdaining all researches.

"Ah! if our sight was piercing enough to discover, where we only see brilliant points on the black background of the sky, resplendent suns which revolve in the expanse, and the inhabited worlds which follow them in their path, if it were given to us to embrace in a general *coup d'œil* these myriads of fire-based systems; and if, advancing with the velocity of light, we could traverse from century to century, this unlimited number of suns and spheres, without ever meeting any limit to this prodigious immensity where God brings forth worlds and beings; looking behind, but no longer knowing in what part of the infinite to find this grain of dust called the Earth, we should stop fascinated and confounded by such a spectacle, and uniting our voice to the concert of universal nature, we should say from the depths of our soul: Almighty God! how senseless we were to believe that there was nothing beyond the Earth, and that our abode alone possessed the privilege of reflecting Thy greatness and power!"

II.

THE CONTEMPLATION OF THE HEAVENS.

How beautiful and worthy of the human mind is this contemplation of the visible splendors of creation! How much superior are these studies to the common preoccupations which occupy our days and pass away our years! How they elevate the soul toward real greatness! In the artificial world that we have formed for ourselves by our citizen habits, we have become so strange to nature that when we return to it we appear to enter into a new world. We have lost belief in its value, and thus deprive ourselves of the purest joys. By freeing ourselves from stormy life, by returning to peace we undergo a hitherto unknown impression, as if the sphere of harmony into which we enter had always remained far from the labors of our minds.

Studies of nature possess this precious characteristic, that being applied to truth, they recall us to our origin, to our material cradle. Worldly life is a real exile for the soul. Imperceptibly we get accustomed to content ourselves with appearances, no longer to seek the bottom and the substance of things. Imperceptibly we lose our value and greatness, when rocked on the surface of this unfathomable ocean on which float human barks. The objects which surround us alone attract our attention, and we forget the past like the future. But there are hours of solitude, when the soul, returning to itself, feels the emptiness of all these appearances, when it discovers how little they can satisfy it, when it anxiously searches and returns with love to real greatness alone, capable of giving firm ground for its repose, instead of the fluctuations which have agitated it. Then the soul has homesickness; it demands the truth; it wishes for the beautiful, and bids adieu to transient affections. If it is allowed at these hours of reflection to contemplate the beauties of nature; to admire and understand the wonders of creation; entirely giving itself up to the contemplation which captivates it, abandoning itself to the charm of the splendors studied, it devotes itself unreservedly to the spectacle which absorbs it.

forgetful of the false joys of the Earth, and eager after the true and profound ones which Nature, that young mother whose age is unchangeable, pours into the souls of the children who cherish her. The beauties of the heavens will captivate it with their charms, it will demand that such a contemplation shall never cease, that the night shall reveal to it wonder upon wonder, and that it may be permitted not to leave the scene before its admiration is satisfied.

When we give our minds up to these high and magnificent studies we soon feel the great harmony, the admirable unity in which all things are bound together; we feel that all creation is one, that we form a constituent part of it, and that an immense life, scarcely guessed at, envelopes us. Then all phenomena take their place in the universal concert.

The golden star which shines in the depths of the heavens and the little grain of crystallized sand which reflects the solar ray, unite their light; the majestic sphere which revolves harmoniously in its gigantic orbit and the little bird which sings under the leaves; the immense nebula which arranges its system of suns in the vast expanse, and the beehive which receives the rhomboids of a republic in eternal concord; gravitation which bears up in space these formidable globes and these systems of worlds, and the humble zephyr which wafts beloved perfumes from one flower to another; great phenomena and imperceptible actions unite with each other in the general movement, and the infinitely great and the infinitely small embrace each other. For the universe is the action of a single thought.

No human speech, no work formed by the hand of man, can compete with the harmony of nature or the work of creation. Compare for an instant the most admirable *chef d'œuvre* among the wonders of art with the most simple among the productions of nature. As was said long ago, compare the richness of regal ornaments, the oriental tissue of Solomon's garments when in all his glory, the golden plates of his temple, the mosaics of his palaces, to the whiteness of the lilies, the bloom of the roses, and seek if the comparison can be thought of for an instant. The great characteristic which distinguishes these works, is that in the one, a restricted power marks the limits of its skill, while in the other the impress of an infinite power always remains. Magnify the power of our senses, take that astonishing lens which raises up giants where the most insignificent beings remained invisible; at its focus, the finest tissue, the most delicate work of human art is changed into a shapeless and coarse object; on the other hand, the most modest tissue formed by the hands of nature reveals hidden riches in proportion as the magnifying power increases.

Try now to compare our most wonderful instruments, from our formidable machinery which holds captive those powerful forces of which man has made himself master, to those exact instruments, so elegant, so sensitive with the untamable forces with which matter is animated, or with those admirable and precise laws which rule in an incomprehensible perfection the harmonious movements of the starry spheres at the concert of the heavens, and say how much art is surpassed by nature.

And the work of nature is charming in the infinitely small as in the infinitely great. The sublime spectacles which the contemplation of the heavens unveils to us are doubtless the most striking, the magnificence of which imposes itself most impressively on our astonished mind; but if we examined little things our imagination will remain confounded before them as before the greatest. On the poor little white butterfly which, born yesterday, will be in dust before to-morrow has passed, the analyzing eye of the microscope will show magnificent feathers of snowy white or dead yellow, symetrically arranged, with as much care as those of the eagle intended to fly to the heavens; nevertheless to the naked eye there is nothing but an impalpable dust, which adheres to the fingers. On its head you may count twenty thousand eyes. If the finer drops of dew suspended at sunrise to the leaves of the lower branches, fall at the touch of a passing bird, you will see painted on this fine rain a rainbow not less rich than the gigantic arch uplifted at the end of a storm in the regions of the atmosphere; charming little rainbow, formed for a life of a few tenths of a second and disappearing as it was born, Examine these humble wild flowers with colored petals; emeralds and rubies succeed each other, gold and sapphire intermingle their delicate tints; it is in miniature the same magnificence of colors as shines in the double stars. We could continue without limit these comparisons, which prove to us, in all directions, the infinity of the creative power.

Nevertheless we do not think of it, and we pass indifferently by these wonders. If the night was deprived of stars, said a philosopher, and there was only one place on the Earth whence the constellations and bodies would be visible, the pilgrimage to this place would never cease, and each would wish to admire these wonders. But that which daily surrounds us loses its value, custom destroy attention, and we forget nature for pleasures certainly infinitely less worthy of our thoughts. If sometimes we allow ourselves to be exalted by these wonders of the science of the heavens, we quickly return to the things of the world, forgetting our grand questions. The Earth has the gift of captivating us so strongly that we willingly forget the heavens for it.

Let us consider, dream, and think sometimes of the beautiful in nature. Let us allow ourselves to be drawn away by those delicious reveries which carry us from earthly tumults to calm and silence. Let us ascend to that limpid source, whence descend all consolation in sadness, all coolness after the fatigue of the day, all peace in disquietude. When our lips are parched by the winds of the world, let us moisten them at this clear spring, let us ask a kiss from the lips of Nature—and may this pure aspiration keep us from poisoned cups.

The fulness and height of man's happiness, said Seneca, is to tread under foot all bad desires, to dive into the heavens, and to penetrate the most hidden folds of nature. With what satisfaction, when our thought has taken flight from the midst of these, does it mock at the mosaics of our riches, and our earth with all its gold! To disdain these porticoes—these brilliant platforms of ivory—these rivers running through palaces —one must have embraced the circle of the universe, and looked from on high on this narrow globe, a great portion of which is submerged, while that which is above water is either savage, or torrid, or frozen. This is, then, says the sage, the spot divided among many nations with fire and sword! Here are our mortals, with their absurd frontiers! If the human intelligence were given to ants, would they not also divide a square of garden into several provinces? When thou shalt have risen to the really grand objects of which I speak, each time that thou shalt see armies marching with colors raised, and as if it were a serious matter, horsemen sometimes flying unguardedly, or retreating on their supports, thou wilt be tempted to say, "These are evolutions of ants—great movements in little space." Oh, how little is man if he does not rise above human things! There are regions above, without limits, which our soul as admitted to possess, provided that it carries away with it the least possible that is material, and that, being purified from all stain, and free from fetters, it is worthy of flying thither. As soon as it reaches there, it is nourished and developed; it is as if delivered from its irons, and returned to its source: it recognizes itself to be a daughter of heaven from the delight it takes in celestial things; it enters there not as a stranger, but as if at home. An eager spectator, there is nothing but it sounds and interrogates. Ah! who could hinder it? Does it not know that all this is its domain? Man does not live on bread alone—he requires thought. It is on rising to these noble contemplations that he becomes worthy of his rank; it is by occupying his mind with these beautiful and fertile subjects of study that his countenance will preserve the divine expression of his destiny, and will shine more and more. Let us not forget the teachings of the night, but return sometimes to meditate under its silent gloom. Instead of a passing reverie, now that we have partly lifted the veil which hid the celestial mysteries from us, our minds will have an object better understood; we shall understand what we admire, and we shall better appreciate these distant creations. These nocturnal hours will have a double value in our eyes, as they will place us henceforth in communication with worlds whose natures are no longer unknown to us. And it is with greater intimacy that we shall address that salutation to the Night, with which we opened our interview with the heavens:

"O Nuit! que ton langage est sublime pour moi,
Lorsque seul et pensif, assui calme que toi,
Contemplant les soleils dont ta robe est parée,
J'erre et médite en paix sous ton ombre sacrée!"

THE END.

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2

LONGEVITY:

THE MEANS OF PROLONGING LIFE AFTER MIDDLE AGE.

BY

JOHN GARDNER, M.D.

PREFACE TO THE THIRD EDITION.

THE notices this work has received by reviewers, both in the medical and general press, have been uniformly favorable.

No one has questioned the justness of the assumption, that very numerous persons in advanced life endure sufferings and die prematurely, who might enjoy ease and comfort, and have their lives greatly prolonged, by the exercise of properly directed care, and the judicious use of means within their reach.

The hints and suggestions I have given to elderly people for attaining a healthy and happy old age, and for prolonging life, have also met with general approbation.

If we have no *elixir vitæ* in a single medicine, we have well-ascertained laws of hygiene—an ever-advancing and improving art of healing, based upon an accurate knowledge of the human constitution and a closer study of remedial agents; and these may be accepted as, in some measure, an equivalent. At least, we must be satisfied with them for the present. What may emerge in the progress of science we can only conjecture. Such forecasts as I have ventured upon in a note may be accepted for what they are worth.

The revision and additions made in this edition, it is hoped, have increased its interest and usefulness.

WHAT IS THE NATURAL OR NORMAL DURATION OF HUMAN LIFE?

To attain to a lengthened life, to enjoy ease and tranquillity in life's decline, and immunity from pain, debility, and other forms of suffering, are objects worthy of far more earnest attention than they usually receive.

At the dawn of modern science, when the properties of natural bodies began to be observed, men sought to find the philosopher's stone and an *elixir vitæ;* hoping to preserve life forever, or at least for a long and indefinite period, and to obtain wealth by a short and easy process.

Since we have more accurately investigated the constitution of man, body and mind, the conditions of life, health, disease, and death, the nature and relations of things around us, we are able to form more rational aims, and to pursue them with better hopes of success.

How to evade the causes of disease, to obviate their effects when they touch us, how to reach the utmost extent of the term allotted to human existence, are legitimate objects of research. And since the most subtle and most tremendous physical forces are made subservient to our daily wants, and the composition and interaction of the materials of our earth, animate and inanimate, are to some extent ascertained and utilized, surely we may expect that means and appliances should be attainable to preserve and prolong human life, to render longevity the rule for many, and not, as now, the exceptional lot of a few.

In this line of thought, a question emerges which we must meet and answer *in limine.*

How long can men live if exempted or protected from all the influences tending to extinguish life prematurely? What is the term, if any, which Divine Providence has affixed to the duration of human life?

As an obvious fact, numbers reach the age of eighty or ninety. A few exceed these years, and nearly or quite touch one hundred. There are others, still fewer indeed, who live even longer than one hundred years.

The late Sir George Cornewall Lewis having expressed doubts as to the evidence of any life exceeding one hundred years, much inquiry ensued. The affirmation, if not absolutely proved, must appear to those who have followed the controversy to be most probable. Quite recently, however, the first case on record verified by an assurance society of a person dying at the age of one hundred and three occurred. One such case is conclusive, and must not be ignored in dealing with the question before us; while all the recorded stories of persons living one hundred and fifty to two hundred years and upward—Jenkyns, Parr, etc.—must in the present state of our knowledge be regarded as myths. The very numerous cases claiming an age somewhat beyond one hundred, when no positive evidence could be adduced, are now proved to have no inherent impossibility. (See Note A, p. 176.)

There have been many attempts to determine what is the limit of human life; and various opinions have been advanced, based upon data as various. None have appeared so reasonable and so worthy of acceptance as that of M. Flourens, and his views have accordingly attracted much notice.

M. Flourens conceives he has discovered a fixed relation to exist between the time required for the growth to maturity of an animal body, and its ultimate natural duration, all causes of premature mortality excluded.

Taking his observations from the group mammalia, of the class vertebrata, as having the closest resemblance to man, and such species as are permitted to live the full term of their natural lives under circumstances not admitting error or doubt—the elephant, horse, dog, etc.—he found that their natural life extends exactly to five times the period of their growth.

Applying the rule thus obtained to human life, and taking the age when the body is fully matured to be twenty years, he concludes the natural duration of the life of man to be ***one hundred years.*** (See Note B, p. 176.)

If these observations and inference are on the whole well founded, a slight modification must be admitted; since it is highly probable that the time of perfect maturity of growth is not an absolutely fixed, but a variable quantity, some individuals attaining it somewhat earlier, some later. It would perhaps be safe to assume that the body has reached its full development and maturity from eighteen to twenty-one. These numbers, multiplied by five, would bring the natural life of man to be from ninety to one hundred and five years. This conclusion must, we think, be regarded as the truth, or, at least, a very close approximation to the truth—the discovery of a most interesting and important natural fact or law.

Recent inquiries have proved the fact of many persons living beyond the age of one hundred; but no one has yet been met with exceeding one hundred and five (*vide seq.*).

The inference necessarily follows, that all persons who die under eighty years of age, many who die under ninety, some who die under one hundred, or even one hundred and five, die prematurely. (See Note C, p. 177.)

And this inference is supported by observations made in another direction; for all pathologists agree in stating that very few persons indeed die of mere old age. Of those whose lives reach to between eighty and ninety, and even extend beyond ninety, the majority die of diseases which might have been avoided, cured, or kept in abeyance, until the full term of human life had been attained.

The Registrar-General, in several publications, has deplored the premature mortality of the people of England, and in most forcible language urged the subject on the attention of all thoughtful persons. (See Note D, p. 177.)

His remarks, although they refer to persons of all ages, are most applicable to those who have reached or passed middle age; since it may be assumed that at this epoch knowledge and experience have been matured, and individuals are most capable of judging of the expediency of taking measures for their own preservation.

THE PURPOSE AND LIMIT OF THIS WORK.

To trace human life from birth to old age; to point out in detail the known causes which cut it short in infancy, childhood, youth, and maturity; to discuss the occasions and circumstances leading to culpable or unavoidable neglect of precautions and measures for its preservation—would require a work of considerable magnitude. My present purpose is to treat of ONE EPOCH only—that which may not inaptly be designated *Advanced Age*—in popular language, *the Decline of Life*; to show what is the precise nature of the changes in the constitution which take place in that epoch, and constitute in the aggregate *ageing*; to enumerate the most common and prominent physical troubles incident to advanced age; to point out the antidotes and means furnished by science and experience for ameliorating or avoiding those troubles, and for retarding the effects of time, and thus for prolonging life.

IS THE DURATION OF LIFE IN ANY DEGREE WITHIN OUR POWER?

This question may not unreasonably be raised; and it may be well to consider it, and to state briefly the arguments on which an affirmative answer may be founded.

Some persons may be disposed, *primâ facie*, to entertain doubts on the subject. The expression in Holy Scriptures will occur to them, "There is an appointed time for man upon earth." Such an interpretation and application of this text is not unfrequently made; and we often hear the phrase, "His time was come," used to modify the sorrow for the premature loss of friends. This must be an error. The expression rather refers to the limit generally of human life—the hundred years of M. Flourens, or the hundred and five as explained above, or the average duration of life in the human race. That it cannot be meant to apply to individuals, implying a fatal fixity to the term of their existence, is amply proved by incontrovertible facts.

1. The average duration of life has increased during the present century in England and some other countries. This is so generally admitted as to need no proof.

2. This average varies with different classes of society and with different occupations. Thus, the clergy enjoy the longest lives: medical men have the shortest, etc.

3. The rich, or those exempt from the cares and anxieties of business, *cæteris paribus*, live longer than the middle classes or th poor.

Gr at l ngevity is, indeed, not uncommon in eleemosynary institutions, asylums, and union workhouses. The reason is obvious their inmates are (many of them at least) absolutely free from cares: neither for themselves nor their relatives need they suffer anxiety. Generally well fed, cl hed, and housed, seldom exposed to external causes of disease (pathogens), they enjoy advantages in these respects not always within the reach of the wealthy, and never of the classes immediately above them in the social scale.

We are able to specify some of the causes of the general extension of human life.

a. Sanitary improvements enforced by law.

b. The more wholesome and provident habits of all classes in avoiding the recognized causes of disease.

c. Better food, clothing, ventilation and drainage of dwellings, the use of coal as fuel, etc.

d. Draining and cultivation of the land.

e. The progress of the arts of healing—medicine and surgery.

The benefits already derived from these and other items of progress justify the hope of a further extension of the duration of life in the future.

It must be observed that the extended average is by no means solely due to the lessened mortality of children and young persons. The obituaries published daily in the newspapers frequently excite attention and remark from the number of *very* aged people whose death is recorded.

The irresistible inference from the above well-established facts is, that both material and moral influences abridge or prolong human life. The sum of all science and the instruction derived from experience is, that means exist which enable us to prolong life in every stage.

Consequently the enjoyment of long life is—within limits not strictly definable indeed—in every man's power.

SOME GENERAL CONSIDERATIONS RESPECTING ADVANCED AGE.

While preparing in youth for the struggle of life, or engaged in its active duties, we have scant time or leisure to give to what we deem a distant future ; but when those periods are past, and we are consciously warned that the time approaches for retirement and repose, we may well turn our thoughts to the questions how the remainder of life can be best preserved from suffering, and whether any and what means may be found to prolong it to its utmost limit.

Satirists have handled, and wits have made themselves merry with, the nervousness and anxiety of old people about their ailments. How sorry would such sallies appear, were they directed against a man's care respecting his dwelling. Should we impugn the wisdom of keeping a house waterproof, of anticipating or arresting decay and dilapidations, of watchfulness and care to prevent injuries from time and weather? What sense would there be in disregarding the loss of a single slate from the roof, the trickling of a few drops of water through the ceilings, the ingress of a puff of air through a crack in the wall? What should we say of him who neglected a loosened beam or sinking foundations until the whole building was in danger of falling about his ears? Is a man's own body of less importance to himself than his house? If the timely relief of some slight pain, the notice and repair of some scarcely perceptible disorder in the fabric or the feelings, may avert acute and prolonged sufferings, or even save for a lengthened time a valuable life — and every life is valuable—is it not most unwise to neglect seeking the remedy? Is it not worth some trouble, care, and expense to understand the evil in its source and its tendency, and to counteract it?

When may a man or woman be considered old? What is the limit of middle or adult age? and when is the line of demarcation between this and the decline of life passed?

This period cannot, indeed, be strictly defined by years. The effects of wear and tear are experienced by some at a much earlier age than by others. Mental or bodily labor, cares, violent emotions, anxieties, etc., produce in a briefer time the changes otherwise requiring years. The phrase *fast living* is full of meaning. It implies a crowding of pleasures or sufferings into a shorter compass than natural. Still, we may approximate to the era of ageing. Some have said a man is old at forty-five ; others have considered seventy the normal standard. Long observation has convinced me that sixty-three is an age at which the majority of persons may be termed old ; and, as a rule, we may adopt this as the epoch of the commencing decline of life. Exceptions, of course, there are ; but in a mixed company few would fail to discern those who may fairly be pronounced old people, as distinguished from the middle-aged ; and, we venture to say, most of them would be found, on inquiry, to have reached or passed sixty-three.

Sixty-three, it will be observed, corresponds to what the old philosophers designated, "the grand climacteric" — seven multiplied by nine. They fancied some mystical relation belonged to the number seven and its multiples. And no doubt the successive stages of life are marked by certain peculiarities. In early life we think those stages are septennial ; but, later, they are rather decades. However this may be, every one is conscious of changes in the constitution, tastes, feelings, mode of thinking, susceptibilities, etc., being marked and recognizable at several epochs of advancing life.

Physiology makes us acquainted with changes in the very structure of our bodies, whence all the external manifestations of ageing flow. These we shall analyze and describe in the sequel.

Pathologists have often observed that the effects of pathogens (*i.e.*, external causes of disease—poisons, contagions, etc.) differ greatly at various ages. Adults are not liable to many diseases which assault childhood. Elderly persons are exempt from many others which afflict youth and middle age. We know, too, that food and medicine vary in their effects upon us at different stages of life. And, moreover, such diseases as youth and age suffer in common present, even to superficial observation, dissimilar aspects, proceed in different courses, and issue in different results.

When we first hear the epithet "old" applied to us, we are shocked, and would willingly believe it untrue ; but it soon becomes familiar, and we acquiesce in the imputation as inevitable. Those of us display most wisdom who do not attempt to blind themselves to the fact, but begin without delay to consider the new wants age creates, and the new duties it imposes. Conscious of having passed into a new condition of existence, the physiological details of the changes within us should awaken much interest, and particularly excite another inquiry of no small importance.

Ageing, as we have seen, begins at various periods of life, determined always, or mostly, by the general course of the past. There may be in age a condition regarded as perfect health, although doubtless rarely so, as would be discovered, were a strict examination made in any case. More commonly there may be some defect, damage, or latent disorder in the constitution, the result of special wear and tear, previous habits, or attacks of disease long since supposed to have passed away.

When, therefore, a consciousness of ageing comes, the questions should be entertained and answered, Is there any such damage existing? What are the weak points in the system? A careful scientific investigation will supply an answer; and if any special organs exhibit any sign of weakness, disorder, or lesion, whether it be the brain, the heart, the lungs, the stomach, the liver, the kidneys, especial attention should be directed to the part, and appropriate remedies at once adopted. Any organ previously the seat of active disease will generally be the first to give way under the general condition of ageing. To urge this by any arguments on persons retiring from the active pursuits of life, and hoping to enjoy a calm and prolonged life, would be, one would think, as superfluous as to persuade them to dwell in houses wind and water proof, or to regulate the temperature of their houses according to the seasons.

Such an investigation of the constitution as I suggest may involve trouble and expense; but who that purchases an estate or house neglects to employ a surveyor? What merchant or trader fails to take stock when he begins or quits business?

I am quite sure it often happens at this epoch of life, that some incipient disease may be detected, which, if neglected, would develop and prove fatal in five to ten years, but which, if detected and guarded against, would admit of the extension of life for twenty or thirty years.

If this be thought too exalted an opinion of the efficacy of remedial measures, it will scarcely be questioned that many aged persons have their lives embittered by sufferings which could be readily relieved if due attention were given to them. But regimen, including, of course, everything around us, and medicinal agents with special powers to repair damage and invigorate weak organs, are as available and efficacious in age as in youth. It is a fallacy to suppose age is necessarily accompanied by pain and suffering. How often do we hear the expression, "Oh, he is an old man! What can we expect?" or, "Consider her age: what is the use of medicine?" Whereas I maintain that advanced age ought to be a stronger and more urgent reason for seeking, without delay, every means of relief. The first symptom of disorder in any part, however slight, should receive immediate attention: pain should not be endured an hour in any part without proper investigation of its seat and cause, and recourse to remedies.

It is very generally considered that sudden death is an evil, and that it is preferable for us all to have some warning and forecast of the inevitable end of life. The Church of England teaches its members to pray for exemption from sudden death. We read and hear daily of persons dying suddenly. Careful inquiry of surviving friends, if such there be, will almost always discover that there were warnings, although neglected—signs, slight perhaps, but sufficient to indicate to a practised eye, had such an eye been directed to them, the approaching catastrophe. And, in no small number of cases there is, at the same time, good reason to lament the neglect, embittered by the certainty that science had resources adequate to avert the deplored issue.

I have already remarked that the disorders and diseases of aged persons differ greatly from those of youth, and adults in middle life; and it must be added that they ought to engage the special attention of a distinct class of physicians.

Specialties are not generally in favor with the profession; but the public hold a different opinion. The propriety of such specialties scarcely admits of an argument. The diseases of the mind, of women and children, of the eyes, ear, throat, teeth, etc., have special practitioners, popularly supposed to be more skilful and experienced in their treatment respectively than those who spread their practice over the whole field of medicine. I am certain that the troubles, disorders, and condition of elderly people demand very special and careful study and observation to understand.

There are several works on the disorders and diseases incident to advanced life, written by physicians of repute. Of these, we may mention Dr. Rush of Philadelphia, U. S., Sir Anthony Carlisle, Sir Henry Halford, Dr. Van Oven, Dr. Day, Sir Henry Holland, and Dr. Maclachlan. All these authors treat chiefly of overt diseases, their symptoms, and mode of treatment.

But, underlying such overt diseases, is the cause of the peculiarities they exhibit—the especial condition of the system in aged persons. This I have found no satisfactory attempt to explain or describe. It is, nevertheless, definite and appreciable enough. Even to the eye of a common observer, some of the phenomena are unmistakable. We are conscious enough of them in ourselves, and our younger friends are not slow in observing them.

It is, however, only when the changes and peculiarities of the system in aged persons are carefully studied, with their relations, antecedents, and consequences, that we are able to devise hygienic measures, preventive of overt disease and preservative of life.

And when defined, and its several items recognized and described, does the state of ageing admit of being ameliorated, retarded, and the inevitable result of the intrusion of the great and mysterious factor —Time — postponed ? This question will be answered in the sequel affirmatively.

Of course, if a life is to be preserved and prolonged by any means or measures, it must be with the sensible and rational co-operation of the individual. It would be very happy for us had we a mystic elixir capable of preserving life, in spite of old damages and injurious habits ; but we have not. If life is not worth some trouble for its preservation, my labor in writing is useless. I know the tendency of most persons is to shut their eyes, and glide on to the end ; but some will surely profit by information designed, at least, for their benefit. A French writer, alluding to the too common neglect of means and precautions prescribed by science for preserving and prolonging life, says, "Men do not usually die : they kill themselves."

This negligence is strikingly contrasted with the desire and efforts made to conceal the advance of age. The use of hair-dyes, cosmetics, rouge, etc., testifies to the fear of appearing old. Were as much trouble taken, and expense judiciously incurred, to abate and stay the radical changes in the constitution which make age dreaded as an evil, it would be far better, and indirectly the purpose aimed at would be more completely attained. The personal appearance of an aged person in the enjoyment of health can seldom or never be displeasing.

WHY ARE THE MEANS FOR PRESERVING HEALTH AND PROLONGED LIFE NEGLECTED ?

It may be useful to consider for a moment the causes of the neglect which so often leads to the abridgment of life.

They are twofold : first, prevalent erroneous opinions ; and, second, inordinate love of money, or, at least, injudicious economy.

On the first point I avail myself of the following admirable remarks of the *Times*, on the occasion of a trial of one of the sect calling themselves "The Peculiar People," who repudiate medicine, and trust solely in the divine aid.

"Their present doctrine," says the *Times*, "is partly an expression of the vulgar error which considers the doctor as a person working by the aid of physic only, and which regards physic as an agency for causing some indirect change in the pre-existing state of the bodily functions. There are many, even among the educated classes, who have yet to learn that the business of the physician is not so much to heal the sick as to place them in a condition most favorable to their recovery—to find out where their habits or occupations, or the hurtful influences to which they have been exposed, have thrown an undue stress upon this or upon that organ ; to consider by what assistance the natural balance of the system may be restored ; to relieve pain, and to obviate for the time the tendency to death.

"The argument which enunciates the duty of using appropriate means, notwithstanding the most assured faith in the divine protection, is so old, and has been worn so threadbare (by repetition), that it would be impertinent even to refer to it, were it not that 'recent facts' show the existence, in the very centre of our civilization, of people of reputable character and good intentions before whom this argument has never been brought, or upon whom it has at least failed to produce any impression.

"A theology which does not recognize in the healing properties and powers of plants and minerals a divine provision and ordinance to meet the needs of mankind is fatally defective. Science seeks to discover and apply them. To neglect and refuse the benefits they proffer is indefensible on any basis of reason or common-sense.

"Medical men would themselves be the first to admit, first, that many cases of ordinary sickness tend naturally to recovery ; second, many others tend, as we all know, irresistibly to death ; third, but there remains a third class, and *a very large one*, in which science and experience alike bear witness that the skill of the physician or the surgeon may determine the movement of the wavering balance, and may make the difference between death and recovery."

The second point, the sacrifice of life to economy, may be illustrated by an anecdote. A gentleman had a sharp attack of acute disease—just a case where the balance was turned by skilled attention and vigorous measures. The physician took his leave with the remark, "You will be liable to another attack. Send for me or some other medical man at once. A delay of a day or two many prove fatal." The patient reckoned up the fees he had paid, and found they amounted to twenty guineas. Just a year after the disease returned ; but, consulting with his wife, they thought that, with the aid of the old prescriptions, many guineas might be saved They disregarded the doctor's judicious advice—delayed a few days—the attack proved fatal. After hearing the history of the disease, he said, "I am confident, had proper means been taken at the first, the attack might have been warded off." This gentleman distributed fifty thousand pounds by his will.

There is no short and sharp process to stay the troubles of the aged. An occasional visit to the best of physicians or surgeons will not do. There must be watchfulness, and the immediate use of measures of relief for every degree of deviation from health. If money is regarded as more valuable than life, nothing more can be said. (See Note F, p. 178.)

IS LONGEVITY DESIRABLE ?

Is it desirable to live to old age, to prolong life when the epoch of its decline has been reached, when its active duties must be in some measure abandoned and superseded by bodily repose, quiet meditation, and thought ?

This can only be decided by each individual for himself or herself.

Not unfrequently the life of aged persons, heads of families or otherwise, is of incalculable value and importance to their children, friends, or dependants.

Many people, without considering such ties or claims, may deem a prolonged life desirable for themselves, having attained the objects of their ambition—wealth or reputation. Or even those who have simply reached a position giving them ease and immunity from care and anxiety after an active life of business, must surely desire to enjoy the quiet and repose of age as long as possible.

Surely, to all such, every available means for the preservation of life, and for attaining the full period of existence, should be of great interest, carefully sought and diligently employed.

Three thousand years ago a wise man wrote, " There is an evil which I have seen under the sun, and it is common among men. A man to whom God has given riches, wealth, and honor, so that he wanteth nothing for his soul of all that he desireth ; yet God giveth him not the power to eat thereof, but a stranger eateth it : this is vanity and an evil disease."

This is equally true at the present moment. Witness the tens of thousands scattered over the whole country, and, indeed, we may say, the whole world, wasting their lives in indolence, self-indulgence, perhaps vice ; expending the wealth gained by the labor, anxiety, and often, it must be feared, by means of questionable propriety, of those who had a very brief tenure of it. Surely, if it be desirable to obtain riches, it is not less desirable to have the enjoyment of them as long as the laws of our being permit. Age has real and substantial enjoyments when not marred by suffering. If God has provided the means, it is our own fault if we refuse or neglect to use them. (See Note E, p. 177.)

Impatient under some slight pain, some disappointment, or the conviction that pleasures long enjoyed can no longer be pursued, people will say they care not how soon their life may end. This is oftener on the lips than in the heart. It is certainly unwise, and a token rather of weakness than of moral courage. If it means anything, it signifies a readiness to throw away a man's best possession. It is the spirit of a thoughtless prodigal, not the wisdom to be derived from experience, and which ought to characterize age.

PHYSIOLOGY OF ADVANCED AGE.

The characteristics of age being open to ordinary observation, a popular term—DECAY—is applied to the aggregate. This word has a very wide and deep signification in science. It is the province of physiology to analyze and define it. As a general expression, it is suitable both in science and ordinary language, but it must not exclude a careful attention to the special phenomena it includes.

In order to render this section intelligible to non-professional readers, it is necessary to make a few preliminary remarks.

Physiologists distinguish the textures of the body from the proximate elements, or materials, of which they are composed. Flesh, bones, cartilages, membranes, vessels, etc., the skin, the blood, the fluids, nerve-matter, etc.—these are all made up of a comparatively few materials : albumen, gelatine, fibrine, fat, together with lime, potass, soda, magnesia, iron, chlorine, and oxygen, in various combinations, and a large amount of water—a compound of oxygen and hydrogen.

It is with these materials that the mysterious principle, *life*, coustructs the textures and builds up all the organs, compacting them into one whole.

While life continues there must be a constant influx into the system of raw materials, as food and air. These undergo, in the stomach and lungs, changes fitting them to become parts of the living blood and textures.

The reduction of these materials into the form of the proximate elements, and appropriating them to build or repair the various organs, is termed digestion and assimilation. A highly complicated, curious, and beautiful mechanism is provided for the purpose, which is the object of the science of anatomy. Passing by the mechanism, we confine our attention to the materials.

Every active motion of the body and mind involves the use and destruction of some part of the substances composing the blood and textures. After fulfilling these uses they undergo changes, and are finally excluded from the body (excretions). During health there is a normal order, a fixed and regular direction and manner, in all these changes.

We can distinguish two groups of materials, and two series of changes. To one group we apply the term nitrogenous, because the element nitrogen takes the leading part in them. The other we designate carbonaceous, from a similar predominance of carbon.

The materials containing nitrogen are the nutritive parts of food ; those in which carbon prevails, the carbonaceous, are for the maintenance of animal heat, essential to preserve the due temperature for all the actions.

The latter, however, have an intermediary use. They become fat ; and this aids the mobility of the muscles, and gives rotundity and beauty of form to the surface.

The nitrogenous matters, when used up, pass out of the system chiefly by the urine.

The carbonaceous are thrown off for the most part in the breath.

In the urine, too, the saline constituents leave the system.

It can now be partly understood how any interruption of the supply of food or pure air, and how any disorder or disturbance of the changes, the metamorphoses of the constituents, or proximate elements of the body, produce various diseases.

Let us now contemplate the condition of a person in what would be termed good health, who would, if interrogated, say, "I am quite well," or perhaps, "I am as well as I can expect ;" that is, free from any overt disease, but who has reached the age of say fifty-five to seventy, and is visibly ageing. As compared with the condition in youth or vigorous middle life—

1. The *fibrine* of the blood and tissues is of a looser texture (*i.e.*, less compactly organized).

2. The *albumen* is less perfect, forming a feebler coagulum when heated.

3. The *chondrin* (*i.e.*, the condensed gelatine of the cartilages joining the ends of the bones in the joints) is less compact and dense ; its spongy texture admitting nodules of earthy matter to be deposited in it.

4. The *fat* is more oily, softer, more fusible.

5. The *bones* are more brittle, from a deficiency of the earthy phosphates. (See Note G, p. 178.)

6. The *blood* is weak, watery ; its coagulum less in amount ; its color is darker ; its saline constituents more variable ; the total quantity circulating in the blood-vessels is less.

To these conditions of the proximate elements and component parts are referable the flabbiness of the muscles, wrinkled skin, sunken eyes, furrowed face, drooping features, stooping gait, diminished acuteness of the senses, dimness of vision, dulness of hearing, all more or less perceptible in advanced age.

That property of the textures in youth which we call resilience, springiness, elasticity, is lost in age. This fault, when found in the lungs, tends to the frequency of fatal congestion.

7. Nervine is the matter composing the brain, spinal cord, and nerves. In the nerves, nervine, sheathed in a skin-like covering, is spread throughout the whole body. Where we can best see it, which is in the brain itself, we find it softer, yielding more readily to any slight violence, and visibly changed in appearance — a change not easily described in words, beyond mere softening.

This matter of the brain and nerves is the seat of feeling and all the senses, the channel of the will and motory power, the mysterious depository of all that is stored in the memory, and probably the agent in all the mental faculties.

Mental diseases in their multitudinous forms — paralysis (frequent in aged persons), obtuseness of the senses (taste, hearing, sight, smell), follow molecular changes in nerve-matter (*nervine*).

Such being the condition of the system in advanced life, as to its materials, we can readily understand how overt disease may speedily arise in the several organs, appearing to be spontaneous, and how readily disease may be excited by external agents. (See Note H, p. 178.)

On the one hand, some one or more organs will exhibit signs of degeneracy, morbid feebleness, sluggish action, partial or complete loss of power, softening or other change of texture, failure of their functions. This is popularly termed decay.

On the other hand, susceptibility to morbid influences from without ; predisposition to suffer from changes of temperature, particularly cold ; to impressions when exposed to even weak poisons, to temporary fatigue, or to privation — all these, and the like, are explicable on the above physiological grounds.

Our state in advanced life may be regarded as analogous to and classed with *diatheses ; i.e.*, special tendencies or predispositions, such as we meet with and recognize in every stage of existence—a liability to some one form of disease rather than to others.

It may not appear very scientific or precise to speak of age, as to its internal characteristics, as a *diathesis ;* but this is the nearest approach to a correct definition for the purpose of comparison we can reach. And something is always gained when we can arrange any set of phenomena under a general head or principle. The Registrar-General groups together certain states or rather diseases, under the generic term *diathetic;* the general idea being of a latent, subtle condition of the system (*diathesis*), when occasional causes produce peculiar trains of symptoms, and modify ordinary diseases.

We may therefore safely speak of the *senile diathesis;* and this simple name may not be barren of results, considering the influence of words upon our inquiries and conclusions.

What of the indwelling life itself? How is this affected by lapse of time? It has been supposed that a certain amount is implanted at birth, which is lessened or enfeebled in age, and at length is worn out and extinguished. The *vital lamp* is a favorite metaphor; and life is assumed to end as a lamp goes out, for lack of fuel. It must be remembered that this is figurative, and we must not push such analogies too far. It is true, there is a limited duration to every organized body—a time when its life ceases; but i. would seem to be its teguments and env lope which weaken and decay: to this the law of extinction in time applies, rather than to the vital principle itself. Hence, as we have already noticed, few persons die of simple old age; and the vital, as distinguished from muscular or molecular force, is very often observed to be very vigorous in old people. The idea of enfeebled vital power need not in any degree lessen our efforts to prolong life.

Delicacy of constitution, and sickliness in childhood and youth, and even extending into middle age, do not in all cases prevent the attainment of longevity. In reading the memoirs of distinguished individuals, who have lived to a good old age, it is very common to find it stated that they were remarkably feeble children. The late Mr. Samuel Rogers, the poet, said he never knew what health was until he had attained his fiftieth year.

The fact of the frequent longevity of the inmates of unions and eleemosynary institutions, which is well attested, seems to prove that hard labor, rough living, even disorders of health in early and middle age, are not an insuperable bar to the attainment of ease and comfort at a later period; and a prolonged life may notwithstanding be hoped for by persons who have experienced such troubles in a better social position.

It is usual, when the lives of centenarians are written, to meet the observation, that they had an originally good constitution; but this is merely an inference from the fact of their longevity, not from any satisfactory evidence of their primitive soundness and vigor. (See Note I, p. 178.)

HEREDITY.

Considerable importance is attached by insurance societies to hereditary influence upon the length of life in individuals proposing to insure. To a certain extent this may be judicious. We often find the members of a family, even when numerous, dying about the same age. Diseases suffered by parents appear in their offspring at a time corresponding pretty closely to that at which the former were attacked. Robert Southey noticed the curious resemblance of persons in age to parents whom they were most unlike in early life. Nevertheless, our inferences on this point may carry us too far. Many persons whose parents died young attain to a good old age, and aged persons not unfrequently survive all their offspring. The subject still demands a rigorous statistical inquiry. And when we find, as frequently happens, elderly people indulging in gloomy forebodings because they have reached an age equal to or beyond that attained by their ancestors, we may confidently assure them, that, so far from there being any law of nature to support the opinion, it ought rather to encourage and enforce the adoption of measures for the preservation and extension of their own life.

Hereditary diseases there are, and every physician takes account of them in dealing with his patients; but it is also certain that in many cases it is rather exposure to the same causes of disease, the same habits and occupations, which bring about the resemblance in the results; and these, too, have to be duly estimated.

THE MEANS OF AMELIORATING AND RETARDING THE EFFECTS OF AGE.

The first item of advice we would offer to persons who have passed the meridian of life is, if possible, to secure for themselves mental tranquillity. The secular business of life, if it has been mainly employed, as it is with most of us, in obtaining the means of living and provision for ourselves and families, ought to be over as soon as enough has been acquired to satisfy reasonable wants and desires, to secure contentment and quiet so far as worldly possessions can give them. If, with an adequate fortune, some object of ambition has been pursued, with age should come a calm retrospect, and estimate of its worth. It is happy for a man who reaches this goal at the age of fifty or earlier. At sixty, or as soon after as possible, our desires should be adjusted to our attainments and means, by modifying the former rather than attempting to better the latter by hazardous or even by legitimate enterprises. At least, all mental anxiety or disquietude should be carefully avoided. In this country, indeed, there are very many persons who never have any grounds for an anxious thought. Born to fortune, and exempt from ambition, they are nevertheless subjected to the common lot of humanity—beset by troubles of another kind, some real, some imaginary. It is not the idle and listless, who, in any marked measure, enjoy the blessing of longevity. Wholesome occupation and moderate means are most favorable to long life, which, as we have before remarked, attaches to the clergy, and to the female sex pre-eminently.

This fact teaches us the next lesson, namely, that *sobriety* is most congenial to health and life. Experience fails to support the pretensions of the zealous preachers of total abstinence from fermented liquors. A judicious use of wine, the quantity and quality being duly regarded, is certainly beneficial in advanced life. No rule can be given with any approach to accuracy as to the kind and amount of wine which is desirable: so much depends upon previous habits. I, for my own part, as a physician, greatly prefer to prescribe the wine, and define the quantity, for an aged patient who has been in early and middle age extremely temperate. If wine or other stimulant has been indulged in excessively, it is rare, on careful investigation, to find a person at or beyond the age of sixty-three entirely free from some damage in one or more organs. Still, such damage, if not very considerable, admits of reparation, when there is a resolute will to abstain, or regulate the amount of stimulants by the real needs of the constitution.

As to food, common-sense should suffice for every one to observe the effects of any course or article of diet, and to avoid any which is felt to be injurious. Generally, aged persons require a diet containing most nutrition in the least bulk. Hence animal substances should preponderate. Generally they will have a preference for mutton, poultry, game, and often for gelatinous food, rather than beef, pork, lamb, or veal. And this preference is in accordance with physiology. Farinaceous substances, although not excluded from the role of diet, should be adopted sparingly; exceptions depending upon special conditions, such as morbid leanness, disorders of the kidneys, etc., which will be spoken of below. We often witness grave errors committed from want of correct information. For instance, arrowroot or some form of starch, beef-tea, so-called concentrated foods, etc., are taken for the muscular debility common in the aged. Under such a diet the weakness continues, and increases, often to a fatal end. In the general defect of nutrition, some one organ droops in function and becomes disorganized, to the danger or loss of life.

As with the use of wine and stimulants, the diet of aged persons must be regulated by giving due consideration to their former habits, present mode of living, pecuniary means, and the like; but one rule may be suggested, namely, to divide the amount of food taken into three or four meals, rather than one large one (dinner usually), in the day. A sense of fulness or oppression after eating should never be disregarded.

As the system in advanced life is more amenable to certain morbid influences from without than in early life, it is advisable for elderly people to be more watchful against them.

A wholesome dwelling, well drained, free from damp, its interior unaffected by changes of temperature without, and admitting free ventilation when artificially warmed, are certain conditions of prolonged life. Nothing is so fatal to old people as cold, and this is intensified by the addition of moisture. Therefore, when possible, a residence should be selected in an elevated position, on a sandy or gravelly soil, where fogs are rare, and where exercise, walking or riding, can be taken in fine weather without getting chilled or wetted. Night air, in our climate, ought never to be encountered. The evenings, if not the entire day, should be spent in rooms moderately heated—not too hot—and well ventilated. About 60° F. is the temperature most congenial. The bedroom especially should be kept at this heat both night and day. A glass house for walking exercise during the cold of the winter is a great comfort. Exposure to cold, with wraps about the throat and heavy clothing, should be decidedly avoided. Some people think it effeminate to have a fire in their bedroom in cold weather: this is a great mistake. Both for warmth and ventilation no means have yet been devised equally advantageous with an open fire and chimney; and by the use of certain species of coal, which burn slowly without requiring to be stirred, a tolerably equable temperature can be maintained through the night. When there is no fire the chimney should be kept open for the ventilation. Disturbed sleep, and headaches in the morning, are common consequences of the use of a closed register stove.

Of suitable clothing, varying with the seasons, it is unnecessary to speak.

With other misleading advertisements abounding in the newspapers, and trickling down whole columns of the *Times* in particular, hot or Turkish baths are recommended as infallible means of prolonging life. With respect to the Turkish bath, elderly persons should, I think, never use it; since it is extremely exhaustive, and it is seldom they have any redundant muscular strength. If used, it should be very rarely, and only by advice of a physician.

Hot baths demand also great care. I have often known, and more frequently heard, of cases where they have proved fatal. When there are symptoms of head-trouble—pain, dizziness, etc.—suddenly depriving the brain of blood by immersion in hot water, which causes the blood to flow to other parts of the body, induces cerebral collapse, and either immediate death, or fatal paralysis, or stupor (coma). For cleanliness, and to preserve a healthy state of the skin, I recommend all old people to employ hot water with soap and flannel or sponge (the flannel is best), using a moderate degree of friction. A foot-bath of hot water, with the addition of a tablespoonful of flour of mustard, is very useful when there is fulness of the vessels of the head, continued sleeplessness, or obstinately cold extremities.

The objections to the hot bath do not apply to the employment of hot air or vapor, the patient being in bed in a recumbent position. There are simple contrivances by which this kind of bath can be readily obtained without trouble. This simple remedy is too often neglected in cases where free perspiration so produced would prove of great value.

A modified kind of shampooing—consisting of friction over the skin, and kneading of the deeper textures, muscles, and joints—is a very useful proceeding to remove the stiffness and immobility, and the sense of fatigue after slight exertion, often experienced. This process will often remove the pains in the loins besetting elderly people, as well as impart elasticity to the limbs and agility to their movements.

A tranquil mind; well selected and arranged diet; moderation in the use of wine and other stimulants; exercise short of fatigue in favorable states of the weather; confinement to a warm house in cold or wet weather; well warmed and ventilated sleeping apartments; clothing adapted to the seasons; maintenance of the animal heat of the body, particularly of the lower extremities; careful avoidance of external influences tending to produce disease, malaria, and the like; judicious bathing, to secure a healthy skin — these are the principal points claiming the attention of aged persons, even when enjoying the best health.

To these must be added immediate recourse to the physician when any overt disorder or suffering is experienced.

My purpose is not to teach elderly people to treat themselves when ill; but, in the following pages, to deal with infirmities besetting them, which are generally borne without an effort to obtain relief, being regarded as either too insignificant, or as inevitable and irremediable evils. In some instances such conditions or changes in the system as would be sure to bring, in a longer or shorter time, disorders and fatal disease if neglected, are shown to be amenable to simple and easily-employed measures.

The question may now be asked, whether there is any probability, or even possibility, of the discovery of a physical agent capable of completely arresting the changes in the system constituting ageing, or preserving the integrity of the body and all its parts with the vigor of youth and middle-age up to the extreme limit of life? This question is by no means an idle one. If, a few years since, it had been asked whether it were possible for any thing or process so entirely to suppress feeling that the limbs could be amputated without pain, such a question might well have been deemed visionary, and treated with contempt. But the use of anæsthetics has now been practised so long that their effects cease to excite our wonder, although they are really most wonderful. Not one or two agents with this property, but many, are now known.

Scientific ideas run long in grooves. When a new line is struck and followed, most unexpected discoveries are made. Inferences from analogy are easy or obvious, yet they are often most prolific in results. Inoculation of small-pox led to the discovery of vaccination. When the nature and properties of such agents as the ethers, chloroform, chloral, and its hydrate, are considered, together with their history and the manner in which they became known, we are greatly encouraged to hope for the discovery, at no distant period, of an agent which shall effectually stay the changes in the system incident to age; in short, arrest the progress of what we call decay Whether the mineral, vegetable, or animal kingdom will furnish it, we cannot foretell. Our knowledge of the action of vegetable products on the human constitution, extensive as it is, is yet only of a minute proportion of the whole. Vegetable substances exert a wide and various healing influence. Opium, foxglove, colchicum, belladonna, tobacco, tea, etc., are to a certain extent known. Thousands are partially recognized; but who shall say what future experiment may bring to light? (See Note M, p. 179.)

It is, however, rather to a comparatively new class of bodies we look as the most probable source of the great desideratum. The chemistry of ternary and quaternary compounds, formerly designated organic chemistry, presents us with what is practically an illimitable number. To this class of substances belong the most energetic and manageable anæsthetics; and either by enlightened inquiry or as the result of some accident, it is almost certain some of them will be found to exert a powerful action on the living system. Already, out of the line of anæsthesia, or narcotism, we have one of these artificially prepared substances, which promises to be a remedy for that habit of body termed the gouty diathesis—a condition so very frequently issuing in overt and fatal disease. (See paragraph on Gout, p. 150.)

By the combined aid of physiology and chemistry, we are approaching very closely to an exact knowledge of every kind of material (proximate elements) forming the human body — their exact constitution, composition, and mode of formation. Some of them can be made artificially in the laboratory, a certain proof of science being on the right track. We may, therefore, look with confidence to these sciences to investigate completely the changes induced by diseases which are most frequently results of the intrusion of foreign substances with the air, water, or food, into the processes of formation, sustenance, or decomposition of the natural compounds.

The changes in ageing are consequently not beyond our reach; and it is probable that a rational and scientific basis will be laid erelong for completely arresting them. While great energy and vast sums of money are expended on experiments in mechanics, electricity, etc., the means of arresting disease and prolonging life are left to haphazard individual efforts, seldom or never rewarded.

Jenner's case is singular. Philanthropy is in complete subjection to fashion and precedent. Still, I feel assured, if the public could be brought to apprehend the prospect of success by investigations instituted with the object of discovering the means of prolonging human life, pecuniary aid would be forthcoming. It is only by well-concerted efforts, and having definite ends in view, that our present science can be made available for the purpose. Its processes are very costly, both in time and money; but in a country where wealth so abounds, the latter ought not to be the obstacle. There are men, too, quite capable and qualified; but they are necessarily engaged in other pursuits, while most erroneous ideas on the subject generally prevail. At some future time the indifference and neglect of the present will excite remark and wonder.

In the mean time we must proceed in another direction, guided simply by experience and such analogies as may be found and accumulated by observation. Much has already been done, but very few have the full benefit of the knowledge already obtained.

A healthy and vigorous state of every part and every organ is essential to the health and well-being of the whole system. And as ageing, or what is the same to our means of observation, begins sometimes locally, and sometimes over the system generally, we first look for the local degeneracy; and, finding none to call for special remedies, we address ourselves to the entire system. We have many and most valuable agents capable of invigorating and imparting tone to the whole. And these, judiciously selected and combined, and administered with a full knowledge and control over the diet, regimen, and habits of a patient, will greatly ameliorate the effects, if not retard the advance, of ageing. He must have had little experience who has not seen this influence exerted by well-selected remedies.

The special disorders of the system, and those commencing locally, will be described in the sections following.

RECUPERATIVE POWER—VIS MEDICATRIX—LIFE.

We have one well-established fact, highly encouraging in the research for means to arrest ageing—a fact at once very curious and instructive. It is, that the natural healing or recuperative power termed *vis medicatrix naturæ*, to which the physician and surgeon look in patients at every period of life as an essential element in the success of their arts, remains in the system in old people until a very great age. By virtue of this power we see broken bones unite, the assaults of disease resisted, and recovery occurring after considerable injuries and severe attacks. And it may fairly be inferred that the changes, degradation, and decay in age are disorders and unnatural incidents of that epoch of life, inasmuch as we see the efforts of this power exerted to resist and control them. (See Note F, p. 178.)

Thus the tastes and appetite of elderly people vary from those of youth and middle age, guiding the choice of food and its amount, and to the kinds and quantity of stimulants and other drinks. Animal food, aromatics, bitters, the alliaceous tribe of vegetables, are generally preferred ; and a due supply, with other items of living, tends greatly to check or keep the changes of age in abeyance. The desire for mental and bodily repose, sensitiveness to cold, etc., point in the same direction.

Science has not at present obtained any clew to the mystery of life. The difference between a living and a dead or lifeless thing is obvious enough. We recognize life as an attribute of organisms—bodies with a mechanical arrangement of their parts, and in other conditions or states. Life exists without sense or motion in vegetables, in seeds, in eggs ; with feeling and motion, but without thought, in many animals, with instinct added in others, and with superadded faculties in some ; only in man associated with mind. Life in organisms is an individual thing, special and peculiar in every species. In the more complicated animal structures there is but one life. Destroyed in any considerable part, it ceases throughout the whole. There is no such thing as a diffused or general life. In this it strongly contrasts with electricity, caloric, light, although there is a certain analogy with it and these bodies or forces. They are, moreover, all essential to the continuance of life ; but so also is water, and more or less other matters of a grosser and ponderable nature. It is as absurd and false to represent electricity or heat as being identical with life, as it would be to identify it with water or phosphorus or iron, or the materials which it animates. The term protoplasm has been applied to material, not only always present with life as its invariable tegument, but imagined to be independent and separate from organized species.

Inasmuch as we know, as a matter of fact, that life exists in connection only with certain compound substances made up of a few elements, we must take this as an ultimate truth admitting no explanation. We may call these compounds protoplasm, or bioplasm if we like ; but these terms explain nothing. People pretend to define life just as our ancestors used to define light, deceiving themselves with words. Life is essentially something *per se.* It cannot be transferred from species to species, or individuals to individuals. It is transmitted by descent. It flows in species in the downward stream of time. The individual dies ; but the life which has passed from him to his offspring continues, and passes on from generation to generation. Why two sexes are needed for this continuance of life we know not ; but so it is. There is no subject on which more nonsense has been written by men having a reputation for science than this. They prove themselves to be unacquainted with the very first lesson taught by the logic of science—not to confound resemblance with identity. Not to distinguish life from its teguments and appertainings is to violate both science and common-sense.

For an individual life to continue in existence, the integrity of its envelope—the body in which it dwells—must be preserved. And the means we must employ to insure its continuity and normal energy must be directed to the body, its textures, its organs, its processes, and actions.

These remarks are designed to dispel illusions and false notions, now very prevalent, and besetting persons not versed in true science, and to direct attention to the real and only method we must pursue to promote human longevity.

WATER.

When it is considered how large a proportion of water enters into the composition of our bodies — considerably more than half our weight consisting of water— and how many functions it performs during life, it becoms evident that the question of the purity or impurity of that which is imbibed becomes of paramount importance in relation to health. The average amount taken into the system by every individual, in some shape or other, may be reckoned at about three pints per diem.

As the vehicle of the introduction of many subtle poisons, it is now popularly recognized ; and the pressure put by the government and the press on companies supplying water to towns is necessary, if we wish the people to enjoy health. Attention directed to wells, and other sources whence families are supplied, is demanded from every one who has influence in the matter. This is at present very partially accomplished.

Much has been done toward obtaining a supply of wholesome water to the larger towns. The greater part of the organic matters formerly taken without a suspicion of their injurious nature are now excluded ; and, by filtering and other expedients, all or most of the impurities suspended in water are removed before it comes into our households. So far well. But when we are inquiring into the causes of premature decay and susceptibility to disease, we must needs look closer into the character and properties of the water taken habitually for months, years, and decades.

After all possible precautions have been taken to secure pure water, this is never done perfectly. The least impure water ever obtained still contains a notable quantity of earthy matter—lime and magnesia salts, soda, potash, etc. Hard waters contain these in the greatest although variable quantities; and the effect of taking, say, three pints daily of such water may be somewhat appreciated by observing the deposit found on the inner surface of the vessels in which they are boiled. In fact, a quantity of these saline matters is taken into the system quite sufficient to account for many disorders, the origin of which is otherwise inexplicable. It does not matter what may be combined with the water, or how it is treated — whether taken as tea, soups, spirits, or beer — the earthy substances are there. The deposits so frequently seen in the ligaments about the joints, on the coats of the blood-vessels, and about the heart, in old people, probably have come from this source. And when we are discussing the question, how to preserve and extend life in advanced age, the character of the water habitually taken must be regarded.

The amount of lime, salts, and other earthy matter is greatest in spring-water; next in that from streams and rivers; while in rain-water, carefully collected in clean reservoirs, there is little or none. But rain-water is by no means free from contamination: much organic matter is usually found in it, and it readily dissolves substances of which cisterns are made, and even the lead of the pipes through which it flows. Iron is the least injurious constituent found in water, and its presence is very common. If the precautions against injurious agents are perfect, they will include, not merely the use of the softest and purest water supplied by Nature, but absolute abstinence from any water except it be distilled.

There is only one objection to the use of distilled water, whether as a beverage, or in tea, for cooking, etc.—namely, its cost. This surely may be entirely disregarded by most persons who are willing to incur some amount of trouble and expense to secure for themselves a long life.

It is true that distilled water is very vapid and unpleasant when drunk without admixture; but a water-drinker may easily make it, not only tolerable but delicious, by saturating that used for drinking with carbonic acid gas. The apparatus for making this gas and charging water with it is simple and inexpensive, and the process is easy. (See Note K, p. 179.)

In the report of the Water Supply Committee of the House of Commons, it is stated that "moderately hard water, the hardness of which is due to the presence of carbonate of lime, when used for drinking is not injurious to health. Persons, however, who are accustomed to soft water may suffer by changing it for hard, and *vice versa*. But, when the hardness is due to sulphate of lime, it is objectionable."

These statements do not invalidate my opinion. The use of hard water for drinking may not produce any immediate or sensible bad effects, but the cumulative effects of hard water drunk habitually for years is quite another matter. Even carbonate of lime may then prove very injurious. (See Note L, p. 179.)

There is another suggestion I would make, as to the use of water by elderly people. It is, that they should occasionally and often substitute pure hot water with their meals for all other drinks, especially if any feeling of oppression and fulness is experienced after eating.

Not lukewarm water, which produces nausea and is disagreeable to the palate, but water as hot as it can be taken. Water at a temperature of 120° F. is very pleasant to the taste, and congenial to the stomach. It promotes the digestion and assimilation of the food, and will generally, if taken freely, supersede aperient medicines, while it will equally correct a disposition to diarrhœa.

If plain hot water should be imagined to be inadmissible, add a small quantity of some light bitter, such as is acquired by pouring boiling water on a slip of dried orange-peel, and allowing it to cool down to the drinking-point. A little ginger in powder or a few drops of the essence of ginger, or a few grains of grated nutmeg, are to some persons more agreeable than bitters.

There is sold by druggists a concentrated infusion of orange-peel, a teaspoonful of which, added to a tumbler of hot water, imparts a bitter very agreeable to most persons. This saves trouble, and proves a valuable promoter both of appetite and digestion.

An eminent surgeon has recently amused and surprised a large audience by expressing the opinion that the importance of obtaining pure water is exaggerated. He regards it as a matter of indifference whether we drink one kind of water or another; alleging that, as it can never be found perfectly pure, a little more or less of organic or earthy matter may be disregarded. We are so accustomed to have, in popular assemblies, the strangest notions and paradoxes advanced, apparently with no other view than to startle the world, that we need give little heed to this, which is contrary to all experience and science. The surgeon's faith is in his knife. Suppose a chemist were to employ impure water in his investigations, what would be the value of his results? The human frame is far more sensitive to the action of agents, and its processes more easily disturbed by the presence of foreign matter, even in the minutest quantities, than any chemical compound. Common-sense is adequate to judge and determine this question.

MINERAL WATERS.

In all ages the water from springs, hot or cold, holding salts and minerals in solution, has been recognized as salubrious to the healthy, and remedial in many diseases.

The subject of the composition of mineral waters, and the value of any especial one in the disorders of advanced life, is too large to be entered upon here.

Two cautions worthy of attention may be given to persons past middle life, respecting their use of mineral waters.

1st. In resorting to any spa or watering-place, and adopting the use of the mineral water, elderly people should consider—1. The climate. 2. The effects of the journey. 3. The change of habits involved. 4. The exact nature and properties of the water. The step should not be taken at haphazard, or because commended by others on the ground that they were benefited by it. If A extols a remedy which cured him, B should hesitate to employ it unless he is quite sure his own case is the same.

2d. The next precaution may be best understood by an analogy. A farmer finds the soil of a field in a bad state, his crops failing. He employs a dressing of lime, and finds its effect great and satisfactory. His crop, from that field, is doubled the first year. He employs another dressing of the same kind the next year. He thinks the land improved, but in a far less degree. A third time he uses the same dressing, and the result is a total failure. He has inflicted a positive injury on his land.

In a manner precisely similar, an elderly person takes a course of mineral water, well selected, we may suppose, for the purpose. Its influence on the general decay which has begun within his system is most favorable. He is invigorated, and rejoices in the elasticity and vigor which it has imparted. The next year, of course, the remedy is repeated. There may be some good produced. The third time, not only is there no advantage derived, but serious and even fatal consequences ensue.

The introduction of mineral salts into the blood and tissues the first time supplies a real need: the very same mineral salts in excess are deleterious, and really poisonous. The life of the Emperor Napoleon III. was evidently cut short prematurely by just such a proceeding with the waters of Vichy. A city millionnaire, within my knowledge, was recommended the internal use of Seltzer water. Its effect was at first extremely beneficial. He went on with it to excess; and the result was an injury to the constitution, which proved fatal.

STIMULANTS—SPIRITUOUS AND MALT LIQUORS—WINE.

To the general remarks, page 6, the following may be added.

The advocates of total abstinence signally fail to produce evidence in support of their opinion, that wine, beer, and all stimulants, are inimical to health and longevity. Their bold assertions are of no more soundness than the Bacchanalian songs which represent wine as the panacea for all human ills.

Science, common-sense, Holy Scripture, and all experience testify to the benefits to be derived from wine when used in moderation and with proper restrictions. Malt liquors may be regarded as equivalent to wine. They contain some portion of stimulant, with much real nutritive matter.

I am speaking to elderly people; and, as a physician, I say, a portion of good sound malt liquor, be it porter or ale, taken with the food, satisfies the appetite, and prevents the repletion apt to follow a meal of mere animal and vegetable food. The quantity, as a rule, should not exceed eight ounces.

In replacing them with wine, especial regard should be had to its quality. The artificial mixtures called wines may be a source of much mischief. If really good wine can be obtained, "the pure blood of the grape," the selection of the kind to be preferred is of less moment. The light wines of France are suitable for six months in the year only, in this climate. For the rest of the year, good port has no equal. The change from one to the other is also beneficial. If those who have taken wine liberally would gradually reduce the amount to four, or even two, ounces of port, sherry, marsala, or madeira, at dinner, they would do well. The same amount for those not previously accustomed to it, and who, from debility, sluggish circulation, or other reasons, adopt it, should never be exceeded.

Sherries are too often sophisticated; marsala is much recommended as likely to be pure and less acid. It is good to vary the kind taken. The number and names of wines submitted to our choice is legion.

It should be a rule to avoid forever any wine found uncongenial to the stomach or to produce headache. (See Note N, p. 180.)

It is always best and most advisable for all persons to abstain from the daily and habitual use of ardent spirits altogether. They should be reserved for emergencies. And it is wise not to refuse them when real need arises.

A sudden indigestion, spasms, a chill caused by exposure to wet or cold weather, temporary depression of the vital forces, justify the use of spirits in proper quantity; and in such cases they are invaluable.

Elderly persons who in winter suffer from cold feet, and find artificial heat applied externally fails to afford relief, may with undoubted propriety and advantage take half an ounce to one ounce of brandy, rum, or whiskey in hot water on going to bed. The choice must be determined by the effects. If a headache or foul tongue in the morning follows, the inference is, the spirit was impure, probably containing fusel-oil. A very slight trace of this noxious ingredient in spirits will, in some constitutions, produce headache, as accurate a test of impurity as chemistry can employ.

There is a form in the British Pharmacopœia for a brandy mixture, intended for use in the collapse occurring in many diseases. As all the colleges concurred in producing that work, we may assume that a large proportion of the physicians of Great Britain approve of this occasional use of ardent spirits. A pamphlet circulated extensively by the Temperance League charges the profession with exciting and abetting drunkenness by this use of spirits. It maintains that we ought in emergencies rather let our patients die than administer alcohol in any form. Such fanaticism neutralizes all the arguments in favor of total abstinence.

CLIMATE, ITS EFFECTS ON LONGEVITY.

If the recorded cases of persons who have attained to a great age, say ninety and upward, are tabulated according to the locality where they have occurred, it might be concluded that climate has had little influence. In every part of the world, in every county and district in this country, such aged persons have been and are still met with. Against the acknowledged longevity of those classes whose wealth enables them to enjoy a change of climate whenever they please, we may set the frequent observation of the clergy, the female sex, the pauper, all of whom are most commonly obliged to spend their time within a very narrow range of place.

And yet it must be admitted we have ample testimony to the great benefit to health derived from a resort to milder climates during our cold, wet, fickle, and inconstant winters. If, however, during this season due precautions are taken by elderly people, a rigid avoidance of exposure to cold, damp, unfavorable winds, they will, in most cases, do as well in England as anywhere. Of course, in exceptional cases, where some failure of a local organ, the lungs and air-passages more especially, already exists, a resort to a warm climate may be advisable. The range of choice is now—thanks to steam and rail—very wide. Every quarter of the globe is available. Fashion has ever been the guide, and probably will continue to be so. Without being able to give any very definite statistics on the subject, I have a well-grounded suspicion that, in many places of resort for change of climate, there are circumstances and conditions tending to counterbalance their advantages, by exposing visitors to forms of mischief different perhaps in kind from those they would encounter at home, but equally injurious and opposed to the attainment of long life.

A really fair and impartial estimate of the character of scarcely any of those resorts is obtainable; so many interests are involved, concealments practised, and motives existing, to allure the stream of visitors, that the real facts cannot be ascertained.

The refreshment of change to this place or that, of immunity from the cares of home and business, the mild occupations of the mind, and the bodily exercise usually associated with the climate, greatly benefit the young and the adult; although how often do we witness one or more children of a large family—and even an adult—given to these migratory habits fall victims to some local and fatal disease?

The choice of a place to elderly people in search of health and invigoration must depend upon their actual condition. This should be well and accurately ascertained, and suitable precautions observed to guard against all local influences to which they may be exposed in the place selected. Thus we not unfrequently meet with patients who have brought home with them the effects, or even the active poison, of malaria (a very subtle cause of exhaustive disease), rheumatism, urinary disease from impure water or the too long use of acid wines, and other diseases contracted in some place resorted to for health.

Upon the whole, I am inclined to think the majority of persons who have passed the line of demarcation between adult and old age would do best by making judicious arrangements at home for warmth, pleasing occupation, exercise, and diet.

A residence in India and other hot climates appears to be not unfavorable to longevity, when no permanent damage is left by the diseases prevalent there. It would be interesting to know what proportion of a given class, civilians for instance, escape injury, and return to England with sound constitutions. Those who arrive with the traces of former attacks—fever, dysentery, liver disorders, etc. — are exceptionally amenable to remedies, the changed conditions surrounding them being very favorable to a cure. I have known many persons who have spent the greater part of their lives in India and other hot countries who have reached a good old age.

DEVIATION FROM AVERAGE HEALTH IN AGED PERSONS.

Let me repeat, it is not intended in this work to treat of such diseases as would naturally and commonly claim attention and the assistance of the physician ; but such deviations from health as are generally neglected, from the notion that they are insignificant, or necessary conditions of age.

In like manner, although some medicines or remedial agents will be spoken of, a full account of their properties is not necessary here. If more information is desired on either branch of the subject—*i.e.*, diseases or remedies—the author would refer to his volume entitled " Household Medicine."

FAULTY NUTRITION.

The primary and fundamental condition of the continuance of health is a supply of food and its assimilation ; that is, its conversion into healthy blood, from whence, through the circulation, every part and organ receives nourishment ; in other words, material suitable for its sustenance and repair. For in every part there is a constant process of wearing away and restoration ; and if the balance of waste and repair is not maintained, disease quickly ensues.

Every one knows that several organs are concerned in the process of nutrition—the stomach, liver, pancreas, spleen, upper and lower bowels. Certain fluids are formed, with power to dissolve, mix with, and modify the food, until it mixes with the circulating blood, and is endued with life. The blood-vessels and lungs take important parts in this business.

When any of the digestive and assimilative organs are enfeebled or diseased, we address our means to their relief. In the sequel, some of the disorders of these organs will be noticed.

Here we would observe there is a state often seen in aged persons, evidently referable to imperfect or interrupted nutrition, and yet we are unable to refer it to the failure of any of those organs in particular.

This state is a marked and evident general loss of flesh, without suffering, often with pallor of the surface, especially noticeable in the cheeks : with the obvious attenuation, there is not unfrequently lightness of movement, cheerfulness, mental clearness, good appetite, and easy digestion, so far as the stomach is concerned ; while all the bodily functions appear natural, the loss of flesh proceeds. Sometimes morbid sleepiness and undue fatigue after moderate exercise will be observed. Neither patient nor friends take much heed of the change. Perhaps some modification of the diet is adopted, and articles of food are recommended which are entirely valueless—arrowroot, beef-tea, Liebig's extract, or other equally wrong substance.

Whenever an aged person thus loses flesh and color, attention should be given to it in a sensible manner, even when apparently in other respects well. Since, if it goes far, the susceptibility to cold and other external influences, to assaults of ordinary diseases, become greatly increased ; and what would, in ordinary circumstances, be a slight attack or injury, may prove fatal.

A considerable change of diet should immediately be adopted, and any habits calculated to weaken the system abandoned.

The food and regimen to be adopted must depend much on the manner of living previously. As a general rule (and only such a rule can be given), food rich in albuminous or staminal principles, such as eggs, with solid but juicy and tender meats, are to be recommended as the staple articles. Light wines, if before taken habitually, or even more generous port, sherry, or marsala, should be replaced by good stout ; aerated bread substituted for ordinary bread. It is true that the heat employed in baking bread destroys to a great extent the fermenting power of yeast ; but something remains in bread made with yeast which renders it more liable to undergo changes, and with moisture and heat to become more rapidly sour.

Fruit and pastry should be taken sparingly ; and, as a diluent of animal food, rice should be taken instead of potatoes. Green vegetables, either cooked or raw, as they are eaten in salads, must be selected in accordance with other considerations. They supply potash, sulphur, and iron compounds when duly digested.

Fluids should be taken sparingly (see Water).

Another point should receive attention—namely, the mastication of the food, of whatever kind, should be effected slowly and completely. When the teeth are defective, the dentist should be consulted, to correct or replace the natural with artificial ones. If this fails, the food should be held for a time in the mouth, and moved about with the tongue, so as to get it well mixed with the saliva. Even fluids should be so dealt with. Merely chopping up meat or vegetables very fine is insufficient. The dissolving power of the saliva is very great, and no one doubts its influence in bringing about the changes necessary for converting food into real nourishment.

Cold bathing should be abandoned, and hot water with friction, by means of soap and flannel, substituted.

Gentle exercise in warm weather is advisable ; but cold air, especially when damp or at night, carefully avoided.

In the condition described, when loss of flesh is noticed, the susceptibility of the system to injury from cold is greatly increased.

A considerable proportion of the day should be devoted to entire repose.

Of change of climate I have already spoken.

If these, or similar means, produce a favorable change, and flesh begins to increase, there will be no need of drugs.

In some cases, some of the preparations of iron are very beneficial. It must be remembered that iron is as truly an aliment as albumen.

Cod-liver oil is fashionable for all cases of leanness ; but its use by aged persons, whose means allow of a free choice of aliments, is unnecessary and hazardous.

A weak infusion of orange-peel, chamomile, calumba, or other light bitter, with a slight acidity imparted by dilute sulphuric acid, is good and grateful. Sage, balm, or wormwood tea have been in repute. But a judiciously-selected diet, with the other items of regimen described above, are usually efficient.

LOCAL FAILURE OF NUTRITION.

Physicians have always sought for guidance in the treatment of disease in the living by the changes to be seen after death. The disorganizations thus discovered are the results of disorders when they have done their worst. There can be no doubt that there is a disordered condition prior to, and the cause of, such morbid changes.

It is to the very first and initiatory symptoms our attention must be directed if we would save life ; and these must be correctly interpreted.

With respect to the point before us, I am certain that fatal disease of the kidneys (degeneracy as it is termed — Bright's disease), disease of the brain (softening, for instance), and lesions in the structure of other organs, are the results of a failure in the nutrition of such parts. They do not get, or they fail to appropriate, the materials from the blood essential to their integrity and health. They shrink, shrivel, and lose their power of action. The root of their troubles is in the processes of assimilation. Hence the necessity of very close and minute observation to detect the very first indications of disorder in aged persons.

OBESITY.

The counterpart of the condition described in the foregoing section is a tendency, after middle age, to become too fat. The popular expression applied to persons of a rounded form, moderate embonpoint, clear skin, and a ruddy color—that they are "in good condition" — accords with science. This condition is most commonly accompanied by healthy internal organs, a very desirable and hopeful state.

When fat is increased beyond a certain limit it may be regarded as disease ; yet, until it becomes burdensome, it is generally disregarded. When it accumulates locally, about or within vital organs — the heart, liver, etc.—it shortens life. In elderly people fat often accumulates in the mesentery (this is the organ known in animals as the flare), producing the prominent or pendulous abdomen.

It is a strange thing, although often observed, that the public will receive from writers, avowedly entirely ignorant of medicine, suggestions respecting treatment with more favor than from the scientific physician. Hence the great popularity of a pamphlet and plan of Mr. Banting for the relief of obesity. It was, in fact, only his physician's advice related and expanded. A proper regulation of the diet and exercise will generally remove undue obesity. All fatty matters, sugar, and starches, should be avoided. Pastry, puddings, rice, and farinas, strictly forbidden. Lean meats, green vegetables, whole-meal bread, salads, a free use of vinegar, soda or potass water as the only beverage, except tea, and this without milk and sugar—these should form the diet. Spirits, beer, potatoes, butter, must all be abandoned. Vapor-baths and occasional enemas of soap and water aid in the reduction of fat.

Of course the physician can aid these domestic measures by medicines ; and it may be safely affirmed that no one need suffer long from the troubles incident to obesity, if he or she will take the necessary precautions and means of relief.

PAIN.

THE USE AND MISUSE OF NARCOTICS.

The nerves, the seat of pain, pervade, in the form of fine fibrils, every part and every organ of the body; proceeding from the brain and spinal cord, as thin cords, they pass to and spread through the various tissues and even the bones.

Pain arises from any kind of lesion, whether external injury or internal change. It comes in every degree, from mere uneasiness to acute and unbearable agony, almost always accompanying disease of every description.

The opinion has been held. that aged persons are not so sensitive to pain as younger people: my own observations do not permit me to agree with this. It is true, individuals differ at all ages in their sensitiveness and power of endurance. I have noticed aged persons suffering most acutely from slight operations, the extraction of a tooth, or the prick of a lancet, while they will often long endure dull though distressing pain without seeking relief, under the idea of its being incident to age.

This is at all times, and in all cases, an error. If the nature and exact seat of pain are not at once discerned, if a remedy is not immediately found, this should rather excite greater care and more diligent search for the means of relief.

Pain, wherever situated and of whatever degree, should in every person advanced in life, be relieved; and science has furnished the means.

It may be first remarked, that local pain does not always imply lesion, or disease in the part where it is felt. This is one of the phenomena of the sympathy existing between different organs often remote from each other. The sagacity of the physician is often tested by his ability to refer accurately to the seat of disease indicated by pain in a distant part.

There is much in the pains of aged persons of great interest, in relation to the question how life may be prolonged to its full limit.

The process which, for brevity, I may term decay, is, I am persuaded, almost always attended with pain. This decay, or ageing, does not indeed go on simultaneously in all parts of the body; one part, or more, may thus change before others, the locality of the pain not obviously indicating the part affected.

There is, however, very frequently, in advanced life, a widely diffused pain in the limbs, loins, back, and even affecting the muscles of the chest and abdomen, to which I think a proper designation has not been appropriated. I would call it

DOLOR SENILIS,

pains which we constantly hear spoken of erroneously as *rheumatic*. Rheumatism and rheumatic pains, in popular language, stand for not one but many kinds of pain, having different seats, different causes and origin, and, if properly treated, must be subjected to different plans of treatment.

Dolor senilis is of very various degrees of intensity: sometimes it exists as a mere general uneasiness or discomfort, often being aggravated in bed, or on first rising in the morning; sometimes it becomes severe, and it is the more severe kind which is termed rheumatic.

Long observation and treatment of aged persons have satisfied me that there are also cases of this diffused pain, more or less severe, caused by the presence of poisons. Calomel, or other mercurial salts, having been taken for other diseases, and very properly so, will, even years after, reveal a lingering existence in the system, by pain, often deep-seated, generally appearing to be in or upon the bones. Pathologists have recognized a chronic inflammation of the covering of the bones (periostitis, as it is termed), certainly referable, among other causes, to the prior use of mercurials.

Malaria occasions similar diffused pains, when it is received into the system in too feeble a state to manifest its true character; *i.e.*, failing to produce fever, agues, or periodicity in attacks. The connection of malaria with neuralgia, a term applied more especially to pain seated in the larger divisions of nerves, and running along their course, is generally recognized.

True rheumatism and gout also may be the cause of diffused pains, without any overt or distinct revelation of their true character.

There are, moreover, other states, termed, for want of a better or more discriminating term. *cachexia*, or bad habit of body, the source of such pains.

It is of primary importance to distinguish clearly these several cases—namely:

1. Simple age.
2. Mercurial or other mineral poisons.
3. Malaria.
4. Rheumatism.
5. Gout, often termed rheumatic gout.
6. Cachexia—undefined bad habits of constitution.

It need scarcely be said, remedial measures of every kind must be selected appropriate to each. It is too usual to jump to the conclusion, without very minute inquiry, that all pain in old people is rheumatism—to try a variety of remedies at haphazard; and, on their failing, the suffering is submitted to as inevitable.

No one so suffering, and failing from

ignorance or carelessness to obtain relief, can reasonably hope for a very long life.

NARCOTICS.

We have a long list of medicines capable of relieving pain of almost any kind temporarily, termed narcotics, calmatives, sedatives, etc. And very precious they are, enabling us to afford relief from pain more or less perfectly ; and, even if only temporarily, when it becomes too severe to be borne with patience, they cannot be too highly prized.

These may—nay, must—be employed ; but it should be with great caution, and always bearing in mind that, for the most part, they act by *benumbing the seat or centres of feeling*, without touching or remedying the source and origin of the pain. In all cases, besides affording immediate relief by judiciously selected narcotics, the nature and cause of suffering should be carefully sought, and appropriate remedies, diet, and regimen had recourse to.

The vegetable kingdom has until recently supplied us with these agents ; but most remarkable and powerful ones have been discovered among the artificial bodies prepared by advanced chemistry.

The former are : 1. Opium, its educts and products — morphia and its salts, codeine, narcotine, etc.

Besides these, there are preparations of opium varying in properties and application by reason of the vehicle in which it is dissolved, or some adjunct modifying its action—laudanum, liquor opii sedativus, wine of opium, confection of opium, etc. The last of these is a modern representative of compounds which had a great reputation for ages for the relief of suffering and procuring sleep, under the names theriacum, mithridatum, etc.

2. Tobacco. 3. Henbane. 4. Belladonna. 5. Aconite. 6. Conium. 7. Cannabis Indica. 8. Solanum nigra. 9. Thapsus verbascum. 10. Veratrum viride. 11. Foxglove, etc.

The latter, *i.e.*, artificial compounds, are : 1. The ethers, of which there are several. 2. Chloroform. 3. Chloral in combination with water—hydrate of chloral. 4. Amylene, etc.

These, as well as the vegetable narcotics, have severally special applications and properties, no one being precisely like another in its operation, or efficacy in relieving suffering.

It is not surprising that, in order to obtain ease and secure sleep, the use of narcotics should be adopted without medical advice or sanction ; nay, that it should become habitual, and pass into a vice scarcely less injurious than drunkenness. We can understand this misuse of narcotics while we deplore it. Let no one, however, suppose that he or she who indulges in narcotics to obtain a spurious ease will ever attain to length of days. In the stupor so induced, many diseases march on to inevitable destruction.

If there are any exceptions, we may perhaps make them in favor of tobacco and opium. Much has been written against the use of tobacco, but there are very few cases where it can be charged fairly with abridging life. In consequence of its power of calming nervous excitability, of rendering the mucous membrane of the air-passages less susceptible to the influence of cold and damp, and the cause, whatever it may be, of influenza, it must, when used in moderation, rather tend to promote longevity. I have known very aged persons who have been smokers for the greater part of a century.

With respect to opium and its numerous preparations, I concur fully in the eulogium passed on it by the late Mr. Skey, and deem it of incalculable value to old people. Of course, its use must be guided by experience ; but I should little esteem a physician who has any prejudice against it. Employed judiciously, externally or internally, it is a powerful remedy and source of comfort.

A very common trouble of elderly people is an irritable state of the bladder, causing a too frequent necessity for passing the water, and sometimes very severe pain after passing it. This is most effectually relieved by a few drops of laudanum ; but since this condition of the bladder is produced either by the presence of calculi, gravel, or a morbid state of the urine, its cause should be sought, and proper remedies employed, while temporary relief is secured by opiates.

Again : nothing is more common than irritable ulcers on the legs or other parts in old people. Trifled with, or acquiesced in for years, they will seldom, if ever, resist the proper use of opiate preparations, applied locally. Such ulcers, and, we may add, local irritations without ulceration, beset many after middle life ; and I have seen them healed or removed, after existing many years, and in persons after ninety. It is an error to suppose there is danger in healing long-standing ulcers or skin-disease by means of opium.

In spasmodic pains, whether of the stomach (where they most commonly occur from the presence of some indigestible substance) or elsewhere, ether or chloroform affords relief most readily.

Of bronchial irritation and painful cough

I shall speak below, merely remarking here that the proper selection of the means of relief from the class of substances we are speaking of is of great importance.

Pains and griping in the lower bowels find immediate relief best from opiates, demanding, however, that the cause should be sought and removed.

I would repeat, it is not my intention to afford patients the means of treating themselves for any overt attack of disease, but simply to indicate, firstly, the common deviations from health in elderly people, and, secondly, the direction whence the remedy is to be found. One exception to this is in the diffused and oft-neglected pains described above as *dolor senilis.*

SARSAPARILLA.

There is one great and valuable remedy, having a wide range of influence, which I cannot pass by ; since, whether such pains arise from the decay of age, poisonous taints in the system, cachexia, or, in fact, anything except gout, it will afford great and often permanent relief. I mean sarsaparilla. This root, having no very marked or peculiar sensible properties, has long been recognized as a valuable remedy. It is usually taken combined with other ingredients, added rather to produce a pleasant flavor than for any medicinal properties, under the name of "compound decoction." There are people who hold that sarsaparilla has no value as a remedy. They must either have had no experience, or have been imposed upon. I have prescribed it for numberless patients, and have, in my own person, proved it to be worthy of its reputation. The following passage, abridged from "Household Medicine," indicates not only the sources of fallacy in those who do not recognize its value, but also the scope and conditions of its influence. The authorities in its favor are too numerous to be named ; but I may mention the late Sir B. Brodie as an author whose views exactly coincide with my own upon this point.

"One great advantage of sarsaparilla is, that its use can be intrusted to the patient, needing no watching or superintendence. It holds, in fact, an intermediate position between food and medicine. Whenever doubts have arisen respecting its value, they are attributable to one of three causes : 1. Sarsaparilla has been improperly prescribed ; or, 2. What is more usual, some worthless root or substance has been given as a substitute for it ; or 3. The sarsaparilla used was bad and inert. The English markets and shops abound in *spurious and worthless* sarsaparilla ; and preparations are sold professing to be made with it which do not contain a grain of the true root. One reason of this is, the genuine and active root is expensive. . . . Sarsaparilla is, to use the words of Sir W. Fordyce, the *great restorer of appetite, flesh, color, strength, and vigor* to constitutions enfeebled or emaciated by early excesses, by acute diseases, or by the use of mercury. Even in the failure of the powers, or premature ageing, arising from wear and tear or over bodily or mental exertion, its restorative power is very great. In many painful diseases, and what are termed bad habits of body, it generally affords complete relief. General as its use has become, it deserves to be far oftener employed, particularly at the age (uncertain as to date) when youthful activity begins to flag, and the faculties of body or mind are enfeebled, even without the existence of any specific disease to call for it ; but as an adjunct to the diet proper to that period of life. Persons who have resided in hot climates, whether they have had recourse to mercury or not, will find sarsaparilla the best means of relieving the lassitude and ennui from which they are apt to suffer.

"When taking a course of sarsaparilla, persons should wear flannel next the skin, and avoid exposure to change of temperature or damp. We recommend, whenever possible, sarsaparilla should be taken in the form of compound decoction, prepared at home. The best Jamaica sarsaparilla only should be purchased ; and the smaller and more abounding in small fibres the better. The virtue resides in the bark of the root. When the fibres are removed, half the value of the root is gone. Still it is necessary to be cautious in the purchase, as it is certain that the roots, after having the greater part of their extractive matter removed by soaking in water and boiling, are dried and sold to be retailed to the public. When the decoction cannot be made at home, or when required in travelling, the compound decoction concentrated, and especially a hydro-alcoholic concentrated decoction, prepared by a conscientious chemist, may be substituted."

Besides sarsaparilla we have many subtances called medicines, which should rather be deemed articles of, or adjuncts to, diet, with no mean powers as restoratives and tonics, and which are capable of materially retarding the changes incident to ageing. These must be selected, combined, and their use directed according to the condition of the individual for whom they are prescribed.

Iron, in some of its combinations, as we have said, enters into and performs very important functions in the natural processes and compounds forming the blood and tissues. Other substances alien to the system—that is, not supplying any element in the natural composition of the body—undoubtedly exert a highly genial influence in the debility and disorders of age. An exposition of this subject, however, belongs to a work on the science of medicine.

GOUT.

The place for remarks on this disease is assuredly here, under the more general designation *pain*. A very painful disease it is in its overt state, and few persons suffering from it will fail to have recourse to the physician. We happily possess medicines able to afford relief. Colchicum, in one form or other, is almost invariably employed, whether it be in a secret compound, as eau médicinale, eau de Husson, or in the orthodox prescription. Gout, as it exists in an open and acute attack, however, it is not my purpose to speak of beyond a single remark, namely, that as an adjunct to the specific drug, evacuating the bile-ducts by a dose of podophyllin is a most beneficial measure.

The reports of the Registrar-General have reversed many a popular maxim, and destroyed illusions respecting diseases. In the last report, issued for 1873, gout is found to destroy more lives directly than strong drinks—the number of deaths from gout exceeding those from delirium tremens; and indirectly, as the Registrar observes, many deaths referred to other causes are doubtless due to gout.

Mr. Farr, the eminent secretary to the Registrar, applies to gout the designation *diathetic disease:* what is meant is, that gout exists in the system for a time in a latent state, as a condition, not necessarily exhibiting any symptom of disease, either general or local. "A gouty constitution" is the popular expression for this. Sometimes, indeed, it reveals its presence to an experienced observer by shifting or wandering pains (erratic gout); but these are easily mistaken for pains of a different character, if occurring before an overt attack has been experienced. As is well known, acute disease of a very painful and peculiar kind may show itself in such constitutions at any moment, either altogether spontaneously, or excited by some accidental circumstance. The toes, fingers, or other parts of the feet or hands, are usually the seat of the first attack.

After a first overt attack of gout, we may be *sure* there is the gouty diathesis; and it is now certain that it is a frequent cause of the premature abridgment of life.

Gout is usually attributed to high feeding and luxury. This is by no means universally true. It occurs, perhaps, more frequently in persons who have indulged to excess in the pleasures of the table; but the taint may be hereditary, or it may be generated by a low diet, and abstinence carried to extremes.

The question for us here is, Is there any remedy for the gouty diathesis? A proper regulation of the diet is, of course, indispensable; and to this is commonly added the free use of alkalies, potass, soda, and lithia, or the alkaline earth magnesia, or the oxide of bismuth. These, either as medicines or in mineral waters, are employed; because in gout there prevails an acid in the system—uric acid—and they serve to neutralize acids. Some slight amelioration, perhaps a prolongation of the intervals between the attacks, attends at first the use of these alkalies; but subsequently, as many medical authors allege, and by their continual action, they aggravate the disease.

There is one vegetable remedy which has a reputation for relieving the gouty constitution from the pervading poison. It was known and employed long ago, but, like many other remedies, has slipped from the books of the colleges, and therefore from practice. This was also for a time the fate of colchicum. The value of colchicum, as a means of relieving overt gout, was known to physicians two hundred years ago; was forgotten, and only came into use again by being made a secret medicine of. Sir H. Halford has the merit of its rediscovery in recent times. In like manner the winter-cherry (*physalis alkakengi*) is said to be the active ingredient in a patent medicine reputed to obliterate the gouty constitution.

The very name of the winter cherry, as well as its use as a remedy, was forgotten until I gave a brief account of it in "Household Medicine," in 1862. Since then it has been in a few instances employed, and found to deserve its ancient reputation.

To any reader of this book who has given attention to the recent progress of science, it will be no surprise to learn that there is good reason to hope that a remedy has been discovered, which, at no distant period, will reduce the number of deaths from gout very greatly, if it does not entirely obliterate this item from the Registrar's list. How soon it may be recognized, and brought into use, it is impossible to predict. In the year 1800 a great chemist announced the discovery of an anæsthetic—an agent having the power to render the human body insensible to pain under surgical operations—namely, nitrous oxide, or laughing-gas. Teeth could be extracted.

limbs amputated, without giving the slightest pain. Sixty-eight years elapsed before it was adopted by surgeons. In the mean time other anæsthetics were discovered—ether, chloroform, etc.; but these also were known many years before adoption.

Again, chloral was discovered in 1832, by Liebig; nearly forty years passed ere it was used to procure sleep, for which it is now found to be so valuable.

How long it will be before *sarcosine*, the substance alluded to, and described by German physicians, comes into fashion for the cure of gout?

RHEUMATISM.

Acute rheumatism, or rheumatic fever, a very formidable disease from the amount of suffering it entails, commonly attacks persons at an earlier age than the epoch we are considering. It is very apt, however, to leave serious damage in the system after its acute symptoms have subsided, which lasts in many cases through a whole life. One of its effects is a tendency to more or less frequent attacks of chronic rheumatism. This may be termed rheumatic diathesis. In whatever it consists—whether a poison is generated, or a change wrought in the tissues by the acute disease—it too often lingers into old age. I have already mentioned that other painful states in elderly people are very commonly confounded with it. Hence the confusion and contradiction we constantly meet with respecting the effect of remedies. If a patient suffering from diffused pains in the muscles, joints, etc., has experienced at some former period of life an attack of rheumatic fever, it affords a presumption that his present pains are rheumatic. The locality of the pains, when they are partially or wholly localized, helps the diagnosis. What are called the fibrous textures—the ligaments and coverings of the joints, the sheaths of the muscles—are the most frequent seat of rheumatic pain. The coats of the nerves, too, are doubtless sometimes affected; and then the pain closely simulates neuralgia from malaria or other causes.

The treatment of chronic rheumatism, as it attacks elderly people, may be most effectually directed to the locality of the pain. Stimulating and sedative embrocations and fomentations are of much value. Many internal remedies are reported to be useful, and justly so; but they are not discriminated with sufficient accuracy, any more than the distinction between rheumatic and other pains. The general remarks I have ventured to make on pain as inimical to life, and its tendency to abridge its duration, are as much applicable to rheumatic as to any form of pain, from any cause, or of any other nature.

LUMBAGO.

This disease consists of a condition of the muscles of the loins in which any motion is attended with acute pain. It occurs far more frequently in adults while in the full vigor of life than later. It is in many medical works confounded with rheumatism; but it differs essentially, and by very well marked symptoms.

The attack of lumbago is most frequently, especially a first attack, sudden: an unusual movement, stooping to lift a weight, a fall, a blow, or the like, is followed at once by severe pain in the lumbar region, with inability to move, to walk, to turn in bed, to rise from a sitting posture, to stand in an upright position, without aggravating the suffering. It may go off as suddenly, or continue a few days, or even weeks. It is not attended with fever or disturbance of the natural functions; it does not even prevent sound and refreshing sleep; but, on waking, the patient is scarcely able to turn in his bed.

Narcotics are, therefore, not called for. To the ordinary treatment—mustard and linseed poultices, or hot fomentations to the loins, with a mild aperient—I can add one item of great use.

Let the patient resolutely leave his bed, place himself back to an upright wall, and lift himself gradually erect, and then walk about. The process is a painful one, but possible, although the sufferer is often difficult to persuade; yet, when accomplished, it is efficient.

LIMIT TO THE USE OF NARCOTICS.

I would repeat, in order to make the opinion more emphatic, that narcotics should be employed, for the most part, only as temporary expedients to afford relief from suffering: they are at best but palliatives, and they may obscure the real disease which is causing the pain. The relief they afford should never exclude close investigation, and immediate resort to the measures and remedies appropriate to the special disorder discovered to be the source of the suffering.

THE STOMACH AND DIGESTION.

It has been remarked, by writers on medicine, that elderly people are less frequently subject to indigestion than the young and middle-aged; and, when this disorder is met with in the latter, it has a different character. This may probably be partly ascribed to greater care in the selection of food, more moderation in the quantity taken, better arrangement of the time of meals, and the habit of taking more repose after eating than young persons allow;

these circumstances being guided by experience.

The appetite is generally more regular, and the action of the stomach upon the food (the first stop in digestion) more perfect. I am inclined to regard these facts as indications of a power in the system (*vis medicatrix*) to check the tendency to decay, existing in all its parts—the recuperative power, without which every disorder would run on its course to the destruction of life.

Elderly persons should not take one large meal in the day, as they are apt to do, but make at least three lighter repasts. Sleep after dinner may to some extent compensate for the error when committed.

Any degree of oppression after eating should be avoided rather by taking a smaller quantity, and the omission of the less nutritious articles of food—fish, pastry, potatoes, or other vegetables, even bread—and making the meal of the more nutritive, rather than seeking relief from stimulants. If, guided by appetite, flesh meats, etc., only or mainly are taken, and oppression or other symptoms of lack of power in the stomach occur, instead of soda or other alkalies, relief may be sought by a comparatively new remedy supplied by science, namely, *pepsin*. Alkalies should never be indulged in without good advice, and after the conditions of the system generally have received attention; nor should pepsin, without first diminishing the amount of food to a fair quantity of animal substances, flesh meats, poultry, game, etc. It should not be used to force through the stomach a large amount of incongruous matter, more than the system needs.

Every part, however, demands sustenance and reparation; and therefore loss of appetite cannot in aged persons be neglected with impunity. Its cause should be sought, and remedies applied, as in all cases of disease, without delay.

THE LIVER AND LOWER BOWELS.

These organs perform two functions equally important to the maintenance of health—assimilation of food, and extrusion of worn-out and effete matter.

Old people are said to give too much and too exclusive attention to the state of their bowels. This can scarcely be, since a correct action of the liver and lower bowels is essential to health and comfort. Without entering into the physiology of the former organ, it is readily understood, (1) That bile in sufficient quantity must be formed; and, (2) That there must be a free channel through which it can flow, to reach the food as it leaves the stomach. In both these respects there is apt to be a partial failure. Either bile is not formed, and its constituents remain in the blood; or, from diminished elasticity of the vessels, it does not flow through them freely. They remain full; the stools have not the natural color; and besides this symptom, if the eye is examined, its white coat, the *sclerotic* is seen to be tinged with a greenish or yellow color.

This arises from the bile being absorbed, and carried into the circulating blood. A very small amount may be thus detected; but when much is diverted from its natural channel, it will be seen in the urine; and, if not diverted from this abnormal course, the skin becomes yellow, and the disease is now termed jaundice. This may arise from obstruction of the gall-ducts by mere inspissated bile or from gall-stones. For jaundice the aid of the physician will be sought; but the less obvious forms of this trouble are not unusually neglected.

Other sufferings flow from it—low spirits, melancholy, nervousness, sleeplessness, and often pain more or less severe, with a sense of weight, in the back of the neck, head, or shoulders. This is another form of pain erroneously called rheumatic.

Formerly the remedy resorted to was mercury in some shape. Blue pill and black draught, so popular from the prescription of the late Mr. Abernethy, were taken in all the various cases and symptoms included in the term "biliousness." This plan, it must be admitted, usually affords temporary relief; but all experience testifies the undesirableness of introducing mercurials into the system when they can be avoided, and the inexpediency of frequent doses of black draught.

For the last few years we have happily possessed a substance, derived from the vegetable kingdom, having the remarkable power of acting upon the liver, in doses of varying amounts, stimulating or correcting its action, and evacuating the bile-ducts, without any injurious or long abiding consequences.

A single dose of it will afford relief, and clear off the clouds of melancholy or depression of spirits besetting the mind. And when there is no organic disease, as the cause of jaundice, it is a speedy and safe remedy for that disorder.

Podophyllin is a resinous extract of the rhizome, or underground stem (in common parlance, *the root*) of the May-apple, *Podophyllum peltatum*, a plant growing abundantly in many parts of America.

Podophyllin was introduced to the profession in this country by me in "Household Medicine," and in three papers published in the *Lancet*, February 22d, March 15th, and April 19th, 1862. Since then it has been employed very extensively in this country, in India, and indeed all over the world. It has been inserted in the British Pharmacopœia.

Thus I have the great satisfaction of knowing that thousands of sufferers have been and are daily deriving benefit through my efforts, to whom my name is unknown. The quantity of podophyllin now prepared by manufacturers in this country, besides that imported from America, is immense; although the dose is very small, ranging from ⅛ of a grain to 2 grains. As an alterative and means of evacuating bile, it is unrivalled; and, as a consequence, much mental depression and inquietude vanish before it. It acts like a charm, often in a single dose. "I would not wish to live," said a sufferer, an old retired medical man, "if I had not podophyllin."

Nevertheless, it ought always to be taken, when needed, under skilful advice as to quantity and frequency.

In some cases of liver disorder, taraxacum (*common dandelion*) is very useful. Like sarsaparilla, this plant is rather dietetic than a medicine. Again, in hepatalgia (liver-ache) we have in buck-bean, *Menyanthes trifoliata*, a remedy which is also a general tonic and restorative.

THE LOWER BOWELS.

A daily easy action of the lower bowels is the best condition of these organs for the maintenance of health. It is rarely that tobacco-smokers suffer from constipation, especially if indulged in after breakfast. A little careful attention to diet will generally serve to regulate the action of the bowels. If, in spite of all care, constipation is suffered, an enema of warm water, in which a little soap is dissolved, is the best means of relief. The practice of taking pills of which the constituents are unknown, and advertisements of which teem in the newspapers, cannot be too strongly reprobated. If you have any regard for your health, and desire to enjoy it permanently, persistently refuse to obtain momentary relief by such means. Very few practitioners would fail, if consulted, to relate many instances of great injury caused by the habitual use of advertised pills. If a person's own efforts do not secure the needed purpose, consult a physician as to the most suitable aperient for the special case.

Elderly people often suffer from flatulence. This usually depends on the food: either too much is taken, or some article which must be abstained from. Leguminous vegetables—peas, beans, lentils (revalenta, as it is called)—in most persons produce offensive flatulence. Soups, and even beef-tea, will induce it in some persons. When, however, flatulence becomes habitual, and does not cease on change of diet, it indicates a more serious cause—a failure of power in the intestinal canal—and demands a full investigation as to its locality, and energetic remedies for its relief.

THE KIDNEYS AND URINE.

The removal of waste and effete materials from the system in the way and through the channels appointed by Nature, is of equal importance for the preservation of health as nutrition.

A variety of compounds and salts dissolved in water are separated from the blood by the organs well known as the kidneys. This fluid is the urine.

The bladder is the receptacle for the urine secreted by the kidneys, where it is retained until it can conveniently be expelled. The office of the bladder, therefore, is mainly mechanical. The knowledge of the formation and properties of the urine, as it proceeds in health and is modified in disease, belongs to a very advanced chemistry.

This science has accomplished much for physiology; but its application to pathology is yet in its infancy. At some future time it is highly probable important discoveries will be made respecting the renal secretion, greatly modifying the duration of life. In the mean time, proceeding on scientific grounds when we can, observation and experience will serve the purpose to a limited extent.

SIMPLE OVERFLOW OF URINE.

There is scarcely any circumstance premonitory of impending trouble in old people more frequent than this and other obvious appearances in the urine. Many I have afterward to notice follow upon the simple increased quantity so closely as to cause this first step to be unnoticed. Hence some physicians, who see cases after they have been neglected and have made some progress, doubt the existence of this simple overflow.

In a state of health the amount of urine passed during the twenty-four hours should very nearly correspond with the fluids taken with the food, so as to maintain an equal balance between the loss and supply. Some deviation from this to a limited extent, however, is not inconsistent with health. The quantity passed is usually greater in cold, less in hot weather, obviously because the temperature affects the amount of fluid which transpires through the skin as sensible perspiration.

In advanced life, passing larger quantities of water than is natural often occurs when there is otherwise no such marked deviation from health as to call for medical advice. The bladder fills frequently, and must be emptied, that seems all; but the night's rest is disturbed, and when it increases to a considerable and noticeable extent, the circulating blood becomes thicker, the surface looks dark, the complexion lurid, the muscles and other textures become dryer. Languor, a sense of weariness, even after long repose, and, on rising from bed, stiffness of the limbs, will be experienced. There is in some cases much thirst; in others, very little.

I think simple dysuria, as this is called, does not cause thirst. When there is much thirst, some of the changes mentioned in the sequel are beginning.

People wonder where the water comes from. This is no mystery. The greater part of what we call solid food is made up of water. Our own flesh and blood are mostly water.

In health, the water contained in the solids taken as food, termed in science *constitutional* water, nearly balances the amount removed in the processes of organic change in our own flesh and blood. When the latter lose the water necessary to their healthy condition, the other and more solid parts begin to change and decay, *i.e.*, run into disease.

Dysuria, or simple overflow of water, is analogous to diarrhœa. It may be checked and remedied by change of diet and simple remedies.

There is a group termed diuretics—medicines prescribed for the purpose of increasing the flow of water when it is deficient in quantity. Among these, there are some which act both ways: they increase or diminish the flow according to the condition of the kidneys, by imparting tone or bracing the fibres of those organs, and so inducing a healthy state, when their function of separating water from the blood is duly performed.

The change of diet should be first: if malt liquors have been taken habitually, they should be left off, and a moderate amount of wine substituted. A glass of port with two meals in the day, and about four ounces of water. If dysuria occurs in a wine-drinker, reverse the change, and substitute good stout for the daily wine. If tea or coffee has been the custom, change them, or altogether disuse hot fluids, and take claret and cold water.

Soups and fish should be avoided.

Green vegetables supply certain elements —potash, sulphur, etc.—to the blood and juices, and greatly tend to maintain a healthy condition. In the case before us, the onion tribe are real remedies. Onions, leeks, eschalots, garlic, freely taken, will often arrest the overflow. An onion eaten raw at night is most efficient. If this is considered too coarse an article for food, the doctor may prescribe squill (one of the same tribe) as physic. I prefer the former. Water-cress, garden-cress, and mustard, in salads, asparagus, and especially the girasole, all act as tonics on the kidneys. Potatoes should be entirely abandoned.

Such are the means the patient may use for himself; but medicine furnishes many more.

This simple inordinate flow of urine which I have described, and which is so readily remedied, often, if neglected, issues in, if it does not sometimes begin with, something more serious. The urine may be loaded with albumen (*Bright's disease*), with sugar (*diabetes*), with phosphates (*salts which produce irritable bladder* and *stone*) or with oxalic acid (*oxaluria*). Let us take first:

ALBUMINOUS URINE.

Albumen enters into the natural constitution of most of the tissues and organs. While all the processes are healthy, it is transformed into urea, and is thus removed in the urine. When it escapes as albumen through the kidneys, there is much that is wrong in the system, and serious disease will manifest itself somewhere.

This escape of albumen is seldom observed at its commencement. The redundant flow of urine not being attended with suffering, merely with inconvenience, is allowed to proceed unchecked until much debility is felt, and often until the feet begin to swell. Then the physician is called in; and, if he examines the urine, the mischief is discovered. The way to find albumen is to boil a portion of the urine in a glass tube or silver spoon, when flakes of coagulated albumen appear. To detect minute quantities, a few drops of nitric acid are added to the urine before boiling.

An aged person passing too much water, and feeling himself growing rapidly weak, may test the urine for himself.

The late Dr. Bright gained great celebrity by examining the kidneys in cases which had proved fatal: he found these organs palpably diseased. The change in the structure of the kidneys was regarded as the cause: they are said to be degenerated; and the complaint is now known as "Bright's disease."

Now, there is no doubt that the alteration in the kidneys is one effect of a general change in the albumen in many or all parts of the body. It is the soluble albumen pervading the lungs, muscles, and tissues generally, which is undergoing a change — degradation — an abnormal change, instead of passing into urea. This is proved, first, by the general debility which accompanies the escape of albumen secondly, by the effusion of water into the tissues, that is, dropsy, its immediate consequence; thirdly, by the nature and action of a remarkable remedy recently discovered.

If, when the outflow of albumen is first detected, there are no serious changes already advanced in any important organ, the disease is amenable to a decided or simple course of diet, which is the remedy alluded to.

Hence the importance of attention to the urine if it be habitually redundant, and the simple means described above have been used, and fail to check it.

A happy thought occurred to a German physician, when reflecting on the subject of certain incurable diseases. He conjectured that a great and beneficial change might be wrought in the constitution by complete abstinence from every article of food usually taken by adults, and returning to that on which alone the rapidly-growing body in infancy is fed. He tried it in a variety of cases, and, to his own surprise, he found it strikingly successful in albuminuria, or Bright's disease, in all its stages, even in some where it had brought on dropsy.

This remedy consists in living for a time exclusively on milk; and it has been adopted with marvellous success in this country. Pure milk, with the butter, that is the cream, carefully removed—skimmed milk, in fact. This method of treatment has been called the "milk-cure." It has nothing of charlatanry about it. Its action is explicable on the principles of the soundest science. It accords with physiology. Human milk contains very little fatty matter, and skimmed cow's milk closely resembles it. The effect of thus returning to the simple nourishment of childhood strikingly and beautifully illustrates the chemistry of the living body.

As Bright's disease is one which certainly and rapidly proves fatal under ordinary circumstances, and, indeed, the idea of its being a hopeless disease in the kidneys tends to its being usually treated only by palliatives, it becomes of great importance, now that an efficacious remedy has been discovered, that it should be used properly, and under skilled supervision.

The above remarks and treatment, however, apply to confirmed albuminuria. A small proportion of albumen in the urine in elderly persons need not excite alarm. It is often found in the urine passed at night, after walking or other exercise, and absent after the night's repose. This indicates that the wear and tear of life is beginning to tell upon the system. Change of diet and invigorating medicine are now expedient, but of far less heroic kind than "the milk-cure."

MUDDY URINE AND GRAVEL—ORIGIN AND PREVENTION OF STONE.

In a state of health the urine is a clear transparent fluid, of a straw-color when passed, and remaining so for some time. In many disorders of the system it becomes turbid on cooling, with more or less sediment, with various tints of color, yellowish or reddish brown.

Now, a very important distinction exists, and in elderly persons the due appreciation of it may very often greatly influence the duration of life.

If the sediment and the turbidity disappear, and the urine becomes clear on heating it gently, while it indicates febrile or inflammatory action somewhere in the system, it is in itself of little moment: it will be only temporary. If such urine is continuous, it may direct the patient to consult his physician, to discover what is amiss; and this is the proper course.

If the urine is turbid when first passed, and does not become clear on heating, but rather more thick and muddy, and the sediment is granular, attention must be given to it.

Most people know what gravel is, namely, a sediment in the urine, of a red or dirty white color, usually attended with pain in the region of the kidneys, and often with pain in the bladder itself on passing water. The early stage of this disorder is very generally neglected. After a time the granular sediment from the urine formed in the bladder produces irritation and acute pain on making water; the small granules then adhere together into little masses, which pass with difficulty, often producing an unnatural amount of the secretion of mucus by the bladder itself, which agglutinates them into larger masses, and forms *stones*. This is the history of most cases of stone. Futile, because misdirected, efforts, and palliative and useless medicines and measures, are pursued, until the dreadful and dangerous operation of cutting for or crushing the stone, to remove it, becomes the common resort. It was thus that the life of Napoleon the Third was brought to a premature close, and it is the fate of thousands. I fear it is not wholly without foundation, that the profession are charged with preferring great and brilliant operations to the careful study of causes and the adoption of preventive remedies. But it must not be forgotten that the patient's own neglect, in leaving unnoticed the early symptoms, exonerates the physician, who finds at the first consultation the disease far advanced.

Now the thick, muddy urine, and the resulting gravel and stone, occur in two states of the general system, which require to be carefully distinguished before remedial measures are resorted to.

It is in the general system somewhere that the mischief begins. The materials of the deposit are abnormal products, either of faulty digestion or assimilation of the food, or of agencies affecting and misdirecting the changes in the elementary matters to fit them for expulsion (secretion). The discussion of all this belongs to a medical treatise, but a few simple words will render it clear. Indulgence in high living, superabundant animal food, rich dishes, various wines, etc., with deficient exercise, impure air, and errors of regimen of various kinds, set these morbid changes going. The blood and flesh juices become deteriorated As the kidneys form the channel through which impurities are to escape, their secrĕtion is made unnatural ; and in the kidneys themselves (*i.e.*, in a little pouch which first receives the urine), the sediment agglutinates into masses, forming stones.

What is to be done to prevent the evils thus arising ? First, ascertain whether the urine is acid or alkaline. This is effected by small slips of prepared paper—test papers—obtained of any chemist. Drop a blue paper into the recently passed urine ; if it turns red, there is acid : if a red paper becomes blue, the urine is alkaline. Secondly, adapt the diet to the circumstances. In the first case, abandon acid wines—all wines, in fact, are more or less acid, so are most spirits, brandy for example ; lessen the proportion of animal food, and increase the farinaceous and vegetable. In the second case, reverse the order and manner of the change.

This change of diet is a valuable adjunct to the treatment. A recent and most interesting discovery is now to be explained, as it exactly falls in with the design of this work

With muddy urine, gravel (whether uric acid or phosphates), and incipient stone, there is often pain, irritable bladder, and other troubles. Opium, in one of its numerous forms, and a whole string of narcotics, are employed as palliatives ; and for ease a hundred nostrums are recommended, and everybody (more especially those who are entirely ignorant) has some infallible remedy. Mineral waters are favorites ; and many of them certainly do this—they expedite the crisis of the disease, and complete the formation of the stone. The emperor may almost be said to have fallen a victim to Vichy water.

As regards the pain, opiates are incomparably the best medicine for relieving it.

But the great remedy, which I have termed a discovery, is the substitution of *pure distilled water* for all other water, whether in soup, tea, coffee, or other mixtures, and its free use as a beverage. I wish I knew to whom to give the credit of this discovery. It is precisely in the line of the highest science. (See Note L, p. 179.)

All water from natural sources contains more or less saline matter ; lime and magnesia salts being invariably present. Generally, these constituents are not unwholesome. They give to water its agreeable taste, especially when accompanied with free carbonic acid ; and when the system is in health they supply needful ingredients to the blood. In the condition we are speaking of, the minutest quantities of these salts, added to those already present in too large a proportion, determines the formation of those compounds which go into the urine, and form stones.

It is an odd thing that the very means which science teaches are the most likely to aggravate the disease, are precisely those most frequently recommended for its relief.

No one who has studied the properties of water in its pure state, and when containing small quantities of salts, or even atmospheric air, will be surprised to hear of its effects when so far pure as distilled water, on the constitution, and on stone in the kidneys or bladder. One fact, popularly known, may be mentioned in illustration. Pure distilled water will act on—*i.e.*, dissolve—metallic lead ; whereas the presence of minute quantities of the salts, which render it, as we say, *hard*, will effectually prevent this action.

In the earliest possible stage of the disease we are speaking of—turbid phosphatic urine, or gravel—distilled water should be at once adopted.

Even when stone exists, it has great power. Dr. Murray of Newcastle tells us that, in the infirmary there, it is quite common for patients treated with distilled water to pass water-worn stones ; *i.e.*, they have been so far dissolved as to be rendered small enough to pass through the external passage (*i.e.*, the urethra).

The constitutional treatment by drugs in these cases must be left to the physician.

IRRITABLE BLADDER.

There are disorders of this organ incident to elderly people, which demand a passing notice.

Irritable bladder, frequent desire to empty it, attended with much pain. This will generally be relieved by drinking freely linseed tea, barley water with some gum arabic dissolved in it, or a decoction of the dried stems of the plant known as *twitch* or knot grass (*Triticum repens*). If the pain is severe, five or six drops of laudanum may be added.

Incontinence of urine, retention, irregularity in the flow, etc., should receive the attention of the surgeon. An instrument may be needed, and he will teach the patient to use it for himself safely.

DIABETES, OR SWEET WATER.

This disease consists of an abnormal flow of water laden with sugar. The detection of sugar in the urine must be the work of a chemist. Redundant, limpid urine, great thirst, and loss of flesh, occurring together, will afford good reason to suspect the presence of sugar. Often it is detected by spots on the trousers, which are minute crystals of sugar left where drops of urine have splashed.

This curious disease, which consists in the food first, and afterward the constituents of the body itself, being transformed into sugar, is surely fatal unless checked by proper remedies. This transformation is explained by chemistry ; but why it begins and proceeds in the living body is the main question. The subject is too scientific and complex to be fully treated here. The usual method adopted to arrest it consists in an attempt to exclude from the diet all saccharine substances, and those which are readily transformed into sugar. The patient is prohibited from taking any form of starch, even bread, and is put on bran biscuits or gluten—the staminal principle of wheat, from which all the starch has been separated. This plan diminishes for a time the amount of sugar in the urine, but fails to cure the disease. It is, in fact, a clumsy expedient, like an attempt to render a stream pellucid which is turbid at its source.

We can transform starches and other similar substances into sugar in the laboratory ; but to do this we must have recourse to an agent termed a *ferment*. This is a nitrogenous compound in a state of active change (decomposition or decay). Now, in the body, nearly everything is a compound of nitrogen—the substance of the muscles, the blood, etc. ; and these in health, as we have before remarked, when used up, and become effete, are transformed into urea, and pass off in the urine. In the urine there is a ferment ; and, after it has left the body, this ferment causes the urea to be transformed into ammonia, carbonic acid, and water. That is the natural course of things.

In diabetes a nitrogenous ferment acts in the body, as it does out of the body ; *i.e.*, transforms amylaceous substances first, then the fat, afterward other elements, into sugar and other complementary compounds.

It is to the detection and exclusion of this ferment we must address our measures of treatment, if we would cure diabetes.

THE THROAT—AIR PASSAGES—LUNGS.

Catarrh—Influenza—Bronchitis.

Bronchitis is one of the most formidable and fatal diseases occurring in advanced age.

One in every four persons whose lives extend beyond sixty falls a victim to it.

And yet bronchitis comes under the category of diseases amenable to treatment. Medical science can determine the wavering balance, and very often saves lives obviously tending to a fatal issue if the disease is neglected.

Bronchitis seldom comes in its severest form on a first attack. A susceptibility to a return and frequent repetition usually remains. A succession of attacks at longer or shorter intervals, and with more or less severity, is the general rule. When there has been repeated attack and recovery, all suspicion of danger is lulled, precautions are neglected, and early recourse to proper treatment prevented.

One most common and fatal sequence of bronchitis is congestion of the lungs ; and this will suddenly supervene on what a patient will describe as "his old malady, which has often troubled him, but which has always yielded to some simple treatment."

The earliest and most prominent symptom of bronchitis is *cough*, and this occurs in every degree. More or less irritation of the mucous membrane of the nose cavities, throat, and air passages, termed *catarrh*, very often precedes the inflammatory state of the lining of the bronchia, constituting the disease.

What is its cause? What gives the susceptibility to it? How can it be guarded against? How arrested? There is a constant current of atmospheric air flowing through the nostrils, the nasal cavities, the glottis, or opening situate at the root of the tongue, into the bronchia, or air-passages, the upper part of which is called the larynx. This air, as we breathe, spreads through the lungs in the minute divisions of the bronchial tubes : it is so inspired hot, cold, temperate, moist, dry, pure, or contaminated. The popular name for all catarrhal attacks is "a cold"—catching a cold. This is the basis of the theory of catarrh and bronchitis originating in cold air or changeable weather, variations in the hygroscopic state of the atmosphere, or exposure to cold currents when the body is heated.

There is much truth in this theory; but something more is needed to explain attacks of catarrh, especially in its more intense form, as influenza, when the catarrh is certainly contagious and often epidemic. During the prevalence of such catarrhs, the most fatal attacks of bronchitis are met with. The atmosphere, at certain times, is a vehicle for some subtle poison, gaseous vapors, or it may be minute solid matter, not yet detected—the most energetic, if not the only, cause of catarrh and bronchitis. How often do we hear patients say, "I cannot think how I got this bad cold;" there being no exposure or any circumstance to which it can be referred.

However this may be, it is invariably recognized that some persons are more susceptible of these attacks than others; and the practical question is, How may this susceptibility be remedied? The mo bid impression on the mucous membrane, leading to catarrh, cough, etc., is sometimes first felt locally in the nose; and, as the membrane is continuous, it passes on and downward to the bronchia. If we can harden, so to speak, the membrane, we render the attack less likely.

1. Habitual smokers are, as a rule, less susceptible to attacks of catarrh and bronchitis than those who do not smoke.

2. The habitual use of cold water, simply or with the addition of a teaspoonful of common table salt to half a pint of water, as a gargle to the throat, is very useful.

3. An astringent gargle used freely night and morning.

4. Friction over the throat externally with a rough towel wetted with cold water once or twice daily.

In the section on the Physiology of Age I have described the condition of solids and fluids in elderly persons. A scientific term, *atheromatous*, is applied to the aggregate—flabby, inelastic, pappy. This state of the glottis, larynx, and other parts of the air-passages, exists in persons susceptible to attacks of bronchitis. It can be greatly ameliorated by other measures besides the foregoing; namely, by—

5. The use, by inhalation, of vapors, such as acetic acid, nitrous ether, etc.; and under advice a small apparatus should be employed to insure their perfect application to the parts about the air-passages.

6. The inhalation of liquids in the form of spray. Even cold water so used is beneficial, and any sensible person can apply it for himself as easily as he can use a gargle. A very minute portion of hydrochloric or nitric acid adds to the efficacy of plain water; and some other fluids are much commended, both as prophylactic and curative, when the disease exists.

7. The experiments of Dr. Tyndall have shown that in the atmosphere much solid matter exists, in the form of minute particles, invisible under ordinary circumstances. It is very probable that these may be the exciting cause of many cases of bronchitis. These solid particles may be separated from the air we breathe, by passing it through a layer of cotton-wool. It would, therefore, be a very prudent course to have a thin layer of well-carded cotton-wool spread out and fixed to a wire frame, so adjusted to the windows of sleeping apartments as to fill up all the space when the window is opened. This precaution would most probably save elderly persons from attacks. It would not, indeed, be superfluous, if adopted for sitting-rooms; especially in London and other towns where the atmosphere is loaded with solid matter and mephitic vapors visible enough.

No one can doubt the importance of pure air for healthy respiration. A supply is not unfrequently deficient, when merely closed windows are trusted. Ventilation with warmth cannot be overrated.

When the attack begins—*i.e.*, the cold is caught—it may be arrested in the nasal cavities, or at the upper part of the air-passages, by applying freely the vapor of pure ether, inspiring it by the nostrils from a small, wide-mouthed vial, and expiring it through the mouth; or the contrary way, when the glottis is first struck. This proceeding cannot be extolled too highly: it is very efficacious. And even when cough is established, or the lower bronchia affected, it will afford the most speedy and safe relief.

The means recommended for treating cough are innumerable. Little or no discrimination is exercised, and hundreds of lives fall victims to misapplied remedies.

At first, when bronchitis of a sharper kind comes on, the fluid poured out by the membrane and coughed up is fluid and fr thy. The use of opiates and other medicines to arrest it in this stage is attended with great danger. In fact, the physician only should guide the treatment.

When the secretion becomes thick and slimy, opiates are, and will be, used. But if the specific action of the thapsus verbascum (*mullein*) were known, it would be universally substituted.

Chronic cough in aged persons, with expectoration of much mucus, must be cautiously dealt with, as all judicious writers testify; but the beneficial influence of thapsus, internally or when smoked, is not known, or it would be had recourse to more frequently. The use of opiates should be locally, and in very minute quantity. It is a clumsy and dangerous way of arresting a cough in aged persons, to give them doses of opium, laudanum, or morphia, so large as to affect the local trouble only through the brain.

There is one domestic remedy which cannot be too highly extolled, inasmuch as it never does harm, is easily applicable, and confers great benefit, even, often, to the extent of effecting a perfect cure ; and it is equally useful in the earliest stage of bronchitis, as in old chronic cases. I mean the inhalation of the vapor of water heated to near boiling. If no instrument is at hand, a narrow-mouthed jug may be used. The vapor breathed in through the mouth, and expelled through the nostrils. It is best done when the patient is in bed, and continued for fifteen or twenty minutes. The hot vapor soothes the membrane, removes the secretions, and allays irritation, and thus generally gives a night's rest from the cough. (See Note on Apparatus, p. 182.)

THE HEART.

This is one of the most important organs of the whole body. Its structure appears at first sight to be very complicated ; but its functions being entirely mechanical, it is readily understood. The heart is a double force-pump, having two receptacles appended to it, and being provided with valves to direct the course of the fluid (the blood) on which it acts. Its cavities are hollow muscles, by the contraction of which the blood is moved, and its circulation throughout the whole body effected. These cavities contract in succession. One receives the blood through the vessels from all parts of the body. These vessels are the veins. It passes it into another, which throws or injects it through the lungs, whence it returns into a third cavity. From this it passes into a fourth (the most powerful of all), which forces it again through the arteries into every part of the body. This constitutes the circulation of the blood, for the discovery of which Harvey is so celebrated. By slightly compressing any artery with the finger, we feel the jets of the current : this is the pulse. In health, the action of the several parts of the heart are regular, rhythmical, and produce pulsations numbering from fifty to eighty or ninety in a minute. The pulse is quickest in childhood, gradually becoming slower in adult life, and is slowest in old age. Of course, I mean in a state of health.

Excitement of any kind, mental emotions, fever, inflammation, and other disorders, render the pulse more frequent than natural. Some diseases, particularly of the brain, cause it to beat more slowly.

There are many other qualities of the pulse, besides its speed, which we notice, corresponding to, and significant of, changes in the action of the heart. Thus we have a hard and a soft pulse, full and small, irregular, intermittent, fluttering, etc. Moreover, we are able by the ear, aided by the stethoscope, to ascertain the state of the heart at any time.

It is one of the marvels of our nature that the action of the heart, and the consequent circulation of the blood, can go on, without material interruption, for one hundred years or more.

In advanced life disorders and diseases of the heart are but little more frequent than in earlier periods. Many of them are, to a great extent, under control and remediable. There is no reason for the commonly-entertained apprehensions when an elderly person is said to have a disease of the heart, unless such disease is organic—that is, has become much altered in its structure.

The heart derives its motive power, like every other organ, from the nerves ; not those proceeding directly from the brain and spinal cord, but from a system of nerves termed the great sympathetic. The parts and organs supplied with nerve-force from this system are in a measure cut off from the centres of ordinary sensation ; so that we have no consciousness of their actions, and no power over them through the will. In health we do not know, or at least do not feel, that we have such parts as a heart, a liver, a stomach, etc. ; but all these parts being linked together by the same source of power, disorder in one will often, more or less, disturb the others.

Hence irregular action, palpitation, fluttering, a feeling of indefinable uneasiness in the heart, may any of them be caused by disturbance of the stomach or bowels or liver ; and they disappear when the primary trouble is relieved.

Sometimes, however, the disordered action of the heart, once excited goes on after the exciting cause is removed ; and I believe these functional disorders thus give rise to real organic disease, particularly to enlargement of the organ (hypertrophy), if neglected.

What I would impress on my readers is, not to assume, because they are said to have a weak or diseased heart, their case is out of the reach of remedies. It is true, the line of distinction between permanent organic changes and functional disturbance require much skill to determine. The latter are of far more frequent occurrence ; and we possess remedies of a very remarkable power over the actions of the heart. Nervines and antispasmodics in a marked manner calm down palpitations, flutterings, etc., when temporary.

Digitalis has long been known to possess the power of reducing the frequency of the pulse ; but a plant of recent introduction to English practice from the Eclectics of America, the *veratrum viride*, possesses this power in a most remarkable degree. It demands great care in its administration ; but by giving small, frequently-repeated doses, we can reduce the number of beats of the pulse ten, fifteen, or twenty in the minute in the course of an hour or two.

I have known persons having for many years been supposed to suffer from heart disease attain to a good old age.

When the action of the heart is so far disturbed as to excite attention, there is usually mental depression ; and when it proceeds far, an anxious look is perceptible on the countenance.

Rheumatism affects the heart ; and one of the worst features of this disease, in its acute form, is a tendency to attack and damage the heart. I consider the *veratrum viride* one of the most valuable remedies we possess, inasmuch as its judicious use is remedial in such cases. It not only reduces the frequency of the heart's contractions, but it imparts tone and strength to the organ.

THE BRAIN—MIND—MOTIVE-POWER.

Mind—Emotions—Paralysis—Sleep.

It is unnecessary to enter into elaborate or scientific discussion, or even to refer to disputed questions, respecting the brain and its relations to mind. The popular recognition of the brain as the organ of thought, of feeling, and source of all motion, and controller of all the functions of the body, is sufficient for our present purpose ; yet two or three facts may be stated to render the following intelligible. 1. As the source of motion and power, the seat of all the senses, the energy of the brain passes outward and downward to all parts. 2. A reflex action passes from all parts to the brain through the nerves. 3. Injuries to any organ affect the brain, either through the nervous system or through the blood.

The brain has the most delicate structure of any part of the body. It requires nourishment, and undergoes waste from use and action, like every other part. Disturbance within it may manifest itself in a great variety of ways—in the mental acts ; in the moral sentiments and feelings ; in the nerves, as disordered feeling and pain ; as diminished power of motion in the muscles —loss of power (paralysis), spasmodic or morbid motions—and in the perversion or suppression of organic action. Bearing the facts in mind, the first traces of morbid changes in the brain occurring in elderly persons may be recognized and understood.

If the work of the brain, and consequent waste of its substance, is inordinate, and the supply of suitable matter for its repair and sustenance fails, disease necessarily ensues. An overworked brain is a common and very significant phrase. Deep thought, long continued, care and anxiety in business, study too closely pursued, involve overwork, and frequently induce mischief in the brain. Excitement from any cause, profound emotion, eager pursuit of objects of ambition, lead to more and more continuous action than the texture of the brain can bear. And there are many ways in which disorder in this organ shows itself.

Headache, sleeplessness, failure of memory, of the power of continuous application to some work or thought, illusions (some idea being intrusive, and, if not expelled, becoming dominant), confused dreams, irascibility of temper — these are morbid symptoms of brain overworked.

Not unfrequently morbid feelings in the fingers, twitchings of the muscles, diminished power proceeding to absolute paralysis in some locality, or sudden and extensive paralysis, occur.

These all, or any of them, indicate disorder of brain, and demand immediate and skilful attention. Any muscle in the body may be the seat of paralysis, partial or complete ; for instance, the tongue, producing thickness or difficulty of speech ; the eyelids, causing them to droop ; the muscles of the face, generally on one side, making the mouth to turn awry.

When any of these symptoms occur, especially those of the mind, it is common to hear them attributed to *softening* of the brain. Now, this is for the most part a guess at the underlying cause. The hypothesis is harmless if it does not lead to erroneous practice. A closer and more accurate explanation is, that the brain has suffered waste beyond the amount of nutrition it has received or can appropriate for its repair and sustenance. This explanation provides the key to the treatment required for its relief.

Any treatment will be faulty and inadequate which does not demand, as the very first item, complete repose. The brain must be allowed to rest ; every pursuit demanding thought abandoned — business, ambition, study, work, suspended ; a careful investigation of the patient's state instituted—the digestive organs, the process of assimilation, first of all; the patient's habits and mode of life, etc., and, if any defect or error is discoverable, it must be corrected and remedied.

It is very seldom that some fault will not be discovered in the primary processes (digestion, etc.).

The secretions, too, must be watched to discover any defect in them. If the liver is not making healthy bile, or in sufficient quantity, if the kidneys partially fail in their office, the defect leaves the blood impure, loaded with foreign or effete matter, and carrying into the delicate textures of the brain, instead of healthy nourishment, substances poisonous and incapable of supporting and restoring its power and functions. This is the true theory and explanation of overworked brain, the root and cause of paralysis, disordered mind, and perverted moral affections, or temper.

Sometimes the incipient disorder of the brain manifests itself by signs in the organs of the senses: impaired vision, clouds, or black spots appear, indicating partial loss of sensitiveness in the retina (the immediate seat of sight); singing or buzzing in the ears, or deafness; bad and persistent smells, or false taste; neuralgia, keen pains running along the course of nerves, particularly of the face. These all have the same root and proximate cause, although referable to different parts of the brain.

There are, however, many head troubles of a more ephemeral character, which every elderly person should know and avoid.

Indigestible articles of food will produce headaches, sometimes over one brow, sometimes diffused over the head. In some persons badly refined spirits, brandy, or others having fusel-oil in them—not to speak of adulterations in spirits, or wines—will produce headache, and their influence will often long outlast the presence of the cause inducing the trouble.

The lower bowels being sluggish, acids are generated by the decomposition of the food or excretions. This is a very common cause of dizziness, giddiness, and headache. I have known old people living in constant dread of apoplexy or paralysis, at once disburdened of their fears and suffering from this cause being recognized and remedied.

When the kidneys do not separate the effete salts and metamorphosed nitrogenous tissues, as urea, freely enough, from debility or other change, the blood becomes poisoned, head troubles are experienced, sleepiness or drowsiness at all times will follow, and if the urine wholly fails to be formed and expelled, coma and death will ensue.

Hence the importance of attention to the urine, as to its quantity and quality.

Men of business, in the eager pursuit of what they regard as imperative duties, studious men, in short, all persons who work with the brain more than the muscles, are peculiarly liable to suffer from head troubles. They are apt to disregard the early symptoms of mischief, deeming them trifling, and as having no meaning. Numbness of a finger, dizziness, broken sleep, diminished power of attention, failing memory, and the other symptoms enumerated above—any of these, or similar occurrences, should at once lead to relaxation from business at least, if not entire change of scene and habits, and complete mental repose.

Admitting the correctness of the opinion popularly held by the profession of a softening of the brain, this is by no means unamenable to remedies. Besides the change of diet, scene, and habits, spoken of above, we have valuable and efficient remedies—too powerful, however, too nice in their application, to be intrusted to unskilled hands. The most we can say to our readers is, do not allow scepticism as to the value of such means, or mere procrastination, to deprive you of the benefit they can confer. Do not surrender yourselves to the deceptive and mercenary statements of empirics.

One point, however, may properly be remarked further: if sleeplessness is the foremost symptom, be very cautious and chary in the use of narcotics. None of these, not even the new one, chloral, do more than afford temporary relief. They benumb the over-sensitive fibres, suppress feeling, but rather tend to increase the disease, if used to the neglect of more radical remedies.

Wholesome and refreshing sleep may be in almost all cases secured without recourse to narcotics. A new method of procuring sleep at will is described in "Household Medicine," worthy the notice and adoption of all elderly people.

Its principle may be stated generally as demanding an easy posture of the body in bed, and a determined direction of the thoughts to some subject as remote as possible from the ordinary and habitual currents, or one which can be entertained without the least admixture of emotions of a disagreeable character. Happy and calm will be the sleep of those who, on their pillow, can muse on the consolations of the Gospel, and resign themselves implicitly and without wavering into the keeping of a heavenly Protector and Father.

ESTABLISHED FACTS RELATING TO LONGEVITY.

While the preceding sheets were passing through the press, I became acquainted with a volume entitled, "Human Longevity, its Facts and its Fictions," by W. J. Thoms, Esq. (the esteemed editor of *Notes and Queries*). Mr. Thoms seems to have shared Sir G. Cornewall Lewis's doubts of the probability of human life extending beyond one hundred years. This work is the narrative of his researches into the evidence in proof of published cases of longevity, as they have appeared in the journals. With great pains, labor, and sagacity, Mr. Thoms has pursued the subject for many years. The result he has stated with great candor, although contrary to the opinion he started with. If the same patient and sagacious inquiries could be instituted to determine questions arising in the science of medicine, the same candor in accepting and making known the results, it would be of incalculable profit to mankind, and serve in no small degree to preserve and extend human life. Were the evidence for supposed facts in history similarly dealt with, it would change the entire aspect of the past. Indeed, it would be difficult to find any subject, whether belonging to science, morals, or politics, which would not be benefited and enlarged by being so treated.

After thoroughly sifting the evidence, Mr. Thoms admits that he has found four well-established modern instances of persons living beyond one hundred years. They are as follows :

Mrs. Williams, of Bridehead, Dorset, died October 8th, 1841, within one month of one hundred and two years.

Mr. William Plank died at Harrow, November 19th, 1867, aged one hundred years and twelve days.

Mr. Jacob William Luning died June 23d, 1870, aged one hundred and three years, one month, and four days.

Mrs. Catherine Duncombe Shafto, of Whitworth Park, died March 10th, 1872, aged one hundred and one years, one month, and nine days.

Mr. Thoms's most interesting and valuable contribution to the statistics of human life contains, besides, the history of several persons of great age, but respecting whom the evidence in support of the precise number of years claimed for them is doubtful. Among these is one female, said to have lived to the age of one hundred and six.

I am gratified to find Mr. Thoms agreeing with me in my estimate of M. Flourens's theory, and adding the great authority of Richard Owen as supporting it. Sir Henry Holland thought himself justified in rejecting it.

It is satisfactory to know that Mr. Thoms is still pursuing his inquiries ; but I share in his surprise, that the insurance companies, with their enormous accumulations of wealth, have taken no combined action to determine the question, "What is the extreme duration of human life?" seeing that they must be directly interested in ascertaining the truth.

Since the publication of his book, Mr. Thoms has published another instance of a female who reached her one hundred and second year. This was a Mrs. Monro, who died in the almshouses of the Goldsmiths' Company. (See *Times*, November 7, 1873).

Again, March 28th, 1874, Mr. Thoms relates the case of Mr. Anthony Beresford of Alstonford, who died March 3d, aged one hundred and two years thirteen days.

This case is notable, as showing that life may be enjoyable and useful, even beyond one hundred years. Mr. Beresford was totally blind from an accident since 1819. The loss of one sense was followed by increased acuteness of others. It was said there was not a better judge of a horse, a beast, or sheep, than Mr. Beresford ; and that he knew every sheep in his flocks, by passing them through his legs and handling them ; and that any attempt to baffle him, by giving him the same sheep twice, invariably failed. He retained his mental faculties to the last.

September 12th, 1874, in the *Times*, a third case is noted by Mr. Thoms—a Mrs. Mary Brookman, living in the Isle of Thanet within a few days of that date, who, if she *had* lived until November, would have been one hundred and two. She died, however, a few days before her one hundred and second year.

The extension of human life beyond a century, and verging toward one hundred and five, is now completely established. The proportionate number of centenarians to the population has yet to be learned. It is very probable it will greatly increase in future times. I cannot promise to make any life extend to a century ; but I am confident that many persons die prematurely, from carelessness, before reaching threescore years and ten, who might add at least a decade to these years.

One fact clearly established by Mr. Thoms I must notice, since it has an important bearing on my aim and subject—namely, that the popular idea of longevity being more frequent among the poorer than the rich or middle classes (their relative numbers considered) is a fallacy. Like many popular opinions, it vanishes before statistics.

DISEASES WHICH TERMINATE LIFE AT AND AFTER SIXTY.

A table drawn from the returns of the Registrar-General of the causes of death in 1000 cases, gives us, in round numbers, the following:

1.	Old age..about	280
2.	Diseases of the lungs and air-passages......	250
3.	" of the digestive organs and bowels..............	100
4.	" of the brain and nervous system.	130
5.	" of the heart and blood-vessels....	60
6.	" of the general system—fever, erysipelas, gout, rheumatism, etc.	189

As I have already had occasion to remark we must not place implicit reliance on the registration of deaths. If this is liable to error respecting the ages of persons recorded, it is much more so in the causes of death. It is more than probable that a careful scrutiny would greatly lessen the number (appearing here to be one fourth of the whole) of those dying of old age. Diseases of various kinds, neglected at the beginning, lose their characteristic features; and when the physician is called in he finds only the debility or prostration they have left. It is hopeless to attempt learning from unprofessional bystanders or nurses what has gone on before, and he finds it necessary to certify that the person died of old age. Again, although the medical attendant is required to state in his certificate, not merely the immediate cause of death, but previous disorders, and the length of time they had existed, this is very imperfectly done, still more uncertainty attaching to the information he receives upon this point.

So far as the register points to external agencies as causes of fatal diseases, we may learn from it to avoid them; but it is evident that it throws no light on those numerous and oft-unnoticed changes in the constitution of aged persons, which slowly and insidiously lead to overt disease, or to the debility and collapse recorded as old age.

My aim in these pages has been to specify and describe the very earliest indications of those changes, and to point out the measures they demand if we would prolong life to its normal extent.

After middle life we should watch carefully, but without anxiety or fear, our own condition, and take resolutely the proper steps to stay the first signs of mischief, neither neglecting the aid of medicine nor employing it without good reason. There is a golden mean between scepticism and blind credulity.

If wisdom is ever to be attained, or common-sense to rule the conduct, it is surely when life has extended beyond threescore years.

SUMMARY.

The views advanced in the preceding pages may be briefly summarized.

Ageing is a result of the operation of several concurring causes. Mere lapse of time will produce it. But ageing does not synchronize with age; that is, with the number of years a life has continued. In some persons it begins earlier, and in others later.

Ageing consists in molecular changes proceeding in all the textures and organs of the body, involving a deterioration, degradation, or a species of decay. It may exist without suffering, or consciousness of the change. A person may say, and truly, "I am quite well for an old man, or an old woman." The qualification implies that there is some degree of weakness, some departure of power formerly enjoyed, and the tendency is daily toward more and more debility.

We have shown it to be indisputable that certain appreciable conditions surrounding individuals change and retard the process of ageing, and thus prolong life. (See *ante*, p. 131.) These conditions, for the most part, seem to reach individuals fortuitously. If they are sought, studied, employed, why should not very many, instead of, as at present, very few, persons reap the benefit they confer, and attain to a good old age?

Nay, why should we not be able to augment the force of these conditions, and apply the resources of science to the same end—the arrest or retarding of ageing—and thus not merely increase the number of octogenarians, but extend human life to its utmost limits—one hundred years or beyond?

This should at least be the aim of our efforts.

A close and careful consideration of the powers and properties of substances known to act remedially on the body warrants the inference that the molecular action and changes of ageing are as amenable to their influence as any disease whatever. Experience alone, guided by so much physiology as will help us, must determine this.

There is another point of view in which we have somewhat fully regarded ageing, namely, it does not usually—or we should say, most commonly—proceed in all parts and organs alike, or within the same time. One part or organ ages (so to speak) before the others. Hence elderly persons desirous of attaining longevity, and not unwilling to take some trouble in the matter, must learn for themselves the appearances or symptoms of change in the more important or vital organs at the very earliest moment, and take measures to remedy them; or they must incur the expense of employing a physician to watch over them for the purpose.

They ought not to wait for suffering, or to postpone the search for relief. The health of every part is essential to the health of the whole; and the older we become, the more certain is disturbance in one vital organ to bring a fatal end to the whole, if neglected.

I do not hesitate to make this assertion, although Sir Henry Holland, in his Essay on Old Age, expresses the contrary opinion. He says the sympathy between the several parts of the body, and their influence on each other, diminish with age. This does not accord with my observation. For instance, an indiscreet and heavy meal will sometimes produce a sudden collapse of power in the brain, before any of the food can have been digested. And again, intense headache will often disappear instantly on the use of an enema to empty the lower bowels.

These are results of sympathy: many such are observable in elderly people. I mention them to enforce the foregoing advice. (See Note O, p. 181.)

AN EXPERIMENT PROPOSED.

When Lady Mary Wortley Montagu brought to England a report that in the East a practice prevailed of protecting persons from the worst evils of small-pox by inoculation, public attention and interest was at once aroused. After some discussion, the government consented to allow the operation to be performed on a number of condemned criminals, who on these easy terms saved their lives. The next persons experimented upon were the king's own children. And the practice, being found efficient, was very generally adopted, and prevailed until the safer and more efficacious preventive, vaccination, was discovered.

We would suggest an imitation of the above proceeding—not, indeed, by experimenting on criminals, but on persons either selected from among the inmates of unions, or others, as might be found more expedient.

Let a certain number of men and women, say ten or twelve of each, of nearly the same age, sixty-five or seventy, be placed in the most favorable circumstances for the preservation of health and securing longevity. Let them be placed under careful and strict supervision, protected against all known external agencies capable of causing disease, supplied with clothing, allowed exercise, and a table well furnished with every necessary and wholesome food; and let them be subjected to the use of all means available for promoting longevity.

It would be necessary, in selecting subjects for this experiment, to adopt none in whom any disease could be traced. Their history and antecedents, and as far as possible those of their parents and ancestors, should be ascertained and noted. The aim and purpose in view should be clearly explained and intelligently apprehended by them all, in order that no waywardness or indocility should mar the result. It is this which would render observations pursued with wealthy and independent persons inconclusive. They wil indulge in injurious habits and practices, and expose themselves unnecessarily to the attacks of disease.

Now, this may appear to many readers a somewhat wild and impracticable suggestion; but I believe it could be effected, the only requisite being the necessary funds. But when we consider the enormous wealth of many people in England, their readiness to subscribe to hospitals and other charitable institutions, it does not appear to be impossible that such an experiment should be made. And I may add, my own expectation would be, that many if not most of the patients would have their lives extended to upward of a hundred years. (See Note P, p. 181.)

APPENDIX.

CAUSES OF PREMATURE DEATH.

Taking the causes of premature death in the order of their predominance, diseases of the lungs, inc uding phthisis, first come under consideration.

Far from an insignificant amount of the mortality of infants and young children is caused by these diseases. But their fatality chiefly falls upon youths and adults (fifteen years to fifty-five years), and especially upon adults in the prime of life (twenty to thirty years). The rates of mortality from lung-disease range in various parts of the kingdom from a little over 1000 per 100,000 living in some districts (the districts south of London, for example) to over 2000 in others, and even to close upon 3000 (Wolverhampton). Now the districts of excessive mortality from lung-diseases are the centres of certain special industries; and a study of the circumstances under which these industries are pursued speedily discloses the conditions under which this cause of premature mortality operates in the several districts.

The common condition determining diseases of the lungs is the sudden alternations of temperature to which persons are liable from exposure to weather. But this condition it may be taken will act pretty equably upon persons and communities in different parts of the kingdom, varying chiefly with peculiarities of local topography and individual proclivities, the latter an indeterminate quantity. But there are numerous artificially created conditions which predispose to the operation of the common determining condition—the sudden alternations of temperature—and it is upon the extent to which these artificial conditions exist that the greater or less prevalence of fatal lung-disease depends. We observe these in their simplest state in our ordinary household arrangements, where, in our eagerness to protect ourselves from cold or variable weather, we commonly box ourselves up in atmospheres more or less fouled by domestic operations, by our own breathing and by the insensible emanations from the body, by artificial lights particularly, and by all the various sources of impurity which need the continuous and never-ceasing exercise of the housewife's care, if any reasonable state of cleanliness of air and surroundings is to be obtained and maintained. The lungs supplied with an impoverished and vitiated air gradually lose that aptitude of resistance to those alternations of temperature which occur in the ordinary progress of weather and season, and the time comes when a sudden change, aforetime unheeded and harmless, checks the natural action of the breathing apparatus, and brings about the states known as inflammation of the air-tubes, bronchitis, or of the substance of the lung, pneumonia, or leads to change of the lung-tissue, perhaps unrecognized at first, but which may become one of the formidable diseases of youth and adult life, consumption. It must be obvious how, under the circumstances of nursery life as commonly carried out in this country, the infant and young child are peculiarly exposed to harm, even in the best houses and among the well-to-do classes, from the artificially created atmosphere in which they too generally live. And when we contemplate the conditions of life under which infants and young children exist among the poorest and least provident classes, especially in our large towns, where they are housed in atmospheres fetid with every odious product of human filth, and where in inclement weather warmth is mainly obtained from the huddling together of the living, we can understand how the delicate and sensitive breathing apparatus of infancy and childhood readily breaks down under the incessant irrigation of the filthy air which is breathed.

What may thus be observed in too many cases in our ordinary household life is observed also substantially in all the indoor occupations of youth and manhood. Each of these occupations has to be followed under artificial conditions of atmosphere all favorable to, and some directly active in, the production of lung-diseases.

The industries which contribute most to excessive prevalence of lung-diseases in particular localities are mining, metal-work and cutlery, pottery, flax-working, cotton and wool manufacture, straw-plaiting, glove-making, lace-making, and silk-working. In these several industries we have persons working in artificially created atmospheres, more or less fouled with their own breathing, or with the effluvia of putrefying filth, or, at certain periods, with the products of imperfect combustion of gas or other illuminating agent, or with the dust and dirt of their industry, or surcharged with moisture and highly heated.

In metal-work, cutlery, and pottery, especially the grinding and polishing of cutlery and the scouring of pottery, the adamantine dust from the processes named, which pervades the air of the workshops, becomes a special source of lung-disease. The irritative effect of steel-dust upon the grinder's lungs, and its influence in producing the very fatal form of disease known as grinder's consumption, is one of the most painful studies in the whole range of industrial diseases.

In the cotton manufacture the work is largely carried on in rooms highly heated, and containing an undue amount of moisture in the atmosphere, with much fine dust. The same is true also, to some extent, in the woollen manufacture. The transition from these rooms, after several hours' confinement in them, to the outer atmosphere when the temperature is low, and with rarely any sufficient amount of additional clothing to protect the worker from the cold, is undoubtedly provocative of lung-disease.

Finally, in straw-plaiting, glove-making, and lace-making, when carried out in the workers' rooms, we observe the causes which are apt to foster lung-diseases in our houses operating in great intensity. Carried on, for the most part, in small, ill-ventilated, often damp, and otherwise ill-found cottages, which are cold in winter and unbearably hot in summer, in an atmosphere usually pervaded with filthy emanations coming largely from the outside, the work is pursued by women, many of them hardly out of girlhood, and by not a few children. Under such conditions they work for many hours, sometimes twelve or fourteen, of the day; producing there a close resemblance, in the deficient ventilation, the sedentary occupation, the want of active bodily exercise, and a listless state of mind, to a state of things approximating to what aforetime had been found to exist and to prove so productive of lung disease in jails.

Although the circumstances under which the above-named industries are pursued favors the development of all lung-diseases, including phthisis, there are certain important differences in the conditions which affect the production of phthisis as compared with other diseases which it is necessary to note.

Phthisis is especially the lung-disease of youth and early manhood; other lung-diseases predominate in infancy and early childhood, and in the latter half of life. This predominance of phthisis during the more actively occupied working ages is itself significant of the influence of industrial occupations upon its prevalence, and its occurrence is notably allied to sedentary labors pursued in ill-ventilated rooms, amid fouled atmospheres. But it has been recently ascertained that there is a widely operating condition which exercises a most important influence in predisposing persons to the degenerative changes in the lungs which we call phthisis. This condition is dampness of soil. Eminent authorities in England and America have shown, each independently of the other, that dampness of soil is an important cause of phthisis to the population living upon it. It is difficult to exaggerate the practical value of this conclusion in relation to sanitary work and administration.

Infectious Diseases, such as scarlet-fever, the continued fevers (typhus, enteric fever, etc.), measles, diphtheria, small-pox, malignant cholera, etc., hold the second place in order of magnitude among the causes of premature death. The number of deaths from these diseases during the ten years 1861–70 exceeded 700,000 (of these deaths about 576,000 occurred in infancy and early childhood, up to five years). The distribution of these deaths in different parts of the kingdom manifests much greater variations than have been observed in the case of lung-diseases, and the differences in the prevalence are as suggestive as in the last-named class of diseases of the conditions under which dangerous infectious diseases operate. It is necessary, for a clear apprehension of this part of our subject, to deal separately with each of the more important diseases which enter into the class of infectious diseases. But before doing this, it will be well to explain in what sense the word infectious is used here, and also to note an important distinction which separates the several sorts of diseases into two classes.

Much confusion has arisen, and still arises, in the use of the terms contagion and infection. There was a time when each word was used in a particular sense, and the transmission of a disease by contact (contagion) and of a disease by pollution of the air with the transmitting material (infection) were believed to represent cardinal differences in the propagation of the transmissible diseases. It is now known that the distinction originally implied in the terms does not exist, that there is no such thing as mere contact transmission of the diseases in question, and that the phenomenon of transmission is by no means confined to diffusion of the transmissible material in the air. Hence both the words contagion and infection are now used technically and generally as convertible terms, typifying, as applied to disease, the property of its transmissibility in some way or other from the sick to the healthy. It would have been well if both words could have been discarded, for a tradition of their former use still attaches to them, but they would seem to have become permanently fixed in the language. The tradition of old use adheres, however, more firmly to the word contagion than to the word infection; and even at the present day we find persons bewildering themselves and confusing others by using the former word in a sense which has long ago ceased to be enforced, and which, in fact, is meaningless in the present state of medical science. We have here adopted the word infection and its derivatives in preference to the word contagion and its derivatives, as the former is less apt to trip up the reader by the false lights of old associations than the latter.

The infectious diseases admit of being divided into two classes with reference to the circumstances under which they exist. This division involves a distinction that has an important practical bearing, as will be seen in the sequel.

Several of these diseases, as, for example, small-pox, scarlet-fever, and measles, have originated in remote ages under conditions of life of which we can form no conception in the present day. We know nothing of the causation of these diseases, except as coming to us by successive transmission from period to period, from country to country, from nation to nation, from person to person. They are never absent from among us, at one time existing only in a few scattered centres, at another spreading over the whole people as an epidemic. The infectious diseases, indeed, are especially designated epidemic diseases from this notable phenomenon of general prevalence at intervals. Epidemic is a word which in its proper signification is descriptive, and simply means general prevalence in a community, or a district, or a country. Certain mysterious technical meanings have been attached to the word which are nothing more than concealments of an ignorance which even the learned need not be ashamed to admit. The word epidemic, when used of disease, or of any other phenomenon to which it is applicable, should be used simply in its ordinary and proper sense, as defined by Webster, to wit: "Common to, or affecting, a whole people, or a great number in a community; prevalent; general."

Others of the infectious diseases, as the continued fevers (typhus, enteric fever, relapsing fever), diphtheria, influenza, and malignant cholera, probably have their origin in conditions which recur at intervals, or which habitually exist among us, or which are produced in certain social convulsions. Thus influenza would appear to depend for its origin, as well as for its prevalence, upon as yet undetermined meteorological conditions; diphtheria is so closely allied with sundry sources of domestic insalubrity which apparently affect houses in the country more markedly than in the town, that it would appear to have its origin in a particular combination of these as yet unknown; enteric fever seems to be born out of the excremental filth among which large sections of our population live; typhus and relapsing fever are the products of overcrowding, privation, and absolute famine, as different degrees of this trinity of foulness, want and suffering obtain; while malignant cholera, known to us only in England as a terrible importation at intervals from our great dependency in the East, is believed to be a product of excremental filth, acted upon by a tropical sun, under the conditions mainly found among the low-lying lands in the delta of the Ganges.

The infectious diseases which have had origin at a remote period, under conditions which have probably disappeared, and the infectious diseases which may originate under conditions existing at the present time, present themselves in their practical aspect in different lights, as we shall see presently.

Scarlet fever is the most fatal to life of the infectious diseases common to this country. During the ten years 1861–70, it caused no less than 207,867 deaths, of which 133,462 —nearly nine tenths—occurred among infants and children under five years of age, and 188,557 by the time of expiry of the ninth year. In fact, scarlet-fever kills yearly, on the average, about 21,000 persons, chiefly children not exceeding ten years of age. This disease has been called the "English Pestilence." The distribution of the mortality caused by it over the kingdom is marked by great irregularity. There are localities in which for a period of years no deaths occur from scarlet-fever, and from which it is known that the disease has been wholly absent. On the other hand there are localities where the disease, always being present, deaths from it form one of the most regular features of the mortality returns. The rate of mortality from scarlet-fever per 100,000 living at the ages referred to, during the ten years 1861–70, ranged from 12 at all ages, and 119 at ages under five years (Builth, Brecknock), to 186 and 760 at the same ages respectively (Gateshead), and 215 and 854 (Easington).

The chief districts of constant excessive mortality from scarlet-fever are London, the Tyne-side towns, and the mining districts of Durham, Northumberland, some parts of Cumberland (Carlisle, Cockermouth, Whitehaven), the manufacturing districts of Lancashire, Cheshire, and the West Riding, Birmingham, Wolverhampton and the vicinity, the potteries of Staffordshire, Bristol, and Flint county. These localities constitute the scarlet-fever fields of the kingdom. There the disease is continuously cultivated, and from thence it presumably spreads at intervals, sweeping over the entire kingdom. In the greater number of these places it is known that there are great agglomerations of populations of young children, but these agglomerations are not peculiar to these localities alone. The special conditions which determine the fatal prevalence of scarlet-fever in the localities named have not yet been made, strange to say, a subject of detailed investigation, although such investigation gives the greatest promise of our being able to provide for the arrest of a starting epidemic of scarlet-fever at the source.

The continued fevers—typhus, relapsing fever, enteric fever—stand next in order of fatality to scarlet-fever among the infectious diseases. They caused 189,285 deaths during the ten years 1861–70, of which a seventh only (26,630) occurred under ten years of age.

Typhus is pre-eminently the fever of overcrowding and destitution—of an overcrowding and destitution which happily are becoming things of the past in this country. Wherever overcrowding and destitution are pushed to the extreme, and where these conditions concur with, or follow close upon, great fatigue, there typhus almost invariably makes its appearance. We have thus seen it developed among the Turkish forces and some portions of the Russian forces in the war just ended, and the disease is at the present moment spreading broadcast in the districts and among the soldiers at the seats of war in Eastern Europe and Armenia. This event was looked for as inevitable when the Turkish commissariat arrangements failed, and when the half-starved men, exhausted with fatigue, clad miserably in rags, were compelled to seek warmth by close-packing in their tents and in the houses of the peasantry under indescribable conditions of filth. The conditions which gave rise to the disease were the conditions which favored most its spread by infection. Once developed, the disease has spared none coming within its infective influence; and the civil populations of the districts occupied by the opposing armies, and to which the sick, the wounded, and prisoners have been sent, are now contributing to a mortality which, in the end, will probably prove larger than the mortality caused by sickness and wounds among the troops during the campaign.

There are states of destitution which would seem to give rise to the infection of typhus, the infecting persons themselves not suffering from the disease. In 1868, when famine prevailed in Algeria, the starving Arabs flocked into the towns in the utmost state of misery and privation. It was observed that many of these miserables, as they craved relief or lay about in corners, or beneath such cover as afforded some sort of shelter, exhaled a penetrative putrefactive odor in their breath and from their bodies—in other words, that, still living, they were apparently putrefying. No symptoms of fever or other acute disease were observed, but the persons who came in contact with them were rapidly struck down with typhus, which, thus lighted up, spread on all sides.

Typhus, as ordinarily observed, is peculiarly a disease of towns.

Relapsing fever appears in much the same conditions as give rise to typhus, but it has more marked relations with famine, and hence is popularly known as famine-fever.

Enteric fever is a special product of putrefying human excrement, under conditions not yet fully known. Originating in excrement, the excremental matters of the sick who suffer from it possess the power of producing the disease in others, not less definitely than the breath and emanations from a case of small-pox or of scarlet-fever or of measles will produce small-pox or scarlet-fever or measles, as the case may be. Enteric fever is so universally distributed in the kingdom, and the mode of production by the infective discharges of the sick from the disease has become so much the more common mode, that it is difficult in any given case to exclude the probability of infection. Be this as it may, the occurrence of enteric fever means that the sufferer has taken into his system, by breathing or swallowing, a sufficiency of putrefying excrement, or of excrement to which special infective qualities have been given by having passed through the bowels of a person affected with enteric fever, or of the special morbid products of the two sorts of excrement. He has swallowed or breathed, as the case may be, the actual stuff or its products, as presented to him in the form of an emanation coming from the filthy open privy-pits which still disgrace a large portion of the land, or as a cloud of dust wafted into public places where the stuff has been promiscuously scattered on the surface of the earth, or as it has been conveyed to him suspended in the air which has intruded upon his privacy or permeated his residence from an improperly arranged cesspool or ill-ordered drain, or as he has drunk it unsuspectingly in water or as distributed in milk. Enteric fever, indeed, is the household and municipal fever of this kingdom. Its prevalence and persistence is the surest indication of the failure of householders and local authorities in having secured, the former their families, the latter the communities under their charge, from the mischievous action of the most repulsive filth.

Malignant Cholera.—This formidable infective disease appears in England only at intervals. It takes its origin in India, principally in the low-lying lands of the Lower Provinces of Bengal, especially within the delta of the Ganges. There the disease does not appear to be ever absent, and occasionally it breaks out with great intensity, manifesting at the same time an extraordinary diffusiveness. While usually this diffusiveness is limited to India, and the conditions on which it commonly depends do not exist beyond the coast line or the northern boundary of that country, when the exceptional diffusiveness referred to declares itself, the malady is no longer restricted in its development and power of propagation within the limits of the Indian peninsula. At such times, wherever persons sick of the disease carry it, there it exhibits similar phenomena to those observed in its Indian home, takes temporary root, and grows in any locality favorable for its reproduction into which it may be imported. Each place where it is thus planted becomes a new centre of propagation, and so by successive infections of localities it may traverse the whole world.

Now the local conditions which favor the development of cholera are similar to those which favor the development of enteric fever; and there is good reason for the belief that the infective quality of cholera, as of enteric fever, rests in the intestinal discharges of the patient. The conditions under which cholera spreads in this country are thus stated in the official memorandum issued by the Local Government Board for the information of sanitary authorities—a memorandum prepared for that Board by its former medical officer, the great master in sanitary science and craft in this country, John Simon: "It is characteristic of cholera, not only of the disease in its developed and alarming form, but equally of the slightest diarrhœa which the epidemic influence can cause, that all matters which the patient discharges from his stomach and bowels are infective, and that, if they be left without disinfection after they are discharged, their infectiveness during some days gradually grows stronger and stronger. Probably, under ordinary circumstances, the patient has no power of infecting other persons except by means of these discharges, nor any power of infecting even by them, except in so far as particles of them are enabled to taint the food, water, or air which people consume. Thus, when a case of cholera is imported into any place, the disease is not likely to spread, unless in proportion as it finds locally open to it certain facilities for spreading by indirect infection. In order rightly to appreciate what these facilities must be, the following considerations have to be borne in mind: first, that any choleraic discharge cast without previous thorough disinfection into any cesspool or drain, or other depository or conduit of filth, infects the excremental matters with which it there mingles, and probably to some extent the effluvia which those matters evolve; secondly, that the infective power of choleraic discharges attaches to whatever bedding, clothing, towels, and like things have been imbued with them, and renders these things, if not thoroughly disinfected, as capable of spreading the disease in places to which they are sent (for washing or other purposes) as, in like circumstances, the cholera patient himself would be; thirdly, that if, by leakage or soakage from cesspools or drains, or through reckless casting out of slops and wash-water, any taint (however small) of the infective material gets access to wells or other sources of drinking-water, it imparts to enormous volumes of water the power of propagating the disease. When due regard is had to these possibilities of indirect infection, there will be no difficulty in understanding that even a single case of cholera, perhaps of the slightest degree, and perhaps quite unsuspected in a neighborhood, may, if local circumstances co-operate, exert a terribly infective power on considerable masses of population."

Whooping Cough (as also influenza) has still to be numbered among the diseases of which the conditions of prevalence, otherwise than as they are spread by infection, are unknown. Whooping-cough caused, during the ten years 1861–70, 112,800 deaths.

Measles caused 94,099 deaths during the ten years 1861–70, and its mortality ranged within this period from 126 per 100,000 living, in the least unhealthy districts, to 608 (Warrington), 610 (Abergavenny), 624 (Wigan), and 722 (Liverpool). We know nothing of the history of measles except as a transmitted infection from the sick to the well.

Of all the permanent infections, measles is the most difficult to deal with preventively, as the disease becomes infectious during the three or four days' indisposition which precedes the eruption, and when, very commonly, the child still associates with its companions, and its indisposition is not heeded. Measles varies very greatly in its intensity in different epidemics; sometimes prevailing as a most malignant malady, sometimes, and more frequently, as one of the slightest of specific ailments.

Diphtheria, within the period last named (1861–70), had occasioned 39,454 deaths. The history of this fatal infectious disease goes back to remote times. Unlike that of small-pox and scarlet-fever, the history is not one of continuous propagation by infection. Difficult as it is to deny all chances of infection in a country where the malady is naturalized, yet the most careful observers appear to have come to the conclusion that the disease not unfrequently springs up anew among us. The conditions under which these apparently new growths are observed have been, in towns, markedly connected with exposure of the subjects of the disease to the air of imperfectly ventilated sewers and drains, and in the rural districts, in addition, to the filthy surroundings of ill-kept farmsteads. The disease has a certain preference for country districts as compared with town districts; and dampness of houses or of soil seems to play some part in its localization.

Small-pox, although ranking last but one in the order of mortality caused by infectious diseases, caused not less than 34,786 deaths in the ten years 1861–70. Of all the infectious diseases this is perhaps the least affected in prevalence by individual and external conditions, setting aside the artificial condition of vaccination. There are exceptional persons who, irrespective of vaccination, resist the infectiousness of small-pox; and the disease itself is apparently influenced in its activity by season. It is true that the time of its greatest activity in this country, the colder months of the year, is the time when persons, keeping more to their houses, the chances of dissemination among families are augmented; but in India, where the influence of meteorological changes admits of being more clearly discriminated in respect to the disease, there seems to be no doubt that the potency of the small-pox infection, as that of vaccine virus, is diminished during the hot season. It is reasonable to infer, then, that some part of the fluctuation of small-pox in this country depends directly, and not indirectly, upon seasonal influence. There are reasons for the belief also that local conditions of population may affect the degree of infectiveness of small-pox.

The great epidemic of 1871-72 was unexampled in the memory of living man for the diffusiveness of the disease and its malignancy. Now the starting-point of this epidemic, it is averred by a very thoughtful and competent observer, Léon Colin, was in a part of Brittany. There, shortly before the siege of Paris, small-pox appeared among a population unprotected by vaccination. The disease declared itself with a malignancy only observed in the first instance among populations so placed, and under ordinary circumstances it would probably have exhausted itself in the district where it assumed this character (so slight was the communication between it and the surrounding country), or at the worst would have extended in a scattered and manageable form into the districts immediately adjacent. But the exigencies of the Franco-German war brought about a state of things which, according to our authority, converted what would otherwise have been an exceptionally severe local outbreak of small-pox, which would have served alone to point a local vaccination-moral, into a world-wide dissemination of a malignancy so great as to compel the serious attention of governments. First, it was necessary to draft into the French army, to the utmost limit, conscripts and recruits from the infected district; secondly, it was found impossible to carry out in time of war those precautions as to vaccination and re-vaccination of persons added to the army which are insisted upon in time of peace. So it happened that the conscripts and recruits from the infected locality in Brittany carried with them into the army the malignant disease prevalent in their homes. The army at the time furnished an abundancy of unvaccinated and imperfectly vaccinated individuals for the reception and propagation of the disease in an unmodified state. As the army moved hither and thither it spread the disease among the civil population, and prisoners and wounded taken by the Germans carried the malady among the German forces and into Germany. Paris early received the infection from detachments of troops, having the disease among them, who marched into the city before the siege; and there, shut in, the malady multiplied under circumstances peculiarly favorable for retaining its malignancy. With the raising of the siege and the resumption of communication between Paris and the outer world, the first outrush of the released inhabitants and foreigners who had had to remain within the city during the investment scattered the malady broadcast in hitherto unaffected provinces, to adjacent countries which to that time had remained unaffected, and among other countries to England.

At the time of this importation London was beginning to suffer from one of the recurrent epidemics of small-pox, which mark the accumulation of unvaccinated people in or during the period of indifference which customarily follows the alarm of a present epidemic. But the character of the disease which marked the beginning of the epidemic was wholly different as to intensity from that which was imported from Paris when the siege was raised, and which, displaying an unusual infectiveness as well as malignancy, presently supplanted the existing disease, and gave that aspect to the subsequent progress of the epidemic in the metropolis, and afterward in the country, which marked it. This fact had been ascertained at the time, and long before the origin above assigned to the great outbreak had been ascertained and made known. The history of the epidemic in London and in England generally is consistent with the account we have given; and the history of the progress of the epidemic in other countries, extending over a great portion of the surface of the globe, is also consistent with it.

The origin assigned to this small-pox epidemic suggests a line of observation and practice respecting other infectious diseases of considerable moment. It is not impossible that the occasionally observed malignancy of other infectious diseases, especially scarlet-fever, measles, and diphtheria, may in the first instance be the result of local conditions especially favoring such a development of the malady. It is now known that the virulence of an infective product of disease may be cultivated to an extraordinary pitch in the laboratory. A phenomenon that can be artificially produced may also, it is to be presumed, be naturally produced, and the excessive virulence sometimes observed in the action of the small-pox, the scarlet-fever, the measles, and the diphtheria infections may at times undergo a course of undesigned cultivation under peculiar local and individual circumstances similar to that which has been observed of other sorts of virulent morbid products in the laboratory. This is a possibility which it is now necessary to keep well in mind, in view of the phenomena of malignancy showing themselves in connection with any of the ordinary infectious diseases; because, even pending the determination of the scientific question, such malignancy should influence the precautionary measures adopted to prevent the spread of the disease, by giving to them the greatest stringency of which they are practicable.

Diseases of the brain and nervous system, including hydrocephalus, hold the third place in rank among the causes of premature death. This position is almost wholly due to the preponderance of "convulsions" as a cause of death in infancy among the diseases of this class. During the ten years 1861-70, 669,899 deaths were caused by maladies of this sort, of which numbers 249,990 occurred in infancy, and 106,883 between infancy and the completion of the fourth year of life. These diseases fall to their lowest point as causes of death in adult life, to increase again as life advances and old age steals on.

The fatal diseases of the nervous system which occur in the decline of and in advanced life may be taken in the main to be the results of degenerative changes going on in the nervous tissues, which are, in fact, for the most part, the changes of natural and often premature decay. On the other hand, the fatal diseases of the nervous system in infancy and early childhood are, in a large proportion of cases, the indications of an immaturity or defective vitality or original vice of organization related to the class of developmental diseases so called, which we shall have next to refer to. At the best, the mobile and impressible nervous system of the infant responds to exterior influences and impressions in a manner very different from that commonly observed later in life. Morbid conditions, which, in late childhood, in youth, and in manhood, are manifested by shiverings, appear in the infant to be manifested by convulsions. But the question that most concerns us here is, that the prevalence of diseases manifested by brain symptoms in infancy and early childhood, especially the prevalence of convulsions, is obviously influenced by certain local insanitary conditions. The rate of mortality from diseases of the nervous system, including hydrocephalus, ranges in England from 675 per 100,000 living under five years of age in the least unhealthy districts of the kingdom, to 1456 in the North-Western Counties, and 1504 in London.

The most striking instance of the influence of local insanitary conditions upon excessive local prevalences of these diseases is obtained from what is known of the effects of a vitiated state of the atmosphere in promoting convulsions. About the beginning of the century very many of the children born in the Dublin lying-in hospital died of what were termed "nine-day fits," in other words, fatal convulsions, which ordinarily set in about the ninth day after birth. The master of the hospital, at that time Dr. Clarke, came to the conclusion that much of this excessive mortality from convulsions among the infants depended upon the foul state of the atmosphere, which existed in the then very imperfectly ventilated wards. Acting upon this opinion, measures were adopted for improving the ventilation, a marked diminution in the number of fatal cases of "nine-day fits" following. These measures were still further developed, the rate of mortality from the nine-day fits diminishing with each successive improvement. In the end the mortality among the new-born children was reduced to a sixty-eighth part of what it had been when the first measures for a more effective ventilation of the wards had been adopted.

General diseases, so called, other than the infectious as commonly known, have the fourth place in order of predominance among the causes of premature death, and among these diseases the foremost position is held by cancer, the wasting of infants (mesenteric wasting), croup, scrofula, and rheumatism.

Cancer caused 82,820 deaths during the ten years 1861-70. This formidable malady is of the rarest until after the twenty-fifth year of age. Between the twenty-fifth and thirty-fifth year of age the mortality from it begins to increase ; after the thirty-fifth year the augmentation is considerable ; and the maximum is attained between the fifty-fifth and sixty-fifth year. The disease, in fact, is markedly a disease of adult life. As yet there is, unhappily, no clue to the causes of this dreadful malady, but recent advances in medical knowledge of the mode of development of the disease give reasonable hope that, at some probably not far distant period, we shall obtain an insight as to the conditions which determine it. Cancer has a tendency to run in families ; but the assumption that the inherited cancerous state affects the whole body does not therefore follow. Recent researches tend to show that cancer is primarily a local affection, and that the general state of indisposition which marks its progress is the result of a gradual infection of the system, through the blood, with the cancerous products of the local disease. It is difficult to believe that, if this view of cancer prove to be accurate, it will not lead to important consequences both in the medical, the surgical, and the preventive treatment of the malady.

The mesenteric wasting of infants, and scrofula (when the former name is not used, as is too often the case, to designate the wasting arising from rickets), belong to the same category of disease production in which phthisis and hydrocephalus are included. The same morbid cause, acting in different organs, produces the various results which have received the several names given, namely, in the lungs, phthisis; in the brain and its membranes, hydrocephalus; in certain of the abdominal glands, mesenteric wasting; and in the general glandular system, scrofula. The medical doctrine of the conditions under which these diseases are developed is becoming more hopeful in view of prevention, as in the case of cancer. In these tubercular diseases also it is now beginning to be understood that the starting-point, as in cancer, is a local affection, and that the general affection of the system, or the manifestation of other local centres of disease, is the result of a gradual infection through the blood with the tuberculous products of the centre first formed. Medicine is beginning to see its way to clearer conceptions of the conditions liable to determine the commencing of local mischief, and these conceptions indicate possible future ways of controlling phthisis, and presumably the congenerous diseases.

Rheumatism has not only an important place among the premature causes of death, but it is one of the most important causes of disablement. It is especially a disease arising from cold and damp, whether as experienced in sudden alternations or in continuous exposure. In this country the disease has peculiarly important relations with the conditions under which a large proportion of the rural population live In the rural districts the disease is probably less a question of exposure to the weather than of housing. The foster-beds of rheumatism here—as also in town districts where like conditions of housing obtain—are the too numerous cottages, and even houses of a better class, which have been built without any provision to protect them from the damp of the soil, without sufficient means of lighting and ventilation, and of which even the walls are apt to retain moisture like a sponge. Such houses—damp and chilly, often not weather-proof, incapable of being properly warmed by the biggest fire or the hottest sun, and from which the outer air is as much as possible excluded in order to keep in the buildings such warmth as may be given to them—are the foster-beds of rheumatism. And when, as too commonly happens, they are occupied by families whose means are hardly separated from destitution, rheumatism becomes one of the most important agencies in producing degeneration of race.

The *developmental diseases* (exclusive of old age), namely, atrophy and debility, premature birth, teething, childbirth, etc., have the fifth place in the order of causes of premature death. These diseases derive their generic name of developmental from their being chiefly incident to particular periods of the growth of the frame. Thus, teething includes the deaths of infants and young children which happen during the development of the first set of teeth—the milk-teeth—and for which no other cause appears to be assignable than the disturbance of the system which at times accompanies this development. Atrophy and debility include, for the most part, deaths of infants who from birth, owing to defective conditions of the digestive organs, appear to be incapable of appropriating the nourishment given to them, and waste away, or who appear to die from imperfect vitality, or who are the victims of bad management. Premature birth includes the deaths of children who have been born at a time when they were so undeveloped as to be incapable of sustaining life after birth. Childbirth includes the deaths incident to the parturient state.

But in so far as the developmental diseases affect infancy, they are in great part indications of degenerative changes of race. They are chiefly observed under conditions in which communities have been exposed, generation after generation, to states of occupation and of living which have brought about marked degradation of type in the individuals composing it. Thus, they are notably observed in those mining and manufacturing districts, and in those towns and country districts where numbers of people live who, in the best of times, earn only a bare subsistence; who earn that subsistence by prolonged labor underground, or in unwholesome workshops, and who have in their homes to herd together under conditions of filth and overcrowding which are shocking even when contemplated in the herding of brute beasts. Under circumstances such as these, great numbers of our industrial population have in course of time become stunted in body and mind, and subject to degenerative changes affecting the different parts of the system, each change marking a degradation of vitality, and not a few of these changes capable of being transmitted, together with the deteriorated frame, from parents to children.

This description refers only to one phase of degeneration of race, as it is observed in a civilized country such as England; but this phase is immeasurably the most important with reference to the public health. Degenerations of race are by no means confined to the industrial classes. Each order of life presents some form or other of them, but among the orders who live under conditions of well-being these degenerations are observed mainly as the result of pernicious habits, such as the excessive use of intoxicating liquors (not peculiar to these orders, but among them the evil influence of such excess as a degenerative agency may be more clearly distinguished and closely observed), and of certain maladies, such as the tubercular (consumption being an example), and the cancerous, of which the tendency to may be transmitted in families.

One of the most formidable consequences of these degenerations of race is observed in the great proportion of immature children born among the people subject to them, and of children actually diseased at the time of birth. The terms "premature birth," "teething," "atrophy and debility," among the developmental diseases; "convulsions" and "hydrocephalus," among diseases of the brain and nervous system: and the "wasting of infants" and "scrofula" among the general diseases, largely cover conditions of the system, tubercular or other, which are expressions of a state of degeneration. And when this degeneration has not been such as to destroy life in infancy, its results are observed in after-life, influencing or determining the incidence of numerous forms of disabling or fatal disease, while the degeneration may be propagated from parents to children through several generations.

And again, the terms above-named include also very many deaths of infants who succumb to inanition from insufficient or improper feeding, or to the form of malnutrition known as rickets. Rickets has scarcely a place among the causes of death enumerated in the Registrar-General's returns, yet it is one of the commonest sources of the fatal "wasting," the "convulsions," and the "bronchitis" of infants and young children. In fact, inanition, or, in other words, starvation, simple or in a modified form, such as results in rickets, too frequently concurs with and aggravates those degenerative changes which have been inherited by the infant; and, independently of such changes, it has a most important place among the conditions promoting the large waste of life among infants and young children.

Diseases of the Heart occupy the sixth place in the order of the causes of premature death. These diseases are, with few exceptions, the results of pre-existing morbid conditions, which would fall within other categories. Thus they are determined by scarlet-fever, by rheumatism, by gout, by syphilis, by degenerative disease of the kidneys, tubercular diseases, etc. Heart-disease is also one of the morbid conditions brought about by excessive indulgence in alcoholic drinks. Finally, the heart-disease of mid-life and advancing years is not unfrequently the result of the degeneration of tissues, prematurely manifested, which characterizes the normal degeneration of old age. It is not until after the twenty-fifth year of life that heart-disease begins to assume a prominent position as a cause of premature death, and it becomes more and more prominent in each succeeding decade until the age of seventy-five years. Very much of the fatal heart-disease of manhood and mid-life has been the slowly developed consequence of mischief in the organ determined by scarlet-fever in childhood, and rheumatic fever during adolescence. Heart-disease was credited with 288.447 deaths during the ten years 1861–70, that is to say, 6 per cent of the total mortality from all causes.

Diseases of the Digestive Organs come seventh in order as causes of premature death. Of these diseases those characterized by looseness of the bowels, the diarrhœal diseases, to wit, diarrhœa, home-bred cholera, and flux (dysentery) stand pre-eminent. The cholera, to which reference has been made before in the section on infectious diseases — malignant cholera — must not be confounded with the common cholera of this climate. We know malignant cholera in this country only as an imported disease; but the home-bred cholera, although resembling the malignant in some of its symptoms, has a wholly different history in its development. Much confusion has been caused and exists from one and the same name being commonly applied to both diseases, namely, "cholera," and it would seem as if this source of confusion could not be eradicated. At least this is the conclusion which seems inevitable from the Royal College of Physicians having retained the same name for both diseases, and sought to distinguish the one from the other by the affix of the designation "simple" to the home-bred cholera and "malignant" to the cholera of foreign origin. It is true that the diarrhœal diseases noted in this section, namely, simple cholera, diarrhœa, and dysentery, are governed in their prevalence by the like local conditions which govern the prevalence of malignant cholera, and also of enteric fever, namely, conditions of excremental pollution of air, of soil, or of water. But in the case of the home-bred cholera, ordinary diarrhœa, and bowel flux, these seem to be determined as to prevalence by the products of the common putrefaction of excremental filth at certain seasons of the year, especially in the later summer and autumn, and particularly by high ranges of temperature at these seasons. On the other hand, while malignant cholera and enteric fever equally have close relations as to prevalence with the existence of putrefying excremental filth, something else than the ordinary products of putrefying filth is needed to make the filth operate in predisposing the system to or determining an attack of either disease. This something else, the nature of which is still undetermined, but which appears to be closely, if not inseparably, connected with the discharges of the sick of the diseases, is denominated, for convenience sake, specific.

Diarrhœal disease (inclusive of common diarrhœa, simple cholera, and dysentery, but exclusive of malignant cholera and enteric fever) caused in England during the ten years 1861-70 not less than 215,823 deaths, and its local prevalence, measured by mortality, ranged from 57 (per 100,000 living) in the least unhealthy parts of the country to 195 (Yarmouth), 205 (Birmingham), and 299 (Liverpool).

If now we endeavor to bring together, in one connected view, the different conditions under which the numerous causes of premature death operate, supplying for this purpose such missing links in our detailed account as may be necessary, we shall find that, notwithstanding the great variety of causes as indicated by the large number of names of fatal diseases, these conditions admit of arrangement into three broad categories—namely, (1) as relates to the individual; (2) as relates to his nourishment and habits; (3) as relates to his surroundings.

(1) *Conditions relating to the Individual.*—Notwithstanding the brevity of the refrences which have been made to inherited vices of the body, it must have been obvious from these how immeasurably an important part these vices play in fostering premature death. Now, let it be clearly understood that in the different bodily vices to which attention has been directed—those degenerations of race which are still so largely observed among all classes of the community, but more especially and markedly among some of our mining, manufacturing, and agricultural populations—we are witnessing the effects continued through generations, and exaggerated with each generation, of unwholesome conditions of life, which still exist and are still actively operating among us. Very much of the fatal influence of these inherited vices of constitution are hidden under the names of the assigned causes of death. The medical man is called upon to register as the cause of death the more immediate morbid conditions giving rise to death, not the remoter. But very commonly the immediate conditions are but an accidental or casual indication of the remoter condition, the inherited vice of constitution. As it is, however, under the terms "atrophy and debility," "scrofula," "premature birth," "teething," "convulsions," numerous deaths of infants are recorded who have been born immature; and these constitute but a portion of deaths which originate in the immaturity and defective viability of the infant, hidden under other names. The liability to give birth to immature and non-viable children is one of the most marked characteristics of degenerated races. But the children born of these races who escape the perils of infancy are too apt to carry with them into later life the impress of their origin, with its proclivities to certain forms of fatal disease, and to succumb to affections which, although designated by some names indicative of local mischief, are in reality manifestations of an original vice of constitution. Hence, the propagation of these degenerated races holds a foremost place among the conditions which promote premature death.

(2) *Conditions relating to nourishment and habits.* — "Privation," here used in the sense of starvation, has a place among the causes of death. Thus, 82 deaths on the average were assigned annually to this cause during the 10 years 1866 75. Privation, moreover, plays an important part, as has been pointed out, in the development of typhus and of relapsing fever. But the less obvious results of privation enact even a more important part in promoting premature death than is shown by the instances cited. Privation, as destitution, is one of the most active agencies concerned in bringing about degeneration of race. It is, also, a most potent direct source of infantile mortality. Further, it exercises a powerful influence over the course of numerous diseases, diminishing the chances of recovery from these, or accelerating their fatal consequences. In various modified forms, moreover, it tells evilly on the health-condition of large sections of the population—sections even which may not be subjected to the actual pinch of poverty. Particularly in infancy and childhood the privation resulting from neglect and bad management, from insufficient or improper feeding, is the great source of rickets—the English disease, as it has been designated by foreign writers, from its believed especial prevalence in this country. Scurvy,

happily now very rare as a fatal disease in this kingdom, is a modified form of privation; so also is "purples." Other modified forms, of great practical importance, are brought about by the practice of adulteration or falsification of articles of food, which not very long ago existed so largely, and which is still not extinct. The recognition of these different forms of privation becomes an important element in the medical man's efforts to obviate the fatal consequences of certain diseases.

Then the habits of indulging in alcoholic liquors or narcotic herbs exercises a supremely momentous influence in the promotion of premature death. "Alcoholism" is credited with ten times as many deaths as "privation" in the Registrar-General's returns. Thus, an average number of 800 deaths were assigned annually to this cause during the ten years 1866–75; but of alcoholism as a cause of degeneration of race (with all its consequences), as a cause of numerous fatal diseases of the digestive and urinary organs, as sapping in innumerable ways the sources of life, with or without the help of an excessive use of tobacco and of opium, who can tell the whole story?

But while the excessive use of intoxicating liquors must be ranked with destitution in all its forms as a condition promoting premature death, it must not be forgotten that if, on the one hand, it is one of the most formidable causes of degeneration of race, on the other hand degeneration of race is one of the most potent sources of the passion for intoxicating drink. Moreover, if, again, the excessive use of intoxicating drink is a fertile source of destitution, destitution itself, on the other hand, promotes such excessive use.

3. *Conditions relating to the Individual's surroundings.* — These conditions mainly concern the air he breathes, the water he drinks, and the soil he lives upon.

(*a*) *The Air.*—This is fouled in various manners, each manner contributing, and some in a particular fashion, to the fouling. The houses we live in, from their construction or from the way in which we occupy them, are too often principal sources of pollution of the air we breathe. They may be insufficiently lighted, or insufficiently provided with means for the inlet and outlet of fresh air, and so contribute relatively or directly to overcrowding. They may be imperfectly drained and unfurnished with means for the safe disposal of excremental or other filth, so that the air within them is laden with the products of putrefying organic matter, which the drains and depositories of filth, failing of their proper functions, retain in and about them. To so large an extent does this pollution of the air of dwellings prevail—a pollution, as we have seen, which is concerned in the production of some of the most widely fatal diseases causing premature death, to wit, phthisis, malignant cholera, simple cholera, enteric fever, diarrhœa, dysentery, etc.—that we have it stated on official authority as follows:

"There are houses, there are groups of houses, there are whole villages, there are considerable sections of towns, there are even entire and not small towns, where general slovenliness in everything which relates to the removal of refuse-matters—slovenliness which, in very many cases, amounts to utter bestiality of neglect, as local habit; where within or just outside each house, or in spaces common to many houses, lies for an indefinite time, undergoing fetid decomposition, more or less of the putrefiable refuse which house-life, and some sorts of trade-life, produce: excrement of man and brute, and garbage of all sorts, and ponded slop-waters: sometimes lying bare on the common surface; sometimes unintentionally stored out of sight and recollection in drains or sewers which cannot carry them away; sometimes held in receptacles specially provided to favor accumulation, as privy-pits and other cesspools for excrement and slop-water, and so-called dust-bins receiving kitchen-refuse and other filth. And with this state of things, be it on large or on small scale, two chief sorts of danger arise: one, that volatile effluvia from the refuse pollute the surrounding air and everything which it contains; the other, that the liquid parts of the refuse pass by soakage or leakage into the surrounding soil, to mingle there, of course, in whatever water the soil yields, and in certain cases thus to occasion deadliest pollution of wells and springs. To a really immense extent, to an extent indeed which persons unpractised in sanitary inspection could scarcely find themselves able to imagine, dangers of these two sorts are prevailing throughout the length and breadth of this country, not only in their slighter degrees, but in degrees which are gross and scandalous, and very often, I repeat, truly bestial." *

As to occupation of houses: overcrowding of families therein, and the pollution of air thence arising, is an evil of very wide prevalence, giving occasion on the one hand to large development of fatal lung-disease, tubercular or other; and on the other contributing to—in some cases determining—the existence of typhus, and under all circumstances favoring the spread and fatality of the infectious diseases.

* John Simon, "Supplementary Report of Medical Officer of Privy Council and Local Government Board, 1874," p. 15.

Then there are the air-pollutions occurring in workshops in the pursuit of the different trades mentioned in a previous section, and which exercise so marked an influence in causing local excesses of prevalence of lung-disease.

(*b*) *Water.*—The most hurtful source of the pollution of water — the soakage or passage into wells and springs of decomposing organic refuse, and particularly putrefying excrement, has been noted in the previous section on Air. In so far as water is an important agency in promoting premature death, this for the most part depends upon its pollution with putrefying organic refuse, and especially excremental filth. Sicknesses arising from certain excesses of mineral matters in water do not appear, as a rule, to exercise in this country a marked influence in the promotion of premature death. The influence of water polluted with putrefying organic filth is seen in the production by it of fatal diarrhœa and dysentery, and in the propagation of enteric fever and malignant cholera. There is something inexpressibly revolting in the notion of persons and communities drinking water mingled with their own excrement, and yet it is one of the commonest facts of every-day life in this country; and in addition, as we now know, excrement-polluted water is not rarely given to our infants and young children mingled with the milk on which they are fed.

(*c*) *Soil.*—The part of the soil in the promotion of premature death is as a source of pollution of the air we breathe and of the water we drink. The soil is the great laboratory in which the great mass of solid and liquid filth of those who live upon it undergoes its final decomposition and resolution into harmless elements. But when this soil becomes surcharged with filth, its wholesome action ceases, and the changes which the filth undergoes within it commonly stop short at a period when its products are harmful to those living upon it. These products are taken up by the water in the soil and carried into the springs and wells, and they are also given off into the air above the soil by the movements of the air within the soil outward, as it is influenced by the varying level of the subsoil water, by variations of pressure in the atmosphere, and by other circumstances which go to bring about the breathing, so to say, of the subsoil.

The atmosphere in its general aspects must be included among the surroundings of the individual active in some of their phases as a source of disease. But this action as represented in vicissitudes of weather and its relations to season may be regarded as uniform in its operation over large districts or over an entire country; and until the operation of locally existing fostering causes of fatal disease can be eliminated we shall be unable to discriminate the precise part which atmospheric changes play among the conditions under which the causes of premature death operate.

NOTE A.

LONGEVITY OF THE PATRIARCHS AND IN ANCIENT TIMES.

THE remarks in the text do not of course apply to the cases of extraordinary longevity recorded in the Old Testament Scriptures. Before the flood men are said to have lived five and even nine hundred years; and, as a physiologist, I can assert positively that there is no fact reached by science to contradict or render this improbable. It is more difficult, on *scientific* grounds, to explain why men die at all, than to believe in the duration of life for one thousand years. Only from experience do we learn that all men in the past have died: we *infer* all now, or in future, living will die. Accurate vaticination however, from past experience has its limits. The subject belongs to history, not to anatomy or physiology.

The expression (Gen. 6 : 3), "his days shall be an hundred and twenty years," has been thought to mean that this should be the extreme duration of life; others think it meant the average. Judging of the meaning by subsequent facts, the latter appears to be the correct interpretation. Of the instances recorded, two explanations are admissible: 1st, They were miraculous; or, 2d. The duration of human life may vary in the lapse of ages. We have many indications that this really occurs. Abraham lived one hundred and sixty-five years. Joshua, five hundred years later, is repeatedly called very old. He died at one hundred and ten. An inscription on an Egyptian monument states the extreme duration of life in that country to be one hundred and ten. This was the age of Joseph. The coincidence is remarkable. In the time of David a man of eighty was regarded as very old. The great prophet king himself reached only seventy-five. In the 90th Psalm, by all critics attributed to Moses, it is said, verse 10, "The days of our years are threescore years and ten; and if by reason of strength they be fourscore years, yet is their strength labor and sorrow." If we admit the meaning of this to be, that at and after the time of Moses, the *average* duration of human life was seventy, we are in accord with science and history. At the period of the Roman Empire the average duration of life was very low. We have no precise data respecting it in the middle ages; but indications are not few that it then touched its lowest ebb. Seventy was considered a great age, which few attained. We are, however, now sure that the average has, in modern times, greatly increased. Whether the extreme limit of life has fluctuated or not, we do not know. The average has certainly changed, perhaps alternately advancing and declining. It is obvious that the average may increase either by fewer persons dying young, or more living long. In 1871 nearly one half the children born in this country died within five years. This greatly affects the numerical average, and we may safely conclude there is a considerable increase in the number of those who reach a good old age.

We might, *à priori*, have expected that in the lapse of time since the creation of man, the decline in the vigor and duration of life would have been uniform; but it is not so. And in this lies the ground and encouragement for our endeavors to ameliorate the condition of humanity by promoting the enjoyment of longevity.

NOTE B.

ON HUMAN LONGEVITY AND THE AMOUNT OF LIFE UPON THE GLOBE, BY P. FLOURENS, SECRETARY TO THE ACADEMY OF SCIENCES, PARIS. TRANSLATED BY CHARLES MARTEL. 8VO, BALLIERE.

This volume, containing Flourens's theory, described in the text, is somewhat loose and discursive. What there is of interest in it is comprised in a few sentences !

"This question," he says—*i.e.*, the normal duration of human life—"may be treated in two ways, as Haller and Buffon have done—historically or physiologically. They sought historically what the natural, ordinary, and normal term of the life of man is ; and they placed it between ninety and a hundred years. They afterward sought, still historically, to learn what is the extreme limit of human life ; and Haller has placed it at a little less than two centuries.

"Haller collected a thousand cases of longevity, accepting the popular stories. He thought the case of old Parr, said to have died at the age of one hundred and fifty-two, proved by the fact of Harvey having dissected his body ; but this, we know, proves nothing. Harvey, as to Parr's age, only reports what he has been told.

"Buffon suggested that the total duration of life might be measured by the period of growth. He failed to ascertain the length of this period.

"I find the sign which indicates the term of growth," says Flourens, "in the union of the bones with their epiphyses (soft extremities). As long as the bones are not united to their epiphyses the animal grows ; when once they are united the animal grows no more.

"In man the union of the bones and the epiphyses is effected at twenty years of age.

					Duration of Life.
"In the camel it takes place at				8 years.	about 40
"	horse	"	"	5 "	25
"	ox	"	"	4 "	20
"	dog	"	"	3 "	10 to 12
"	cat	"	"	18 months.	9 to 10

"Buffon says every animal lives six or seven times as long as the period of its growth. He was near the truth. The true relation is five, or very nearly.

"Man, being twenty years growing, lives five times twenty ; that is to say, one hundred yea

Flourens confines his observations to the mammalia. But in order, as it would seem, to reconcile his conclusions with Haller's assumed historical facts, he proceeds to say that extraordinary life may go on to double ordinary life. That a century of ordinary life, and almost a second century, half a century at least, of extraordinary life, is the prospect science holds out to man.

We adopt the opinion in the text, that the historical evidence up to the present time fails in proof of any person's having reached even one hundred and five years.

Note C.

POPULAR ERRORS RESPECTING LONGEVITY.

Sir Henry Holland, whose recent decease has given great currency to his writings at the present time, has, in an essay on longevity, the following passage :

"We have sufficient proof of the frequent prolongation of human life to periods of one hundred and ten to one hundred and thirty or one hundred and forty years ; cases which, thus authenticated, we must take into view when dealing with the question of human longevity."

Mr. Thoms quotes this passage, and remarks that any evidence which can be produced of any human being having attained the age, not of one hundred and thirty or one hundred and forty, but of one hundred and ten years, will be found upon examination to be perfectly worthless.

Sir Henry Holland had evidently no reliable evidence whatever to produce : he merely expressed a popular belief. The newspapers, and even the medical press, are constantly inserting accounts of persons dying at fabulous ages, without the slightest inquiry or proof ; and Mr. Thoms rebukes what he calls the childlike faith of men eminent in the medical profession in accepting such stories as true, while they ostentatiously proclaim their scepticism respecting the origin of man, and other well-established facts. This disposition to embrace and hold fast sensational errors, and to reject simple truth, is not confined to medical men.

We cannot, however, be surprised at finding popular opinion formed and held without evidence when we read in *The Times* such paragraphs as this :

"LONGEVITY.—The report recently issued by the Registrar-General, relating to the year 1871, contained further testimony on the subject of long life. In 1871 the following deaths were registered in England, the ages (like other particulars) being taken on the statement of the relatives or other persons supplying information of the death. There were twenty-seven persons registered as dying at the age of one hundred years, seventeen at one hundred and one, ten at one hundred and two, five at one hundred and three, three at one hundred and four, two at one hundred and five, two at one hundred and six, one at one hundred and seven, one at one hundred and eight, one at one hundred and nine years. The last three should have special mention : a man in the district of Sevenoaks was registered as dying one hundred and seven years old ; a man in the district of Ledbury, one hundred and eight ; a woman in the district of Chester, one hundred and nine years old. Seven centenarians died in the Metropolis, and seven in Lancashire. Of the whole sixty-nine, twenty-five were men and forty-four were women. From 1861 to 1871 the deaths of people registered as being one hundred years old or more averaged seventy-eight a year ; twenty-one men and fifty-seven women. The Registrar-General mentions, as the only known instance of an insured life reaching one hundred years, that of Jacob William Luning, who died in 1870 at the age of one hundred and three years. His age was clearly established by documentary evidence submitted to the Registrar-General, and published by him in his weekly return."

Another popular error, very prevalent, is that cold, and even frost, is congenial to life and health. There is a proverb, "A green yule (*i.e.* Christmas) makes a fat churchyard." The registration of deaths directly contradicts this opinion. Cold, frosty weather destroys many lives, which might have lasted for years were the weather continuously mild.

Note D.

WASTE OF HUMAN LIFE.

In one of his annual reports, the Registrar-General says : "England is a great country, and has done great deeds. It has encountered in succession, and at times in combination, all the great powers of Europe ; has founded vast colonies in America, and has conquered an empire in Asia. Yet greater victories have to be achieved at home. Within the shores of these islands the twenty-eight millions of people dwell who have not only supplied her armies and set her fleets in motion, but have manufactured innumerable products, and are employed in the investigation of scientific truths, and the creation of works of inestimable value to the human race. These people do not live out half their days. A *hundred and forty thousand* of them die every year unnatural deaths ; *two hundred and eighty thousand* are constantly suffering from actual diseases which may be prevented. Their strength is impaired in a thousand ways ; their affections and intellects are disturbed, deranged, and dimmed. Who will deliver the nation from these terrible enemies ? Who will confer on the inhabitants of the United Kingdom the blessings of health and long life ?" In a subsequent paper the Registrar-General tells us there are "two thousand medical men in the metropolis alone engaged in treating existing diseases ; while very few, if any, bestow any attention on measures of prevention, the reason being that they are paid in one case, but would find no remuneration in the other." Perfectly true : even the rich neglect the first attacks of disease from reluctance to pay the physician's fee. The services of the general practitioner are paid for in the shape of a bill for medicines : can anything be more impolitic ?

A sensible course would be to pay the physician an annual stipend for visiting the household periodically —to advise measures of prevention, and afford immediate aid on the first appearance of disturbed health, whether of the family or domestics. More attention would then be given to hygiene. It is not enough to appoint public officers of health : although this is highly proper and useful, it can never safely exclude individual efforts.

Note E.

MORAL AND RELIGIOUS ASPECTS OF LONGEVITY.

The influence of age on the mental faculties, the moral and religious aspects of longevity, do not come within my design. Writers of all ages, heathen and Christian, have treated on the subject—Cicero, Seneca, Cornaro, Sir Thomas Brown, Sir Thomas Bernard, Sir Henry Holland, Lord Brougham, Mr. James Grant.

and many others.

The following is profoundly interesting and suggestive:

"It is related of the late Lord Lyndhurst, so long Lord Chancellor of England, who reached the age of ninety-two in the full possession of his faculties, that in his declining years it was with him a perpetual theme of gratitude to God that his life had been so extended as to enable him to make preparation for death, in which he was earnest and incessant. He applied, says a friend, all the power of his marvellous intellect and all his apprehensive quickness to the study of religion. And through its influences his natural kindliness and loving disposition were refined into the highest Christian graces—true humility, hearty repentance, serene and earnest hope. He died in peace and charity with all mankind, his last words expressing supreme happiness."

I cannot refrain from making one remark, the result of long observation, for the benefit of those who have attained to an advanced age and are blessed with wealth. It is, that money, be it much or little, given to relatives as their needs occur, to charitable institutions or religious uses during the life of the donor, is far more beneficial, morally and materially, both to the recipient and the giver, than double, or rather many times the amount devised by will.

Note F.

IMPORTANCE OF EARLY TREATMENT OF DISORDERS.

The following remarks, derived from a paper in the *Lancet* of September 9th. 1874, are well worthy of the attention of all persons past middle age who are desirous of a long life.

"Increased knowledge of the nature of morbid processes, and of the causes of disease, has naturally been accompanied by an ability to recognize the presence of many maladies much earlier in their history than was formerly possible. Diseases which, a generation back, were only suspected when their grasp upon the sufferer was firmly fixed, can now be detected in their insidious onset. To this we must ascribe a large proportion of the increased power which we possess of combating disease. Morbid tendencies are manageable when morbid states are not; and morbid processes can often be checked in their early stage, which, when more advanced, baffle all attempts at arrest or limitation.

"Over some affections, even in their commencement, we are all but powerless. In the case of others, moreover, almost all the good we can effect depends on the date at which we are able to detect the presence of the disease. If early, we can do much; if late, little or nothing. And when, in these instances, we have an early opportunity of grappling with the morbid process and fail to do good, our failures may often be traced to the fact that our treatment, medicinal, hygienic, climatic, was not sufficiently energetic, and that the patient was allowed to remain in the state or circumstances in which his disease originated, until it had taken a hold too firm to be dislodged, until irreparable damage had been done.

"The failure of early treatment in many diseases is not always to be ascribed to the essentially dangerous character of the malady. It is unquestionably due, not unfrequently, much more to the character of the patient than to that of the disease. The patient, from carelessness, from incredulity, often throws away his chances. The early symptoms of trifling and of severe maladies are so often apparently identical that it is difficult to convince patients of the gravity of symptoms which to them seem insignificant—to make them believe how much depends on abstinence from what appears to be innocuous, or on the performance of that which seems to them unnecessary. The very benefit derived from early and cautious measures in one case may frustrate the attempt to enforce them in another. A robust return from a sea-voyage, for instance, may be held to prove how superfluous it was; and the practitioner has thus to contend against his own success."

It is indeed not uncommon for a patient, whose life has been saved by prompt and skilful measures, to treat the matter lightly, and assume that the alleged danger was only a pretence of his doctor, or existed only in his imagination. So long as the present method of payment for professional services is maintained, the public will not obtain the full benefit of medical science. The physician should be engaged to protect the household and individuals from the assaults of disease, to detect and meet the first and very slightest indications of disorder; and thus we shall certainly see life prolonged in large classes of the community.

Note G.

THE BONES OF OLD PEOPLE BRITTLE.

So little has the condition of the system in elderly people been investigated scientifically, that it is almost universally believed that the brittleness of the bones in age arises from a redundancy of earthy matter. This will be found stated in many books as if it had ever been ascertained. The simple truth is, it is a false inference from the fact that earthy concretions are often met with around the joints, in the blood vessels about the heart, and other parts, which are then said to be ossified.

On the sure ground of chemical analysis, we know that the bones of aged persons have less earthy matter in them than in earlier life.

The following is the average of several analyses:

	Earthy Material.
Neck of thigh-bone of aged persons.	31 3
" " middle-aged persons.	50·1
Shaft of thigh-bone of aged persons.........	53·3
" " middle-aged persons.	56·7

Note H.

CONDITION OF VERY OLD PEOPLE.

In a paper read at a meeting of the Anthropological Institute by Sir G. Duncan Gibb, Bart., M.D., there is an interesting account of the physical and mental condition of several persons living beyond the age of one hundred. The author had taken much pains and trouble to discover and examine these old people. As we might anticipate, he found that, with the external physiognomy of extreme age, their several organs retained sufficient integrity and vigor for the maintenance of life: their circulation, respiration, and digestion were healthy. Sir Duncan Gibb assumes that their original constitution must have been good, and that no important part had received in early life any considerable damage from disease or accident. And, what is most interesting, the mental faculties and senses were in the main well preserved; thus proving that the brain and nervous system do not necessarily degenerate by lapse of time.

It was not Sir Duncan Gibb's purpose to treat of such means as may be resorted to for prolonging life; but, in a few incidental remarks touching on this subject, his views exactly coincide with my own.

Note I.

105 YEARS THE EXTREME LIMIT OF HUMAN LIFE.

Mr. E. Fairfax Taylor, in an article in the *Contemporary Review*, September, 1874, entitled "Longevity in a New Light," treats historically and critically the question, What is the extreme limit to which human life has reached? Mr. Taylor recognizes the judicial candor and arduous labor of Mr. Thoms, admitting that all previous writers on the subject had no evidence of any value in support of their statements. Whatever presumption or hope there may be of finding an individual whose life has exceeded one hundred and five years, no such case has hitherto been proven.

Note J.

A CASE OF RECUPERATION.

A remarkable instance of the force of recuperative power in aged persons is afforded by Pope Pius IX. In April, 1873, the pontiff, to all appearance, had barely a few months, or indeed a few weeks, to live. His limbs were so swollen he could no longer stir; he had ceased to say mass; and the doctors, when they came to see him in the morning, were always under the apprehension of finding him dead.

In April, 1874, he is thus described: "He appears to be rejuvenized, as if he had gone back into his better days by a quarter of a century. His bearing is upright and almost youthful, his cheeks are rosy, his eyes bright, and voice sonorous. His appetite is very good. He takes long walks, fast and briskly, without the aid of a stick, is in joyous spirits, and his conversation sparkles with quips and jokes. The Pope's age in 1874 is 82."

I have seen many similar cases, and no doubt almost every physician whose practice has extended over many years must have witnessed the same.

Note K.

ON THE WATER USED IN COUNTRY TOWNS.

Waters derived from the chalk formations are hard. They often contain from sixteen to eighteen grains of carbonate of lime to a gallon (degrees of hardness).

From the greensand and the new red sandstone are the softest of those derived from deep sources.

Waters of mountainous countries are the softest of natural waters, being of four or five degrees of hardness only. But they are apt to contain much organic matter, and are often tinged with the color of the herbage. Except in appearance, such waters are best for washing, brewing, etc.; while the hard and aërated waters are more sparkling, fresh, and agreeable to the taste.

Reservoirs should be deep—that is, from eighteen to twenty feet—and in two parts, to allow of cleaning without interrupting the supply. When exposed to dust or falling leaves they should be covered (but not so as to exclude a free access of air). In shallow reservoirs confervaceæ and animalculæ are generated.

The softer waters act most on iron pipes and reservoirs. There is a composition for lining them, invented by Dr. Angus Smith, which prevents this action.

Waters containing organic impurities in which carbonic acid is generated act most on lead. Lead is got rid of by placing a piece of zinc in the cistern, and filtration.

The best mode of filtration is through sand and gravel, taking care these are not too fine, and are free from iron. Charcoal filters are apt to get soon clogged.—*From a paper in the Builder, by E. B. Grantham, Esq., C.E.*

N.B. Great care should be taken that no drains, cesspools, or other sources of impurity exist near wells or reservoirs. Very bright sparkling and cool water, when not from a bed of chalk or limestone, may be dangerously impure.

There was a well in or near Berkeley Square celebrated for the coolness, brilliancy, and sparkling of its water. The pump was resorted to by all the neighborhood to supply the table. Faraday found in the water nitrate of potash and abundance of free carbonic acid, which he said were derived from the decomposition of organic matter in an adjacent sewer. During the prevalence of cholera such water is highly dangerous. A late eminent surgeon who prided himself on the water which supplied his country house, and his method of filtering, fell a victim to his mistake. The lesson taught by the outbreak of cholera about the well in Broad Street, Golden Square, ought never to be forgotten.

Note L.

PURE AËRATED WATER.

There is a company at Newcastle-on-Tyne which prepares pure distilled water, and aërates it, so as to remove the objectionable insipidity, thus rendering it suitable for the table, and the preparation of viands, tea, etc. It is sent out in bottles or casks. "Pure Water Co., 8 Clayton Street, Newcastle-on-Tyne."

Note M.

ANTICIPATIONS.

The remedies we already possess for many diseases have a history calculated to inspire hope that, at some not very distant period, means will be found to arrest with certainty the ravages of time upon the human constitution, and to carry on life full of vigor to its utmost limits. Concerted efforts, such as have built up the noble science of chemistry, have never been instituted for the discovery of remedies. Mere chance or individual zeal has hitherto been their source, and a comparatively short time has produced the present science of healing. A few examples will illustrate these remarks.

Peruvian bark was introduced into Europe about three hundred years ago, a cure for intermittent fever. Little more than fifty years have elapsed since the crystalline constituents of this bark were first separated. Quinine, etc., are now employed in every country in the world, and save innumerable lives.

Vaccination has been known and practised scarcely one hundred years. Many persons now living have heard from their fathers of the deadly ravages of small-pox in their days.

These two are the only remedies, excepting general sanitary measures, which have received the attention of Government. The law enforcing vaccination, the cultivation of the tree producing quinine, are very recent recognitions of the importance of the subject to the well-being of communities.

It would well become an enlightened government to take cognizance of another fact recently ascertained. In some localities, in India, in Africa, and in other countries, quinine is by no means infallible; but, when it fails, another crystalline product derived from a common tree growing abundantly at our doors is successful. Commerce often precedes science as well as national policy, and enormous quantities of salicine are made and sold, not merely as a cheap substitute for quinine, but inasmuch as it is in those localities found to be more efficient. Were this recognized, how much money and how many valuable lives would it save the country? It is doubtful whether it is known by the medical men now with our army on the Gold Coast.

Fever, that mysterious disease so destructive to life (*i.e.* continued fever), is treated with great skill and energy on what are called general principles, and many lives are thus saved. Yet when we consider that fevers are always the result of poisons, for there are several without doubt, we feel surprised that an antidote, a remedy which will counteract the poison and cut short the disease, is not only not known, but not sought for. The Prince of Wales, the Imperial Prince of Germany, and the eldest son of the Czar, have all recently passed through all the stages of fever, happily with life; yet how striking a proof do these cases afford of our ignorance of an antidote for continued fever, corresponding to the known remedy for intermittent. Would that I could do more than offer a suggestion to those who have to deal with fever; but I would suggest—

1. That antimony has had a reputation for possessing the desired power for ages, some preparations or salts of this metal more than others. There is one, however, never hitherto tried so far as I know, which, judging from analogy, ought to possess the febrifuge power of the antimony in a very high degree. I allude to stibethyl oxide $Sb(C_2H_5)_3O$, a basic substance forming salts with acids, among which remedies of great power may probably be discovered.

2. The American eclectic physicians, whose contributions to our list of remedies have been most valuable, confidently state that the plant *Gelseminum sempervirens* will arrest and cure fever at its earliest stage. I am aware of the odium attaching to what is termed a search for specifics; but I am willing to incur it, since I am sure it is by the study of the special properties of remedies on the body in disease, rather than by general principles, the art of healing will henceforth be advanced.

Some years ago a writer in the *Quarterly Review* said it would be a great boon to humanity were a substitute for mercury and its salts discovered, having similar powers but entirely innocuous. This, as I have shown, we now possess in podophyllin.

That valuable agent for producing sleep, hydrate of chloral, only came into use in 1860. This property of chloral was discovered by Dr. Liebreicht, a German physician, who finding in the laboratory that, when hydrate of chloral is subjected to the action of caustic potash, it is decomposed, and evolves chloroform, conceived the idea that if taken into the animal body it would be decomposed very slowly by the potash existing in the flesh juices, and the nascent chloroform would produce anæsthesia. This hypothesis proved to be unfounded, but his experiments led to the discovery of its soporific action.

A dentist in America, in 1844, discovered the anæsthetic power of ether when inhaled. Sir James Simpson, seeking for a more convenient substance for rendering the body insensible to pain under operations, found one in chloroform.

Nitrous oxide, or laughing-gas, was experimented upon by Davy in the laboratory of Dr. Beddoes at Bristol; and in the year 1800 he wrote, "As nitrous oxide in its extensive operation appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place." It was only in 1868 that it was brought into practical use as an anæsthetic in extracting teeth.

The same Dr. Beddoes saw accidentally the cure of consumption in a family by arsenic. This hint seems to have been entirely disregarded by the profession, probably from the conventional aversion to specifics; although it was noticed by Dr. Thomas Young, in an historical work on consumption. It did not meet my eye until some time after I had employed arsenic in consumptive cases with marked success. I was led to it by a view I took of the disease founded upon a chemical examination of tubercle. My observations were published in a small work, in 1856, by Churchill & Sons. Even yet this remedy is almost, if not entirely, disregarded by the profession in this country, although several eminent French physicians have adopted it, and testified to its efficacy. I have the pleasure of seeing many persons still living, and in the enjoyment of health, who many years ago were pronounced to be consumptive and their lives despaired of.

Prof. Lister's valuable discovery of the use of carbolic acid for healing wounds and preventing the fatal spread of purulent matter into the system (pyæmia) must not be forgotten in this connection.

While these pages were passing through the press, some extraordinary properties of an Australian tree were announced in *The Times* and other papers, and seem to have attracted much attention. This tree, the *Eucalyptus globulus*, is said to have the power of destroying malaria in its vicinity, and thus rendering localities where it abounds healthy, which otherwise would be highly destructive of human life.

Experiments have been made on a large scale by planting this tree by thousands in Africa, at the Cape, and in Algeria, in places previously most fatal by reason of fevers, and scarcely habitable, and the result has been highly satisfactory. The tree is of very rapid growth, absorbs water in great proportion, and thus dries up marshy places, rendering them susceptible of cultivation, and the whole neighborhood healthy.

These remarks are intended to justify the anticipation I venture to express at the head of this note. In the vegetable kingdom, in the products of the chemical laboratory, we have not thousands, but millions, of substances unstudied and untried. Will any one venture to say what may or may not be discovered to affect human life?

It is curious to observe the variety, both as to their source and nature, of the remedies we already know.

From the depths of the forest in South America, from the roadside in North America, from Australia (a country only known to Europe about one hundred years), from the mineral kingdom, from the new bodies formed by bringing together elements never found united in nature—from all these sources do we derive the means we daily use for relieving suffering and restoring life.

What will the knowledge and power of the next and succeeding generations be?

Note N.

ADULTERATION OF FOOD, ITS EFFECTS ON HUMAN LIFE—WINE.

If it be admitted (and there can scarcely be a doubt on the matter) that adulteration of our food and drink is injurious to the constitution, then we must expect it to tell with most force on persons who have passed middle life. When the daily injury is too slight for observation, its repetition for years, the cumulative effects of even weak poisons, may become very serious. We find many diseases the origin or cause of which is obscure; we deem them to have arisen spontaneously; but if we could ascertain with accuracy what substances had been introduced with the food habitually, we might be able to assign them to some slow poison.

In or about the year 1820 a Mr. Accum, a chemist, wrote a book on the prevalence of adulteration in food, drinks, and medicines. Its title-page bore the significant motto from Scripture, "There is death in the pot." This publication excited great attention. Its facts could not be denied; but it was made the occasion of much amusement, and the reviewers expended their wit upon the subject. Yet it was no laughing matter. Fifty years passed before the legislature dealt with the question; but at last, through the steady perseverance of Mr. Scholefield, the act against adulteration was passed. Under this act, inspectors are appointed, and magistrates punish its infringements. The inspectors are doubtless able and vigilant; but this should by no means supersede the personal care of every person having regard to his own health or that of his family. Commercial men have elastic consciences, and even now they defend many sophistications which they allege are harmless. Selling chicory for coffee, potato starch for arrowroot, compounding mustard with flour, turmeric, and pepper. These and the like practices are strenuously defended as being harmless. But when pickles are colored with verdigris, and cayenne with red lead, etc., they will admit the wrong.

Adulterations and substitutions of cheaper for expensive articles extend to drugs and chemicals—all we eat, drink, or swallow for any purpose.

The foreign producer pursues the same course, with even more dangerous consequences. Tea, sugar, wines, spirits, all demand vigilance.

Some years ago a patent was taken for a method of refining sugar. When cane-juice is to be evaporated, or when the color and impurities are to be removed, the presence of an acid interferes with the process, and requires to be neutralized. This is usually done by means of lime. The patent in question was for the employment of a basic salt of lead, and this was found to cause the product, the refined sugar, to be so greatly increased in quantity that the patent was valued at eighty thousand pounds. The sugar thus made was subjected to examination by the most eminent chemists of the time, including, I believe, Faraday, Brande, and Daniel; and they certified that it contained no trace of lead. In fact, analytical chemistry at that time was at a very low ebb; the attention of these eminent professors having been directed to physics, in which brilliant discoveries were of frequent occurrence. The Government, or rather, I believe I may say, Lord Palmerston, was not satisfied. Dr. Ure was consulted; and, with his usual acumen, he apprehended that the lead might exist in organic combination with the elements of the sugar, and consequently not manifest itself to ordinary tests. Acting upon this, it was discovered that the sugar contained a considerable portion of lead. We owe it to the firmness of Lord Palmerston, who went a little beyond the law, forbidding the use of lead in this country and our colonies, and using his influence with foreign governments to prevent it wherever sugar is grown or refined, that we escaped this active cause of disease. Let me commend to the attention of the inspectors, sugars, especially the whiter sorts; it being very possible that lead may still be furtively employed in the manufacture in foreign countries.

Need I add how dreadful are the effects of lead when accumulated in the living body? No disease is more distressing than paralysis—its usual result.

While adulteration of solid articles of food is easily detected, wines and spirits present some difficulty.

In "Familiar Letters on Chemistry," which I edited for Liebig, it is related that the bulk of German (and probably French) wines are made thus: After the grape-juice is fermented, and the resulting wine drawn off from the residue—*i.e.* the "must"—starch, sugar, cream of tartar, and an amount of water equal to the wine drawn off are added, and subjected to fermentation. This delightful stuff is so far wine as it is flavored by the "must" or dregs left after making the real wine.

Again: In *The Times* of Dec. 10th, 1873, there is a leading article, giving an account of the sherry drank so largely in this country. As my purpose is a serious one—the causes of premature loss of life—I make no apology for this long note.

"The correspondence which we have lately published, on the manufacture of the liquid sold in this country under the name of 'sherry,' seems calculated to shake even the robust faith of the British householder in the merits of his favorite beverage. The correspondence had its origin in the fate of an unfortunate gentleman, who was found, by the verdict of a coroner's jury, to have died from an overdose of alchohol, taken in four gills of sherry; and, as it proceeded, it gradually unfolded some of the mysteries of the processes by which the product called sherry is obtained. In the first place, it seems that the grapes, before being trodden and pressed, are dusted over with a large quantity of plaster of Paris (sulphate of lime), an addition which removes the tartaric and malic acids from the juice, and leaves sulphuric acid in their stead; so that the 'must' contains none of the bitartrate of potash, which is the natural salt of wine, but sulphate of potash instead, usually in the proportion of about two ounces to a gallon. Besides this, the common varieties of 'must' receive an additional pound of sulphuric acid to each butt, by being impregnated with the fumes of five ounces of burning sulphur. When fermentation is complete, the wine may contain from a minimum of about fourteen to a *maximum* of twenty-seven five tenths per cent of proof-spirit; but it is not yet in a state to satisfy the demands of the English market, neither can it be trusted to travel without undergoing secondary fermentation or other changes. It is therefore treated with a variety of ingredients to impart color, sweetness, and flavor; and it receives an addition of sufficient brandy to raise the alcoholic strength of the mixture to thirty-five per cent as a *minimum*, or in some cases to as much as fifty-nine per cent of proof-spirit. When all this has been done, it is shipped in the wood for England, where it is either bottled as 'pure' wine, or is subjected to such further sophistications as the ingenuity of dealers may suggest."

The article goes on to observe that the venders of this precious stuff escape the Adulteration Act by calling it, not "wine," but "sherry," and explaining how and with what materials it is compounded, adding:

"The general result is, that what many people purchase and use as wine is simply a rather strong grog, with an admixture of flavoring matters, and containing a very appreciable quantity of sulphuric acid, a substance which is known in commerce as oil of vitriol, and which, when used in medicine, is administered in small and carefully-considered doses." "What we have described as 'sherry' is, it must be remembered, the best of the many compounds bearing that name which are offered to the public. Besides this, there are thousands of butts manufactured yearly at Cette, at Hamburg, and at various places on the Elbe, which contain no Spanish wine at all, probably no wine of any kind, and which consist only of alcohol, water, and chemical flavoring. These 'sherries' are stronger than any which come from Spain; and they are largely used in this country, not only in 'refreshment-bars' and public houses, but also as a cheap form of diluent for alcohol, by the manufacturers of whiskey and brandy. The liquids sold under these names, even when they have been sent to France and reimported as Cognac, consist in great measure of Hamburg 'sherry,' fortified by the addition of more alcohol."

Surely it would not exceed the duty of a government which has done so much to protect the population from disease by enforcing sanitary regulations—drainage, house-cleaning, etc.—to interfere vigorously, and repress the abominable traffic.

It is quite clear that those persons who desire to enjoy a long life, and escape the disorders of age, must carefully eschew such drinks. As, however, I must admit that some form of stimulant is not merely desirable but essential to life and comfort of many elderly persons, it become an important question, how a wholesome substitute for wines and the spirituous liquors met with in commerce can be obtained.

NOTE O.

CASES OF PROLONGED LIFE.

During my professional career my aged patients have always been objects of special interest to me. I have had many whom I have watched for years. The cases of three or four will illustrate some of the remarks in the text.

1. I visited daily, or nearly so, the widow of an eminent judge. She was a woman of a cheerful temper and general good health, but she had the failing of indulging in eating; and, having usually a good appetite, she was not careful whether her food was suitable or not. The consequence was frequent attacks of indigestion, requiring measures of relief. She reached the age of eighty-nine, but fell a victim to this error. During an attack of influenza, which often affects the stomach and weakens its digestive power, I called upon her at her dinner-hour, and found her eating food which had been strictly prohibited. She thought it a good joke, and called my attention to her disobedience, going on eating, and laughing at my remonstrances. The result was a state of coma, from which the means used only partially roused her, and it proved fatal.

*** The late Duke of Wellington died in a comatose state, induced by a heavy meal of hashed venison taken with an unusually keen appetite.

2. A gentleman, upward of eighty, was suffering most acutely from irritable bladder. Repeated examinations by experienced surgeons proved the non-existence of calculus, yet the ordinary remedies failed to afford relief. "You are an old man, and must expect such troubles," was the remark of one whose prescription had also failed. This gave great offence. I suggested the habitual use of laudanum, instead of wine and spirits. This was adopted; and beginning with twenty drops three times in twenty-four hours, complete relief was obtained. It could never be relinquished; but the usual necessity for increasing the dose did not extend beyond forty drops at a time. The patient thought he had in the laudanum an elixir which would extend his life to near one hundred, and often expressed this opinion. When nearly ninety some family troubles greatly agitated his mind. He had maintained a habit of taking hot baths weekly. In this state of brain I strongly advised its discontinuance, and the substitution of washing without immersion. After a warm discussion on the subject, one day he went to a bath without my knowledge. The result was he became insensible. The brain is deprived for a moment of most of its blood by immersing the body in hot water; when enfeebled, its vessels collapse, and do not fill again properly. He died comatose. I regarded it as much an accidental death as if it had resulted from violence.

3. I was called to an old lady in violent convulsions and total mental insensibility. I spent a whole night employing the usual remedies and appliances, and directing her attendants. It required three or four to keep her on the bed. After much anxious consideration, I resolved to disregard all fashionable theories and timid practice, and to have recourse to blood-letting. Opening a vein in the arm, the blood soon flowed vigorously, the pulse underwent a favorable change, the convulsions ceased, and the first impression was decidedly favorable.

It was six days before mental consciousness returned, with slighter convulsions at intervals, and another bleeding of less amount than at first. The patient recovered, and is now living, a valuable life, at the age of eighty-five.

*** I relate this case because I am sure it is not wise to resign ourselves to the bondage of fashion, or to reject altogether the experience of our forefathers. So entirely is bleeding abandoned as a remedy that it would be difficult, if not impossible, to find a medical man of the present generation who has even seen the operation. I admit its abuse formerly, but its neglect now often sacrifices life.

4. A short time ago I witnessed the decease of a lady aged eighty-four, one of a few cases falling under my notice where a gradual failure of the bodily strength, painless fading away without disease, proved it to be simply from age.

This lady in early life had endured great mental troubles—had lost her husband, and was left almost destitute. In middle age she had repeated attacks of acute inflammation of the liver and bowels, for the treatment of which, as was then customary, she had been repeatedly and copiously bled. The quantity of blood she lost would appear fabulous to any one not conversant with the old practice. After one of these attacks she came under my care, and continued so until her death. As she grew older she became more and more vigorous. She married a second time after she had passed sixty, and lived an active and valuable life, obtaining a comfortable competency for herself and her relatives mainly by her own exertions. Her mind was clear and acute to the last. How it was that patients endured the extraction of thirty to sixty ounces of blood in a few days, and had this repeated in successive attacks without abridging life, would be difficult to explain.

*** In "The Greville Memoirs" we are told that George IV., immediately after his accession to the throne, had a "*bad cold*;" and he was considered to be in great danger, at Brighton, for which he lost eighty ounces of blood. "Sir Henry Halford went to see him, and left orders with Knighton not to take any more blood from the patient. He got worse; and Sir M. Tierney was called in, and took fifty ounces of blood from him, and the next day twenty ounces." The king died ten years after, aged sixty-eight.

NOTE P.

APPLIANCES USEFUL TO AGED PERSONS FOR PROMPT RELIEF OF SUFFERING.

The following ought to be kept at hand by all persons of advanced age:

1. An Etna, with a bottle of pure spirits of wine, for obtaining boiling water in a few minutes.

2. Tin vessels for applying hot water, (1) to the feet, (2) to the chest or abdomen. This should be the common rounded stomach-warmer.

N.B. India-rubber bottles are not so useful, and in other respects they are objectionable.

3. Two or three enema apparatus, of different kinds and modes of action.

4. An Inhaler. The one known as the Eclectic is the best. Many kinds are sold; some useless, or worse.

5. A small Woulfe's bottle, for inhaling ethers, etc.

6. An apparatus for administering a Hot Vapor or Air Bath to the patient when in bed.

7. An open Slipper Bath. This may be used for the hot water when applied with soap and flannel.

All medicines can readily be obtained in towns from the dispensing druggists; but in the country should be kept castor-oil, magnesia, epsom salts, laudanum, mustard, linseed meal, pure washed ether, and such other drugs and chemicals as experience has taught may be useful to any individual.

THE END.

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THE EVOLUTIONIST AT LARGE.

BY GRANT ALLEN.

PREFACE.

These essays originally appeared in the columns of the *St. James's Gazette*, and I have to thank the courtesy of the editor for kind permission to republish them. My object in writing them was to make the general principles and methods of evolutionists a little more familiar to unscientific readers. Biologists usually deal with those underlying points of structure which are most really important, and on which all technical discussion must necessarily be based. But ordinary people care little for such minute anatomical and physiological details. They cannot be expected to interest themselves in the *flexor pollicis longus*, or the *hippocampus major*, about whose very existence they are ignorant, and whose names suggest to them nothing but unpleasant ideas. What they want to find out is how the outward and visible forms of plants and animals were produced. They would much rather learn why birds have feathers than why they have a keeled sternum; and they think the origin of bright flowers far more attractive than the origin of monocotyledonous seeds or exogenous stems. It is with these surface questions of obvious outward appearance that I have attempted to deal in this little series. My plan is to take a simple and well-known natural object, and give such an explanation as evolutionary principles afford of its most striking external features. A strawberry, a snail-shell, a tadpole, a bird, a wayside flower—these are the sort of things which I have tried to explain. If I have not gone very deep, I hope at least that I have suggested in simple language the right way to go to work.

I must make an apology for the form in which the essays are cast, so far as regards the apparent egotism of the first person. When they appeared anonymously in the columns of a daily paper, this air of personality was not so obtrusive: now that they reappear under my own name, I fear it may prove somewhat too marked. Nevertheless, to cut out the personal pronoun would be to destroy the whole machinery of the work: so I have reluctantly decided to retain it, only begging the reader to bear in mind that the *I* of the essays is not a real personage, but the singular number of the editorial *we*.

I have made a few alterations and corrections in some of the papers, so as to bring the statements into closer accordance with scientific accuracy. At the same time, I should like to add that

I have intentionally simplified the scientific facts as far as possible. Thus, instead of saying that the groundsel is a composite, I have said that it is a daisy by family; and instead of saying that the ascidian larva belongs to the sub-kingdom Chordata, I have said that it is a first cousin of the tadpole. For these simplifications, I hope technical biologists will pardon me. After all, if you wish to be understood, it is best to speak to people in words whose meanings they know. Definite and accurate terminology is necessary to express definite and accurate knowledge; but one may use vague expressions where the definite ones would convey no ideas.

G. A.

I.

MICROSCOPIC BRAINS.

SITTING on this little rounded boss of gneiss beside the path which cuts obliquely through the meadow, I am engaged in watching a brigade of ants out on foraging duty, and intent on securing for the nest three whole segments of a deceased earthworm. They look for all the world like those busy companies one sees in the Egyptian wall-paintings, dragging home a huge granite colossus by sheer force of bone and sinew. Every muscle in their tiny bodies is strained to the utmost as they prise themselves laboriously against the great boulders which strew the path, and which are known to our Brobdingnagian intelligence as grains of sand. Besides the workers themselves, a whole battalion of stragglers runs to and fro upon the broad line which leads to the headquarters of the community. The province of these stragglers, who seem so busy doing nothing, probably consists in keeping communications open, and encouraging the sturdy pullers by occasional relays of fresh workmen. I often wish that I could for a while get inside those tiny brains, and see, or rather smell, the world as ants do. For there can be little doubt that to these brave little carnivores here the universe is chiefly known as a collective bundle of odors, simultaneous or consecutive. As our world is mainly a world of visible objects, theirs, I believe, is mainly a world of olfactible things.

In the head of every one of these little creatures is something that we may fairly call a brain. Of course most insects have no real brains; the nerve-substance in their heads is a mere collection of ill-arranged ganglia, directly connected with their organs of sense. Whatever man may be, an earwig at least is a conscious, or rather a semi-conscious, automaton. He has just a few knots of nerve-cells in his little pate, each of which leads straight from his dim eye or his vague ear or his indefinite organs of taste; and his muscles obey the promptings of external sensations without possibility of hesitation or consideration, as mechanically as the valve of a steam-engine obeys the governor-balls. You may say of him truly, "Nihil est in intellectu quod non fuerit in sensu;" and you need not even add the Leibnitzian saving clause, "nisi ipse intellectus;" for the poor soul's intellect is wholly deficient, and the senses alone make up all that there is of him, subjectively considered. But it is not so with the highest insects. They have something which truly answers to the real brain of men, apes, and dogs, to the cerebral hemispheres and the cerebellum which are superadded in us mammals upon the simple sense-centres of lower creatures. Besides the eye, with its optic nerve and optic perceptive organs—besides the ear, with its similar mechanism — we mammalian lords of creation have a higher and more genuine brain, which collects and compares the information given to the senses, and sends down the appropriate messages to the muscles accordingly. Now, bees and flies and ants have got much the same sort of arrangement, on a smaller scale, within their tiny heads. On top of the little knots which do duty as nerve-centres for their eyes and mouths, stand two stalked bits of nervous matter, whose duty is analogous to that of our own brains. And that is why these three sorts of insects think and reason so much more intellectually than beetles or butterflies, and why the larger part of them have organized their domestic arrangements on such an excellent co-operative plan.

We know well enough what forms the main material of thought with bees and flies, and that is visible objects. For you must think about *something* if you think at all ; and you can hardly imagine a contemplative blow-fly setting itself down to reflect, like a Hindu devotee, on the syllable Om, or on the oneness of existence. Abstract ideas are not likely to play a large part in apian consciousness. A bee has a very perfect eye, and with this eye it can see not only form, but also color, as Sir John Lubbock's experiments have shown us. The information which it gets through its eye, coupled with other ideas derived from touch, smell, and taste, no doubt makes up the main thinkable and knowable universe as it reveals itself to the apian intelligence. To ourselves and to bees alike the world is, on the whole, a colored picture, with the notions of distance and solidity thrown in by touch and muscular effort ; but sight undoubtedly plays the first part in forming our total conception of things generally.

What, however, forms the thinkable universe of these little ants running to and fro so eagerly at my feet ? That is a question which used long to puzzle me in my afternoon walks. The ant has a brain and an intelligence, but that brain and that intelligence must have been developed out of *something*. *Ex nihilo nihil fit.* You cannot think and know if you have nothing to think about. The intelligence of the bee and the fly was evolved in the course of their flying about and looking at things : the more they flew, and the more they saw, the more they knew ; and the more brain they got to think with. But the ant does not generally fly, and, as with most comparatively unlocomotive animals, its sight is bad. True, the winged males and females have retained in part the usual sharp eyes of their class—for they are first cousins to the bees—and they also possess three little eyelets or *ocelli*, which are wanting to the wingless neuters. Without these they would never have found one another in their courtship, and they would have run their heads against the nearest tree, or rushed down the gaping throat of the first expectant swallow, and so effectually extinguished their race. Flying animals cannot do without eyes, and they always possess the most highly developed vision of any living creatures. But the wingless neuters are almost blind—in some species quite so ; and Sir John Lubbock has shown that their appreciation of color is mostly confined to an aversion to red light, and a comparative endurance of blue. Moreover, they are apparently deaf, and most of their other senses seem little developed. What can be the raw material on which that pin's head of a brain sets itself working ? For, small as it is, it is a wonderful organ of intellect ; and though Sir John Lubbock has shown us all too decisively that the originality and inventive genius of ants have been sadly overrated by Solomon and others, yet Darwin is probably right none the less in saying that no more marvellous atom of matter exists in the universe than this same wee lump of microscopic nerve-substance.

My dog Grip, running about on the path there, with his nose to the ground, and sniffing at every stick and stone he meets on his way, gives us the clew to solve the problem. Grip, as Professor Croom Robertson suggests, seems capable of extracting a separate and distinguishable smell from everything. I have only to shy a stone on the beach among a thousand other stones, and my dog, like a well-bred retriever as he is, selects and brings back to me that individual stone from all the stones around, by exercise of his nose alone. It is plain that Grip's world is not merely a world of sights, but a world of smells as well. He not only smells smells, but he remembers smells, he thinks smells, he even dreams smells, as you may see by his sniffing and growling in his sleep. Now, if I were to cut open Grip's head (which Heaven forfend), I should find in it a correspondingly big smell-nerve and smell-centre—an olfactory lobe, as the anatomists say. All the accumulated nasal experiences of his ancestors have made that lobe enormously developed. But in a man's head you would find a very large and fine optic centre, and only a mere shrivelled relic to represent the olfactory lobes. You and I and our ancestors have had but little occasion for sniffing and scenting ; our sight and our touch have done duty as chief intelligencers from the outer world ; and the nerves of smell, with their connected centres, have withered away to the degenerate condition in which they now are. Consequently, smell plays but a small part in our thought and our memories. The world that we know is chiefly a world of sights and touches. But in the brain of dog, or deer, or antelope, smell is a prevailing faculty ; it colors all their ideas, and it has innumerable nervous connections with every part of their brain. The big olfactory lobes are in direct communication with a thousand other nerves ; odors rouse trains of thought or powerful emotions in their minds just as visible objects do in our own.

Now, in the dog or the horse sight and smell are equally developed ; so that they probably think of most things about equally in terms of each. In ourselves, sight is highly developed, and smell is a mere relic ; so that we think of most things in terms of sight alone, and only rarely, as with a rose or a lily, in terms of both. But in ants, on the contrary, smell is highly developed and sight a mere relic ; so that they probably think of most things as smellable only, and very little as visible, in form or color. Dr. Bastian has shown that bees and butterflies are largely guided by scent ; and though he is certainly wrong in supposing that sight has little to do with leading them to flowers (for if you cut off the bright-colored corolla they will never discover the mutilated blossoms, even when they visit others on the same plant), yet the mere fact that so many flowers are scented is by itself enough to show that perfume has a great deal to do with the matter. In wingless ants, while the eyes have undergone degeneration, this high sense of smell has been continued and further developed, till it has become their principal sense-endowment, and the chief raw material of their intelligence. Their active little brains are almost wholly engaged in correlating and co-ordinating smells with actions. Their olfactory nerves give them nearly all the information they can gain about the external world, and their brains take in this information and work out the proper movements which it indicates. By smell they find their way about and carry on the business of their lives. Just as you and I know the road from Regent's Circus to Pall Mall by visible signs of the street-corners and the Duke of York's Column, so these little ants know the way from the nest to the corpse of the dismembered worm by observing and remembering the smells which they met with on their way. See : I obliterate the track for an inch or two with my stick, and the little creatures go beside themselves with astonishment and dismay. They rush about wildly, inquiring of one another with their antennæ whether this is really Doomsday, and whether the whole course of nature has been suddenly revolutionized. Then, after a short consultation, they determine upon action ; and every ant starts off in a different direction to hunt the lost track, head to the ground, exactly as a pointer hunts the missing trail of a bird or hare. Each ventures an inch or so off, and then runs back to find the rest, for fear he should get isolated altogether. At last, after many failures, one lucky fellow hits upon the well-remembered train of scents, and rushes back, leaving smell-tracks no doubt upon the soil behind him. The message goes quickly round from post to post, each sentry making passes with his antennæ to the next picket, and so sending on the news to the main body in the rear. Within five minutes communications are re-established, and the precious bit of worm-meat continues triumphantly on its way along the recovered path. An ingenious writer would even have us believe that ants possess a scent-language of their own, and emit various odors from their antennæ which the other ants perceive with theirs, and recognize as distinct in meaning. Be this as it may, you cannot doubt, if you watch them long, that scents and scents alone form the chief means by which they recollect and know one another, or the external objects with which they come in contact. The whole universe is clearly to them a complicated picture made up entirely of infinite interfusing smells.

II.

A WAYSIDE BERRY.

Half-hidden in the luxuriant growth of leaves and flowers that drape the deep side of this green lane, I have just espied a little picture in miniature, a tall wild strawberry-stalk with three full red berries standing out on its graceful branchlets. There are glossy hart's-tongues on the matted bank, and yellow hawkweeds, and bright bunches of red campion ; but somehow, amid all that wealth of shape and color, my eye falls and rests instinctively upon the three little ruddy berries, and upon nothing else. I pick the single stalk from the bank and hold it here in my hands. The origin and development of these pretty bits of red pulp is one of the many curious questions upon which modern theories of life have cast such a sudden and unexpected flood of light. What makes the strawberry stalk grow out into this odd and brightly colored lump, bearing its small fruits imbedded on its swollen surface ? Clearly the agency of those same small birds who have been mainly instrumental in dressing the haw in its scarlet coat, and clothing the spindle-berries with their twofold covering of crimson doublet and orange cloak.

In common language we speak of each single strawberry as a fruit. But it is in reality a collection of separate fruits, the tiny yellow-brown grains which stud its sides being each of them an individual little nut ; while the sweet pulp is, in fact, no part of the true fruit at all, but merely a swollen stalk. There is a white potentilla so like a strawberry blossom that even a botanist must look closely at the plant before he can be sure of its identity. While they are in flower the two heads remain almost indistinguishable ; but when the seed begins to set the potentilla develops only a collection of dry fruitlets, seated upon a green receptacle, the bed or soft expansion which hangs on to the " hull " or calyx. Each fruitlet consists of a thin covering, inclosing a solitary seed. You may compare one of them separately to a plum, with its single kernel, only that in the plum the covering is thick and juicy, while in the potentilla and the fruitlets of the strawberry it is thin and dry. An almond comes still nearer to the mark. Now the potentilla shows us, as it were, the primitive form of the strawberry. But in the developed ripe strawberry as we now find it the fruitlets are not crowded upon a green receptacle. After flowering, the strawberry receptacle lengthens and broadens, so as to form a roundish mass of succulent pulp ; and as the fruitlets approach maturity this sour green pulp becomes soft, sweet, and red. The little seed-like fruits, which are the important organs, stand out upon its surface like mere specks ; while the comparatively unimportant receptacle is all that we usually think of when we talk about strawberries. After our usual Protagorean fashion we regard man as the measure of all things, and pay little heed to any part of the compound fruit-cluster save that which ministers directly to our own tastes.

But why does the strawberry develop this large mass of apparently useless matter ? Simply in order the better to insure the dispersion of its small brown fruitlets. Birds are always hunting for seeds and insects along the hedge-rows, and devouring such among them as contain any available foodstuff. In most cases they crush the seeds to pieces with their gizzards, and digest and assimilate their contents. Seeds of this class are generally inclosed in green or brown capsules, which often escape the notice of the birds, and so succeed in perpetuating their species. But there is another class of plants whose members possess hard and indigestible seeds, and so turn the greedy birds from dangerous enemies into useful allies. Supposing there was by chance, ages ago, one of these primitive ancestral strawberries, whose receptacle was a little more pulpy than usual, and contained a small quantity of sugary matter, such as is often found in various parts of plants; then it might happen to attract the attention of some hungry bird, which, by eating the soft pulp, would help in dispersing the indigestible fruitlets. As these fruitlets sprang up into healthy young plants, they would tend to reproduce the peculiarity in the structure of the receptacle which marked the parent stock, and some of them would probably display it in a more marked degree. These would be sure to get eaten in their turn, and so to become the originators of a still more pronounced strawberry type. As time went on, the largest and sweetest berries would constantly be chosen by the birds, till the whole species began to assume its existing character. The receptacle would become softer and sweeter, and the fruits themselves harder and more indigestible: because, on the one hand, all sour or hard berries would stand a poorer chance of getting dispersed in good situations for their growth, while, on the other hand, all soft-shelled fruitlets would be ground up and digested by the bird, and thus effectually prevented from ever growing into future plants. Just in like manner, many tropical nuts have extravagantly hard shells, as only those survive which can successfully defy the teeth and hands of the clever and persistent monkey.

This accounts for the strawberry being sweet and pulpy, but not for its being red. Here, however, a similar reason comes into play. All ripening fruits and opening flowers have a natural tendency to grow bright red, or purple, or blue, though in many of them the tendency is repressed by the dangers attending brilliant displays of color. This natural habit depends upon the oxidation of their tissues, and is exactly analogous to the assumption of autumn tints by leaves. If a plant, or part of a plant, is injured by such a change of color, though being rendered more conspicuous to its foes, it soon loses the tendency under the influence of natural selection; in other words, those individuals which most display it get killed out, while those which least display it survive and thrive. On the other hand, if conspicuousness is an advantage to the plant, the exact opposite happens, and the tendency becomes developed into a confirmed habit. This is the case with the strawberry, as with many other fruits. The more bright-colored the berry is, the better its chance of getting its fruitlets dispersed. Birds have quick eyes for color, especially for red and white; and therefore almost all edible berries have assumed one or other of these two hues. So long as the fruitlets remain unripe, and would therefore be injured by being eaten, the pulp remains sour, green, and hard; but as soon as they have become fit for dispersion it grows soft, fills with sugary juice, and acquires its ruddy outer flesh. Then the birds see and recognize it as edible, and govern themselves accordingly.

But if this is the genesis of the strawberry, asks somebody, why have not all the potentillas and the whole strawberry tribe also become berries of the same type? Why are there still potentilla fruit-clusters which consist of groups of dry seed-like nuts? Ay, there's the rub. Science cannot answer as yet. After all, these questions are still in their infancy, and we can scarcely yet do more than discover a single stray interpretation here and there. In the present case a botanist can only suggest either that the potentilla finds its own mode of dispersion equally well adapted to its own peculiar circumstances, or else that the lucky accident, the casual combination of circumstances, which produced the first elongation of the receptacle in the strawberry has never happened to befall its more modest kinsfolk. For on such occasional freaks of nature the whole evolution of new varieties entirely depends. A gardener may raise a thousand seedlings, and only one or none among them may present a single new and important feature. So a species may wait for a thousand years, or forever, before its circumstances happen to produce the first step toward some desirable improvement. One extra petal may be invaluable to a five-rayed flower as effecting some immense saving of pollen in its fertilization; and yet the "sport" which shall give it this sixth ray may never occur, or may be trodden down in the mire and destroyed by a passing cow.

III.

IN SUMMER FIELDS.

Grip and I have come out for a morning stroll among the close-cropped pastures beside the beck, in the very centre of our green little dingle. Here I can sit, as is my wont, on a dry knoll, and watch the birds, beasts, insects, and herbs of the field, while Grip scours the place in every direction, intent, no doubt, upon those more practical objects—mostly rats, I fancy—which possess a congenial interest for the canine intelligence. From my coign of vantage on the knoll I can take care that he inflicts no grievous bodily injury upon the sheep, and that he receives none from the quick-tempered cow with the brass-knobbed horns. For a kind of ancestral feud seems to smoulder forever between Grip and the whole race of kine, breaking out every now and then into open warfare, which calls for my prompt interference, in an attitude of armed but benevolent neutrality, merely for the friendly purpose of keeping the peace.

This ancient feud, I imagine, is really ancestral, and dates many ages farther back in time than Grip's individual experiences. Cows hate dogs instinctively, from their earliest calfhood upward. I used to doubt once upon a time whether the hatred was not of artificial origin and wholly induced by the inveterate human habit of egging on every dog to worry every other animal that comes in its way. But I tried a mild experiment one day by putting a half-grown town-bred puppy into a small inclosure with some hitherto unworried calves, and they all turned to make a common headway against the intruder with the same striking unanimity as the most ancient and experienced cows. Hence I am inclined to suspect that the antipathy does actually result from a vaguely inherited instinct derived from the days when the ancestor of our kine was a wild bull, and the ancestor of our dogs a wolf, on the wide forest-clad plains of Central Europe. When a cow puts up its tail at sight of a dog entering its paddock at the present day, it has probably some dim instinctive consciousness that it stands in the presence of a dangerous hereditary foe; and as the wolves could only seize with safety a single isolated wild bull, so the cows now usually make common cause against the intruding dog, turning their heads in one direction with very unwonted unanimity, till his tail finally disappears under the opposite gate. Such inherited antipathies seem common and natural enough. Every species knows and dreads the ordinary enemies of its race. Mice scamper away from the very smell of a cat. Young chickens run to the shelter of their mother's wings when the shadow of a hawk passes over their heads. Mr. Darwin put a small snake into a paper bag, which he gave to the monkeys at the Zoo; and one monkey after another opened the bag, looked in upon the deadly foe of the quadrumanous kind, and promptly dropped the whole package with every gesture of horror and dismay. Even man himself—though his instincts have all weakened so greatly with the growth of his more plastic intelligence, adapted to a wider and more modifiable set of external circumstances—seems to retain a vague and original terror of the serpentine form.

If we think of parallel cases, it is not curious that animals should thus instinctively recognize their natural enemies. We are not surprised that they recognize their own fellows: and yet they must do so by means of some equally strange automatic and inherited mechanism in their nervous system. One butterfly can tell its mates at once from a thousand other species, though it may differ from some of them only by a single spot or line, which would escape the notice of all but the most attentive observers. Must we not conclude that there are elements in the butterfly's feeble brain exactly answering to the blank picture of its specific type? So, too, must we not suppose that in every race of animals there arises a perceptive structure specially adopted to the recognition of its own kind? Babies notice human faces long before they notice any other living thing. In like manner we know that most creatures can judge instinctively of their proper food. One young bird just fledged naturally pecks at red berries; another exhibits an untaught desire to chase down grasshoppers; a third, which happens to be born an owl, turns at once to the congenial pursuit of small sparrows, mice, and frogs. Each species seems to have certain faculties so arranged that the sight of certain external objects, frequently connected with food in their ancestral experience, immediately arouses in them the appropriate actions for its capture. Mr. Douglas Spalding found that newly-hatched chickens darted rapidly and accurately at flies on the wing. When we recollect that even so late an acquisition as articulate speech in human beings has its special physical seat in the brain, it is not astonishing that complicated mechanisms should have arisen among animals for the due perception of mates, food, and foes respectively. Thus, doubtless, the serpent form has imprinted itself indelibly on the senses of monkeys, and the wolf or dog form on those of cows: so that even with a young ape or calf the sight of these their ancestral enemies at once calls up uneasy or terrified feelings in their half-developed minds. Our own infants in arms have no personal experience of the real meaning to be attached to angry tones, yet they shrink from the sound of a gruff voice even before they have learned to distinguish their nurse's face.

When Grip gets among the sheep, their hereditary traits come out in a very different manner. They are by nature and descent timid mountain animals, and they have never been accustomed to face a foe, as cows and buffaloes are wont to do, especially when in a herd together. You cannot see many traces of the original mountain life among sheep, and yet there are still a few remaining to mark their real pedigree. Mr. Herbert Spencer has noticed the fondness of lambs for frisking on a hillock, however small; and when I come to my little knoll here, I generally find it occupied by a couple, who rush away on my approach, but take their stand instead on the merest ant-hill which they can find in the field. I once knew three young goats, kids of a mountain breed, and the only elevated object in the paddock where they were kept was a single old elm stump. For the possession of this stump the goats fought incessantly; and the victor would proudly perch himself on the top, with all four legs inclined inward (for the whole diameter of the tree was but some fifteen inches), maintaining himself in his place with the greatest difficulty, and butting at his two brothers until at last he lost his balance and fell. This one old stump was the sole representative in their limited experience of the rocky pinnacle upon which their forefathers kept watch like sentinels; and their instinctive yearnings prompted them to perch themselves upon the only available memento of their native haunts. Thus, too, but in a dimmer and vaguer way, the sheep, especially during his younger days, loves to revert, so far as his small opportunities permit him, to the unconsciously remembered habits of his race. But in mountain countries, every one must have noticed how the sheep at once becomes a different being. On the Welsh hills he casts away all the dull and heavy serenity of his brethren on the South Downs, and displays once more the freedom, and even the comparative boldness, of a mountain breed. A Merionethshire ewe thinks nothing of running up one side of a low-roofed barn and down the other, or of clearing a stone wall which a Leicestershire farmer would consider extravagantly high.

Another mountain trait in the stereotyped character of sheep is their well-known sequaciousness. When Grip runs after them they all run away together: if one goes through a certain gap in the hedge, every other follows; and if the leader jumps the beck at a certain spot, every lamb in the flock jumps in the self-same place. It is said that if you hold a stick for the first sheep to leap over, and then withdraw it, all the succeeding sheep will leap with mathematical accuracy at the corresponding point; and this habit is usually held up to ridicule as proving the utter stupidity of the whole race. It really proves nothing but the goodness of their ancestral instincts. For mountain animals, accustomed to follow a leader, that leader being the bravest and strongest ram of the flock, must necessarily follow him with the most implicit obedience. He alone can see what obstacles come in the way; and each of the succeeding train must watch and imitate the actions of their predecessors. Otherwise, if the flock happens to come to a chasm, running as they often must with some speed, any individual which stopped to look and decide for itself before leaping would inevitably be pushed over the edge by those behind it, and so would lose all chance of handing down its cautious and sceptical spirit to any possible descendants. On the other hand, those uninquiring and blindly obedient animals which simply did as they saw others do would both survive themselves and become the parents of future and similar generations. Thus there would be handed down from dam to lamb a general tendency to sequaciousness—a follow-my-leader spirit, which was really the best safeguard for the race against the evils of insubordination, still so fatal to Alpine climbers. And now that our sheep have settled down to a tame and monotonous existence on the downs of Sussex or the levels of the Midlands, the old instinct clings to them still, and speaks out plainly for their mountain origin. There are few things in nature more interesting to notice than these constant survivals of instinctive habits in altered circumstances. They are to the mental life what rudimentary organs are to the bodily structure: they remind us of an older order of things, just as the abortive legs of the blind-worm show us that he was once a lizard, and the hidden shell of the slug that he was once a snail.

IV.

A SPRIG OF WATER CROWFOOT.

The little streamlet whose tiny ranges and stickles form the middle thread of this green combe in the Dorset downs is just at present richly clad with varied foliage. Tall spikes of the yellow flag rise above the slow-flowing pools, while purple loose-strife overhangs the bank, and bunches of the arrowhead stand high out of their watery home, just unfolding their pretty waxen white flowers to the air. In the rapids, on the other hand, I find the curious water crowfoot, a spray of which I have this moment pulled out of the stream and am now holding in my hand as I sit on the little stone bridge, with my legs dangling over the pool below, known to me as the undoubted residence of a pair of trout. It is a queer plant, this crowfoot, with its two distinct types of leaves, much cleft below and broad above; and I often wonder why so strange a phenomenon has attracted such very scant attention. But then we knew so little of life in any form till the day before yesterday that perhaps it is not surprising we should still have left so many odd problems quite untouched.

This problem of the shape of leaves certainly seems to me a most important one; and yet it has hardly been even recognized by our scientific pastors and masters. At best, Mr. Herbert Spencer devotes to it a passing short chapter, or Mr. Darwin a stray sentence. The practice of classifying plants mainly by means of their flowers has given the flower a wholly factitious and overwrought importance. Besides, flowers are so pretty, and we cultivate them so largely, with little regard to the leaves, that they have come to usurp almost the entire interest of botanists and horticulturists alike. Darwinism itself has only heightened this exclusive interest by calling attention to the reciprocal relations which exist between the honey-bearing blossom and the fertilizing insect, the bright-colored petals and the myriad facets of the butterfly's eye. Yet the leaf is after all the real plant, and the flower is but a sort of afterthought, an embryo colony set apart for the propagation of like plants in future. Each leaf is in truth a separate individual organism, united with many others into a compound community, but possessing in full its own mouths and digestive organs, and carrying on its own life to a great extent independently of the rest. It may die without detriment to them ; it may be lopped off with a few others as a cutting, and it continues its life-cycle quite unconcerned. An oak tree in full foliage is a magnificent group of such separate individuals—a whole nation in miniature: it may be compared to a branched coral polypedom covered with a thousand little insect workers, while each leaf answers rather to the separate polypes themselves. The leaves are even capable of producing new individuals by what they contribute to the buds on every branch ; and the seeds which the tree as a whole produces are to be looked upon rather as the founders of fresh colonies, like the swarms of bees, than as fresh individuals alone. Every plant community, in short, both adds new members to its own commonwealth, and sends off totally distinct germs to form new commonwealths elsewhere. Thus the leaf is, in truth, the central reality of the whole plant, while the flower exists only for the sake of sending out a shipload of young emigrants every now and then to try their fortunes in some unknown soil.

The whole life-business of a leaf is, of course, to eat and grow, just as these same functions form the whole life-business of a caterpillar or a tadpole. But the way a plant eats, we all know, is by taking carbon and hydrogen from air and water under the influence of sunlight, and building them up into appropriate compounds in its own body. Certain little green worms or convoluta have the same habit, and live for the most part cheaply off sunlight, making starch out of carbonic acid and water by means of their inclosed chlorophyl, exactly as if they were leaves. Now, as this is what a leaf has to do, its form will almost entirely depend upon the way it is affected by sunlight and the elements around it—except, indeed, in so far as it may be called upon to perform other functions, such as those of defence or defiance. This crowfoot is a good example of the results produced by such agents. Its lower leaves, which grow under water, are minutely subdivided into little branching lance-like segments ; while its upper ones, which raise their heads above the surface, are broad and united, like the common crowfoot type. How am I to account for these peculiarities ? I fancy somehow thus :

Plants which live habitually under water almost always have thin, long, pointed leaves, often thread-like or mere waving filaments. The reason for this is plain enough. Gases are not very abundant in water, as it only holds in solution a limited quantity of oxygen and carbonic acid. Both of these the plant needs, though in varying quantities : the carbon to build up its starch, and the oxygen to use up in its growth. Accordingly, broad and large leaves would starve under water : there is not material enough diffused through it for them to make a living from. But small, long, waving leaves which can move up and down in the stream would manage to catch almost every passing particle of gaseous matter, and to utilize it under the influence of sunlight. Hence all plants which live in fresh water, and especially all plants of higher rank, have necessarily acquired such a type of leaf. It is the only form in which growth can possibly take place under their circumstances. Of course, however, the particular pattern of leaf depends largely upon the ancestral form. Thus this crowfoot, even in its submerged leaves, preserves the general arrangement of ribs and leaflets common to the whole buttercup tribe. For the crowfoot family is a large and eminently adaptable race. Some of them are larkspurs and similar queerly-shaped blossoms ; others are columbines which hang their complicated bells on dry and rocky hillsides ; but the larger part are buttercups or marsh marigolds which have simple cup-shaped flowers, and mostly frequent low and marshy ground. One of these typical crowfoots under stress of circumstances—inundation, or the like—took once upon a time to living pretty permanently in the water. As its native meadows grew deeper and deeper in flood it managed from year to year to assume a more nautical life. So, while its leaf necessarily remained in general structure a true crowfoot leaf, it was naturally compelled to split itself up into thinner and narrower segments, each of which grew out in the direction where it could find most stray carbon atoms, and most sunlight, without interference from its neighbors. This, I take it, was the origin of the much-divided lower leaves.

But a crowfoot could never live permanently under water. Seaweeds and their like, which propagate by a kind of spores, may remain below the surface forever ; but flowering plants for the most part must come up to the open air to blossom. The sea-weeds are in the same position as fish, originally developed in the water and wholly adapted to it, whereas flowering plants are rather analogous to seals and whales, air-breathing creatures, whose ancestors lived on land, and who can themselves manage an aquatic existence only by frequent visits to the surface. So some flowering water-plants actually detach their male blossoms altogether, and let them float loose on the top of the water ; while they send up their female flowers by means of a spiral coil, and draw them down again as soon as the wind or the fertilizing insects have carried the pollen to its proper receptacle, so as to ripen their seeds at leisure beneath the pond. Similarly, you may see the arrowhead and the water-lilies sending up their buds to open freely in the air, or loll at ease upon the surface of the stream. Thus the crowfoot, too, cannot blossom to any purpose below the water ; and as such among its ancestors as at first tried to do so must of course have failed in producing any seed, they and their kind have died out forever ; while only those lucky individuals whose chance lot it was to grow a little taller and weedier than the rest, and so overtop the stream, have handed down their race to our own time.

But as soon as the crowfoot finds itself above the level of the river, all the causes which made its leaf like those of other aquatic plants have ceased to operate. The new leaves which sprout in the air meet with abundance of carbon and sunlight on every side ; and we know that plants grow fast just in proportion to the supply of carbon. They have pushed their way into an unoccupied field, and they may thrive apace without let or hindrance So, instead of splitting up into little lance-like leaflets, they loll on the surface, and spread out broader and fuller, like the rest of their race. The leaf becomes at once a broad type of crowfoot leaf. Even the ends of the submerged leaves, when any fall of the water in time of drought raises them above the level, have a tendency (as I have often noticed) to grow broader and fatter, with increased facilities for food ; but when the whole leaf rises from the first to the top the inherited family instinct finds full play for its genius, and the blades fill out as naturally as well-bred pigs. The two types of leaf remind one much of gills and lungs respectively.

But above water, as below it, the crowfoot remains in principle a crowfoot still. The traditions of its race, acquired in damp marshy meadows, not actually under water, cling to it yet in spite of every change. Born river and pond plants which rise to the surface, like the water-lily or the duckweed, have broad floating leaves that contrast strongly with the waving filaments of wholly submerged species. They can find plenty of food everywhere, and as the sunlight falls flat upon them, they may as well spread out flat to catch the sunlight. No other elbowing plants overtop them and appropriate the rays, so compelling them to run up a useless waste of stem in order to pocket their fair share of the golden flood. Moreover, they thus save the needless expense of a stout leaf-stalk, as the water supports their lolling leaves and blossoms; while the broad shade which they cast on the bottom below prevents the undue competition of other species. But the crowfoot, being by descent a kind of buttercup, has taken to the water for a few hundred generations only, while the water-lily's ancestors have been to the manner born for millions of years; and therefore it happens that the crowfoot is at heart but a meadow buttercup still. One glance at its simple little flower will show you that in a moment.

V.

SLUGS AND SNAILS.

Hoeing among the flower-beds on my lawn this morning—for I am a bit of a gardener in my way—I have had the ill-luck to maim a poor yellow slug, who had hidden himself among the encroaching grass on the edge of my little parterre of sky-blue lobelias. This unavoidable wounding and hacking of worms and insects, despite all one's care, is no small drawback to the pleasures of gardening *in propriâ personâ.* Vivisection for genuine scientific purposes in responsible hands, one can understand and tolerate, even though lacking the heart for it one's self; but the useless and causeless vivisection which cannot be prevented in every ordinary piece of farm-work seems a gratuitous blot upon the face of beneficent nature. My only consolation lies in the half-formed belief that feeling among these lower creatures is indefinite, and that pain appears to affect them far less acutely than it affects warm-blooded animals. Their nerves are so rudely distributed in loose knots all over the body, instead of being closely bound together into a single central system as with ourselves, that they can scarcely possess a consciousness of pain at all analogous to our own. A wasp whose head has been severed from its body and stuck upon a pin, will still greedily suck up honey with its throatless mouth; while an Italian mantis, similarly treated, will calmly continue to hunt and dart at midges with its decapitated trunk and limbs, quite forgetful of the fact that it has got no mandibles left to eat them with. These peculiarities lead one to hope that insects may feel pain less than we fear. Yet I dare scarcely utter the hope, lest it should lead any thoughtless hearer to act upon the very questionable belief, as they say even the amiable enthusiasts of Port Royal acted upon the doctrine that animals were mere unconscious automata, by pushing their theory to the too practical length of active cruelty. Let us at least give the slugs and beetles the benefit of the doubt. People often say that science makes men unfeeling: for my own part, I fancy it makes them only the more humane, since they are the better able dimly to figure to themselves the pleasures and pains of humbler beings as they really are. The man of science perhaps realizes more vividly than all other men the inner life and vague rights even of crawling worms and ugly earwigs.

I will take up this poor slug whose mishap has set me preaching, and put him out of his misery at once, if misery it be. My hoe has cut through the soft flesh of the mantle and hit against the little embedded shell. Very few people know that a slug has a shell, but it has, though quite hidden from view; at least, in this yellow kind—for there are other sorts which have got rid of it altogether. I am not sure that I have wounded the poor thing very seriously; for the shell protects the heart and vital organs, and the hoe has glanced off on striking it, so that the mantle alone is injured, and that by no means irrecoverably. Snail flesh heals fast, and on the whole I shall be justified, I think, in letting him go. But it is a very curious thing that this slug should have a shell at all! Of course it is by descent a snail, and, indeed, there are very few differences between the two races except in the presence or absence of a house. You may trace a curiously complete set of gradations between the perfect snail and the perfect slug in this respect; for all the intermediate forms still survive with only an almost imperceptible gap between each species and the next. Some kinds, like the common brown garden snail, have comparatively small bodies and big shells, so that they can retire comfortably within them when attacked; and if they only had a lid or door to their houses they could shut themselves up hermetically, as periwinkles and similar mollusks actually do. Other kinds, like the pretty golden amber-snails which frequent marshy places, have a body much too big for its house, so that they cannot possibly retire within their shells completely. Then come a number of intermediate species, each with progressively smaller and thinner shells, till at length we reach the testacella, which has only a sort of limpet-shaped shield on his tail, so that he is generally recognized as being the first of the slugs rather than the last of the snails. You will not find a testacella unless you particularly look for him, for he seldom comes above ground, being a most bloodthirsty subterraneous carnivore who follows the burrows of earthworms as savagely as a ferret tracks those of rabbits; but in all the southern and western counties you may light upon stray specimens if you search carefully in damp places under fallen leaves. Even in testacellæ, however, the small shell is still external. In this yellow slug here, on the contrary, it does not show itself at all, but is buried under the closely wrinkled skin of the glossy mantle. It has become a mere saucer, with no more symmetry or regularity than an oyster-shell. Among the various kinds of slugs, you may watch this relic or rudiment gradually dwindling further and further towards annihilation; till finally, in the great fat black slugs which appear so plentifully on the roads after summer showers, it is represented only by a few rough calcareous grains, scattered up and down through the mantle; and sometimes even these are wanting. The organs which used to secrete the shell in their remote ancestors have either ceased to work altogether or are reduced to performing a useless office by mere organic routine.

The reason why some mollusks have thus lost their shells is clear enough. Shells are of two kinds, calcareous and horny. Both of them require more or less lime or other mineral matters, though in varying proportions. Now, the snails which thrive best on the bare chalk downs behind my little combe belong to that pretty banded black-and-white sort which everybody must have noticed feeding in abundance on all chalk soils. Indeed, Sussex farmers will tell you that South Down mutton owes its excellence to these fat little mollusks, not to the scanty herbage of their thin pasture-lands. The pretty banded shells in question are almost wholly composed of lime, which the snails can, of course, obtain in any required quantity from the chalk. In most limestone districts you will similarly find that snails with calcareous shells predominate. But if you go into a granite or sandstone tract you will see that horny shells have it all their own way. Now, some snails with such houses took to living in very damp and marshy places, which they were naturally apt to do—as indeed the land-snails in a body are merely pond-snails which have taken to crawling up the leaves of marsh-plants, and have thus gradually acclimatized themselves to a terrestrial existence. We can trace a perfectly regular series from the most aquatic to the most land-loving species, just as I have tried to trace a regular series from the shell-bearing snails to the shell-less slugs. Well, when the earliest common ancestor of both these last-named races first took to living above water, he possessed a horny shell (like that of the amber-snail), which his progenitors used to manufacture from the mineral matters dissolved in their native streams. Some of the younger branches descended from this primeval land-snail took to living on very dry land, and when they reached chalky districts manufactured their shells, on an easy and improved principle, almost entirely out of lime. But others took to living in moist and boggy places, where mineral matter was rare, and where the soil consisted for the most part of decaying vegetable mould. Here they could get little or no lime, and so their shells grew smaller and smaller, in proportion as their habits became more decidedly terrestrial. But to the last, as long as any shell at all remained, it generally covered their hearts and other important organs ; because it would there act as a special protection, even after it had ceased to be of any use for the defence of the animal's body as a whole. Exactly in the same way men specially protected their heads and breasts with helmets and cuirasses, before armor was used for the whole body, because these were the places where a wound would be most dangerous ; and they continued to cover these vulnerable spots in the same manner even when the use of armor had been generally abandoned. My poor mutilated slug, who is just now crawling off contentedly enough towards the hedge, would have been cut in two outright by my hoe had it not been for that solid calcareous plate of his, which saved his life as surely as any coat of mail.

How does it come, though, that slugs and snails now live together in the selfsame districts? Why, because they each live in their own way. Slugs belong by origin to very damp and marshy spots ; but in the fierce competition of modern life they spread themselves over comparatively dry places, provided there is long grass to hide in, or stones under which to creep, or juicy herbs like lettuce, among whose leaves are nice moist nooks wherein to lurk during the heat of the day. Moreover, some kinds of slugs are quite as well protected from birds (such as ducks) by their nauseous taste as snails are by their shells. Thus it happens that at present both races may be discovered in many hedges and thickets side by side. but the real home of each is quite different. The truest and most snail-like snails are found in greatest abundance upon high chalk-downs, heathy limestone hills, and other comparatively dry places ; while the truest and most sluglike slugs are found in greatest abundance among low water-logged meadows, or under the damp fallen leaves of moist copses. The intermediate kinds inhabit the intermediate places. Yet to the last even the most thoroughgoing snails retain a final trace of their original water-haunting life, in their universal habit of seeking out the coolest and moistest spots of their respective habitats. The soft-fleshed mollusks are all by nature aquatic animals, and nothing can induce them wholly to forget the old tradition of their marine or fresh-water existence.

VI.

A STUDY OF BONES.

On the top of this bleak chalk down, where I am wandering on a dull afternoon, I light upon the blanched skeleton of a crow, which I need not fear to handle, as its bones have been first picked clean by carrion birds, and then finally purified by hungry ants, time, and stormy weather. I pick a piece of it up in my hands, and find that I have got hold of its clumped tailbone. A strange fragment truly, with a strange history, which I may well spell out as I sit to rest a minute upon the neighboring stile. For this dry tail-bone consists, as I can see at a glance, of several separate vertebræ, all firmly welded together into a single piece. They must once upon a time have been real disconnected jointed vertebræ, like those of the dog's or lizard's tail ; and the way in which they have become fixed fast into a solid mass sheds a world of light upon the true nature and origin of birds, as well as upon many analogous cases elsewhere.

When I say that these bones were once separate, I am indulging in no mere hypothetical Darwinian speculation. I refer, not to the race, but to the particular crow in person. These very pieces themselves, in their embryonic condition, were as distinct as the individual bones of the bird's neck or of our own spines. If you were to examine the chick in the egg you would find them quite divided. But as the young crow grows more and more into the typical bird-pattern, this lizard-like peculiarity fades away, and the separate pieces unite by "anastomosis" into a single "coccygean bone," as the osteologists call it. In all our modern birds, as in this crow, the vertebræ composing the tail-bone are few in number, and are soldered together immovably in the adult form. It was not always so, however, with ancestral birds. The earliest known member of the class—the famous fossil bird of the Solenhofen lithographic stone—retained throughout its whole life a long flexible tail, composed of twenty unwelded vertebræ, each of which bore a single pair of quill-feathers, the predecessors of our modern pigeon's train. There are many other marked reptilian peculiarities in this primitive oolitic bird; and it apparently possessed true teeth in its jaws, as its later cretaceous kinsmen discovered by Professor Marsh undoubtedly did. When we compare side by side those real flying dragons, the Pterodactyls, together with the very bird-like Deinosaurians, on the one hand, and these early toothed and lizard-tailed birds on the other, we can have no reasonable doubt in deciding that our own sparrows and swallows are the remote feathered descendants of an original reptilian or half-reptilian ancestor.

Why modern birds have lost their long flexible tails it is not difficult to see. The tail descends to all higher vertebrates as an heir-loom from the fishes, the amphibia, and their other aquatic predecessors. With these it is a necessary organ of locomotion in swimming, and it remains almost equally useful to the lithe and gliding lizard on land. Indeed, the snake is but a lizard who has substituted this wriggling motion for the use of legs altogether; and we can trace a gradual succession from the four-legged true lizards, through snake-like forms with two legs and wholly rudimentary legs, to the absolutely limbless serpents themselves. But to flying birds, on the contrary, a long bony tail is only an inconvenience. All that they need is a little muscular knob for the support of the tail-feathers, which they employ as a rudder in guiding their flight upward or downward, to right or left. The elongated waving tail of the Solenhofen bird, with its single pair of quills, must have been a comparatively ineffectual and clumsy piece of mechanism for steering an aërial creature through its novel domain. Accordingly, the bones soon grew fewer in number and shorter in length, while the feathers simultaneously arranged themselves side by side upon the terminal hump. As early as the time when our chalk was deposited, the bird's tail had become what it is at the present day—a single united bone, consisting of a few scarcely distinguishable crowded rings. This is the form it assumes in the toothed fossil birds of Western America. But, as if to preserve the memory of their reptilian origin, birds in their embryo stage still go on producing separate caudal vertebræ, only to unite them together at a later point of their development into the typical coccygean bone.

Much the same sort of process has taken place in the higher apes, and, as Mr. Darwin would assure us, in man himself. There the long prehensile tail of the monkeys has grown gradually shorter, and, being at last coiled up under the haunches, has finally degenerated into an insignificant and wholly imbedded terminal joint. But, indeed, we can find traces of a similar adaptation to circumstances everywhere. Take, for instance, the common English amphibians. The newt passes all its life in the water, and therefore always retains its serviceable tail as a swimming organ. The frog in its tadpole state is also aquatic, and it swims wholly by means of its broad and flat rudder-like appendage. But as its legs bud out, and it begins to fit itself for a terrestrial existence, the tail undergoes a rapid atrophy, and finally fades away altogether. To a hopping frog on land, such a long train would be a useless drag, while in the water its webbed feet and muscular legs make a satisfactory substitute for the lost organ. Last of all, the tree-frog, leading a specially terrestrial life, has no tadpole at all, but emerges from the egg in the full frog-like shape. As he never lives in the water, he never feels the need of a tail.

The edible crab and lobster show us an exactly parallel case among crustaceans. Everybody has noticed that a crab's body is practically identical with a lobster's, only that in the crab the body-segments are broad and compact, while the tail, so conspicuous in its kinsman, is here relatively small and tucked away unobtrusively behind the legs. This difference in construction depends entirely upon the habits and manners of the two races. The lobster lives among rocks and ledges; he uses his small legs but little for locomotion, but he springs surprisingly fast and far through the water by a single effort of his powerful muscular tail. As to his big fore-claws, those, we all know, are organs of prehension and weapons of offence, not pieces of locomotive mechanism. Hence the edible and muscular part of a lobster is chiefly to be found in the claws and tail, the latter having naturally the firmest and strongest flesh. The crab, on the other hand, lives on the sandy bottom, and walks about on its lesser legs, instead of swimming or darting through the water by blows of its tail, like the lobster or the still more active prawn and shrimp. Hence the crab's tail has dwindled away to a mere useless historical relic, while the most important muscles in its body are those seated in the network of shell just above its locomotive legs. In this case, again, it is clear that the appendage has disappeared because the owner had no further use for it. Indeed, if one looks through all nature, one will find the philosophy of tails eminently simple and utilitarian. Those animals that need them evolve them; those animals that do not need them never develop them; and those animals that have once had them, but no longer use them for practical purposes, retain a mere shrivelled rudiment as a lingering reminiscence of their original habits.

VII.

BLUE MUD.

After last night's rain, the cliffs that bound the bay have come out in all their most brilliant colors; so this morning I am turning my steps seaward, and wandering along the great ridge of pebbles which here breaks the force of the Channel waves as they beat against the long line of the Dorset downs. Our cliffs just at this point are composed of blue lias beneath, with a capping of yellow sandstone on their summits, above which in a few places the layer of chalk that once topped the whole country-side has still resisted the slow wear and tear of unnumbered centuries. These three elements give a variety to the bold and broken bluffs which is rare along the monotonous southern escarpment of the English coast. After rain, especially, the changes of color on their sides are often quite startling in their vividness and intensity. To-day, for example, the yellow sandstone is tinged in parts with a deep russet red, contrasting admirably with the bright green of the fields above and the sombre steel-blue of the lias belt below. Besides, we have had so many landslips along this bit of shore, that the various layers of rock have in more than one place got mixed up with one another into inextricable confusion. The little town nestling in the hollow behind me has long been famous as the headquarters of early geologists; and not a small proportion of the people earn their livelihood to the present day by "goin' a fossiling." Every child about the place recognizes ammonites as "snake-stones;" while even the rarer vertebræ of extinct saurians have acquired a local designation as "verterberries." So, whether in search of science or the picturesque, I often clamber down in this direction for my daily stroll, particularly when, as is the case to-day, the rain has had time to trickle through the yellow rock, and the sun then shines full against its face, to light it up with a rich flood of golden splendor.

The base of the cliffs consists entirely of a very soft and plastic blue lias mud. This mud contains large numbers of fossils, chiefly chambered shells, but mixed with not a few relics of the great swimming and flying lizards that swarmed among the shallow flats or low islands of the lias sea. When the blue mud was slowly accumulating in the hollows of the ancient bottom, these huge saurians formed practically the highest race of animals then existing upon earth. There were, it is true, a few primeval kangaroo-mice and wombats among the rank brushwood of the mainland ; and there may even have been a species or two of reptilian birds, with murderous-looking teeth and long lizard-like tails—descendants of those problematical creatures which printed their footmarks on the American trias, and ancestors of the later toothed bird whose tail-feathers have been naturally lithographed for us on the Solenhofen slate. But in spite of such rare precursors of higher modern types, the saurian was in fact the real lord of earth in the lias ocean.

For him did his high sun flame, and his river billowing ran,
And he felt himself in his pride to be nature's crowing race.

We have adopted an easy and slovenly way of dividing all rocks into primary, secondary, and tertiary, which veils from us the real chronological relations of evolving life in the different periods. The lias is ranked by geologists among the earliest secondary formations ; but if we were to distribute all the sedimentary rocks into ten great epochs, each representing about equal duration in time, the lias would really fall in the tenth and latest of all. So very misleading to the ordinary mind is our accepted geological nomenclature. Nay, even commonplace geologists themselves often overlook the real implications of many facts and figures which they have learned to quote glibly enough in a certain off-hand way. Let me just briefly reconstruct the chief features of this scarcely recognized world's chronology as I sit on this piece of fallen chalk at the foot of the mouldering cliff, where the stream from the meadow above brought down the newest landslip during the hard frosts of last December. First of all, there is the vast lapse of time represented by the Laurentian rocks of Canada. These Laurentian rocks, the oldest in the world, are at least 30,000 feet in thickness, and it must be allowed that it takes a reasonable number of years to accumulate such a mass of solid limestone or clay as that at the bottom of even the widest primeval ocean. In these rocks there are no fossils, except a single very doubtful member of the very lowest animal type. But there are indirect traces of life in the shape of limestone probably derived from shells, and of black lead probably derived from plants. All these early deposits have been terribly twisted and contorted by subsequent convulsions of the earth, and most of them have been melted down by volcanic action ; so that we can tell very little about their original state. Thus the history of life opens for us, like most other histories, with a period of uncertainty : its origin is lost in the distant vistas of time. Still, we know that there *was* such an early period ; and from the thickness of the rocks which represent it we may conjecture that it spread over three out of the ten great æons into which I have roughly divided geological time. Next comes the period known as the Cambrian, and to it we may similarly assign about two and a half æons on like grounds. The Cambrian epoch begins with a fair sprinkling of the lower animals and plants, presumably developed during the preceding age ; but it shows no remains of fish or any other vertebrates. To the Silurian, Devonian, and Carboniferous periods we may roughly allow an æon and a fraction each ; while to the whole group of secondary and tertiary strata, comprising almost all the best-known English formations—red marl, lias, oolite, greensand, chalk, eocene, miocene, pliocene, and drift—we can only give a single æon to be divided between them. Such facts will sufficiently suggest how comparatively modern are all these rocks when viewed by the light of an absolute chronology. Now, the first fishes do not occur till the Silurian—that is to say, in or about the seventh æon after the beginning of geological time. The first mammals are found in the trias, at the beginning of the tenth æon. And the first known bird only makes its appearance in the oolite, about half way through that latest period. This will show that there was plenty of time for their development in the earlier ages. True, we must reckon the interval between ourselves and the date of this blue mud at many millions of years ; but then we must reckon the interval between the lias and the earliest Cambrian strata at some six times as much, and between the lias and the lowest Laurentian beds at nearly ten times as much. Just the same sort of lessening perspective exists in geology as in ordinary history. Most people look upon the age before the Norman conquest as a mere brief episode of the English annals ; yet six whole centuries elapsed between the landing of the real or mythical Hengst at Ebbsfleet and the landing of William the Conqueror at Hastings ; while under eight centuries elapsed between the time of William the Conqueror and the accession of Queen Victoria. But, just as most English histories give far more space to the three centuries since Elizabeth than to the eleven centuries which preceded them, so most books on geology give far more space to the single æon (embracing the secondary and tertiary periods) which comes nearest our own time, than to the nine æons which spread from the Laurentian to the Carboniferous epoch. In the earliest period, records either geological or historical are wholly wanting ; in the later periods they become both more numerous and more varied in proportion as they approach nearer and nearer to our own time.

So, too, in the days when Mr. Darwin first took away the breath of scientific Europe by his startling theories, it used confidently to be said that geology had shown us no intermediate form between species and species. Even at the time when this assertion was originally made it was quite untenable. All early geological forms, of whatever race, belong to what we foolishly call "generalized" types : that is to say, they present a mixture of features now found separately in several different animals. In other words, they represent early ancestors of all the modern forms, with peculiarities intermediate between those of their more highly differentiated descendants ; and hence we ought to call them "unspecialized" rather than "generalized" types. For example, the earliest ancestral horse is partly a horse and partly a tapir : we may regard him as a *tertium quid*, a middle term, from which the horse has varied in one direction and the tapir in another, each of them exaggerating certain special peculiarities of the common ancestor and losing others, in accordance with the circumstances in which they have been placed. Science is now perpetually discovering intermediate forms, many of which compose an unbroken series between the unspecialized ancestral type and the familiar modern creatures. Thus, in this very case of the horse, Professor Marsh has unearthed a long line of fossil animals which lead in direct descent from the extremely unhorse-like eocene type to the developed Arab of our own times. Similarly with birds, Professor Huxley has shown that there is hardly any gap between the very bird-like lizards of the lias and the very lizard-like birds of the oolite. Such links, discovered afresh every day, are perpetual denials to the old parrot-like cry of "No geological evidence for evolution."

VIII.

CUCKOO-PINT.

In the bank which supports the hedge, beside this little hanger on the flank of Black Down, the glossy arrow-headed leaves of the common arum form at this moment beautiful masses of vivid green foliage. "Cuckoo-pint" is the pretty poetical old English name for the plant ; but village children know it better by the equally quaint and fanciful title of "lords and ladies." The arum is not now in flower: it blossomed much earlier in the season, and its queer clustered fruits are just at present swelling out into rather shapeless little light-green bulbs, preparatory to assuming the bright coral-red hue which makes them so conspicuous among the hedgerows during the autumn months. A cut-and-dry technical botanist would therefore have little to say to it in its present stage, because he cares only for the flowers and seeds which help him in his dreary classifications, and give him so splendid an opportunity for displaying the treasures of his Latinized terminology. But to me the plant itself is the central point of interest, not the names (mostly in bad Greek) by which this or that local orchid-hunter has endeavored to earn immortality.

This arum, for example, grows first from a small hard seed with a single lobe or seed-leaf. In the seed there is a little store of starch and albumen laid up by the mother-plant, on which the young arum feeds, just as truly as the growing chick feeds on the white which surrounds its native yolk, or as you and I feed on the similar starches and albumens laid by for the use of the young plant in the grain of wheat, or for the young fowl in the egg. Full-grown plants live by taking in food-stuffs from the air under the influence of sunlight; but a young seedling can no more feed itself than a human baby can; and so food is stored up for it beforehand by the parent stock. As the kernel swells with heat and moisture, its starches and albumens get oxidized and produce the motions and rearrangements of particles that result in the growth of a new plant. First a little head rises toward the sunlight and a little root pushes downward toward the moist soil beneath. The business of the root is to collect water for the circulating medium—the sap or blood of the plant—as well as a few mineral matters required for its stem and cells; but the business of the head is to spread out into leaves, which are the real mouths and stomachs of the compound organism. For we must never forget that all plants mainly grow, not, as most people suppose, from the earth, but from the air. They are for the most part mere masses of carbon-compounds, and the carbon in them comes from the carbonic acid diffused through the atmosphere around, and is separated by the sunlight acting in the leaves. There it mixes with small quantities of hydrogen and nitrogen brought by the roots from soil and water; and the starches or other bodies thus formed are then conveyed by the sap to the places where they will be required in the economy of the plant system. That is the all-important fact in vegetable physiology, just as the digestion and assimilation of food and the circulation of the blood are in our own bodies.

The arum, like the grain of wheat, has only a single seed-leaf; whereas the pea, as we all know, has two. This is the most fundamental difference among flowering plants, as it points back to an early and deep-seated mode of growth, about which they must have split off from one another millions of years ago. All the one-lobed plants grow with stems like grasses or bamboos, formed by single leaves inclosing another; all the double lobed plants grow with stems like an oak, formed of concentric layers from within outward. As soon as the arum, with its sprouting head, has raised its first leaves far enough above the ground to reach the sunlight, it begins to form fresh starches and new leaves for itself, and ceases to be dependent upon the store laid up in its buried lobe. Most seeds accordingly contain just enough material to support the young seedling till it is in a position to shift for itself; and this, of course, varies greatly with the habits and manners of the particular species. Some plants, too, such as the potato, find their seeds insufficient to keep up the race by themselves, and so lay by abundant starches in underground branches or tubers, for the use of new shoots; and these rich starch receptacles we ourselves generally utilize as food-stuffs, to the manifest detriment of the young potato-plants, for whose benefit they were originally intended. Well, the arum has no such valuable reserve as that ; it is early cast upon its own resources, and so it shifts for itself with resolution. Its big, glossy leaves grow apace, and soon fill out, not only with green chlorophyl, but also with a sharp and pungent essence which makes them burn the mouth like cayenne pepper. This acrid juice has been acquired by the plant as a defence against its enemies. Some early ancestor of the arums must have been liable to constant attacks from rabbits, goats, or other herbivorous animals, and it has adopted this means of repelling their advances. In other words, those arums which were most palatable to the rabbits got eaten up and destroyed, while those which were nastiest survived, and handed down their pungency to future generations. Just in the same way nettles have acquired their sting and thistles their prickles, which efficiently protect them against all herbivores, except the patient, hungry donkey, who gratefully accepts them as a sort of *sauce piquante* to the succulent stems.

And now the arum begins its great preparations for the act of flowering. Everybody knows the general shape of the arum blossom—if not in our own purple cuckoo-pint, at least in the big white "Ethiopian lilies" which form such frequent ornaments of cottage windows. Clearly, this is a flower which the plant cannot produce without laying up a good stock of material beforehand. So its sets to work accumulating starch in its root. This starch it manufactures in its leaves, and then buries deep under ground in a tuber, by means of the sap, so as to secure it from the attacks of rodents, who too frequently appropriate to themselves the food intended by plants for other purposes. If you examine the tuber before the arum has blossomed, you will find it large and solid ; but if you dig it up in the autumn after the seeds have ripened, you will see that it is flaccid and drained ; all its starches and other contents have gone to make up the flower, the fruit, and the stalk which bore them. But the tuber has a further protection against enemies besides its deep underground position. It contains an acrid juice like that of the leaves, which sufficiently guards it against four-footed depredators. Man, however, that most persistent of persecutors, has found out a way to separate the juice from the starch ; and in St. Helena the big white arum is cultivated as a food-plant, and yields the meal in common use among the inhabitants.

When the arum has laid by enough starch to make a flower it begins to send up a tall stalk, on the top of which grows the curious hooded blossom known to be one of the earliest forms still surviving upon earth. But now its object is to attract, not to repel, the animal world ; for it is an insect-fertilized flower, and it requires the aid of small flies to carry the pollen from blossom to blossom. For this purpose it has a purple sheath around its head of flowers and a tall spike on which they are arranged in two clusters, the male blossoms above and the female below. This spike is bright yellow in the cultivated species. The fertilization is one of the most interesting episodes in all nature, but it would take too long to describe here in full. The flies go from one arum to another, attracted by the color, in search of pollen ; and the pistils, or female flowers, ripen first. Then the pollen falls from the stamens or male flowers on the bodies of the flies, and dusts them all over with yellow powder. The insects, when once they have entered, are imprisoned until the pollen is ready to drop, by means of several little hairs, pointing downward, and preventing their exit on the principle of an eel-trap or lobster-pot. But as soon as the pollen is discharged the hairs wither away, and then the flies are free to visit a second arum. Here they carry the fertilizing dust with which they are covered to the ripe pistils, and so enable them to set their seed ; but, instead of getting away again as soon as they have eaten their fill, they are once more imprisoned by the lobster-pot hairs, and dusted with a second dose of pollen, which they carry away in turn to a third blossom.

As soon as the pistils have been impregnated, the fruits begin to set. Here they are, on their tall spike, whose inclosing sheath has now withered away, while the top is at this moment slowly dwindling, so that only the cluster of berries at its base will finally remain. The berries will swell and grow soft, till in autumn they become a beautiful scarlet cluster of living coral. Then once more their object will be to attract the animal world, this time in the shape of field-mice, squirrels, and small birds; but with a more treacherous intent. For though the berries are beautiful and palatable enough they are deadly poison. The robins or small rodents which eat them, attracted by their bright colors and pleasant taste, not only aid in dispersing them, but also die after swallowing them, and become huge manure heaps for the growth of the young plant. So the whole cycle of arum existence begins afresh, and there is hardly a plant in the field around me which has not a history as strange as this one.

IX.

BERRIES AND BERRIES.

This little chine, opening toward the sea through the blue lias cliffs, has been worn to its present pretty gorge-like depth by the slow action of its tiny stream—a mere thread of water in fine weather, that trickles down its centre in a series of mossy cascades to the shingly beach below. Its sides are overgrown by brambles and other prickly brushwood, which form in places a matted and impenetrable mass; for it is the habit of all plants protected by the defensive armor of spines or thorns to cluster together in serried ranks, through which cattle or other intrusive animals cannot break. Among them, near the down above, I have just lighted upon a rare plant for Southern Britain—a wild raspberry-bush in full fruit. Raspberries are common enough in Scotland among heaps of stones on the windiest hillsides; but the south of England is too warm and sickly for their robust tastes, and they can only be found here in a few bleak spots like the stony edges of this weather-beaten down above the chine. The fruit itself is quite as good as the garden variety, for cultivation has added little to the native virtues of the raspberry. Good old Izaac Walton is not ashamed to quote a certain quaint saying of one Dr. Boteler concerning strawberries, and so I suppose I need not be afraid to quote it after him. "Doubtless," said the Doctor, "God *could* have made a better berry, but doubtless also God never did." Nevertheless, if you try the raspberry, picked fresh, with plenty of good country cream, you must allow that it runs its sister fruit a neck-and-neck race.

To compare the structure of a raspberry with that of a strawberry is a very instructive botanical study. It shows how similar causes may produce the same gross result in singularly different ways. Both are roses by family, and both have flowers essentially similar to that of the common dog-rose. But even in plants where the flowers are alike, the fruits often differ conspicuously, because fresh principles come into play for the dispersion and safe germination of the seed. This makes the study of fruits the most complicated part in the unravelling of plant life. After the strawberry has blossomed, the pulpy receptacle on which it bore its green fruitlets begins to swell and redden, till at length it grows into an edible berry, dotted with little yellow nuts, containing each a single seed. But in the raspberry it is the separate fruitlets themselves which grow soft and bright-colored, while the receptacle remains white and tasteless, forming the "hull" which we pull off from the berry when we are going to eat it. Thus the part of the raspberry which we throw away answers to the part of the strawberry which we eat. Only, in the raspberry the separate fruitlets are all crowded close together into a single united mass, while in the strawberry they are scattered about loosely, and imbedded in the soft flesh of the receptacle. The blackberry is another close relative ; but in its fruit the little pulpy fruitlets cling to the receptacle, so that we pick and eat them both together ; whereas in the raspberry the receptacle pulls out easily, and leaves a thimble-shaped hollow in the middle of the berry. Each of these little peculiarities has a special meaning of its own in the history of the different plants.

Yet the main object attained by all is in the end precisely similar. Strawberries, raspberries, and blackberries all belong to the class of attractive fruits. They survive in virtue of the attention paid to them by birds and small animals. Just as the wild strawberry which I picked in the hedgerow the other day procures the dispersion of its hard and indigestible fruitlets by getting them eaten together with the pulpy receptacle, so does the raspberry procure the dispersion of its soft and sugary fruitlets by getting them eaten all by themselves. While the strawberry fruitlets retain throughout their dry outer coating, in those of the raspberry the external covering becomes fleshy and red, but the inner seed has, notwithstanding, a still harder shell than the tiny nuts of the strawberry. Now, this is the secret of nine fruits out of ten. They are really nuts, which clothe themselves in an outer tunic of sweet and beautifully colored pulp. The pulp as it were, the plant gives in, as an inducement to the friendly bird to swallow its seed ; but the seed itself it protects by a hard stone or shell, and often by poisonous or bitter juices within. We see this arrangement very conspicuously in a plum, or still better in a mango ; though it is really just as evident in the raspberry, where the smaller size renders it less conspicuous to human sight.

It is a curious fact about the rose family that they have a very marked tendency to produce such fleshy fruits, instead of the mere dry seed-vessels of ordinary plants, which are named fruits only by botanical courtesy. For example, we owe to this single family the peach, plum, apricot, cherry, damson, pear, apple, medlar, and quince, all of them cultivated in gardens or orchards for their fruits. The minor group known by the poetical name of Dryads, alone supplies us with the strawberry, raspberry, blackberry, and dewberry. Even the wilder kinds, refused as food by man, produce berries well known to our winter birds—the haw, rose-hip, sloe, bird-cherry, and rowan. On the other hand, the whole tribe numbers but a single thoroughgoing nut—the almond ; and even this nut, always somewhat soft-shelled and inclined to pulpiness, has produced by a "sport" the wholly fruit-like nectarine. The odd thing about the rose tribe, however, is this : that the pulpy tendency shows itself in very different parts among the various species. In the plum it is the outer covering of the true fruit which grows soft and colored ; in the apple it is a swollen mass of the fruit-stalk surrounding the ovules ; in the rose-hip it is the hollowed receptacle ; and in the strawberry it is the same receptacle, bulging out in the opposite direction. Such a general tendency to display color and collect sugary juices in so many diverse parts may be compared to the general bulbous tendency of the tiger-lily or the onion, and to the general succulent tendency of the cactus or the house-leek. In each case, the plant benefits by it in one form or another ; and whichever form happens to get the start in any particular instance is increased and developed by natural selection, just as favorable varieties of fruits or flowers are increased and developed in cultivated species by our own gardeners.

Sweet juices and bright colors, however, could be of no use to a plant till there were eyes to see and tongues to taste them. A pulpy fruit is in itself a mere waste of productive energy to its mother, unless the pulpiness aids in the dispersion and promotes the welfare of the young seedlings. Accordingly, we might naturally expect that there would be no fruit-bearers on the earth until the time when fruit-eaters, actual or potential, arrived upon the scene ; or, to put it more correctly, both must inevitably have developed simultaneously and in mutual dependence upon one another. So we find no traces of succulent fruits even in so late a formation as that of these lias or cretaceous cliffs. The birds of that day were fierce-toothed carnivores, devouring the lizards and saurians of the rank low-lying sea-marshes ; the mammals were most primeval kangaroos or low ancestral wombats, gentle herbivores, or savage marsupial wolves, like the Tasmanian devil of our own times. It is only in the very modern tertiary period, whose soft muddy deposits have not yet had time to harden under superincumbent pressure into solid stone, that we find the earliest traces of the rose family, the greatest fruit-bearing tribe of our present world. And side by side with them we find their clever aboreal allies, the ancestral monkeys and squirrels, the primitive robins, and the yet shadowy forefathers of our modern fruit-eating parrots. Just as bees and butterflies necessarily trace back their geological history only to the time of the first honey-bearing flowers, and just as the honey-bearing flowers in turn trace back their pedigree only to the date of the rudest and most unspecialized honey-sucking insects, so are fruits and fruit-eaters linked together in origin by the inevitable bond of a mutual dependence. No bee, no honey ; and no honey, no bee : so, too, no fruit, no fruit-bird ; and no fruit-bird, no fruit.

X.

DISTANT RELATIONS.

Behind the old mill, whose overshot wheel, backed by a wall thickly covered with the young creeping fronds of hart's-tongue ferns, forms such a picturesque foreground for the view of our little valley, the mill-stream expands into a small, shallow pond, overhung at its edges by thick-set hazel - bushes and clambering honeysuckle. Of course it is only dammed back by a mud wall, with sluices for the miller's water-power ; but it has a certain rustic simplicity of its own, which makes it beautiful to our eyes for all that, in spite of its utilitarian origin. At the bottom of this shallow pond you may now see a miracle daily taking place, which but for its commonness we should regard as an almost incredible marvel. You may there behold evolution actually illustrating the transformation of life under your very eyes : you may watch a low type of gill-breathing gristly-boned fish developing into the highest form of lung - breathing terrestrial amphibian. Nay, more—you may almost discover the earliest known ancestor of the whole vertebrate kind, the first cousin of that once famous ascidian larva, passing through all the upward stages of existence which finally lead it to assume the shape of a relatively perfect four-legged animal. For the pond is swarming with fat black tadpoles, which are just at this moment losing their tails and developing their legs, on the way to becoming fully formed frogs.

The tadpole and the ascidian larva divide between them the honor of preserving for us in all its native simplicity the primitive aspect of the vertebrate type. Beasts, birds, reptiles, and fishes have all descended from an animal whose shape closely resembled that of these wriggling little black creatures which dart up and down like imps through the clear water, and raise a cloud of mud above their heads each time that they bury themselves comfortably in the soft mud of the bottom. But while the birds and beasts, on the one hand, have gone on bettering themselves out of all knowledge, and while the ascidian, on the other hand, in his adult form has dropped back into an obscure and sedentary life—sans eyes, sans teeth, sans taste, sans everything—the tadpole alone, at least during its early days, remains true to the ancestral traditions of the vertebrate family. When first it emerges from its egg it represents the very most rudimentary animal with a backbone known to our scientific teachers. It has a big hammer-looking head, and a set of branching outside gills, and a short distinct body, and a long semi-transparent tail. Its backbone is a mere gristly channel, in which lies its spinal cord. As it grows, it resembles in every particular the ascidian larva, with which, indeed, Kowalewsky and Professor Ray Lankester have demonstrated its essential identity. But since a great many people seem wrongly to imagine that Professor Lankester's opinion on this matter is in some way at variance with Mr. Darwin's and Dr. Haeckel's, it may be well to consider what the degeneracy of the ascidian really means. The fact is, both larval forms—that of the frog and that of the ascidian—completely agree in the position of their brains, their gill-slits, their very rudimentary backbones, and their spinal cords. Moreover, we ourselves and the tadpole agree with the ascidian in a further most important point, which no invertebrate animal shares with us; and that is that our eyes grow out of our brains, instead of being part of our skin, as in insects and cuttle-fish. This would seem *à priori* a most inconvenient place for an eye—inside the brain; but then, as Professor Lankester cleverly suggests, our common original ancestor, the very earliest vertebrate of all, must have been a transparent creature, and therefore comparatively indifferent as to the part of his body in which his eye happened to be placed. In after ages, however, as vertebrates generally got to have thicker skulls and tougher skins, the eye-bearing part of the brain had to grow outward, and so reach the light on the surface of the body: a thing which actually happens to all birds, beasts, and reptiles in the course of their embryonic development. So that in this respect the ascidian larva is nearer to the original type than the tadpole or any other existing animal.

The ascidian, however, in mature life, has grown degraded and fallen from his high estate, owing to his bad habit of rooting himself to a rock and there settling down into a mere sedentary swallower of passing morsels—a blind, handless, footless, and degenerate thing. In his later shape he is but a sack fixed to a stone, and with all his limbs and higher sense-organs so completely atrophied that only his earlier history allows us to recognize him as a vertebrate by descent at all. He is in fact a representative of retrogressive development. The tadpole, on the contrary, goes on swimming about freely, and keeping the use of its eyes, till at last a pair of hind legs and then a pair of fore legs begin to bud out from its side, and its tail fades away, and its gills disappear, and air-breathing lungs take their place, and it boldly hops on shore a fully evolved tailless amphibian.

There is, however, one interesting question about these two larvæ which I should much like to solve. The ascidian has only *one* eye inside its useless brain, while the tadpole and all other vertebrates have *two* from the very first. Now which of us most nearly represents the old mud-loving vertebrate ancestor in this respect? Have two original organs coalesced in the young ascidian, or has one organ split up into a couple with the rest of the class? I think the latter is the true supposition, and for this reason: In our heads, and those of all vertebrates, there is a curious cross-connection between the eyes and the brain, so that the right optic nerve goes to the left side of the brain and the left optic nerve goes to the right side. In higher animals, this "decussation," as anatomists call it, affects all the sense-organs except those of smell; but in fishes it only affects the eyes. Now, as the young ascidian has retained the ancestral position of his almost useless eye so steadily, it is reasonable to suppose that he has retained its other peculiarities as well. May we not conclude, therefore, that the primitive vertebrate had only one brain-eye; but that afterward, as this brain-eye grew outward to the surface, it split up into two, because of the elongated and flattened form of the head in swimming animals, while its two halves still kept up a memory of their former union in the cross-connection with the opposite halves of the brain? If this be so, then we might suppose that the other organs followed suit, so as to prevent confusion in the brain between the two sides of the body; while the nose, which stands in the centre of the face, was under no liability to such error, and therefore still keeps up its primitive direct arrangement.

It is worth noting, too, that these tadpoles, like all other very low vertebrates, are mud-haunters; and the most primitive among adult vertebrates are still cartilaginous mud-fish. Not much is known geologically about the predecessors of frogs; the tailless amphibians are late arrivals upon earth, and it may seem curious, therefore, that they should recall in so many ways the earliest ancestral type. The reason doubtless is because they are so much given to larval development. Some ancestors of theirs—primeval newts or salamanders—must have gone on for countless centuries improving themselves in their adult shape from age to age, yet bringing all their young into the world from the egg, as mere mud-fish still, in much the same state as their unimproved forefathers had done millions of æons before. Similarly, caterpillars are still all but exact patterns of the primeval insect, while butterflies are totally different and far higher creatures. Thus, in spite of adult degeneracy in the ascidian and adult progress in the frog, both tadpoles preserve for us very nearly the original form of their earliest backboned ancestor. Each individual recapitulates in its own person the whole history of evolution in its race. This is a very lucky thing for biology; since without these recapitulatory phases we could never have traced the true lines of descent in many cases. It would be a real misfortune for science if every frog had been born a typical amphibian, as some tree-toads actually are, and if every insect had emerged a fully formed adult, as some aphides very nearly do. Larvæ and embryos show us the original types of each race: adults show us the total amount of change produced by progressive or retrogressive development.

XI.

AMONG THE HEATHER.

This is the worst year for butterflies that I can remember. Entomologists all over England are in despair at the total failure of the insect crop, and have taken to botanizing, angling, and other bad habits, in default of means for pursuing their natural avocation as beetle-stickers. Last year's heavy rains killed all the mothers as they emerged from the chrysalis; and so only a few stray eggs have survived till this summer, when the butterflies they produce will all be needed to keep up next season's supply. Nevertheless, I have climbed the highest down in this part of the country to-day, and come out for an airing among the heather, in the vague hope that I may be lucky enough to catch a glimpse of one or two old lepidopterous favorites. I am not a butterfly-hunter myself. I have not the heart to drive pins through the pretty creatures' downy bodies, or to stifle them with reeking chemicals; though I recognize the necessity for a hardened class who will perform that useful office on behalf of science and society, just as I recognize the necessity for slaughtermen and knackers. But I prefer personally to lie on the ground at my ease and learn as much about the insect nature as I can discover from simple inspection of the living subject as it flits airily from bunch to bunch of bright-colored flowers.

I suppose even that apocryphal person, the general reader, would be insulted at being told at this hour of the day that all bright-colored flowers are fertilized by the visits of insects, whose attentions they are specially designed to solicit. Everybody has heard over and over again that roses, orchids, and columbines have acquired their honey to allure the friendly bee, their gaudy petals to advertise the honey, and their divers shapes to insure the proper fertilization by the correct type of insect. But everybody does not know how specifically certain blossoms have laid themselves out for a particular species of fly, beetle, or tiny moth. Here on the higher downs, for instance, most flowers are exceptionally large and brilliant; while all Alpine climbers must have noticed that the most gorgeous masses of bloom in Switzerland occur just below the snow-line. The reason is, that such blossoms must be fertilized by butterflies alone. Bees, their great rivals in honey-sucking, frequent only the lower meadows and slopes, where flowers are many and small : they seldom venture far from the hive or the nest among the high peaks and chilly nooks where we find those great patches of blue gentian or purple anemone, which hang like monstrous breadths of tapestry upon the mountain sides. This heather here, now fully opening in the warmer sun of the southern counties—it is still but in the bud among the Scotch hills, I doubt not—specially lays itself out for the humble-bee, and its masses form about his highest pasture-grounds ; but the butterflies—insect vagrants that they are—have no fixed home, and they therefore stray far above the level at which bee-blossoms altogether cease to grow. Now, the butterfly differs greatly from the bee in his mode of honey-hunting ; he does not bustle about in a business-like manner from one buttercup or dead-nettle to its nearest fellow ; but he flits joyously, like a sauntering straggler that he is, from a great patch of color here to another great patch at a distance, whose gleam happens to strike his roving eye by its size and brilliancy. Hence, as that indefatigable observer, Dr. Hermann Müller has noticed, all Alpine or hill-top flowers have very large and conspicuous blossoms, generally grouped together in big clusters so as to catch a passing glance of the butterfly's eye. As soon as the insect spies such a cluster, the color seems to act as a stimulant to his broad wings, just as the candle-light does to those of his cousin the moth. Off he sails at once, as if by automatic action, toward the distant patch, and there both robs the plant of its honey and at the same time carries to it on his legs and head fertilizing pollen from the last of its congeners which he favored with a call. For of course both bees and butterflies stick on the whole to a single species at a time ; or else the flowers would only get uselessly hybridized instead of being impregnated with pollen from other plants of their own kind. For this purpose it is that most plants lay themselves out to secure the attention of only two or three varieties among their insect allies, while they make their nectaries either too deep or too shallow for the convenience of all other kinds. Nature, though eager for cross-fertilization, abhors "miscegenation" with all the bitterness of an American politician.

Insects, however, differ much from one another in their æsthetic tastes, and flowers are adapted accordingly to the varying fancies of the different kinds. Here, for example, is a spray of common white galium, which attracts and is fertilized by small flies, who generally frequent white blossoms. But here, again, not far off, I find a luxuriant mass of the yellow species, known by the quaint name of "lady's bedstraw"—a legacy from the old legend which represents it as having formed Our Lady's bed in the manger at Bethlehem. Now why has this kind of galium yellow flowers, while its near kinsman yonder has them snowy white ? The reason is that lady's bedstraw is fertilized by small beetles ; and beetles are known to be one among the most color-loving races of insects. You may often find one of their number, the lovely bronze and golden-mailed rose-chafer, buried deeply in the very centre of a red garden rose, and reeling about when touched as if drunk with pollen and honey. Almost all the flowers which beetles frequent are consequently brightly decked in scarlet or yellow. On the other hand, the whole family of the umbellates, those tall plants with level bunches of tiny blossoms, like the fool's parsley, have all but universally white petals ; and Müller, the most statistical of naturalists, took the trouble to count the number of insects which paid them a visit. He found that only 14 per cent were bees, while the remainder consisted mainly of miscellaneous small flies and other arthropodous riff-raff ; whereas in the brilliant class of composites, including the asters, sunflowers, daisies, dandelions, and thistles, nearly 75 per cent of the visitors were steady, industrious bees. Certain dingy blossoms which lay themselves out to attract wasps are obviously adapted, as Müller quaintly remarks, "to a less æsthetically cultivated circle of visitors." But the most brilliant among all insect-fertilized flowers are those which specially affect the society of butterflies; and they are only surpassed in this respect throughout all nature by the still larger and more magnificent tropical species which owe their fertilization to humming-birds and brush-tongued lories.

Is it not a curious, yet a comprehensible circumstance, that the tastes which thus show themselves in the development, by natural selection, of lovely flowers, should also show themselves in the marked preference for beautiful mates? Poised on yonder sprig of harebell stands a little purple-winged butterfly, one of the most exquisite among our British kinds. That little butterfly owes its own rich and delicately shaded tints to the long selective action of a million generations among its ancestors. So we find throughout that the most beautifully colored birds and insects are always those which have had most to do with the production of bright-colored fruits and flowers. The butterflies and rose-beetles are the most gorgeous among insects; the humming-birds and parrots are the most gorgeous among birds. Nay, more: exactly like effects have been produced in two hemispheres on different tribes by the same causes. The plain brown swifts of the North have developed among tropical West Indian and South American orchids the metallic gorgets and crimson crests of the humming-bird; while a totally unlike group of Asiatic birds have developed among the rich flora of India and the Malay Archipelago the exactly similar plumage of the exquisite sun-birds. Just as bees depend upon flowers, and flowers upon bees, so the color-sense of animals has created the bright petals of blossoms; and the bright petals have reacted upon the tastes of the animals themselves, and through their tastes upon their own appearance.

XII.

SPECKLED TROUT.

It is a piece of the common vanity of anglers to suppose that they know something about speckled trout. A fox might almost as well pretend that he was intimately acquainted with the domestic habits of poultry, or an Iroquois describe the customs of the Algonquins from observations made upon the specimens who had come under his scalping-knife. I will allow that anglers are well versed in the necessity for fishing up-stream rather than in the opposite direction; and I grant that they have attained an empirical knowledge of the æsthetic preferences of trout in the matter of blue duns and red palmers; but that as a body they are familiar with the speckled trout at home I deny. If you wish to learn all about the race in its own life you must abjure rod and line, and creep quietly to the side of the pools in an unfished brooklet, like this on whose bank I am now seated; and then, if you have taken care not to let your shadow fall upon the water, you may sit and watch the live fish themselves for an hour together, as they bask lazily in the sunlight, or rise now and then at cloudy moments with a sudden dart at a May-fly who is trying in vain to lay her eggs unmolested on the surface of the stream. The trout in my little beck are fortunately too small even for poachers to care for tickling them; so I am able entirely to preserve them as objects for philosophical contemplation, without any danger of their being scared away from their accustomed haunts by intrusive anglers.

Trout always have a recognized home of their own, inhabited by a pretty fixed number of individuals. But if you catch the two sole denizens of a particular scour, you will find another pair installed in their place to-morrow. Young fry seem always ready to fill up the vacancies caused by the involuntary retirement of their elders. Their size depends almost entirely upon the quantity of food they can get; for an adult fish may weigh anything at any time of his life, and there is no limit to the dimensions they may theoretically attain. Mr. Herbert Spencer, who is an angler as well as a philosopher, well observes that where the trout are many they are generally small; and where they are large they are generally few. In the mill-stream down the valley they measure only six inches, though you may fill a basket easily enough on a cloudy day; but in the canal reservoir, where there are only half a dozen fish altogether, a magnificent eight-pounder has been taken more than once. In this way we can understand the origin of the great lake trout, which weigh sometimes forty pounds. They are common trout which have taken to living in broader waters, where large food is far more abundant, but where shoals of small fish would starve. The peculiarities thus impressed upon them have been handed down to their descendants, till at length they have become sufficiently marked to justify us in regarding them as a separate species. But it is difficult to say what makes a species in animals so very variable as fish. There are, in fact, no less than twelve kinds of trout wholly peculiar to the British Islands, and some of these are found in very restricted areas. Thus, the Loch Stennis trout inhabits only the tarns of Orkney; the Galway sea trout lives nowhere but along the west coast of Ireland; the gillaroo never strays out of the Irish loughs; the Killin charr is confined to a single sheet of water in Mayo; and other species belong exclusively to the Llanberis lakes, to Lough Melvin, or to a few mountain pools of Wales and Scotland. So great is the variety that may be produced by small changes of food and habitat. Even the salmon himself is only a river trout who has acquired the habit of going down to the sea, where he gets immensely increased quantities of food (for all the trout kind are almost omnivorous), and grows big in proportion. But he still retains many marks of his early existence as a river fish. In the first place, every salmon is hatched from the egg in fresh water, and grows up a mere trout. The young parr, as the salmon is called in this stage of its growth, is actually (as far as physiology goes) a mature fish, and is capable of producing milt, or male spawn, which long caused it to be looked upon as a separate species. It really represents, however, the early form of the salmon, before he took to his annual excursion to the sea. The ancestral fish, only a hundredth fraction in weight of his huge descendant, must have somehow acquired the habit of going seaward—possibly from a drying up of his native stream in seasons of drought. In the sea, he found himself suddenly supplied with an unwonted store of food, and grew, like all his kind under similar circumstances, to an extraordinary size. Thus he attains, as it were, to a second and final maturity. But salmon cannot lay their eggs in the sea; or at least, if they did, the young parr would starve for want of their proper food, or else be choked by the salt water, to which the old fish have acclimatized themselves. Accordingly, with the return of the spawning season there comes back an instinctive desire to seek once more the native fresh water. So the salmon return up stream to spawn, and the young are hatched in the kind of surroundings which best suit their tender gills. This instinctive longing for the old home may probably have arisen during an intermediate stage, when the developing species still haunted only the brackish water near the river mouths; and as those fish alone which returned to the head waters could preserve their race, it would soon grow hardened into a habit ingrained in the nervous system, like the migration of birds or the clustering of swarming bees around their queen. In like manner the Jamaican land-crabs, which themselves live on the mountain-tops, come down every year to lay their eggs in the Caribbean; because, like all other crabs, they pass their first larval stage as swimming tadpoles, and afterward take instinctively to the mountains, as the salmon takes to the sea. Such a habit could only have arisen by one generation after another venturing farther and farther inland, while always returning at the proper season to the native element for the deposition of the eggs.

These trout here, however, differ from the salmon in one important particular besides their relative size, and that is that they are beautifully speckled in their mature form, instead of being merely silvery like the larger species. The origin of the pretty speckles is probably to be found in the constant selection by the fish of the most beautiful among their number as mates. Just as singing-birds are in their fullest and clearest song at the nesting period, and just as many brilliant species only possess their gorgeous plumage while they are going through their courtship, and lose the decoration after the young brood is hatched, so the trout are most brightly colored at spawning time, and become lank and dingy after the eggs have been safely deposited. The parent fish ascend to the head-waters of their native river during the autumn season to spawn, and then, their glory dimmed, they return down-stream to the deep pools, where they pass the winter sulkily, as if ashamed to show themselves in their dull and dusky suits. But when spring comes round once more, and flies again become abundant, the trout begin to move up-stream afresh, and soon fatten out to their customary size and brilliant colors. It might seem at first sight that creatures so humble as these little fish could hardly have sufficiently developed æsthetic tastes to prefer one mate above another on the score of beauty. But we must remember that every species is very sensitive to small points of detail in its own kind, and that the choice would only be exerted between mates generally very like one another, so that extremely minute differences must necessarily turn the scale in favor of one particular suitor rather than his rivals. Anglers know that trout are attracted by bright colors, that they can distinguish the different flies upon which they feed, and that artificial flies must accordingly be made at least into a rough semblance of the original insects. Some scientific fishermen even insist that it is no use offering them a brown drake at the time of year or the hour of day when they are naturally expecting a red spinner. Of course their sight is by no means so perfect as our own, but it probably includes a fair idea of form, and an acute perception of color, while there is every reason to believe that all the trout family have a decided love of metallic glitter, such as that of silver or of the salmon's scales. Mr. Darwin has shown that the little stickleback goes through an elaborate courtship, and I have myself watched trout which seemed to me as obviously love-making as any pair of turtle-doves I ever saw. In their early life salmon fry and young trout are almost quite indistinguishable, being both marked with blue patches (known as "finger-marks") on their sides, which are remnants of the ancestral coloring once common to the whole race. But as they grow up, their later-acquired tastes begin to produce a divergence, due originally to this selective preference of certain beautiful mates ; and the adult salmon clothes himself from head to tail in sheeny silver, while the full-grown trout decks his sides with the beautiful speckles which have earned him his popular name. Countless generations of slight differences, selected from time to time by the strongest and handsomest fish, have sufficed at length to bring about these conspicuous variations from the primitive type, which the young of both races still preserve.

XIII.

DODDER AND BROOMRAPE.

This afternoon, strolling through the undercliff, I have come across two quaint and rather uncommon flowers among the straggling brushwood. One of them is growing like a creeper around the branches of this overblown gorse-bush. It is the lesser dodder, a pretty clustering mass of tiny pale pink convolvulus blossoms. The stem consists of a long red thread, twining round and round the gorse, and bursting out here and there into thick bundles of beautiful bell-shaped flowers. But where are the leaves ? You may trace the red threads through their labyrinthine windings up and down the supporting gorse-branches all in vain : there is not a leaf to be seen. As a matter of fact, the dodder has none. It is one of the most thoroughgoing parasites in all nature. Ordinary green-leaved plants live by making starches for themselves out of the carbonic acid in the air, under the influence of sunlight; but the dodder simply fastens itself on to another plant, sends down rootlets or suckers into its veins, and drinks up sap stored with ready-made starches or other food-stuffs, originally destined by its host for the supply of its own growing leaves, branches, and blossoms. It lives upon the gorse just as parasitically as the little green aphides live upon our rose-bushes. The material which it uses up in pushing forth its long thread-like stem and clustered bells is so much dead loss to the unfortunate plant on which it has fixed itself.

Old-fashioned books tell us that the mistletoe is a perfect parasite, while the dodder is an imperfect one; and I believe almost all botanists will still repeat the foolish saying to the present day. But it really shows considerable haziness as to what a true parasite is. The mistletoe is a plant which has taken, it is true, to growing upon other trees. Its very viscid berries are useful for attaching the seeds to the trunk of the oak or the apple; and there it roots itself into the body of its host. But it soon produces real green leaves of its own, which contain the ordinary chlorophyl found in other leaves, and help it to manufacture starch, under the influence of sunlight, on its own account. It is not, therefore, a complete drag upon the tree which it infests; for though it takes sap and mineral food from the host, it supplies itself with carbon, which is after all the important thing for plant-life. Dodder, however, is a parasite pure and simple. Its seeds fall originally upon the ground, and there root themselves at first like those of any other plant. But, as it grows, its long twining stem begins to curl for support round some other and stouter stalk. If it stopped there, and then produced leaves of its own, like the honeysuckle and the clematis, there would be no great harm done; and the dodder would be but another climbing plant the more in our flora. However, it soon insidiously repays the support given it by sending down little bud-like suckers, through which it draws up nourishment from the gorse or clover on which it lives. Thus it has no need to develop leaves of its own; and it accordingly employs all its stolen material in sending forth matted thread-like stems and bunch after bunch of bright flowers. As these increase and multiply, they at last succeed in drawing away all the nutriment from the supporting plant, which finally dies under the constant drain, just as a horse might die under the attacks of a host of leeches. But this matters little to the dodder, which has had time to be visited and fertilized by insects, and to set and ripen its numerous seeds. One species, the greater dodder, is thus parasitic upon hops and nettles; a second kind twines round flax; and the third, which I have here under my eyes, mainly confines its dangerous attentions to gorse, clover, and thyme. All of them are, of course, deadly enemies to the plants they infest.

How the dodder acquired this curious mode of life it is not difficult to see. By descent it is a bind-weed, or wild convolvulus, and its blossoms are in the main miniature convolvulus blossoms still. Now, all bind-weeds, as everybody knows, are climbing plants, which twine themselves round stouter stems for mere physical support. This is in itself a half-parasitic habit, because it enables the plant to dispense with the trouble of making a thick and solid stem for its own use. But just suppose that any bind-weed, instead of merely twining, were to put forth here and there little tendrils, something like those of the ivy, which managed somehow to grow into the bark of the host, and so naturally graft themselves to its tissues. In that case the plant would derive nutriment from the stouter stem with no expense to itself, and it might naturally be expected to grow strong and healthy, and hand down its peculiarities to its descendants. As the leaves would thus be rendered needless, they would first become very much reduced in size, and would finally disappear altogether, according to the universal custom of unnecessary organs. So we should get at length a leafless plant, with numerous flowers and seeds, just like the dodder. Parasites, in fact, whether animal or vegetable, always end by becoming mere reproductive sacs, mechanisms for the simple elaboration of eggs or seeds. This is just what has happened to the dodder before me.

The other queer plant here is a broomrape. It consists of a tall, somewhat faded-looking stem, upright instead of climbing, and covered with brown or purplish scales in the place of leaves. Its flowers resemble the scales in color, and the dead-nettle in shape. It is, in fact, a parasitic dead-nettle, a trifle less degenerate as yet than the dodder. This broomrape has acquired somewhat the same habits as the other plant, only that it fixes itself on the roots of clover or broom, from which it sucks nutriment by its own root, as the dodder does by its stem-suckers. Of course it still retains in most particulars its original characteristics as a dead-nettle ; it grows with their upright stem and their curiously shaped flowers, so specially adapted for fertilization by insect visitors. But it has naturally lost its leaves, for which it has no further use, and it possesses no chlorophyl, as the mistletoe does. Yet it has not probably been parasitic for as long a time as the dodder, since it still retains a dwindling trace of its leaves in the shape of dry purply scales, something like those of young asparagus shoots. These leaves are now, in all likelihood, actually undergoing a gradual atrophy, and we may fairly expect that in the course of a few thousand years they will disappear altogether. At present, however, they remain very conspicuous by their color, which is not green, owing to the absence of chlorophyl, but is due to the same pigment as that of the blossoms. This generally happens with parasites, or with that other curious sort of plants known as saprophytes, which live upon decaying living matter in the mould of forests. As they need no green leaves, but have often inherited leafy structures of some sort, in a more or less degenerate condition, from their self-supporting ancestors, they usually display most beautiful colors in their stems and scales, and several of them rank among our handsomest hothouse plants. Even the dodder has red stalks. Their only work in life being to elaborate the materials stolen from their host into the brilliant pigments used in the petals for attracting insect fertilizers, they pour this same dye into the stems and scales, which thus render them still more conspicuous to the insects' eyes. Moreover, as they use their whole material in producing flowers, many of these are very large and handsome ; one huge Sumatran species has a blossom which measures three feet across. On the other hand, their seeds are usually small and very numerous. Thousands of seeds must fall on unsuitable places, spring up, and waste all their tiny store of nourishment, find no host at hand on which to fasten themselves, and so die down for want of food. It is only by producing a few thousand young plants for every one destined ultimately to survive that dodders and broomrapes manage to preserve their types at all.

XIV.

DOG'S MERCURY AND PLANTAIN.

THE hedge and bank in Haye Lane are now a perfect tangled mass of creeping plants, among which I have just picked out a queer little three-cornered flower, hardly known even to village children, but christened by our old herbalists "dog's mercury." It is an ancient trick of language to call coarser or larger plants by the specific title of some smaller or cultivated kind, with the addition of an animal's name. Thus we have radish and horse-radish, chestnut and horse-chestnut, rose and dog-rose, parsnip and cow-parsnip, thistle and sow-thistle. On the same principle, a somewhat similar plant being known as mercury, this perennial weed becomes dog's mercury. Both, of course, go back to some imaginary medicinal virtue in the herb which made it resemble the metal in the eyes of old-fashioned practitioners.

Dog's mercury is one of the oddest English flowers I know. Each blossom has three small green petals, and either several stamens, or else a pistil, in the centre. There is nothing particularly remarkable in the flower being green, for thousands of other flowers are green and we never notice them as in any way unusual. In fact, we never as a rule notice green blossoms at all. Yet anybody who picked a piece of dog's mercury could not fail to be struck by its curious appearance. It does not in the least resemble the inconspicuous green flowers of the stinging-nettle, or of most forest trees : it has a very distinct set of petals which at once impress one with the idea that they ought to be colored. And so indeed they ought : for dog's mercury is a degenerate plant which once possessed a brilliant corolla and was fertilized by insects, but which has now fallen from its high estate and reverted to the less advanced mode of fertilization by the intermediation of the wind. For some unknown reason or other this species and all its relations have discovered that they get on better by the latter and usually more wasteful plan than by the former and usually more economical one. Hence they have given up producing large bright petals, because they no longer need to attract the eyes of insects ; and they have also given up the manufacture of honey, which under their new circumstances would be a mere waste of substance to them. But the dog's mercury still retains a distinct mark of its earlier insect-attracting habits in these three diminutive petals. Others of its relations have lost even these, so that the original floral form is almost completely obscured in their case. The spurges are familiar English roadside examples, and their flowers are so completely degraded that even botanists for a long time mistook their nature and analogies.

The male and female flowers of dog's mercury have taken to living upon separate plants. Why is this ? Well, there was no doubt a time when every blossom had both stamens and pistil, as dog-roses and buttercups always have. But when the plant took to wind fertilization it underwent a change of structure. The stamens on some blossoms became aborted, while the pistil became aborted on others. This was necessary in order to prevent self-fertilization ; for otherwise the pollen of each blossom, hanging out as it does to the wind, would have been very liable to fall upon its own pistil. But the present arrangement obviates any such contingency, by making one plant bear all the male flowers and another plant all the female ones. Why, again, are the petals green ? I think because dog's mercury would be positively injured by the visits of insects. It has no honey to offer them, and if they came to it at all, they would only eat up the pollen itself. Hence I suspect that those flowers among the mercuries which showed any tendency to retain the original colored petals would soon get weeded out, because insects would eat up all their pollen, thus preventing them from fertilizing others ; while those which had green petals would never be noticed and so would be permitted to fertilize one another after their new fashion. In fact, when a blossom which has once depended upon insects for its fertilization is driven by circumstances to depend upon the wind, it seems to derive a positive advantage from losing all those attractive features by which its ancestors formerly allured the eyes of bees or beetles.

Here, again, on the roadside is a bit of plantain. Everybody knows its flat rosette of green leaves and its tall spike of grass-like blossom, with long stamens hanging out to catch the breeze. Now plantain is a case exactly analogous to dog's mercury. It is an example of a degraded blossom. Once upon a time it was a sort of distant cousin to the veronica, that pretty sky-blue speedwell which abounds among the meadows in June and July. But these particular speedwells gave up devoting themselves to insects and became adapted for fertilization by the wind instead. So you must look close at them to see at all that the flowering spike is made up of a hundred separate little four-rayed blossoms, whose pale and faded petals are tucked away out of sight flat against the stem. Yet their shape and arrangement distinctly recall the beautiful veronica, and leave one in little doubt as to the origin of the plant. At the same time a curious device has sprung up which answers just the same purpose as the separation of the male and female flowers on the dog's mercury. Each plantain blossom has both stamens and pistils, but the pistils come to maturity first, and are fertilized by pollen blown to them from some neighboring spike. Their feathery plumes are admirably adapted for catching and utilizing any stray golden grain which happens to pass that way. After the pistils have faded, the stamens ripen, and hang out at the end of long waving filaments, so as to discharge all their pollen with effect. On each spike of blossoms the lower flowerets open first; and so, if you pick a half-blown spike, you will see that all the stamens are ripe below, and all the pistils above. Were the opposite arrangement to occur, the pollen would fall from the stamens to the lower flowers of the same stalk; but as the pistils below have always been fertilized and withered before the stamens ripen, there is no chance of any such accident and its consequent evil results. Thus one can see clearly that the plantain has become wholly adapted to wind-fertilization, and as a natural effect has all but lost its bright-colored corolla.

Common groundsel is also a case of the same kind; but here the degradation has not gone nearly so far. I venture to conjecture, therefore, that groundsel has been embarked for a shorter time upon its downward course. For evolution is not, as most people seem to fancy, a thing which used once to take place; it is a process taking place around us every day, and it must necessarily continue to take place to the end of all time. By family the groundsel is a daisy; but it has acquired the strange and somewhat abnormal habit of self-fertilization, which in all probability will ultimately lead to its total extinction. Hence it does not need the assistance of insects; and it has accordingly never developed or else got rid of the bright outer ray-florets which may once have attracted them. Its tiny bell-shaped blossoms still retain their dwarf yellow corollas; but they are almost hidden by the green cup-like investment of the flower-head, and they are not conspicuous enough to arrest the attention of the passing flies. Here, then, we have an example of a plant just beginning to start on the retrograde path already traversed by the plantain and the spurges. If we could meet prophetically with a groundsel of some remote future century, I have little doubt we should find its bell-shaped petals as completely degraded as those of the plantain in our own day.

The general principle which these cases illustrate is that when flowers have always been fertilized by the wind, they never have brilliant corollas; when they acquire the habit of impregnating their kind by the intervention of insects, they almost always acquire at the same time alluring colors, perfumes, and honey; and when they have once been so impregnated, and then revert once more to wind-fertilization, or become self-fertilizers, they generally retain some symptoms of their earlier habits, in the presence of dwarfed and useless petals, sometimes green, or if not green at least devoid of their former attractive coloring. Thus every plant bears upon its very face the history of its whole previous development.

XV.

BUTTERFLY PSYCHOLOGY.

A SMALL red-and-black butterfly poises statuesque above the purple blossom of this tall field-thistle. With its long sucker it probes industriously floret after floret of the crowded head, and extracts from each its wee drop of buried nectar. As it stands just at present, the dull outer sides of its four wings are alone displayed, so that it does not form a conspicuous mark for passing birds; but when it has drunk up the last drop of honey from the thistle flower, and flits joyously away to seek another purple mass of the same sort, it will open its red-spotted vans in the sunlight, and will then show itself off as one among the prettiest of our native insects. Each thistle-head consists of some two hundred separate little bell-shaped blossoms, crowded together for the sake of conspicuousness into a single group, just as the blossoms of the lilac or the syringa are crowded into larger though less dense clusters; and, as each separate floret has a nectary of its own, the bee or butterfly who lights upon the compound flower-group can busy himself for a minute or two in getting at the various drops of honey without the necessity for any further change of position than that of revolving upon his own axis. Hence these composite flowers are great favorites with all insects whose suckers are long enough to reach the bottom of their slender tubes.

The butterfly's view of life is doubtless on the whole a cheerful one. Yet his existence must be something so nearly mechanical that we probably overrate the amount of enjoyment which he derives from flitting about so airily among the flowers, and passing his days in the unbroken amusement of sucking liquid honey. Subjectively viewed, the butterfly is not a high order of insect; his nervous system does not show that provision for comparatively spontaneous thought and action which we find in the more intelligent orders, like the flies, bees, ants, and wasps. His nerves are all frittered away in little separate ganglia distributed among the various segments of his body, instead of being governed by a single great central organ, or brain, whose business it always is to correlate and co-ordinate complex external impressions. This shows that the butterfly's movements are almost all automatic, or simply dependent upon immediate external stimulants: he has not even that small capacity for deliberation and spontaneous initiative which belongs to his relation the bee. The freedom of the will is nothing to him, or extends at best to the amount claimed on behalf of Buridan's ass: he can just choose which of two equidistant flowers shall first have the benefit of his attention, and nothing else. Whatever view we take on the abstract metaphysical question, it is at least certain that the higher animals can do much more than this. Their brain is able to correlate a vast number of external impressions, and to bring them under the influence of endless ideas or experiences, so as finally to evolve conduct which differs very widely with different circumstances and different characters. Even though it be true, as determinists believe (and I reckon myself among them), that such conduct is the necessary result of a given character and given circumstances — or, if you will, of a particular set of nervous structures and a particular set of external stimuli—yet we all know that it is capable of varying so indefinitely, owing to the complexity of the structures, as to be practically incalculable. But it is not so with the butterfly. His whole life is cut out for him beforehand; his nervous connections are so simple, and correspond so directly with external stimuli, that we can almost predict with certainty what line of action he will pursue under any given circumstances. He is, as it were, but a piece of half-conscious mechanism, answering immediately to impulses from without, just as the thermometer answers to variations of temperature, and as the telegraphic indicator answers to each making and breaking of the electric current.

In early life the future butterfly emerges from the egg as a caterpillar. At once his many legs begin to move, and the caterpillar moves forward by their motion. But the mechanism which set them moving was the nervous system, with its ganglia working the separate legs of each segment. This movement is probably quite as automatic as the act of sucking in the new-born infant. The caterpillar walks, it knows not why, but simply because it has to walk. When it reaches a fit place for feeding, which differs according to the nature of the particular larva, it feeds automatically. Certain special external stimulants of sight, smell, or touch set up the appropriate actions in the mandibles, just as contact of the lips with an external body sets up sucking in the infant. All these movements depend upon what we call instinct—that is to say, organic habits registered in the nervous system of the race. They have arisen by natural selection alone, because those insects which duly performed them survived, and those which did not duly perform them died out. After a considerable span of life spent in feeding and walking about in search of more food, the caterpillar one day found itself compelled by an inner monitor to alter its habits. Why, it knew not; but, just as a tired child sinks to sleep, the gorged and full-fed caterpillar sank peacefully into a dormant state. Then its tissues melted one by one into a kind of organic pap, and its outer skin hardened into a chrysalis. Within that solid case new limbs and organs began to grow by hereditary impulses. At the same time the form of the nervous system altered, to suit the higher and freer life for which the insect was unconsciously preparing itself. Fewer and smaller ganglia now appeared in the tail segments (since no legs would any longer be needed there), while more important ones sprang up to govern the motions of the four wings. But it was in the head that the greatest changes took place. There, a rudimentary brain made its appearance, with large optic centres, answering to the far more perfect and important eyes of the future butterfly. For the flying insect will have to steer its way through open space, instead of creeping over leaves and stones; and it will have to suck the honey of flowers, as well as to choose its fitting mate, all of which demands from it higher and keener senses than those of the purblind caterpillar. At length one day the chrysalis bursts asunder, and the insect emerges to view on a summer morning as a full-fledged and beautiful butterfly.

For a minute or two it stands and waits till the air it breathes has filled out its wings, and till the warmth and sunlight have given it strength. For the wings are by origin a part of the breathing apparatus, and they require to be plimmed by the air before the insect can take to flight. Then, as it grows more accustomed to its new life, the hereditary impulse causes it to spread its vans abroad, and it flies. Soon a flower catches its eye, and the bright mass of color attracts it irresistibly, as the candle-light attracts the eye of a child a few weeks old. It sets off toward the patch of red or yellow, probably not knowing beforehand that this is the visible symbol of food for it, but merely guided by the blind habit of its race, imprinted with binding force in the very constitution of its body. Thus the moths, which fly by night and visit only white flowers whose corollas still shine out in the twilight, are so irresistibly led on by the external stimulus of light from a candle falling upon their eyes that they cannot choose but move their wings rapidly in that direction; and though singed and blinded twice or three times by the flame, must still wheel and eddy into it, till at last they perish in the scorching blaze. Their instincts, or, to put it more clearly, their simple nervous mechanism, though admirably adapted to their natural circumstances, cannot be equally adapted to such artificial objects as wax candles. The butterfly in like manner is attracted automatically by the color of his proper flowers, and settling upon them, sucks up their honey instinctively. But feeding is not now his only object in life: he has to find and pair with a suitable mate. That, indeed, is the great end of his winged existence. Here, again, his simple nervous system stands him in good stead. The picture of his kind is, as it were, imprinted on his little brain, and he knows his own mates the moment he sees them, just as intuitively as he knows the flowers upon which he must feed. Now we see the reason for the butterfly's large optic centres: they have to guide it in all its movements. In like manner, and by a like mechanism, the female butterfly or moth selects the right spot for laying her eggs, which of course depends entirely upon the nature of the young caterpillars' proper food. Each great group of insects has its own habits in this respect, may-flies laying their eggs on the water, many beetles on wood, flies on decaying animal matter, and butterflies mostly on special plants. Thus throughout its whole life the butterfly's activity is entirely governed by a rigid law, registered and fixed forever in the constitution of its ganglia and motor nerves. Certain definite objects outside it invariably produce certain definite movements on the insect's part. No doubt it is vaguely conscious of all that it does ; no doubt it derives a faint pleasure from due exercise of all its vital functions, and a faint pain when they are injured or thwarted ; but on the whole its range of action is narrowed and bounded by its hereditary instincts and their nervous correlatives. It may light on one flower rather than another ; it may choose a fresher and brighter mate rather than a battered and dingy one ; but its little subjectivity is a mere shadow compared with ours, and it hardly deserves to be considered as more than a semi-conscious automatic machine.

XVI.

BUTTERFLY ÆSTHETICS.

The other day, when I was watching that little red-spotted butterfly whose psychology I found so interesting, I hardly took enough account, perhaps, of the insect's own subjective feelings of pleasure and pain. The first great point to understand about these minute creatures is that they are, after all, mainly pieces of automatic mechanism : the second great point is to understand that they are probably something more than that as well. To-day I have found another exactly similar butterfly, and I am going to work out with myself the other half of the problem about him. Granted that the insect is, viewed intellectually, a cunning bit of nervous machinery, may it not be true at the same time that he is, viewed emotionally, a faint copy of ourselves ?

Here he stands on a purple thistle again, true, as usual, to the plant on which I last found him. There can be no doubt that he distinguishes one color from another, for you can artificially attract him by putting a piece of purple paper on a green leaf, just as the flower naturally attracts him with its native hue. Numerous observations and experiments have proved with all but absolute certainty that his discrimination of color is essentially identical with our own ; and I think, if we run our eye up and down nature, observing how universally all animals are attracted by pure and bright colors, we can hardly doubt that he appreciates and admires color as well as discriminates it. Mr. Darwin certainly judges that butterflies can show an æsthetic preference of the sort, for he sets down their own lovely hues to the constant sexual selection of the handsomest mates. We must not, however, take too human a measure of their capacities in this respect. It is sufficient to believe that the insect derives some direct enjoyment from the stimulation of pure color, and is hereditarily attracted by it wherever it may show itself. This pleasure draws it on, on the one hand, toward the gay flowers which form its natural food ; and, on the other hand, toward its own brilliant mates. Imprinted on its nervous system is a certain blank form answering to its own specific type ; and when the object corresponding to this blank form occurs in its neighborhood, the insect blindly obeys its hereditary instinct. But out of two or three such possible mates it naturally selects that which is most brightly spotted, and in other ways most perfectly fulfils the specific ideal. We need not suppose that the insect is conscious of making a selection or of the reasons which guide it in its choice : it is enough to believe that it follows the strongest stimulus, just as the child picks out the biggest and reddest apple from a row of ten. Yet such unconscious selections, made from time to time in generation after generation, have sufficed to produce at last all the beautiful spots and metallic eyelets of our loveliest English or tropical butterflies. Insects always accustomed to exercising their color-sense upon flowers and mates, may easily acquire a high standard of taste in that direction, while still remaining comparatively in a low stage as regards their intellectual condition. But the fact I wish especially to emphasize is this—that the flowers produced by the color-sense of butterflies and their allies are just those objects which we ourselves consider most lovely in nature; and that the marks and shades upon their own wings, produced by the long selective action of their mates, are just the things which we ourselves consider most beautiful in the animal world. In this respect, then, there seems to be a close community of taste and feeling between the butterfly and ourselves.

Let me note, too, just in passing, that while the upper half of the butterfly's wing is generally beautiful in color, so as to attract his fastidious mate, the under half, displayed while he is at rest, is almost always dull, and often resembles the plant upon which he habitually alights. The first set of colors is obviously due to sexual selection, and has for its object the making an effective courtship; but the second set is obviously due to natural selection, and has been produced by the fact that all those insects whose bright colors show through too vividly when they are at rest fall a prey to birds or other enemies, leaving only the best protected to continue the life of the species.

But sight is not the only important sense to the butterfly. He is largely moved and guided by smell as well. Both bees and butterflies seem largely to select the flowers they visit by means of smell, though color also aids them greatly. When we remember that in ants scent alone does duty instead of eyes, ears, or any other sense, it would hardly be possible to doubt that other allied insects possessed the same faculty in a high degree; and, as Dr. Bastian says, there seems good reason for believing that all the higher insects are guided almost as much by smell as by sight. Now it is noteworthy that most of those flowers which lay themselves out to attract bees and butterflies are not only colored but sweetly scented; and it is to this cause that we owe the perfumes of the rose, the lily-of-the-valley, the heliotrope, the jasmine, the violet, and the stephanotis. Night-flowering plants, which depend entirely for their fertilization upon moths, are almost always white, and have usually very powerful perfumes. Is it not a striking fact that these various scents are exactly those which human beings most admire, and which they artificially extract for essences? Here, again, we see that the æsthetic tastes of butterflies and men decidedly agree; and that the thyme or lavender whose perfume pleases the bee is the very thing which we ourselves choose to sweeten our rooms.

Finally, if we look at the sense of taste, we find an equally curious agreement between men and insects; for the honey which is stored by the flower for the bee and by the bee for its own use, is stolen and eaten up by man instead. Hence, when I consider the general continuity of nervous structure throughout the whole animal race, and the exact similarity of the stimulus in each instance, I can hardly doubt that the butterfly really enjoys life somewhat as we enjoy it, though far less vividly. I cannot but think that he finds honey sweet, and perfumes pleasant, and color attractive; that he feels a lightsome gladness as he flits in the sunshine from flower to flower, and that he knows a faint thrill of pleasure at the sight of his chosen mate. Still more is this belief forced upon me when I recollect that, so far as I can judge, throughout the whole animal world, save only in a few aberrant types, sugar is sweet to taste, and thyme to smell, and song to hear, and sunshine to bask in. Therefore, on the whole, while I admit that the butterfly is mainly an animated puppet, I must qualify my opinion by adding that it is a puppet which, after its vague little fashion, thinks and feels very much as we do.

XVII.

THE ORIGIN OF WALNUTS.

Mr. Darwin has devoted no small portion of his valuable life to tracing, in two bulky volumes, the Descent of Man. Yet I suppose it is probable that in our narrow anthropinism we should have refused to listen to him had he given us two volumes instead on the Descent of Walnuts. Viewed as a question merely of biological science, the one subject is just as important as the other. But the old Greek doctrine that "man is the measure of all things" is strong in us still. We form for ourselves a sort of pre-Copernican universe, in which the world occupies the central point of space, and man occupies the central point of the world. What touches man interests us deeply: what concerns him but slightly we pass over as of no consequence. Nevertheless, even the origin and development of walnuts is a subject upon which we may profitably reflect, not wholly without gratification and interest.

This kiln-dried walnut on my plate, which has suggested such abstract cogitations to my mind, is shown by its very name to be a foreign production; for the word contains the same root as Wales and Welsh, the old Teutonic name for men of a different race, which the Germans still apply to the Italians, and we ourselves to the last relics of the old Keltic population in Southern Britain. It means "the foreign nut," and it comes for the most part from the south of Europe. As a nut, it represents a very different type of fruit from the strawberry and raspberry, with their bright colors, sweet juices, and nutritious pulp. Those fruits which alone bear the name in common parlance are attractive in their object; the nuts are deterrent. An orange or a plum is brightly tinted with hues which contrast strongly with the surrounding foliage; its pleasant taste and soft pulp all advertise it for the notice of birds or monkeys, as a means for assisting in the dispersion of its seed. But a nut, on the contrary, is a fruit whose actual seed contains an abundance of oils and other pleasant food-stuffs, which must be carefully guarded against the depredations of possible foes. In the plum or the orange we do not eat the seed itself: we only eat the surrounding pulp. But in the walnut the part which we utilize is the embryo plant itself; and so the walnut's great object in life is to avoid being eaten. Accordingly, that part of the fruit which in the plum is stored with sweet juices is, in the walnut, filled with a bitter and very nauseous essence. We seldom see this bitter covering in our over-civilized life, because it is, of course, removed before the nuts come to table. The walnut has but a thin shell, and is poorly protected in comparison with some of its relations, such as the American butternut, which can only be cracked by a sharp blow from a hammer—or even the hickory, whose hard covering has done more to destroy the teeth of New Englanders than all other causes put together, and New England teeth are universally admitted to be the very worst in the world. Now, all nuts have to guard against squirrels and birds; and therefore their peculiarities are exactly opposite to those of succulent fruits. Instead of attracting attention by being brightly colored, they are invariably green like the leaves while they remain on the tree, and brown or dusky like the soil when they fall upon the ground beneath; instead of being inclosed in sweet coats, they are provided with bitter, acrid, or stinging husks; and, instead of being soft in texture, they are surrounded by hard shells, like the cocoanut, or have a perfectly solid kernel, like the vegetable ivory.

The origin of nuts is thus exactly the reverse side of the origin of fruits. Certain seeds, richly stored with oils and starches for aiding the growth of the young plant, are exposed to the attacks of squirrels, monkeys, parrots, and other arboreal animals. The greater part of them are eaten and completely destroyed by these their enemies, and so never hand down their peculiarities to any descendants. But all fruits vary a little in sweetness and bitterness, pulpy or stringy tendencies. Thus a few among them happen to be protected from destruction by their originally accidental possession of a bitter husk, a hard shell, or a few awkward spines and bristles. These the monkeys and squirrels reject; and they alone survive as the parents of future generations. The more persistent and the hungrier their foes become, the less will a small degree of bitterness or hardness serve to protect them. Hence, from generation to generation, the bitterness and the hardness will go on increasing, because only those nuts which are the nastiest and the most difficult to crack will escape destruction from the teeth or bills of the growing and pressing population of rodents and birds. The nut which best survives on the average is that which is least conspicuous in color, has a rind of the most objectionable taste, and is inclosed in the most solid shell. But the extent to which such precautions become necessary will depend much upon the particular animals to whose attacks the nuts of each country are exposed. The European walnut has only to defy a few small woodland animals, who are sufficiently deterred by its acrid husk ; the American butternut has to withstand the long teeth of much more formidable forestine rodents, whom it sets at naught with its stony and wrinkled shell ; and the tropical cocoas and Brazil nuts have to escape the monkey, who pounds them with stones, or flings them with all his might from the tree-top so as to smash them in their fall against the ground below.

Our own hazelnut supplies an excellent illustration of the general tactics adopted by the nuts at large. The little red tufted blossoms which everybody knows so well in early spring are each surrounded by a bunch of three bracts ; and as the nut grows bigger, these bracts form a green leaf-like covering, which causes it to look very much like the ordinary foliage of the hazel-tree. Besides, they are thickly set with small prickly hairs, which are extremely annoying to the fingers, and must prove far more unpleasant to the delicate lips and noses of lower animals. Just at present the nuts have reached this stage in our copses ; but as soon as autumn sets in, and the seeds are ripe, they will turn brown, fall out of their withered investment, and easily escape notice on the soil beneath, where the dead leaves will soon cover them up in a mass of shrivelled brown, indistinguishable in shade from the nuts themselves. Take, as an example of the more carefully protected tropical kinds, the cocoanut. Growing on a very tall palm-tree, it has to fall a considerable distance toward the earth ; and so it is wrapped round in a mass of loose knitted fibre, which breaks the fall just as a lot of soft wool would do. Then, being a large nut, fully stored with an abundance of meat, it offers special attractions to animals, and consequently requires special means of defence. Accordingly its shell is extravagantly thick, only one small soft spot being left at the blunter end, through which the young plant may push its head. Once upon a time, to be sure, the cocoanut contained three kernels, and had three such soft spots or holes ; but now two of them are aborted, and the two holes remain only in the form of hard scars. The Brazil-nut is even a better illustration. Probably few people know that the irregular angular nuts which appear at dessert by that name are originally contained inside a single round shell where they fit tightly together, and acquire their queer indefinite shapes by mutual pressure. So the South American monkey has first to crack the thick external common shell against a stone or otherwise ; and, if he is successful in this process, he must afterward break the separate sharp-edged inner nuts with his teeth—a performance which is always painful and often ineffectual.

Yet it is curious that nuts and fruits are really produced by the very slightest variations on a common type, so much so that the technical botanist does not recognize the popular distinction between them at all. In his eyes, the walnut and the cocoanut are not nuts, but " drupaceous fruits," just like the plum and the cherry. All four alike contain a kernel within, a hard shell outside it, and a fibrous mass outside that again, bounded by a thin external layer. Only, while in the plum and cherry this fibrous mass becomes succulent and fills with sugary juice, in the walnut its juice is bitter, and in the cocoanut it has no juice at all, but remains a mere matted layer of dry fibres. And while the thin external skin becomes purple in the plum and red in the cherry as the fruits ripen, it remains green and brown in the walnut and cocoanut all their time. Nevertheless, Darwinism shows us both here and elsewhere that the popular distinction answers to a real difference of origin and function. When a seed-vessel, whatever its botanical structure, survives by dint of attracting animals, it always acquires a bright-colored envelope and a sweet pulp ; while it usually possesses a hard seed-shell, and often infuses bitter essences into its kernel. On the other hand, when a seed-vessel survives by escaping the notice of animals, it generally has a sweet and pleasant kernel, which it protects by a hard shell and an inconspicuous and nauseous envelope. If the kernel itself is bitter, as with the horse-chestnut, the need for disguise and external protection is much lessened. But the best illustration of all is seen in the West Indian cashew-nut, which is what Alice in Wonderland would have called a portmanteau seed-vessel—a fruit and a nut rolled into one. In this curious case, the stalk swells out into a bright-colored and juicy mass, looking something like a pear, but of course containing no seeds ; while the nut grows out from its end, secured from intrusion by a covering with a pungent juice, which burns and blisters the skin at a touch. No animal except man can ever successfully tackle the cashew-nut itself ; but by eating the pear-like stalk other animals ultimately aid in distributing the seed. The cashew thus vicariously sacrifices its fruit-stem for the sake of preserving its nut.

All nature is a continuous game of cross-purposes. Animals perpetually outwit plants, and plants in return once more outwit animals. Or, to drop the metaphor, those animals alone survive which manage to get a living in spite of the protections adopted by plants ; and those plants alone survive whose peculiarities happen successfully to defy the attack of animals. There you have the Darwinian Iliad in a nutshell.

XVIII.

A PRETTY LAND-SHELL.

THE heavy rains which have done so much harm to the standing corn have at least had the effect of making the country look greener and lovelier than I have seen it look for many seasons. There is now a fresh verdure about the upland pastures and pine woods which almost reminds one of the deep valleys of the Bernese Oberland in early spring. Last year's continuous wet weather gave the trees and grass a miserable draggled appearance ; but this summer's rain, coming after a dry spring, has brought out all the foliage in unwonted luxuriance ; and everybody (except the British farmer) agrees that we have never seen the country look more beautiful. Though the year is now so far advanced, the trees are still as green as in springtide ; and the meadows, with their rich aftermath springing up apace, look almost as lush and fresh as they did in early June. Londoners who get away to the country or the seaside this month will enjoy an unexpected treat in seeing the fields as they ought to be seen a couple of months sooner in the season.

Here, on the edge of the down, where I have come up to get a good blowing from the clear south-west breeze, I have just sat down to rest myself a while and to admire the view, and have reverted for a moment to my old habit of snail-hunting. Years ago, when evolution was an infant—an infant much troubled by the complaints inseparable from infancy, but still a sturdy and vigorous child, destined to outlive and outgrow its early attacks—I used to collect slugs and snails, from an evolutionist standpoint, and put their remains into a cabinet ; and to this day I seldom go out for a walk without a few pill-boxes in my pocket, in case I should happen to hit upon any remarkable specimen. Now here in the tall moss which straggles over an old heap of stones I have this moment lighted upon a beautifully marked shell of our prettiest English snail. How beautiful it is I could hardly make you believe, unless I had you here and could show it to you; for most people only know the two or three ugly brown or banded snails that prey upon their cabbages and lettuces, and have no notion of the lovely shells to be found by hunting among English copses and under the dead leaves of Scotch hill-sides. This cyclostoma, however—I *must* trouble you with a Latin name for once—is so remarkably pretty, with its graceful elongated spiral whorls, and its delicately chiselled fretwork tracery, that even naturalists (who have perhaps, on the whole, less sense of beauty than any class of men I know) have recognized its loveliness by giving it the specific epithet of *elegans*. It is big enough for anybody to notice it, being about the size of a periwinkle; and its exquisite stippled chasing is strongly marked enough to be perfectly visible to the naked eye. But besides its beauty, the cyclostoma has a strong claim upon our attention because of its curious history.

Long ago, in the infantile days of evolutionism, I often wondered why people made collections on such an irrational plan. They always try to get what they call the most typical specimens, and reject all those which are doubtful or intermediate. Hence the dogma of the fixity of species becomes all the more firmly settled in their minds, because they never attend to the existing links which still so largely bridge over the artificial gaps created by our nomenclature between kind and kind. I went to work on the opposite plan, collecting all those aberrant individuals which most diverged from the specific type. In this way I managed to make some series so continuous that one might pass over specimens of three or four different kinds, arranged in rows, without ever being able to say quite clearly, by the eye alone, where one group ended and the next group began. Among the snails such an arrangement is peculiarly easy; for some of the species are very indefinite, and the varieties are numerous under each species. Nothing can give one so good a notion of the plasticity of organic forms as such a method. The endless varieties and intermediate links which exist among dogs is the nearest example to it with which ordinary observers are familiar.

But the cyclostoma is a snail which introduces one to still deeper questions. It belongs in all our scientific classifications to the group of lung-breathing mollusks, like the common garden snail. Yet it has one remarkable peculiarity: it possesses an operculum, or door to its shell, like that of the periwinkle. This operculum represents among the univalves the under-shell of the oyster or other bivalves; but it has completely disappeared in most land and fresh-water snails, as well as among many marine species. The fact of its occurrence in the cyclostoma would thus be quite inexplicable if we were compelled to regard it as a descendant of the other lung-breathing mollusks. So far as I know, all naturalists have till lately always so regarded it; but there can be very little doubt, with the new light cast upon the question by Darwinism, that they are wrong. There exists in all our ponds and rivers another snail, not breathing by means of lungs, but provided with gills, known as paludina. This paludina has a door to its shell, like the cyclostoma; and so, indeed, have all its allies. Now, strange as it sounds to say so, it is pretty certain that we must really class this lung-breathing cyclostoma among the gill-breathers, because of its close resemblance to the paludina. It is, in fact, one of these gill-breathing pond-snails which has taken to living on dry land, and so has acquired the habit of producing lungs. All molluscan lungs are very simple: they consist merely of a small sac or hollow behind the head, lined with blood-vessels; and every now and then the snail opens this sac, allowing the air to get in and out by natural change, exactly as when we air a room by opening the windows. So primitive a mechanism as this could be easily acquired by any soft-bodied animal like a snail. Besides, we have many intermediate links between the pond-snails and my cyclostoma here. There are some species which live in moist moss, or the beds of trickling streams. There are others which go farther from the water, and spend their days in damp grass. And there are yet others which have taken to a wholly terrestrial existence in woods or meadows and under heaps of stones. All of them agree with the pond-snails in having an operculum, and so differ from the ordinary land and river-snails, the mouths of whose shells are quite unprotected. Thus land-snails have two separate origins—one large group (including the garden-snail) being derived from the common fresh-water mollusks, while another much smaller group (including the cyclostoma) is derived from the operculated pond-snails.

How is it, then, that naturalists had so long overlooked this distinction? Simply because their artificial classification is based entirely upon the nature of the breathing apparatus. But, as Mr. Wallace has well pointed out, obvious and important functional differences are of far less value in tracing relationship than insignificant and unimportant structural details. Any water-snail may have to take to a terrestrial life if the ponds in which it lives are liable to dry up during warm weather. Those individuals alone will then survive which display a tendency to oxygenize their blood by some rudimentary form of lung. Hence the possession of lungs is not the mark of a real genealogical class, but a mere necessary result of a terrestrial existence. On the other hand, the possession of an operculum, unimportant as it may be to the life of the animal, is a good test of relationship by descent. All snails which take to living on land, whatever their original form, will acquire lungs; but an operculated snail will retain its operculum, and so bear witness to its ancestry; while a snail which is not operculated will of course show no tendency to develop such a structure, and so will equally give a true testimony as to its origin. In short, the less functionally useful any organ is, the higher is its value as a gauge of its owner's pedigree, like a Bourbon nose or an Austrian lip.

XIX.

DOGS AND MASTERS.

Probably the most forlorn and abject creature to be seen on the face of the earth is a masterless dog. Slouching and slinking along, cringing to every human being it chances to meet, running away with its tail between its legs from smaller dogs whom under other circumstances it would accost with a gruff who-the-dickens-are-you sort of growl—it forms the very picture of utter humiliation and self-abasement. Grip and I have just come across such a lost specimen of stray doghood, trying to find his way back to his home across the fields—I fancy he belongs to a travelling show which left the village yesterday—and it is quite refreshing to watch the air of superior wisdom and calm but mute compassionateness with which Grip casts his eye sidelong upon that wretched masterless vagrant, and passes him by without even a nod. He looks up to me complacently as he trots along by my side, and seems to say with his eye, "Poor fellow! he's lost his master, you know—careless dog that he is!" I believe the lesson has had a good moral effect upon Grip's own conduct, too; for he has now spent ten whole minutes well within my sight, and has resisted the most tempting solicitations to ratting and rabbiting held out by half a dozen holes and burrows in the hedge-wall as we go along.

This total dependence of dogs upon a master is a very interesting example of the growth of inherited instincts. The original dog, who was a wolf or something very like it, could not have had any such artificial feeling. He was an independent, self-reliant animal, quite well able to look after himself on the boundless plains of Central Europe or High Asia. But at least as early as the days of the Danish shell-mounds, perhaps thousands of years earlier, man had learned to tame the dog and to employ him as a friend or servant for his own purposes. Those dogs which best served the ends of man were preserved and increased; those which followed too much their own original instincts were destroyed or at least discouraged. The savage hunter would be very apt to fling his stone axe at the skull of a hound which tried to eat the game he had brought down with his flint-tipped arrow, instead of retrieving it : he would be most likely to keep carefully and feed well on the refuse of his own meals the hound which aided him most in surprising, killing, and securing his quarry. Thus there sprang up between man and the dog a mutual and ever-increasing sympathy which on the part of the dependent creature has at last become organized into an inherited instinct. If we could only thread the labyrinth of a dog's brain. we should find somewhere in it a group of correlated nerve-connections answering to this universal habit of his race ; and the group in question would be quite without any analogous mechanism in the brain of the ancestral wolf. As truly as the wing of the bird is adapted to its congenital instinct of flying, as truly as the nervous system of the bee is adapted to its congenital instinct of honeycomb building, just so truly is the brain of the dog adapted to its now congenital instinct of following and obeying a master. The habit of attaching itself to a particular human being is nowadays ingrained in the nerves of the modern dog just as really, though not quite so deeply, as the habit of running or biting is ingrained in its bones and muscles. Every dog is born into the world with a certain inherited structure of limbs, sense-organs, and brain : and this inherited structure governs all its future actions, both bodily and mental. It seeks a master because it is endowed with master-seeking brain organs ; it is dissatisfied until it finds one, because its native functions can have free play in no other way. Among a few dogs, like those of Constantinople, the instinct may have died out by disuse, as the eyes of cave animals have atrophied for want of light ; but when a dog has once been brought up from puppyhood under a master, the instinct is fully and freely developed, and the masterless condition is thenceforth for him a thwarting and disappointing of all his natural feelings and affections.

Not only have dogs as a class acquired a special instinct with regard to humanity generally, but particular breeds of dogs have acquired particular instincts with regard to certain individual acts. Nobody doubts that the muscles of a greyhound are specially correlated to the acts of running and leaping ; or that the muscles of a bulldog are specially correlated to the act of fighting. The whole external form of these creatures has been modified by man's selective action for a deliberate purpose : we breed, as we say, from the dog with the best points. But besides being able to modify the visible and outer structure of the animal, we are also able to modify, by indirect indications, the hidden and inner structure of the brain. We choose the best ratter among our terriers, the best pointer, retriever, or setter among other breeds, to become the parents of our future stock. We thus half unconsciously select particular types of nervous system in preference to others. Once upon a time we used even to rear a race of dogs with a strange instinct for turning the spit in our kitchens ; and to this day the Cubans rear bloodhounds with a natural taste for hunting down the trail of runaway negroes. Now, everybody knows that you cannot teach one sort of dog the kind of tricks which come by instinct to a different sort. No amount of instruction will induce a well-bred terrier to retrieve your handkerchief : he insists upon worrying it instead. So no amount of instruction will induce a well-bred retriever to worry a rat : he brings it gingerly to your feet, as if it was a dead partridge. The reason is obvious, because no one would breed from a retriever which worried or from a terrier which treated its natural prey as if it were a stick. Thus the brain of each kind is hereditarily supplied with certain nervous connections wanting in the brain of other kinds. We need no more doubt the reality of the material distinction in the brain than we need doubt it in the limbs and jaws of the greyhound and the bulldog. Those who have watched closely the different races of men can hardly hesitate to believe that something analogous exists in our own case. While the highest types are, as Mr. Herbert Spencer well puts it, to some extent "organically moral" and structurally intelligent, the lowest types are congenitally deficient. A European child learns to read almost by nature (for Dogberry was essentially right after all), while a Negro child learns to read by painful personal experience. And savages brought to Europe and "civilized" for years often return at last with joy to their native home, cast off their clothes and their outer veneering, and take once more to the only life for which their nervous organization naturally fits them. "What is bred in the bone," says the wise old proverb, "will out in the blood."

XX.

BLACKCOCK.

Just at the present moment the poor black grouse are generally having a hot time of it. After their quiet spring and summer they suddenly find their heath-clad wastes invaded by a strange epidemic of men, dogs, and hideous shooting implements; and being as yet but young and inexperienced, they are falling victims by the thousand to their youthful habit of clinging closely for protection to the treacherous reed-beds. A little later in the season, those of them that survive will have learned more wary ways: they will pack among the juniper thickets, and become as cautious on the approach of perfidious man as their cunning cousins, the red grouse of the Scottish moors. But so far youthful innocence prevails; no sentinels as yet are set to watch for the distant gleam of metal, and no foreshadowing of man's evil intent disturbs their minds as they feed in fancied security upon the dry seeds of the marsh plants in their favorite sedges.

The great families of the pheasants and partridges, in which the blackcock must be included, may be roughly divided into two main divisions so far as regards their appearance and general habits. The first class consists of splendidly colored and conspicuous birds, such as the peacock, the golden pheasant, and the tragopan; and these are, almost without exception, originally jungle-birds of tropical or sub-tropical lands, though a few of them have been acclimatized or domesticated in temperate countries. They live in regions where they have few natural enemies, and where they are little exposed to the attacks of man. Most of them feed more or less upon fruits and bright-colored food-stuffs, and they are probably every one of them polygamous in their habits. Thus we can hardly doubt that the male birds, which alone possess the brilliant plumage of their kind, owe their beauty to the selective preference of their mates; and that the taste thus displayed has been aroused by their relation to their specially gay and bright natural surroundings. The most lovely species of pheasants are found among the forests of the Himalayas and the Malay Archipelago, with their gorgeous fruits and flowers and their exquisite insects. Even in England our naturalized Oriental pheasants still delight in feeding upon blackberries, sloes, haws, and the pretty fruit of the honeysuckle and the holly; while our dingier partridges and grouse subsist rather upon heather, grain, and small seeds. Since there must always be originally nearly as many cocks as hens in each brood, it will follow that only the handsomest or most attractive in the polygamous species will succeed in attracting to them a harem; and as beauty and strength usually go hand in hand, they will also be the conquerors in those battles which are universal with all polygamists in the animal world. Thus we account for the striking and conspicuous difference between the peacock and the peahen, or between the two sexes in the pheasant, the turkey, and the domestic fowl.

On the other hand, the second class consists of those birds which are exposed to the hostility of many wild animals, and more especially of man. These kinds, typified by the red grouse, partridges, quails, and guinea-fowls, are generally dingy in hue, with a tendency to pepper-and-salt in their plumage; and they usually display very little difference between the sexes, both cocks and hens being colored and feathered much alike. In short, they are protectively designed, while the first class are attractive. Their plumage resembles as nearly as possible the ground on which they sit or the covert in which they skulk. They are thus enabled to escape the notice of their natural enemies, the birds of prey, from whose ravages they suffer far more in a state of nature than from any other cause. We may take the ptarmigans as the most typical example of this class of birds; for in summer their zigzagged black-and-brown attire harmonizes admirably with the patches of faded heath and soil upon the mountain-side, as every sportsman well knows; while in the winter their pure white plumage can scarcely be distinguished from the snow in which they lie huddled and crouching during the colder months. Even in the brilliant species, Mr. Darwin and Mr. Wallace have pointed out that the ornamental colors and crest are never handed down to female descendants when the habits of nesting are such that their mothers would be exposed to danger by their conspicuousness during incubation. Speaking broadly, only those female birds which build in hollow trees or make covered nests have bright hues at all equal to those of the males. A female bird nesting in the open would be cut off if it showed any tendency to reproduce the brilliant coloring of its male relations.

Now the blackcock occupies to some extent an intermediate position between these two types of pheasant life, though it inclines on the whole to that first described. It is a polygamous bird, and it differs most conspicuously in plumage from its consort, the gray-hen, as may be seen from the very names by which they are each familiarly known. Yet, though the blackcock is handsome enough, and shows evident marks of selective preference on the part of his ancestral hens, this preference has not exerted itself largely in the direction of bright color, and that for two reasons. In the first place the blackcock does not feed upon brilliant food-stuffs, but upon small bog-berries, hard seeds, and young shoots of heather, and it is probable that an æsthetic taste for pure and dazzling hues is almost confined to those creatures which, like butterflies, humming-birds, and parrots, seek their livelihood among beautiful fruits or flowers. In the second place, red, yellow, or orange ornaments would render the blackcock too conspicuous a mark for the hawk, the falcon, or the weapons of man; for we must remember that only those blackcocks survive from year to year and hand down their peculiarities to descendants which succeed in evading the talons of birds of prey or the small-shot of sportsmen. Feeding as they do on the open, they are not protected, like jungle-birds, by the shade of trees. Thus any bird which showed any marked tendency to develop brighter or more conspicuous plumage would almost infallibly fall a victim to one or other of his many foes; and however much his beauty might possibly charm his mates (supposing them for the moment to possess a taste for color), he would have no chance of transmitting it to a future generation. Accordingly, the decoration of the blackcock is confined to glossy plumage and a few ornamental tail-feathers. The gray-hen herself still retains the dull and imitative coloring of the grouse race generally; and as for the cocks, even if a fair percentage of them is annually cut off through their comparative conspicuousness as marks, their loss is less felt than it would be in a monogamous community. Every spring the blackcock hold a sort of assembly or court of love, at which the pairing for the year takes place. The cocks resort to certain open and recognized spots, and there invite the gray-hens by their calls, a little duelling going on meanwhile. During these meetings they show off their beauty with great emulation, after the fashion with which we are all familiar in the case of the peacock; and when they have gained the approbation of their mates and maimed or driven away their rivals, they retire with their respective families. Unfortunately, like most polygamists, they make bad fathers, leaving the care of their young almost entirely to the hens. According to the veracious account of Artemus Ward, the great Brigham Young himself pathetically descanted upon the difficulty of extending his parental affections to 131 children. The imperious blackcock seems to labor under the same sentimental disadvantage.

XXI.

BINDWEED.

Not the least beautiful among our native wild flowers are many of those which grow, too often unheeded, along the wayside of every country-road. The hedge-bordered highway on which I am walking to-day, to take my letters to the village post, is bordered on either side with such a profusion of color as one may never see equalled during many years' experience of tropical or sub-tropical lands. Jamaica and Ceylon could produce nothing so brilliant as this tangled mass of gorse, and thistle, and St. John's-wort, and centaury, intermingled with the lithe and whitening sprays of half-opened clematis. And here, on the very edge of the road, half smothered in its gray dust, I have picked a pretty little convolvulus blossom, with a fly buried head-foremost in its pink bell; and I am carrying them both along with me as I go, for contemplation and study. For this little flower, the lesser bindweed, is rich in hints as to the strange ways in which Nature decks herself with so much waste loveliness, whose meaning can only be fully read by the eyes of man, the latest comer among her children. The old school of thinkers imagined that beauty was given to flowers and insects for the sake of man alone: it would not, perhaps, be too much to say that, if the new school be right, the beauty is not in the flowers and insects themselves at all, but is read into them by the fancy of the human race. To the butterfly the world is a little beautiful; to the farm-laborer it is only a trifle more beautiful; but to the cultivated man or the artist it is lovely in every cloud and shadow, in every tiny blossom and passing bird.

The outer face of the bindweed, the exterior of the cup, so to speak, is prettily marked with five dark russet-red bands, between which the remainder of the corolla is a pale pinky-white in hue. Nothing could be simpler and prettier than this alternation of dark and light belts; but how is it produced? Merely thus. The convolvulus blossom in the bud is twisted or contorted round and round, part of the cup being folded inside, while the five joints of the corolla are folded outside, much after the fashion of an umbrella when rolled up. And just as the bits of the umbrella which are exposed when it is folded become faded in color, so the bits of the bindweed blossom which are outermost in the bud become more deeply oxidized than the other parts, and acquire a russet-red hue. The belted appearance which thus results is really as accidental, if I may use that unphilosophical expression, as the belted appearance of the old umbrella, or the wrinkles caused by the waves on the sea-sands. The flower happened to be folded so, and got colored, or discolored, accordingly. But when a man comes to look at it, he recognizes in the alternation of colors and the symmetrical arrangement one of those elements of beauty with which he is familiar in the handicraft of his own kind. He reads an intention into this result of natural causes, and personifies Nature as though she worked with an æsthetic design in view, just as a decorative artist works when he similarly alternates colors or arranges symmetrical and radial figures on a cup or other piece of human pottery. The beauty is not in the flower itself; it is in the eye which sees and the brain which recognizes the intellectual order and perfection of the work.

I turn the bindweed blossom mouth upward, and there I see that these russet marks, though paler on the inner surface, still show faintly through the pinky white corolla. This produces an effect not unlike that of a delicate shell cameo, with its dainty gradations of semi-transparent white and interfusing pink. But the inner effect can be no more designed with an eye to beauty than the outer one was; and the very terms in which I think of it clearly show that my sense of its loveliness is largely derived from comparison with human handicraft. A farmer would see in the convolvulus nothing but a useless weed; a cultivated eye sees in it just as much as its nature permits it to see. I look closer, and observe that there are also thin lines running from the circumference to the centre, midway between the dark belts. These lines, which add greatly to the beauty of the flower, by marking it out into zones, are also due to the folding in the bud; they are the inner angles of the folds, just as the dark belts are the overlapping edges of the outer angles. But, in addition to the minor beauty of these little details, there is the general beauty of the cup as a whole, which also calls for explanation. Its shape is as graceful as that of any Greek or Etruscan vase, as swelling and as simply beautiful as any beaker. Can I account for these peculiarities on mere natural grounds as well as for the others? I somehow fancy I can.

The bindweed is descended from some earlier ancestors which had five separate petals, instead of a single fused and circular cup. But in the convolvulus family, as in many others, these five petals have joined into a continuous rim or bowl, and the marks on the blossom where it was folded in the bud still answer to the five petals. In many plants you can see the pointed edges of the former distinct flower-rays as five projections, though their lower parts have coalesced into a bell-shaped or tubular blossom, as in the common harebell. How this comes to pass we can easily understand if we watch an unopened fuchsia; for there the four bright-colored sepals remain joined together till the bud is ready to open, and then split along a line marked out from the very first. In the plastic bud condition it is very easy for parts usually separate so to grow out in union with one another. I do not mean that separate pieces actually grow together, but that pieces which usually grow distinct sometimes grow united from the very first. Now, four or five petals, radially arranged, in themselves produce that kind of symmetry which man, with his intellectual love for order and definite patterns, always finds beautiful. But the symmetry in the flower simply results from the fact that a single whorl of leaves has grown into this particular shape, while the outer and inner whorls have grown into other shapes; and every such whorl always and necessarily presents us with an example of the kind of symmetry which we so much admire. Again, when the petals forming a whorl coalesce, they must, of course, produce a more or less regular circle. If the points of the petals remain as projections, then we get a circle with vandyked edges, as in the lily of the valley; if they do not project, then we get a simple circular rim, as in the bindweed. All the lovely shapes of bell-blossoms are simply due to the natural coalescence of four, five, or six petals; and this coalescence is again due to an increased certainty of fertilization secured for the plant by the better adaptation to insect visits. Similarly, we know that the colors of the corolla have been acquired as a means of rendering the flower conspicuous to the eyes of bees or butterflies; and the hues which so prove attractive to insects are of the same sort which arouse pleasurable stimulation in our own nerves. Thus the whole loveliness of flowers is in the last resort dependent upon all kinds of accidental causes—causes, that is to say, into which the deliberate design of the production of beautiful effects did not enter as a distinct factor. Those parts of nature which are of such a sort as to arouse in us certain feelings we call beautiful; and those parts which are of such a sort as to arouse in us the opposite feelings we call ugly. But the beauty and the ugliness are not parts of the things; they are merely human modes of regarding some among their attributes. Wherever in nature we find pure color, symmetrical form, and intricate variety of pattern, we imagine to ourselves that nature designs the object to be beautiful. When we trace these peculiarities to their origin, however, we find that each of them owes its occurrence to some special fact in the history of the object; and we are forced to conclude that the notion of intentional design has been read into it by human analogies. All nature is beautiful, and most beautiful for those in whom the sense of beauty is most highly developed; but it is not beautiful at all except to those whose own eyes and emotions are fitted to perceive its beauty.

XXII.

ON CORNISH CLIFFS.

I AM lying on my back in the sunshine, close to the edge of a great broken precipice, beside a clambering Cornish fishing village. In front of me is the sea, bluer than I have seen it since last I lay in like fashion a few months ago on the schistose slopes of the Maurettes at Hyères, and looked away across the plain to the unrippled Mediterranean and the Stœchades of the old Phocæan merchantmen. On either hand rise dark cliffs of hornblende and serpentine, weathered above by wind and rain, and smoothed below by the ceaseless dashing of the winter waves. Up to the limit of the breakers the hard rock is polished like Egyptian syenite; but beyond that point it is fissured by disintegration and richly covered with a dappled coat of gray and yellow lichen. The slow action of the water, always beating against the solid wall of crystalline rock, has eaten out a thousand such little bays all along this coast, each bounded by long headlands, whose points have been worn into fantastic pinnacles, or severed from the main mass as precipitous islets, the favorite resting-place of gulls and cormorants. No grander coast scenery can be found anywhere in the southern half of Great Britain.

Yet when I turn inland I see that all this beauty has been produced by the mere interaction of the sea and the barren moors of the interior. Nothing could be flatter or more desolate than the country whose seaward escarpment gives rise to these romantic coves and pyramidal rocky islets. It stretches away for miles in a level upland waste, only redeemed from complete barrenness by the low straggling bushes of the dwarf furze, whose golden blossom is now interspersed with purple patches of ling or the paler pink flowers of the Cornish heath. Here, then, I can see beauty in nature actually beginning to be. I can trace the origin of all these little bays from small rills which have worn themselves gorge-like valleys through the hard igneous rock, or else from fissures finally giving rise to sea-caves, like the one into which I rowed this morning for my early swim. The waves penetrate for a couple of hundred yards into the bowels of the rock, hemmed in by walls and roof of dark serpentine, with its interlacing veins of green and red bearing witness still to its once molten condition; and at length in most cases they produce a blow-hole at the top, communicating with the open air above, either because the fissure there crops up to the surface, or else through the agency of percolation. At last, the roof falls in; the boulders are carried away by the waves; and we get a long and narrow cove, still bounded on either side by tall cliffs, whose summits the air and rainfall slowly wear away into jagged and exquisite shapes. Yet in all this we see nothing but the natural play of cause and effect; we attribute the beauty of the scene merely to the accidental result of inevitable laws; we feel no necessity for calling in the aid of any underlying æsthetic intention on the part of the sea, or the rock, or the creeping lichen, in order to account for the loveliness which we find in the finished picture. The winds and the waves carved the coast into these varied shapes by force of blind currents working on hidden veins of harder or softer crystal; and we happen to find the result beautiful, just as we happen to find the inland level, dull, and ugly. The endless variety of the one charms us, while the unbroken monotony of the other wearies and repels us.

Here on the cliff I pick up a pretty fern and a blossoming head of the autumn squill—though so sweet a flower deserves a better name. This fern, too, is lovely in its way, with its branching leaflets and its rich glossy-green hue. Yet it owes its shape just as truly to the balance of external and internal forces acting upon it as it does the Cornish coast-line. How comes it then that in the one case we instinctively regard the beauty as accidental, while in the other we set it down to a deliberate æsthetic intent? I think because, in the first case, we can actually see the forces at work, while in the second they are so minute and so gradual in their action as to escape the notice of all but trained observers. This fern grows in the shape that I see, because its ancestors have been slowly moulded into such a form by the whole group of circumstances directly or indirectly affecting them in all their past life; and the germ of the complex form thus produced was impressed by the parent plant upon the spore from which this individual fern took its birth. Over yonder I see a great dock-leaf; it grows tall and rank above all other plants, and is able to spread itself boldly to the light on every side. It has abundance of sunshine as a motive-power of growth, and abundance of air from which to extract the carbon that it needs. Hence it and all its ancestors have spread their leaves equally on every side, and formed large flat undivided blades. Leaves such as these are common enough; but nobody thinks of calling them pretty. Their want of minute subdivision, their monotonous outline, their dull surface, all make them ugly in our eyes, just as the flatness of the Cornish plain makes it also ugly to us. Where symmetry is slightly marked and variety wanting, as in the cabbage leaf, the mullein, and the burdock, we see little or nothing to admire. On the other hand, ferns generally grow in hedgerows or thickets, where sunlight is much interrupted by other plants, and where air is scanty, most of its carbon being extracted by neighboring plants which leave but little for one another's needs. Hence you may notice that most plants growing under such circumstances have leaves minutely subdivided, so as to catch such stray gleams of sunlight and such floating particles of carbonic acid as happen to pass their way. Look into the next tangled and overgrown hedgerow which you happen to pass, and you will see that almost all its leaves are of this character; and when they are otherwise the anomaly usually admits of an easy explanation. Of course the shapes of plants are mostly due to their normal and usual circumstances, and are comparatively little influenced by the accidental surroundings of individuals; and so when a fern of such a sort happens to grow like this one on the open, it still retains the form impressed upon it by the life of its ancestors. Now, it is the striking combination of symmetry and variety in the fern, together with vivid green coloring, which makes us admire it so much. Not only is the frond as a whole symmetrical, but each frondlet and each division of the frondlet is separately symmetrical as well. This delicate minuteness of workmanship, as we call it, reminds us of similar human products—of fine lace, of delicate tracery, of skilful filigree or engraving. Almost all the green leaves which we admire are noticeable, more or less, for the same effects as in the case of maple, parsley, horse-chestnut, and vine. It is true, mere glossy greenness may, and often does, make up for the want of variety, as we see in the arum, holly, laurel, and hart's-tongue fern; but the leaves which we admire most of all are those which, like maidenhair, are both exquisitely green and delicately designed in shape. So that, in the last resort, the beauty of leaves, like the beauty of coast scenery, is really due to the constant interaction of a vast number of natural laws, not to any distinct æsthetic intention on the part of Nature.

On the other hand, the pretty pink

squill reminds me that semi-conscious æsthetic design in animals has something to do with the production of beauty in nature—at least, in a few cases. Just as a flower garden has been intentionally produced by man, so flowers have been unconsciously produced by insects. As a rule, all bright red, blue, or orange in nature (except in the rare case of gems) is due to animal selection, either of flowers, fruits, or mates. Thus we may say that beauty in the inorganic world is always accidental; but in the organic world it is sometimes accidental and sometimes designed. A waterfall is a mere result of geological and geographical causes, but a bluebell or a butterfly is partly the result of a more or less deliberate æsthetic choice.

A BALLADE OF EVOLUTION.

In the mud of the Cambrian main
  Did our earliest ancestor dive:
From a shapeless albuminous grain
  We mortals our being derive.
He could split himself up into five,
  Or roll himself round like a ball;
For the fittest will always survive,
  While the weakliest go to the wall.

As an active ascidian again
  Fresh forms he began to contrive,
Till he grew to a fish with a brain,
  And brought forth a mammal alive.
With his rivals he next had to strive,
  To woo him a mate and a thrall;
So the handsomest managed to wive,
  While the ugliest went to the wall.

At length as an ape he was fain
  The nuts of the forest to rive;
Till he took to the low-lying plain,
  And proceeded his fellow to knive.
Thus did cannibal men first arrive,
  One another to swallow and maul;
And the strongest continued to thrive,
  While the weakliest went to the wall.

ENVOY.

Prince, in our civilized hive,
  Now money's the measure of all;
And the wealthy in coaches can drive,
  While the needier go to the wall.

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FACTS AND FICTIONS OF ZOOLOGY.

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WITH NUMEROUS ILLUSTRATIONS.

"Beholding the bright countenance of truth in the quiet and still air of delightful studies."—MILTON.

ZOOLOGICAL MYTHS.

WHEN the country swain, loitering along some lane, comes to a standstill to contemplate, with awe and wonder, the spectacle of a mass of the familiar "hair-eels" or "hair-worms" wriggling about in a pool, he plods on his way firmly convinced that, as he has been taught to believe, he has just witnessed the results of the transformation of some horse's hairs into living creatures. So familiar is this belief to people of professedly higher culture than the countryman, that the transformation just alluded to has to all, save a few thinking persons and zoologists, become a matter of the most commonplace kind. When some quarrymen, engaged in splitting up the rocks, have succeeded in dislodging some huge mass of stone, there may sometimes be seen to hop from among the *débris* a lively toad or frog, which comes to be regarded by the excavators with feelings akin to those of superstitious wonder and amazement. The animal may or may not be captured; but the fact is duly chronicled in the local newspapers, and people wonder for a season over the phenomenon of a veritable Rip Van Winkle of a frog, which, to all appearance, has lived for "thousands of years in the solid rock." Nor do the hair-worm and the frog stand alone in respect of their marvellous origin. Popular zoology is full of such marvels. We find unicorns, mermaids, and mermen; geese developed from the shell-fish known as "barnacles;" we are told that crocodiles may weep, and that sirens can sing—in short, there is nothing so wonderful to be told of animals that people will not believe the tale. Whilst, curiously enough, when they are told of veritable facts of animal life, heads begin to shake and doubts to be expressed, until the zoologist despairs of educating people into distinguishing fact from fiction, and truth from theories and unsupported beliefs. The story told of the old lady, whose youthful acquaintance of seafaring habits entertained her with tales of the wonders he had seen, finds, after all, a close application in the world at large. The dame listened with delight, appreciation, and belief, to accounts of mountains of sugar and rivers of rum, and to tales of lands where gold and silver and precious stones were more than plentiful. But when the narrator descended to tell of fishes that were able to raise themselves out of the water in flight, the old lady's credulity began to fancy itself imposed upon; for she indignantly repressed what she considered the lad's tendency to exaggeration, saying, "Sugar mountains may be, and rivers of rum may be, but fish that flee ne'er can be!" Many popular beliefs concerning animals partake of the character of the old lady's opinions regarding the real and the fabulous; and the circumstance tells powerfully in favor of the opinion that a knowledge of our surroundings in the world, and an intelligent conception of animal and plant life, should form part of the school-training of every boy and girl, as the most effective antidote to superstitions and myths of every kind.

The tracing of myths and fables is a very interesting task, and it may, therefore, form a curious study, if we endeavor to investigate very briefly a few of the popular and erroneous beliefs regarding lower animals. The belief regarding the origin of the hair-worms is both widely spread and ancient. Shakespeare tells us that

> "Much is breeding,
> Which, like the courser's hair, hath yet but life,
> And not a serpent's poison."

The hair-worms certainly present the appearance of long, delicate black hairs, which move about with great activity amidst the mud of pools and ditches. These worms, in the early stages of their existence, inhabit the bodies of insects, and may be found coiled up within the grasshopper, which thus gives shelter to a guest exceeding many times the length of the body of its host. Sooner or later the hair-worm, or *Gordius aquaticus* as the naturalist terms it, leaves the body of the insect, and lays its eggs, fastened together in long strings, in water. From each egg a little creature armed with minute hooks is produced, and this young hair-worm burrows its way into the body of some insect, there to repeat the history of its parent. Such is the well-ascertained history of the hair-worm, excluding entirely the popular belief in its origin. There certainly does exist in science a theory known as that of "spontaneous generation," which, in ancient times, accounted for the production of insects and other animals by assuming that they were produced in some mysterious fashion out of lifeless matter. But not even the most ardent believer in the extreme modification of this theory which holds a place in modern scientific belief, would venture to maintain the production of a hair-worm by the mysterious vivification of an inert substance such as a horse's hair.

The expression "crocodile's tears" has passed into common use, and it therefore may be worth while noting the probable origin of this myth. Shakespeare, with that wide extent of knowledge which enabled him to draw similes from every department of human thought, says that

> "Gloster's show
> Beguiles him, as the mournful crocodile
> With sorrow snares relenting passengers."

The poet thus indicates the belief that not only do crocodiles shed tears, but that sympathizing passengers, turning to commiserate the reptile's woes, are seized and destroyed by the treacherous creatures. That quaint and credulous old author—the earliest writer of English prose—Sir John Maundeville, in his "Voiage," or account of his "Travaile," published about 1356—in which, by the way, there are to be found accounts of not a few wonderful things in the way of zoological curiosities—tells us that in a certain "contre and be all yonde, ben great plenty of Crokodilles, that is, a manner of a long Serpent as I have seyed before." He further remarks that "these Serpents slew men," and devoured them, weeping; and he tells us, too, that "whan thei eaten thei meven (move) the over jowe (upper jaw), and nought the nether (lower) jowe: and thei have no tonge (tongue)." Sir John thus states two popular beliefs of his time and of days prior to his age, namely, that crocodiles move their upper jaws, and that a tongue was absent in these animals.

As regards the tears of the crocodile, no foundation of fact exists for the belief in such sympathetic exhibitions. But a highly probable explanation may be given of the manner in which such a belief originated. These reptiles unquestionably emit very loud and singularly plaintive cries, compared by some travellers to the mournful howling of dogs. The earlier and credulous travellers would very naturally associate tears with these cries, and, once begun, the supposition would be readily propagated, for error and myth are ever plants of quick growth. The belief in the movement of the upper jaw rests on an apparent basis of fact. The lower jaw is joined to the skull very far back on the latter, and the mouth-opening thus comes to be singularly wide; whilst, when the mouth opens, the skull and upper jaw are apparently observed to move. This is not the case, however; the apparent movement arising from the manner in which the lower jaw and the skull are joined together. The belief in the absence of the tongue is even more readily explained. When the mouth is widely opened, no tongue is to be seen. This organ is not only present, but is, moreover, of large size; it is, however, firmly attached to the floor of the mouth, and is specially adapted, from its peculiar form and structure, to assist these animals in the capture and swallowing of their prey.

One of the most curious fables regarding animals which can well be mentioned, is that respecting the so-called "Bernicle" or "Barnacle Geese," which by the naturalists and educated persons of the Middle Ages were believed to be produced by those little Crustaceans named "Barnacles." With the "Barnacles" every one must be familiar who has examined the floating drift-wood of the sea-beach, or who has seen ships docked in a seaport town. A barnacle is simply a kind of crab inclosed in a triangular shell, and attached by a fleshy stalk to fixed objects. If the barnacle is not familiar to readers, certain near relations of these animals must be well known, by sight at least, as amongst the most familiar denizens of our sea-coasts. These latter are the "Sea-Acorn" or *Balani*, whose little conical shells we crush by hundreds as we walk over the rocks at low-water mark; whilst every wooden pile immersed in the sea becomes coated in a short time with a thick crust of the "Sea-Acorns." If we place one of these little animals, barnacle or sea-acorn—the latter wanting the stalk of the former—in its native waters, we shall observe a beautiful little series of feathery plumes to wave backward and forward, and ever and anon to be quickly withdrawn into the secure recesses of the shell. These organs are the modified feet of the animal, which not only serve for sweeping food-particles into the mouth, but act also as breathing-organs. We may, therefore, find it a curious study to inquire through what extraordinary transformation and confusion of ideas such an animal could be credited with giving origin to a veritable goose; and the investigation of the subject will also afford a singularly apt illustration of the ready manner in which the fable of one year or period becomes transmitted and transformed into the secure and firm belief of the next.

We may begin our investigation by inquiring into some of the opinions which were entertained on this subject and ventilated by certain old writers. Between 1154 and 1189 Giraldus Cambrensis, in a work entitled "Topographia Hiberniæ," written in Latin, remarks concerning "many birds which are called *Bernacæ:* against nature, nature produces them in a most extraordinary way. They are like marsh geese, but somewhat smaller. They are produced from fir timber tossed along the sea, and are at first like gum. Afterward they hang down by their beaks, as if from a sea-weed attached to the timber, surrounded by shells, in order to grow more freely." Giraldus is here evidently describing the barnacles themselves. He continues: "Having thus, in process of time, been clothed with a strong coat of feathers, they either fall into the water or fly freely away into the air. They derive their food and growth from the sap of the wood or the sea, by a secret and most wonderful process of alimentation. I have frequently, with my own eyes, seen more than a thousand of these small bodies of birds, hanging down on the sea-shore from one piece of timber, inclosed in shells, and already formed." Here, again, our author is speaking of the barnacles themselves, with which he naturally confuses the geese, since he presumes the Crustaceans are simply geese in an undeveloped state. He further informs his readers that, owing to their presumably marine origin, "bishops and clergymen in some parts of Ireland do not scruple to dine off these birds at the time of fasting, because they are not flesh, nor born of flesh," although for certain other and theological reasons, not specially requiring to be discussed in the present instance, Giraldus disputes the legality of this practice of the Hibernian clerics.

In the year 1527 appeared "The Hystory and Croniclis of Scotland, with the cosmography and dyscription thairof, compilit be the noble Clerk Maister Hector Boece, Channon of Aberdene." Boece's "History" was written in Latin; the title we have just quoted being that of the English version of the work (1540), which title further sets forth that Boece's work was "Translatit laitly in our vulgar and commoun langage be Maister Johne Bellenden, Archedene of Murray, And Imprentit in Edinburgh, be me Thomas Davidson, prenter to the Kyngis nobyll grace." In this learned work the author discredits the popular ideas regarding the origin of the geese. "Some men belevis that thir clakis (geese) growis on treis be the nebbis (bills). Bot thair opinoun is vane. And becaus the nature and procreatioun of thir clakis is strange, we have maid na lytyll laboure and deligence to serche ye treuth and verite yairof, we have salit (sailed) throw ye seis quhare thir clakis ar bred, and I fynd be gret experience, that the nature of the seis is mair relevant caus of thair procreatioun than ony uthir thyng." According to Boece, then, "the nature of the seis" formed the chief element in the production of the geese, and our author proceeds to relate how "all treis (trees) that ar cassin in the seis be proces of tyme apperis first wormeetin (worm-eaten), and in the small boris and hollis (holes) thairof growis small worms." Our author no doubt here alludes to the ravages of the *Teredo*, or ship-worm, which burrows into timber, and with which the barnacles themselves are thus confused. Then he continues, the "wormis" first "schaw (show) thair heid and feit, and last of all thay schaw thair plumis and wyngis. Finaly, quhen thay ar cumyn to the just mesure and quantite of geis, thay fle in the aire as othir fowlis dois, as was notably provyn, in the yeir of God ane thousand iii hundred lxxxx, in sicht of mony pepyll, besyde the castell of Petslego." On the occasion referred to, Boece tells us that a great tree was cast on shore, and was divided, by order of the "lard" of the ground, by means of a saw. Wonderful to relate, the tree was found not merely to be riddled with a "multitude of wormis," throwing themselves out of the holes of the tree, but some of the "wormis" had "baith heid, feit, and wyngis," but, adds the author, "they had no fedderis (feathers)."

Unquestionably, either the scientific use of the imagination had operated in this instance in inducing the observers to believe that in this tree, riddled by the ship-worms and possibly having barnacles attached to it, they beheld young geese; or Boece had construed the appearances described as those representing the embryo stages of the barnacle geese.

Boece further relates how a ship named the *Christofir* was brought to Leith, and was broken down because her timbers had grown old and failing.

In these timbers were beheld the same "wormeetin" appearances, "all the hollis thairof" being "full of geis." Boece again most emphatically rejects the idea that the "geis" were produced from the wood of which the timbers were composed, and once more proclaims his belief that the "nature of the seis resolvit in geis" may be accepted as the true and final explanation of their origin. A certain "Maister Alexander Galloway" had apparently strolled with the historian along the sea-coast, the former giving "his mynd with maist ernist besynes to serche the verite of this obscure and mysty dowtis." Lifting up a piece of tangle, they beheld the sea-weed to be hanging full of mussel-shells from the root to the branches. Maister Galloway opened one of the mussel-shells, and was "mair astonist than afore" to find no fish therein, but a perfectly shaped "foule, smal and gret," as corresponded to the "quantity of the shell." And once again Boerce draws the inference that the trees or wood on which the creatures are found have nothing to do with the origin of the birds; and that the fowls are begotten of the "occeane see, quhilk," concludes our author, "is the caus and production of mony wonderful thingis."

More than fifty years after the publication of Boece's "History," old Gerard of London, the famous "master in chirurgerie" of his day, gave an account of the barnacle goose, and not only entered into minute particulars of its growth and origin, but illustrated its manner of production by means of the engraver's art of his day. Gerard's "Herball," published in 1597, thus contains, amongst much that is curious in medical lore, a very quaint piece of zoological history. He tells us that "in the north parts of Scotland, and the Ilands adjacent, called Orchades (Orkneys)," are found "certaine trees, whereon doe growe certaine shell fishes, of a white colour tending to russet; wherein are conteined little living creatures: which shels in time of maturitie doe open, and out of them grow those little living foules whom we call Barnakles, in the north of England Brant Geese, and in Lancashire tree Geese; but the other that do fall upon the land, perish, and come to nothing: thus much by the writings of others, and also from the mouths of people of those parts, which may," concludes Gerard, "very well accord with truth."

Not content with hearsay evidence, however, Gerard relates what his eyes saw and hands touched. He describes how on the coasts of a certain "small Iland in Lancashire called Pile of Foulders" (probably Peel Island), the wreckage of ships is cast up by the waves, along with the trunks and branches "of old and rotten trees."

FIG. 1.—The Barnacle Tree (from Gerard's "Herball").

On these wooden rejectamenta "a certaine spume or froth" grows, according to Gerard. This spume "in time breedeth unto certaine shels, in shape like those of the muskle, but sharper pointed, and of a whitish colour." This description, it may be remarked, clearly applies to the barnacles themselves. Gerard then continues to point out how, when the shell is perfectly formed, it "gapeth open, and the first thing that appeereth is the foresaid lace or string"—the substance described by Gerard as contained within the shell—"next come the legs of the Birde hanging out; and as it groweth greater, it openeth the shell by degrees, till at length it is all come forth, and hangeth only by the bill; in short space after it commeth to full maturitie, and falleth into the sea, where it gathereth feathers, and groweth to a foule, bigger than a Mallard, and lesser than a Goose, having blacke legs and bill or beake, and feathers blacke and white . . . which the people of Lancashire call by no other name than a tree Goose."

Accompanying this description is the engraving of the bernicle tree (Fig. 1) bearing its geese-progeny. From the open shells in two cases, the little geese are seen protruding, whilst several of the fully fledged fowls are disporting themselves in the sea below. Gerard's concluding piece of information, with its exordium, must not be omitted. "They spawne," says the wise apothecary, "as it were, in March or Aprill; the Geese are found in Maie or June, and come to fulnesse of feathers in the moneth after. And thus hauing, through God's assistance, discoursed somewhat at large of Grasses, Herbes, Shrubs, Trees, Mosses, and certaine excrescences of the earth, with other things moe incident to the Historie thereof, we conclude and end our present volume, with this woonder of England. For which God's name be euer honored and praised." It is to be remarked that Gerard's description of the goose-progeny of the barnacle tree exactly corresponds with the appearance of the bird known to ornithologists as the "barnacle-goose;" and there can be no doubt that, skilled as was this author in the natural-history lore of his day, there was no other feeling in his mind than that of firm belief in and pious wonder at the curious relations between the shells and their fowl-offspring. Gerard thus attributes the origin of the latter to the barnacles. He says nothing of the "wormeetin" holes and burrows so frequently mentioned by Boece, nor would he have agreed with the latter in crediting the "nature of the occeane see" with their production, save in so far as their barnacle-parents lived and existed in the waters of the ocean.

The last account of this curious fable which we may allude to in the present instance is that of Sir Robert Moray, who, in his work entitled "A Relation concerning Barnacles," published in the "Philosophical Transactions" of the Royal Society in 1677-78, gives a succinct account of these crustaceans and their bird-progeny. Sir Robert is described as "lately one of his Majesties Council for the Kingdom of Scotland," and we may therefore justly assume his account to represent that of a cultured, observant person of his day and generation. The account begins by remarking that the "most ordinary trees" found in the western island of Scotland "are Firr and Ash." "Being," continues Sir Robert, "in the Island of East (Uist), I saw lying upon the shore a cut of a large Firr tree of about 2½ foot diameter, and 9 or 10 foot long; which had lain so long out of the water that it was very dry: And most of the shells that had formerly cover'd it, were worn or rubb'd off. Only on the parts that lay next the ground, there still hung multitudes of little Shells; having within them little Birds, perfectly shap'd, supposed to be Barnacles." Here again the description applies to the barnacles; the "little birds" they are described as containing being of course the bodies of the shell-fish.

"The Shells," continues the narrator, "hang at the Tree by a Neck longer than the Shell;" this "neck" being represented by the stalk of the barnacle. The neck is described as being composed "of a kind of filmy substance, round, and hollow, and creassed, not unlike the Wind-pipe of a Chicken; spreading out broadest where it is fastened to the Tree, from which it seems to draw and convey the matter which serves for the growth and vegetation of the Shell and the little Bird within it." Sir Robert Moray therefore agrees in respect of the manner of nourishment of the barnacles with the opinion of Giraldus already quoted. The author goes on to describe the "Bird" found in every shell he opened; remarking that "there appeared nothing wanting as to the internal parts, for making up a perfect Sea-fowl:

every little part appearing so distinctly, that the whole looked like a large Bird seen through a concave or diminishing Glass, colour and feature being everywhere so clear and neat." The "Bird" is most minutely described as to its bill, eyes, head, neck, breast, wings, tail and feet, the feathers being "everywhere perfectly shaped, and blackish-coloured. All being dead and dry," says Sir Robert, "I did not look after the Internal parts of them," a statement decidedly inconsistent with his previous assertion as to the perfect condition of the "internal parts;" and he takes care to add, "nor did I ever see any of the little Birds alive, nor met with anybody that did. Only some credible persons," he concludes, "have assured me they have seen some as big as their fist."

This last writer thus avers that he saw little birds within the shells he clearly enough describes as those of the barnacles. We must either credit Sir Robert with describing what he never saw, or with misconstruing what he did see. His description of the goose corresponds with that of the barnacle goose, the reputed progeny of the shells; and it would, therefore, seem that this author, with the myth at hand, saw the barnacles only with the eyes of a credulous observer, and thus beheld, in the inside of each shell—if, indeed, his research actually extended thus far—the reproduction in miniature of a goose, with which, as a mature bird, he was well acquainted.

Annexed is a woodcut, copied from Munster's "Cosmography" (1550), a very popular book in its time, showing the tree with its fruit, and the geese which are supposed to have just escaped from it.

FIG. 2.—Barnacle Tree (from Munster's "Cosmography").

This historical ramble may fitly preface what we have to say regarding the probable origin of the myth. By what means could the barnacles become credited with the power of producing the well-known geese? Once started, the progress and growth of the myth are easily accounted for. The mere transmission of a fable from one generation or century to another is a simply explained circumstance, and one exemplified by the practices of our own times. The process of accretion and addition is also well illustrated in the perpetuation of fables; since the tale is certain to lose nothing in its historical journey, but, on the contrary, to receive additional elaboration with increasing age. Professor Max Müller, after discussing various theories of the origin of the barnacle myth, declares in favor of the idea that confusion of language and alteration of names lie at the root of the error. The learned author of the "Science of Language" argues that the true barnacles were named, properly enough, *Bernaculæ*, and lays stress on the fact that bernicle geese were first caught in Ireland. That country becomes *Hibernia* in Latin, and the Irish geese were accordingly named *Hibernicæ*, or *Hiberniculæ*. By the omission of the first syllable—no uncommon operation for words to undergo—we obtain the name *Berniculæ* for the geese, this term being almost synonymous with the name *Bernaculæ* already applied, as we have seen, to the barnacles. Bernicle geese and bernicle shells, confused in name, thus became confused in nature ; and, once started, the ordinary process of growth was sufficient to further intensify, and render more realistic, the story of the bernicle tree and its wonderful progeny.

By way of a companion legend to that of the barnacle tree, we may select the story of the "Lamb Tree" of Cathay, told by Sir John Maundeville, whose notes of travel regarding crocodiles' tears, and other points in the confirmation of these reptiles, have already been referred to. Sir John, in that chapter of his work which treats "Of the Contries and Yles that ben bezonde the Lond of Cathay ; and of the Frutes there," etc., relates that in Cathay "there growethe a manner of Fruyt, as thoughe it were Gowrdes : and whan thei ben rype, men kutten (cut) hem a to (them in two), and men fynden with inne a lytylle Best (beast), in Flessche in Bon and Blode (bone and blood) as though it were a lytylle Lomb (lamb) with outen wolle (without wool). And men eten both the Frut and the Best ; and that," says Sir John, "is a great marveylle. Of that frut," he continues, "I have eten ; alle thoughe it were wondirfulle"—this being added, no doubt, from an idea that there might possibly be some stay-at-home persons who would take Sir John's statement *cum grano salis*. "But," adds this worthy "knyght of Ingelond," "I knowe wel that God is marveyllous in His Werkes." Not to be behind the inhabitants of Cathay in a tale of wonders, the knight related to these Easterns "als gret a marveylle to hem that is amonges us ; and that was of the Bernakes. For I tolde hem hat in oure Countree weren Trees that beren a Fruyt, that becomen Briddes (birds) fleeynge : and tho that fellen in the Water lyven (live) ; and thei that fallen on the Erthe dyen anon : and thei ben right gode to mannes mete (man's meat). And here had thei als gret marvayle," concludes Sir John, "that sume of hem trowed it were an impossible thing to be." Probably the inhabitants of Cathay, knowing their own weakness as regards the lamb tree, might possess a fellow-feeling for their visitor's credulity, knowing well, from experience, the readiness with which a "gret marvayle" could be evolved and sustained.

Passing from the sphere of the mythical and marvellous as represented in mediæval times, we may shortly discuss a question, which, of all others, may justly claim a place in the records of zoological curiosities—namely, the famous and oft-repeated story of the "Toad from the solid rock," as the country newspapers style the incident. Regularly, year by year, and in company with the reports of the sea-serpent's reappearance, we may read of the discoveries of toads and frogs in situations and under circumstances suggestive of a singular vitality on the part of the amphibians, of more than usual credulity on the part of the hearers, or of a large share of inventive genius in the narrators of such tales. The question possesses for every one a certain degree of interest, evoked by the curious and strange features presented on the face of the tales. And it may therefore not only prove an interesting but also a useful study, if we endeavor to arrive at some just and logical conceptions of these wonderful narrations.

Instances of the discovery of toads and frogs in solid rocks need not be specially given ; suffice it to say, that these narratives are repeated year by year with little variation. A large block of stone or face of rock is detached from its site, and a toad or frog is seen hereafter to be hopping about in its usual lively manner. The conclusion to which the bystanders invariably come is that the animal must have been contained within the rock, and that it was liberated by the dislodgment of the mass. Now, in many instances, cases of the appearance of toads during quarrying operations have been found, on close examination, to present no evidence whatever that the appearance of the animals was due to the dislodgment of the stones. A frog or toad may be found hopping about among some recently formed *débris*, and the animal is at once seized upon and reported as having emerged from the rocks into the light of day. There is in such a case not the slightest ground for supposing any such thing; and the animal may more reasonably be presumed to have simply hopped into the *débris* from its ordinary habitat. But laying aside narratives of this kind, which lose their plausibility under a very commonplace scrutiny, there still exist cases, reported in an apparently exact and truthful manner, in which these animals have been alleged to appear from the inner crevices of rocks after the removal of large masses of the formations. We shall assume these latter tales to contain a plain, unvarnished statement of what was observed, and deal with the evidence they present on this footing.

One or two notable examples of such verified tales are related by Smellie, in his "Philosophy of Natural History." Thus, in the "Memoirs of the French Academy of Sciences" for 1719, a toad is described as having been found in the heart of an elm tree; and another is stated to have been found in the heart of an old oak tree, in 1731, near Nantz. The condition of the trees is not expressly stated, nor are we afforded any information regarding the appearance of the toads—particulars of considerable importance in view of the suggestions and explanations to be presently brought forward. Smellie himself, while inclined to be sceptical in regard to the truth or exactness of many of the tales told of the vitality of toads, yet regards the matter as affording food for reflection, since he remarks, "But I mean not to persuade, for I cannot satisfy myself; all I intend is, to recommend to those gentlemen who may hereafter chance to see such rare phenomena, a strict examination of every circumstance that can throw light upon a subject so dark and mysterious; for the vulgar, ever inclined to render uncommon appearances still more marvellous, are not to be trusted."

This author strikes the key-note of the inquiry in his concluding words, and we shall find that the explanation of the matter really lies in the clear understanding of what are the probabilities, and what the actual details, of the cases presented for consideration. We may firstly, then, glance at a few of the peculiarities of the frogs and toads, regarded from a zoological point of view. As every one knows, these animals emerge from the egg in the form of little fish-like "tadpoles," provided with outside gills, which are soon replaced by inside gills, resembling those of fishes. The hind legs are next developed, and the fore limbs follow a little later; whilst, with the development of lungs, and the disappearance of the gills and tail, the animal leaves the water, and remains for the rest of its life an air-breathing, terrestrial animal. Then, secondly, in the adult frog or toad, the naturalist would point to the importance of the skin as not only supplementing, but, in some cases, actually supplanting the work of the lungs as the breathing organ. Frogs and toads will live for months under water, and will survive the excision of the lungs for like periods; the skin in such cases serving as the breathing surface. A third point worthy of remembrance is included in the facts just related, and is implied in the information that these animals can exist for long periods without food, and with but a limited supply of air. We can understand this toleration on the part of these animals when we take into consideration their cold-blooded habits, which do not necessitate, and which are not accompanied by, the amount of vital activity we are accustomed to note in higher animals. And, as a last feature in the purely scientific history of the frogs and toads, it may be remarked that these animals are known to live for long periods. One pet toad is mentioned by a Mr. Arscott as having attained, to his knowledge, the age of thirty-six years ; and a greater age still might have been recorded of this specimen, but for the untoward treatment it sustained at the hands, or rather beak, of a tame raven. In all probability it may be safely assumed that, when the conditions of life are favorable, these creatures may attain a highly venerable age —regarding the lapse of time from a purely human and interested point of view.

We may now inquire whether or not the foregoing considerations may serve to throw any light upon the tales of the quarryman. The first point to which attention may be directed is that involved in the statement that the amphibian has been imprisoned in a *solid* rock. Much stress is usually laid on the fact that the rock was solid ; this fact being held to imply the great age, not to say antiquity, of the rock and its supposed tenant. The impartial observer, after an examination of the evidence presented, will be inclined to doubt greatly the justification for inserting the adjective " solid ;" for usually no evidence whatever is forthcoming as to the state of the rock prior to its removal. No previous examination of the rock is or can be made, from the circumstance that no interest can possibly attach to its condition until its removal reveals the apparent wonder it contained, in the shape of the live toad. And it is equally important to note that we rarely, if ever, find mention of any examination of the rock being made subsequently to the discovery. Hence, a first and grave objection may be taken to the validity of the supposition that the rock was solid, and it may be fairly urged that on this supposition the whole question turns and depends. For if the rock cannot be proved to have been impermeable to and barred against the entrance of living creatures, the objector may proceed to show the possibility of the toad having gained admission, under certain notable circumstances, to its prison-house.

The frog or toad in its young state, and having just entered upon its terrestrial life, is a small creature, which could, with the utmost ease, wriggle into crevices and crannies of a size which would almost preclude such apertures being noticed at all. Gaining access to a roomier crevice or nook within, and finding there a due supply of air, along with a dietary consisting chiefly of insects, the animal would grow with tolerable rapidity, and would increase to such an extent that egress through its aperture of entrance would become an impossibility. Next, let us suppose that the toleration of the toad's system to starvation and to a limited supply of air is taken into account, together with the fact that these creatures will hibernate during each winter, and thus economize, as it were, their vital activity and strength ; and after the animal has thus existed for a year or two—no doubt under singularly hard conditions—let us imagine that the rock is split up by the wedge and lever of the excavator. We can then readily enough account for the apparently inexplicable story of " the toad in the rock." " There is the toad and here is the solid rock," say the gossips. " There is an animal which has singular powers of sustaining life under untoward conditions, and which, in its young state, could have gained admittance to the rock through a mere crevice," says the naturalist in reply. Doubtless, the great army of the unconvinced may still believe in the tale as told them ; for the weighing of evidence and the placing *pros* and *cons* in fair contrast are not tasks of congenial or wonted kind in the ordinary run of life. Some people there will be who will believe in the original solid rock and its toad, despite the assertion of the geologist that the earliest fossils of toads appear in almost the last-formed rocks, and that a live toad in rocks of very ancient age—presuming, according to the popular belief, that the animal was inclosed when the rock was formed—would be as great an anomaly and wonder as the mention, as an historical fact, of an express train or the telegraph in the days of the patriarchs. In other words, the live toad which hops out of an Old Red Sandstone rock must be presumed, on the popular belief, to be older by untold ages than the oldest *fossil* frogs and toads. The reasonable mind, however, will ponder and consider each feature of the case, and will rather prefer to countenance a supposition based on ordinary experience, than an explanation brought ready-made from the domain of the miraculous; whilst not the least noteworthy feature of these cases is that included in the remark of Smellie, respecting the tendency of uneducated and superstitious persons to magnify what is uncommon, and in his sage conclusion that as a rule such persons in the matter of their relations "are not to be trusted."

But it must also be noted that we possess valuable evidence of a positive and direct kind bearing on the duration of life in toads under adverse circumstances. As this evidence tells most powerfully against the supposition that the existence of those creatures can be indefinitely prolonged, it forms of itself a veritable court of appeal in the cases under discussion. The late Dr. Buckland, curious to learn the exact extent of the vitality of the toad, caused, in the year 1825, two large blocks of stone to be prepared. One of the blocks was taken from the oolite limestone, and in this first stone twelve cells were excavated. Each cell was one foot deep and five inches in diameter. The mouth of each cell was grooved so as to admit of two covers being placed over the aperture; the first or lower cover being of glass, and the upper one of slate. Both covers were so adapted that they could be firmly luted down with clay or putty; the object of this double protection being that the slate cover could be raised so as to inspect the contained object through the closed glass cover without admitting air. In the second or sandstone block, a series of twelve cells was also excavated; these latter cells, being, however, of smaller size than those of the limestone block, each cell being only six inches in depth by five inches in diameter. These cells were likewise fitted with double covers.

On November 26th, 1825, a live toad —kept for some time previously to ensure its being healthy—was placed in each of the twenty-four cells. The largest specimen weighed 1185 grains, and the smallest 115 grains. The stones and the immured toads were buried on the day mentioned, three feet deep, in Dr. Buckland's garden. There they lay until December 10th, 1826, when they were disinterred and their tenants examined. All the toads in the smaller cells of the sandstone block were dead, and from the progress of decomposition it was inferred that they had succumbed long before the date of disinterment. The majority of the toads in the limestone block were alive, and, curiously enough, one or two had actually increased in weight. Thus, No. 5, which at the commencement of its captivity had weighed 1185 grains, had increased to 1265 grains; but the glass cover of No. 5's cell was found to be cracked. Insects and air must therefore have obtained admittance and have afforded nourishment to the imprisoned toad; this supposition being rendered the more likely by the discovery that in one of the cells, the covers of which were also cracked and the tenant of which was dead, numerous insects were found. No. 9, weighing originally 988 grains, had increased during its incarceration to 1116 grains; but No. 1, which in the year 1825 had weighed 924 grains, was found in December, 1826, to have decreased to 698 grains; and No. 11, originally weighing 936 grains, had likewise disagreed with the imprisonment, weighing only 652 grains when examined in 1826.

At the period when the blocks of stone were thus prepared, four toads were pinned up in holes five inches deep and three inches in diameter, cut in the stem of an apple tree ; the holes being firmly plugged with tightly fitting wooden plugs. These four toads were found to be dead when examined along with the others in 1826 ; and of four others inclosed in basins made of plaster of Paris, and which were also buried in Dr. Buckland's garden, two were found to be dead at the end of a year, their comrades being alive, but looking starved and meagre. The toads which were found alive in the limestone block in December, 1826, were again immured and buried, but were found to be dead, without leaving a single survivor, at the end of the second year of their imprisonment.

These experiments may fairly be said to prove two points. They firstly show that under cirumstances even of a favorable kind when compared with the condition popularly believed in—namely, that of being inclosed in a *solid* rock—the limit of the toad's life may be assumed to be within two years ; this period being no doubt capable of being extended when the animal gains a slight advantage, exemplified by the admission of air and insect-food. Secondly, we may reasonably argue that these experiments show that toads when rigorously treated, like other animals, become starved and meagre, and by no means resemble the lively, well-fed animals reported as having emerged from an imprisonment extending, in popular estimation, through periods of inconceivable duration.

These tales are, in short, as devoid of actual foundation as are the modern beliefs in the venomous properties of the toad, or the ancient beliefs in the occult and mystic powers of various parts of its frame when used in incantations. Shakespeare, whilst attributing to the toad venomous qualities, has yet immortalized it in his famous simile by crediting it with the possession of a "precious jewel." But even in the latter case the animal gets but scant justice ; for science strips it of its poetical reputation, and in this, as in other respects, shows it, despite fable and myth, to be zoologically an interesting, but otherwise a commonplace member of the animal series.

THE SEA-SERPENTS OF SCIENCE.

"There are more things in heaven and earth, Horatio,
Than are dreamt of in your philosophy."
Hamlet.

In the dull season of the year, when there is a decided lack of interesting or startling events, and when newspaper editors are at their wits' end for material, three objects derived from the domain of the biologist have been credited with the task of reviving the tide of public interest, and of restoring peace and composure to the editorial mind. It need hardly be said that the three objects alluded to are : "the frog from the solid rock," "the gigantic gooseberry"—occasionally supplemented by the discovery of "an egg of marvellous proportions"—and last, though by no means least, comes the announcement—made as if the being were some eminent tragedian returning to the scene of former triumphs—of the "reappearance of the great sea-serpent !" People have come in fact to regard the annual advent of the "Great Unknown" as a sure and settled event ; and doubtless there are many who would confess to a feeling of disappointment did the season slip past without an announcement of the mysterious stranger's visit.

Notwithstanding the interest which the discussion of the sea-serpent question inevitably evokes, there are comparatively few persons to be found who regard the question from other than a purely sceptical point of view. The intelligence that the sea-serpent "has been seen again" is usually reckoned as equivalent to the statement that some grog-laden mariner has been exhibiting that phenomenon known to physiologists as "unconscious cerebration ;" or that some observer has been interpreting an unusual appearance in the sea by the light of the serpentine myth. Occasionally the subject affords an opportunity for the display of the anything but scientific use of the imagination of some feeble jokers, who succeed in imposing upon the credulity of editors, and in seeing their absurd descriptions of fictitious animals in all the prominence of large type. I have before me at the present time a most circumstantial account of the "capture of the sea-serpent at Oban," in which the animal is described as having been attacked by a file of volunteers armed with rifles, and by a perfect flotilla of yachts and boats. The animal was, according to this account, happily delivered over to the tender mercies of the native talent. After causing stones to fly in showers by the sweep of its tail as it lay on the beach, it was secured, and a list of zoological characters such as belong to no one known animal is duly given. It can hardly be deemed astonishing that a non-scientific London *entrepreneur*, on reading the account of the monster's capture, at once telegraphed to secure it for exhibition. History, it need scarcely be said, does not record the sayings of this gentleman on learning that, as one of the credulous public, he had been duly hoaxed.

The literature of the subject is in one sense a huge record of mistakes and errors in observation, and the ordinary public, as well as the scientific world, have long been accustomed to accept the erroneous side as representative of the entire subject, and as if no element or substratum of probability and fact was included in the whole matter. Thus, for example, because on one occasion an alleged sea-serpent on closer investigation was proved to consist of a long train or tail of sea-weed, with some heterogeneous material serving for the head—or since, on other occasions forms described as being of serpentine size have resolved themselves into shoals of porpoises swimming in line—readers of such detached statements are apt to rush to the settled conclusion that all sea-serpent tales are explicable on some analogous footing. The relegation of the subject to the sphere of fable is therefore to be accounted a perfectly natural result of the almost invariable construction put upon a few ill-founded tales and mediæval myths—to be presently alluded to—and also of the indifference with which zoologists themselves have treated the subject; while ignorance of the existence of a great body of perfectly reliable evidence supporting the view that large serpentine forms have been seen, together with a common incompetence to weigh evidence and to decide upon the merits of the case, may also be cited as two important factors in inducing a general disbelief in the personality of the modern Leviathan.

Of the older chroniclers of sea-serpent lore, perhaps the most noteworthy is Olaus Magnus, the worthy archbishop of Upsala, who devotes a whole chapter in the course of his writings to the sea-serpent, and discourses most volubly upon the marine snake, and other monsters of the deep, such as krakens, whales, and the like. Speaking of some sea monsters, the exact nature of which it is zoologically impossible to define, Magnus writes that "their forms are horrible, their heads square, all set with prickles, and they have sharp and long horns about, like a tree rooted up by the roots. They are ten or twelve cubits long, very black, and with huge eyes, the compass whereof is about eight or ten cubits. The apple of the eye is of one cubit, and is red and fiery colored, which in the dark night appears to fishermen afar off under waters as a burning fire, having hairs like goose feathers, thick and long, like a beard hanging down. The rest of the body, for the greatness of the head, which is square, is very small, not being above 14 or 15 cubits long. One of these sea monsters will easily drown many great ships, provided with many strong mariners."

The sea-serpent of this writer appears to have been a terrible animal, worthy of a place in the records of those knightly encounters with strange beasts which mark our earlier literature. The marine snake of Magnus was 200 feet long, twenty feet thick, and appeared "like a pillar" when he elevated his head in mid-air. His hair was a cubit long, his scales were sharp and his skin black; and his eyes were like flaming fire. The appearances of such monsters were naturally regarded in the light of grave portents of coming disasters. One old writer, relating the capture of a marine monster, says that "in 1282, there was a fish taken in the sea, in all respects like unto a lyon." The fishermen reported that "the fishe gave many frighfull scrikes and cries when it was taken, and at this time," continues the narrative, "there fell a great discord between the Englishmen that were students in Paris and those of Pycardy that studyed there likewise. Their division was so terrible that it could hardly be appeased." Starting thus with a basis of myth, it is little to be wondered at that modern ideas have continued to invest the "sea-serpent" and its kind with an atmosphere of the ridiculous.

The simple and attentive consideration of the matter, however, reveals certain aspects and features, in virtue of which it can hardly be dismissed from the sphere either of popular or of scientific thought, and which commend the subject to the intelligent mind, as a study of both a curious and highly interesting kind. Can we, for example, after perusing the mass of evidence accumulated during past years, dismiss the subject *simpliciter*, as founded on no basis of fact? The answer to such a question must be an emphatic negative; since the evidence brought before our notice includes the testimony of several hundreds of sane and reasonable persons, who in frequent cases have testified on oath and by affidavit to the truth of their descriptions of curious marine forms, seen and observed in various seas. The second supposition, that all of these persons have simply been deceived, is one which must also be dismissed. For, after making all due allowance for exaggeration, and for variations in accounts arising from different modes of expression and even from mental peculiarities in the witnesses, there remains a solid body of testimony, which, unless there is some special tendency to mendacity on the part of persons who travel by sea, we are bound, by all the rules of fair criticism and of evidence, to receive as testimony of honest kind. As I have elsewhere observed, "There are very many calmly and circumstantially related and duly verified accounts of serpentine, or, at any rate, of anomalous marine forms, having been closely inspected by the crews and passengers of vessels. Either, therefore, we must argue that in every instance the sense of intelligent men and women must have played them false, or we must simply assume that they are describing what they have never seen. The accounts in many instances so minutely describe the appearance of such forms, inspected from a near standpoint, that the possibility of their being mistaken for inanimate objects, as they might be if viewed from a distance, is rendered entirely improbable. We may thus, then, affirm firstly that there are many verified pieces of evidence on record, of strange marine forms having been met with—which evidences, judged according to ordinary and common-sense rules, go to prove that certain hitherto undescribed marine organisms do certainly exist in the sea-depth."

The first issue I must therefore submit to the reader, as representing one of a large and impartial jury, is, that the mass of evidence accumulated on the sea-serpent question, when weighed and tested, even in a *primâ facie* manner, plainly shuts us up to the belief that appearances, resembling those produced by the presence in the sea of huge serpentine forms, have been frequently noted by competent and trustworthy observers. Unless we are to believe that men and women have deliberately prevaricated, and that without the slightest excuse or show of reason, we must believe that they have witnessed marine appearances, certainly of unwonted and unusual kind. That "something" has assuredly been seen, must be the verdict on this first issue. What that "something" is or was, and whether or not the evidence will support the opinion that the appearances described bear out the existence of a "sea-serpent" in the flesh, form points for discussion in the next instance.

In the consideration of this second issue, two chief aspects are presented. We have thus, firstly, to assure ourselves that the evidence, the character of which has just been discussed, will support the assertion that the appearances noted were produced by *living organisms*. And provided this point be decided in the affirmative, we must assure ourselves, in the second place, of the probable *kind* and *nature* of these beings.

Allusion has already been made to erroneous observations, which have subjected the stories of sea-serpents to almost universal ridicule, and in which various *lifeless* objects were at first credited with the representation of the marine monster. That a long and connected string of seaweed, extending for some fifty or sixty feet along the surface of a sea, slightly disturbed by a rippling breeze, may be moved by the waves in a manner strongly suggestive of the movements of a snake in swimming, is a statement to the correctness of which I can bear personal testimony, and to the truth of which even observant sea-side visitors may testify. The movements of an unusually long frond or group of fronds of tangle, attached to a rock, and set in motion at low water, by a light swell, has before now, and when seen indistinctly, suggested the idea of the existence at the spot of some large denizen of the sea, browsing on the sea-weeds, with the fore part of its body, represented by the tangle fronds, occasionally appearing at the surface of the water. Floating trunks and roots of trees, serving as a nucleus around which sea-weed has collected, and to which barnacles and sea-acorns—producing a variegated effect by reason of their light color—have attached themselves in great numbers, have also presented appearances closely resembling those of large marine animals swimming slowly along at the surface of the water. In one instance of this latter kind, related to me by a friend who was an actual spectator, the floating piece of timber assumed a shape imitating in the closest and most remarkable manner the head of some reptile—by the same rule, I suppose, that in the gnarled trunks and branches of trees one may frequently discern likenesses to the human face and to the forms of other living things. In this latter instance, the floating object was perceived at some miles' distance from the deck of a yacht; and even when seen through a telescope, and carefully scrutinized by men accustomed to make out the contour and nature of objects at sea, the resemblance to the head of some animal was so close that the course of the vessel was changed and the object in due time overhauled. This latter, therefore, presents an example of a case, the details of which, when related, tempt people to maintain without further parley, that sea-serpents always resolve themselves into inanimate objects of one kind or another. And so great in some minds is the fear of popular ridicule regarding this subject, that one ship-captain related that when a sea-serpent had been seen by his crew from the deck of the vessel, he remained below; since to use his own words, "had I said I had seen the sea-serpent, I should have been considered to be a warranted liar all my life after!"

But the natural supposition and remark of the inanimate nature of objects seen at sea is at once noted to be anything but universal in its nature and application, when the records of sea-serpent history are examined in detail. Numerous cases exist in which the object, presumed to be a living being, has been scrutinized so closely that, save on the supposition that senses have played their owners false, or that minds have given way to an unaccountable impulse for lying, we must face and own the belief that living animals have been seen. Let us briefly examine one or two of the accounts of this kind which have been duly and faithfully recorded, with a view of ascertaining whether or not we may detect any inherent or implied elements of improbability, and whether the evidence as to living things having been seen is of trustworthy kind.

One of the most circumstantially recorded and best-known reports of the appearance of a sea-serpent is that of Captain M'Quhæ, who commanded H. M. S. Dædalus, in 1848, and whose case, originally published and commented upon in the *Times* of that year, may be almost unknown to the present and rising generation of readers. The first announcement in the *Times* appeared in the form of a paragraph on October 9th, 1848, stating that when the Dædalus was on her passage home from the East Indies, and when between the Cape of Good Hope and St. Helena, the captain and most of the officers and crew saw an animal which from its form and shape they assumed to be a sea-serpent. Captain M'Quhæ's own statement, contained in his reply to an official inquiry from the admiralty, gives the date of the marine monster's appearance as 6th August, 1848, and its exact habitat, at 5 P.M. of that day, as latitude 24° 44′ S, and longitude 9° 22′ E. The captain simply states it to be "an enormous serpent, with head and shoulders kept about four feet constantly above the surface of the sea, and, as nearly as we could approximate by comparing it with the length of what our maintop-sail yard would show in the water, there was at the very least sixty feet of the animal *à fleur d'eau*, no portion of which was, to our perception, used in propelling it through the water, either by vertical or horizontal undulation." The animal, Captain M'Quhæ states—and the observation is important, as bearing on the question of the living nature of the object described—passed the ship, "rapidly, but so close under our lee quarter, that had it been a man of my acquaintance I should easily have recognized his features with the naked eye." The further dimensions of the animal are given as 15 or 16 inches in diameter "behind the head, which was," continues Captain M'Quhæ, "without any doubt, that of a snake," while the color is described as being "a dark brown, with yellowish white about the throat." No fins were visible, but it appeared to possess "something like the mane of a horse, or rather (like ?) a bunch of sea-weed, washed about its back." Lieutenant Drummond, of the Dædalus, who was officer of the watch on the memorable occasion, states in his report that the animal had a "back fin," which was "perhaps twenty feet in the rear of the head." This fin evidently corresponds to the structure described in the captain's report as "something like the mane of a horse," and which the introduction of the word "like" (as I have inserted it in parenthesis after the word "rather" in his description) serves to correlate with the "bunch of sea-weed" which "washed about its back."

So far as an exact and circumstantial description, attested by the narrative of other witnesses, can testify to the actual nature of an object, viewed, it must be remarked, by educated and observant men, the instance just given would appear to admit of not the slightest doubt that a truly living and actively moving animal was observed, and also that its appearance was decidedly serpentine. It is noteworthy that in the whole course of the discussion which followed upon the publication of Captain M'Quhæ's observation, no one was found even to suggest that the appearance was other than that of a living animal; although, as will afterwards be remarked, opinions varied greatly as to the nature of the being which thus afforded so tantalizing and insufficient a glimpse of its structure and identity.

Passing over many interesting reports of sea-serpents' appearances now of some years' date, I find in the daily newspapers, almost of the date at which these words are penned, statements, both made on oath and before legal authorities, regarding the "great unknown." The first of these statements I shall give in the words of the newspaper reports, which present a clear, unvarnished statement of the narrative, and of the circumstances in which it was offered for public investigation.

"The story of the mate and crew of the barque Pauline, of London, said to have arrived in port from a twenty months' voyage to Akyab—about having seen 'a sea-serpent' while on a voyage in the Indian seas, was declared to on oath before Mr. Raffles, the stipendiary magistrate, at the Liverpool Police Court. The affidavit was made in consequence of the doubtfulness with which anything about the 'sea-serpent' has hitherto been received; and to show the genuine character of the story it has been placed judicially on record. The following is a copy of the declaration, which will be regarded as unprecedented in its way :—

BOROUGH OF LIVERPOOL, IN THE COUNTY PALATINE OF LANCASTER, TO WIT.

We, the undersigned, captain, officers, and crew of the bark *Pauline* (of London), of Liverpool, in the county of Lancaster, in the United Kingdom of Great Britain and Ireland, do solemnly and sincerely declare that on July 8, 1875, in lat. 5° 13′ S., long. 35° W., we observed three large sperm whales, and one of them was gripped round the body with two turns of what appeared to be a huge serpent. The head and tail appeared to have a length beyond the coils of about thirty feet, and its girth eight or nine feet. The serpent whirled its victim round and round for about fifteen minutes, and then suddenly dragged the whale to the bottom, head first.

GEORGE DREVAR, *Master*.
HORATIO THOMPSON.
JOHN HENDERSON LANDELLS.
OWEN BAKER,
WM. LEWARN.

Again, on July 13, a similar serpent was seen about two hundred yards off, shooting itself along the surface, the head and neck being out of the water several feet. This was seen only by the captain and one ordinary seaman, whose signatures are affixed.

GEORGE DREVAR, *Master*.
OWEN BAKER.

A few moments after it was seen elevated some sixty feet perpendicularly in the air by the chief officer and the following able seamen, whose signatures are also affixed.

HORATIO THOMPSON.
WILLIAM LEWARN.
OWEN BAKER.

And we make this solemn declaration conscientiously, believing the same to be true, and by virtue of the provisions of an Act made and passed in the sixth year of the reign of his late Majesty, entitled 'An Act to repeal an Act of the present Session of Parliament, entitled an Act for the more effectual abolition of oaths and affirmations, taken and made in various departments of the State, and to substitute declarations in lieu thereof, and for the more entire suppression of voluntary and extra-judicial oaths and affidavits, and to make other provisions for the abolition of unnecessary oaths.' Severally declared and subscribed at Liverpool aforesaid the tenth day of January, one thousand eight hundred and seventy-seven.

GEORGE DREVAR, *Master*.
WILLIAM LEWARN, *Steward*.
HORATIO THOMPSON, *Chief Officer*.
J. H. LANDELLS, *Second Officer*.
OWEN BAKER.

Severally declared and subscribed at Liverpool aforesaid, the tenth day of January, one thousand eight hundred and seventy-seven, before T. S. Raffles, J.P. for Liverpool."

The second and final piece of evidence I shall cite, is that obtained from an article entitled "Strange Sea Monsters," by Mr. R. A. Proctor, which appeared in the *Echo* of the 15th January, 1877. In this communication, Mr. Proctor makes reference to some of the views which I have promulgated on this subject, and by way of illustration, gives the following interesting particulars of a recent sea-serpent narrative :

"Soon after the British steamship Nestor anchored at Shanghai, last October, John K. Webster, the captain, and James Anderson, the ship's surgeon, appeared before Mr. Donald Spence, Acting Law Secretary in the British Supreme Court, and made affidavit to the following effect :

On September 11, at 10.30 A.M., fifteen miles north-west of North Sand Lighthouse, in the Malacca Straits, the weather being fine and the sea smooth, the captain saw an object which had been pointed out by the third officer as 'a shoal!' Surprised at finding a shoal in such a well-known track, I watched the object, and found that it was in motion, keeping up the same speed with the ship, and retaining about the same distance as first seen. The shape of the creature I would compare to that of a gigantic frog. The head, of a pale yellowish color, was about twenty feet in length, and six feet of the crown were above the water. I tried in vain to make out the eyes and mouth; the mouth may, however, have been below water. The head was immediately connected with the body, without any indication of a neck. The body was about forty-five or fifty feet long, and of an oval shape, perfectly smooth, but there may have been a light ridge along the spine. The back rose some five feet above the surface. An immense tail, fully one hundred and fifty feet in length, rose a few inches above the water. This tail I saw distinctly from its junction with the body to its extremity; it seemed cylindrical, with a very slight taper, and I estimate its diameter at four feet. The body and tail were marked with alternate bands of stripes, black and pale yellow in color. The stripes were distinct to the very extremity of the tail. I cannot say whether the tail terminated in a fin or not. The creature possessed no fins or paddles so far as we could perceive. I cannot say if it had legs. It appeared to progress by means of an undulatory motion of the tail in a vertical plane (that is, up and down).

Mr. Anderson, the surgeon, confirmed the captain's account in all essential respects. He regarded the creature as an enormous marine salamander. 'It was apparently of a gelatinous (that is, flabby) substance. Though keeping up with us, at the rate of nearly ten knots an hour, its movements seemed lethargic. I saw no eyes or fins, and am certain that the creature did not blow or spout in the manner of a whale. I should not compare it for a moment to a snake. The only creatures it could be compared with are the newt or frog tribe.' "*

Placing these two latter narratives side by side with that of Captain M'Quhæ, we may firstly remark the singular coincidence that in all three narratives mention is made of the head of the animal being elevated above water—this feature in the animal's mode of progression having evidently struck the observers as a noticeable point; while the coincidence, viewed as a piece of internal evidence, speaks strongly in favor of the implied truthfulness of the narratives. I think one may fairly assume that the supposition that the parties concerned were deceived into mistaking a lifeless for a living object, cannot for a moment be reasonably entertained. Laying aside for the present all questions as to the zoological position and rank of the animal, we may take it for granted, as based on evidence of reasonable kind, that the "something" seen in each of these cases—which, be it remarked, are but types of many other authenticated records of similar kind—was an active living animal. And we may also affirm that, from the circumstances in which the statements were made, as well as from the character of our witnesses, from their evident desire and from the trouble taken by them to place on record a faithful account of what they had seen, we have ample evidence to prove that part of our second issue which dealt with the question of the living or lifeless nature of the objects seen. If internal evidence is to be trusted at all, the present case strongly exemplifies its worth and value.

We have, however, still to deal with a point in our second proposition, which brings us within the scope of truly scientific inquiry—namely, that devoted to the consideration of the kind or nature of the animals observed by narrators of sea-serpent tales. In the elucidation of this topic we may incidentally discover implied proofs of the correctness and truth of the narratives on which the history of the sea-serpent is literally founded. The discussion of the question from a zoological point of view may be fitly prefaced by an allusion to certain readily explained cases of serpentine appearances caused by well-known and common forms of marine life assuming peculiar attitudes in the water, and of being indistinctly seen by observers. The instance already alluded to, of a shoal of porpoises swimming in line, with their backs and dorsal fins appearing now and then, with a kind of regular alternating motion above the surface of the water, presents an example of a deceptive appearance brought about by a somewhat unusual habit of familiar animals. I well remember being struck with surprise at an unwonted spectacle I beheld in the Frith of Forth some

* It is just possible that the "flabby" or "gelatinous" creature mentioned in this narrative was a giant cuttle-fish, whose manner of swimming, color, absence of limbs, etc., would correspond with the details of the narrative. The "immense tail" might be the enormous arms of such a creature trailing behind the body as it swam backward, propelled by jets of water from the breathing "funnel."

years ago, of an apparently long animal swimming rapidly through the water, and showing several widely detached black fins. Being alone in a small skiff at the time, I confess to the feeling of caution prompting me to restrain my curiosity and to remain at a safe distance from the animal. My curiosity was, however, speedily dispelled by beholding the apparently long and single animal resolve itself into a few sun-fishes (*Orthagoriscus*), which happened to be rolling over and over in the water in line; their motions, viewed from a distance, together with the imperfect glimpse I had at first caught of the animals, rendering my former idea of the presence of an elongated moving body all the more realistic. Such cases are, however, not to be placed side by side with the plain accounts of unknown animals of large size having been distinctly seen in latitudes favoring the growth of animals with which we are less familiar, and to the explanation of the affirmed and verified accounts of which we may next direct attention.

As was naturally to be expected, zoologists began to overhaul their lists on the narration of these tales, with the view of attempting to discover some *known* form which would correspond with the details and appearances observed and described in the sea-serpent accounts. Could the zoologist point with reason to any single form or to a few animals which might, without any undue liberties being taken either with the animals themselves or with the sea-serpent tales, be regarded as the representatives of the marine monsters? Such was the question propounded for the solution of naturalists in former years, and such emphatically is the chief question for consideration in the subject as it at present stands.

The only group of animals to which our attention may be specially directed with the view of finding a zoological solution of the problem, is that of the *Vertebrata*—the highest group of animals, which possesses the fishes as its lowest, and man and quadrupeds as its highest representatives. Laying aside the class of birds as including no forms at all allied to our present inquiry, we are left with, speaking generally, three groups of animals, from the ranks of which various forms may be selected to aid us in solving the sea-serpent mystery. These three groups are the fishes, reptiles and mammalia, and it may be shown that from each of these classes, but more notably from among the fishes and reptiles, various animals, corresponding more or less closely with the descriptions given of strange marine monsters, may be obtained. An important consideration, however, must not be overlooked at this stage, namely, that too frequently the attempt to reconcile the sea-serpent with some *known* animal of serpentine form and nature, has limited the perceptions and foiled the labors of naturalists. Starting with the fixed idea that the unknown form must be a serpent, and not widening their thoughts to admit of the term "serpentine" being extended to groups of animals other than the reptilia, naturalists soon exhausted the scientific aspect of the subject, and the zoological solution of the problem was almost at once given up. Then, also, as far as I have been able to ascertain, zoologists and other writers on this subject have never made allowance for the *abnormal and huge development of ordinary marine animals.* My own convictions on this matter find in these two considerations, but especially in the last idea, the most reasonable and likely explanation of the personality of the sea-serpent, and also the reconciliation of such discrepancies as the various narrations may be shown to evince. If we thus fail to find in the ranks of ordinary animal life, or among the reptiles themselves, the representatives of the "sea-serpents," I think we may nevertheless build up a most reasonable case both for their existence and for the explanation of their true nature, by taking into account the facts, *that the term "sea-serpent," as ordinarily employed, must be extended to include other forms of Vertebrate animals which possess elongated bodies; and that cases of the abnormally large development of ordinary serpents and of serpent-like* *animals will reasonably account for the occurrence of the animals collectively named sea-serpents.*

The case related by Captain M'Quhæ formed, as has been remarked, subject-matter for much discussion. As Mr. Gosse records in his charming work, "The Romance of Natural History," the various suggestions thrown out regarding the nature of the "serpent" seen by the crew of the Dædalus, included and advocated its correspondence with a gigantic seal—this idea emanating from Professor Owen; with a *Plesiosaurus*—an extinct reptile, which possessed a very long swan-like neck, and which attained a usual length varying from eighteen to twenty or more feet; with other and allied forms of extinct reptilia; and with a large species of shark, the basking shark (*Selache maxima*). The idea of Professor Owen does not in the least correspond with Captain M'Quhæ's circumstantial account of the appearance; and to Owen's views the captain contributed a courteous but firm reply, refusing absolutely to admit that his description was susceptible of such modification as would bring Professor Owen's idea of a gigantic seal and the serpent of the Dædalus into close correspondence. Mr. Gosse and others support the suggestion that the animal seen on this occasion was a kind of *Plesiosaurus*. And this idea received apparent support from the fact recorded by Captain M'Quhæ that no motion was observed in the portion of the animal above water; it being thus concluded that the movements were produced by limbs existing in the form of swimming paddles, such as the *Plesiosauri* possessed, and which would in their natural position be concealed below the surface of the water. The suggestion of a huge shark is simply untenable from the utter want of correspondence between any feature of the shark's conformation and the account of Captain M'Quhæ.

The idea that the animal observed in this instance was a huge serpent, seems to have been simply slurred over without that due attention which this hypothesis undoubtedly merits. While to my mind the only feasible explanation of the narrative of the crew of the Pauline must be founded on the idea that the animals observed by them were gigantic snakes. The habits of the animals in attacking the whales evidently point to a close correspondence with those of terrestrial serpents of large size, such as the boas and pythons; while the fact of the animal being described in the various narratives as swimming with the head out of water, would seem to indicate that, like all reptiles, they were air-breathers, and required to come more or less frequently to the surface for the purpose of respiration. The difficulties which appear to stand in the way of reconciling the sea-serpent with a marine snake, in this or in other cases, are two in number. The great majority of intelligent persons are unaware of the existence of serpents of truly and exclusively marine habits; and thus the mere existence of such snakes constitutes an apparent difficulty, which, however, a slight acquaintance with the history of the reptilia would serve at once to remove. Mr. Gosse speaks of these marine snakes—the *Hydrophidæ* of the naturalist—which inhabit the warmer seas, possess compressed fin-like tails adapted for swimming, and are frequently met with far out at sea.* While, as regards the claims of the "sea-serpent" to belong to the true

* It is interesting to note that frequent mention of the occurrence of large "sea-serpents" is made by the crews of vessels which have sailed through the Indian Ocean. An instance of a large sea-snake being seen in its native seas is afforded by the report of the master of the bark Georgina from Rangoon, which (as reported in the newspapers of September 4th, 1877) put into Falmouth for orders on the 1st September. On May 21st, 1877, in latitude 2° N. and longitude 90° 53′ E., a large serpent about forty or fifty feet long, gray and yellow in color, and ten or eleven inches thick, was seen by the crew. It was visible for twenty minutes, during which time it crossed the bow, and ultimately disappeared under the port-quarter. There can be little doubt that this sea-serpent was simply a largely developed marine snake.

serpent order, naturalists have dismissed this idea, simply because it has never occurred to them that a gigantic development of an ordinary species of sea-snake would fully correspond with most of the appearances described, and would in the most natural manner explain many of the sea-serpent tales. Suppose that a sea-snake of gigantic size is carried out of its ordinary latitude, and allow for slight variations or inaccuracies in the accounts given by Captain M'Quhæ, and I think we have in these ideas the nearest possible approach to a reasonable solution of this interesting problem.

It will be asked how I account for the apparent absence of motion in the fore part of the body, and for the existence of a dorsal or back fin. I may suggest, in reply, that the simple movements of the laterally compressed tail, altogether concealed beneath the surface, would serve to propel the animal forward without causing the front portion of the body to exhibit any great or apparent motion; while the appearance of a fin may possibly be explained on the presumption that sea-weed may have become attached to the animal, or that the upper ridge of the vertically compressed tail extended far forward and appeared as a fin-like structure.

The most important feature in my theory, however, in which I may be desired to lead evidence, and that which really constitutes the strong point of this explanation, is the probability of the development to a huge or gigantic size of ordinary marine serpents. This point is one in support of which zoology and physiology will offer strong and favorable testimony. There is no single fact, so far as I am aware, which militates in the slightest degree against the supposition that giant members of the sea-serpents may be occasionally developed. The laws which regulate human growth and structure, and in virtue of which veritable "sons of Anak," like Chang the Chinese giant, and the Russian giant, differing widely in proportions from their fellow mortals, are developed, must be admitted to hold good for the entire animal kingdom. There is, in fact, no valid reason against the supposition that a giant serpent is occasionally produced, just as we familiarly observe almost every kind of animal to produce now and then a member of the race which mightily exceeds the proportions of its neighbors. But clearer still does our case become when we consider that we have proof of the most absolute and direct kind of the giant development of such forms as cuttle-fishes, which have thus appeared as if in realization of Victor Hugo's "devil-fish," which plays so important a part in that strange, weird tale, the "Toilers of the Sea." The huge polypus of Pliny; the kraken of Bishop Pontoppidan, which that learned Churchman described as "*similior insulæ quam bestiæ*;" the "poulpe" of De Montfort, which was large enough to swallow a three-decker; and lastly Victor Hugo's cephalopodous creation, were deemed, not so very long ago, to belong entirely to the domain of myth and fancy. A few fragments of cuttle-fishes of large size had been now and then cast up on various coasts, it is true, but these instances were not regarded as at all sufficient to establish the existence of giant members of the group. At the present time, however, we are in full possession of the details of several undoubted cases of the occurrence of cuttle-fishes of literally gigantic proportions—developed, in fact, to an extent justly comparable to that of the supposed "sea-serpent," when the latter is compared with its ordinary representatives of the tropical oceans. An illustration (copied from a photograph) of the head and tentacles of one of these cuttle-fish monsters is annexed (Fig. 3). This creature was cast ashore on the Newfoundland coast, a few years ago. The length of each of the long arms or tentacles coiled round the extremities of the support is twenty-four feet. The eight shorter arms are each six feet in length and ten inches in circumference at the base, and the eyes measured each four inches in diameter. Other giants of the cuttle-fish race are known to science, and no residuum of doubt now remains in the minds of naturalists regarding the existence of prototypes of Victor Hugo's "devil-fish." Many zoologists might hesitate greatly before assigning these monsters to new genera or species, and would simply regard them as giant developments of ordinary and already known cuttle-fish forms. Is there anything more improbable, I ask, in the idea of a gigantic development of an ordinary marine snake into a veritable giant of its race—or, for that matter, in the existence of distinct species of monster sea-serpents—than in the production of huge cuttle-fishes, which, until within the past few years, remained unknown to the foremost pioneers of science? In the idea of gigantic developments of snakes or snake-like animals, be they fishes or reptiles, I hold we have at least a feasible and rational explanation of the primary fact of the actual existence of such organisms.

The difference regarding details of appearance and structure described in the sea-serpent tales, leads us next, and lastly, to point out certain considerations which may serve to explain away some of the difficulties which beset the question. That many of the appearances described may have been produced by animals other than true serpents cannot be doubted. It therefore constitutes an important part of our task to indicate the probabilities of various other animal forms "doing duty," so to speak, for sea-serpents on some occasions.

Amongst the fishes we may find not a few examples of snake-like animals,

FIG. 3.—Giant cuttle fish's head. The arms, ten in number (two being longer than the others), are represented coiled round a support.

which, admitting the fact of the occurrence of gigantic developments, may be supposed to mimic very closely the appearance of marine serpents. Any one who has watched the movements of a large conger-eel, for example, in any of our great aquaria, must have remarked not only its serpentine form, but also the peculiar gliding motion, which seems frequently to be produced independently of the active movements of the tail or pectoral fin. I do not doubt, however, that a giant eel might by most persons be readily enough referred to its proper place in the animal sphere, although, when viewed from some distance, and seen in an imperfect and indistinct manner, the spectators—all unprepared to think of an eel being so largely developed—might report the appearance as that of a marine snake.

A visit paid to the Newcastle Museum of Natural History, on which occasion I had the pleasure of inspecting a dried and preserved ribbon or tape-fish of large size, forcibly confirmed an idea that such an animal, developed to a gigantic size, and beheld from a distance by persons unskilled in natural history—and who would, therefore, hardly dream of associating the elongated being before them with their ordinary ideas of fish-form and appearance—might account for certain of the tales of sea-serpents which have been brought under our notice. I had been specially struck with the mention, in several accounts of sea-serpents, of a very long back fin, sometimes termed a "mane," and of a banded body covered with tolerably smooth skin; whilst in several instances the description given of the heads of the sea-monsters closely corresponded with the appearance of the head of the tape-fishes. These fishes have further been described by naturalists as occasionally having been seen swimming with an undulating or serpentine motion close to the surface of the water, the head being somewhat elevated above the surface—this latter feature, as we have observed, forming a remark of frequent occurrence in sea-serpent tales. I found, on making inquiry into the history of these fishes, that their serpentine form had struck previous observers, but, as far I could ascertain, their merits as representatives of sea-serpents had never before been so persistently advocated.

These views and the dimensions of the specimen at Newcastle, I communicated to the *Scotsman* and *Courant* newspapers in June, 1876. The measurements of the ribbon-fish at Newcastle are given as 12 feet 3 inches in length, the greatest depth being 11¼ inches, and greatest thickness only 2¾ inches; the small dimensions in thickness, and the relatively long length and depth, giving to these fishes the popular names of ribbon and tape-fishes. The species was the well-known *Gymnetrus* or *Regalecus Banksii* of naturalists; and by the museum-attendant at Newcastle I was informed that a still larger specimen of the same species was recently obtained off the Northumberland coast, the length of this latter being 13½ feet, the depth 15 inches, and the thickness 5 inches. These fishes possess a greatly compressed body. The breast fins are very small, and the ventral or belly fins are elongated and spine-like. The first rays of the dorsal or back fin are very long, whilst the fin itself extends the whole length of the back, and attains an average breadth of about three inches.

Curiously enough, the publication of these views regarding the ribbon-fishes drew forth from the head of a well-known firm of fish merchants in Edinburgh a remarkable confirmation of the idea that gigantic specimens of these fishes might be occasionally developed. The gentleman in question wrote to inform me that about thirty years ago he engaged the smack Sovereign, of Hull, Baillie commander, to trawl in the Frith of Forth for Lord Norbury, then residing at Elie Lodge, Fifeshire. Whilst engaged in their trawling operations the crew of the Sovereign captured a giant tape-fish, which, when spread out at length on the deck, extended beyond the limits of the vessel at stem and stern. The smack was a vessel of forty tons burthen, and the length may therefore be safely estimated at sixty feet—this measurement being exceeded by the ribbon-fish. The breadth of the fish measured from five to nine inches, and the dorsal fin was from six to seven inches in depth. Unfortunately Lord Norbury seemed inclined to view the giant he had captured with distrust, and ordered the fish to be cut in pieces and thrown overboard; but it is also worthy of remark that the trawlers seemed to express no great surprise at the size of Lord Norbury's specimen, since they asserted that they had met with one much larger, this latter being colored of a dirty brown hue.

It is interesting to note that the details furnished in the following account —taken from the *Times* of June 14th, 1877—of a marine monster having been seen in the Mediterranean Sea, appear to be explicable on the ideas just mentioned regarding the tape-fishes. The account is furnished by observers whose veracity it would simply be impertinent to question: "The Osborne, 2, paddle royal yacht, Commander Hugh L. Pearson, which arrived at Portsmouth from the Mediterranean on Monday, and at once proceeded to her moorings in the harbor, has forwarded an official report to the Admiralty, through the commander-in-chief (Admiral Sir George Elliot, K.C.B.), respecting a sea-monster which she encountered during her homeward voyage. At about five o'clock in the afternoon of the 2d instant, the sea being exceptionally calm, while the yacht was proceeding round the north coast of Sicily toward Cape Vito, the officer on the watch observed a long ridge of fins, each about six feet long, moving slowly along. He called for a telescope, and was at once joined by other officers. The Osborne was steaming westward at ten and a half knots an hour, and, having a long passage before her, could not stay to make minute observations. The fins were progressing in an eastwardly direction, and as the vessel more nearly approached them, they were replaced by the foremost part of a gigantic sea-monster. Its skin was, so far as could be seen, altogether devoid of scales, appearing rather to resemble in sleekness that of a seal. The head was bullet-shaped, with an elongated termination, being somewhat similar in form to that of a seal, and was about six feet in diameter. Its features were only seen by one officer, who described them as like those of an alligator. The neck was comparatively narrow, but so much of the body as could be seen developed in form like that of a gigantic turtle, and from each side extended two fins, about fifteen feet in length, by which the monster paddled itself along after the fashion of a turtle. The appearance of the monster is accounted for by a submarine volcano, which occurred north of Galita, in the Gulf of Tunis, about the middle of May, and was reported at the time by a steamer which was struck by a detached fragment of submarine rock. The disturbance below water, it is thought probable, may have driven up the monster from its 'native element,' as the site of the eruption is only one hundred miles from where it was reported to have been seen."

I thought the opportunity a favorable one for offering a reasonable explanation of the circumstance, and I communicated my views to the *Times* in the following terms, the latter appearing in that journal for June 15th, 1877: "About a year ago I ventilated in the columns of several journals the idea that the 'sea-serpents' so frequently seen were in reality giant tape-fishes or ribbon-fishes. While not meaning by this statement to exclude the idea that other animals—such as giant sea-snakes themselves—may occasionally personate the 'sea-serpent,' I am, as a zoologist, fully convinced that very many of the reported appearances of sea-serpents are explicable on the supposition that giant tape-fishes—of the existence of which no reasonable doubt can be entertained —have been seen. The report of Captain Pearson, of the royal yacht Osborne, appears, as far as zoological characters are concerned, to be fully explained on the 'ribbon-fish' theory. The long back fins, the scaleless skin, the rounded head, and, lastly, the two great side (or pectoral) fins, each measuring many feet in length, all form so many details corresponding exactly to the appearance of a great tape-fish. I offer these observations with the view of showing that, given a recital founded, as I believe the present narrative to be, on fact, we possess in the lists of living and of well-known animals adequate representatives of the 'great unknown.'"

The imperfect view obtained of the body renders the expression contained in the report, that the body was "like that of a gigantic turtle," somewhat problematical as to its correctness, and in the absence of more defined information, does not necessarily invalidate the views expressed above as to the personality of this strange tenant of the Mediterranean Sea.

In an article entitled "Strange Sea Creatures," which appeared in the *Gentleman's Magazine* for March,. 1877, Mr. R. A. Proctor, speaking of my views regarding the sea-serpent, remarks that I offer "as an alternative only the ribbon-fish." This observation being hardly correct, I may point out that in the article in *Good Words*, from which Mr. Proctor quotes my views, I distinctly refer to the probability of giant sea-snakes being occasionally developed and appearing as the modern sea-serpent. The use of the word "only" in Mr. Proctor's remark is misleading; since I offer the ribbon-fishes simply as explanatory of certain sea-serpent narratives, and not as a sole and universal representative of the modern leviathan.

Thus, then, with the ribbon-fishes at hand, and with the clear proofs before us that these and other animals may be developed to a size which, when compared with their ordinary dimensions, we can only term enormous, I think the true and valid explanation of the sea-serpent question is neither far to seek nor difficult to find. To objectors of a practical turn of mind, who may remind me that we have not yet procured even a single bone of a giant serpent, I would point out that I by no means maintain the frequent development of such beings. The most I argue for and require is their occasional production; and I would also remind such objectors of the case of the giant cuttle-fishes which, until within the past few years, remained in the same mysterious seclusion affected at present by the great serpentine unknown. I need only add that I have as firm faith in the actual discovery of the giant serpent of the sea, as that in the giant tape-fish we find its representative, or that in the huge development of ordinary forms we discover the true and natural law of its production.

To sum up my arguments by way of conclusion, I respectfully submit, as does a pleading counsel to his jury—

Firstly: That many of the tales of sea-serpents are amply verified, when judged by the ordinary rules of evidence; this conclusion being especially supported by the want of any *primâ facie* reason for prevarication;

Secondly: That, laying aside appearances which can be proved to be deceptive and to be caused by inanimate objects or by unusual attitudes on the part of familiar animals, there remains a body of evidence only to be explained on the hypothesis that certain gigantic marine animals, at present unfamiliar or unknown to science, do certainly exist; and

Thirdly: That the existence of such animals is a fact perfectly consistent with scientific opinion and knowledge, and is most readily explained by recognizing the fact of the occasional development of gigantic members of groups of marine animals already familiar to the naturalist.

Since the foregoing remarks were penned, details have been published (*Nature*, February 21st, 1878) respecting "A New Underground Monster," which have a very decided bearing on the sea-serpent question, as tending to show that even in the land-fauna of remote districts there may be included animals of a size and nature utterly undreamt of by the scientific world. The details alluded to are forwarded by the well-known naturalist Fritz Müller, and are related of the appearance and doings of the "Minhocao," a creature supposed to be a "gigantic earth-worm," and which inhabits the highlands of the southern provinces of Brazil. The account as given in the pages of *Nature* is of similar nature to the stories told us of the existence and appearance of sea-serpents. There is the same simplicity of narrative, united to an absence of all reason or cause for exaggeration or invention. We are therefore bound, as already remarked, either to accept such stories as true—as relating to observed facts—and to examine them impartially with the view of detecting discrepancy and of possibly modifying details ; or, on the other hand, to unhesitatingly and simply reject them. This latter procedure would of course be founded on an unwarrantable supposition—such as in the ordinary affairs of life would not for a moment be tolerated—namely, that deliberate lying and meaningless deception are vices of commoner occurrence than humanity at large has been led to suppose. The marks or tracks of the animal, of whatever description it may be, are a valuable source of evidence which, unfortunately, the "pathless deep" cannot offer to the inquirers into the personality of the "sea-serpent." Pending further research, one may only remark that the details given are in all respects of a very circumstantial and clearly related kind, and are such as would lead us to be exceedingly hopeful, now that scientific attention has been directed to the matter, of new and extraordinary additions being made to the lists of zoologists. The following is the account of the animal in question :

"The stories told of this supposed animal," says Fritz Müller, "sound for the most part so incredible that one is tempted to consider them as fabulous. Who could repress a smile at hearing men speak of a worm some fifty yards in length and five in breadth, covered with bones as with a coat of armor, uprooting mighty pine trees as if they were blades of grass, diverting the courses of streams into fresh channels, and turning dry land into a bottomless morass ? And yet, after carefully considering the different accounts given of the minhocao one can hardly refuse to believe that some such animal does really exist, although not quite so large as the country folk would have us to believe.

"About eight years ago a minhocao appeared in the neighborhood of Lages. Francisco de Amaral Varella, when about ten kilometres distant from that town, saw lying on the bank of the Rio das Caveiras a strange animal of gigantic size, nearly one metre in thickness, not very long, and with a snout like a pig, but whether it had legs or not he could not tell. He did not dare to seize it alone, and whilst calling his neighbors to his assistance, it vanished, not without leaving palpable marks behind it in the shape of a trench as it disappeared under the earth. A week later a similar trench, perhaps constructed by the same animal, was seen on the opposite side of Lages, about six kilometres distant from the former, and the traces were followed, which led ultimately under the roots of a large pine tree, and were lost in the marshy land. Herr F. Kelling, from whom this information was obtained, was at that time living as a merchant in Lages, and saw himself the trenches made by the minhocao. Herr E. Odebrecht, whilst surveying a line of road from Itajahy into the highlands of the province of Santa Caterina, several years ago, crossed a broad marshy plain traversed by an arm of the river Marombas. His progress here was much impeded by devious winding trenches which followed the course of the stream, and occasionally lost themselves in it. At the time Herr Odebrecht could not understand the origin of these peculiar trenches, but he is now inclined to believe that they were the work of the minhocao.

"About fourteen years ago, in the month of January, Antonio José Branco, having been absent with his whole family eight days from his house, which was situated on one of the tributaries of the Rio dos Cachorros, ten kilometres from Curitibanos, on returning home found the road undermined, heaps of earth being thrown up, and large trenches made. These trenches commenced at the source of a brook, and followed its windings, terminating ultimately in a morass after a course of from 700 to 1000 metres. The breadth of the trenches was said to be about three metres. Since that period the brook has flowed in the trench made by the minhocao. The path of the animal lay generally beneath the surface of the earth under the bed of the stream ; several pine trees had been rooted up by its passage. One of the trees from which the minhocao in passing had torn off the bark and part of the wood, was said to be still standing and visible last year. Hundreds of people from Curitibanos and other places had come to see the devastation caused by the minhocao, and supposed the animal to be still living in the marshy pool, the waters of which appeared at certain times to be suddenly and strangely troubled. Indeed, on still nights a rumbling sound like distant thunder and a slight movement of the earth was sensible in the neighboring dwellings. This story was told to Herr Müller by two eye-witnesses, José, son of old Branco, and a stepson, who formerly lived in the same house. Herr Müller remarks that the appearance of the minhocao is always supposed to presage a period of rainy weather.

"In the neighborhood of the Rio dos Papagaios, in the province of Paranà, one evening in 1849, after a long course of rainy weather, a sound was heard in the house of a certain Joao de Deos, as if rain were again falling in a wood hard by, but on looking out the heavens were seen to be bright with stars. On the following morning it was discovered that a large piece of land on the farther side of a small hill had been entirely undermined, and was traversed by deep trenches which led toward a bare open plateau covered with stones, or what is called in this district a 'legeado.' At this spot large heaps of clay turned up out of the earth marked the onward course of the animal from the legeado into the bed of a stream running into the Papagaios. Three years after this place was visited by Senhor Lebino José dos Santos, a wealthy proprietor, now resident near Curitibanos. He saw the ground still upturned, the mounds of clay on the rocky plateau, and the remains of the moved earth in the rocky bed of the brook quite plainly, and came to the conclusion that it must have been the work of two animals, the size of which must have been from two to three metres in breadth.

"In the same neighborhood, according to Senhor Lebino, a minhocao had been seen several times before. A black woman going to draw water from a pool near a house one morning, according to her usual practice, found the whole pool destroyed, and saw a short distance off an animal which she described as being as big as a house moving off along the ground. The people whom she summoned to see the monster were too late, and found only traces of the animal, which had apparently plunged over a neighboring cliff into deep water. In the same district a young man saw a huge pine suddenly overturned, when there was no wind and no one to cut it. On hastening up to discover the cause, he found the surrounding earth in movement, and an enormous worm-like black animal in the middle of it, about twenty-five metres long, and with two horns on its head.

"In the province of São Paulo, as Senhor Lebino also states, not far from Ypanema, is a spot that is still called Charquinho, that is Little Marsh, as it formerly was, but some years ago a minhocao made a trench through the marsh into the Ypanema river, and so converted it into the bed of a stream.

"In the year 1849, Senhor Lebino was on a journey near Arapehy, in the State of Uruguay. There he was told that there was a dead minhocao to be seen a few miles off, which had got wedged into a narrow cleft of a rock, and so perished. Its skin was said to be as thick as the bark of a pine tree, and formed of hard scales like those of an armadillo.

"From all these stories it would appear conclusive that in the high district where the Uruguay and the Paranà have their sources, excavations and long trenches are met with, which are undoubtedly the work of some living animal. Generally, if not always, they appear after continued rainy weather, and seem to start from marshes or river-beds, and to enter them again. The accounts as to the size and appearance of the creature are very uncertain. It might be suspected to be a gigantic fish allied to *Lepidosiren* and *Ceratodus*; the 'swine's snout' would show some resemblance to *Ceratodus*, while the horns on the body rather point to the front limbs of *Lepidosiren*, if these particulars can be at all depended upon. In any case, concludes Herr Müller, it would be worth while to make further investigations about the minhocao, and, if possible, to capture it for a zoological garden !

"To conclude this remarkable story, we may venture to suggest whether, if any such animal really exist, which, upon the testimony produced by Fritz Müller, appears very probable, it may not rather be a relic of the race of gigantic armadilloes which in past geological epochs were so abundant in Southern Brazil. The little *Chlamydophorus truncatus* is, we believe, mainly, if not entirely, subterranean in its habits. May there not still exist a large representative of the same or nearly allied genus, or, if the suggestion be not too bold, even a last descendant of the Glyptodonts ?"

SOME ANIMAL ARCHITECTS.

One of the most interesting departments of natural history study is that which devotes itself to the elucidation of the manner in which living beings utilize the various materials of the universe in which they exist, for purposes of protection, for offence or defence, or for food, raiment, and the common necessaries of life. While man, in virtue of his superior powers of adapting himself to his surroundings, may excel lower forms in respect of the variety of means and substances he calls to aid in the advancement of his interest and comfort, it must at the same time be admitted that he is frequently surpassed by the unerring skill with which a particular product is utilized and manufactured by his lower neighbors. Indeed, as a rule, the elegance and quality of the products of animal life at large are found to be apparently out of all proportion to the means by which they were elaborated. And in very many instances the lower animal accomplishes, in the way of direct and unassisted manufacture, a work which man may, after all, but imperfectly imitate by the aid of cunning artifice and mechanical contrivance. The production of a silken thread by the "spinnerets" of the spider or caterpillar is apparently an act of the simplest possible character, viewed in regard to the apparatus and actions which engage in its manufacture ; but placed in relation to human contrivance, we may well fail to conceive the delicacy of the spinning-jenny or more modern machine which could evolve a product of like nature. The instinct of the animal, blind and automaton-like as it may be, certainly holds its own in respect of the perfection and results of its work, when compared with the fruits of intelligence, and with the highest exercise of experience and acquired art.

In no phase of their operation do the vital acts and functions of animals present us with greater profusion of detail than in the consideration of the ways and means adopted for the construction of various portions of their bodies from materials derived from the outer world. The power possessed by living beings, not only of laying hold of such materials, but of duly selecting and appropriating such substances as are best adapted to the work in hand, constitutes, after due reflection, one of the marvels of life at large. Nowhere can we see this marvellous power of selection better exemplified than in certain of the lowest forms of animal life, as representing one extremity of the scale of being, and in man as illustrating the highest grade in the ranks of animal society. The waters of our oceans, both at the surface and in their depths, are inhabited by beings of microscopic size, and of a marvellous simplicity of body. Each of these minute animals consists of a speck of structureless, jelly-like substance—the protoplasm or sarcode of the physiologist. Placed under the microscope, these living particles may be seen to live and move, to eat and digest, as do their higher neighbors. Compared with the latter, they may be noted to present singular and paradoxical exceptions to the ordinary rules of living and being, since they are thus observed to live, literally without possessing any apparent structures to carry on the functions of life.

Such are the beings known to naturalists as the foraminifera and the radiolarians (Figs. 4, 5, 6). Between these

FIG. 4.—Shells of foraminifera, all magnified: *a*, *Lagena*, or "flask animalcule;" *b*, *Discorbina*; *c*, *Polystomella*.

two groups no absolute distinction, as far as their living substance is concerned, can be drawn. Yet that distinctions may and do exist is perfectly obvious, if we consider the results of the life in each case. The particle of living jelly we term a foraminifer (Fig. 6) takes from the water of the sea a proportion of the lime which exists dissolved in that medium, and from this lime moulds and forms a shell, in which it protects its soft semi-fluid body. The neighbor-particle we name a radiolarian (Fig. 5), existing side by side with the foraminifer, selects flint as its special material from its native waters, and builds a shell of this substance, exhibiting in many cases outlines of mathematical nature, and shapes of the most graceful and elegant kind. Thus there must exist, even in such simple and primitive organisms, not only a selective principle of the exact nature of which we are utterly ignorant, but a further exercise, in the building of a shell, of a power of whose exact direction and extent we know absolutely nothing.

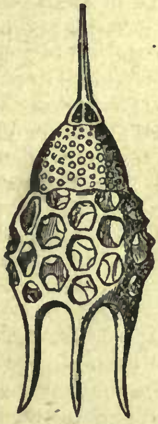

FIG. 5.—A radiolarian shell (*Podocyrtis*).

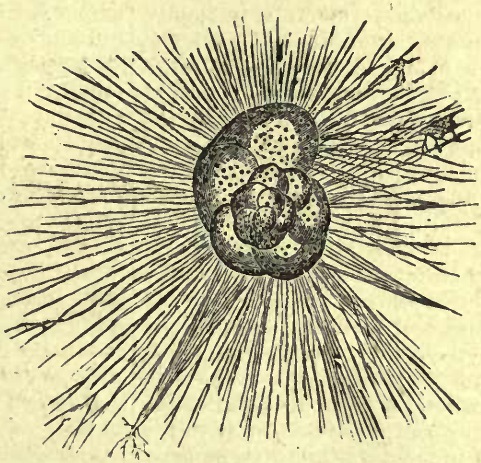

FIG. 6.—A living foraminifer (*Rotalia*), showing the living matter protruded from the shell.

But if the puzzle of life and of animal architecture is so difficult of solution in these lower forms, it is found to present no plainer aspects when offered for investigation in the personality and frame of even the highest being. Regarded from an aspect similar to that in which the denizens of the depths have just been studied, man's existence is seen to comprehend phases of equally puzzling nature. No law of life rests on a firmer basis than that which maintains that the act of living and being is associated with constant change and alteration, and that the wear and tear of life demand proportional repair. Through each tissue of the body, the life-renewing blood is therefore continually being distributed. The muscle, wearied in the actual work of the body, recruits itself from the supply of nourishment thus afforded it; nerves renew their strength from the same source; and even thought itself thus becomes related in a distinct manner to the material blood from which the thinking brain derives the wherewithal to carry on its work. Nor is this all. It is not only the case that each tissue derives from the blood the necessary matter to replace that which has been lost and expended in the work of life. Each tissue, it must be likewise noted, also takes from the common stream of nourishment the materials necessary for the building up of new substance. From the blood, bone selects the materials necessary for the formation of new bone; nerve from the same source gathers matter for the production of new nerve-tissue; muscle therefrom elaborates new muscle; cells of wondrously diverse kind, like buyers of many nations in a common market, select from the blood the special food or pabulum suited to their wants, and therefrom manufacture new cells—in short, the process of growth in man and in all animals of higher grade, exemplifies the results of many varied operations effected by the tissues and organs of the body upon the common material offered to them in the shape of the nutrient blood. How this property of "selection" is exercised, or what is its exact nature, science knows not as yet. But the possession of this remarkable property of selecting and using appropriate material in the actions of life, explain it how we may, constitutes one of the most consistent and clearly defined distinctions which can be drawn between the world of life and the great encompassing universe of non-living matter.

The foregoing remarks may serve to elucidate in some degree the essential nature of a process whereby certain animal forms not only build up structures of massive kind in modern seas, but through which they have been enabled to effect change and alteration of no ordinary extent on our earth, in past epochs of its history. With the coral-animals every one must be familiar as far as the mere name of these beings is concerned; and doubtless few people are unfamiliar with some variety or other of the substance manufactured by the animals just named. As presenting a subject for a brief investigation into some curious phases, not only of animal life but of physical history also, the coral-animal stands possibly without a rival; and as illustrative of a veritable race of animal architects, these beings have no equal, either in respect of the variety or the magnitude of their operations.

Probably no portion of the domain of the naturalist has been more plentifully overrun with error than the special territory which includes the coral-polypes as its tenants. To begin with, errors in the name are of plentiful occurrence; the most common instance of this kind being found in the erroneous designation of "insects" often bestowed on the coral-animals. The name "insect" was no doubt applied in a very loose and general sense in bygone days. But it is the first duty of science to be correct in its nomenclature, and as suggestive of a relationship to the familiar "insect" the use of this term, as applied to the coral-architects, is of grossly erroneous nature. Ere now, also, the fishes of the sea have been credited with the work of building coral-reefs, and the vague term "animalcules" was used in former days to indicate the nature of the workers in coral. Nor have poets been behind in propagating erroneous ideas concerning the nature and work of the coral animals. As Professor Dana remarks, Montgomery's "Pelican Island" contains statements which a scientific man at least can hardly excuse on the ground of poetical license. "The poetry of this excellent author," says Dana, "is good, but the facts nearly all errors—if literature allows of such an incongruity. There is no 'toil,' no 'skill,' no 'dwelling,' no 'sepulchre,' in the coral-plantation, any more than in a flower-garden; and as little are the coral-polypes shapeless worms that 'writhe and shrink their tortuous bodies to grotesque dimensions.'" The coral-animals, in short, manufacture or secrete the coral-substance as a part of their life-action and nature, just as a flower manufactures its color, or as a higher animal forms its bones. The living acts of the coral-animal include the formation of coral as an essential and natural duty, and not as a work of a merely accidental or occasional kind.

It is noteworthy that the animal nature of coral was first discovered only some hundred and fifty years ago. Such an assertion may appear somewhat strange to the ordinary reader, considering the universally admitted animal nature of the substance. But it must be remembered that the distinctions between animals and plants have only in comparatively late years been duly investigated; and the habit of placing reliance upon external form and outward appearance as a means of distinction, certainly tended to place the plant-like and rooted corals as veritable plants before the eyes of naturalists in past days. The appearance of a piece of red coral, or of the nearly allied *Isis* or "mare's-tail" coral, in its living state (Fig. 7), for example, is decided-

FIG. 7.—"Mare's-tail" coral (*Isis hippuris*).

ly plant-like. We see a branching structure, consisting of a hard, central axis of coral, covered with a soft skin or living bark, imbedded in which numerous little beings, each possessing a circle of eight fringed arms or feelers, are to be noted. These little beings are the "coral-polypes." That they are sensitive is proved by their habit of shrinking within the living bark of which they form part, when irritated or alarmed; and as the appearance of the polypes is flower-like to a high degree, it is not surprising to find that the Count de Marsigli should have described and figured the sensitive "flowers" of the coral "plant" in his celebrated work entitled "La Physique de la Mer," published in 1706. The ideas which prevailed at that date regarding the exact structure of the supposed coral "plant," however, were of improved kind as compared with prior conceptions of its nature. Ovid states the popular belief of the classic period when he relates that the coral was a sea-weed which existed in a soft state so long as it remained in the sea, but had the curious property of becoming hard on exposure to the air. Messer Boccone, in the 17th century, was the first to refute this idea, and showed that, although the coral "plant" possessed a soft outer bark, it was in reality a permanently hard structure even in its native waters. It so happened that about 1723 a pupil of Count Marsigli's, Jean André de Peysonnel by name, obtained a commission from the French Academy of Sciences to study the coral "plants" in their native seas. Proceeding to Marseilles and to the North African Coast, Peysonnel soon found reason to alter the views with which he had been indoctrinated respecting the nature of the living parts in the coral. Studying the red coral attentively, this observer said that the coral "flowers" of Marsigli were true animals, and were in fact closely related to the familiar but plant-like "orties" or sea-anemones, which Réaumur in 1710 had shown to be animals. In his remarks on the coral-polypes, Peysonnel compared the coral animals to "une petite ortie ou poulpe." And that the comparison of the coral-polype to the "ortie" or anemone is a perfectly just one, is proved by the fact that the zoologist of to-day selects the latter animals as the type of the great class of coral-producing animals.

It is no easier task to root out and supplant long-established beliefs in science than in the ordinary affairs of life; and Peysonnel found to his cost that to play the *rôle* of a conscientious observer and reformer is by no means a labor of easy or enviable kind. Réaumur, whose discovery of the animal nature of the sea-anemones might have been supposed to have given him a peculiar aptitude for criticising Peysonnel's observations after a just fashion, was one of the first to condemn the young student of Marseilles ; and other Academicians followed in the wholesale condemnation of the revolutionary tendencies of Peysonnel's discovery. Disgusted with the treatment shown him by the Academicians whose accredited emissary he was, Peysonnel sailed for the Antilles, engaged in the profession of a naval surgeon, and forwarded to the Royal Society of London the results of his further researches on the coral-polypes. To this day, Peysonnel's observations remain in manuscript in the library of the Natural History Museum at Paris ; but it is satisfactory to learn that the ill-treated *savant* lived long enough to find the truth and worth of his discoveries fully admitted. Certain experiments of Trembley, published in 1744, upon those peculiar fresh-water polypes, the hydræ, led to the recognition of these plant-like beings as true animals. The lists of plant-like forms were next overhauled, with the result of demonstrating the animal nature of many organisms which were formerly included within the botanist's domain, and amongst these new-found animals were the coral-polypes, whose exact nature Peysonnel had demonstrated many years before.

The animal nature of the coral-producing beings having thus been demonstrated, their place in the animal series may in the next instance be briefly referred to. As already remarked, the common sea-anemone of our coasts may be selected as the type of the coral-animals—as far as the structure of its soft parts is concerned. The anemones, as every sea-side visitor knows, do not manufacture or secrete any hard skeleton ; but if we suppose that such a power existed in these familiar denizens of our coasts, and that, taking lime from the sea-water, they elaborated such material into hard parts of various kind, we should possess a broad but essentially correct idea of the nature of any coral-polype. We thus note the incongruity of applying such a name as a coral "insect" to these animals ; whilst we can also realize the justness of Peysonnel's descriptions. The coral-polype is a little lime-secreting anemone, possessing a central mouth surrounded by arms or tentacles, the latter capable of withdrawal on being irritated. Peysonnel's name off "poulpe," also given to the coral-animals, is seen to be equally applicable ; this name "poulpe" being derived, like the English "polype," from the Latin "polypus," a term meaning "many-footed." The name "poulpe" or "polype" was also given to the cuttle-fishes—these latter animals, like the anemones and coral-polypes, having numerous arms arranged around a central mouth.

Such being the relations of the coral-polypes to the sea-anemones, certain of the more important differences they exhibit from their familiar representatives may be noted. The common groups of sea-anemones exist, like most other animals, in a single and simple condition—that is to say, each animal is entirely independent of and disconnected from its neighbors. The reverse, however, is the case with the coral-polypes ; for among these animals there exists a marked tendency to produce compound "colonies" or aggregated masses of animals, which, curiously enough, originate from single and simple forms by a veritable process of building. Some coral-polypes are, like the sea-anemones, single in their nature. No better example of a solitary coral-polype could be cited than the little Devonshire "cup coral," or *Carophyllia* (Fig. 8), one of the few lingering remnants of British coral-life. The cup coral appears before us as a veritable anemone, possessing the power of elaborating an internal living skeleton ; and the foreign mushroom corals or *Fungiæ* may also be cited as representatives of simple corals. The branch of red coral and the vast majority of reef-building and other corals exhibit, however, the true characteristics of their race, in that they are of compound nature, and form, in the reef-building corals, by a process of continuous and connected growth, masses of immense size and extent. Indeed, it is this feature of constant and connected production which gives to these animals their characteristic power of forming huge monuments of stable and enduring kind on the surface of the earth. It may appear somewhat strange to speak of budding in connection with the animal form. The process, however, not only occurs in the class of coral-polype, but is represented in the nearly allied zoophytes, and in several other groups of animals. The history of a great mass of coral may be thus traced from its earliest stage, when an egg, liberated from some member of an already-formed colony, settled down, attached itself, and produced a single anemone-like polype. This solitary polype next began to bud, and so produced a series of new and connected beings ; and if we suppose the budding process to be in turn repeated by each member of the colony, we can readily understand how the compound organism should attain in due time a growth of almost unlimited extent. Many corals also provide for their increase by a process of *fission*, that is, of simple division of the body-substance into new individuals. The occurrence of this process in the corals is not surprising when we consider that the common sea-anemone may be divided artificially, like the hydra, with the result of producing one or more new individuals. Some of the star corals or Astræas, of the Pacific, grow into great stony hemispheres through this method of increase, these masses frequently possessing a diameter of from ten to fifteen feet. Life and death in the living coral, to use Mr. Dana's words, may be regarded as "going on together, *pari passu.*" As new living parts are developed, the older parts die, but necessarily leave behind their coral-substance to form enduring parts of the mass. In some cases, according to the author just quoted, "a polyp, but a fourth of an inch long, or even shorter, is finally bound at the top of a stem many inches in height. . . . The tissues that once filled the cells of the rest of the corallum have dried away, as increase went on above. . . . The coral-zoophyte may be levelled by transported masses swept over it by the waves ; yet, like the trodden seed, it sprouts again, and continues to grow and flourish as before." Thus the fertility of the coral-polypes may be regarded as of double nature, since we find that each member of a coral colony is capable—first, of giving origin to eggs, each of which when duly developed represents the initiatory stage in the production of a new colony ; and secondly, of increasing each individual colony by an unlimited process of budding or fission.

FIG. 8.—Corals. A, *Dendrophyllia*, one of the "tree corals ;" B, *Carophyllia*, the "cup coral."

As features in the general structure of corals, which deserve a brief notice by way of conclusion to their personal history, we may refer to the main differences observable in the coral-structure, and to certain variations in the chemical composition of the coral. A piece of red coral, or mare's-tail (Fig. 7), exemplifies one of the two chief varieties of coral ; the coral-substance forming in this instance a solid central axis, on the outside of which the living bark consisting of numerous polypes is situated. In this and similar cases, all traces of the separate coral-polypes disappear when the living matter is washed away. But in the second variety of coral-structure, well exemplified by the Carophyllia and the great reef-building corals (Fig. 8), the coral-substance is outside the living parts, each little polype being contained within a cell which it has secreted and formed. This latter mode of growth produces the massive solid corals, on the presence and increase of which the formation of reefs depends; the more delicate and branching species being formed after the type of the red coral and its neighbors. That lime is the chief element represented in the coral-substance may be readily inferred from the preceding remarks. A few corals, however, exhibit a composition in which the lime plays an altogether secondary part. Thus the *Isis* or mare's-tail coral (Fig. 7) of the Indian Ocean and elsewhere, consists of alternate joints of horny and limy matter; whilst in another group, represented by the *Gorgonias* or "sea-fans," the coral is entirely composed of horny material. The essential details comprised in the general history of the coral-polypes may be briefly summarized by way of introduction to the investigation of their actual work in reef-formation, by asserting each coral-animal to be in all essential details of structure a sea-anemone; and by the further statements, that the coral-polypes differ from the anemone in respect of their ability to form an internal or external skeleton usually consisting of limy matter, and that they increase indefinitely by a process of budding or of division, and thus give rise to connected colonies. Bearing these details in mind, the further history of the operations of these animals will be readily understood.

Two important points in the life of the coral-polypes demand attention by way of introduction to the general history of their architectural operations. Like all other living beings, the coral animals require certain special conditions as those of their normal existence. In the case before us, the two conditions demanded are a certain *temperature* and a certain *depth* of sea; these conditions constituting the environments, as it were, of coral life. The question of temperature is a highly important one, inasmuch as the condition of the sea as to warmth will be found to regulate the distribution in space of the corals. The geography of these animals, in short, is bounded by well defined lines or degrees of temperature; and the statement that reef-building corals will not as a rule flourish and grow in seas the temperature of which falls below 68° Fahr., may be taken as a summary of what has been ascertained on this point. We must, therefore, look to equatorial seas, as those in which the typical development of reef-building corals occurs; and a ready mode of stating the facts of the distribution of coral life consists in our selecting the equator as a natural centre of our globe, and in measuring off a band of 1800 miles in breadth on each side of that line. A broad band or area some 3600 miles in breadth, encompassing our globe, and having the equator for its centre, will thus be found to include in its course the chief regions of coral growth. But, as Mr. Dana remarks, whilst the distribution of corals depends to a very great extent upon temperature, "regional peculiarities" also "exist that are not thus accounted for."

Whilst the Pacific and Indian Oceans form great repositories of coral-reefs existing within the limits just mentioned, and whilst the Red Sea, the N.E. coast of Australia, and the coast of Florida also exemplify great areas of coral development, certain other oceanic tracts exist from which coral-reefs are wholly absent. Mr. Darwin thus informs us that "no coral-reefs were observed during the surveying voyages of the Beagle on the west coast of South America south of the equator, or round the Galapagos Islands. It appears also," he continues, "that there are none on this coast north of the equator." The western coast of Africa is singularly free from coral-reefs; and it may be laid down as a rule of the widest possible kind, that coral-reefs are not found near the estuaries of great rivers, a result clearly due to the mixed or brackish character of the water in such situations. It may be shown that the absence of reefs on the western coasts of South America and Africa is due to the lower temperature which prevails in these areas, but it is possible that other causes—to be hereafter noted—less dependent on temperature or on the sea itself, may more feasibly explain the non-development of coral life in certain regions.

The condition included under the head of *depth* is, if anything, a more important item in the maintenance of coral life and growth than that of heat. If we cite evidence on this point, we may ascertain that the subject of the depth at which corals live received attention from more than one naturalist in past days. The French explorers Quoy and Gaimard, in their report of observations published in 1824, were probably the first who ventilated the opinion that the living reef-building corals existed in *limited depths of sea.* Foster and the earlier navigators assumed that, as coral-reefs were found in depths of literally unfathomable kind, the coral-polypes grew from the abysses of ocean. But Quoy and Gaimard concluded, from observations made in two voyages, that a depth of from thirty to thirty-six feet represented the zone of coral life. Ehrenberg set the limit from which living coral was fished at six fathoms, and Mr. Stutchbury, another observer, maintained that a depth of sixteen or seventeen fathoms might be regarded as the farthest limit of the living reef coral-forming corals. Mr. Darwin concludes "that in ordinary cases, reef-building polypifers do not flourish at greater depths than between twenty and thirty fathoms, and rarely at above fifteen fathoms." And Mr. Dana remarks that "there is hence little room to doubt that *twenty fathoms* may be received as the ordinary limit in depth of reef-corals in the tropics." In answer to a suggestion that "reefs may possibly rise from very great depths through the means of small corals first making a platform for the growth of the stronger kinds," Mr. Darwin says, "this, however, is an arbitrary supposition ; it is not always remembered that in such cases there is an antagonistic power at work, namely, the decay of organic bodies when not protected by a covering of sediment or by their own rapid growth. We have," he adds, "moreover, no right to calculate on unlimited time for the accumulation of small organic bodies into great masses. . . . As well might it be imagined that the British seas would in time become choked up with beds of oysters, or that the numerous small coral-lines off the inhospitable shores of Terra del Fuego would in time form a solid and expansive coral reef."

The causes of the limitation in depth of corals may be summed up by recognizing the necessity of a due supply of light and air for maintaining the vitality of the living animals. The living polypes require light as a condition for the exercise of their vital functions, and they no less imperatively demand a due supply of the vivifying oxygen ; these essentials for vitality being obtainable only in surface-waters, or within a limited depth in the ocean. Recognizing the settled and affirmed nature of these two conditions of coral life, we may next proceed to examine the curiously complicated problem which the condition of limited depth especially imposes upon the naturalist. How, in other words, when we take into account the limitation in depth of living corals, can we explain the creation of coral-reefs and islands existing in abyssal or unfathomable depths of sea ?

It is a striking characteristic of scientific procedure that no new or strange fact is long left without an explanation. That the first explanation may not necessarily be correct, but is, on the contrary, more likely to prove untenable when a wider knowledge of the fact or facts is obtained, are statements which the history of scientific hypotheses and their verification fully indorses, and which the fate of the first-offered theories of the erection of coral-reefs fully confirms. To appreciate the points which the theories of the erection of coral-reefs include, it becomes necessary to glance, in the first instance, at the various forms which coral-reefs may assume. These reefs may be divided into fringing reefs, barrier reefs, and atolls or lagoon reefs. The nature of the first-named erections is explained by their name. They simply fringe or skirt the margins or coasts of lands, and appear to be mere coral-extensions of the ordinary beach. A typical reef of this description is seen to surround the island of Mauritius, and another skirts the coast of Cuba. A sounding-lead allowed to descend on the seaward face or edge of a fringing reef would strike the true sea-bottom at a depth not exceeding twenty-five fathoms. Its outer edge is formed of true reef-building corals, which seem to thrive best amid the spray and surf. Near the shore, different and less hardy corals live; and in the shallow water which intervenes between the reef and the shore, a whitish mud, consisting of the *débris* of the dead corals, is found, together with the blocks of coral which have been torn from the reef and cast up on the shore by the violence of storms. "A fringing reef," says Mr. Darwin, "if elevated in a perfect condition above the level of the sea, would present the singular appearance of a broad, dry moat, bounded by a low wall or mound." The breadth of a fringing reef depends on the slope of the beach; the more gradual the slope, the farther seaward will the reef extend; whilst a steep beach, preventing a great depth of water nearer the shore than the sloping form, will proportionally limit the seaward growth of the corals. On very steep coasts, fringing reefs may not exceed fifty yards in width, that measurement representing the distance from the shore at which the coral-polypes reach their farthest limit of depth.

The barrier reef is an erection of a very different kind from the preceding variety of reef. In its most typical form, well seen on the north-east coast of Australia, or on the western coast of New Caledonia, a barrier reef appears as a great bank or reef of coral, separated from the adjoining land by a belt of water named the "inner channel." Sometimes an island—like Tahiti—is surrounded by a barrier reef, which stands like a great wall around the land, but is separated from the latter by a channel. In the latter case the barrier reef receives the appropriate name of "encircling reef." Some of the barrier reefs are of immense extent. The great barrier reef on the north-east coast of Australia extends uninterruptedly for 1000 miles, and nearly in a straight line, and varies from ten to ninety miles in breadth. If transferred to European seas and extended round European coasts, this reef would reach from Brest across the mouths of the Irish Sea and English Channel, round the western coast of Ireland to Iceland; whilst if extended in another direction, it would pass round the coasts of Scotland and the Shetland Isles, and terminate on the Norwegian shores. Soundings taken on the seaward face of a barrier reef reveal immense depths and a state of matters very different from that existing in the fringing reef. The seaward aspect of the latter was seen to exist within the limit of depth of the coral-polypes. The barrier reef, on the contrary, is found to rise from depths altogether beyond the sphere of coral life. And whilst the face of the fringing reef is covered with living coral, that of the barrier reef possesses a living incrustation only in its upper part, and to a depth of 100 feet or more; all its substance below this limit consisting of dead coral.

The third variety of reef is named the atoll or lagoon reef. This latter form of reef exists as a more or less circular ring of coral of varying breadth, inclosing a sheet of still water—the lagoon. These coral islands are common in the Indian and Pacific Oceans. Keeling or Cocos Atoll, in the former ocean, measures 9½ miles in its greatest width. Bow Island is 30 miles long and 6 miles wide; whilst in the Maldive Archipelago, atolls of very large size are met with; one island measuring 88 geographical miles in length, its greatest width being under 20 miles, and its least width 9½ miles. Beholding a great coral ring, bearing on its surface a low island soil with vegetation, and protecting a quiet lake-haven from the restless ocean without, it is little to be wondered at that the earlier voyagers recorded their surprise that the apparently insignificant architects of such an erection are able to withstand the force of the waves and to preserve their work amid the continual attacks of the sea. Pyrard de Laval, writing in 1605, well remarks, "It is a marvel to see each of these atollons surrounded on all sides by a great bank of stone—walls such as no human hands could build on the space of earth allotted to them. . . . Being in the middle of an atollon, you see all around you this great stone bank, which surrounds and protects the island from the waves; but it is a formidable attempt, even for the boldest, to approach the bank and watch the waves as they roll in and break with fury upon the shore." Soundings on the seaward side of an atoll reveal abyssal depths as in the case of barrier reefs; and, as in the latter instance, the living corals exist only at the surface margins of the reef, extending downward merely to their natural limit of depth. The massive living corals, as before, flourish best where the surf is of the heaviest description, whilst more delicate kinds grow within the quiet waters of the lagoon; and it must be borne in mind that the living corals, of whatever variety, require to be constantly immersed in their native waters. Exposure, even for a limited period, to the rays of the sun, is fatal to their vitality. From this observation it becomes clear that the labors of the coral-polypes are inadequate to raise the reefs above the surface of the water; other agencies, as will be presently noted, completing the erection, by the addition of foreign matter for the elevation of the reef. The depth of the central lagoon varies, a depth of forty-nine fathoms being of maximum kind; and the bottom of this central lake consists usually of sand and soft clay, or fine calcareous mud, the latter resulting from the grinding-down process to which the coral is subjected by fishes and other enemies. The coral ring of the atoll is broken at one or more points by an opening, often large enough to admit the passage of large ships into the quiet haven within. This passage into the lagoon invariably occurs on the leeward aspect of the atoll; this fact possessing a practical interest for the navigator who has succeeded in safely avoiding the dangerous swell and surf of the seaward side.

Noting these three varieties of coral-reefs, we may now proceed to inquire into the chief theories which from time to time have been constructed with the view of explaining their mode of formation. Just as the nature of the coral itself formed, as we have seen, a subject of debate amongst the earlier writers, so the "reason why" the coral-polypes aggregated themselves together in the form of atolls and barrier reefs, constituted one of the knotty points of early biological science. The same mysterious "instinct," which was supposed to be the cause of their secreting lime, was credited with being the directing impulse in causing the selection of admirable sites for the coral-reefs. They formed a great protecting reef, according to Flinders, that they might work in safety under its shelter, and that the leeward aspect of the reef might form a kind of nursery-ground, whence "their infant colonies might be safely sent forth." In this case the coral-polypes are credited with the possession of intelligence of no mean order, and are presumed to co-operate together for an end and in a manner utterly unknown to be represented in any other group of animals. Such a theory, moreover, leaves untouched the essential question of the causes in virtue of which coral-reefs should assume the characteristic forms observed in the atolls and barrier reefs, and the want of an explanation of the latter points suggested a theory whose simplicity is unfortunately its only recommendation. It was believed that, taking into account the imitation in depths of living corals, these animals obtained a basis and foundation in land which lay submerged some 120 or 150 feet in the sea ; so that every coral-reef was regarded as simply presenting us with a coral top to solid land. The circular form of the atoll was ingeniously accounted for on the supposition that the coral-polypes had built around the rim of a volcanic crater, and that the break in the coral ring affording entrance to the lagoon was represented by a fissure of greater or less extent in the continuity of the crater's margin. The plausibility of this theory becomes sadly weakened if we subject its supporters to the cross-examination of the physical geographer. For the stability of the ideas thus ventilated, it would require to be proved firstly that submarine plateaus or ridges existed not only in great profusion in the coral regions, but also that these plateaus existed at a uniform depth, so as to afford the necessary basis for the operations of the polypes. That physical geography affords not the slightest justification or foundation for such a belief, is a fact known to every school-boy ; and now that we are tolerably familiar with the nature of the bed of more than one great ocean through recent sounding and dredging expeditions, this theory might be simply relegated to the limbo of impossible beliefs on the ground of its entire inconsistence with plain fact.

But its improbability might also be argued from the fact of its assuming the existence, in the coral areas of the ocean, of sunken land, which could not —except on the most arbitrary of suppositions—be supposed to be limited to these areas alone. And as other ridges of land within 150 feet of the surface are unknown in other seas and areas, the theorist would have to explain the singularity of submarine plateaus existing so plentifully in one region and their entire absence in another. Geological science, if appealed to in this matter, would own that it knew of no support which could be given to the assumption of local elevations in the sea-bed ; whilst it would suggest that the levelling tendency of the waters of the sea in smoothing down the ocean-bed would weigh greatly against the theorist's views. Thus, if the existence of submarine ridges be disproved, this first theory must necessarily fall to pieces and be wholly put out of court. The suggestion that atolls exist on a volcanic foundation meets with a similar fate when tested by the facts of geology and the logic of common-sense. It may thus be remarked, that the mere shape and configuration of many of the atolls is entirely inconsistent with this explanation, no volcanic crater possessing, for instance, the form of Bow Atoll, "which is five times as long as it is broad." And the mere question of size is at once seen to prove the utterly untenable nature of the suggestion of the origin of atolls. Since it might be asked if reason could support a theory which on its own showing must postulate the existence of a volcanic crater eighty-eight miles long by twenty miles broad at its greatest width, the latter being the measurements of one of the Maldive atolls. As in the previous case, this theory demands the recognition of the existence of numerous volcanic chains all existing within a limited depth of the surface ; and, in view of the utter want of evidence to show that any such immense volcanic area ever existed, this supposition must be unhesitatingly rejected. One further idea emanating from Chamisso may be lastly noted. This author held that, as the reef-building corals love the surf, the outermost parts of the reef will tend first to reach the surface and so assume a circular form. But this idea assumes that the foundations of the reef in such a case consist of a flat bank, and the existence of such foundations is, as we have already noted, inconsistent with fact. The origin of barrier reefs did not receive from the naturalists and geologists of the past the same amount of attention as the question of the nature and origin of the atolls—a result due to the apparently more recondite character of the latter problem. The great Australian barrier reef was alleged to be founded "on the edge of the submarine precipice parallel to the shore."

This idea may be dismissed with the remark that no evidence is afforded that any such precipice or plateau exists.

It may be affirmed that until the year 1842 no theory of the origin of coral-reefs which stood the test of scientific cross-examination was promulgated. In that year Mr. Darwin gave to the world his views on this subject, and enunciated a theory which has firmly stood its ground against the most severe examination and criticism, and which at the present time remains as the only feasible theory of the origin of coral-reefs. If it be taken as a test of the truth of a hypothesis that it intelligently explains all the facts of a case and is found to be inconsistent with none, then Mr. Darwin's ideas may be regarded as constituting a theory of the most perfect kind. And it may be fearlessly affirmed that, had Mr. Darwin accomplished no further investigation than his researches on coral-reefs, he would have been entitled to the admiration and gratitude of all who regard the advancement of knowledge as of supreme consequence to man's welfare. Mr. Darwin spent some five or six years of his life (1831–36) as naturalist on board H.M.S. Beagle under Captain Fitzroy, and was thus enabled to study the coral-polypes and their work in the most direct and advantageous manner; whilst Mr. Dana, representing the scientific leader of an American circumnavigating expedition (1838–42) under Captain (now Admiral) Wilkes, may be regarded as an authority of equal rank with Mr. Darwin on the subject of coral-reefs. It is worthy of remark that, whilst Mr. Darwin's observations were published in 1842, Mr. Dana's report on coral-reefs was then in manuscript, but the conclusions at which these observers arrived, independently of one another, were of essentially identical kind, and the fact speaks powerfully for the implied correctness of the views promulgated by these explorers. Mr. Darwin's theory, besides offering a consistent explanation of all the facts of coral life, serves in the most direct manner to correlate and connect in the most natural fashion the various forms of coral-reefs. Starting with the assumption, already seen to rest on the most solid evidence, that coral life is limited to 150 feet as a maximum depth, Mr. Darwin rests his theory of the origin of reefs on the fact that land subsides.

The recognition of the geological phenomena known as the subsidence or sinking of land forms the key-note of Mr. Darwin's views; and it may therefore be viewed as a pardonable digression, if the nature of these phenomena is in the present instance briefly explained. That land rises and sinks is a fact well known to the geologist, who can point to many areas of the earth's surface in proof of his statement. Every one conversant with the elements of geology knows that the majority of the rocks composing the crust of the globe have been formed under water, and that a process of elevation must be assumed to account for their present position. Thus, true chalk is a rock composed of the remains of the minute foraminiferous shells already noticed. The cretaceous rocks were deposited in the sea-beds of the past, just as the shells of modern foraminifera fall to the bottom of existing oceans to form a chalky layer which may be destined, when elevated, to form the chalk of the future. Elevation of the earth's surface thus exists as a primary fact of geological science. But it may be conclusively shown that, whilst at the present day certain areas of our earth's surface are undergoing this process of upheaval, other areas as surely exhibit an opposite or subsiding tendency. The fact that land subsides must, however, be regarded in the light of the obvious relations which exist between the sea and the land. The subsidence of land is ascertained and calculated by its fluctuations as regards the sea-level. Hence it is necessary that the burden of the change should be laid upon the shoulders of the land, and that the sea should be shown to be a factor of constant and unvarying nature in this process. That the water of the ocean obeys the same laws as the fluid in a vessel, is a stable fact. Practically, we may regard the sea-level as invariable ; and although the theories of the influence of a polar ice-cap as tending to disturb the oceanic equilibrium are not wanting, such widely operating causes, even if proved to exist, would affect areas of so wide an extent that their influence would be of the most slight and meagre kind. On the contrary, where the changes between the level of land and sea are of a markedly local description and limited to a certain defined area, the alteration is clearly seen to have its seat in the land and not in the sea, the level of which, outside the defined area of change, can be shown to be absolutely unaltered. For example, on the coasts of Devon and Cornwall the remains of submerged forests are met with, the roots of the trees being still fixed in the soil. As these trees must have grown on land, it follows that the incident reveals the submergence of a land-surface. If we credit the sea with having risen, and suppose that the land has been stationary, we must be able to show not only that the whole southern coast of England has been similarly invaded by the sea, but that the opposite coast of France, and all the coasts bordering the North Sea and Atlantic, have been inundated. It is needless to point out that no such evidence is forthcoming, and that we are dealing with a subsidence of land, and not with a rising of the sea. Ample evidence of the existence of large areas of land subsidence is afforded by the geological survey of the southern coasts of Sweden ; the lower streets of the seaport towns of Scania, formerly inhabited, being now under water. The coasts of Greenland are similarly being depressed, and very marked alterations in climate may be shown to result from the existence of these movements on the part of what can no longer be regarded as the "stable land."

Bearing in mind the fact that land may subside completely beneath the surface of the sea, we may return from this necessary digression to the consideration of Mr. Darwin's theory of coral-reefs. Beginning with the fringing reef, well seen in the island of Mauritius, it is shown that such an erection forms the initial stage of coral-formation. Here we find a natural foundation for the work of the living coral-polypes ; the animals having fixed on a natural coast-line, and having, at a suitable depth for themselves, constructed a belt or fringe of coral, the seaward depth of which, as we have seen, does not descend below the fifteen-fathom line. So long as the land skirted by the fringing reef remains stable and stationary, so long will the reef remain essentially in its primitive condition. According as the shore slopes abruptly or gently, so will the breadth of the reef be limited, or be extended out to sea. No increase in depth is possible, seeing that the polypes have already attained, or have built upward from, their lowest depth ; and if the land remains in the condition in which it was when the fringing reef was first formed, the latter erection will also remain *in statu quo.* But, in accordance with the evidence of the geologist, land may sink. If we suppose that the land on which a fringing reef has grown slowly subsides, changes of great extent may be shown to occur within the attached zone of coral life. The lowermost corals, being carried out of their depth, must of necessity die ; a new sphere of operation being at the same time afforded by the subsiding operation for the uppermost corals. These latter will therefore continue to produce new polypes, and an upward growth of the coral will accordingly accompany the downward movement of the land. If the land-subsidence continues, the increase of the sea-wall or outer aspect of the reef will be greater than that of its shore side or inward portion, seeing that on the former surface the conditions of life are more suitable for the growth of the massive reef-building corals. The inner part or shore aspect of what was once the fringing reef thus becomes deeper and deeper as subsidence proceeds, and in due time we find a great coral-ridge growing up in front of the sinking land, and separated therefrom by a belt of deep water. In this way the barrier reef is evolved by the subsidence of the fringing reef. But the land may be depressed to a still greater extent, and as before, the upward coral-growth will keep pace with the subsidence. If we suppose that we are dealing with the case of an island or with land of limited extent, we may conceive that in time the last island peak or surface of original land will sink beneath the waves. The coral-growth has, however, been proceeding uninterruptedly as before ; and the lost land becomes ultimately surrounded by a great wall or cup of coral, inclosing a quiet lake—the atoll or lagoon of the Pacific voyager.

The formation of coral-reefs may be readily understood from an inspection of the appended theoretical figures (Figs. 9 and 10), by the late Mr. Jukes. The sea-levels are represented at S S ; and in the first figure A B and C D are two shores sloping seaward at different inclinations or angles. On these shores corals grow at their own limited depth, represented by the line F F, and thus form a fringing reef (R E G). The greater growth of the reef at E G, that is, farthest from the land, may produce a sheet of water between R and E ; and the breadth of the reef is seen to be greatest where the sea-bed slopes least abruptly. If the shores (A B and C D) begin to subside, the sea will flow upon the land, and the width of the reef (R E) will be increased, especially on the outer face (E G) by the upward growth of the coral, so that in time the belt or sheet of water between R and E becomes of considerable extent, and a barrier reef is formed. In the case of land of limited extent, the formation of an atoll readily takes place as represented in the second figure. The various lines (S S) represent the unaltering sea-level. The shaded central portion represents the original land. The letters B B indicate the successive upward growth of the coral as the land subsided ; and as the land disappears in the deep it becomes an atoll (A A), surrounded by a great wall or cup of coral-structure.

The final processes which the atoll undergoes consist in the filling up of the lagoon by *débris* derived from the reef, and in the formation of a soil on the coral-ring by the action of the sea, which detaches fragments of coral-rock, and heaps up sand on the surface of the new land. The sea will drift its weeds on the coral-rock, and these will decay and form a fertile soil in which seeds carried by the winds will take root and grow ; and ultimately some race of nomads may be found to colonize this strange sea-born land. Thus we observe that a fringing reef affords evidence of either the rising or stationary character

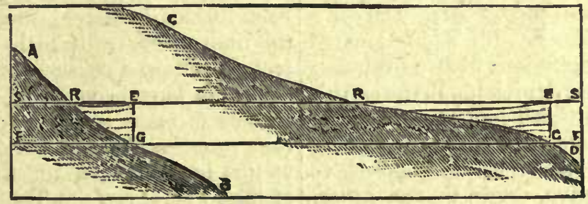

FIG. 9.—Diagram of coral-reefs (Jukes) : A B. fringing reef ; C D, barrier reef.

FIG. 10.—Diagram of atoll or lagoon reef (Jukes).

of its land; the barrier reef clearly intimates the subsidence of its foundations; and the atoll exists as an enduring monument erected over the burial-place of old and forgotten territory.

Such being Mr. Darwin's views, the feasibility of his theory may be proved by an appeal to the facts and deductions of geological science in particular. First, is it capable of proof that the regions in which the atolls and barrier reefs mostly abound constitutes areas of land-subsidence? One vast area of this kind, extending in the Pacific Ocean for 7000 miles from Pitcairn's Island and the Low Archipelago to the Caroline and Pellew Islands, is a region wherein the work of coral-erection proceeds apace; and between India and Madagascar another area of depression measuring 1500 miles in length has been clearly mapped out. A counter-proof of the correctness of Mr. Darwin's views is afforded by the deductions of geology in ascertaining that movements of elevation and depression in the earth's crust do not proceed contemporaneously in the same area; the causes producing the one movement being opposed to those which give origin to the other. Thus volcanic force invariably tends to produce elevation of the earth's crust, and the geologist would therefore esteem it a proof of the correct nature of Mr. Darwin's theory, could it be shown that active volcanoes were absent from the areas in which atoll and barrier reefs exist. Mr. Darwin's reply to this criticism is illustrated by an elaborately prepared map of the distribution of volcanoes, and may be given in his own words. It may "be considered," he says, "as almost established, that volcanoes are often present in the areas which have lately risen or are still rising, and are invariably absent in those which have lately subsided or are still subsiding;" whilst he has conclusively shown that the areas of active coral-formation exist as regions destitute of active volcanoes, and in some instances as areas possessing no volcanoes at all. "The regions occupied by fringing reefs may be said to be those in which volcanic matter every now and then bursts forth," and tends to elevation. The areas of barrier reefs and atolls are "wide spaces sinking without any volcanic outbursts; and we may," concludes Mr. Darwin, "feel sure that the movement has been so slow as to have allowed the corals to grow up to the surface, and so widely extended as to have buried over the broad face of the ocean every one of these mountains, above which the atolls now stand like monuments marking the place of their burial."

These ideas are strongly supported by the observations made on *raised* coral-reefs. That sinking must take place in the course of the formation of reefs is proved by the examination of some raised coral-rocks, "as at the island of Mangaia in the Hervey Group," where the elevated reef rises 300 feet above the sea-level. These rocks must have been formed in water; and as we know the limit of coral life to have been 150 feet, it follows that such elevated reefs could not have been made "without a sinking of many scores of feet during their progress." Another explorer tells us that he can vouch for the existence of raised coral reefs at Timor and Java, these coral-rocks existing at heights varying from 100 to 200 feet above the level of the sea.

The subject of coral and coral-reefs, like most other studies in natural science, becomes related in an intimate manner to other branches of knowledge, and to other trains of thought. In the case before us, it may prove interesting if, by way of conclusion, we endeavor to point out one of the many subsidiary subjects on which a study like the present is adapted to throw some degree of light. The most sublime idea of nature which man can well obtain is that of the uniformity and constant character of natural operations and laws. To the student of nature, the idea of capriciousness exists only as the result of an erroneous interpretation of some violated course of law and order; and in the modern study of earth-science the geologist is led to recognize in the principle of the uniformity of nature the means whereby all physical actions are bound together in one harmonious whole. It so happens that the evidence capable of being adduced from the growth of coral-reefs goes far to prove the constant and uniform state of our earth throughout immense periods of time. The testimony of Mr. Dana with regard to the rate at which coral grows is to the effect that the massive corals on which the increase of reef depends are of very slow growth; the branching and certain other kinds growing at a faster rate. One-eighth of an inch per year is given by this author as "the average upward increase of the whole reef-ground per year;" and the estimate appears to be a perfectly just one, when judged by the evidence afforded us of the rate of growth in corals. All authorities agree in stating the growth of massive corals at a very low rate, and the time which has been occupied in the formation of a reef 2000 feet thick must, therefore, on Mr. Dana's estimate, be set down at 192,000 years. This computation, it must be remembered, is one dealing with the work of modern corals. In the far-back past, coral-reefs existed similar in every respect to their modern representatives; these fossil reefs in many cases evincing an immense thickness. Hence we are led to believe that, notwithstanding the alteration which our earth has undergone, it has had prolonged periods of rest; and the existence of a modern coral-reef may therefore afford evidence, not only of the immensity of past time, but also of the uniformity of nature's ways and works during periods compared with which the farthest limits of history and even of man's own age are but as yesterday. The deductions from a study like the present may be fitly expressed in Langel's words, as giving us "a higher conception of the universe than that entertained by the ancients;" since science "no longer regards the material world as the plaything of mere caprice," but "embraces the past, the present and the future in a magnificent unity, outside of which nothing can exist."

PARASITES AND THEIR DEVELOPMENT.

If man is to be regarded as the favored child of Nature, and if it be held as true that life at large is subservient to his sway and rule, it is no less true that he is liable to suffer severely from the attack of certain of his lower neighbors, and that he is despoiled in various fashions by some of the most insignificant of living beings. Insects of various kinds, insignificant as to size, but powerful beyond comprehension in virtue of their numbers, devastate the crops which exercise his mind and appliances in their cultivation. And after the crops have been fully stored and garnered, the labor of months and the full fruition of the farmer's hopes may be destroyed by the insidious attack of granary-pests. Plants of lowly grade—minute fungi and like organisms—personally known to the microscopist alone, blight at once the prospects of the agriculturist and of his cereals. A minute fungus, burrowing its way within the tissues of the potato-plant, has ere now brought destitution and famine on a nation, and still causes disease amongst our tubers to an extent which none but our potato-growers can fully realize. Nor is the farmer's sphere singular in respect of its liability to the attack of animal and plant foes. Parasites, the complexity of whose life history almost defies belief, invades the stock of the breeder of cattle and sheep and decimate his flock; whilst these same parasites may occasionally invade the human domain itself, and cause disease and death to prevail to an alarming extent. Hidden enemies in the sea burrow into the sides of ships, or undermine man's piers and bulwarks. Poison-traps lie in wait for human footsteps; and claw and tooth are as ruthless when opposed to humanity as when prepared to attack lower life. Speaking generally, therefore, man may be readily shown to be by no means the undisputed "monarch of all he surveys" in the territory of either botanist or zoologist; and the province of mind and intellect may be invaded by foes against which man may find it impossible to contend. Much has been done, it is true, in the way of repressing many of our lower enemies, and the increase of scientific knowledge has had few triumphs of higher kind than are witnessed in those researches which have exposed the nature of our animal and plant enemies and shown us the steps necessary to be taken for their annihilation. But the field of inquiry seems well-nigh boundless; and it should certainly form one of the most powerful arguments in favor of the study of natural science, that on the advance in our knowledge of economy, botany, and zoology the prosperity of our commerce and the conservation of our health may be shown largely to depend.

Perhaps one of the richest fields of research in the way of repression of our lower enemies, is offered by the life-history of some of the most common parasites which decimate our flocks and herds, and which, as already remarked, occasionally invade the human territory itself. Well does the shepherd know the symptoms of "rot" in his flock, and anxiously does he apply to the veterinarian for advice in his extremity. His sheep, in such a strait, present a dull and dejected appearance; they are "off their feed," he will tell the observer; and are in a thoroughly emaciated condition, despite the shepherd's kindly care and supervision. By-and-by deaths will begin to be of frequent occurrence, and when the dead subjects are carefully inspected the cause of the disorder is not hard to discover. The body of the affected sheep exhibits a state of thorough disorganization, and when the liver is carefully inspected, hundreds of small flattened bodies, each about three-quarters of an inch long, are found within the bile-ducts; whilst in the bile itself thousands of small particles are to be discovered by microscopic aid. The small flat bodies are "flukes" (Fig. 11), and the particles are the egg of these animals. What, it may be asked, are these flukes, which, according to trustworthy evidence, carry off annually between one and two millions of sheep at the very lowest computation? The reply to this question is readily given. The "liver-fluke" is one of a group of internal parasites

Fig. 11.—Liver-fluke, or *Fasciola*, magnified.

which has been known from comparatively early times. It was certainly known in 1547, and was lucidly described in 1552 by an author who was shrewd enough to attribute to its presence an epidemic which decimated the flocks of Dutch farmers in that year. Its "area of distribution," to use a scientific but expressive phrase, is not confined to sheep alone, but includes cattle, the horse, hares and rabbits, the spaniel, deer and antelopes, and even man himself. A little flat and somewhat oval body, with a tree-like arrangement of tubes for a digestive system, and possessing a couple of suckers for adhesive purposes—such are the main features which a liver-fluke presents for examination. A more innocent-looking animal could hardly be found, and the cause of its injurious effects upon its animal hosts might remain a mystery, did our inquiries cease with the investigation, so to speak, of its *personnel*.

A highly important consideration, however, and one which extends beyond the restricted domain of our present subject, is that which recognizes in *numbers* and *time* two important factors in elevating agencies of apparently unimportant kind into forces of vast or uncontrollable nature. The rain-drop is insignificant regarded merely as a particle of water, no doubt; but multiply your rain-drops indefinitely, and you obtain the agent which will wear the hardest rock, excavate the giant cavern, or form the foaming cataract with strength to sweep away the greatest obstacles man or nature may oppose to its fury. Invest, further, the idea of the single rain-drop with time, and the action which appears feeble, if viewed for a single moment, becomes of mighty extent when multiplied into years and centuries. And similarly with the case of the fluke and its neighbor-parasites. A single fluke is of itself an unimportant quantity, but when this quantity becomes multiplied by hundreds, the proverb that "union is strength" receives a new and very decided application. Existing in large numbers within the liver-ducts of the sheep, the flukes cause irritation, and a whole train of symptoms which end usually in starvation and death. Hence the extreme fertility of parasites might well afford a text whereon a sophist might inveigh against the wise regulation of the domain of living nature, were it not that in reality these animals are checked and controlled through the actual complexity of their own development. Strange as the statement may seem, it is nevertheless true that Nature appears to offer a premium against the development and increase of these and other parasites, through their having to undergo a series of very striking changes on the way to maturity. The parasite's path to adult life may truly be described as chequered in the highest degree. There are numerous pitfalls and snares laid for its reception, and for the extinction of its young life; and the "struggle for existence" in the present case is not only fierce, but, in the case of a very large majority of the combatants, utterly hopeless.

Let us briefly trace the life-history of a fluke by way of practical illustration of these latter remarks. From each individual fluke residing within the body of its sheep-host, hundreds of eggs are discharged. Each egg undergoes a preliminary process of development, and from the eggs which escape into water, little free-swimming bodies are liberated. These minute living particles are young or embryo flukes. Each resembles an inverted cone in shape and swims rapidly through the water by aid of the microscopic filaments which fringe its body. It is clear that such eggs as do not reach water will not undergo development, and hence a first check to the increase of the flukes exists in the fact that many eggs must perish from the absence of appropriate surroundings. Sooner or later, the young fluke loses its power of swimming, and becomes of oval shape; crawling inelegantly, by contractions of its body, over the muddy bottom of its pool or river. Thereafter it appears to seek an entrance to the body of some co-tenant of its pool, such a creature being usually found in the shape of a water-snail. Buried within the tissues of this first "host," the young fluke becomes transformed into a sac or bag, within which other young may arise by a veritable process of budding. This rising generation appears in the form of small bodies, each provided with a vibratile tail. From the body of the snail these "secondary young" soon make their escape, and whilst existing in the water are readily conveyed into the stomach of the sheep in the act of drinking. Thence these young flukes penetrate to the liver of the animal, and become transferred into the mature and flattened adult.

The unexplained necessity for such a complicated series of changes in development, and for the varied circumstances which mark the career of the young fluke, present us with conditions which operate powerfully against the undue increase of the race. An exactly analogous series of changes is to be perceived in the development of many other parasites, and amongst others in that of the various groups of tapeworms (Figs. 12 and 13), which reside within the digestive system of man and many quadrupeds, and which are in reality "compound" animals, each joint being a semi-independent unit of the compound being. But for the complexity of their development, and for the consequent limitation of their increase, these parasites would overrun and exterminate their hosts in a short period of time. A common tapeworm begins life as a minute body, set free from its coverings and investments, and provided with a special boring apparatus, consisting of six hooks.

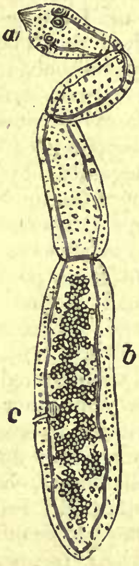

FIG. 12.—Tapeworm (*Tænia echinococcus*) of dog, in its mature condition : *a*, head, with suckers ; *b*, a full-grown joint ; *c*, aperture by which the eggs escape.

This little creature will perish unless it can gain access to the body of some warm-blooded quadruped, and the pig accordingly appears on the scene as the most convenient host for the reception of the little embryo. But within the body of the pig there is not the slightest possibility of the little embryo becoming a tapeworm. The pig has merely to perform the part of unconscious "nurse," and to prepare its "guest" for a yet higher stage of existence. Being swallowed by the pig, the young parasite bores its way through the tissues from the digestive system to the muscles of the animal, and there develops around its body a kind of bag or sac. In this state it represents the "cystic worm" of old writers ; and occasionally it may prefer the liver, brain, or even the eye of its first host to the muscles in which it usually resides. Here, however, it can attain no further development. If the pig dies a natural death there can be no possibility of the tapeworm stage being evolved. But if, as is most likely, the pig suffers death at the butcher's hands, the little cystic worms may be bought by mankind at

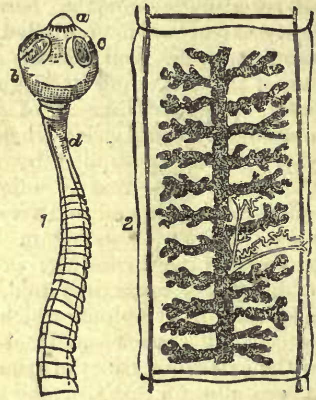

FIG. 13.—Common tapeworm (*Tænia solium*). 1. The head, magnified, showing hooks (*a*), and suckers (*b*, *c*) ; *d*, the neck, with immature joints. 2. A joint, largely magnified, showing the branching "ovary," in which the numerous eggs of each joint are matured

large along with the pork in which they are contained. Such persons as partake of this comestible in an imperfectly cooked condition thereby qualify themselves for becoming the "hosts" of tapeworms ; since, when a cystic worm from the muscles of the pig is introduced into the human stomach, the little bladder or sac which the worm possesses drops off, and the minute head of the worm (Fig. 13, *a*) becomes attached to the lining membrane of the digestive system. Once fixed in this position, the circle of development may be said to be completed. A process of budding sets in, and joint after joint (Fig. 13, 2) is produced, until the adult tapeworm, measuring, it may be, many feet in length, is developed ; whilst each egg of this full-grown being, if surrounded by the requisite conditions, and if provided with a pig-host to begin with, will repeat the marvellous and complicated life-history of its parent.

The history of the tapeworms, like that of the flukes, therefore, exhibits a very complex series of conditions, and unless these conditions are fulfilled by the young parasite, development is either cut short or is altogether suspended. The fact of a double host having to be provided for the due development of tapeworms is not peculiar to the production of the species inhabiting man. All of these parasites pass through an essentially similar series of developments. The cystic worms, or immature tapeworms, which cause the "measles" in the pig, become, as we have seen, and when eaten by man, the common and adult species of human tapeworm (Fig. 13). The cystic worms man obtains from underdone beef are developed within his economy into a tapeworm of another kind. The young parasites which reside in the liver of the rabbit, and which attain no higher development than that seen in the pig or ox, become when swallowed by the dog or fox the special tapeworm-tenant of these animals. The cystic worm of the mouse develops into the tapeworm of the cat; so that the dog, fox, and cat do not enjoy an immunity from enemies, but actually acquire disease from the victims they so ruthlessly pursue. The chances of destruction which beset the young parasite on its way through the world are so multifarious when compared with its chances of favorable development, that, practically, the immense number of eggs produced by these animals are of small account. Of the thousands of eggs developed, the merest fraction attain development, and the presence of a complex life-history in parasites must be regarded as in reality forming a saving clause, as far as man is concerned, when we consider our comparative immunity from their attack.

Even more extraordinary than the phases of development which have just been detailed are those undergone by a special form of tapeworm inhabiting the dog. The egg of this latter parasite gains admittance to the body of the dog-louse, and therein becomes the cystic worm, analogous to that formed within the muscles of the pig in the case of the human tapeworm. The dog, in the process of cleaning his skin, swallows the skin-parasite with its contained but immature tapeworm; and, once introduced to the dog's digestive system, the latter form liberates itself from the louse and becomes the mature and adult tapeworm. Anything more extraordinary than this peculiar circle of development can hardly be imagined in the life-histories of animals. Nor are the conditions which have determined and which continue the development rendered clear to us by the most careful study of the subject. Why is it that the tapeworm should not attain its full development within the pig, rabbit, mouse, or dog-louse, as its first host, we do not know; nor can it be rendered plain what conditions have so sharply divided the life of these parasites into two periods of such well-marked kind.

The whole question of parasitism, however, exhibits a striking illustration of the influence of habit and of surrounding conditions on the life of the animals. No one may doubt that the habit of one animal attaching itself to another is an acquired one. The most ardent advocate of the doctrine of special creation would never dream of maintaining that parasites were created as we find them in relationship with their hosts. Even were this argument advanced as a mere matter of unsupported belief, the order and the succession of life upon the globe would present facts which would at once veto the belief. The lowest animals appeared first, and were succeeded by forms of gradually increasing complexity. Hence the parasites must have been developed before their hosts. Man appeared long after the tapeworms or their ancestors were produced; and the intricate relationship between man and his neighbor-animals and the parasites must have been acquired in a gradual fashion. Best of all, this opinion is supported by the information to be gained from a survey of parasitic life at large. We may begin such a survey by noting animals which attach themselves to other animals as mere "lodgers." Such are external parasites. Next may be traced parasites which depend for house-room upon other animals, but which do not require board and sustenance from their hosts. Such "messmates" are presented by the little fishes which live within the bodies of large sea-anemones and other organisms, and which swim in and out at will, obtaining their food for the most part from the external world. A simple modification of habit in such animals would convert them into true parasites. Suppose that the guest found that it might readily obtain food by living on the matter its host elaborated for its own use, and suppose, further, that the animal-guest gradually accommodated itself by successive modifications to its new mode of life—we have thus the influence of habit brought into play and exercised upon the descendants of the first parasite in producing a literal race of such beings. Such a belief or theory is neither contrary to facts as we find them nor is it unsupported by direct evidence. Take, for example, the case of *Sacculina*

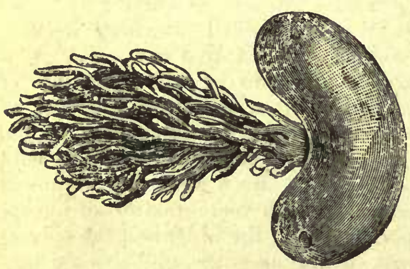

Fig. 14.—Sacculina purpurea, a crab-parasite, showing its "roots."

(Fig. 14), a well-known parasite, which attaches itself to the bodies of hermit-crabs and their allies. In shape the sacculina resembles a simple sac or bag —a kind of miniature sausage, in fact —which sends into the body of its host a number of root-like processes. These roots entwine themselves amongst the organs of the crab's body, and serve to absorb from the tissues of the host a certain amount of nourishment. If we lay open this curious organism, we find that the sac-like body contains eggs. No traces of structure are discernible; and but for occasional movements of the body, destined to inhale water and expel that fluid from its interior, one might regard the sacculina as some abnormal growth which had protruded from the body of the crab. The sacculina is a true parasite in every sense of the term. It is dependent, not merely for lodgment, but for nourishment also, upon its host; and as we shall presently note, its thorough dependence upon the crab becomes the more curious when the past history of the sacculina, as revealed by its development, is duly studied.

From each egg of the sac-like parasite thus described a little active creature (Fig. 15) is developed. Known

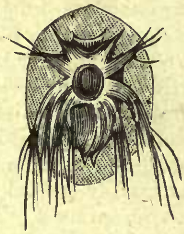

Fig. 15.—Young of sacculina.

to naturalists as a "nauplius," the young sacculina is seen to be utterly unlike its parent. It possesses an oval body, and is furnished with three pairs of jointed feet, which are used actively as swimming organs. By aid of the long bristles with which the feet are provided, the little sacculina swims merrily through the sea. Its body terminates behind in a kind of forked appendage of movable nature. After the lapse of a short period, changes ensue in the structure of the little body, but there appear as yet no indications of its parasitic origin, or of any tendency to imitate the fixed and attached existence of its parent. The body of the young sacculina next becomes folded upon itself, so as to inclose the young animal in a more or less complete manner; and the two front limbs become developed beyond the other pairs, and form large organs wherewith the little creature may ultimately moor itself to some fixed object. From the extremities of these altered fore limbs two elongated processes or filaments are seen to sprout, and these processes are regarded as the beginnings of the root-like organs seen in the attached, parasitic, and full-grown sacculina. The other two pairs of feet are cast off, and in their place six pairs of short swimming feet of forked shape are developed. After this stage has been attained, the young animal seeks a crab-host; the root-like front feet attach themselves to the body of the crab and penetrate into its substance; the other feet are cast away as useless organs; and with the assumption of the sac-like body, the young sacculina becomes converted into the likeness of the parent-form.

Such is a brief sketch of the development of a true parasite, and we may now inquire what the life-history of this animal teaches us concerning its antecedents, and regarding its assumption of a parasitic life. The most reasonable view which can be taken of the development of an animal or plant is that of regarding the phases of its production as presenting us with a condensed or panoramic picture of the stages through which it had passed in the course of its origin or evolution from some pre-existing form. If we refuse to regard development in this light, the stages through which the living being passes in its progress toward maturity present themselves as a set of unmeaning and wholly inexplicable actions and conditions. Whilst, on the other hand, when we recognize that in the development of an animal we may trace its ancestry, much that is otherwise incomprehensible becomes plain and reasonable, and very discordant phases of life become harmoniously adjusted through such a consideration. And when we further discover that a large number of animals, widely differing from each other in their adult structure, exactly resemble each other in their young state, the feasible nature of the statement that such a likeness implies a common origin is readily demonstrated. On any other supposition, in short, the development of living beings presents us with phases of utterly unintelligible nature.

Now, the young sacculina is found to present a close resemblance to a large number of other animals belonging to the great class known as the *Crustacea*. To this group belong the barnacles, water-fleas, fish-lice, shrimps, crabs, lobsters, etc. Most of these animals leave the egg in the form of a "nauplius," and present the closest possible resemblance to the young sacculinæ. The young of the fixed and rooted barnacles (Fig. 16), which attach themselves

FIG. 16.—Young barnacle.

like pseudo-parasites to the sides of ships, so closely resemble young sacculinæ that it would be a difficult, if not absolutely an impossible, task to separate or distinguish the young from those of the sacculina in the earlier stages of growth. The young barnacle (Fig. 16), like the young sacculina, resembles a shrimp of peculiar kind on a roving commission, much more closely than it does the adult and attached form. And hence we discern in the common likeness of the young of these animals a proof of their common origin. At one time, therefore, we may believe that the sacculina existed as a free swimming creature, of active habits, and possessing a tolerably high degree of organization. Doubtless some less energetic member of the sacculina family secured a temporary resting-place on the body of the crab, and found such a position to be of desirable kind from the rest and protection it afforded. The feelers or feet, which were at first used for mere attachment, may have come in time to penetrate the body of the crab-host, and may thus have become transformed into organs of nourishment. By and by the sedentary life, with its advantages in the way of cheap living and easy existence for the sacculina, would become a fixed habit. The sacculinæ, which acquired this habit, together with their descendants, would flourish and increase in numbers owing to the advantage gained by them in that "struggle for existence" in which sacculinæ and their highest animal-neighbors are forced, one and all, to take part. And as the wholly free sacculinæ became transformed into higher forms of life, or became extinct, their rooted and parasitic brethren may be regarded as having gradually degenerated. A process of physiological back-sliding invariably takes place in such cases. This retrogression would be manifested in the sacculinæ by the casting off of structures which were no longer of use to a fixed and rooted being—the degeneration and disappearance of structure not required in the animal economy taking place in virtue of the well-known law of the "use and disuse" of organs. The legs would thus become gradually diminished, and would finally disappear altogether. Internal organs, and parts useful to the free-swimming animal, would become useless as the creature became more and more dependent on its host. Finally the sac-like organism would be evolved as the result of its parasitic habits; and the degeneracy which marks the slavishly dependent mind in higher life is thus viewed as also destroying the independence and as warping and distorting the character which once marked the free and active creature of lower grade. Thus we may understand, by the study of life-histories such as those of the sacculina and its comrades, how parasitism is induced, and how a change of life and habits of such sweeping character, converting an active being into a sedentary and degraded animal, becomes established through the slow but sure effects of habit, use, and wont, perpetuated through many generations.

Perhaps the most inveterate and dreaded enemy which man has to encounter in the ranks of parasites is the little *Trichina* (Fig. 17), which has, on more than one occasion, caused a fatal epidemic, on the Continent especially, through its development in excessive numbers. This little worm-like para-

FIG. 17.—Trichina imbedded in muscle, magnified.

site was first discovered in the dissecting-room of St. Bartholomew's Hospital. The circumstances of its discovery have been frequently repeated in anatomical rooms by the observation that very small hardened bodies are to be sometimes met with imbedded among the muscular tissue of the human subject. When one of these little bodies is carefully examined, it is found to consist of a little sac or bag of oval shape (Fig. 17), containing within it a little worm coiled up in a spiral fashion. These sacs attain a length of about the one-seventieth of an inch or so, and if they have existed within the muscles for a lengthened period, they will be found to be somewhat limy in structure; the presence of this mineral implying degeneration of the sac and its tenant. When the first trichinæ were examined and named by Professor Owen, their life-history and importance, as regards the human economy, were unknown and undreamt of. But the occurrence on the Continent of certain mysterious cases of illness, and the careful investigation of such cases by medical men, led to the recognition of the fact that this tiny worm, which, in its fully grown condition (Figs. 18 and 19), does not exceed a mere fraction of an inch, may nevertheless, through its development in large numbers, prove a source of fatal disease to man. In proof of this fact we may quote Dr. Cobbold's extract from the *Leipziger Zeitung* for December 8, 1863, in which it is stated that six persons were seized with all the symptoms of trichina disease, "after eating *raw* beef mixed with chopped pork." The *Neue Hannoversche Zeitung* for December 13 of the same year chronicles the death of twenty-one persons in Hettstädt through eating the flesh of an English pig, the butcher himself perishing from the trichina disease. Eighty persons, according to the *Zeitung für Norddeutschland*, were affected in December, 1863,

FIG. 18.—Trichina (female), magnified.

in Plauen, but only one died. In 1862, of thirty-eight persons attacked in Calhe, near Magdeburg, eight died; and in Hettstädt twenty died out of a total of 135 who were attacked.

The symptoms exhibited by the patients were those of an acute fever, accompanied by distressing pains in the muscles. The discovery of the trichina's fatal powers, as might be expected, caused no little consternation, but he avowed his entire disbelief in the fatal effects which were said to follow the introduction of those parasites within the human economy. He would, in fact, have no objection, for that matter, to eat the sausage. "Eat! eat!" was the cry which resounded through the hall, and in compliance with the request, the *savant* ate the sausage. Lamentable to relate, the trichinæ proved too much for even a scientific organization, and the subject of the experiment was said to have died from the trichina disease induced by his own act. Nor may the fatality of the trichina disease be regarded as a mystery in the light of the facts as to the numbers of the parasites which one "host" may contain. Dr. Cobbold affirms, and with good reason, that 20,000,000 of trichinæ may be contained in one subject. In one ounce of muscle taken from a cat which had been experimented upon as a producer of trichinæ, Leuckart estimated that 325,000 of the parasites were contained. An average-sized man, weighing ten stones, will carry about four stones of muscle; and assuming that all the voluntary muscles of the body were affected, such a person might afford lodgment to 30,000,000 of these parasites. In this instance, therefore, numbers clearly mean power, and that, too, of a fatal kind.

The history of the trichina's development again brings before us a most singular series of phases, and once more presents us with the necessity for a

FIG. 19.—Trichina (male), magnified.

we are not aware that the affection of our Continental neighbors for raw meat declined in consequence. If one narrative, indeed, is to be trusted, there were not wanting, it seems, those who affected an entire disbelief in the trichina and in the fatal effects it was capable of inducing. One headstrong *savant* was thus said to have fallen a victim to his scepticism. Holding in his hand a piece of sausage which he alleged had been declared to contain trichinæ,

"double-host," as in the case of the tapeworms. If we start with the trichinæ as they exist within the muscles of the pig, we find that the parasites are contained each within the little sac or cyst already mentioned. The pig, it may be remarked, is not the only host which affords lodgment to the trichina, since dogs and cats, rats and mice, rabbits and hares, oxen, horses, sheep, guinea-pigs, and other animals, are found to be subject to their attack. It must, however, be noted that, as found in the muscle of any animal, the trichinæ are not only perfectly harmless to that animal, but, further, exist in an undeveloped or immature condition. As seen inclosed in their little sac-like cradles (Fig. 17), the trichinæ are, in every sense of the term, "juvenile" parasites. They represent, in fact, a young and rising generation waiting for a favorable turn of Fortune's wheel to start them on the further stages of their life-history. This favorable turn arrives at the moment when the flesh containing the young and immature trichina-population is eaten by a warm-blooded animal. Suppose the "trichinaised" flesh of a pig to be eaten, without due culinary preparation, by man, the result of the preliminary processes of digestion in the stomach is the dissolution of the little cysts, and the consequent liberation of the "juvenile" population. In two days thereafter the precocious "juveniles," influenced by the change of life and situation, have become mature trichinæ, and, after the sixth day, enormous numbers of eggs are produced by these matured forms. After this stage has been attained, the parent parasites become of no further account in the history of the host, but the young form the subjects of grave concern. This new generation is found to be a restless and migratory body, and influenced by the habits of their ancestors, the young pass from the digestive organs, through the tissues of the body, to seek a lodgment in the muscles. Now comes the tug of war—for the host at least. With thousands of these microscopic pests boring their way through the tissues, there is no lack of explanation of the excessive muscular pains felt by the trichinaised patient. But relief comes in due course when the restless brood has located itself in the muscles. There each young trichina develops around itself a cyst or capsule, and returns to the primitive form in which we first beheld it. There, also, it will rest permanently, and degenerate into a speck of calcareous matter—unless, indeed, an unlooked-for contingency arises. Were cannibalism a fashionable vice amongst us, the eaters would receive from the muscles of the eaten the young population of trichinæ, just as the original subject received the juvenile brood from the pig. Within the cannibal organization, the young parasites would become fully developed, would produce young in large quantities, and would inflict upon the digester of human tissue, pains and grievances compared with which the proverbial troubles which afflict the just are as nothing.

Less to be dreaded than the trichina, but more extraordinary in its habits, is the "Guinea-worm," a well-known parasite, confined in its distribution to certain portions of Arabia, to the banks of the Ganges, and to Abyssinia and the Guinea coast. From the latter locality the organism derives its name. The Guinea-worm troubles not the internal economy of man, but has, strange to say, a striking and persistent aptitude for locating itself under the skin of the legs and feet. The interest with which the Guinea-worm is regarded by naturalists and others is derived from the fact of its curious life-history and habits, and from the supposition that this parasite represents the "fiery serpents" which so exercised the minds and tortured the bodies of the ancient Israelites. This supposition is somewhat strengthened by the knowledge that Plutarch, in his "Symposiacon," quotes a remark to the effect that "the people taken ill on the Red Sea suffered from many strange and unknown attacks," and that amongst others worms, "little snakes which came out upon them, gnawed away their legs and arms, and when touched, retracted, coiled themselves up in the muscles, and there gave rise to the most insupportable pains." Making allowance for a few exaggerations, such a description, especially in its latter portion, applies very closely to this curious enemy of man. In length, the Guinea-worm may vary from one to six feet, whilst specimens of twelve feet in length are not unknown. The body is cylindrical in shape, and attains a thickness of about one tenth of an inch.

Curiously enough, not a single male Guinea-worm has yet been met with, all the known specimens belonging to the opposite sex. The worm enters the skin as a minute organism which possesses a singular vitality, and which exists in its free condition in muddy pools, in wells, tanks, and in marshes. In all probability the young Guinea-worm gains access to the skin through the sweat-ducts. Once located within the skin, the animal grows rapidly, and in about a year attains the dimensions just given. Every traveller in the East knows the Guinea-worm by repute, and has witnessed the familiar operation performed for its extraction. Ancient works on medicine contain the descriptions of this operation, and exhibit drawings of the worm and of the appearances produced by its tenancy in the skin. The sole aims of the operator are those of extracting the parasite by gentle traction, and of avoiding the infliction of any injury to its body. This latter forms, in fact, the great *desideratum* of the operator; since, if the body of the parasite be broken, and a portion left still within the body of its host, additional and it may be serious irritation is thereby set up. The long slender body of the worms is accordingly wound slowly and carefully around some object, and the negroes of the Guinea-coast are said to be dexterous and skilful in the performance of this somewhat delicate operation.

Perhaps one of the most remarkable points in the history of parasites is that which refers to the geographical distribution of certain of their numbers. That parasites require to be provided with certain appropriate conditions for development is a fact already noted. Indeed, we may go much farther and say that the conditions demanded for the successful developments of many of these animals are infinitely complicated, and are in many cases of singularly curious nature. But it would also seem that in their "distribution" over the surface of the globe, and in their selection of certain countries or regions as especial spheres of development, some parasites evince remarkable traits of character. One of the best known instances of this fact is afforded by a species of tapeworm, to which the somewhat uncouth—to ears unscientific, at least—name of *Bothriocephalus* has been given. This latter is a species of "broad-headed" tapeworm, differing from its common neighbors in special points. It is unquestionably the largest or longest parasite which invades the human territory, and may attain a length of over twenty-five feet; its average breadth being about an inch or rather less. In a large "broad-head," as we may call it, upward of four thousand joints or segments may exist, and as each joint—after the first six hundred—is capable of producing eggs and embryos, this foreign neighbor is seen to be fully as productive as its commoner relations. The most interesting fact regarding the "broad-head," however, relates to its geography and to its exact range amongst the human populations of the earth. It is a tolerably well-ascertained fact, that our common tapeworms may affect inhabitants of any climate, but the "broad-headed" species affects a singularity in its distribution in that it has never been known to occur outside the European province—that is, it has never been found in any other continent save in cases where it has been conveyed to other continents by European hosts. But the "broad-head" is, moreover, found to affect certain districts or regions within this European area, so that its distribution in Europe is itself of peculiar kind. Its head-quarters appear to be the cantons of Western Switzerland and the nearest French provinces. It affects Poland, Russia, and Sweden in the north and north-western parts, and it also occurs, but less typically, in Holland and Belgium. In Eastern Prussia and Pomerania the "broad-head" has occasionally appeared; but the latter districts are probably to be regarded in the light of occasional habitats rather than of stated and permanent kind.

The reasons for the restrictions of the parasite to such a limited field are by no means clear. We are not yet sufficiently acquainted with its development and life-history to make generalizations, but one significant fact remains to be noted, namely, that the "broad-head" flourishes in the regions in which the common tapeworm is an unknown or comparatively rare visitant. Now this observation is exactly paralleled by the peculiarities of the distribution of higher animals. In one country we may find what are termed "representative species" of the animals which occur in another and distant region. Thus the puma in the New World assumes the place of the lion of the Eastern hemisphere; the tapirs of the Eastern Archipelago are balanced in the opposite side of the world by the American species; and the llamas of South America represent their camel neighbors of the Old World. There thus appears in such cases to be a balancing of animal life: the one species in one region or continent assuming the functions of the nearly related but different species inhabiting another area of the world. Regarding the case of the parasites in this light, we may deduce a similar conclusion, namely, that the "broad-head" may discharge in its especial field of action the functions performed in other fields or areas by the common tapeworm. Nature, in any case, may certainly be credited with the general avoidance of any confusion of interests, and with the exclusion of rivalry from the domain and functions of like or nearly related creatures, wherever that domain may exist, and whatever these functions may be.

As a final example of a most singular and at the same time utterly harmless little intruder on the human domain, may be mentioned the minute mite known to naturalists as a species of *Demodex* (Fig. 20), and which, curiously enough, seems to take up its abode in the ducts or "follicles" of the skin at the sides of the nose. It is highly probable that this little creature is very frequently to be found in the situation just mentioned, its minute size and harmless character preventing our being made aware of its mere existence. Demodex measures a mere fraction of an inch in length, and may be said to present us with yet another instance of an organism whose selective powers in the choice of a habitation appear to be of the most singular description.

The lessons to be drawn from a consideration of the entire subject of the parasitic enemies of man bear very strongly on questions of common hygiene and sanitation. The extension of our knowledge of parasites and of their life-histories clearly points to the desirability for the exercise of great care in the choice and preparation of our common foods—especially of animal kind. Uncooked animal food in any form should be unhesitatingly rejected on common sanitary grounds—the prevailing and fashionable taste for "underdone" meat notwithstanding. The

FIG. 20.—Demodex, magnified.

Mosaic abhorrence of the pig is fully justified by an appeal to zoological knowledge regarding the parasites to which that familiar and not uninteresting quadruped plays the part of entertainer and host; but the due exercise of the culinary art should in large measure mitigate the severity of the sentence passed against pork as a common medium of parasitic infection. Unwashed vegetables, which may harbor or lodge, without developing, the embryos of parasites, are similarly to be regarded with suspicion. Indeed, it may be said that the chances of parasitic infection from this latter source are greater than those from badly cooked meat, the vegetable matter escaping even the chance of having its minute tenants destroyed. Unsavory as the subject may at first sight appear, the whole question before us teems with an interest which should effectually appeal to every one in the light of saving knowledge. And it is not the least worthy remark which may be made regarding such a topic, that zoological science may be shown capable of extending its interests into the most intimate departments of the household, and even of encroaching on the sphere of that domestic autocrat, the cook.

WHAT I SAW IN AN ANT'S NEST.

Amongst those spectacles and incidents in human existence which remain fixed on the memory of the spectator from their sad or unwonted nature, that of a panic-stricken crowd, gathered by the report of some national disaster, stands pre-eminent. Still more terrible in its details is the history of some catastrophe which has laid a city in ruins and wrought death and desolation to thousands of the inhabitants. A deadly epidemic, or fatal plague, scaring a nation with its dread, mysterious power, is a calamity appalling enough ; but the spectacle of a city overthrown at one fell swoop by the earthquake shock may perhaps rank foremost amongst the untoward incidents which environ the sphere of man. A certain event, occurring during a recent holiday by the sea, tended forcibly to impress upon the mind that the great catastrophes of life are not limited to humanity's special sphere, and that in lower life panic and alarm seem to exercise no small influence, as in man's estate ; whilst the incident referred to also afforded food for reflection on topics not far removed from some weighty matters in the history of man's own nature and constitution. In this latter view, it is especially hoped the observations of a brief period of leisure-time may not be without their due meed of interest.

The chance removal, from its secure site, of a large stone placed in close proximity to the sea-beach, where the bliss of idleness was being fully exemplified by a small party of holiday-makers, proved, on close examination, to be the cause of a literal revolution in lower life. Imagine a city to be totally unroofed ; try to conceive of the sudden downfall of houses and buildings, and the consequent panic of the inhabitants, and you may obtain an idea of the disturbance our simple procedure effected in the peaceable, well-ordered colony of ants which had located themselves securely beneath the friendly shelter of the stone. The scene presented to view was one of the most curious and interesting which could engage the attention of an observer in any field of inquiry, and the occurrence certainly banished the idle mood of the time, and lent a zest to the subsequent hours of our holiday. Running hither and thither in wild confusion were the denizens of this underground colony ; their six little legs carrying their curious globular bodies backward and forward over the disturbed area from which the stone had been removed. At first the movements of the ants were extremely erratic and purposeless. Panic and alarm appeared to be the order of the day during the few minutes which elapsed after removal of the stone. But soon the eye could discern movements of purposive kind on the part of the alarmed residents. There was "racing and chasing" in all directions ; but the ants which had at first radiated from the centre of disturbance, as if on some definite quest, soon returned thereunto, and continued to advance and retire from the field of action with tolerable regularity. Not less than sixty or seventy ants appeared to be engaged in this labor of scouring the country around. The object of their repeated journeys in all directions was soon discovered. They were the self-appointed scouts, engaged in the work of reconnoitring. Such at least is a fair interpretation of the acts of the ants, and such also is the conclusion, borne out by the subsequent course of events. For, after the scouts had spent a considerable time in their rapid journeys to the environments of the nest, a new set of ants appeared upon the scene, destined to perform a highly important series of labors.

The scouts continued their journeyings, and gave one the idea of a set of fussy individuals who were superintending, or even bullying, their new neighbors, who appeared from amongst the ruins and *débris* of the ant city, carrying in their mouths certain oval bodies of a dirty-white color, and measuring each about one third of an inch in length. Each of these bodies closely resembled a grain of corn in shape, size, and appearance. The spectacle of these small insects carrying off these bodies in their powerful jaws impressed one forcibly with the idea that, relatively to its size, an ant is an herculean insect.

Occasionally there might be seen certain rather ludicrous incidents connected with the removal of the objects in question. One ant might be witnessed in the endeavor to hoist the oval body it was carrying in its mouth over some obstacle lying in the path, and the staggering gait of the insect seemed very accurately to mimic the similar disposition of a human porter struggling under a burdensome load. Another ant, carrying the oval body before it, would arrive at a steep incline formed of loose sand, and presenting a treacherous surface even to the light feet of the insect. The efforts of the ant to carry the body upward being found to be fruitless, the insect might be seen to whirl about with great rapidity of action, and ascend the hill backward, pulling the body after it, instead of pushing it as before.

Another instance might be witnessed in which an ant which had literally come to grief with its burden would be assisted by a kindly neighbor; but it was no uncommon sight to behold in the excessive eagerness of the insects an actual means of defeating the object they had in view, since two ants would in some cases seize the same burden, and then came the tug of war. One pulled one way whilst the other tugged in the opposite direction; and the observer could almost have supposed that the burden itself might have been parted in twain by the treatment to which it was subjected—the incident affording a new application of the remark that a surfeit of zeal is destructive of the best intentions. The nature of the bodies which the ants seemed so excessively anxious to preserve from injury was readily determined. The oval bodies, resembling grains of corn, were the *pupæ* or *chrysalides* of the ants—the sleeping babies and young hopefuls, on whom the hopes of the colony were, and, I may say, are, founded. It is noteworthy, however, that upon some mistaken notions regarding the nature of these bodies many of the ideas concerning the frugal care of these insects were founded. Solomon's advice that the sluggard should "go to the ant," with the view of considering her ways and of gaining wisdom as a result of the study, was in days of old thought to be approved by the observation that the ants husbanded their stores of food in the shape of the grains of corn they had gained from the autumnal store. There can be little doubt that some species of ants do store food; but their praiseworthy actions in this direction have been greatly exaggerated, and there appears, indeed, to be some danger of idle persons being prepared with the retort to the wise man, that the ant is by no means the model creature he thought her to be. If, however, the supposed corn-grains turn out to be the rising generation of ants in their chrysalis-state, it may be said that what the ants may have lost in the way of fame in this direction has been amply compensated for by the discovery of more wonderful traits of character than Solomon could possibly have dreamt of.

The work of removing the developing population thus appeared in our ant's nest to absorb the entire energies of the alarmed denizens. Pupa after pupa was carried out from amongst the *débris* and taken for a considerable distance—certainly fifteen inches—to a place of security, beneath a small sloping stone of flat shape, which roofed over a hollow in the ground. So far as I could observe, the scouts must have discovered this place of refuge, and have communicated the intelligence to their neighbors. The regularity with which the slumbering innocents were conveyed to the same spot would appear to point to concerted work and to a definite idea, if one may so term it, having animated the laborers. I was careful to ascertain at an early stage of the proceedings that the place of refuge had no communications with the nest. It was, in point of fact, an entirely new habitation, and, as far as human judgment might venture upon an opinion, the new residence appeared to give promise of being a safe and convenient domicile. Now and then an ant would emerge from the ruins of the nest carrying a younger hopeful in the larva or caterpillar stage. This latter was a little white grub, which corresponds in its development to the grub or caterpillar of the butterfly or fly; the ants thus exemplifying insects which undergo a complete "metamorphosis." It was rather a difficult matter to ascertain clearly if the ants were actually excavating the chrysalides from amongst the *débris*. Bearing in mind what Sir John Lubbock has told us concerning the apparent inability of ants to discover the whereabouts of companions buried under earth, I rather lean to the belief that my ants simply conveyed to a place of safety those chrysalides which were at hand and readily obtainable. The latter fact I could not ascertain, since I feared to disturb the ants at their interesting labors; but a simple experiment served to show the feasibility of the idea that the crysalides were probably within easy reach of the ants.

Taking possession of one chrysalis which was being conveyed to the new domicile, I buried it about half an inch deep in the sand, directly in the track over which the ants were journeying to their new residence, and a second chrysalis I placed at a little distance from this track, but in a spot over which numerous ants were running apparently without any definite aim. The second pupa-ant was not buried in any sense, and was covered merely with a sprinkling of sand. The result in both cases was negative. No attempt was made to disinter the chrysalis from the beaten track, although numberless ants walked directly over it; and I extricated the chrysalis five hours after its interment, and when the busy scene of the morning had been replaced by a dull prospect, over which only a single ant now and then hurried in a rapid fashion. The other chrysalis was also unnoticed, despite its proximity to the surface of the sand. Whether or not ants want a sense of smell or other means of guiding them to the whereabouts of their neighbors or children, is a subject difficult of determination either toward a positive or negative result. And I am the more inclined to wonder at the incapacity of the insects to discover their buried companions, since they appear to be perfectly capable of detecting them at a considerable distance above ground. When a chrysalis was placed in a spot remote from the nest, and an ant placed within a foot or so of the chrysalis, the insect would occasionally seem to be attracted to the neighborhood of the object. I frequently observed that if an ant happened to crawl within two or three inches of the chrysalis as it lay on the ground, it appeared to become conscious of the object, although at the same time it seemed ignorant of its precise locality. In such a case the insect would proceed hither and thither in an erratic fashion, but would continue to hover or rotate around the chrysalis until it seized the object and bore it off in triumph in its jaws. Relatively to the size of the ant, we must consider this latter incident by no means a slight tribute to its acuteness.

The busy scene resulting from the disturbance of the nest proceeded actively during at least two hours. The nest appeared to be by no means a large one. At the end of two hours, however, the ants were still rushing hither and thither, bent on errands unknown to their observers, although the work of conveying the chrysalides had at the lapse of the period just mentioned entirely ceased. Five and a half hours after the nest had been alarmed, not an ant was visible over the disturbed area, and our next task was that of investigating the manner in which the insects had dispersed themselves and their belongings in their new habitation by carefully removing the flat sloping stone already mentioned as that beneath which the main stream of the ants had disappeared. Not an insect was to be seen after this operation was performed, and it was only after the removal of several small stones which lay below the flat stone that the colony in its new sphere was brought into view. Our investigation once again excited the restless beings. Then ensued, for the second time, the seizure of the chrysalides, which, however, were to be seen packed together in a secure position and already partly covered with particles of earth and sand. To have reached the position in which we found them, the insects must have descended at least three inches after entering below the stone, and the labor of the continual ascent in search of fresh chrysalides must therefore have been of no light kind. We saw enough to convince us that the ants had already settled down in a new organization, which, with an undisturbed history, might repeat the peaceful state of their former life; and we also had the thought presented, that in the exercise of their duties under the pressure of an unwonted exigency, the insects behaved and acted with no small degree of intelligence, and apparently in harmonious concert to the desired end.

But the thoughts suggested by the brief observation of the disturbed ant's nest hardly end thus. We may very naturally proceed to inquire into the regular organization and constitution of the ant colony, and also, as far as fact and theory may together lead, into the analogies—if analogies there be—which exist between the social instincts of ants and the ways of the higher animals, man included.

The common ants and their neighbors belong to the order of insects known as the *Hymenoptera*, a group represented by other insects of "social" habits, such as bees, wasps, and hornets. The termites, or white ants of the tropics, are the only "ants" foreign to this order of insects, the white ants being near relations of the dragon-flies, May-flies, etc. The family history of the latter, as told by Mr. Bates, may serve to introduce us agreeably to ant society at large. The nests of the termites may attain a height of five feet, and present the appearance of conical hillocks, formed of earth particles "worked," says Mr. Bates, "with a material as hard as stone." In the neighborhood of the nests, narrow covered galleries or underground ways are everywhere to be seen, these latter being the passages along which the materials used for building the nests are conveyed. The termites are small soft-bodied animals of a pale color, but resemble the common or true ants in that they live in colonies, composed, like those of bees, of three chief grades of individuals. These grades are known as males, females, and blind "neuters," the latter forming at once the largest bulk of the population, and including in their numbers the true "working classes" of this curious community. In the common ants, the "neuters" are regarded as being undeveloped female insects. These neuters exhibit in the termites a further division into ordinary "workers" (Fig. 21, 4), which perform the multifarious duties connect-

FIG. 21.—1, winged termite; 2, wingless termite; 3, soldier; 4, worker.

ed with the ordinary life of the colony, and "soldiers" (3), which perfectly exemplify the laws of military organization in higher life, in that they have no part in the common labor, but devote themselves entirely to the defence of the colony and to the

"Pride, pomp, and circumstance of glorious war."

The workers appear to perform a never-ending round of duties. They build the nests, make the roads, attend to the wants of the young, train up the latter in the ways of ant existence, wait on the sovereigns of the nest, and like diplomatic courtiers, duly arrange for the royal marriages of the future. As Mr. Bates remarks, "The wonderful part in the history of the termites is, that not only is there a rigid division of labor, but nature has given to each class a structure of body adapting it to the kind of labor it has to perform. The males and females form a class apart; they do no kind of work, but in the course of growth acquire wings to enable them to issue forth and disseminate their kind. The workers and soldiers are wingless, and differ solely in the shape and armature of the head. This member in the laborers is smooth and rounded, the mouth being adapted for the working of the materials in building the hive. In the soldier the head is of very large size, and is provided in almost every kind with special organs of offence and defence in the form of horny processes resembling pikes, tridents, and so forth. . . . The course of human events in our day seems, unhappily, to make it more than ever necessary for the citizens of civilized and industrious communities to set apart a numerous armed class for the protection of the rest; in this, nations only do what nature has of old done for the termites. The soldier termes, however, has not only the fighting instinct and function; he is constructed as a soldier, and carries his weapons not in his hand but growing out of his body." When a colony of termites is disturbed, the ordinary citizens disappear and the military are called out. The soldiers mounted the breach, says Mr. Bates, "to cover the retreat of the workers," when a hole was made in the archway of one of their covered roads, and with military precision the rear-men fall into the vacant places in the front ranks as the latter are emptied by the misfortune of war.

In a termite colony there is but one king and queen, the royal couple being the true parents of the colony. The state-apartments are situated in the centre of the hive, and are strictly guarded by workers. Both king and queen are wingless, and are of larger size than their subjects. The queen engages in a continual round of maternal duties, the eggs deposited by the sovereign-mother being at once seized by the workers and conveyed to special or "nursery cells," where the young are duly tended and brought up. Once a year, at the beginning of the rainy season, winged termites appear in the hive as developments of certain of the eggs laid by the queen-termite. These latter are winged males and females (Fig. 21, 1), the two sexes being present in equal numbers. Some of these, after shedding their wings, become the founders—kings and queens—of new communities, the privilege of sex being thus associated with the important and self-denying work of perpetuating the species or race in time. Sooner or later—a termite family takes about a year to grow—a veritable exodus of the young winged termites takes place; and just before this emigration movement occurs, a hive may be seen to be stocked with "termites" of all castes and in all stages of development. The workers never exhibit a change of form during their growth; the soldiers begin to differ from the workers in the possession of larger heads and jaws; whilst the young which are destined to become the winged males and females are distinguished by the early possession of the germs of wings which become larger as the skin is successively moulted. Amongst the bees, blind Huber supposed that an ordinary or neuter egg develops into a queen bee if the larva is fed upon a special kind of food—"royal food," as it is called. Although some entomological authorities differ from Huber with regard to the exact means by which the queen bee is reared and specialized from other larvæ, yet the opinion thus expressed possesses a large amount of probability. Whatever may be the exact method or causes through or by which the queen bee is developed, Mr. Bates strongly asserts that the differences between the soldiers and worker termites are distinctly marked from the egg. This latter observer maintains that the difference is not due to variations in food or treatment during their early existence, but is fixed and apparent from the beginning of development. This fact is worthy of note, for it argues in favor of the view that if, as is most likely, the differences between the grades of termites may have originally been produced by natural selection or other causes, these differences have now become part and parcel of the constitution of these insects, and are propagated by the ordinary law of heredity. Thus acquired conditions have become in time the natural "way of life" of these animals.

Mr. Bates has also placed on record the noteworthy fact that a species of termites exists in which the members of the soldier class did not differ at all from the workers "except in the fighting instinct." This observation, if it may be used at all in elucidation of the various grades of society amongst these insects—at least the present state of our knowledge would seem to lead to such a conclusion as being much more feasible than the theory of special or sudden creation of the peculiarities of the race. It is admitted that the termites are in many respects inferior in structure to the bees and wasps, whilst the white ants themselves are the superiors of their own order—that of the *Neuroptera*. That the termites preceded the bees and their neighbors, the common ants, in the order of development of social instincts, is a conclusion supported by the fact that the *Neuroptera* form the first group of insects which are preserved to us in the "records of the rocks." Fossil *Neuroptera* occur in the Devonian rocks of North America; the first traces of in-

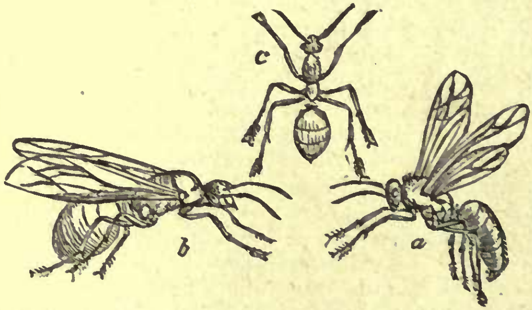

FIG. 22.—Red, or horse-ant (*Formica rufa*): *a*, male; *b*, female, winged; *c*, worker.

origin of the curious family life of these insects, points not to sudden creation, but to gradual acquirement and modification as having been the method of development of the specialized classes and castes in termite society. Firstly, we may thus regard the beginnings of the further development of a colony to appear in a nest in which workers and soldiers are alike, as stated by Mr. Bates. Then, through the practice of the fighting instinct, we may conceive that natural selection would be competent to adapt the soldiers more perfectly for their duties militant, by developing the head and jaws as offensive weapons. Possibly, were our knowledge of the termites at all complete, we should meet with all stages in the development and specialization of the sects allied to the bees and wasps being geologically more recent, and appearing in the oolitic strata. The occurrence of high social instincts in an ancient group of insects renders the repetition of these instincts in a later and higher group the less remarkable. The observation, however, does not of necessity carry with it any actual or implied connection between the termites and their higher neighbors, although, indeed, the likeness between the social life of the two orders of insects might warrant such a supposition.

The common ants (Fig. 22), the study of which in their native haunts is a matter of no great difficulty, and one which will fully reward the seeking mind, like the termites, possess three grades of individuals. In a single ant' nest more than one female may be found, the ants differing from the bees in this respect; and in the nests of some species of ants there are apparently "soldiers" resembling the military termites in the possession of large heads and well-developed jaws. Very amazing differences are to be perceived amongst the various species of ants. Differences in size are of common occurrence, but naturalists have actually succeeded in classifying ants in a general way, by differences in manner and disposition. We know, for example, that the horse-ant (*Formica rufa*, Fig. 22) has little *individual* intelligence, but is extremely socialistic, and moves and acts *en masse* with precision and tact. Another species (*F. fusca*) is timid and retiring. *F. pratensis* is a revengeful creature, since it "worries"

FIG. 23.—Apple aphis (*Eriosoma mali*): *a*, wingless insect, magnified; *b*, wingless insect in excrescence of the tree, magnified.

its fallen foes; *F. cinerea* is bold and audacious; others are termed "thieves" and "cowards;" some are phlegmatic; and to complete the list of failings and traits which are human enough in character, one species is said to present an invariable greediness as its prevailing characteristic. The common ants resemble the termites in the general details of their life. We see in an ant's nest the same restless activity of the workers, the same earnest attention paid to the young and pupæ, the same instinct in shielding the young from danger, and much the same general routine of development. Certain rather special, and it may be said extraordinary, habits of ants may, however, demand notice before we attempt a brief survey of their instincts at large. Few readers are unacquainted with the *Aphides*, or plant-lice, those little wingless insects which infest our plants and herbs in myriads in summer. It is a fact now well known to naturalists, and first placed on record by Huber, that between the ants and plant-lice, relations of a very friendly and, as far as the ants are concerned, advantageous character have become established. Ants have been observed to stroke the tips of the bodies of the plant-lice with their antennæ, this act causing the plant-lice to exude drops of a clear sweet fluid, of which the ants are extremely enamoured. The ants would thus appear to habitually "milk" their insect-neighbors, and, as far as observation goes, some ants seem not merely to keep the plant-lice in their nests so as to form a veritable dairy-establishment, but also to make provision in the future by securing the eggs of the aphides, and bringing up the young as we rear calves.

That the relation between the ants and plant-lice are of very stable kind is proved by the interesting remarks of Mr. Darwin, who "removed all the ants from a group of about a dozen aphides on a dock-plant, and prevented their attendance during several hours." Careful watching showed that the plant-lice after this interval did not excrete the sweet fluid. Mr. Darwin then stroked the plant-lice with a hair, endeavoring thus to imitate the action of the ant's feelers, but not a single plant-louse seemed disposed to emit the secretion. Thereafter a single ant was admitted to their company, the insect, in Mr. Darwin's words, appearing, "by its eager way of running about, to be well aware what a rich flock it had discovered." The ant first stroked one aphis and then another, each insect excreting a drop of the sweet juice "as soon as it felt the antennæ;" and "even the quite young aphides behaved in this manner, showing that the action was instinctive, and not the result of experience." If, as Mr. Darwin remarks, it is a convenience for the aphides to have the sweet secretion removed, and that "they do not excrete solely for the food of the ants," the observation does not in any degree lessen the curious nature of the relationship which has become established between the ants and their neighbors, or the interesting features in ant life which have inaugurated and perpetuated the habit.

Not less remarkable are the "slave-making" instincts of certain species of ants. It may be safely maintained that the slave-making habit forms a subject of more than ordinary interest not merely to naturalists but to metaphysicians given to speculate on the origin and acquirement of the practices of human existence. Pierre Huber, son of the famous entomologist, was the first to describe the slave-making instincts in a species (*Polyergus rufescens*) noted for its predaceous instincts, and subsequent observations have shown that other species participate in these habits. *Polyergus* is thoroughly dependent on slaves. Without these bondsmen it is difficult to see how the ants could exist. Huber tells us that the workers of this species perform no work save that of capturing slaves. Use and wont, and the habit of depending entirely on their servitors, have produced such changes in the structure of the ants that they are unable to help themselves. The jaws of these ants are not adapted for work; they are carried by their slaves from an old nest to a new one; and, more extraordinary still, they require to be fed by their slaves, even with plenty of food close at hand. Out of thirty of these ants placed by Huber in a box, with some of their larvæ and pupæ, and a store of honey, fifteen died in less than two days of hunger and of sheer inability to help themselves. When, however, one of their slaves was introduced, the willing servitor "established order, formed a chamber in the earth, gathered together the larvæ, extricated several young ants that were ready to quit the condition of pupæ, and preserved the life of the remaining Amazons." It must be noted that there are very varying degrees in the dependence of the ant-masters on their slaves. In the recognition of this graduated scale of relationship and dependence, indeed, will be found the clue to the acquirement of this instinct. The horse-ant (*Formica rufa*) will carry off the larvæ and pupæ of other ants *for food*, and it sometimes happens that some of these captives, spared by their cannibal neighbors, will grow up in the nest of their captor. A well-known ant, the *Formica sanguinea*, found in the South of England, is, however, a true slave-making species, but exhibits no such utter dependence on its servitors as does *Polyergus*. The slave-making habit is not only typically developed in the *Sanguineas*, but the bearing of the captives to their masters indicates a degree of relationship and organization such as could hardly be conceived to exist outside human experience. The *Sanguineas* make periodical excursions, and, like a powerful predatory clan, carry off the pupæ or chrysalides of a neighboring species, *F. fusca*. Thus the children of the latter race are born within the nest of their captors in an enslaved condition. As slaves "born and bred," so to speak, they fall at once into the routine of their duties, assist their masters in the work of the nest, and tend and nurse the young of the family. The slaves, curiously enough in this instance, are black in color, whilst the masters are twice the size of the servitors, and are red in color, and that the slaves are true importations is proved by the fact that males and females of the slave species are never developed within the nest of the masters, but only within those of their own colonies. The slaves in this instance rarely leave the nest, the masters foraging for food, and employing their captives in household work, as it were; whilst, when the work of emigration occurs, the masters carry the slaves in their mouths like household goods and chattels, instead of being carried by them, as in the case of *Polyergus*.

Mr. Darwin gives an interesting account of the different attitudes exhibited by the *Sanguineas* toward species of ants other than the black race from which their slaves are usually drawn. A few pupæ of the yellow ant (*F. flava*), a courageous and pugnacious little species, were placed within the reach of the slave-making *Sanguineas.* A like chance presented with the pupæ of their slave race was eagerly seized, and the chrysalides carried off. The pupæ of the yellow ants, however, were not merely left untouched, but the slave-makers exhibited every symptom of terror and alarm at the sight of the chrysalides of their yellow neighbors. Such an instance demonstrates the existence not merely of perception but also of the memory of past experience, probably of not over agreeable kind, of encounters with the yellow ants. When, on the contrary, a nest of the slaves is attacked, the *Sanguineas* are both bold and wary. Mr. Darwin traced a long file of *Sanguineas* for forty yards backward to a clump of heath, whence he perceived the last of the invaders marching homeward with a slave pupa in its mouth. Two or three individuals of the attacked and desolate nest were rushing about in wild despair, and "one," adds Mr. Darwin, "was perched motionless, with its own pupa in its mouth, on the top of a spray of heath, an image of despair over its ravaged home." The picture thus drawn is not the less eloquent because its subject is drawn from lower existence; although the pains and sorrows of ant life may not legitimately be judged by the standard of human woe.

The explanation of the slave-making instinct in ants begins with the recognition of the fact that many ants, not slave-makers, store up pupæ of other species for food. If we suppose that some of the pupæ, originally acquired through a cannibal-like instinct, came to maturity within the nest of their captors, and in virtue of their own inherited instincts engaged in the work of the hive, we may conceive of a rational beginning of the slave-making instinct. If, further, the captors learned to appreciate the labors of their captives, as lightening their own work, the habit of collecting pupæ as slaves might succeed and supersede that of collecting them for food. In any case, we should require to postulate on the part of the slave-makers a degree of instinct altogether unusual in insects, or, indeed, in higher animals; but that such instinct is developed in ants other than slave-makers admits of no dispute. The strengthening, through repetition, of a habit useful to the species may thus be credited with the beginning of the practice of slavery amongst ants; whilst special circumstances—such as the number of the slaves as compared with the number of masters—would tend to develop a greater or less degree of dependence of the captors or their servitors.

Huber, for instance, informs us that the *Fusca*-slaves of the *Sanguineas* of Switzerland work with their masters in building the nest; they close and open the doors of the hive; but their chief office appears to be that of hunting for plant-lice. In England, on the contrary, the slaves are strictly household servants, rarely venturing out of doors. Such differences depend most probably on the fact that a greater number of slaves occur in Swiss than in English nests, and they may therefore be employed in a wider range of duties on the Continent than at home. A fewer number of slaves, a greater aptitude on the part of the slaves for their duties, the inability of the masters to perform the duties of the slaves—each or all of these causes combined would serve to increase the value of the servitors, and at the same time to reduce the independence of the masters.

This increase of the value of the slaves as active factors in the ant community might at length proceed to such extremes as we see exemplified in the *Polyergus,* already referred to—a race which has become literally unable to feed itself, and to discharge the simplest duties of ant existence, and whose actual life is entirely spent in marauding expeditions on the nests of its neighbors.

The subject of the general intelligence of ants, and of their ability to adapt themselves to awkward and unusual circumstances, may be briefly touched upon by way of conclusion.

Between the reason and intelligence

of higher animals and the "instinct" of ants there is unquestionably a great gulf fixed. I make this statement unhesitatingly, notwithstanding that I should no more willingly attempt to define "instinct" than to give an exact definition of "insanity." In the latter case one may make the definition so limited as practically to exclude all save one class of cases, or so wide as to include even the judge on the bench. In the case of instinct, the rigid definition of one authority might cause us to regard it as the exclusive property of lower forms and as having no relationship whatever with the mental powers of higher beings; or, on the other hand, as being but a modified form of, or in some respects identical with, these very powers. We know too little respecting the so-called "automatic" powers and ways, even of higher animals, to dogmatize regarding the acts of lower animals, but we may safely assume that one apparent ground of distinction between instinct and reason may be found in the common incompetence of instinct to move out of the beaten track of existence, and in the adaptation of reason, through the teachings of experience, to new and unwonted circumstances. Let Dr. Carpenter speak as an authority on such a subject. "The whole nervous system of invertebrated animals, then, may be regarded as ministering entirely to *automatic* action; and its highest development, as in the class of insects, is coincident with the highest manifestations of the 'instinctive' powers, which, when carefully examined, are found to consist entirely in movements of the excito-motor and sensori-motor kinds. (The terms '*excito-motor*' and '*sensori-motor*' are applied to nervous actions resulting in movements of varying kinds, and produced by impressions made on nervous centres, but without any necessary emotion, reason, or consciousness.) When we attentively consider the habits of these animals, we find that their actions, though evidently adapted to the attainment of certain ends, are very far from evincing a *designed* adaptation on the part of the beings that perform them. . . . For, in the first place, these actions are invariably performed in the same manner by all the individuals of a species, when the conditions are the same; and thus are obviously to be attributed rather to a uniform impulse than to a free choice, the most remarkable example of this being furnished by the economy of bees, wasps, and other 'social' insects, in which every individual of the community performs its appropriated part with the exactitude and method of a perfect machine. The very perfection of the adaptation, again, is often of itself a sufficient evidence of the unreasoning character of the beings which perform the work; for if we attribute it to their own intelligence, we must admit that this intelligence frequently equals, if it does not surpass, that of the most accomplished Human Reasoner."

Appealing to the most recent observations on ants, we may find evidence of the truth of Dr. Carpenter's statements, whilst at the same time we may also detect instances of the development of higher powers which are hardly to be classed as "automatic," and which, in certain species (as in the *Ecitons*, charmingly described by Mr. Belt in "The Naturalist in Nicaragua"), may be said to be elevated above the common instincts of the race. Dr. Henry Maudsley has also well summed up the relationship of the acts of these insects to the acts of higher forms, and to new adaptations when he says: "I do not say that the ant and the bee are entirely destitute of any power of adaptation to new experiences in their lives—that they are, in fact, purely organized machines, acting always with unvarying regularity; it would appear, indeed, from close observation, that these creatures do sometimes discover in their actions traces of a sensibility to strange experiences, and of corresponding adaptations of movements. We cannot, moreover, conceive how the remarkable instincts which they manifest can have been acquired originally, except by virtue of some such power. But the power in them now is evidently of a rudimentary kind, and must remain so while they have not those higher nerve-centres in which the sensations are combined into ideas, and perceptions of the relations of things are acquired. Granting, however, that the bee or ant has these traces of adaptive action, it must be allowed that they are truly rudiments of functions, which in the supreme nerve-centres we designate as reason and volition. Such a confession might be a trouble to a metaphysical physiologist, who would thereupon find it necessary to place a metaphysical entity behind the so-called instincts of the bee, but can be no trouble to the inductive physiologist—he simply recognizes an illustration of a physiological diffusion of properties, and of the physical conditions of primitive volition, and traces in the evolution of mind and its organs, as in the evolution of other functions and their organs, a progressive specialization and increasing complexity."

The recently published experiments of Sir John Lubbock show that ants under certain circumstances are both stupid and devoid of any intelligent comprehension in the way of surmounting difficulties ; but this distinguished observer has also shown that as regards communication between ants, and in the regulation of the ordinary circumstances of their lives, these insects evince a high degree of intelligence, and exhibit instincts of a very highly developed kind. Still, making every allowance for the development of extraordinary mental power in some species of ants, there can be little doubt of the purely automatic beginnings and nature of most, if not all, of the acts of ordinary ant existence. The young ant, wasp, or bee will begin its labors and discharge them as perfectly at the beginning of its existence as a perfect insect, as at the close of life. Here there is no experience, no tuition, no consciousness, no reason, and no powers save such as have been transferred to the insect as a mere matter of heredity and derivation from its ancestors, who lived by an unconscious rule of thumb, so to speak. It is very hard at first to convince one's self, when watching an ant's nest, that intelligence and consciousness play little or no part in the apparently intelligent operations of these insects. But to assume the contrary would be to maintain that the insect stands on an equal footing to man himself, and for such a supposition there is neither lawful ground nor sympathy. The marvellous instinct of lower life stands on a platform of its own, has its own phases of development, and probably its own unconscious way of progress. The higher reason and intellect of humanity similarly possesses its own peculiar standard, rate, and method of culture. And man may seek and find in the ways of lower existence not merely a lesson in the ordering of his existence, but some comfort also in the thought that the progress of lower nature is not unknown in the domain of human hopes and aspirations.

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HEREDITARY TRAITS,

AND OTHER ESSAYS.

By Richard A. Proctor.

I.

HEREDITARY TRAITS.

In Montaigne's well known essay on the "Resemblance of Children to their Fathers," the philosopher of Périgord remarks that "there is a certain sort of crafty humility that springs from presumption; as this, for example, that we confess our ignorance in many things, and are so courteous as to acknowledge that there are in works of nature some qualities and conditions that are imperceptible to us, and of which our understanding cannot discern the means and causes; by which honest declaration we hope to obtain that people shall also believe us of those that we say we do understand." "We need not trouble ourselves," he goes on, "to seek out miracles and strange difficulties; methinks there are such incomprehensible wonders amongst the things that we ordinarily see as surpass all difficulties of miracles." He applies these remarks to inherited peculiarities of feature, figure, character, constitution, habits, and so forth. And certainly few of the phenomena of nature are more wonderful than these, in the sense of being less obviously referable to any cause which seems competent to produce them. Many of those natural phenomena which are regarded as most striking are in this respect not to be compared with the known phenomena of heredity. The motions of the planets can all be referred to regular laws; chemical changes are systematic, and their sequence at least is understood; the phenomena of heat, light, and electricity are gradually finding interpretation. It is true that all these phenomena become in a sense as miracles when we endeavor to ascertain their real cause. In their case we can ascertain the "how," but in no sense the "why." Gravity is a mystery of mysteries to the astronomer, and has almost compelled us to believe in that "action at a distance" which Newton asserted to be unimaginable by anyone with a competent power of reasoning about things philosophical. The ultimate cause of chemical changes is as great a mystery now as it was when the four elements were believed in. And the nature of the ether itself in which the undulations of heat, light and electricity are transmitted is utterly mysterious even to those students of science who have been most successful in determining the laws according to which those undulations proceed. But the phenomena themselves, being at once referable (in our own time at least) to law, have no longer the mysterious and in a sense miraculous character recognized in them before the laws of motion, of chemical affinity, of light and heat and electricity had been ascertained. It is quite otherwise with the phenomena of heredity. We know nothing even of the proximate cause of any single phenomenon; far less of that ultimate cause in which all these phenomena had their origin. The inheritance of a trait of bodily figure, character, or manner is a mystery as great as that other and cognate mystery, the appearance of some seemingly sudden variation in a race which has for many generations presented an apparently unvarying succession of attributes, bodily, physical or mental.

It need hardly be said that this would not be the place for the discussion of the problems of heredity and variation, even if in the present position of science we could hope for any profitable result from the investigation of either subject. But some of the curious facts which have been noted by various students of heredity will, I think, be found interesting; and though not suggesting in the remotest degree any solution of the real difficulties of the subject, they may afford some indication of the laws according to which parental traits are inherited, or seemingly sudden variations introduced.

The commonest, and therefore the least interesting, though perhaps the most instructive of the phenomena of heredity, are those affecting the features and the outward configuration of the body. These have been recognized in all ages and among all nations. A portion of the Jewish system of legislature was based on a recognition of the law that children inherit the bodily qualities of the parents. The Greeks noted the same fact. Among the Spartans, indeed, a system of selection from among newborn children prevailed, which, though probably intended only to eliminate the weaker individuals, corresponded closely to what would be done by a nation having full belief in the efficacy of both natural and artificial selection, and not troubled with any strong scruples as to the method of applying their doctrines on such matters. Among the Romans we find certain families described by their physical characteristics, as the *Nasones* or Big-nosed, the *Labeones* or Thick-lipped, the *Capitones* or Big-headed, the *Buccones* or Swollen-cheeked. In more recent times similar traits have been recognized in various families. The Austrian lip and Bourbon nose are well known instances.*

Peculiarities of structure have a double interest, as illustrating both variation and persistence. We usually find them introduced without any apparent cause into a family, and afterwards they remain as hereditary traits, first inherited regularly, then intermittently, and eventually, in most cases, dying out or becoming so exceptional that their occurrence is not regarded as an hereditary peculiarity. Montaigne mentions that in the family of Lepidus, at Rome, there were three, not successively but by intervals, that were born with the same eye covered with a cartilage. At Thebes there was a family almost every member of which had the crown of the head pointed like a lance-head; all whose heads were not so formed being regarded as illegitimate. A better authenticated case is that of the Lambert family. The peculiarity affecting this family appeared first in the person of Edward Lambert, whose whole body, except the face, the palms of the hands, and the soles of the feet,

* It is said by Ribot that of all the features the nose is the one which heredity preserves best.

was covered with a sort of shell consisting of horny excrescences. He was the father of six children, all of whom, so soon as they had reached the age of six weeks, presented the same peculiarity. Only one of them lived. He married, and transmitted the peculiarity to all his sons. For five generations all the male members of the Lambert family were distinguished by the horny excrescences which had adorned the body of Edward Lambert.

A remarkable instance of the transmission of anomalous characteristics is found in the case of Andrian Jeftichjew, who, three or four years ago, was exhibited with his son Fedor Jeftichjew in Berlin and Paris. They were called in Paris *les hommes-chiens*, or dog-men, the father's face being so covered with hair as to present a striking resemblance to the face of a Skye terrier. Andrian was thus described: "He is about fifty-five years of age, and is said to have been the son of a Russian soldier. In order to escape the derision and the unkind usage of his fellow-villagers, Andrian in early life fled to the woods, where for some time he lived in a cave.

"During this period of seclusion he was much given to drunkenness. His mental condition does not seem to have suffered, however, and he is on the whole of a kindly and affectionate disposition. It may be of interest to state that he is an orthodox member of the Russo-Greek Church, and that, degraded as he is intellectually, he has very definite notions about heaven and the hereafter. He hopes to introduce his frightful countenance into the court of heaven; and he devotes all the money he makes, over and above his outlay for creature comforts, to purchasing the prayers of a devout community of monks in his native village, Kostroma, after his mortal career is ended. He is of medium stature, but very strongly built. His excessive capillary development is not true hair, but simply an abnormal growth of the *down* or fine hairs which usually cover nearly the entire surface of the human body Strictly speaking, he has neither head-hair, beard, moustache, eyebrows, nor eyelashes, their place being taken by this singular growth of long silky down. In color this is of a dirty yellow; it is about three inches in length all over the face, and feels like the hair of a Newfoundland dog. The very eyelids are covered with this long hair, while flowing locks come out of his nostrils and ears. On his body are isolated patches, strewed, but not thickly, with hairs one and a-half to two inches long." Dr. Bertillon, of Paris, compared a hair from Andrian's chin with a very fine hair from a man's beard, and found that the latter was three times as thick as the former; and a hair from Andrian's head is only one-half as thick as an average human hair. Professor Virchow, of Berlin, made careful inquiry into the family history of Andrian Jeftichjew. So far as could be learned, Andrian was the first in whom this wonderful hirsuteness had been noticed. Neither his reputed father nor his mother presented any peculiarity of the kind, and a brother and sister of his, who are still living, are in no way remarkable for capillary development. The son Fedor, who was exhibited in company with Andrian, was illegitimate, and about three years of age. Andrian's legitimate children, a son and a daughter, both died young. Nothing is known of the former; but the daughter resembled the father. "Fedor is a sprightly child," said the account from which we have already quoted, "and appears more intelligent than the father." The growth of down on his face is not so heavy as to conceal his features; but there is no doubt that, when the child comes to maturity, he will be at least as hirsute as his parent. The hairs are as white and as soft as the fur of the Angora cat, and are longest at the outer angles of the eyes. There is a thick tuft between the eyes, and the nose is well covered. The moustache joins the whiskers on each side, after the English fashion, and this circumstance gives to accurate pictures of the child a ludicrous resemblance to a well-fed Englishman of about fifty. As in the father's case, the inside of Fedor's nostrils and ears has a thick crop of hair. Both father and son are almost toothless, Andrian having only five teeth, one in the upper jaw and four in the lower, while the child has only four teeth, all in the lower jaw. In both cases the four lower teeth are all incisors. To the right of Andrian's one upper tooth there still remains the mark of another which has disappeared. That beyond these six teeth the man never had any others is evident to any one who feels the gums with the finger."

The deficiency of teeth, accompanied as it is by what is in reality a deficiency, not a renundancy of hair —for Andrian and his son have no real hair—accords well with Darwin's view, that a constant correlation exists between hair and teeth. He mentions as an illustration the deficiency of teeth in hairless dogs. The tusks of the boar, again, are greatly reduced under domestication, and the reduction is accompained by a corresponding diminution of the bristles. He mentions also the case of Julia Pastrana, a Spanish dancer or opera singer, who had a thick masculine beard and a hairy forehead, while her teeth were so redundant that her mouth projected, and her face had a gorilla-like appearance. It should rather be said that, in general, those creatures which present an abnormal development in the covering of their skin, whether in the way of redundancy or deficiency, present, generally, perhaps always, an abnormal dental development, as we see in sloths and armadilloes on the one hand, which have the front teeth deficient, and in some branches of the whale family on the other, in which the teeth are redundant either in number or in size. In individual members of the human family it certainly is not always the case that the development of the hair and that of the teeth are directly correlated; for some who are bald when quite young have excellent teeth, and some who have lost most of their teeth while still on the right side of forty have excellent hair to an advanced age.*

Another case, somewhat similar to that of Andrian and his son, is found in a Burmese family, living at Ava, and first described by Crawford in 1829. Shwe-Maong, the head of the family, was about thirty years old. His whole body was covered with silky hairs, which attained a length of nearly five inches on the shoulders and spine. He had four daughters, but only one of them resembled him. She was living at Ava in 1855, and, according to the account given by a British officer who saw her there, she had a son who was hairy like his grandfather, Shwe-Maong. The case of this family illustrates rather curiously the relation between the hair and teeth. For Shwe-Maong retained his milk teeth till he was twenty years old (when he attained puberty), and they were replaced by nine teeth only, five in the upper and four in the lower jaw. Eight of these were incisors, the ninth (in the upper jaw) being a canine tooth.

Sex-digitism, or the possession of hands and feet with six digits each, has occurred in several families as a sudden variation from the normal formation, but after it has appeared has usually been transmitted for several generations. In the case of the Colburn family this peculiarity lasted

* Shakespeare, who was bald young (and, so far as one can judge from his portraits, had a good set of teeth), suggests a correlation between hairiness and want of wit, which is at least likely to be regarded by those who "wear his baldness while they're young," as a sound theory. "Why," asks Antipholus of Syracuse, "is Time such a niggard of hair, being, as it is, so plentiful an excrement?" "Because," says Dromio of Syracuse, "it is a blessing that he bestows on beasts; and what he hath scanted men in hair he hath given them in wit."

for four generations without interruption, and still reappears occasionally. In a branch of a well-known Scotch family, sex-digitism—after continuing for three or four generations—has apparently disappeared; but it still frequently happens that the edge of the hands on the side of the little finger is partially deformed.

Hare-lip, albinism, halting and other peculiarities commonly reappear for four or five generations, and are seldom altogether eradicated in less than ten or twelve.

The tendency to variation shown in the introduction of these peculiarities, even though they may have been eventually eradicated, is worth noticing in its bearing on our views respecting the formation of new and persistent varieties of the human as of other races. It must be noticed that in the case of the human race the conditions not only do not favor the continuance of such varieties, but practically forbid their persistence. It is otherwise with some varieties, at least, of domestic animals, insomuch that varieties which present any noteworthy even though accidentally observed advantage have been made practically persistent; we say practically, because there seems little reason to doubt that in every case which has hitherto been observed the normal type would eventually be reverted to if special pains were not taken to separate the normal from the abnormal form.

An excellent illustration of the difference between the human race and a race of animals under domestication, in this particular respect, is found in the case of the Kelleia family on the one hand, and that of the Ancon or Otter sheep on the other.

The former case is described by Reaumur. A Maltese couple named Kelleia, whose hands and feet were of the ordinary type, had a son, Gratio, who had six movable fingers on each hand and six somewhat less perfect toes on each foot. Gratio Kelleia married a woman possessing only the ordinary number of fingers and toes. There were four children of this marriage—Salvator, George, Andre and Marie. Salvator had six fingers and six toes like the father; George and Andre had each five fingers and five toes like the mother, but the hands and feet of George were slightly deformed; Marie had five fingers and five toes, but her thumbs were slightly deformed. All four children grew up, and married folk with the ordinary number of fingers and toes. The children of Andre alone (who were many) were without exception of the normal type, like their father. The children of Salvator, who alone was six-fingered and six-toed like Gratio, the grandfather, were four in number; three of them resembled the father, while the other—the youngest—was of the normal type like his mother and grandmother. As these four children were the descendants of four grandparents of whom one only was hexadactylic, we see that the variety had been strong enough in their case to overcome the normal type in threefold greater strength. But the strangest part of the story is that relating to George and Marie. George, who was a pentadactyle, though somewhat deformed about the hands and feet, was the father of four children; first, two girls, both purely hexadactylic; next, a girl, hexadactylic on the right side of the body and pentadactylic on the left side; and lastly, a boy, purely pentadactylic. Marie, a pentadactyle with deformed thumbs, gave birth to a boy with six toes, and three normally formed children. It will be seen, however, that the normal type showed itself in greater force than the variety in the third generation from Gratio; for while one child of Salvator's, one of George's, three of Marie's, and all of Andre's (some seven or eight) were of the normal type—twelve or thirteen in all—only five, viz., three of Salvator's and two of George's, presented the variety purely. Three others were more or less abnormally formed in fingers and toes; but even counting these, the influence of the variety was shown only in eight of the grandchildren of Gratio, whereas twelve or thirteen were of the normal type.

The story of the Ancon or Otter sheep, as narrated by Colonel David Humphreys in a letter to Sir Joseph Banks, published in the *Philosophical Transactions* for 1813, has been thus abridged by Huxley: "It appears that one Seth Wright, the proprietor of a farm on the banks of the Charles River, in Massachusetts, possessed a flock of fifteen ewes and a ram of the ordinary kind. In the year 1791 one of the ewes presented her owner with a male lamb differing, for no assignable reason, from its parents by a disproportionately long body and short bandy legs; whence it was unable to emulate its relatives in those sportive leaps over the neighbors' fences in which they were in the habit of indulging, much to the good farmer's vexation. With the 'cuteness' characteristic of their nation, the neighbors of the Massachusetts farmer imagined it would be an excellent thing if all his sheep were imbued with the stay-at-home tendencies enforced by Nature upon the newly-arrived ram; and they advised Wright to kill the old patriarch of his fold and install the new Ancon ram in his place. The result justified their sagacious anticipations. . . . The young lambs were almost always either pure Ancons or pure ordinary sheep. But when sufficient Ancon sheep were obtained to interbreed with one another, it was found that the offspring were always pure Ancon. Colonel Humphreys, in fact, states that he was acquainted with only 'one questionable case of a contrary nature.' By taking care to select Ancons of both sexes for breeding from, it thus became easy to establish an exceedingly well-marked race—so peculiar that even when herded with other sheep, it was noted that the Ancons kept together. And there is every reason to believe that the existence of this breed might have been indefinitely protracted, but the introduction of the Merino sheep—which were not only very superior to the Ancons in wool and meat, but quite as quiet and orderly—led to the complete neglect of the new breed, so that in 1813 Colonel Humphreys found it difficult to obtain the specimen whose skeleton was presented to Sir Joseph Banks. We believe that for many years no remnant of it has existed in the United States."

It is easy, as Huxley remarks, to understand why, whereas Gratio Kelleia did not become the ancestor of a race of six-fingered and six-toed men, Seth Wright's Ancon ram became a nation of long-bodied, short-legged sheep. If the purely hexadactylic descendants of Gratio Kelleia, and all the purely hexadactylic members of the Colburn family, in the third and fourth generations, had migrated to some desert island, and had been careful not only to exclude all visitors having the normal number of fingers and toes, but to send away before the age of puberty all children of their own which might depart in any degree from the pure hexadactylic type, there can be no doubt that, under favorable conditions, the colony would have become a nation of six-fingered folk. Among such a nation the duodecimal system of notation would flourish, and some remarkable performers on the pianoforte, flute, and other instruments might be looked for; but we do not know that they would possess any other advantage over their pentadactylic contemporaries. Seeing that the system of colonizing above described is antecedently unlikely, and that no special advantage could be derived from the persistence of any hitherto known abnormal variety of the human race, it is unlikely that, for many generations yet to come, we shall hear of six-fingered, hairy-faced, horny-skinned, or hare-lipped nations. The only peculiarities which have any chance of becoming permanent are such as, while not very uncommon, stand in the way of intermarriage with persons not similarly affected. A similar remark, as will presently appear, applies to mental and moral characteristics. The law according to which contrast is found attractive and similitude repugnant, though wide in its range, is not universal; and there are cases in which resemblance, if it has not the charm found (under ordinary circumstances) in contrast, is yet a necessary element in matrimonial alliances.

The inheritance of constitutional traits comes next to be considered. It is probably not less frequently observed, and is, in several respects, more interesting than the inheritance of peculiarities of bodily configuration.

Longevity, which may be regarded as measuring the aggregate constitutional energy, is well known to be hereditary in certain families, as is short duration of life in other families. The best proof that this is the case is found in the action of insurance companies, in ascertaining through their agents the longevity of the ancestors of persons proposing to insure their lives. Instances of longevity during several successive generations are too common to be worth citing. Cases in which, for generation after generation, a certain age, far short of the threescore years and ten, has not been passed, even when all the circumstances have favored longevity, are more interesting. One of the most curious among these is the case of the Turgot family, in which the age of fifty-nine had not been for generations exceeded, to the time when Turgot made the name famous. At the age of fifty, when he was in excellent health, and apparently had promise of many years of life, he expressed to his friends his conviction that the end of his life was near at hand. From that time forward he held himself prepared for death, and, as we know, he died before he had completed his fifty-fourth year.

Fecundity is associated sometimes with longevity, but in other cases it is as significantly associated with short duration of life. Of families in which many children are born, but few survive, we naturally have less striking evidence than we have of families in which many children of strong constitutions are born for several successive generations. What may be called the fecundity of the short-lived is a quality commonly leading in no long time to the disappearance of the family in which it makes its appearance. It is the reverse, of course, with fecundity in families whose members show individually great vigor of constitution and high vital power. Ribot mentions several cases of this sort among the families of the old French *noblesse.* Thus Anne de Montmorency —who, despite his feminine name, was certainly by no means feminine in character (at the Battle of St. Denis, in his sixty-sixth year, he smashed with his sword the teeth of the Scotch soldier who was giving him his death-blow) was the father of twelve children. Three of his ancestors, Matthew I., Matthew II. and Matthew III., had, in all, eighteen children, of whom fifteen were boys. "The son and grandson of the great Condé had nineteen between them, and their great-grandfather, who lost his life at Jarnac, had ten. The first four Guises reckoned in all forty-three children, of whom thirty were boys. Achille de Harley had nine children, his father ten, and his great-grandfather eighteen." In the family of the Herschels, in Hanover and in England, a similar fecundity has been shown in two generations out of three. Sir W. Herschel was one of a family of twelve children, of whom five were sons. He himself did not marry till his fiftieth year, and had only one son. But Sir John Herschel was the father of eleven children.

Of constitutional peculiarities those affecting the nervous system are most frequently transmitted. We do not, however, consider them at this point, because they are viewed ordinarily rather as they relate to mental and moral characteristics than as affections of the body. The bodily affections most commonly transmitted are those depending on what is called diathesis—a general state or disposition of the constitution predisposing to some special disease. Such are scrofula, cancer, tubercular consumption, gout, arthritis, and some diseases specially affecting the skin. It would not be desirable to discuss here this particular part of our subject, interesting though it undoubtedly is. But it may be worth while to note that we have, in the variety of forms in which the same constitutional bad quality may present itself, evidence that what is actually transmitted is not a peculiarity affecting a particular organ, even though in several successive generations the disease may show itself in the same part of the body, but an affection of the constitution generally. We have here an answer to the question asked by Montaigne in the essay from which we have already quoted. The essay was written soon after he had for the first time experienced the pangs of renal calculus: " 'Tis to be believed," he says, "that I derived this infirmity from my father, for he died wonderfully tormented" with it; he was " never sensible of his disease till the sixty-seventh year of his age, and before that had never felt any grudging or symptom of it" . . . "but lived till then in a happy, vigorous state of health, little subject to infirmities, and continued seven years after in this disease, and dyed a very painful death. I was born about twenty-five years before his disease seized him, and in the time of his most flourishing and healthful state of body, his third child in order of birth: where could his propension to this malady lie lurking all that while? And he being so far from the infirmity, how could that small part of his substance carry away so great an impression of its share? And how so concealed that, till five-and-forty years after, I did not begin to be sensible of it? being the only one to this hour, amongst so many brothers and sisters, and all of one mother, that was ever troubled with it. He that can satisfie me in this point, I will believe him in as many other miracles as he pleases, always provided that, as their manner is, he does not give me a doctrine much more intricate and fantastic than the thing itself, for current pay." When we note, however, that in many cases the children of persons affected like the elder Montaigne are not affected like the parents, but with other infirmities, as the tendency to gout, and *vice versa* (a circumstance of which I myself have but too good reason to be cognizant, a parent's tendency to gout having in my case been transmitted in the modified but even more troublesome form of the disease which occasioned Montaigne so much anguish), we perceive that it is not "some small parts of the substance" which transmits its condition to the child, but the general state of the constitution. Moreover, it may be hoped in many cases (which would scarcely be the case if the condition or qualities of some part of the body only were transmitted) that the germs of disease, or rather the predisposition to disease, may be greatly diminished, or even entirely eradicated by suitable precautions. Thus persons inheriting a tendency to consumption have become, in many cases, vigorous and healthy by passing as much of their time as possible in the open air, by avoiding crowded and over-heated rooms, taking moderate but regular exercise, judicious diet, and so forth. We believe that the disease which troubled the last fifteen years of the life of Montaigne might readily have been prevented, and the tendency to it eradicated, during his youth.

Let us turn, however, from these considerations to others more interesting, though less important, and on the whole perhaps better suited to these pages.

The inheritance of tricks or habits is one of the most perplexing of all the phenomena of heredity. The less striking the habit, the more remarkable, perhaps, is its persistence as an inherited trait. Giron de Bzareingues states that he knew a man who, when he lay on his back, was wont to throw his right leg across the left; one of this person's daughters had the same habit from her birth, constantly assuming that position in the cradle, notwithstanding the resistance offered by the swaddling bands.* Darwin mentions another case in his *Variation of Animals and Plants Under Domestication:* A child had the odd habit of setting its fingers in rapid motion whenever it was particularly pleased with anything. When greatly excited, the same child would raise the hand on both sides as high as the eyes, with the fingers in rapid motion as before. Even in old age he experienced a difficulty in refraining from these gestures. He had eight children, one of whom, a little girl, when four years of age, used to set her fingers going, and to lift up her hands after the manner of her father. A still more remarkable case is described by Galton. A gentleman's wife noticed that when he lay fast asleep on his back in bed he had the curious trick of raising his right arm slowly in front of his face, up to his forehead, and then dropping it with a jerk, so that the wrist fell heavily on the bridge of his nose. The trick did not occur every night, but occasionally, and was independent of any ascertained cause. Sometimes it was repeated incessantly for an hour or more. The gentleman's nose was prominent, and its bridge often became sore from blows which it received. At one time an awkward sore was produced that was long in healing, on account of the recurrence, night after night, of the blows which first caused it. His wife had to remove the button from the wrist of his night-gown, as it made severe scratches, and some means were attempted of tying his arm. Many years after his death, his son married a lady who had never heard of the family incident. She, however, observed precisely the same peculiarity in her husband; but his nose, from not being particularly prominent, has never as yet suffered from the blows. The trick does not occur when he is half asleep, as, for example, when he is dozing in his arm-chair; but the moment he is fast asleep, he is apt to begin. It is, as with his father, intermittent; sometimes ceasing for many nights, and sometimes almost incessant during a part of every night. It is performed, as it was with his father, with his right hand. One of his children, a girl, has inherited the same trick. She performs it, likewise, with the right hand, but in a slightly modified

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* While penning the above lines I have been reminded of an experience of my own, which I had never before thought of as connected with the subject of heredity; yet it seems not unlikely that it may be regarded as a case in point. During the infancy of my eldest son it so chanced that the question of rest at night, and consequently the question of finding some convenient way of keeping the child quiet, became one of considerable interest to me. Cradle-rocking was effective, but, carried on in the usual way, prevented my own sleep, though causing the child to sleep. I devised, however, a way of rocking the cradle with the foot, which could be carried on in my sleep, after a few nights' practice. Now, it is an odd coincidence (only, perhaps) that the writer's next child, a girl, had, while still an infant, a trick which I have noticed in no other case. She would rock herself in the cradle by throwing the right leg over the left at regular intervals, the swing of the cradle being steadily kept up for many minutes, and being quite as wide in range as a nurse could have given. It was often continued when the child was asleep.

Since writing the above, I have learned from my eldest daughter, the girl who, as a child, had the habit described, that a recent little brother of hers, one of twins, and remarkably like her, had the same habit, rocking his own cradle so vigorously as to disturb her in the next room with the noise. These two only of twelve children have had this curious habit; but as this child is thirteen years younger than she is, the force of the coincidence in point of time is to some degree impaired.

form; for after raising the arm, she does not allow the wrist to drop upon the bridge of the nose, but the palm of her half-closed hand falls over and down the nose, striking it rather rapidly—a decided improvement on the father's and grandfather's method. The trick is intermittent in this girl's case also, sometimes not occurring for periods of several months, but sometimes almost incessantly.

Strength in particular limbs or muscles is often transmitted hereditarily. So also is skill in special exercises. Thus in the north country there are families of famous wrestlers. Among professional oarsmen, again, we may note such cases as the Clasper family in the north, the Mackinneys in the south; while among amateur oarsmen we have the case of the Playford family, to which the present amateur champion sculler belongs. In cricket, the Walker family and the Grace family may be cited among amateurs, the Humphreys among professional players. Grace in dancing was transmitted for three generations in the Vestris family It must, however, be noted that in some of these cases we may fairly consider that example and teaching have had much to do with the result. Take rowing for instance. A good oarsman will impart his style to a whole crew if he rows stroke for them; and even if he only trains them (as Morrison, for instance, trained the Cambridge crew a few years ago), he will make good oarsmen of men suitably framed and possessing ordinary aptitude for rowing. I remember well how a famous stroke-oar at Cambridge (John Hall, of Magdalen) imparted to one at least of the University crew (a fellow-collegian of his, and therefore rowing with him constantly also in his College boat) so exact an imitation of his style that one rather dusky evening, when the latter was "stroking" a scratch four past a throng of University men, a dispute arose as to which of the two was really stroke of the four. Anyone who knows how characteristic commonly is the rowing of any first-class stroke, and still more anyone who chances to know how peculiar was the style of the University "stroke-oar" referred to, will understand how closely his style must have been adopted, when experienced oarsmen, not many yards from the passing four, were unable to decide at once which of the two men were rowing—even though the evening was dusky enough to prevent the features of the stroke (whose face was not fully in view at the moment) from being discerned. Seeing that a first-rate oarsman can thus communicate his style so perfetly to another, it cannot be regarded as demonstrably a case of hereditary transmission of the Claspers rowed in the same style as their father, or if the present champion amateur sculler (making allowances for the change introduced by the sliding seat) rows very much like his father and his uncle.

Some peculiarities, such as stammering, lisping, babbling, and the like, are not easily referable to any special class of hereditary traits, because it is not clear how far they are to be regarded as depending on bodily or how far on mental peculiarities. It might seem obvious that stammering was in most cases uncontrollable by the will, and babbling might seem as certainly controllable. Yet there are cases which throw doubt on either conclusions. Thus, Dr. Lucas tells us of a servant-maid whose loquacity was apparently quite uncontrollable. She would talk to people till they were ready to faint; and if there were no human being to listen to her, she would talk to animals and inanimate objects, or would talk aloud to herself. She had to be discharged. "But," she said to her master, "I am not to blame; it all comes from my father. He had the same fault, and it drove my mother to distraction; and his father was just the same." Stammering has been transmitted through as many as five generations. The same has been noticed of peculiarities of vision. The Montmorency look, a sort of half squint, affected nearly all the members of the Montmorency family. The peculiarity called Daltonism, an inability to distinguish between certain colors of the spectrum, was not so named, as is often asserted, merely because the distinguished chemist Dalton was affected by it, but because three members of the same family were similarly affected. Deafness and blindness are not commonly hereditary where the parents have lost sight or hearing either by accident or through illness, even though the illness or accident occur during infancy; but persons born either blind or deaf frequently if not commonly transmit the defect to some at least among their offspring. Similar remarks apply to deaf-mutism.

The senses of taste and smell must also be included in the list of those which are affected by transmitted peculiarities. If we include the craving for liquor among such peculiarities, we might at once cite a long list of cases; but this craving must be regarded as nervo-physical, the sense of taste having in reality very little to do with it. It is doubtful how the following hideous instance should be classed. It is related by Dr. Lucas: "A man in Scotland had an irresistible desire to eat human flesh. He had a daughter; although removed from her father and mother, who were both sent to the stake before she was a year old, and although brought up among respectable people, this girl, like her father, yielded to the horrible craving for human flesh." He must be an ardent student of physiological science who regrets that, at this stage, circumstances intervened which prevented the world from ascertaining whether the peculiarity would have descended to the third and fourth generations.

Amongst the strangest cases of hereditary transmissions are those relating to handwriting. Darwin cites several curious instances in his *Variation of Plants and Animals under Domestication*. "On what a curious combination of corporeal structure, mental character, and training, he remarks, "must handwriting depend. Yet everyone must have noted the occasional close similarity of the handwriting in father and son, even although the father had not taught the son. A great collector of franks assured me that in his collection there were several franks of father and son hardly distinguishable except by their dates." Hofacker, in Germany, remarks on the inheritance of handwriting, and it has been even asserted that English boys, when taught to write in France, naturally cling to their English manner of writing. Dr. Carpenter mentions the following instance as having occurred in his own family, as showing that the character of the handwriting is independent of the special teaching which the right hand receives in this art: "A gentleman who emigrated to the United States and settled in the back-woods, before the end of last century, was accustomed, from time to time, to write long letters to his sister in England, giving an account of his family affairs. Having lost his right arm by an accident, the correspondence was temporarily kept up by one or other of his children; but in the course of a few months he learned to write with his left hand, and, before long, the handwriting of the letters thus written came to be indistinguishable from that of his former letters."

I had occasion, two or three years ago, to consider in an article on "Strange Mental Feats," in my *Science Byeways*, the question of inherited mental qualities and artistic habits, and would refer the reader for some remarkable instances of transmitted powers to that article.* Galton in his work on *Hereditary Genius*, and Ribot in his treatise on *Heredity*, have collected many facts bearing on this interesting question. Both writers show a decided bias in favor of a view which would give to heredity a rather too important position among the factors of genius. Cases are cited which seem very little

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* See my *Science Byeways*, p. 337 *et seq.*

to the purpose, and multitudes of instances are omitted which oppose themselves, at a first view at any rate, to the belief that heredity plays the first part in the genesis of great minds. Nearly all the greatest names in philosophy, literature, and science, and a great number of the greatest names in art, stand absolutely alone. We know nothing achieved by the father or grandfather of Shakspeare, or of Goethe, or Schiller, or Evans (George Eliot), or Thackeray, or Dickens, or Huxley. None of Newton's family were in any way distinguished in mathematical or scientific work; nor do we know of a distinguished Laplace, or Lagrange, or Lavoisier, or Harvey, or Dalton, or Volta, or Faraday, besides those who made these names illustrious. As to general literature, page after page might be filled with the mere names of those whose ancestry have been quite undistinguished. To say that among the ancestors of Goethe, Schiller, Byron, and so forth, certain qualities, virtues or vices, passions or insensibilities to passion, may be recognized "among the ancestors of men of science, certain aptitudes for special subjects or methods of search," among the ancestors of philosophers and literary men, certain qualities or capabilities, and that such ancestral peculiarities determined the poetic, scientific or literary genius of the descendent, is in reality to little purpose, for there is probably not a single family possessing claims to culture in any civilized country among the members of which individuals might not be found with qualities thus emphasized, so to speak. Such *a posteriori* reasoning is valueless. If instances could be so classified that after carefully studying them we could make even the roughest approach to a guess respecting the cases in which a family might be expected to produce men of any particular qualities, there would be some use in these attempts at generalization; at present all that can be said is that some mental qualities and some artistic aptitudes have unquestionably in certain instances been transmitted, and that on the whole men of great distinction in philosophy, literature, science and art are rather more likely than others to have among their relations (more or less remote) persons somewhat above the average in mental or artistic qualities. But it is not altogether certain that this superiority is even quite so great as it might be expected to be if hereditary transmission played no part at all in the matter. For it cannot be denied that a great mathematician's son has rather a better chance than others of being a mathematician, a great author's son of being a writer, a great artist's son of being skillful in art, a great philosopher's son of taking philosophic views of things. Nearly every son looks forward while still young to the time when he shall be doing his father'swork; nearly every father hopes, while his children are yet young, that some at least among them will follow his pursuits. The fact that so few sons of great men do follow in their fathers' footsteps shows that, despite the strong ambition of the son and the anxious hope of the father, the son, in the majority of instances, has not had ability even to take a fairly good position in the work wherein the father has been, perhaps, pre-eminently distinguished.

I have said that certain mental qualities have certainly been transmitted in some cases. Galton mentions one noteworthy instance relating to memory. In the family of Porson good memory was so notable a faculty as to give rise to the byword, "the Porson memory." Lady Hester Stanhope, says the late F. Papillon, "she whose life was so full of adventure, gives, as one among many points of resemblance between herself and her grandfather, her retentive memory. 'I have my grandfather's grey eyes,' she said, 'and his memory of places. If he saw a stone on the road, he remembered it; it is the same with myself. His eye, which was ordinarily dull and lusterless, was lighted up, like my own, with a dull gleam whenever he was seized with passion.'"

In endeavoring to form an opinion on the law of heredity in its relation to genius, we must remember that a remark somewhat similar to one made by Huxley respecting the origin of new species applies to the origin of a man of genius. Before such a man became celebrated no one cared particularly to inquire about his ancestry or relations; when his fame was established, the time for making the inquiry had passed away. It is quite possible that, if we had exact and full information, in a great number of cases we might find the position taken up by Mr. Galton and M. Ribot greatly strengthened; it is, however, also possible that we might find it much weakened, not only by the recognition of a multitude of cases in which the approach of a great man was in no sort indicated by scintillations of brightness along the genealogical track, but by a yet greater number of cases in which families containing numbers of clever, witty and learned folks have produced none who attained real distinction.

There is an excellent remark in a thoughtful but anonymous paper on Heredity in the *Quarterly Journal of Science*, two years or so ago, which suggests some considerations well worth noting. "If we look," says the writer, "on the intellect as not a single force but a complex of faculties, we shall find little to perplex us in the phenomenon of spontaneity"—that is (in this case), in the appearance of a man of genius in a family not before remarkable in any way. "Suppose a family who have possessed some of the attributes of greatness, but who, in virtue of a principle equally true in psychology and in mechanics, that 'nothing is stronger than its weakest part,' has remained in obscurity. Let a man of this family marry a woman whose faculties are the complement of his own. It is possible that a child of such a couple may combine the defects or weaknesses of both parents, and we have then the case of spontaneous imbecility or criminality. But it is also possible that he may combine the excellences of both, and burst upon the world as a spontaneous genius. . . . Again, we must remember that, even if we consider the intellect as 'one and indivisible,' it is far from being the only faculty needful for the attainment of excellence, even in the fields of pure science. Combined with it there must be the moral faculties of patience, perseverance, and concentration. The will must be strong enough to overcome all distracting temptations, whether in themselves good or evil. Lastly, there must be constitutional energy and endurance. Failing these, the man will merely leave among his friends the conviction that he might have achieved greatness, if ——. We once knew a physician, resident in a small country town, who from time to time startled his associates by some profound and suggestive idea, some brilliant *apercu.* But a constitutional languor prevented him from ever completing an investigation, or from leaving the world one written line."

The effect of circumstances also must not be overlooked. It is certain that some of those who stand highest in the world's repute would have done nothing to make their names remembered but for circumstances which either aided their efforts or compelled them to exertion; and it cannot be doubted, therefore, that many who have been by no means celebrated have required but favoring opportunities or the spur of adverse circumstances to have achieved distinction. We note the cases in which men who have been intended by their parents for the desk or routine work have fortunately been freed for nobler work, to which their powers have specially fitted them. But we are apt to forget that for each such case there must be many instances in which no fortunate chance has intervened. The theory that genius *will* make its way, despite all obstacles, is like the popular notion that "murder will out," and other such fancies. We note when events happen which favor such notions, but we not only do not note—in the very nature of things it is impossible that we should have the chance of noting—cases unfavorable to a notion which, after all, is but a part of the general and altogether erroneous idea that what we think ought to be, will be. That among millions of men in a civilized community, trained under multitudinous conditions, for diverse professions, trades, and so forth, exposed to many vicissitudes of fortune, good and bad, there should be men from time to time

Who break their birth's invidious bar,
  And grasp the skirts of happy chance,
  And breast the blows of circumstance,
And grapple with their evil star,

is no truer proof of the general theory that genius will make its mark, despite circumstance, than is the occasional occurrence of strange instances in which murder has been detected despite seemingly perfect precautions.

It must, however, be in a general sense admitted that mental powers, like bodily powers, are inherited. If the ancestry of men of genius could be traced, we should in each case probably find enough, in the history of some line at least along which descent could be traced, to account for the possession of special powers, and enough in the history of that and other lines of descent to account for the other qualities or characteristics which, combined with those special powers, gave to the man's whole nature the capacity by which he was enabled to stand above the average level of his fellow-men. We might, with knowledge at once wider and deeper than we actually possess of the various families of each nation, and their relationships, predict in many cases, not that any given child would prove a genius, but that some one or other of a family would probably rise to distinction. To predict the advent of a man of great genius as we predict the approach of an eclipse or a transit, will doubtless never be in men's power; but it is conceivable that at some perhaps not very remote epoch, anticipations may be formed somewhat like those which astronomers are able to make respecting the recurrence of meteoric showers at particular times and seasons, and visible in particular regions. Already we know so much as this, that in certain races of men only can special forms of mental energy, like special bodily characteristics, be expected to appear. It may well be that hereafter such anticipations may be limited to special groups of families.

When we pass from mental to moral qualities we find ourselves in the presence of problems which could not be thoroughly dealt with in these pages. The general question, how far the moral characteristics of each person born into the world depends on those of the parents, or more generally of the ancestry, is one involving many considerations which, perhaps unfortunately, have been associated with religious questions. And apart from this, the answers to this question have been found to have a very wide range—from the opinion of those who (like Miss Martineau) consider that our characters, even where they seem to undergo changes resulting from the exercise of will, are entirely due to inheritance, to the view of those who consider, like Heinroth, that no moral characteristic can possibly be regarded as inherited in such sort as to modify either responsibility for evil-doing or credit for well-doing. Probably most will be content to accept a view between these extremes, without too nicely considering how far moral responsibility is affected by the influence of inherited tendencies.

There are, however, some illustrations relating to exceptional habits, which may be mentioned here without bringing in the general question.

I have not referred to insanity in speaking of inherited mental qualities, because insanity must be regarded as a disease of the moral rather than of the mental nature. Its origin may be in the mind, as the origin of mental diseases is in the brain, that is, is in the body; but the principal manifestations of insanity, those which must guide us in determining its true position, are unquestionably those relating to moral habitudes. Insanity is not always, or at least not always demonstrably, hereditary. Esquirol found among 1,375 lunatics 337 unquestionable cases of hereditary transmission. Guislain and others regard hereditary lunacy as including, roughly, one-fourth of the cases of insanity. Moreau and others hold that the proportion is greater. It appears, however, that mental alienation is not the only form in which the insanity of an ancestor may manifest itself. Dr. Morel gives the following instructive illustration of the "varied and odd complications occurring in the hereditary transmissions of nervous disease." He attended four brothers belonging to one family. The grandfather of these children had died insane; their father had never been able to continue long at anything; their uncle, a man of great intellect and a distinguished physican, was noted for his eccentricities. Now, these four children, sprung from one stock, presented very different forms of physical disorder. One of them was a maniac, whose wild paroxysms occurred periodically. The disorder of the second was melancholy madness; he was reduced by his stupor to a merely automatic condition. The third was characterized by an extreme irascibility and suicidal disposition. The fourth manifested a strong liking for art; but he was of a timorous and suspicious nature. This story seems, in some degree, to give support to the theory that genius and mental aberration are not altogether alien; that, in fact,

> Great wit to madness nearly is allied,
> And thin partitions do their bounds divide.

Of the hereditary transmission of idiotcy we naturally have not the same kind of evidence. Madness often, if not generally, comes on or shows itself late in life, whereas idiotcy is not often developed in the adult. Insanity is the diseased or weakened condition of a mind possessing all the ordinary thinking faculties; idiotcy implies that some of these faculties are altogether wanting. It has been asserted, by the way, that idiotcy is a production of civilization. The civilized "present, as peoples," says Dr. Duncan, "indications of defective vital force, which are not witnessed among those human beings that live in a state of nature. There must be something rotten in some parts of our boasted civilization: and not only a something which has to do with our psychology, but a great deal more with our power of physical persistence. It is a fact that the type of the perfect minded, just above the highest idiots, or the simpletons, is more distinguishable amongst the most civilized of the civilized than among those who are the so-called children of nature. Dolts, boobies, stupids, *et hoc genus omne*, abound in young Saxondom; but their representatives are rare amongst the tribes that are slowly disappearing before the white man." But it seems barely possible that the difference may be due to the care with which civilized communities interfere to prevent the elimination of idiot infants by the summary process of destroying them. The writer from whom I have just quoted refers to the fact that, even under the Roman Empire, as during the Republic, idiots were looked upon as "useless entities by the practical Roman." They had no sanctity in his eyes, and hence their probable rarity; doubtless the unfortunate children were neglected, and there is much reason for believing that they were "exposed." "A congenital idiot soon begins to give trouble," proceeds Dr. Duncan, "and to excite unusual attention; and, moreover, unless extra care is given to it, death is sure to ensue in early childhood." May not idiot children in savage communities have an even worse chance of survival than under the Roman Empire? and may not dolts, boobies, and stupids, *et hoc genus omne*, among savages, have such inferior chances in the infantine and later in the adult struggle for existence, that we may explain thus the comparative rarity of these varieties in savage communities? It certainly does not seem to have been proved as yet that civilization *per se* is favorable to the development of insanity.

The liking for strong drink, as is too well known, is often transmitted. It is remarked by Dr. Howe that "the children of drunkards are deficient in bodily and vital energy, and are predisposed by their very organization to have cravings for alcoholic stimulants. If they pursue the course of their fathers, which they have more temptation to follow and less power to avoid than the children of the temperate, they add to their hereditary weakness, and increase the tendency to idiotcy or insanity in their constitution; and this they leave to their children after them." Whatever opinion we may form on the general question of responsibility for offences of commission or of omission, on this special point all who are acquainted with the facts must agree, admitting that, in some cases of inherited craving for alcoholic stimulants, the responsibility of those who have failed and fallen in the struggle has been but small. "The fathers have eaten sour grapes, and the children's teeth are set on edge." Robert Collyer, of Chicago, in his noble sermon "The Thorn in the Flesh" has well said: "In the far-reaching influences that go to every life, and away backward as certainly as forward, children are sometimes born with appetites fatally strong in their nature. As they grow up the appetite grows with them, and speedily becomes a master, the master a tyrant; and by the time he arrives at manhood, the man is a slave. I heard a man say that for eight-and-twenty years the soul within him had had to stand like an unsleeping sentinel, guarding his appetite for strong drink. To be a man at last under such a disadvantage, not to mention a saint, is as fine a piece of grace as can well be seen. There is no doctrine that demands a larger vision than this of the depravity of human nature. Old Dr. Mason used to say that 'as much grace as would make John a saint, would hardly keep Peter from knocking a man down.'"

There are some curious stories of special vices transmitted from parent to child, which, if true, are exceedingly significant, to say the least.* Gama Machado relates that a lady with whom he was acquainted, who possessed a large fortune, had a passion for gambling and passed whole nights at play. "She died young," he proceeds, "of a pulmonary complaint. Her eldest son, who was in appearance the image of his mother, had the same passion for play. He died of consumption like his mother, and at the same age; his daughter, who resembled him, inherited the same tastes and died young." Hereditery predisposition to theft, mur-

* The following statement from the researches of Brown-Sequard seems well worth noting in this connection: "In the course of his masterly experimental investigations into the functions of the nervous system he discovered that, after a particular lesion of the spinal cord of guinea-pigs, a slight pinching of the skin of the face would throw the animal into a kind of epileptic convulsion. That this artificial epilepsy should be constantly producible in guinea-pigs, and not in any other animals experimented on, was in itself sufficiently singular; and it was not less surprising that the tendency to it persisted after the lesion of the spinal cord seemed to have been entirely recovered from. But it was far more wonderful that the offspring of these epileptic guinea-pigs showed the same predisposition without having been themselves subjected to any lesion whatever; whilst no such tendency showed itself in any of the large number of young bred by the same accurate observer from parents that had not thus been operated on."

der and suicide, has been demonstrated in several cases. But the world at large is naturally indisposed to recognise congenital tendency to crime as largely diminishing responsibility for offences or attempted offences of this kind. So far as the general interests of the community are concerned, the demonstrated fact that a thief or murderer has *inherited* his unpleasant tendency should be a *raison de plus* for preventing the tendency from being transmitted any farther. In stamping out the hereditary ruffian or rascal by life imprisonment, we not only get rid of the "grown serpent," but of the worm which

Hath nature that in time would venom breed.

An illustration of the policy at least (we do not say the justice) of preventive measures in such cases, is shown in the case of a woman in America, of whom the world may fairly say what Father Paul remarked to gentle Alice Brown, it "never knew so criminal a family as hers." A young woman of remarkably depraved character infested, some seventy years since, the district of the Upper Hudson. At one stage of her youth she narrowly, and somewhat unfortunately, escaped death. Surviving, however, she bore many children, who in turn had large families, insomuch that there are now some eighty direct descendants, of whom one-fourth are convicted criminals, whilst the rest are drunkards, lunatics, paupers, and otherwise undesirable members of the community.

With facts such as these before us, we cannot doubt that in whatever degree variability may eliminate after awhile peculiar mental or moral tendencies, these are often transmitted for many generations before they die out. If it be unsafe to argue that the responsibility of those inheriting special characteristics is diminished, the duties of others towards them may justly be considered to be modified. Other duties than the mere personal control of tendencies which men may recognize in themselves are also introduced. If a man finds within himself an inherent tendency towards some sin, which yet he utterly detests, insomuch that while the spirit is willing the flesh is weak, or perchance utterly powerless, he must recognize in his own life a struggle too painful and too hopeless to be handed down to others. As regards our relations to families in which criminal tendencies have been developed, either through the negligence of those around (as in certain dens in London where, for centuries, crime has swarmed and multiplied), or by unfortunate alliances, we may "perceive here a divided duty." It has been remarked that "we do not set ourselves to train tigers and wolves into peaceful domestic animals; we seek to extirpate them," and the question has been asked, "why should we act otherwise with beings, who, if human in form, are worse than wild beasts?" "To educate the son of a garroter or 'corner-man' into an average Englishman" may be "about as promising a task as to train one of the latter into a Newton or a Milton." But we must not too quickly despair of a task which may be regarded as a duty inherited from those who in past generations neglected it.

There is no hope of the reversion of tiger or wolf to less savage types, for, far back as we can trace their ancestry, we find them savage of nature. With our criminal families the case is not so utterly hopeless. Extirpation being impossible (though easily talked of) without injustice, which would be the parent of far greater troubles even than our criminal classes bring upon us, we should consider the elements of hope which the problem undoubtedly affords. By making it the manifest interest of our criminal population to scatter, or, failing that, by leaving them no choice in the matter, the poison in their blood may before many generations be eradicated, not by wide-spreading merely, but because of the circumstance that only the better sort among them would have (when scattered) much chance of rearing families as well as of escaping imprisonment.

II.

ARTIFICIAL SOMNAMBULISM.

Rather more than a quarter of a century ago, two Americans visited London, who called themselves professors of Electro-Biology, and claimed the power of "subjugating the most determined wills, paralyzing the strongest muscles, preventing the evidence of the senses, destroying the memory of the most familiar events or of the most recent occurrences, inducing obedience to any command, and making an individual believe himself transformed into any one else." All this and more was to be effected, they said, by the action of a small disc of zinc and copper held in the hand of the "subject," and steadily gazed at by him, "so as to concentrate the electro-magnetic action." The pretensions of these professors received before long a shock as decisive as that which overthrew the credit of the professors of animal magnetism when Haygarth and Falconer successfully substituted wooden tractors for the metallic tractors which had been supposed to convey the magnetic fluid. In 1851, Mr. Braid, a Scotch surgeon, who had witnessed some of the exhibitions of the electro-biologists, conceived the idea that the phenomena were not due to any special qualities possessed by the discs of zinc and copper, but simply to the fixed look of the "subject" and the entire abstraction of his attention. The same explanation applied to the so-called "magnetic passes" of the mesmerists. The monotonous manipulation of the operator produced the same effect as the fixed stare of the "subject." He showed by his experiments that no magnetizer, with his imaginary secret agents or fluids, is in the least wanted; but that the subjects can place themselves in the same condition as the supposed subjects of electro-biological influences by simply gazing fixedly at some object for a long time with fixed attention.

The condition thus superinduced is not hypnotism, or artificial somnambulism, properly so called. "The electro-biological" condition may be regarded as simply a kind of reverie or abstraction artificially produced. But Braid discovered that a more perfect control might be obtained over "subjects," and a condition resembling that of the sleep-walker artificially induced, by modifying the method of fixing the attention. Instead of directing the subject's gaze upon a bright object, placed at a considerable distance from the eyes, so that no effect was required to concentrate vision upon it, he placed a bright object somewhat above and in front of the eyes at so short a distance that the convergence of their axes upon it was accompanied with sufficient effect to produce even a slight amount of pain. The condition to which the "subjects" of this new method were reduced was markedly different from the ordinary "electro-biological" state. Thus on one occasion, in the presence of 800 persons, fourteen men were experimented upon. "All began the experiment at the same time; the former with their eyes fixed upon a projecting cork, placed securely on their foreheads; the others at their own will gazed steadily at certain points in the direction of the audience. In the course of ten minutes the eyelids of these ten persons had involuntarily closed. With some, consciousness remained; others were in catalepsy, and entirely insensible to being stuck with needles; and others on awakening knew absolutely nothing of what had taken place during their sleep." The other four simply passed into the ordinary condition of electro-biologized "subjects," retaining the recollection of all that happened to them while in the state of artificial abstraction or reverie.

Dr. Carpenter, in that most interesting work of his, "Mental Physiology," thus describes the state of hypnotism: "The process is of the same kind as that employed for the induction of the 'biological' state, the only difference lying in the *greater* *intensity* of the gaze, and in the more complete concentration of will upon the direction of the eyes, which the nearer approximation of the object requires for the maintenance of the convergence. In hypnotism, as in ordinary somnambulism, no remembrance whatever is preserved in the waking state of anything that may have occurred during its continuance; although the previous train of thought may be taken up and continued uninterruptedly on the next occasion that the hypnotism is induced. And when the mind is not excited to activity by the stimulus of external impressions, the hypnotized subject appears to be profoundly asleep; a state of torpor, in fact, being usually the first result of the process, and any subsequent manifestation of activity being procurable only by the prompting of the operator. The hypnotized subject, too, rarely opens his eyes; his bodily movements are usually slow; his mental operations require a considerable time in their performance; and there is altogether an appearance of heaviness about him, which contrasts strongly wtih the comparatively wide-awake air of him who has not passed beyond the ordinary 'biological' state."

We must note, however, in passing, that the condition of complete hypnotism had been obtained in several instances by some of the earlier experimenters in animal magnetism. One remarkable instance was communicated to the surgical section of the French Academy on April 16, 1829, by Jules Cloquet. Two meetings were entirely devoted to its investigation. The following account presents all the chief points of the case, surgical details being entirely omitted, however, as not necessary for our present purpose: A lady, aged sixty-four, consulted M. Cloquet on April 8, 1829, on account of an ulcerated cancer of the right breast, which had continued gradually growing worse, during several years. M. Chapelain, the physician attending the lady, had "magnetized" her for some months, producing no remedial effects, but only a very profound sleep or torpor, during which all sensibility seemed to be annihilated, while the ideas retained all their clearness. He proposed to M. Cloquet to operate upon her while she was in this state of torpor, and the latter, considering the operation the only means of saving her life, consented. The two doctors do not appear to have been troubled by any scruples as to their right thus to conduct an operation to which, when in her normal condition, the patient strenuously objected. It sufficed for them that when they had put her to sleep artificially, she could be persuaded to submit to it. On the appointed day M. Cloquet found the patient ready "dressed and seated in an elbow-chair, in the attitude of a person enjoying a quiet, natural sleep." In reality, however, she was in the somnambulistic state, and talked calmly of the operation. During the whole time that the operation lasted—from ten to twelve minutes—she continued to converse quietly with M. Cloquet, "and did not exhibit the slightest sign of sensibility. There was no motion of the limbs or of the features, no change in the respiration nor in the voice; no motions even in the pulse. The patient continued in the same state of automatic indifference and impassibility in which she had been some minutes before the operation." For forty-eight hours after this, the patient remained in the somnambulistic state, showing no sign of pain during the subsequent dressing of the wound. When awakened from this prolonged sleep she had no recollection of what had passed in the interval; "but on being informed of the operation, and seeing her children around her, she experienced a very lively emotion, which the 'magnetiser' checked by immediately setting her asleep." Certainly none of the hypnotized "subjects" of Mr. Braid's experiments showed more complete abstraction from their normal condition than this lady; and other cases cited in Bertrand's work, "Le Magnétisme Animal en France" (1826), are almost equally remarkable. As it does not appear that in any of these cases Braid's method of producing hypnotism by causing the eyes, or rather their optical axes, to be converged upon a point, was adopted, we must conclude that this part of the method is not absolutely essential to success. Indeed, the circumstance that in some of Braid's public experiments numbers of the audience became hypnotized without his knowledge, shows that the more susceptible "subjects" do not require to contemplate a point near and slightly above the eyes, but may be put into the true hypnotic state by methods which, with the less susceptible, produce only the electro-biological condition.

It will be well, however, to inquire somewhat carefully into this point. My present object, I would note, is not merely to indicate the remarkable nature of the phenomena of hypnotism, but to consider these phenomena with direct reference to their probable cause. It may not be possible to obtain a satisfactory explanation of them. But it is better to view them as phenomena to be accounted for than merely as surprising but utterly inexplicable circumstances.

Now we have fortunately the means of determining the effect of the physical relations involved in these experiments, apart from those which are chiefly due to imagination. For animals can be hypnotised, and the conditions necessary for this effect to be fully produced have been ascertained.

The most familiar experiment of this sort is sometimes known as Kircher's. Let the feet of a hen be tied together (though this is not necessary in all cases), and the hen placed on a level surface. Then, if the body of the hen is gently pressed down, the head extended, with the beak pointing downwards, touching the surface on which the hen stands, and a chalk mark is drawn slowly along the surface, from the tip of the beak in a line extending directly from the bird's eye, it is found that the hen will remain for a considerable time perfectly still, though left quite free to move. She is, in fact, hypnotized.

We have now to inquire what parts of the process just described are effective in producing the hypnotic condition, or whether all are essential to success in the experiment.

In the first place, the fastening of the feet may be dispensed with. But it has its influence, and makes the experiment easier. An explanation, or rather an illustration, of its effect is afforded by a singular and interesting experiment devised by Lewissohn, of Berlin: If a frog is placed on its back, it immediately, when the hand which had held it is removed, turns over and escapes. But if the two fore legs are tied with a string, the frog, when placed on its back, breathes heavily, but is otherwise quite motionless, and does not make the least attempt to escape, even when the experimenter tries to move it. "It is as though," says Czermak, describing the experiment as performed by himself, "its small amount of reasoning power had been charmed away, or else that it slept with open eyes. Now I press upon the cutaneous nerves of the frog, while I loosen and remove the threads on the fore legs. Still the animal remains motionless upon its back, in consequence of some remaining after-effect; at last, however, it returns to itself, turns over and quickly escapes."

Thus far the idea suggested is that the animal is so affected by the cutaneous pressure as to suppose itself tied and therefore unable to move. In other words, this experiment suggests that imagination acts on animals as on men, only in a different degree. I may cite here a curious case which I once noticed and have never been able to understand, though it seems to suggest the influence of imagination on an animal one would hardly suspect of being at all under the influence of any but purely physical influences. Hearing a noise as of a cat leaping down from a pantry window, which looked out on an enclosed yard, I went directly into the yard, and there saw a strange cat running off with a fish she had stolen. She was at the moment leaping on to a bin, from the top of which, by another very easy leap, she could get on to the wall enclosing the yard, and so escape. With the idea rather of frightening her than hurting her (does one missile out of a hundred flung at cats ever hit them?), I threw at the thief a small piece of wood which I had in my hand at the moment. It struck the wall above her just as she was going to leap to the top of the wall, and it fell, without touching her, between her and the wall. To my surprise, she stood perfectly still, looking at the piece of wood, her mouth, from which the fish had fallen, remaining open, and her whole attitude expressing stupid wonder. I make no doubt I could have taken her prisoner, or struck her heavily, if I had wished, for she made no effort to escape until, with a parlor broom which stood by, I pushed her long the top of the bin toward the wall, when she seemed suddenly to arouse herself, and leaping to the top of the wall, she made off. My wife witnessed the last scene of this curious little comedy. In fact, it was chiefly, perhaps, because she pleaded for mercy on "the poor thing" that the soft end of the broom alone came into operation; for, though not altogether agreeing with the Count of Roussillon that anything can be endured before a cat, I did not at the moment regard that particular cat with special favor.

The extension of the neck and depression of the head in the experiment with the hen have no special significance, for Czermak has been able to produce the same phenomena of hypnotism without them, and has failed to produce the hypnotic effect on pigeons when attending to this point, and in other respects proceeding as nearly as possible in the same way as with hens. "With the hens," he says, "I often hung a piece of twine, or a small piece of wood, directly over their crests, so that the end fell before their eyes. The hens not only remained perfectly motionless, but closed their eyes, and slept with their heads sinking until they came in contact with the table. Before falling asleep, the hens' heads can be either pressed down or raised up, and they will remain in this position as if they were pieces of wax. That is, however, a symptom of a cataleptic condition, such as is seen in human beings under certain pathological conditions of the nervous system."

On the other hand, repeated experiments convinced Czermak that the pressure on the animal as it is held is of primary importance. It is frequently the case, he says, that a hen, which for a minute has been in a motionless state, caused by simply extending the neck and depressing the head, awakes and flies away, but on being caught again immediately, she can be placed once more in the condition of lethargy, if we place the animal in a squatting position, and overcome with gentle force the resistance of the muscles, by firmly placing the hand upon its back. During the slow and measured suppression, one often perceives an extremely remarkable position of the head and neck, which are left entirely free. The head remains as if held by an invisible hand in its proper place, the neck being stretched out of proportion, while the body by degrees is pushed downwards. If the animal is thus left entirely free, it remains for a minute or so in this peculiar condition with wide-open staring-eyes. "Here," as Czermak remarks, "the actual circumstances are only the effect of the emotion which the nerves of the skin excite, and the gentle force which overcomes the animal's resistance. Certainly the creature a short time before had been in a condition of immobility, and might have retained some special inclination to fall back into the same, although the awakening, flight, and recapture, together with the refreshment given to the nervous system, are intermediate circumstances." Similar experiments are best made upon small birds. Now, it is well known to bird-fanciers that goldfinches, canary-birds, etc., can be made to remain motionless for some time by simply holding them firmly for a moment and then letting them go. "Here, in my hand," said Czermak, in his lecture, "is a timid bird, just brought from market. If I place it on its back, and hold its head with my left hand, keeping it still for a few seconds, it will lie perfectly motionless after I have removed my hands, as if charmed, breathing heavily, and without making any attempt to change its position or to fly away." ("Two of the birds," says the report, "were treated in this manner without effect; but the third, a siskin, fell into a sleeping condition, and remained completely immovable on its back, until pushed with a glass tube, when it awoke and flew actively around the room.")

Also when a bird is in a sitting position, and the head is pressed slightly back, the bird falls into a sleeping condition, even though the eyes had been open. "I have often noticed," says Czermak, "that the birds under these circumstances close their eyes for a few minutes or even a quarter of an hour, and are more or less fast asleep."

Lastly, as to the chalk-line in Kircher's experiment. Czermak found, as already said, that pigeons do not become motionless, as happens to hens, if merely held firmly in the hand, and their heads and necks pressed gently on the table. Nor can they be hypnotized like small birds in the experiment last mentioned. "That is," he says, "I held them with a thumb placed on each side of the head, which I bent over a little, while the other hand held the body gently pressed down upon the table; but even this treatment, which has such an effect on little birds, did not seem to succeed at first with the pigeons; almost always they flew away as soon as I liberated them and entirely removed my hands." But he presently noticed that the short time during which the pigeons remained quiet lengthened considerably when the finger only of the hand which held the head was removed. Removing the hand holding the body made no difference, but retaining the other hand near the bird's head, the hand made all the difference in the world. Pursuing the line of research thus indicated, Czermak found to his astonishment that the fixing of the pigeon's look on the finger placed before its eyes was the secret of the matter. In order to determine the question still more clearly, he tried the experiment on a pigeon which he had clasped firmly by the body in his left hand, but whose neck and head were perfectly free. "I held one finger of my right hand steadily before the top of its beak—and what did I see? The first pigeon with which I made this attempt remained rigid and motionless, as if bound, for several minutes, before the outstretched finger of my right hand! Yes, I could take my left hand, with which I had held the bird, and again touch the pigeon without waking it up; the animal remained in the same position while I held my outstretched finger still pointing towards the beak." "The lecturer," says the report, "demonstrated this experiment in the most successful manner with a pigeon which was brought to him."

Yet it is to be noticed that among animals, as among men, different degrees of subjectivity exist. "Individual inward relations," says Czermak, "as well as outward conditions, must necessarily exercise some disturbing influence, whether the animal will give itself up to the requisite exertions of certain parts of its brain with more or less inclination or otherwise. We often see, for example, that a pigeon endeavors to escape from confinement by a quick turning of its head from side to side. In following those singular and characteristic movements of the head and neck, with the finger held before the bird, one either gains his point, or else makes the pigeon so perplexed and excited that it at last becomes quiet, so that, if it is held firmly by the body and head, it can be forced gently down upon the table. As Schopenhauer says of sleeping, "The brain must bite." I will also mention here, by the way, that a tame parrot, which I have in my house, can be placed in this sleepy condition by simply holding the finger steadily before the top of its beak."

I may cite here a singular illustration of the effect of perplexity in the case of a creature in all other respects much more naturally circumstanced than the hens, pigeons, and small birds of Czermak's experiments. In the Spring of 1859, when I was an undergraduate at Cambridge, I and a friend of mine were in canoes on the part of the Cam which flow through the College grounds. Here there are many ducks and a few swans. It occurred to us, not, I fear, from any special scientific spirit, but as a matter of curiosity, to inquire whether it was possible to pass over a duck in a canoe. Of course on the approach of either canoe a duck would try to get out of the way on one side or the other; but on the course of the canoe being rapidly changed, the duck would have to change his course. Then the canoe's course would again be changed, so as to compel the duck to try the other side. The canoe drawing all the time nearer, and her changes of course being made very lightly and in quicker and quicker alteration as she approached, the duck would generally get bewildered, and finally would allow the canoe to pass over him, gently pressing him under water in its course. The process, in fact, was a sort of mild keel-hauling. The absolute rigidity of body and the dull stupid stare with which some of the ducks met their fate seems to me (*now:* I was not in 1859 familiar with the phenomena of hypnotism) to suggest that the effect was to be explained as Czermak explains the hypnotism of the pigeons on which he experimented.

We shall be better able now to understand the phenomena of artificial somnambulism in the case of human beings. If the circumstances observed by Kircher, Czermak, Lewissohn, and others suggest, as I think they do, that animal hypnotism is a form of the phenomenon sometimes called fascination, we may be led to regard the possibility of artificial somnambulism in men as a survival of a property playing in all probability an important and valuable part in the economy of animal life. It is in this direction, at present, that the evidence seems to tend.

The most remarkable circumstance about the completely hypnotized subject is the seemingly complete control of the will of the "subject" and even of his opinions. Even the mere suggestions of the operator, not expressed verbally or by signs, but by movements imparted to the body of the subject, are at once responded to, as though, to use Dr. Garth Wilkinson's expression, the *whole man* were given to each perception. Then, "if the hand be placed," says Dr. Carpenter, "upon the top of the head, the somnambulist will frequently, of his own accord, draw up his body to its fullest height, and throw his head slightly back; his countenance then assumes an expression of the most lofty pride, and his whole mind is obviously possessed by that feeling. When the first action does not of itself call forth the rest, it is sufficient for the operator to straighten the legs and spine, and to throw the head somewhat back, to arouse that feeling and the corresponding expression to its fullest intensity. During the most complete domination of this emotion, let the head be bent forward, and the body and limbs gently flexed; and the most profound humility then instantaneously takes its place." Of course in some cases we may well believe that the expressions thus described by Dr. Carpenter have been simulated by the subject. But there can be no reason to doubt the reality of the operator's control in many cases. Dr. Carpenter says that he has not only been an eye witness of them on various occasions, but that he places full reliance on the testimony of an intelligent friend, who submitted himself to Mr. Braid's manipulations, but retained sufficient self-consciousness and voluntary power to endeavor to exercise some resistance to their influence at the time, and subsequently to retrace his course of thought and feeling. "This gentleman declares," says Dr. Carpenter, "that, although accustomed to the study of character and to self-observation, he could not have conceived that the whole mental state should have undergone so instantaneous and complete a metamorphosis, as he remembers it to have done, when his head and body were bent forward in the attitude of humility, after having been drawn to their full height in that of self-esteem."

A most graphic description of the phenomena of hypnotism is given by Dr. Garth Wilkinson: "The preliminary state is that of abstraction, produced by fixed gaze upon some unexciting and empty thing (for poverty of object engenders abstraction), and this abstraction is the logical premiss of what follows. Abstraction tends to become more and more abstract, narrower and narrower; it tends to unity and afterwards to nullity. There, then, the patient is, at the summit of attention, with no object left, a mere statue of attention, a listening, expectant life; a perfectly undistracted faculty, dreaming of a lessening and lessening mathematical point; the end of his mind sharpened away to nothing. What happens? Any sensation that appeals is met by this brilliant attention, and receives its diamond glare; being perceived with a force of leisure of which our distracted life affords only the rudiments. External influences are sensated, sympathized with, to an extraordinary degree; harmonious music sways the body into graces the most affecting; discords jar it, as though they would tear it limb from limb. Cold and heat are perceived with similar exaltation; so also smells and touches. In short, *the whole man appears to be given to each perception.* The body trembles like down with the wafts of the atmosphere; the world plays upon it as upon a spiritual instrument finely attuned."

This state, which may be called the natural hypnotic state, may be artificially modified. "The power of suggestion over the patient," says Dr. Garth Wilkinson, "is excessive. If you say, 'What animal is it?' the patient will tell you it is a lamb, or a rabbit, or any other. 'Does he see it?' 'Yes.' 'What animal is it *now?*' putting depth and gloom into the tone of *now*, and thereby suggesting a difference. 'Oh!' with a shudder, 'it is a wolf.' 'What color is it?' still glooming the phrase. 'Black.' 'What color is it now?' giving the *now* a cheerful air. 'Oh! a beautiful blue!' (rather an unusual color for a wolf, I would suggest), spoken with the utmost delight (and no wonder! especially if the hypnotic subject were a naturalist). And so you lead the subject through any dreams you please, by variations of questions and of inflections of the voice! and *he sees and feels all as real.*"

We have seen how the patient's mind can be influenced by changing the posture of his body. Dr. Wilkinson gives very remarkable evidence on this point. "Double his fist and pull up his arm, if you dare," he says of the subject, "for you will have the strength of your ribs rudely tested. Put him on his knees and clasp his hands, and the saints and devotees of the artists will pale before the trueness of his devout actings. Raise his head while in prayer, and his lips pour forth exulting glorifications, as he sees heaven opened, and the majesty of God raising him to his place; then in a moment depress the head, and he is in dust and ashes, an unworthy sinner, with the pit of hell yawning at his feet. Or compress the forehead, so as to wrinkle it vertically, and thorny-toothed clouds contract in from the very horizon" (in the subject's imagination, it will be understood); "and what is remarkable, the smallest pinch and wrinkle, such as will lie between your nipping nails, is sufficient nucleus to crystalize the man into that shape, and to make him all foreboding, as, again, the smallest expansion in a moment brings the opposite state, with a full breathing of delight."

Some will perhaps think the next instance the most remarkable of all, perfectly natural though one-half of the performance may have been. The subject being a young lady, the operator asks whether she or another is the prettier, raising her head as he puts the question. "Observe," says Dr. Wilkinson, "the inexpressible hauteur, and the puff sneers let off from the lips" (see Darwin's treatise on the "Expression of the Emotions," plate IV. 1, and plate V. 1), "which indicate a conclusion too certain to need utterance. Depress the head, and repeat the question, and mark the self-abasement with which she now says '*She is*,' as hardly worthy to make the comparison."

In this state, in fact, "whatever posture of any passion is induced, the passion comes into it at once, and dramatizes the body accordingly."

It might seem that there must of necessity be some degree of exaggeration in this description, simply because the power of adequately expressing any given emotion is not possessed by all. Some can in a moment bring any expression into the face, or even simulate at once the expression and the aspect of another person, while many persons, probably most, possess scarcely any power of the sort, and fail ridiculously even in attempting to reproduce the expressions corresponding to the commonest emotions. But it is abundantly clear that the hypnotized subject possesses for the time being abnormal powers. No doubt this is due to the circumstance that for the time being "the whole man is given to each perception." The stories illustrative of this peculiarity of the hypnotized state are so remarkable that they have been rejected as utterly incredible by many who are not acquainted with the amount of evidence we have upon this point.

The instances above cited by Dr. Garth Wilkinson, remarkable though they may be, are surpassed altogether in interest by a case which Dr. Carpenter mentions: of a factory girl whose musical powers had received little cultivation, and who could scarcely speak her own language correctly, who nevertheless exactly imitated both the words and the music of vocal performances by Jenny Lind. Dr. Carpenter was assured by witnesses in whom he could place implicit reliance, that this girl, in the hypnotized state, followed the Swedish nightingale's songs in different languages "so instantaneously and correctly, as to both words and music, that it was difficult to distinguish the two voices. In order to test the powers of the somnambulist to the utmost, Mademoiselle Lind extemporized a long and elaborate chromatic exercise, which the girl imitated with no less precision, though in her waking state she durst not even attempt anything of the sort."

The exaltation of the senses of hypnotized subjects is an equally wonderful phenomenon. Dr. Carpenter relates many very remarkable instances as occurring within his own experience. He has "known a youth, in the hypnotized state," he says, "to find out by the sense of smell, the owner of a glove which was placed in his hand from amongst a party of more than sixty persons, scenting at each of them one after the other until he came to the right individual. In another case, the owner of a ring was unhesitatingly found out from amongst a company of twelve, the ring having been withdrawn from the finger before the somnambule was introduced." The sense of touch has, in other cases, been singularly intensified, insomuch that slight differences of heat, which to ordinary feeling were quite inappreciable, would be at once detected, while such differences as can be but just perceived in the ordinary state would produce intense distress.

In some respects the increase of muscular power, or rather of the power of special muscles, is even more striking, because it is commonly supposed by most persons that the muscular power depends entirely on the size and quality of the muscles, the state of health and like conditions, not on the imagination. Of course every one knows that the muscles are capable of greater efforts when the mind is much excited by fear and other emotions. But the general idea is, I think, that whatever the body is capable of doing under circumstances of great excitement, it is in reality capable of doing at all times if only a resolute effort is made. Nor is it commonly supposed that a very wide difference exists between the greatest efforts of the body under excitement and those of which it is ordinarily capable. Now, the condition of the hypnotized subject is certainly not one of excitement. The attempts which he is directed to make are influenced only by the idea that he *can* do what he is told, not that he *must* do so. When a man pursued by a bull leaps over a wall, which, under ordinary conditions, he would not even think of climbing, we can understand that he only does because he must, what if he liked he could do at any time. But if a man who had been making his best efforts in jumping, cleared only a height of four feet, and presently being told to jump over an eight feet wall, cleared the height with apparent ease, we should be disposed to regard the feat as savoring of the miraculous.

Now, Dr. Carpenter saw one of Mr. Braid's hypnotized subjects—a man so remarkable for the poverty of his physical development that he had not, for many years, ventured to lift up a weight of twenty pounds in his ordinary state—take up a quarter of a hundred weight upon his little finger, and swing it round his head with the utmost apparent ease, on being told that it was as light as a feather. "On another occasion he lifted a half hundred weight on the last joint of his forefinger as high as his knee." The personal character of the man placed him above all suspicion of deceit in the opinion of those who best knew him; and as Dr. Carpenter acutely remarks, "the impossibility of any trickery in such a case would be evident to the educated eye, since, if he had practiced such feats (which very few, even of the strongest men, could accomplish without practice), the effect would have made itself visible in his muscular development." "Consequently," he adds, "when the same individual afterwards declared himself unable, with the greatest effort, to lift a handkerchief from the table, after having been assured that he could not possibly move it, there was no reason for questioning the truth of his conviction, based as this was upon the same kind of suggestion as that by which he had been just before prompted to what seemed an otherwise impossible action."

The explanation of this and the preceding cases cannot be mistaken by physiologists, and is very important in its bearing on the phenomena of hypnotism generally, at once involving an interpretation of the whole series of phenomena, and suggesting other relations not as yet illustrated experimentally. It is well known that in our ordinary use of any muscles we employ but a small part of the muscle at any given moment. What the muscle is actually capable of is shown in convulsive contractions, in which far more force is put forth than the strongest effort of the will could call into play. We explain, then, the seeming increase of strength in any set of muscles during the hypnotic state as due to the concentration of the subject's will in an abnormal manner, or to an abnormal degree, on that set of muscles. In a similar way, the great increase of certain powers of perception may be explained as due to the concentration of the will upon the corresponding parts of the nervous system.

In like manner, the will may be directed so entirely to the operations necessary for the performances of difficult feats, that the hypnotized or somnambulistic subject may be able to accomplish what in his ordinary condition would be impossible or even utterly appalling to him. Thus sleepwalkers (whose condition precisely resembles that of the artificially hypnotized, except that the suggestions they experience come from contact with inanimate objects, instead of being aroused by the actions of another person) "can clamber walls and roofs, traverse narrow planks, step firmly along high parapets, and perform other feats which they would shrink from attempting in their waking state." This is simply, as Dr. Carpenter points out, because they are *not distracted* by the sense of danger which their vision would call up from concentrating their exclusive attention on the guidance afforded by their muscular sense.".

But the most remarkable and suggestive of all the facts known respecting hypnotism is the influence which can by its means be brought to bear upon special parts or functions of the body. We know that imagination will hasten or retard certain processes commonly regarded as involuntary (indeed, the influence of imagination is itself in a great degree involuntary). We know further that in some cases imagination will do much more than this, as in the familiar cases of the disappearance of warts under the supposed influence of charms, the cure of scrofula at a touch, and hundreds of well-attested cases of so-called miraculous cures. But although the actual cases of the curative influence obtained over hypnotized patients may not be in reality more striking than some of these, yet they are more suggestive at any rate to ordinary minds, because they are known not to be the result of any charm or miraculous interference, but to be due to simply natural processes initiated by natural though unfamiliar means.

Take, for instance, such a case as the following, related by Dr. Carpenter (who has himself witnessed many remarkable cases of hypnotic cure): "A female relative of Mr. Braid's was the subject of a severe rheumatic fever, during the course of which the left eye became seriously implicated, so that after the inflammatory action had passed away, there was an opacity over more than one-half of the cornea, which not only prevented distinct vision, but occasioned an annoying disfigurement. Having placed herself under Mr. Braid's hypnotic treatment for the relief of violent pain in her arm and shoulder, she found, to the surprise alike of herself and Mr. Braid, that her sight began to improve very perceptibly. The operation was therefore continued daily; and in a very short time the cornea became so transparent that close inspection was required to discover any remains of the opacity." On this, Carpenter remarks that he has known other cases in which secretions that had been morbally suspended have been reinduced by this process; and is satisfied that, if applied with skill and discrimination, it would take rank as one of the most potent methods of treatment which the physician has at his command. He adds that "the channel of influence is obviously the system of nerves which regulates the secretions—nerves which, though not under direct subjection to the will, are peculiarly affected by emotional states."

I may remark, in passing, that nerves which are not ordinarily under the influence of the will, but whose office would be to direct muscular movements if only the will could influence them, may by persistent attention become obedient to the will. When I was last in New York, I met a gentleman who gave me a long and most interesting account of certain experiments which he had made on himself. The account was not forced on me, the reader must understand, but was elicited by questions suggested by one or two remarkable facts which he had casually mentioned as falling within his experience. I had only his own word for much that he told me, and some may perhaps consider that there was very little truth in the narrative. I may pause here to make some remarks, by the way, on the traits of truthful and untruthful persons. I believe very slight powers of observation are necessary to detect want of veracity in any man, though absence of veracity in any particular story may not be easily detected or established. I am not one of those who believe every story they hear, and trust in every one they meet. But I have noticed one or two features by which the habitual teller of untruths may be detected very readily, as may also one who, without telling actual falsehoods, tries to heighten the effect of any story he may have to tell, by strengthening all the particulars. My experience in this respect is unlike Dickens's, who believed, and indeed found, that a man whom on first seeing he distrusted, and justly, could explain away the unfavorable impression. "My first impression," he says, "about such people, founded on face and manner alone, was invariably true; my mistake was in suffering them to come nearer to me and explain themselves away." I have found it otherwise, though, of course, Dickens was right about his own experience; the matter depends entirely on the idiosyncrasies of the observer. I have often been deceived by face and expression; never, to the best of my belief (and belief in this case is not mere opinion, but is based on results), by manner of speaking. One peculiarity I have never found wanting in habitually mendacious persons—a certain intonation which I cannot describe, but recognize in a moment, suggestive of the weighing of each sentence as it is being uttered, as though to consider how it would tell. Another is a peculiarity of manner, but it only shows itself during speech; it is a sort of watchfulness often disguised under a careless tone, but perfectly recognizable however disguised. Now, the gentleman who gave me the experience I am about to relate conveyed to my mind, by every intonation of his voice and every peculiarity and change of manner, the idea of truthfulness. I cannot convey to others the impression thus conveyed to myself; nor do I expect that others will share my own confidence; I simply state the case as I know it, and as far as I know it. It will, however, be seen that a part of the evidence was confirmed on the spot.

The conversation turned on the curability of consumption. My informant, whom I will henceforth call A., said that, though he could not assert from experience that consumption was curable, he believed that in many cases where the tendency to consumption is inherited, and the consumptive constitution indicated so manifestly that under ordinary conditions the person would before long be hopelessly consumptive, an entire change may be made in the condition of the body, and the person become strong and healthy. He said: "I belong myself to a family many of whose members have died of consumption. My father and mother both died of it, and all my brothers and sisters save one brother; yet I do not look consumptive, do I?" And certainly he did not. He then took from a pocket-book a portrait of his brother, showing a young man manifestly in very bad health, looking worn, weary, and emaciated. From the same pocket-book A. then took another portrait asking if I recognized it. I saw here again a worn and emaciated face and figure. The picture was utterly unlike the hearty, well-built man before me, yet it manifestly represented no other. If I had been at all doubtful, my doubts would have been removed by certain peculiarities to which A. called my attention. I asked how the change in his health had been brought about. He told me a very remarkable story of his treatment of himself, part of which I omit because I am satisfied he was mistaken in attributing to that portion of his self-treatment any part of the good result which he had obtained, and that if many consumptive patients adopted the remedy, a large proportion, if not all, would inevitably succumb very quickly. The other portion of his account is all that concerns us here, being all that illustrates our present subject. He said: "I determined to exercise every muscle of my body; I set myself in front of a mirror and concentrated my attention and all the power of my will on the muscle or set of muscles I proposed to bring into action. Then I exercised those muscles in every way I could think of, continuing the process till I had used in succession every muscle over which the will has control. While carrying out this system, I noticed that gradually the will acquired power over muscles which before I had been quite unable to move. I may say, indeed, that every set of muscles recognized by anatomists, except those belonging to internal organs, gradually came under the control of my will." Here I interrupted, asking (not by any means as doubting his veracity, for I did not): "Can you do what Dundreary said he thought some fellow might be able to do—can you waggle your left ear?" "Why, certainly," he replied; and turning the left side of his head towards me, he moved his left ear about; not, it is true, waggling it, but drawing it up and down in a singular way, which was, he said, the only exercise he ever gave it. He said, on this, that there are many other muscles over which the will has ordinarily no control, but may be made to obtain control; and forthwith, drawing the cloth of his trousers rather tight round the thigh (so that the movement he was about to show might be discernible) he made in succession the three muscles of the front and inner side of the thigh rise about half an inch along some nine or ten inches of their length. Now, though these muscles are among those which are governed by the will, for they are used in a variety of movements, yet not one in ten thousand, perhaps in a million, can move them in the way described.

How far A.'s system of exciting the muscles individually as well as in groups may have operated in improving his health, as he supposed, I am not now inquiring. What I wish specially to notice is the influence which the will may be made to obtain over muscles ordinarily beyond its control. It may be that under the exceptional influence of the imagination, in the hypnotic condition, the will obtains a similar control for a while over even those parts of the nervous system which appertain to the so-called involuntary processes. In other words, the case I have cited may be regarded as occupying a sort of middle position between ordinary cases of muscular action and those perplexing cases in which the hypnotic subject seems able to influence pulsation, circulation, and processes of secretion in the various parts or organs of his body.

It must be noted, however, that the phenomena of hypnotism are due solely to the influence of the imagination. The quasi-scientific explanations which attributed them to magnetism, electricity, some subtle animal fluid, some occult force, and so forth, have been as completely negatived as the supernatural explanation. We have seen that painted wooden tractors were as effectual as the metal tractors of the earlier mesmerists; a small disc of card or wood is as effective as the disc of zinc and copper used by the electro-biologists; and now it appears that the mystical influence, or what was thought such, of the operator is no more essential to success than magnetic or electric apparatus.

Dr. Noble, of Manchester, made several experiments to determine this point. Some among them seem absolutely decisive.

Thus, a friend of Dr. Noble's had a female servant whom he had frequently thrown into the hypnotic state, trying a variety of experiments many of which Dr. Noble had witnessed. Dr. Noble was at length told that his friend had succeeded in magnetizing her from another room and without her knowledge, with some other stories even more marvelous, circumstantially related by eye-witnesses, "amongst others by the medical attendant of the family, a most respectable and intelligent friend" of Dr. Noble's own. As he remained unsatisfied, Dr. Noble was invited to come and judge for himself, proposing whatever test he pleased. "Now had we visited the house," he says, "we should have felt dissatisfied with any result," knowing "that the presence of a visitor or the occurrence of anything unusual was sure to excite expectation of some mesmeric process." "We therefore proposed," he proceeds, "that the experiment should be carried on at our own residence; and it was made under the following circumstances: The gentleman early one evening wrote a note as if on business, directing it to ourselves. He thereupon summoned the female servant (the mesmeric subject), requesting her to convey the note to its destination, and to wait for an answer. The gentleman himself, in her hearing, ordered a cab, stating that if anyone called he was going to a place named, but was expected to return by a certain hour. Whilst the female servent was dressing for her errand, the master placed himself in the vehicle and rapidly arrived at our dwelling. In about ten minutes after the note arrived, the gentleman, in the meantime, being secreted in an adjoining apartment, we requested the young woman who had been shown into our study to take a seat whilst we wrote the answer; at the same time placing the chair with its back to the door leading into the next room, which was left ajar. It had been agreed that after the admission of the girl into the place where we were, the magnetizer, approaching the door in silence on the other side, should commence operations. There, then, was the patient or "subject" placed within two feet of her magnetizer, a door only intervening, and that but partially closed; but she, all the while, perfectly free from all idea of what was going on. We were careful to avoid any unnecessary conversation with the girl, or even to look towards her, lest we should raise some suspicion in her own mind. We wrote our letter (as if in answer) for nearly a quarter of an hour, once or twice only making an indifferent remark, and on leaving the room for a light to seal the supposed letter, we beckoned the operator away. No effect whatever had been produced, although we had been told that two or three minutes were sufficient, even when mesmerizing from the drawing-room, through walls and apartments, into the kitchen. In our own experiment the intervening distance has been very much less, and only one solid substance intervened, and that not completely; but here we suspect was the difference—*the "subject" was unconscious of the magnetism, and expected nothing.*"

In another case Dr. Noble tried the converse experiment with equally convincing results. Being in company one evening with a young lady said to be of high mesmeric susceptibility, he requested and received permission to test this quality in her. In one of the usual ways he "magnetized" her, and having so far satisfied himself, he "demagnetized" her. He next proceeded to "hypnotize" her, adopting Mr. Braid's method of directing the stare at a fixed point. "The result varied in no respect from that which had taken place in the foregoing experiment; the duration of the process was the same, and its intensity of effect neither greater nor less." "Dehypnotization" again restored the young lady to herself. "And now," says Dr. Noble, "we requested our patient to rest quietly at the fire-place, to think of just what she liked, and to look where she pleased, excepting at ourselves, who retreated behind her chair, saying that a new mode was about to be tried, and that her turning round would disturb the process. We very composedly took up a volume which lay upon a table, and amused ourselves with it for about five minutes, when on raising our eyes, we could see by the excited features of other members of the party that the young lady was once more *magnetized.* We were informed by those who had attentively watched her during the progress of our little experiment, that all had been in every respect just as before. The lady herself, before she was undeceived, expressed a distinct consciousness of having *felt our unseen passes streaming down the neck.*"

In a similar way, Mr. Bertrand, who was the first (Dr. Carpenter tells us) to undertake a really scientific investigation of the phenomena of mesmerism, proved that the supposed effect of a magnetized letter from him to a female somnambule was entirely the work of her own lively imagination. He magnetized a letter first, which on receipt was placed at his suggestion upon the epigastrium of the patient, who was thrown into the magnetic sleep with all the customary phenomena. He then wrote another letter, which he did not magnetize, and again the same effect was produced. Lastly he set about an experiment which should determine the real state of the case. "I asked one of my friends," he says, "to write a few lines in my place, and to strive to imitate my writing, so that those who should read the letter should mistake it for mine (I knew he could do so). He did this; our stratagem succeeded, and the sleep was produced just as it would have been by one of my own letters.

It is hardly necessary to say, perhaps, that none of the phenomena of hypnotism require, as indeed none of them, rightly understood, suggest, the action of any such occult forces as spiritualists believe in. On the other hand, I believe that many of the phenomena recorded by spiritualists as having occured under their actual observation are very readily to be explained as phenomena of hypnotism. Of course I would not for a moment deny that in the great majority of cases much grosser forms of deception are employed. But in others, and especially in those where the concentration of the attention for some time is a necessary preliminary to the exhibition of the phenomena (which suitable "subjects" only are privileged to see), I consider the resulting self-deception as hypnotic.

We may regard the phenomena of hypnotism in two aspects—first and chiefly as illustrating the influence of imagination on the functions of the body; secondly, as showing under what conditions the imagination may be most readily brought to bear in producing such influence. These phenomena deserve far closer and at the same time far wider attention than they have yet received. Doubt has been thrown upon them because they have been associated with false theories, and in many cases with fraud and delusion. But, rightly viewed, they are at once instructive and valuable. On the one hand they throw light on some of the most interesting problems of mental physiology; on the other they promise to afford valuable means of curing certain ailments, and of influencing in useful ways certain powers and functions of the body. All that is necessary, it should seem, to give hypnotic researches their full value, is that all association of those purely mental phenomena with charlatanry and fraud should be abruptly and definitely broken off. Those who make practical application of the phenomena of hypnotism should not only divest their own minds of all idea that some occult and as it were extra-natural force is at work, but should encourage no belief in such force in those on whom the hypnotic method is employed. Their influence on the patient will not be lessened, I believe, by the fullest knowledge on the patient's part that all which is to happen to him is purely natural—that, in fact, advantage is simply to be taken of an observed property of the imagination to obtain an influence not otherwise attainable over the body as a whole (as when the so-called magnetic sleep is to be produced), or over special parts of the body. Whether advantage might not be taken of other than the curative influences of hypnotism is a question which will probably have occurred to some who may have followed the curious accounts given in the preceding pages. If special powers may be obtained, even for a short time, by the hypnotized subject, these powers might be systematically used for other purposes than mere experiment. If, again, the repetition of hypnotic curative processes eventually leads to a complete and lasting change in the condition of certain parts or organs of the body, the repetition of the exercise of special powers during the hypnotic state may after a while lead to the definite acquisition of such powers As it now appears that the hypnotic control may be obtained without any effort on the part of the operator, the effort formerly supposed to be required being purely imaginary and the hypnotic state being in fact readily attainable without any operation whatever, we seem to recognize possibilities which, duly developed, might be found of extreme value to the human race. In fine, it would seem that man possesses a power which has hitherto lain almost entirely dormant, by which, under the influence of properly guided imagination, the will can be so concentrated on special actions that feats of strength, dexterity, artistic (and even perhaps scientific) skill may be accomplished by persons who, in the ordinary state, are quite incapable of such achievements.

III.

BODILY ILLNESS AS A MENTAL STIMULANT.

During special states of disease the mind sometimes develops faculties such as it does not possess when the body is in full health. Some of the abnormal qualities thus exhibited by the mind seem strikingly suggestive of the possible acquisition by the human race of similar powers under ordinary conditions. For this reason, though we fear there is no likelihood at present of any practical application of the knowledge we may obtain on this subject, it seems to me that there is considerable interest in examining the evidence afforded by the strange powers which the mind occasionally shows during diseases of the body, and especially during such diseases as are said, in unscientific but expressive language, to lower the tone of the nervous system.

We may begin by citing a case which seems exceedingly significant. Miss H. Martineau relates that a congenital idiot, who had lost his mother when he was less than two years old, when dying, "suddenly turned his head, looked bright and sensible, and exclaimed in a tone never heard from him before, 'Oh, my mother! how beautiful!' and sank down again—dead." Dr. Carpenter cites this as a case of abnormal memory, illustrating his thesis that the basis of recollection "may be laid at a very early period of life." But the story seems to contain a deeper meaning. The poor idiot not only recalled a long-past time, a face that he had not seen for years, except in dreams, but he gained for a moment a degree of intelligence which he had not possessed when in health. The quality of his brain was such, it appears, that with the ordinary activity of the circulation, the ordinary vitality of the organ, mental action was uncertain and feeble; but when the circulation had all but ceased, when the nervous powers were all but prostrate, the feeble brain, though it may have become no stronger actually, became relatively stronger, in such sort that for the time specified, a mere moment before dissolution, the idiot became an intelligent being.

A somewhat similar case is on record in which an insane person, during that stage of typhus fever in which sane persons are apt to become delirious, became perfectly sane and reasonable, his insanity returning with returning health. Persons of strongest mind in health are often delirious for a short time before death. Since, then, the idiot in the same stage of approaching dissolution may become intelligent, while the insane may become sane under the conditions which make the sane become delirious, we recognize a relationship between the mental and bodily states which might be of considerable use in the treatment of mental diseases. It may well be that conditions of the nervous system which are to be avoided by persons of normal mental qualities may be advantageously superinduced in the case of those of abnormally weak or abnormally violent mind. It is noteworthy that different conditions would seem to be necessary for the idiotic and for the insane, if the cases cited sufficed to afford basis for generalization. For the idiot of Miss Martineau's story became intelligent during the intense depression of the bodily powers immediately preceding dissolution, whereas the insane person became sane during that height of fever when delirium commonly makes its appearance.

Sir H. Holland mentions a case which shows that great bodily depression may affect a person of ordinary clear and powerful mind. "I descended on one and the same day," he says, "two very deep mines in the Hartz mountains, remaining some hours under ground in each. While in the second mine, and exhausted both from fatigue and inanition, I felt the utter impossibility of talking longer with the German Inspector who accompanied me. Every German word and phrase deserted my recollection; and it was not until I had taken food and wine, and been some time at rest, that I regained them again."

A change in the mental condition is sometimes a sign of approaching serious illness, and is felt to be so by the person experiencing it. An American writer, Mr. Butterworth, quotes the following description given by a near relative of his who was suffering from extreme nervous debility: "I am in constant fear of insanity," she said, "and I wish I could be moved to some retreat for the insane. I understand my condition perfectly; my reason does not seem to be impaired; but I can think of *two things at the same time*. This is an indication of mental unsoundness, and is a terror to me. I do not seem to have slept at all for the last six months. If I sleep it must be in a succession of vivid dreams that destroy all impression of somnolence. Since I have been in this condition I seem to have a very vivid impression of what happens to my children who are away from home, and I am often startled to hear that these impressions are correct. I seem to have also a certain power of anticipating what one is about to say, and to read the motives of others. I take no pleasure in this strange increase of mental power; it is all unnatural. I cannot live in this state long, and I often wish I were dead."

It must, however, be remembered that persons who are in a state of extreme nervous debility, not only possess at times abnormal mental qualities, but are also affected morally. As Huxley has well remarked of some stories bearing on spiritualism, they come from persons who can hardly be trusted even according to their own account of themselves. Mr. Butterworth's relation described a mental condition which, even if quite correctly pictured as she understood it, may yet be explained without believing that any very marvelous increase had taken place in her mental powers. Among the vivid impressions which she constantly had of what might be happening to her children away from home, it would have been strange if some had not been correct. The power of anticipating what others were about to say is one which many imagine they have, mistaking the occasional coincidence between their guesses and what has been next said for indications of a power which, in reality, they do not possess. And so also with regard to the motives of others. Many are apt, especially when out of health, to guess at others' motives, sometimes rightly, but often very wrongly, yet always rightly in their own behalf, no matter what evidence may presently appear to the contrary.

The case cited by Mr. Butterworth affords evidence rather of the unhealthy condition of the patient's mind than of abnormal powers, except as regards the power of thinking of two things at the same time, which we may fairly assume was not ordinarily possessed by its relative. It is rather difficult to define such a power, however. Several persons have apparently possessed the power, showing it by doing two things at the same time which both appear to require thought, and even close attention. Julius Cæsar, for example, could write on one subject and dictate on another simultaneously. But in reality, even in cases such as these, the mind does not think of two things at once. It simply takes them in turn, doing enough with each, in a short time, a mere instant, perhaps, to give work to the pen or to the voice, as the case may be, for a longer time. When Cæsar was writing a sentence, he was not necessarily thinking of what he was writing. He had done the thinking part of the work before; and was free, while continuing the mere mechanical process of writing, to think of matter for dictation to his secretary. So also while he was speaking he was free to think of matter for writing. If, indeed, the thought for each sentence of either kind had occupied an appreciable time, there would have been interruptions of his writing, if not of his dictation (dictation is not commonly a continuous process under any circumstances, even when shorthand writers take down the words). But a practiced writer or speaker can in a moment form a sentence which shall occupy a minute in writing and several seconds in speaking.

I certainly do not myself claim the power of thinking of two things at once—nay, I believe that no one ever had or could have such a power; yet I find it perfectly easy, when lecturing, to arrange the plan for the next ten minutes' exposition of a scientific subject, and to adopt the words themselves for the next twenty seconds or so, while continuing to speak without the least interruption. I can also work out a calculation on the blackboard while continuing to speak of matters outside the subject of the calculation. It is more a matter of habit than an indication of any mental power, natural or acquired, to speak or write sentences, even of considerable length, after the mind has passed on to other matters. In a similar way some persons can write different words with the right and left hands, and this, too, while speaking of other matters. (I have seen this done by Professor Morse, the American naturalist, whose two hands added words to the diagrams he had drawn while his voice dealt with other parts of the drawing: to add to the wonder, too, he wrote the words indifferently from right to left or from left to right.) In reality the person who thus does two things at once is no more thinking of two things at once than a clock is, when the striking and the working machinery are both in action at the same time.*

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* Since the above was written I have noticed a passage in Dr. Carpenter's *Mental Physiology*, p. 719, bearing on the matter I have been dealing with: "The following statement recently made to me by a gentleman of high intelligence, the editor of a most important provincial newspaper, would be almost incredible, if cases somewhat similar were not already familiar to us: 'I was formerly,' he said, 'a reporter in the House of Commons; and it several times happened to me that, having fallen asleep from sheer fatigue towards the end of a debate, I had found, on awaking after a short interval of entire unconsciousness, that I had continued to note down correctly the speaker's words'

As an illustration of special mental power shown in health, by a person whose mental condition in illness we shall consider afterwards, Sir Walter Scott may be mentioned. The account given by his amanuensis has seemed surprising to many, unfamiliar with the nature of literary composition (at least after long practice), but is in reality such as anyone who writes much can quite readily understand, or might even have known must necessarily be correct. "His thoughts," says the secretary to whom Scott dictated his *Life of Napoleon Buonaparte*, "flowed easily and felicitously, without any difficulty to lay hold of them or to find appropriate language" (which, by the way, is more than all would say who had read Scott's *Life of Buonaparte*, and certainly more than can be said of his secretary, unless it really was a familiar experience with him to be unable to lay hold of his thoughts). "This was evident by the absence of all solicitude (*miseria cogitandi*) from his countenance. He sat in his chair, from which he rose now and then, took a volume from the bookcase, consulted it, and restored it to the shelf—all without intermission in the current of ideas, which continued to be delivered with no less readiness than if his mind had been wholly occupied with the words he was uttering. It soon became apparent to me, however, that he was carrying on two distinct trains of thought, one of which was already arranged and in the act of being spoken, while at the same time he was in advance, considering what was afterwards to be said. "This I discovered (he should rather have said, "this I was led to infer") "by his sometimes introducing a word which was wholly out of place—*entertained* instead of *denied*, for example—but which I presently found to belong to the next sentence, perhaps four or five lines further on, which he had been preparing at the very moment when he gave me the words of the one that preceded it." In the same way I have often unconsciously substituted one word for another in lecturing, the word used always belonging to a later sentence than the word intended to be used. I have noticed also this peculiarity, that when a substitution of this kind has been once made, an effort is required to avoid repeating the mistake, even if it be not repeated quite unconsciously, to the end of the discourse. In this way, for example, I once throughout an entire lecture used the word "heavens" for the word "screen" (the screen on which lantern pictures were shown).

'I believe,' he added, 'that this is not an uncommon experience among Parliamentary reporters.' The reading aloud with correct emphasis and intonation, or the performance of a piece of music, or (as in the case of Albert Smith) the recitation of a frequently-repeated composition, whilst the conscious mind in *entirely engrossed* in its own thoughts and feelings may be thus accounted for without the supposition that the mind is actively engaged in two different operations at the same moment, which would seem tantamount to saying that there are two egos in the same organism." An instance in my own experience seems even more remarkable than the reporter's work during sleep, for he had but to continue a mechanical process, whereas in my case there must have been thought. Late one evening at Cambridge I began a game of chess with a fellow-student (now a clergyman, and well-known in chess circles). I was tired after a long day's rowing, but continued the game to the best of my ability, until at a certain stage I fell asleep, or rather fell into a waking-dream. At any rate, all remembrance of what passed after that part of the game had entirely escaped me when I awoke or returned to consciousness about three in the morning. The chessboard was there, but the men were not as when the last conscious move was made. The opponent's king was checkmated. I supposed my opponent had set the men in this position either as a joke or in trying over some end game. But I was assured that the game had continued to the end, and that I had won, apparently playing as if fully conscious! Of course I cannot certify this of my own knowledge.

A similar peculiarity may be noticed with written errors. Thus, in my treatise on a scientific subject, in which the utmost care had been given to minute points of detail, I once wrote "seconds" for "minutes" throughout several pages — in fact, from the place where first the error was made, to the end of the chapter. (See the *first* edition of my *Transits of Venus*, pp. 131–136, noting as an additional peculiarity that the whole object of the chapter in which this mistake was made was to show how many minutes of difference existed between the occurrence of certain events.)

An even more curious instance of a mistake arising from doing one thing while thinking of another occurred to me fourteen years ago. I was correcting the proof-sheets of an astronomical treatise in which occurred these words: "Calling the mean distance of the earth 1, Saturn's mean distance is 9·539; again, calling the earth's period 1, Saturn's mean period is 29·457:—now what relation exists between these numbers 9·539 and 29·457 and their powers? The first is less than the second, but the square of the first is plainly greater than the second; we must therefore try higher powers," etc., etc. The passage was quite correct as it stood, and if the two processes by which I was correcting verbal errors and following the sense of the passage had been really continuous processes of thought, unquestionably the passage would have been left alone. If the passage had been erroneous, and had been simply left in that condition, the case would have been one only too familiar to those who have had occasion to correct proofs. But what I actually did was deliberately to make nonsense of the passage while improving the sound of the second sentence. I made it run, "the first is less than the second, but the square of the first is plainly greater than the square of the second," the absurdity of which statement a child would detect. If the first proof in its correct form, with the incorrect correction carefully written down in the margin, had not existed when, several months later, the error was pointed out in the *Quarterly Journal of Science*, I should have felt sure that I had written the words wrongly at the outset. For blunders such as this are common enough. But that I should deliberately have taken a correctly-worded sentence and altered it into utter absurdity I could not, but for the evidence, have believed to be possible. The case plainly shows that not only may two things be done at once when the mind, nevertheless, is thinking only of one, but that something may be done which suggests deliberate reflection when in reality the mind is elsewhere or not occupied at all. For in this case both the processes on which I was engaged were manifestly carried on without thought, one being purely mechanical, and the other, though requiring thought if properly attended to, being so imperfectly effected as to show that no thought was given to it.

To return to Sir Walter Scott. It is known but too well that during the later years of his life there came with bodily prostration a great but not constant failure of his mental powers. Some of the phenomena presented during this part of his career are strikingly illustrative of abnormal mental action occurring even at times when the mental power is on the whole much weakened. *The Bride of Lammermoor*, though not one of the best of Scott's novels, is certainly far above such works as *Count Robert of Paris*, *The Betrothed*, and *Castle Dangerous*. Its popularity may perhaps be attributed chiefly to the deep interest of the "ower true tale" on which it is founded: but some of the characters are painted with exceeding skill. Lucy herself is almost a nonentity, and Edgar is little more than a gloomy, unpleasant man, made interesting only by the troubles which fall on him. But Caleb Balderstone and Ailsie Gourlay stand out from the canvas as if alive: they are as lifelike and natural, yet as thoroughly individualized as Edie Ochiltree and Meg Merrilies. The novel neither suggested when it first appeared, nor has been regarded even after the facts became known, as suggesting that Scott. when he wrote it, was in bad health, Yet it was produced under pressure of severe illness, and when Scott was at least in this sense unconscious, that nothing of what he said and did in connection with the work was remembered when he recovered. "The book," says James Ballantyne, "was not only written, but published, before Mr. Scott was able to rise from his bed; and he assured me that when it was first put into his hands in a complete shape, *he did not recollect one single incident, character, or conversation it contained!* He did not desire me to understand, nor did I understand, that his illness had erased from his memory the original incidents of the story, with which he had been acquainted from his boyhood. These remained rooted where they had ever been; or, to speak more explicitly, he remembered the general facts of the existence of the father and mother, of the son and daughter, of the rival lovers, of the compulsory marriage, and the attack made by the bride upon the hapless bridegroom, with the general catastrophe of the whole. *All these things he recollected*, just as he did before he took to his bed; *but he literally recollected nothing else*—not a single character woven by the romancer, not one of the many scenes and points of humor, not *anything with which he was himself connected*, as the writer of the work.

Later, when Scott was breaking down under severe and long-continued labor, and first felt the approach of the illness which ultimately ended in death, he experienced strange mental phenomena. In his diary for February 17, 1829, he notes that on the preceding day, at dinner, though in company with two or three old friends, he was haunted by "a sense of pre-existence," a confused idea that nothing that passed was said for the first time; that the same topics had been discussed, and that the same persons had expressed the same opinions before. "There was a vile sense of a want or reality in all that I did or said."

Dr. Reynolds related to Dr. Carpenter a case in which a Dissenting minister, who was in apparently sound health, was rendered apprehensive of brain-disease—though, as it seemed, without occasion—by lapse of memory similar to that experienced by Sir Walter Scott. He "went through an entire pulpit service on a certain Sunday morning with the most perfect consistency—his choice of hymns and lessons, and his *extempore* prayer being all related to the subject of his sermon. On the following Sunday morning he went through the introductory part of his service in precisely the same manner—giving out the same hymns, reading the same lessons, and directing the *extempore* prayer in the same channel. He then gave out the same text and preached the very same sermon as he had done on the previous Sunday. When he came down from the pulpit, it was found that he had not the smallest remembrance of having gone through precisely the same service on the previous Sunday; and when he was assured of it, he felt considerable uneasiness lest his lapse of memory should indicate some impending attack of illness. None such, however, supervened; and no *rationale* can be given of this curious occurrence, the subject of it not being liable to fits of 'absence of mind' and not having had his thoughts engrossed at the time by any other special pre-occupation." It is possible that the explanation here is the simple one of mere coincidence. Whether this explanation is available or not would depend entirely on the question whether the preacher's memory was ordinarily trustworthy or not, whether in fact he would remember the arrangements, prayers, sermon, etc., he had given on any occasion. These matters, becoming, after long habit, almost automatic, it might very well happen that the person going through such duties would remember them no longer and no better than one who had been present when they were performed, and who had not paid special attention to them. That if he had thus unconsciously carried out his duties on one Sunday, he should (being to this degree forgetful) conduct them in precisely the same way on the next Sunday, would rather tend to show that his mental faculties were in excellent working order than the reverse. Wendell Holmes tells a story which effectively illustrates my meaning; and he tells it so pleasantly (as usual) that I shall quote it unaltered. "Sometimes, but rarely," he says, "one may be caught making the same speech twice over, and yet be held blameless. Thus a certain lecturer" (Holmes himself, doubtless), "after performing in an inland city, where dwells a *litteratrice* of note, was invited to meet her and others over the social tea cup. She pleasantly referred to his many wanderings in his new occupation. 'Yes,' he replied, 'I am like the huma, the bird that never lights, being all ways in the cars, as he is always on the wing.' Years elapsed. The lecturer visited the same place once more for the same purpose. Another socia-cup after the lecture, and a second meeting with the distinguished lady. 'You are constantly going from place to place,' she said. 'Yes,' he answered, 'I am like the huma,' and finished the sentence as before. What horror when it had flashed over him that he had made this fine speech, word for word, twice over! Yet it was not true, as the lady might perhaps have fairly inferred, that he had embellished his conversation with the huma daily during the whole interval of years. On the contrary, he had never once thought of the odious fowl until the recurrence of precisely the same circumstances brought up precisely the same idea." He was not in the slightest degree afraid of brain disease. On the contrary, he considered the circumstance indicative of good order in the mental mechanism. "He ought to have been proud," says Holmes, speaking for him, and meaning no doubt that he *was* proud, "of the accuracy of his mental adjustments. *Given certain factors, and a sound brain should always evolve the same fixed product with the certainty of Babbage's calculating machine.*"

Somewhat akin to the unconscious recurrence of mental processes after considerable intervals of time is the tendency to imitate the actions of others, as though sharing in their thoughts, and according to many, *because* mind acts upon mind. This tendency, though not always associated with disease, is usually a sign of bodily illness. Dr. Carpenter mentions the following singular case, but rather as illustrating generally the influence of suggestions derived from external sources in determining the current of thought, than as showing how prone the thoughts are to run in undesirable currents when the body is out of health: "During an epidemic of fever, in which an active delirium had been a common symptom, it was observed that many of the patients of one particular physician were possessed by a strong tendency to throw themselves out of the window, whilst no such tendency presented itself in unusual frequency in the practice of others. The author's informant, Dr. C., himself a distinguished professor in the university, explained the tendency of what had occurred within his own knowledge, he having been himself attacked by the fever, and having been under the care of this physician, his friend and colleague, Dr. A. Another of Dr. A.'s patients, whom we shall call Mr. B., seems to have been the first to make the attempt in question, and, impressed with the necessity of taking due precautions, Dr. A. then visited Dr. C., *in whose hearing* he gave directions to have the windows properly secured, as Mr. B. had attempted to throw himself out. Now, Dr. C. distinctly remembers that, although he had not previously experienced any such desire, it came upon him with great urgency as soon as ever the idea was thus suggested to him, his mind being just in that state of incipient delirium which is marked by the temporary dominance of some one idea, and by the want of volitional power to withdraw the attention from it. And he deemed it probable that, as Dr. A. went on to Mr. D., Mr. E., etc., and gave similar directions, a like desire would be excited in the minds of all those who might happen to be in the same impressible condition." The case is not only interesting as showing how the mind in disease receives certain impressions more strongly than in health, and in a sense may thus be said to possess for the time an abnormal power, but it affords a useful hint to doctors and nurses, who do not always (the latter indeed scarcely ever) consider the necessity of extreme caution when speaking about their patients and in their presence. It is probable that a considerable proportion of the accidents, fatal and otherwise, which have befallen delirious patients might be traced to incautious remarks made in their hearing by foolish nurses or forgetful doctors.

In some cases doctors have had to excite a strong antagonistic feeling against tendencies of this kind. Thus, Zerffi relates that an English physician was once consulted by the mistress of a ladies' school, where many girls had become liable to fits of hysterics. He tried several remedies, but in vain. At last, justly regarding the epidemic as arising from the influence of imagination on the weaker girls (one hysterical girl having infected the others), he determined to exert a stronger antagonistic influence on the weak minds of his patients. He therefore remarked casually to the mistress of the school, in the hearing of the girls, that he had now tried all methods but one, which he would try, as a last resource, when next he called—"the application of a red-hot iron to the spine of the patients, so as to quiet their nervously-excited systems." "Strange to say," remarks Zerffi—meaning no doubt, 'it is hardly necessary to say that'—"the red-hot iron was never applied, for the hysterical attacks ceased as if by magic."

In another case mentioned by Zerffi, a revival mania in a large school near Cologne was similarly brought to an abrupt end. The Government sent an inspector. He found that the boys had visions of Christ, the Virgin, and departed saints. He threatened to close the school if these visions continued, and thus to exclude the students from all the prospects which their studies afforded them. "The effect was as magical as the red-hot iron remedy — the revivals ceased as if by magic."

The following singular cases are related in Zimmermann's *Solitude:* "A nun, in a very large convent in France, began to mew like a cat. At last all the nuns began to mew together every day at a certain time, and continued mewing for several hours together. This daily cat-concert continued, until the nuns were informed that a company of soldiers was placed by the police before the entrance to the convent, and that the soldiers were provided with rods with which they would whip the nuns until they promised not to mew any more." . . . "In the fifteenth century, a nun in a German convent fell to biting her companions. In the course of a short time all the nuns of this convent began biting each other. The news of this infatuation among the nuns soon spread, and excited the same elsewhere; the biting mania passing from convent to convent through a great part of Germany. It afterwards visited the nunneries of Holland, and even spread as far as Rome." No suggestion of bodily disease is made in either case. But any one who considers how utterly unnatural is the manner of life in monastic communities will not need the evidence derived from the spread of such preposterous habits to be assured that in convents the perfectly sane mind in a perfectly healthy body must be the exception rather than the rule.

The dancing mania, which spread through a large part of Europe in the fourteenth and fifteenth centuries, although it eventually attacked persons who were seemingly in robust health, yet had its origin in disease. Dr. Hecker, who has given the most complete account we have of this strange mania, in his *Epidemics of the Middle Ages*, says that when the disease was completely developed the attack commenced with epileptic convulsions. "Those affected fell to the ground senseless, panting and laboring for breath. They foamed at the mouth, and suddenly springing up, began their dance amidst strange contortions. They formed circles hand in hand, and appearing to have lost all control over their senses, continued dancing, regardless of the bystanders, for hours together, in wild delirium, until at length they fell to the ground in a state of exhaustion. They then complained of extreme oppression, and groaned as if in the agonies of death, until they were swathed in clothes bound tightly round their waists; upon which they again recovered, and remained free from complaint until the next attack. . . . While dancing they neither saw nor heard, being insensible to external impressions through the senses; but they were haunted by visions, their fancies conjuring up spirits, whose names they shrieked out; and some of them afterwards asserted that they felt as if they had been immersed in a stream of blood, which obliged them to leap so high. Others during the paroxysm saw the heavens open, and the Savior enthroned with the Virgin Mary, according as the religious notions of the age were strangely and variously reflected in their imaginations." The epidemic attacked people of all stations, but especially those who led a sedentary life, such as shoemakers and tailors; yet even the most robust peasants finally yielded to it. They "abandoned their labors in the fields as if they were possessed by evil spirits, and those affected were seen assembling indiscriminately from time to time, at certain appointed places, and unless prevented by the lookers-on, continued to dance without intermission, until their very last breath was expended. Their fury and extravagance of demeanor so completely deprived them of their senses, that many of them dashed their brains out against the walls and corners of buildings, or rushed headlong in rapid rivers, where they found a watery grave. Roaring and foaming as they were, the bystanders could only succeed in restraining them by placing benches and chairs in their way, so that by the high leaps they were thus tempted to take, their strength might be exhausted. As soon as this was the case they fell, as it were, lifeless to the ground, and by very slow degrees recovered their strength. Many there were who even with all this exertion had not expended the violence of the tempest which raged within them; but awoke with newly revived powers, and again and again mixed with the crowd of dancers; until at length the violent excitement of their disordered nerves was allayed by the great involuntary exertion of their limbs, and the mental disorder was calmed by the exhaustion of the body. The cure effected by these stormy attacks was in many cases so perfect, that some patients returned to the factory or plough, as if nothing had happened. Others, on the contrary, paid the penalty of their folly by so total a loss of power that they could not regain their former health, even by the employment of the most strengthening remedies."

It may be doubted, perhaps, by some whether such instances as these illustrate so much the state to which the mind is reduced when the body is diseased, as the state to which the body is reduced when the mind is diseased, though, as we have seen, the dancing mania when fully developed followed always on bodily illness. In the cases we now have to deal with, the diseased condition of the body was unmistakable.

Mrs. Hemans on her deathbed said that it was impossible for imagination to picture or pen to describe the delightful visions which passed before her mind. They made her waking hours more delightful than those passed in sleep. It is evident that these visions had their origin in the processes of change affecting the substance of the brain as the disease of the body progressed. But it does not follow that the substance of the brain was undergoing changes necessarily tending to its ultimate decay and dissolution. Quite possibly the changes were such as might occur under the influence of suitable medicinal or stimulant substances, and without any subsequent ill effects. Dr. Richardson, in an interesting article on ether-drinking and extra-alcoholic intoxication (*Gentleman's Magazine* for October), makes a remark which suggests that the medical men of our day look forward to the discovery of means for obtaining some such influence over the action of the brain. After describing the action of methylic and ethylic ethers in his own case, he says: "They who have felt this condition, who have lived as it were in another life, however transitorily, are easily led to declare with Davy that 'nothing exists but thoughts! the universe is composed of impressions, ideas, pleasures and pains!' I believe it is so, and that we might by scientific art, and there is such an art, learn to live altogether in a new sphere of impressions, ideas, pleasures, and pains." "But stay," he adds, as if he had said too much. "I am anticipating, unconsciously, something else that is in my mind. The rest is silence; I must return to the world in which we now live, and which all know."

Mr. Butterworth mentions the case of the Rev. William Tennent, of Freehold, New Jersey, as illustrative of strange mental faculties possessed during disease. Tennant was supposed to be far gone in consumption. At last, after a protracted illness, he seemingly died, and preparations were made for his funeral. Not only were his friends deceived, but he was deceived himself, for he thought he was dead, and that his spirit had entered Paradise. "His soul, as he thought, was borne aloft to celestial altitudes, and was enraptured by visions of God and all the hosts of Heaven. He seemed to dwell in an enchanted region of limitless light and inconceivable splendor. At last an angel came to him and told him he must go back. Darkness, like an overawing shadow, shut out the celestial glories; and, full of sudden horror, he uttered a deep groan. This dismal utterance was heard by those around him, and prevented him from being buried alive, after all the preparations had been made for the removal of the body."

We must not fall into the mistake of supposing, however, as many seem to do, that the visions seen under such conditions, or by ecstatics, really present truths of which the usual mental faculties could not become cognizant. We have heard such cases as the deathbed visions of Mrs. Hemans and the trance visions of Tennent urged as evidence in favor of special forms of doctrine. We have no thought of attacking these, but assuredly they derive no support from evidence of this sort. The dying Hindoo has visions which the Christian would certainly not regard as heaven born. The Mahomedan sees the plains of Paradise, peopled by the houris of his heaven, but we do not, on that account, accept the Koran as the sole guide to religious truth. The fact is, that the visions pictured by the mind during the disease of the body, or in the ecstatic condition, have their birth in the mind itself, and take their form from the teachings with which that mind has been imbued. They may, indeed, seem utterly unlike those we should expect from the known character of the visionary, just as the thoughts of a dying man may be, and often are, very far removed from the objects which had occupied all his attention during the later years of his life. But if the history of the childhood and youth of an ecstatic could be fully known, or if (which is exceedingly unlikely) we could obtain a strictly truthful account of such matters from himself, we should find nearly every circumstance of his visions explained, or at least an explanation suggested. For, after all, much which would be necessary to exactly show the origin of all he saw would be lost, since the brain retains impressions of many things of which the conscious memory has entirely passed away.

The vivid picturing of forgotten events of life is a familiar experience of the opium-eater. Thus, De Quincy says: "The minutest incidents of childhood or forgotten scenes of later years were often revived. I could not be said to recollect them, for if I had been told of them when waking, I should not have been able to acknowledge them as part of my past experience. But placed as they were before me in dreams, like intuitions, and clothed in all their evanescent circumstances and accompanying feelings, I recognized them instantaneously." A similar return of long-forgotten scenes and incidents to the mind may be noticed, though not to the same degree, when wine has been taken in moderate quantity after a long fast.

The effects of hachisch are specially interesting in this connection, because, unless a very powerful dose has been taken, the hachischin does not wholly lose the power of introspection, so that he is able afterwards to recall what has passed through his mind when he was under the influence of the drug. Now, Moreau, in his interesting *Etudes Psychologiques* (*Du Hachich et d'Aliénation Mentale*), says that the first result of a dose sufficient to produce the *hachisch fantasia* is a feeling of intense happiness. "It is really *happiness* which is produced by the hachisch; and by this simply an enjoyment entirely moral, and by no means sensual, as we might be induced to suppose. This is surely a very curious circumstance, and some remarkable inferences might be drawn from it; this, for instance, among others—that every feeling of joy and gladness, even when the cause of it is exclusively moral—that those enjoyments which are least connected with material objects, the most spiritual, the most ideal, may be nothing else than sensations purely physical, developed in the interior of the system, as are those procured by hachisch. At least so far as relates to that of which we are internally conscious, there is no distinction between these two orders of sensations, in spite of the diversity in the causes to which they are due, for the hachisch-eater is happy, not like the gourmand or the famished man when satisfying his appetite, or the voluptuary in gratifying his amative desires, but like him who hears tidings which fill him with joy, like the miser counting his treasures, the gambler who is successful at play, or the ambitious man who is intoxicated with success."

My special object, however, in noting the effects of opium and hachisch, is rather to note how the mental processes or faculties observed during certain states of disease may be produced artificially, than to enter into the considerations discussed by Dr. Moreau. It is singular that while the Mohamedan order of Hachischin (or Assassins) bring about, by the use of their favorite drug, such visions as accompany the progress of certain forms of disease, the Hindoo devotees, called Yogi, are able to produce artificially the state of mind and body recognized in cataleptic patients. The less advanced Yogi can only enter the state of abstraction called reverie, but the higher orders can simulate absolute inanition, the heart apparently ceasing to beat, the lungs to act and the nerves to convey impressions to the brain, even though the body be subjected to processes which would cause extreme torture under ordinary conditions. "When in this state," says Carpenter, "the Yogi are supposed to be completely possessed by Brahma, 'the supreme soul,' and to be incapable of sin in thought, word or deed." It has been supposed that this was the state into which those entered who in old times were resorted to as oracles. But it has happened that in certain stages of disease the power of assuming the death-like state has been possessed for a time. Thus, Colonel Townsend, who died in 1797, we read, had in his last sickness the extraordinary power of apparently dying and returning to life again at will. "I found his pulse sink gradually," says Dr. Cheyne, who attended him, "so that I could not feel it by the most exact or nice touch. Dr. Raymond could not detect the least motion of the heart, nor Dr. Skrine the least soil of the breath upon the bright mirror held to the mouth. We began to fear he was actually dead. He then began to breathe softly." Colonel Townsend repeated the experiment several times during his illness, and could always render himself insensible at will.

Lastly, I may mention a case, which, however, though illustrating in some degree the influence of bodily illness on the mind, shows still more strikingly how the mind may influence the body—that of Louise Lateau, the Belgian peasant. This girl had been prostrated by a long and exhausting illness, from which she recovered rapidly after receiving the sacrament. This circumstance made a strong impression on her mind. Her thoughts dwelt constantly on the circumstances attending the death of Christ. At length she noticed that on every Friday blood came from a spot on her left side. "In the course of a few months similar bleeding spots established themselves on the front and back of each hand, and on the upper surface of each foot, while a circle of small spots formed in the forehead, and the hæmorrhage from these recurred every Friday, sometimes to a considerable amount. About the same time, fits of ecstacy began to occur, commencing every Friday between eight and nine in the morning and ending about six in the evening, interrupting her in conversation, in prayer, or in manual occupations. This state," says Dr. Carpenter, "appears to have been intermediate between that of the biologized and that of the hypnotized subject; for whilst as unconscious as the latter of all sense impressions, she retained, like the former, a recollection of all that had passed through her mind during the ecstacy. She described herself as suddenly plunged into a vast flood of bright light, from which more or less distinct forms began to evolve themselves, and she then witnessed the several scenes of the Passion successively passing before her. She minutely described the cross and the vestments, the wounds, the crown of thorns about the head of the Savior, and gave various details regarding the persons about the cross, the disciples, holy women, Jews and Roman soldiers. And the progress of her vision might be traced by the succession of actions she performed at various stages of it. Most of these movements were expressive of her own emotions, whilst regularly, about three in the afternoon, she extended her limbs in the form of a cross. The fit terminated with a state of extreme physical prostration, the pulse being scarcely perceptible, the breathing slow and feeble and the whole surface bedewed with a cold perspiration. After this state had continued for about ten minutes, a return to the normal condition rapidly took place."

There seems no reason for supposing that there was any deceit on the part of Louise Lateau herself, though that she was self-deceived no one can reasonably doubt. Of course many in Belgium, especially the more ignorant and superstitious (including large numbers of the clergy and of religious orders of men and women), believed that her ecstasies were miraculous, and no doubt she believed so herself. But none of the circumstances observed in her case, or related by her, were such as the physiologist would find any difficulty in accepting or explaining. Her visions were such as might have been expected in a person of her peculiar nervous organization, weakened as her body had been by long illness, and her mind affected by what she regarded as her miraculous recovery. As to the transudation of blood from the skin, Dr. Tuke, in his "Illustrations of the Influence of the Mind upon the Body in Health and Disease" (p.267), shows the phenomenon to be explicable naturally. It is a well-authenticated fact, that under strong emotional excitement blood escapes through the perspiratory ducts, apparently through the rupture of the walls of the capillary passages of the skin.

We see, then, in Louise Lateau's case, how the mind affected by disease may acquire faculties not possessed during health, and how in turn the mind thus affected may influence the body so strangely as to suggest to ignorant or foolish persons the operation of supernatural agencies.

The general conclusion to which we seem led by the observed peculiarities in the mental faculties during disease is, that the mind depends greatly on the state of the body for the co-ordination of its various powers. In health, these are related in what may be called the normal manner. Faculties capable of great development under other conditions exist in moderate degree only, while probably, either consciously or unconsciously, certain faculties are held in control by others. But during illness, faculties not ordinarily used suddenly or very rapidly acquire undue predominance, and controlling faculties usually effective are greatly weakened. Then for a while the mental capacity seems entirely changed. Powers supposed not to exist at all (for of mental faculties, as of certain other qualities, *de non existentibus et de non apparentibus eadem est ratio*) seem suddenly created, as if by a miracle. Faculties ordinarily so strong as to be considered characteristic seem suddenly destroyed, since they no longer produce any perceptible effect. Or, as Brown-Sequard says, summing up the results of a number of illustrative cases described in a course of lectures delivered in Boston: "It would seem that the mind is largely dependent on physical conditions for the exercise of its faculties, and that its strength and most remarkable powers, as well as its apparent weakness, are often more clearly shown and recognized by some inequality of action in periods of disturbed and greatly impaired health."

IV.

DUAL CONSCIOUSNESS.

Rather more than two years ago, I considered, in the pages of "Science Byways," the theory originally propounded by Sir Henry Holland, but then recently advocated by Dr. Brown-Sequard, of New York, that we have two brains, each perfectly sufficient for the full performance of mental functions. I did not, for my own part, either advocate or oppose that theory, but simply considered the facts which had been urged in support of it, or which then occurred to me as bearing upon it, whether for or against. I showed, however, that some classes of phenomena which had been quoted in support of the theory seemed in reality opposed to it, when all circumstances were considered. For example, Brown-Sequard had referred to some of those well-known cases in which, during severe illness, a language forgotten in the patient's ordinary condition had been recalled, the recollection of the language enduring only while the illness lasted. I pointed to a case in which there had not been two mental conditions only, as indicated by the language of the patient, but three; the person in question having in the beginning of his illness spoken English only, in the middle of his illness French only, and on the day of his death Italian only (the language of his childhood). The interpretation of that case, and of others of a similar kind, must, I remarked, be very different from that which Brown-Sequard assigned, perhaps correctly, "to cases of twofold mental life." A case of the last-named kind has recently been discussed in scientific circles, which seems to me to bear very forcibly on the question whether Holland's theory of a dual brain is correct. I propose briefly to describe and examine this case, and some others belonging to the same class, two of which were touched upon in my former essay, but slightly only, as forming but a small part of the evidence dealt with by Brown-Sequard, whose arguments I was then considering. I wish now to deal, not with the question of the duality of the brain, but with the more general question of dual or intermittent consciousness.

Among the cases dealt with by Brown-Sequard was that of a boy at Notting Hill, who had two mental lives. Neither life presented anything specially remarkable in itself. The boy was a well-mannered lad in his abnormal as well as in his normal condition,—or one might almost say (as will appear more clearly after other cases have been considered) that the *two* boys were quiet and well-behaved. But the two mental lives were entirely distinct. In his normal condition the boy remembered nothing which had happened in his abnormal condition; and *vice versa*, in his abnormal condition he remembered nothing which had happened in his normal condition. He changed from either condition to the other in the same manner. "The head was seen to fall suddenly, and his eyes closed, but he remained erect if standing at the time, or if sitting he remained in that position (if talking, he stopped for a while, and if moving, he stopped moving); and after a minute or two his head rose, he started up, opened his eyes, and was wide awake again." While the head was drooped he appeared as if either sleeping or falling asleep. He remained in the abnormal state for a period which varied between one hour and three hours; it appears that every day, or nearly every day, he fell once into his abnormal condition.

This case need not detain us long; but there are some points in it which deserve more attention than they seem to have received from Dr. Brown-Sequard. It is clear that if the normal and abnormal mental lives of this boy had been entirely distinct, then in the abnormal condition he would have been ignorant and—in those points in which manners depend on training—ill-mannered. He would have known only, in this condition, what he had learned in this condition; and as only about a tenth part of his life was passed in the abnormal condition, and presumably that portion of his life not usually selected as a suitable time for teaching him, the abnormal boy would of necessity have been much more backward in all things which the young are taught than the normal boy. As nothing of this kind was noted, it would appear probable that the boy's earlier years were common to both lives, and that his unconsciousness of his ordinary life during the abnormal condition extended only to those parts of his ordinary life which had passed since these seizures began. Unfortunately, Brown-Sequard's account does not mention when this had happened.

It does not appear that the dual brain theory is required so far as this case is concerned. The phenomena seem rather to suggest a peculiarity in the circulation of the brain corresponding in some degree to the condition probably prevailing during somnambulism or hypnotism, though with characteristic differences. It may at least be said that no more valid reason exists for regarding this boy's case as illustrating the distinctive duality of the brain than for so regarding some of the more remarkable cases of somnambulism;

for though these differ in certain respects from the boy's case, they resemble it in the circumstances on which Brown-Sequard's argument is founded. Speaking generally of hypnotism—that is, of somnambulism artificially produced—Dr. Carpenter says: "In hypnotism, as in ordinary somnambulism, no remembrance whatever is preserved, in the waking state, of anything that may have occurred during its continuance; although the previous train of thought may be taken up and continued uninterruptedly on the next occasion when hypnotism is induced." In these respects the phenomena of hypnotism precisely resemble those of dual consciousness as observed in the boy's case. In what follows, we observe features of divergence. Thus "when the mind is not excited to activity by the stimulus of external impressions, the hypnotized subject appears to be profoundly asleep; a state of complete torpor, in fact, being usually the first result of the process just described, and any subsequent manifestation of activity being procurable only by the prompting of the operator. The hypnotized subject, too, rarely opens his eyes; his bodily movements are usually slow; his mental operations require a considerable time for their performance; and there is altogether an appearance of heaviness about him which contrasts strongly with the comparatively wide-awake air of him who has not passed beyond the ordinary biological state."

It would not be easy to find an exact parallel to the case of the two-lived boy in any recorded instance of somnambulism. In fact, it is to be remembered that recorded instances of mental phenomena are all selected for the very reason that they are exceptional, so that it would be unreasonable to expect them closely to resemble each other. One case, however, may be cited, which in certain points resembles the case of Dr. Brown-Sequard's patient. It occurred within Dr. Carpenter's own experience. A young lady of highly nervous temperament suffered from a long and severe illness, characterized by all the most marked forms of hysterical disorder. In the course of this illness came a time when she had a succession of somnambulistic seizures. "The state of somnambulism usually supervened in this case in the waking state, instead of arising, as it more commonly does, out of the conditions of ordinary sleep. In this condition her ideas were at first entirely fixed upon one subject—the death of her only brother, which had occurred some years previously. To this brother she had been very strongly attached; she had nursed him in his last illness; and it was perhaps the return of the anniversary of his death, about the time when the somnambulism first occurred, that gave to her thoughts that particular direction. She talked constantly of him, retraced all the circumstances of his illness, and was unconscious of anything that was said to her which had not reference to this subject. . . . Although her eyes were open, she recognized no one in this state—not even her own sister, who, it should be mentioned, had not been at home at the time of her brother's last illness." (It will presently appear, however, that she was able to recognize those who were about her during these attacks, since she retained ill-feeling against one of them; moreover, the sentences which immediately follow suggest that the sense of sight was not dormant.) "It happened on one occasion that, when she passed into this condition, her sister, who was present, was wearing a locket containing some of their deceased brother's hair. As soon as she perceived this locket she made a violent snatch at it, and would not be satisfied until she had got it into her possession, when she began to talk to it in the most endearing and even extravagant terms. Her feelings were so strongly excited on this subject, that it was deemed prudent to check them; and as she was inaccessible to all entreaties for the relinquishment of the locket, force was employed to obtain it from her. She was so determined, however, not to give it up, and was so angry at the gentle violence used, that it was found necessary to abandon the attempt, and having become calmer after a time, she passed off into ordinary sleep. Before going to sleep, however, she placed the locket under her pillow, remarking, 'Now I have hid it safely, and they shall not take it from me.' On awaking in the morning she had not the slightest consciousness of what had passed; but the impression of the excited feelings still remained, for she remarked to her sister, 'I cannot tell what it is that makes me feel so, but every time that S. comes near me I have a kind of shuddering sensation;' the individual named being a servant, whose constant attention to her had given rise to a feeling of strong attachment on the side of the invalid, but who had been the chief actor in the scene of the previous evening. This feeling wore off in the course of a day or two. A few days afterwards the somnambulism again returned; and the patient being upon her bed at the time, immediately began to search for the locket under her pillow." As it had been removed in the interval, "she was unable to find it, at which she expressed great disappointment, and continued searching for it, with the remark, 'It *must* be there—I put it there myself a few minutes ago, and no one can have taken it away.' In this state the presence of S. renewed her previous feelings of anger; and it was only by sending S. out of the room that she could be calmed and induced to sleep. The patient was the subject of many subsequent attacks, in every one of which the anger against S. revived, until the current of thought changed, no longer running exclusively upon what related to her brother, but becoming capable of direction by *suggestions* of various kinds presented to her mind, either in conversation, or, more directly, through the several organs of sense."

I have been particular in quoting the above account, because it appears to me to illustrate well, not only the relation between the phenomena of dual consciousness and somnambulism, but the dependence of either class of phenomena on the physical condition. If it should appear that dual consciousness is invariably associated with some disorder either of the nervous system or of the circulation, it would be impossible, or at least very difficult to maintain Brown-Sequard's explanation of the boy's case. For one can hardly imagine it possible that a disorder of the sort should be localized so far as the brain is concerned, while in other respects affecting the body generally. It so chances that the remarkable case recently dealt with by French men of science forms a sort of connecting link between the boy's case and the case just cited. It closely resembles the former in certain characteristic features, while it resembles the latter in the evidence which it affords of the influence of the physical condition on the phenomena of double consciousness. The original narrative by M. Azam is exceedingly prolix; but it has been skillfully condensed by Mr. H. J. Slack, in the pages of a quarterly journal of science. I follow his version in the main.

The subject of the disorder, Felida X., was born in Bordeaux, in 1843. Until the age of thirteen she differed in no respect from other girls. But about that time symptoms of hysterical disorder presented themselves, and although she was free from lung-disease, she was troubled with frequent spitting of blood. After this had continued about a year, she for the first time manifested the phenomena of double consciousness. Sharp pains attacked both temples, and in a few moments she became unconscious. This lasted ten minutes, after which she opened her eyes, and entered into what M. Azam calls her second state, in which she remained for an hour or two, after which the pains and unconsciousness came on again, and she returned to her ordinary condition. At intervals of about five or six days such attacks were repeated; and her relations noticed that her character and conduct during her abnormal state were changed. Finding, also, that in her usual condition she remembered nothing which had passed when she was in the other state, they thought she was becoming idiotic; and presently called in M. Azam, who was connected with a lunatic asylum. Fortunately, he was not so enthusiastic a student of mental aberration as to recognize a case for the lunatic asylum in every instance of phenomenal action. He found Felida intelligent, but melancholy, morose and taciturn, very industrious, and with a strong will. She was very anxious about her bodily health. At this time the mental changes occurred more frequently than before. Nearly every day, as she sat with her work on her knees, a violent pain shot suddenly through her temples, her head dropped upon her breast, her arms fell by her side, and she passed into a sort of sleep, from which neither noises, pinches, nor pricks could awaken her. This condition lasted now only two or three minutes. "She woke up in quite another state, smiling gaily, speaking briskly, and trilling (*fredonnant*) over her work, which she recommenced at the point where she left it. She would get up, walk actively, and scarcely complained of any of the pains she had suffered from so severely a few minutes before. She busied herself about the house, paid calls, and behaved like a healthy young girl of her age. In this state she remembered perfectly all that had happened in her two conditions." (In this respect her case is distinct from both the former, and is quite exceptional. In fact, the inclusion of the consciousness of both conditions during the continuance of one condition only, renders her case not, strictly speaking, one of double consciousness, the two conditions not being perfectly distinct from each other). "In this second life, as in the other, her moral and intellectual faculties, though different, were incontestably sound. After a time (which, in 1858, lasted three or four hours), her gaiety disappeared, the torpor suddenly ensued, and in two or three minutes she opened her eyes and re-entered her ordinary life, resuming any work she was engaged in just where she left off. In this state she bemoaned her condition, and was quite unconscious of what had passed in the previous state. If asked to continue a ballad she had been singing, she knew nothing about it, and if she had received a visitor, she believed she had seen no one. The forgetfulness extended to everything which happened during her second state, and not to any ideas or information acquired before her illness." Thus her early life was held in remembrance during both her conditions, her consciousness in these two conditions being in this respect single; in her second or less usual condition she remembered also all the events of her life, including what had passed since these seizures began; and it was only in her more usual condition that a portion of her life was lost to her—that, namely, which had passed during her second condition. In 1858 a new phenomenon was noticed as occasionally occurring—she would sometimes wake from her second condition in a fit of terror, recognizing no one but her husband. The terror did not last long, however; and during sixteen years of her married life her husband only noticed this terror on thirty occasions.

A painful circumstance preceding her marriage somewhat forcibly exhibited the distinction between her two states of consciousness. Rigid in morality during her usual condition, she was shocked by the insults of a brutal neighbor, who told her of a confession made to M. Azam during her second condition, and accused her of shamming innocence. The attack —unfortunately but too well founded as far as facts were concerned—brought on violent convulsions, which required medical attendance during two or three hours It is important to notice the difference thus indicated between the character of the personalities corresponding tc her two conditions. "Her moral faculties," says M. Azam, "were incontestably sound in her second life, though different,"—by which, be it understood, he means simply that her sense of right and wrong was just during her second condition; not, of course, that her conduct was irreproachable. She was in this condition, as in the other, altogether responsible for her actions. But her power of self-control, or rather perhaps the relative power of her will as compared with tendencies to wrong-doing, was manifestly weaker during her second condition. In fact, in one condition she was oppressed and saddened by pain and anxiety, whereas in the other she was almost free from pain, gay, light-hearted and hopeful. Now I cannot altogether agree with Mr. Slack's remark, that if, during her second state, "she had committed a robbery or an assassination, no moral responsibility could have been assumed to rest upon her with any certainty, by any one acquainted with her history," for her moral faculties in her second condition being incontestably sound, she was clearly responsible for her actions while in that condition. But certainly, the question of punishment for such an offence would be not a little complicated by her two-fold personality. To a woman, in her ordinary condition, remembering nothing of the crime committed (on the supposition we are dealing with), in her abnormal condition, punishment for that crime would certainly seem unjust, seeing that her liability to enter into that condition had not in any degree depended on her own will. The drunkard who, waking in the morning with no recollection of the events of the past night, finds himself in jail for some crime committed during that time, although he may think the punishment he has to endure, severe measure for a crime of which in his ordinary condition he is incapable, knows at least that he is responsible for placing himself under that influence which made the crime possible. Supposing even he had not had sufficient experience of his own character when under the influence of liquor, to have reason to fear he might be guilty of the offence, he yet perceives that to make intoxication under any circumstances an excuse for crime would be most dangerous to the community, and that he suffers punishment justly. But the case of dual consciousness is altogether different, and certainly where responsibility exists under both conditions, while yet impulse and the restraining power of will are differently related in one and the other condition, the problem of satisfying justice is a most perplexing one. Here are in effect two different persons residing in one body, and it is impossible to punish one without punishing the other also. Supposing justice waited until the abnormal condition was resumed, then the offender would probably recognize the justice of punishment; but if the effects of the punishment continued until the usual condition returned, a person would suffer who was conscious of no crime. If the offence were murder, and if capital punishment were inflicted, the ordinary individuality, innocent entirely of murder, would be extinguished along with the first, a manifest injustice. As Huxley says of a similar case, "the problem of responsibility is here as complicated as that of a prince-bishop, who swore as a prince and not as a bishop. 'But, your highness, if the prince is damned, what will become of the bishop,' said the peasant." *

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* Should any doubt whether these conditions of dual existence are a reality (a doubt, however, which the next case dealt with in the text should remove), we would remind them that a similar difficulty unmistakably existed in the case of Eng and Chang, the Siamese twins. It would have been almost impossible to inflict any punishment on one by which the other would not have suffered, and

It does not appear to me that there is in the case of Felida X. any valid reason for regarding the theory of two brains as the only available explanation. It is a noteworthy circumstance that the pains preceding each change of condition affected both sides of the head. Some modification of the circulation seems suggested as the true explanation of the changes in condition, though the precise nature of such modification, or how it may have been brought about, would probably be very difficult to determine. The state of health, however, on which the attacks depended seems to have affected the whole body of the patient, and the case presents no features suggesting any lateral localization of the cerebral changes.

On the other hand, the case of Sergeant F. (a few of the circumstances of which were mentioned in my essay entitled "Have we two Brains?") seems to corresespond with Dr. Holland's theory, though that theory is far from explaining all the circumstances. The man was wounded by a bullet which fractured his *left* parietal bone, and his *right* arm and leg were almost immediately paralyzed. When he recovered censciousness three weeks later, the *right* side of the body was completely paralyzed, and remained so for a year. These circumstances indicate that the cause of the mischief still existing lay in the shock which the left side of the brain received when the man was wounded. The right side may have learned (as it were) to exercise the functions formerly belonging to the left side, and thus the paralysis affecting the right side until this had happened may have passed away. These points are discussed in the essay above named, however, and need not here detain us. Others which were not then dealt with may now be noted with advantage. We would specially note some which render it doubtful whether in the abnormal condition the man's brain acts at all, whether in fact his condition, so far as consciousness is concerned, is not similar to that of a frog deprived of its brain in a certain well-known experiment. (This appears to be the opinion to which Professor Huxley inclines, though, with proper scientific caution, he seems disposed to suspend his judgment.) The facts are very singular, whatever the explanation may be.

In the normal condition, the man is what he was before he was wounded—an intelligent, kindly fellow, performing satisfactorily the duties of a hospital attendant. The abnormal state is ushered in by pains in the forehead, as if caused by the constriction of a band of iron. In this state the eyes are open and the pupils dilated. (The reader will remember Charles Reade's description of David Dodd's eyes, "like those of a seal.") The eyeballs work incessantly and the jaws maintain a chewing motion. If the man is *en pays de connaissance*, he walks about as usual; but in a new place, or if obstacles are set in his way, he stumbles, feels about with his hands, and so finds his way. He offers no resistance to any forces which may act upon him, and shows no signs of pain if pins are thrust into his body by kindly experimenters. No noise affects him. He eats and drinks apparently without tasting or smelling his food, accepting assafœtida or vinegar as readily as the finest claret. He is sensible to light only under certain conditions. But the sense of touch is strangely exalted (in all respects apparently except as to sensations of pain or pleasure), taking, in fact, the place of all the other senses. I say the sense of touch, but it is not clear whether there is any real sensation at all. The man appears in the abnormal condition to be a mere machine. This is strikingly exemplified in the following case, which I translate directly from Dr. Mesnet's account: "He was walking in the garden, under a group of trees, and his

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capital punishment inflicted on one would have involved the death of the other.

stick, which he had dropped a few minutes before, was placed in his hands. He feels it, moves his hand several times along the bent handle of the stick, becomes watchful, seems to listen, suddenly he calls out, 'Henry!' then, 'There they are! there are at least a score of them! Join us two; we shall manage it.' And then, putting his hand behind his back, as if to take a cartridge, he goes through the movement of loading his weapon, lays himself flat on the grass, his head concealed by a tree, in the posture of a sharpshooter, and with shouldered weapon follows all the movements of the enemy, whom he fancies he sees at a short distance." This, however, is an assumption; the man cannot in this state *fancy* he sees, unless he has at least a recollection of the sensation of sight, and this would imply cerebral activity. Huxley, more cautious, says justly that the question arises "whether the series of actions constituting this singular pantomime was accompanied by the ordinary states of consciousness or not? Did the man dream that he was skirmishing? or was he in the condition of one of Vaucanson's automata—a mechanism worked by molecular changes in his nervous system? The analogy of the frog shows that the latter assumption is perfectly justifiable."

The pantomimic actions just related corresponded to what probably happened a few moments before the man was wounded; but this human automaton (so to call him, without theorizing as to his actual condition) goes through other performances. He has a good voice, and was at one time a singer in a *café*. "In one of his abnormal states he was observed to begin humming a tune. He then went to his room, dressed himself carefully, and took up some parts of a periodical novel which lay on his bed, as if he were trying to find something. Dr. Mesnet, suspecting that he was seeking his music, made up one of these into a roll and put it into his hand. He appeared satisfied, took up his cane and went downstairs to the door. Here Dr. Mesnet turned him round, and he walked quite contentedly in the opposise direction, toward the room of the *concierge*. The light of the sun shining through a window now happened to fall upon him, and seemed to suggest the footlights of the stage on which he was accustomed to make his appearance. He stopped, opened his roll of imaginary music, put himself into the attitude of a singer, and sung, with perfect execution, three songs, one after the other, after which he wiped his face with his handkerchief and drank, without a grimace, a tumbler of strong vinegar and water which was put into his hand."

But the most remarkable part of the whole story is that which follows: "Sitting at a table in one of his abnormal states, Sergeant F. took up a pen, felt for paper and ink, and began to write a letter to his general, in which he recommended himself for a medal on account of his good conduct and courage." (Rather a strange thing, by the way, for a mere automaton to do.) "It occurred to Dr. Mesnet to ascertain experimentally how far vision was concerned in this act of writing. He therefore interposed a screen between the man's eyes and his hands; under these circumstances, F. went on writing for a short time, but the words became illegible, and he finally stopped, without manifesting any discontent. On the withdrawal of the screen, he began to write again where he had left off. The substitution of water for ink in the inkstand had a similar result. He stopped, looked at his pen, wiped it on his coat, dipped it in the water and began again, with a similar result. On another occasion, he began to write upon the topmost of ten superimposed sheets of paper. After he had written a line or two, this sheet was suddenly drawn away. There was a slight expression of surprise, but he continued his letter on the second sheet exactly as if it had been the first. This operation was repeated five times, so that the fifth sheet contained nothing but the writer's signature at the bottom of the page. Nevertheless, when the signature was finished, his eyes turned to the top of the blank sheet and he went through the form of reading what he had written—a movement of the lips accompanying each word; moreover, with his pen, he put in such corrections as were needed, in that part of the blank page which corresponded with the position of the words which required correction in the sheets which had been taken away. If the five sheets had been transparent, therefore, they would, when superposed, have formed a properly-written and corrected letter. Immediately after he had written his letter, F. got up, walked down to the garden, made himself a cigarette, lighted and smoked it. He was about to prepare another, but sought in vain for his tobacco-pouch, which had been purposely taken away. The pouch was now thrust before his eyes and put under his nose, but he neither saw nor smelled it; when, however, it was placed in his hand, he at once seized it, made a fresh cigarette, and ignited a match to light the latter. The match was blown out and another lighted match placed before his eyes, but he made no attempt to take it; and if his cigarette was lighted for him, he made no attempt to smoke. All this time his eyes were vacant, and neither winked nor exhibited any contraction of the pupil."

These and other similar experiments are explained by Dr. Mesnet (and Professor Huxley appears to agree with him) by the theory that F. "sees some things and not others; that the sense of sight is accessible to all things which are brought into relation with him by the sense of touch, and, on the contrary, insensible to all things which lie outside this relation." It seems to me that the evidence scarcely supports this conclusion. In every case where F. appears to see, it is quite possible that in reality he is guided entirely by the sense of touch. All the circumstances accord much better with this explanation than with the theory that the sense of sight was in any way affected. Thus the sunlight shining through the window must have affected the sense of touch and in a manner similar to what F had experienced when before the footlights of the stage, where he was accustomed to appear as a singer. In this respect there was a much closer resemblance between the effect of sunlight and that of the light from footlights, than in the circumstances under which both sources of light affect the sense of sight. For in one case the light came from above, in the other from below; the heat would in neither case be sensibly localized. Again, when a screen was interposed between his eyes and the paper on which he was writing, he probably became conscious of its presence in the same way that a blind man is conscious of the presence of objects near him, even (in some cases) of objects quite remote, by some subtle effects discernible by the sense of touch excited to abnormal relative activity in the absence of impressions derived from the sense of sight. It is true that one might have expected him to continue writing legibly, notwithstanding the interposed screen; but the consciousness of the existence of what in his normal condition would effectually have prevented his writing legibly, would be sufficient to explain his failure. If, while in full possession of all our senses, the expectation of failure quite commonly causes failure, how much more likely would this be to happen to a man in F.'s unfortunate abnormal condition. The sense of touch again would suffice to indicate the presence of water instead of ink in his pen when he was writing. I question whether the difference might not be recognized by any person of sensitive touch after a little practice; but certainly a blind man, whose sense of touch was abnormally developed, would recognize the difference, as we know from experiments which have indicated even greater delicacy of perception than would be required for this purpose. The experiment with superposed sheets of paper is more remarkable than any of the others, but certainly does not suggest that light makes any impression upon Sergeant F. It proves, in fact, so far as any experiment could prove such a point, that the sense of touch alone regulates the man's movements. Unconscious of any change (because, after the momentary surprise produced by the withdrawal of the paper, he still found he had paper to write on), he continued writing. He certainly did not in this case, as Dr Mesnet suggests, see all things which are brought into relation with him by the sense of touch; for if he had, he would not have continued to write when he found the words already written no longer discernible.

On the whole, it appears reasonable to conclude, as Professor Huxley does, that though F. may be conscious in his abnormal state, he may also be a mere automaton for the time being. The only circumstance which seems to oppose itself very markedly to the latter view is the letter-writing. Everything else that this man did was what he had already done prior to the accident. If it could be shown that the letters written in his abnormal state were transcripts, not merely *verbatim et literatim*, but exact in every point, of some which he had written before he was wounded, then a strong case would be made out for the automaton theory. Certainly, few instances have come under the experience of scientific men where a human being has so closely resembled a mere machine as this man appears to do in his abnormal condition.

The moral nature of F. in his abnormal condition is for this reason a matter of less interest than it would be, did he show more of the semblance of conscious humanity. Still it is worthy of notice, that, whereas in his normal condition he is a perfectly honest man, in his abnormal state "he is an inveterate thief, stealing and hiding away whatever he can lay his hands on with much dexterity, and with an absolutely absurd indifference as to whether the property is his own or not."

It will be observed that the cases of dual consciousness thus far considered, though alike in some respects, present characteristic divergences. In that of the boy at Norwood, the two characters were very similar, so far as can be judged, and each life was distinct from the other. The next case was only introduced to illustrate the resemblance in certain respects between the phenomena of somnambulism and those of double or rather alternating consciousness. The woman Felida X. changed markedly in character when she passed from one state to the other. Her case was also distinguished from that of the boy by the circumstance that in one state she was conscious of what had passed in the other, but while in this other state was unconscious of what had passed in the former. Lastly, in Sergeant F.'s case we have to deal with the effect of an injury to the brain, and find a much greater difference between the two conditions than in the other cases. Not only does the man change in character, but it may justly be said that he is little more than an animal, even if he can be regarded as more than a mere automaton while in the abnormal condition. We find that a similar variety characterizes other stories of double consciousness. Not only are no two cases closely alike, but no case has been noted which has not been distinguished by some very marked feature from all others.

Thus, although in certain respects the case we have next to consider resembles very significantly the case of Sergeant F., it also has a special significance of its own, and may help us to interpret the general problem presented to us by the phenomena of dual consciousness. I abridge and in some respects simplify the account given by Dr. Carpenter in his interesting treatise on *Mental Physiology.* Comments of my own are distinguished from the abridged narrative by being placed within brackets:

A young woman of robust constitution had narrowly escaped drowning. She was insensible for six hours, and continued unwell after being restored to animation. Ten days later she was seized with a fit of complete stupor, which lasted four hours; when she opened her eyes she seemed to recognize no one, and appeared to be utterly deprived of the senses of hearing, taste and smell, as well as of the power of speech. Sight and touch remained, but though movements were excited and controlled by these senses, they seemed to arouse no ideas in her mind. In fact, her mental faculties seemed entirely suspended. Her vision at short distances was quick, and the least touch startled her; but unless she was touched or an object were placed where she could not help seeing it, she took no notice of what was passing around her. [It does not appear to me certain that at this stage of her illness she *saw* in the ordinary sense of the word; the sense of touch may alone have been affected, as it certainly is affected to some degree by an object so placed that *it could not but be seen by a short-sighted person*. But it is clear that later the sense of sight was restored, supposing, which is not perhaps probable, that it was ever lost in the early stage.] She did not even know her own mother, who attended constantly upon her. Wherever she was placed she remained. Her appetite was good, but [like F.] she ate indifferently whatever she was fed with, and took nauseous medicines as readily as agreeable food. Her movements were solely of the automatic kind. Thus, she swallowed food put into her mouth, but made no effort to feed herself. Yet when her mother had conveyed the spoon [in the patient's hand] a few times to her mouth, the patient continued the operation. It was necessary, however, to repeat this lesson every time she was fed, showing the complete absence of memory. "The very limited nature of her faculties, and the automatic life she was leading, appear further evident from the following particulars. One of her first acts on recovering from the fit had been to busy herself in picking the bedclothes; and as soon as she was able to sit up and be dressed, she continued the habit by incessantly picking some portion of her dress. She seemed to want an occupation for her fingers, and accordingly part of an old straw bonnet was given to her, which she pulled into pieces with great minuteness; she was afterwards bountifully supplied with roses: she picked off the leaves, and then tore them up into the smallest particles imaginable. A few days subsequently, she began forming upon the table, out of those minute particles, rude figures of roses and other common garden flowers; she had never received any instructions in drawing. Roses not being so plentiful in London, waste paper and a pair of scissors were put into her hand, and for some time she found an occupation in cutting the paper into shreds; after a time these cuttings assumed rude shapes and figures, and more particularly the shapes used in patchwork. At length she was supplied with proper materials for patchwork, and after some initiatory instruction, she took to her needle and to this employment in good earnest. She now labored incessantly at patchwork from morning till night, and on Sunday and week-days, for she knew no difference of days; nor could she be made to comprehend the difference. She had no remembrance from day to day of what she had been doing on the previous day, and so every morning commenced *de novo*. Whatever she began that she continued to work at while daylight lasted; manifesting no uneasiness for anything to eat or drink, taking not the slightest heed of anything which was going on around her, but intent only on her patchwork." From this time she began to improve, learning like a child to register ideas. She presently learned worsted-work, and showed delight in the harmony of colors and considerable taste in selecting between good and bad patterns. After a while she began to devise patterns of her own. But still she had no memory from day to day of what she had done, and unless the unfinished work of one day was set before her on the next, she would begin something new.

And now, for the first time, ideas derived from her life before her illness seemed to be awakened within her. When pictures of flowers, trees, and animals were shown her, she was pleased; but when she was shown a landscape in which there was a river or a troubled sea, she became violently agitated, and a fit of spasmodic rigidity and insensibility immediately followed. The mere sight of water in motion made her shudder. Again, from an early stage of her illness she had derived pleasure from the proximity of a young man to whom she had been attached. At a time when she did not remember from one hour to another what she was doing, she would anxiously await his evening visit, and be fretful if he failed to pay it. When, during her removal to the country, she lost sight of him, she became unhappy and suffered from frequent fits; on the other hand, when he remained constantly near her, she improved in health, and early associations were gradually awakened.

At length a day came when she uttered her first words in this her second life. She had learned to take heed of objects and persons around her; and on one occasion seeing her mother excessively agitated, she became excited herself, and suddenly, yet hesitatingly, exclaimed, "What's the matter?" After this she began to articulate a few words. For a time she called every object and person "this," then gave their right names to wild flowers (of which she had been passionately fond when a child), and this "at a time when she exhibited not the least recollection of the 'old familiar friends and places' of her childhood." The gradual expansion of her intellect was manifested chiefly at this time in signs of emotional excitement, frequently followed by attacks of spasmodic rigidity and insensibility.

It was through the emotions that the patient was restored to the consciousness of her former self. She became aware that her lover was paying attention to another woman, and the emotion of jealousy was so strongly excited, that she had a fit of insensibility which resembled her first attack in duration and severity. But it restored her to herself. "When the insensibility passed off, she was no longer spell-bound. The veil of oblivion was withdrawn; and, as if awakening from a sleep of twelve months' duration, she found herself surrounded by her grandfather, grandmother, and their familiar friends and acquaintances. She awoke in the possession of her natural faculties and former knowledge, but without the slightest remembrance of anything which had taken place in the year's interval, from the invasion of the first fit to the [then] present time. She spoke, but she heard not; she was still deaf, but being able to read and write as formerly, she was no longer cut off from communication with others. From this time she rapidly improved, but for some time continued deaf. She soon perfectly understood by the motion of her lips what her mother said; they conversed with facility and quickness together, but she did not understand the language of the lips of a stranger. She was completely unaware of the change in her lover's affections which had taken place in her state of second consciousness, and a painful explanation was necessary. This, however, she bore very well; and she has since recovered her previous bodily and mental health.

There is little in this interesting narrative to suggest that the duality of consciousness in this case was in any way dependent on the duality of the brain. During the patient's abnormal condition, the functions of the brain [proper] would seem to have been for a time in complete abeyance, and then to have been gradually restored. One can perceive no reason for supposing that the shock she had sustained would affect one side rather than the other side of the brain, nor why her recovery should restore one side to activity and cause the side which (on the dual brain hypothesis) had been active during her second condition to resume its original activity. The phenomena appear to suggest that in some way the molecular arrangement of the brain matter became modified during her second condition; and that when the original arrangement was restored all recognizable traces of impressions received while the abnormal arrangement lasted were obliterated. As Mr. Slack presents one form of this idea, "the grey matter of the brain may have its molecules arranged in patterns somewhat analogous to those of steel filings under the influence of a magnet, but in some way the direction of the forces—or vibrations—may be changed in them. The pattern will then be different." We know certainly that thought and sensation depend on material processes,—chemical reaction between the blood and the muscular tissues. Without the free circulation of blood in the brain, there can be neither clear thought nor ready sensation. With changes in the nature of the circulation come changes in the quality of thought and the nature of sensation, and with them the emotions are changed also. Such changes affect all of us to some degree. It may well be that such cases as we have been dealing with are simply instances of the exaggerated operation of causes with which we are all familiar; and it may also be that in the exaggeration itself of these causes of change lies the explanation of the characteristic peculiarity of cases of dual consciousness—the circumstances, namely, that either the two states of consciousness are absolutely distinct one from the other, or that in one state only are events remembered which happened in the other, no recollection whatever remaining in this latter state of what happened in the other, or lastly, that only faint impressions excited by some intense emotion experienced in one state remain in the other state.

It seems possible, also, that some cases of another kind may find their explanation in this direction, as, for instance, cases in which, through some strange sympathy, the brain of one person so responds to the thoughts of another, that for the time being the personality of the person thus influenced may be regarded as in effect changed into that of the person producing the influence. Thus, in one singular case cited by Dr. Carpenter, a lady was "metamorphosed into the worthy clergyman on whose ministry she attended, and with whom she was personally intimate. I shall never forget," he says, "the intensity of the lackadaisical tone in which she replied to the matrimonial counsels of the physician to whom he (she) had been led to give a long detail of his (her) hypochondriacal symptoms: 'A wife for a dying man, doctor.' No *intentional* simulation could have approached the exactness of the imitation alike in tone, manner, and language, which spontaneously proceeded from the idea with which the fair subject was possessed, that she herself experienced all the discomforts whose detail she had doubtless frequently heard from the real sufferer." The same lady, at Dr. Carpenter's request, mentally "ascended in a balloon and proceeded to the North Pole in search of Sir John Franklin, whom she found alive; and her description of his appearance and that of his companions was given with an inimitable expression of sorrow and pity."

It appears to us that very great interest attaches to the researches made by Prof. Barrett into cases of this kind, and that it is in this direction we are to look for the explanation of many mysterious phenomena formerly regarded as supernatural, but probably all admitting (at least all that have been properly authenticated) of being interpreted so soon as the circumstances on which consciousness depends shall have been determined. Thus the following account of experiments made at the village school in Westmeath seem especially suggestive: "Selecting some of the village children, and placing them in a quiet room, giving each some small object to look at steadily, he found one amongst the number who readily passed into a state of reverie. In that state the subject could be made to believe the most extravagant statements, such as that the table was a mountain, a chair a pony, a mark on the floor an insuperable obstacle. The girl thus mesmerized passed on the second occasion into a state of deeper sleep or trance, wherein no sensation whatever was experienced, unless accompanied by pressure on the eyebrows of the subject. When the pressure of the fingers was removed, the girl fell back in her chair utterly unconscious of all around, and had lost all control over her voluntary muscles. On reapplying the pressure, though her eyes remained closed, she sat up and answered questions readily, but the manner in which she answered them, her acts and expressions, were capable of wonderful diversity, by merely altering the place on the head where the pressure was applied. So sudden and marked were the changes produced by a movement of the fingers, that the operation seemed very like playing on some musical instrument. On a third occasion the subject, after passing through these, which have been termed the biological and phrenological states, became at length keenly and wonderfully sensitive to the voice and acts of the operator. It was impossible for the latter to call the girl by her name, however faintly and inaudibly to those around, without at once eliciting a prompt response. If the operator tasted, smelt, or touched anything, or experienced any sudden sensation of warmth or cold, a corresponding effect was produced on the subject, though nothing was said, nor could the subject have seen what had occurred to the operator. To be assured of this he bandaged the girl's eyes with great care, and the operator having gone behind the girl to the other end of the room, he watched him and the girl, and repeatedly assured himself of this fact." Thus far, Professor Barrett's observations, depending in part on what the operator experienced, may be open to just so much doubt as may affect our opinion of the veracity of a person unknown; but in what follows we have his own experience alone to consider. "Having mesmerized the girl himself, he took a card at random from a pack which was in a drawer in another room. Glancing at the card to see what it was, he placed it within a book, and in that state brought it to the girl. Giving her the closed book, he asked her to tell him what he had put within its leaves. She held the book close to the side of her head, and said, 'I see something inside with red spots on it'; and she afterwards said there were five red spots on it. The card was the five of diamonds. The same result occurred with another card; and when an Irish banknote was substituted for the card, she said, 'Oh, now I see a number of heads—so many that I cannot count them.' He found that she sometimes failed to guess correctly, asserting that the things were dim; and she could give no information of what was within the book unless he had previously known what it was himself. More remarkably still, he asked her to go in imagination to Regent Street, in London, and tell him what shops she had seen. The girl had never been out of her remote village, but she correctly described to him Mr. Ladd's shop, of which he happened to be thinking, and mentioned the large clock that overhangs the entrance to Beak Street. In many other cases he convinced himself that the existence of a distinct idea in his own mind gave rise to an image of the idea (that is, to a corresponding image) on the mind of the subject; not always a clear image, but one that could not fail to be recognized as a more or less distorted reflection of his own thought." It is important to notice the limit which a scientific observer thus recognized in the range of the subjects' perception. It has been stated that subjects in this condition have been able to describe occurrences not known to any person, which yet have been subsequently verified. Although some narratives of the kind have come from persons not likely to relate what they *knew* to be untrue, the possibility of error outweighs the probability that such narratives can really be true. There is a form of unconscious cerebration by which untruthful narratives come to be concocted in the mind. For instance, Dr. Carpenter heard a scrupulously conscientious lady asseverate that a table "rapped" when nobody was within a yard of it; but the story was disproved by the lady herself, who found from her note-book, recording what really took place, that the hands of six persons rested on the table when it rapped. And apart from the unconscious fiction-producing power of the mind, there is always the possibility, nay, often the extreme probability, that the facts of a case may be understood. Persons may be supposed to know nothing about an event who have been conscious of its every detail; nay, a person may himself be unconscious of his having known, and in fact of his really knowing, of a particular event. Dual consciousness in this particular sense is a quite common experience, as, for instance, when a story is told us which we receive at first as new, until gradually the recollection dawns upon us and becomes momentarily clearer and clearer, not only that we have heard it before, but of the circumstances under which we heard it, and even of details which the narrator from whom a few moments before we receive it as a new story has omitted to mention.*

The most important of all the questions depending on dual consciousness is one into which I could not properly enter at any length in these pages—the question, namely, of the relation between the condition of the brain and responsibility, whether such responsibility be considered with reference to human laws or to a higher and all-knowing tribunal. But there are some points not wanting in interest which may be here more properly considered.

In the first place it is to be noticed that a person who has passed into a state of abnormal consciousness, or who is in the habit of doing so, can have no knowledge of the fact in his normal condition except from the information of others. The boy at Norwood might be told of what he had said and done while in his less usual condition, but so far as any experience of his own was concerned, he might during all that time have been

* An instance of the sort turns up in Pope's correspondence with Addison, and serves to explain a discrepancy between Tickell's edition of the *Spectator* and the original. In No. 253, Addison had remarked that none of the critics had taken notice of a peculiarity in the description of Sisyphus lifting his stone up the hill, which is no sooner carried to the top of it but it immediately tumbles to the bottom. "This double motion," says Addison, "is admirably described in the numbers of those verses. In the four first it is heaved up by several spondees intermixed with proper breathing places, and at last trundles down in a continual line of dactyls." On this Pope remarks: "I happened to find the same in Dionysius of Halicarnassus's Treatise, who treats very largely upon these verses. I know you will think fit to soften your expression, when you see the passage, which you must needs have read, though it be since slipt out of your memory." These words, by the way, were the last (except "I am, with the utmost esteem, &c.") ever addressed by Pope to Addison. It was in this letter that Pope with sly malice asked Addison to look over the first two books of his (Pope's) translation of Homer.

in a profound sleep. Similarly of all the other cases. So that we have here the singular circumstance to consider, that a person may have to depend on the information of others respecting his own behavior—not during sleep or mental aberration or ordinary absence of mind—but (in some cases at least) while in possession of all his faculties and unquestionably responsible for his actions. Not only might a person find himself thus held responsible for actions of which he had no knowledge, and perhaps undeservedly blamed or condemned, but he might find himself regarded as untruthful because of his perfectly honest denial of all knowledge of the conduct attributed to him. If such cases were common, again, it would not improbably happen that the simulation of dual consciousness would become a frequent means of attempting to evade responsibility.

Another curious point to be noticed is this. Supposing one subject to alternations of consciousness were told that in his abnormal condition he suffered intense pain or mental anguish in consequence of particular actions during his normal state, how far would he be influenced to refrain from such actions by the fear of causing pain or sorrow to his "double," a being of whose pains and sorrows, nay, of whose very existence, he was unconscious? In ordinary life a man refrains from particular actions which have been followed by unpleasant consequences, reasoning, in some cases, "I will not do so-and-so, because I suffered on such and such occasions when I did so" (we set religious considerations entirely on one side by assuming that the particular actions are not contrary to any moral law), in others, "I will not do so-and-so, because my so doing on former occasions has caused trouble to my friend A or B;" but it is strange to imagine any one reasoning, "I will not do so-and-so, because my so doing on former occasions has caused my second self to experience pain and anguish, of which I myself have not the slightest recollection." A man may care for his own well-being, or be unwilling to bring trouble on his friends, but who is that second self that his troubles should excite the sympathy of his fellow-consciousness? The considerations here touched on are not so entirely beyond ordinary experience as might be supposed. It may happen to any man to have occasion to enter into an apparently unconscious condition during which in reality severe pains may be suffered by another self, though on his return to his ordinary condition no recollection of those pains may remain, and though to all appearance he has been all the time in a state of absolute stupor; and it may be a reasonable question, not perhaps whether he or his double shall suffer such pains, but whether the body which both inhabit will suffer while he is unconscious, or while that other consciousness comes into existence. That this is no imaginary supposition is shown by several cases in Abercrombie's treatise on the "Intellectual Powers." Take, for instance, the following narrative: "A boy," he tells us, "at the age of four suffered fracture of the skull, for which he underwent the operation of the trepan. He was at the time in a state of perfect stupor, and after his recovery retained no recollection either of the accident or of the operation. At the age of fifteen, however, during the delirium of fever, he gave his mother an account of the operation, and the persons who were present at it, with a correct description of their dress, and other minute particulars. He had never been observed to allude to it before; and no means were known by which he could have acquired the circumstances which he mentioned." Suppose one day a person in the delirium of fever or under some other exciting cause should describe the tortures experienced during some operation, when, under the influence of anæsthetics, he had appeared to all around to be totally unconscious, dwelling in a special manner perhaps on the horror of pains accompanied by utter powerlessness to shriek or groan, or even to move; how far would the possibilities suggested by such a narrative influence one who had a painful operation to undergo, knowing as he would quite certainly, that whatever pains his *alter ego* might have to suffer, not the slightest recollection of them would remain in his ordinary condition?

There is indeed almost as strange a mystery in unconsciousness as there is in the phenomena of dual consciousness. The man who has passed for a time into unconsciousness through a blow, or fall, or fit, cannot help asking himself Like Bernard Langdon in that weird tale Elsie Venner, "Where was the mind, the soul, the thinking principle all the time?" It is irresistibly borne in upon him that he has been dead for a time. As Holmes reasons, "a man is stunned by a blow and becomes unconscious, another gets a harder blow and it kills him. Does he become unconscious too? If so, *when*, and *how does he come to his consciousness?* The man who has had a slight and moderate blow comes to himself when the immediate shock passes off and the organs begin to work again, or when a bit of skull is 'pried' up, if that happens to be broken. Suppose the blow is hard enough to spoil the brain and stop the play of the organs, what happens then?" So far as physical science is concerned, there is no answer to this question; but physical science does not as yet comprehend all the knowable and the knowable comprehends not all that has been, is, and will be. What we know and can know is nothing, the unknown and the unknowable are alike infinite.

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A CONTRIBUTION TO ANTHROPOLOGY AND THE HISTORY OF RELIGION.

BY

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CHAPTER I.

INTRODUCTORY.

David Hume was the first in modern times to reject the transcendental theories of Religion and to seek an explanation for it in the empiric world of man, on psychological principles. "No passions," says he, "can be supposed to work upon such barbarians, but the ordinary affections of human life; the anxious concern for happiness, the dread of future misery, the terror of death, the thirst of revenge, the appetite for food and other necessaries. These are their only motives." *

To these motives of fear and hope Hume now adds, on the one hand, man's ignorance of Nature and of its phenomena; and on the other the faculty of imagination, as factors going to make up the notion of God. "We hang in perpetual suspense between life and death, health and sickness, plenty and want, which are distributed among the human species by secret and unknown causes, whose operation is oft unexpected and always unaccountable. These *unknown causes*, then, become the constant object of our hope and fear; and while the passions are kept in perpetual alarm by an anxious expectation of the events, the imagination is equally employed in forming ideas of those powers, on which we have so entire a dependence. Could men anatomize nature, according to the most probable, at least the most intelligible philosophy, they would find that these causes are nothing but the particular fabric and structure of the minute parts of their own bodies and of external objects; and that, by a regular and constant machinery, all the events are produced, about which they are so much concerned. But this philosophy exceeds the comprehension of the ignorant multitude, who can only conceive the *unknown causes*, in a general and confused manner; though their imagination, perpetually employed on the same subject, must labor to form some particular and distinct idea of them. The more they consider these causes themselves, and the uncertainty of

* David Hume, *Works*, Vol. IV.

their operation, the less satisfaction do they meet with in their researches; and, however unwilling, they must at last have abandoned so arduous an attempt, were it not for a propensity in human nature, which leads into a system that gives them satisfaction. There is a universal tendency among mankind to conceive all beings like themselves, and to transfer to every object those qualities with which they are familiarly acquainted, and of which they are intimately conscious. We find human faces in the moon, armies in the clouds, and by a natural propensity, if not corrected by experience and reflection, ascribe malice or good-will to everything that hurts or pleases us. Hence the frequency and beauty of the *prosopopœia* in poetry, where trees, mountains and streams are personified, and the inanimate parts of nature acquire sentiment and passion." "No wonder, then, that mankind, being placed in such an absolute ignorance of causes, and being at the same time so anxious concerning their future fortune, should immediately acknowledge a dependence on invisible powers, possessed of sentiment and intelligence." Such is the account which Hume gives of Polytheism. He does not, it is true, make an application of his theory to Fetichism directly, though much of what he says about the rise of Polytheism will serve equally well to account for fetichism.

Benjamin Constant, inasmuch as he looks for the origin of religion in man himself, agrees with Hume; but inasmuch as he postulates a special faculty, "the religious sentiment," which is not demonstrable, he again quits the empirical standpoint. Meiners, in his History of Religions, agrees fully with Hume, whose theory he states, and then makes this application of it to the subject of fetichism: "Fetichism," says he, "is not only the most ancient, but it is also the most universal form of religion. It furnishes incontrovertible proof that the lack of correct knowledge was the true and only cause of polytheism; and that for the uncultured savage everything is God, or may be God." * Kaiser, in his "Biblical Theology," places the origin of religion, not in this or that sentiment, but "subjectively in the entire character of man," and "objectively in Nature, to which man is related." † He holds that primitive man was without the impress of Spirit, that he was developed out of inferior organisms and that his first attempt at a religious belief took the form of fetichism. "The first, or the best piece of wood, or stone he meets,—some animal, some star will be esteemed a god." "While the intellectual faculties are still dormant, and in the absence of knowledge and experience, of invention and culture, whether mental or moral, we are not to be surprised if man regards proximate causes as ultimate, and pays worship to material objects, especially those which arrest his attention by their brightness, their velocity, their great size, etc." "The necessities of the case, and history itself prove that fetichism is the primitive religion of man. The base of human culture rests upon the earth, but its summit penetrates the invisible spaces of heaven, and reaches into infinity."

This theory of Kaiser's, in so far as it differs from Hume's and agrees with that of Meiners in asserting that fetichism is the primitive religion, is rejected by Theodor Waitz in his "Anthropology of Savage Tribes." He holds with Hume, that "a rude systemless Polytheism" was the primitive religion; and his arguments are identical with those of Hume as already set forth.‡ According to him,

* C. Meiners, Allg. Krit. Gesch. d. Religionen. Hannover, 1806, Vol. I. S. 143.

† Gottl. Phil. Christ. Kaiser, Die biblische Theologie oder Judaismus u. Christianismus nach der grammatisch-historischen Interpretationsmethode u. nach einer freimüthigen Stellung in die Kritisch-vergleichende Universalgeschichte der Religionen und in die universale Religion. Erlangen, 1813. Theil, I. S. 2.

‡ Th. Waitz, Anthropologie der Naturvölker.

fetichism springs from polytheism, and here he agrees with Pfleiderer. But whereas according to Pfleiderer external causes bring about its development, Waitz assigns for it causes purely internal and psychological. "The negro," says he, "carries the belief in an animated Nature to its uttermost limits; but as his mind is too rude to conceive of *one* universal animated nature, his imagination leads him to regard every trifling object around him as endowed with life. In every material thing he sees a spirit, often of great power, and quite disproportionate to the object itself." This object and this spirit make up a whole, the *fetich*. Waitz, however, does not explain to us the reason why the savage takes this view of material and inanimate things, and yet this is a question of high importance.

And precisely this point do I find treated with great clearness by Reinhard in his valuable "Historical Sketch of the Rise and Progress of Religious Ideas."* From the fact that religion is to be found among men, whatever their condition, he concludes that it must have its basis in the human mind itself, and he holds that if we would study the origin of religious ideas we must go back to the ages of barbarism, that is, to primitive times. That religion then was monotheistic cannot be shown: but on the other hand fetichism always characterizes the lowest stage of intellectual development. [The account given by Reinhard of the rise of fetichism, being substantially that which is set forth in the present work, need not be given here, as it will be found in full detail in the subsequent chapters; and as Feuerbach agrees in essentials with Reinhard it will be enough to make a general reference to his work upon this subject.†]

The true way of arriving at an understanding of fetichism is by observing savage life; and here, books of travel are of great importance. Among these there is none more instructive than A. Bastian's "Visit to San Salvador, Capital of the Kingdom of Congo: a Contribution to Mythology and Psychology."* As the author never transfers to the savage his own thoughts and motives, but views him as he is, from the psychological point of view, his work is properly called a contribution to psychology, and with equal justice a contribution to mythology, since fetichism is the first step in religion.

CHAPTER II.

THE MIND OF THE SAVAGE IN ITS INTELLECTUAL AND MORAL ASPECTS.

By fetichism we understand the religious veneration of material objects. If such objects are to be worshiped, they must first of all appear to be worthy of veneration, or, in other words, the worshiper must so consider them. The fetich, however, *e.g.* a piece of metal, still continues to be, in external form and in essential constitution, the self-same thing, whether observed by a European or by an African. Hence that which renders it a fetich is nothing intrinsic to the thing itself, but the view which the fetichist takes of it. If therefore we would understand fetichism in its true nature, we must investigate the savage's mode of apprehending objects, or in other words, we must study the intellectual status of the fetichist. Fetichism has an historical position in all nations which stand lowest in intellectual development, that is, among savages, so-called. Our first

* Phil. Christ. Reinhard, Abriss einer Geschichte der Entstehung der religiösen Ideen. Jena, 1794.

† Ludwig Feuerbach, Das Wesen der Religion. Vorlesungen über das Wesen der Religion. Nebst Zusätzen u. Aumerkungen. Leipzig, 1851.

* Afrikanische Reisen von Dr. A. Bastian. Ein Besuch in San Salvador, der Hauptstadt der Königreichs Congo. Bremen, 1859.

task, accordingly, will be to ascertain the savage's intellectual status. We propose therefore to sketch the savage mind first in its logical, and then in its ethical aspects.

1. *The Intellect of the Savage.*

The understanding has cognition only of those objects which are given to it in experience, and its range is consequently restricted by the limits of its experience. But what are the objects of experience? Those which are to be found in the man's *world:* and hence a man's cognitions can never go beyond *his world.* We say *his* world, meaning the universe, as far as he knows it. If therefore we would fix the intellectual status of any individual, we must first ascertain the number and the nature of his cognitions or objects.

As the understanding, then, has no cognitions save those which come to it out of its world, it follows that the number and the nature of one man's cognitions, or objects—in other words, the empiric contents of his mind—will differ from those of another, just as their respective *worlds* differ. Thus the sum-total of cognitions held by a mountaineer is different from that held by a seafaring man; and an Eskimo's cognitions are different from those of a Hindu, in proportion as their respective worlds differ; and they mutually resemble each other, in proportion as their worlds are alike. The *number* of objects (cognitions) differs in the same way. Thus the savage has but few, while the civilized European has many. From the paucity or the multiplicity of these flow consequences of the highest importance for a just estimate of the respective individuals. The greater the number of objects which a man has, the better equipped and the more cultivated will be his understanding, the more alert his thinking faculty, and the higher his development as a human being. On the other hand, the fewer his objects, the lower is his grade of development. It is universally true that man grows only as he apprehends objects.

The most fully developed intellect, therefore, is that which possesses the greatest number of objects. But if I would have many objects, I must discriminate and distinguish between them sharply; for unless they be thus defined, they tend to amalgamate, and so the number of objects would be diminished. Hence it is only in proportion as the understanding draws distinctions, that its objects are manifold and varied; and *vice versa,* it can make sharp distinctions only where its objects are varied. From this it follows that the faculty of accurate thinking or of sharply defining depends immediately and necessarily upon the number of the objects; so that, given the number of a man's objects, we might determine the strength or the feebleness of his thinking powers, or of his intellectual faculty. But since the objects are distinct only in so far as the understanding discriminates between them, the number of the objects must depend upon the sharpness with which these distinctions are drawn.

The status of a people as regards civilization might be determined by the greater or less accuracy with which they discriminate between objects; and the lowest grade of culture will accordingly be characterized by a lack of the power of discrimination. In the domain of *thought* that man only will attain eminence who can make distinctions where others do not. All erroneous and illogical thinking owes its rise to a weakness of the intellect, which fails to perceive really existent distinctions. The critic is a critic only in so far as he perceives distinctions, and consequently disparity, between objects which another takes to be identical. We call a man well-bred, or refined, in the social sense, who in every circumstance of life knows how to adapt his demeanor to the various individuals he meets with: but this he cannot do unless he can appreciate differences of character and of circumstance. The rude and unobservant treat all alike, under all circumstances, as though no differences existed. A man of refined *moral* sense is he who, in judging of what is due to each individual, makes the nicest distinctions: and, on the other hand, the less accurate the distinctions a man makes in moral questions, the more one-sided, prejudiced, and vicious he will be.

Accordingly, the lowest stage of intellect is characterized by a lack of many distinctions which are found in higher stages: or in other words by the absence of many objects possessed by the higher stages.

As compared then with a well developed intelligence, one which is undeveloped has a very contracted sphere of objects. The world it inhabits, its object-world, must be very narrow and restricted. Consider only the grade of intelligence which animals attain, and the number of objects which they have: both stand equally low. The intellect of the child is less developed, logically and ethically, than that of the adult; and the reason is, that the objects of the former are inferior to those of the latter, whether as regards their number or their value. The child is yet ignorant of those things which are the objects of the adult. Abstract conceptions, such as virtue and vice, are strange and incomprehensible to him. His conceptions are all of a concrete nature, such as are given him in his *world;* and this world is restricted to the nursery, to his home, or to the town in which he lives, all regarded as objects of sense. His world widens by degrees, but it is only by becoming engrossed with still new objects, that he reaches the stage of culture attained by his times or by his nation. If these objects had not been presented to him, he would have remained a child all his life, as far as intellectual growth is concerned. The child's world is contracted, and so is his intellect: but this world of his lies immediately within the compass of a larger world. Betwixt the two there exist most intimate relations, and an uninterrupted commerce, and hence the child's world and intellect are ever expanding.

But in the case of the savage there is no such commerce between his little world and the great world around, and hence he fails to advance beyond a certain degree of sensuous apprehension. When our child has made some progress in the formation of sensuous conceptions, he comes in contact with a whole world of abstract and scientific notions, which are instilled into his mind at school. He learns reading and writing, and hears of heaven and earth, and of foreign countries and nations. The results of centuries of laborious study are set before him on the blackboard, as it were. His will also is disciplined and his passions controlled; he is taught how best to shape his conduct, and hence he is not under the necessity of making a long series of painful experiments. But these intellectual notions and objects are utterly wanting in the world which surrounds the savage. His whole life long he continues in the stage of mere sensuous apprehension; and even this will fail to furnish him with as many objects as the child possesses: for we can contemplate only that which is within our world. What then does a savage see, an Eskimo for instance? Ice and snow, bears and fishes, and—Eskimos. Nothing more; for "the whole expanse of Greenland is in great part covered with ice from 2000 to 3000 feet in thickness, as we judge from the height of the fragments of glaciers dropping into the sea." Nature therefore presents to the contemplation of the Eskimo no objects, save ice: there is no change, but everlasting sameness; and man too remains unchanged and undeveloped. With regard to the Eskimos, Captain Parry says that they are not aware that there is any world different from their own, or that Nature may wear an aspect other than that with which they are familiar. The savage's world is narrow, the number of his objects contracted, and therefore is his intellect undeveloped.

Hence the broader the world in

which a man lives, and the more his various conceptions are multiplied, the better equipped is his brain for the exercise of thinking: and *vice versa*, the narrower his world, and the fewer his conceptions, the less practiced is his brain in making distinctions, and the less able is he to *think*. It is a truth confirmed by every one's experience that the thinking faculty, like every other, needs practice to give it dexterity; and that unless it is rigorously and continuously exercised, it will still lack expertness, no matter what may be the natural advantages. If a man begins to be a student at forty, without any previous acquaintance with books, he sets a task for his intractable brain which it is still as ill-fitted to perform, as a Chinese lady with compressed feet would be to dance like Pepita. For "passé cet âge, les opinions sont faites; quant aux fondements, ils sont bâtis, maçonnés, inébranlables; autour d'eux l'habitude, la paresse d'esprit, les occupations pratiques sont comme un ciment que rien ne peut dissoudre." *

Bearing these principles in mind, let us consider the state of some wretched savage, some native of Tierra del Fuego, for instance. He has never come in contact with civilization, has never heard of abstract terms, nor knows anything of the outer world, which for him is undiscovered land, as was the New World for Europeans before Columbus's times. He knows only the barren deserts of his native home, where there are neither towns nor houses. He has never entered a school; and his only desire is the gratification of his hunger, his lust and his indolence. His conceptions are all sensuous, nor are these numerous, being such only as come to him from the few miles of territory around him—from arid wastes and bare rocks, from birds and fellow-savages. Hence the number of his concrete notions is very small; nor can it increase, for he never quits his native place and never sees new objects. The necessary consequence, on psychological grounds, is that he is unable to apprehend or to think like a civilized European. It is for this reason that the instruction conveyed to savages by the missionaries is received by them "as meaningless words, and quickly absorbed into their fetichism, without producing any lasting effect." * Their power of apprehending must be exceedingly feeble, and they "will not trouble their brains with nice distinctions." † Now we can understand why it is that "thinking is a very laborious exercise for the savage;" and also why it is that "when he is questioned as to intellectual things, he quickly complains of weariness and headache." ‡ The thinking faculty of the Bushman is unable to seize the simplest ideas and is characterized by extreme stupidity.§ The Abipones, who are more advanced in culture than the Bushmen, have numbers only as high as *three*. *Four* they express by three-and-one; *five*, by the fingers of one hand; *ten*, by those of both hands; *twenty*, by the hands and feet: but when the number exceeds twenty, they express it by taking up in the hand an indefinite quantity of sand.‖ The Corannas experience difficulty in counting beyond *three;* ¶ a nation in Guinea has numbers as high as *five*,** and some Brazilian aborigines, as high as *four:* whatever exceeds that number is

* Taine, Les Philosophes Classiques du XIX. Siècle en France.

* Bastian, S. 102, *Aumerkung*.

† *Ibid.* 143. This does not imply the incapacity of a savage's child, when instructed, to attain a higher degree of intellectual culture. "The negro is tolerably apt to learn, but his whole development depends on the first instruction he receives. When taken into the factories, his brain is a tabula rasa, but ready to receive new impressions." (Bastian, 140.)

‡ Burchell, Travels in the Interior of S. Africa, II. p. 307.

§ *Ibid.* I. 338.

‖ M. Dobrizhofer, Historia de Abiponibus. Vienna, 1784.

¶ Campbell, Travels in South Africa, 71, 281.

** Bowdich, Mission to Ashantee, 542.

*many.** It is difficult for us to imagine ourselves in so lowly an intellectual status as this: but that such status is possible, we may see in the analogous case of young children, who are unable to appreciate a number when it exceeds four or five. But the American Indian, whose world possesses a greater number of objects, and who is continually engaged in the struggle with wild beasts and other foes, leads a more active life. As he has more objects, so he has a greater number of conceptions, and hence his intellectual power is greater. Still his conceptions are little better than mere sensuous impressions. Now these impressions he is receiving daily as long as he lives, and it is no wonder if in distinguishing between them he acquires a degree of acuteness which we lack, owing to our being more taken up with abstract notions. Hence the Indian's nice discernment of scarcely perceptible tracks on the prairie, and of scarcely visible signs in the primeval forest. Hence, too, his power of taking in notions that are somewhat abstract: though this power of his must not be exaggerated. "In North America many Indians can count up to a thousand by scoring;"† but only up to a thousand, observe, and that only by scoring. Some African nations use the numbers *five* or *six* as the basis of their numeration, instead of *ten*, so that *five-and-two* or *six-and-one* will express seven.‡ It is plain that these tribes must lack all the advantage derived from numeration. They cannot reckon: and yet without reckoning according to the four simple rules of arithmetic, commerce is impossible. It is impossible *suum cuique reddere* without some system of measurement, and this requires numeration and reckoning.§ Hence simply for the reason that their numeration is defective, apart from all other reasons, savages fail duly to appreciate the difference between *meum* and *tuum*. It needs no words to show that they totally lack all such scientific knowledge as is based on measurement.

"They are wont to make an inexact division of time into moons and days, and many of them are ignorant of any division save the diurnal. The day they divide according to the sun's course into three or four parts of indefinite length."* Chronology they have none, nor indeed is such a thing possible among a people whose memory scarce goes back of yesterday.† The mere narration of historical facts were therefore an impossibility for them, even if they had a history. But as their lives are uneventful, they furnish no material for history. Let us consider what events transpire among them that might be deemed worthy of remembrance. The day opens; they feel hungry; they take some game; they sleep: then they repeat *da capo*. "Though the American Indians resemble the natives of Africa and of the Polar Regions in their distaste for work, they differ from them in this that they love repose above all things; while the others rather love to give themselves up to sport and enjoyment. The Indian never exerts himself, except where exertion is unavoidable, and when the hunt is over he enjoys undisturbed repose in his hammock."‡ Hence the life of the savage is uneventful, monotonous, stagnant. The individual may be developed to a certain degree; but not so the tribe. "The total development of all the successive generations of a Bushman stock is little more than the development of the first Bushman." § "Some tribes have legends and ballads recounting sundry warlike exploits of their forefathers, but these records do not refer to

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* Eschwege, Journal von Brasilien, I. 168.

† Wuttke, Bd. I. S. 156.

‡ Th. Winterbottom, Acct. of the Native Africans in the Neighborhood of Sierra Leone. Lond. 1803, p. 230.

§ *Cf.* Kuno Fischer, Logik, 2, Aufl. § 94, ff.

* Wuttke, I. S. 156.

† Bastian, S. 100.

‡ Wuttke, I. S. 164.

§ *Cf.* the Author's work "Die Thierseele." Leipzig, 1868, Cap. I. § 2.

events of any antiquity. Most savages are as destitute of historic records as though they were the primitive stock of mankind, and just sprung into existence. The Greenlanders, who stand considerably above the lowest grade of savagery, have, instead of history, only genealogies, oftentimes of ten generations." * Similar genealogical lists, but not so long, are found among Negroes, Indians and South Sea Islanders: but never actual history. In fact, they regard the past as very unimportant; and even those among them whose intellect is somewhat developed prefer legend to history.

As the world of such savages is extremely narrow and circumscribed, the number of conceptions formed by them is necessarily very scanty. Their notions are merely of the things of sense, and they *think* not at all—if by *thinking* is meant the elaboration of conceptions not immediately referable to sensible objects. He who entertains no thoughts is unable to give expression to thoughts. Hence, from the conditions of life amid which savages are placed it flows as a necessary consequence, that their language will be as undeveloped and as scanty as their circle of conceptions.† They can have words only for those objects of which they are cognizant. But as these objects are but few; it follows that their vocabulary must be scant. Then, inasmuch as they have no abstract notions, they cannot have any words to express objects not directly perceived by the senses. In the next place their language will be very deficient in those formulas which simply indicate the mutual relations of objects, as recognized by the human mind, and hence will lack inflexions, conjunctions and prepositions. Accordingly the Negro languages are generally very defective: the language spoken in Acra and in Fanti has neither adverbs nor prepositions: neither a comparative degree, nor a passive voice.* From this we may conclude that the people who speak these languages are still ignorant of some of the most elementary distinctions between conceptions, and that they remain through life in the same low stage of intellectual development in which children among us are found when they are learning to speak. It is stated that the Bushmen of South Africa are not distinguished from one another by separate names,† and Herodotus makes the same statement as to a tribe dwelling in the Sahara, the Atarantes: "They alone of men, so far as I can learn, are without names." ‡

Inasmuch as the circle of their conceptions embraces only sensible objects, it is to be expected that on the whole they will discriminate more nicely between such objects than we can, provided a considerable number of them come under their cognizance. The reason of this is that their senses are constantly exercised, and that they have no abstract notions to divert their attention. Hence the North American Indians perceive distinctions, and mark these distinctions with special names, where we use one general term. Thus, for instance, in place of our one verb "to go" they have many words, one signifying "to go in the morning," another "in the evening," another "to go in moccasins," etc. Everything is viewed as unique and individual, and as though it had no connection, no relation with other things. This is owing to the fact that the savage does not compare his conceptions with one another, a process performed not by the senses but by the intellect. Hence it is that the languages of the Indians abound in sesquipedalian word-combinations to express purely concrete notions. But these combinations

* D. Cranzen's Historie von Grönland. Barby, 1762, I. 261.

† *Cf.* Steinthal, Die Mande-Neger-Sprachen, psychologisch und phonetisch betrachtet. Berlin, 1867.

* Bowdich, p. 470.

† Lichtenstein, R. um südl. Afrika (1803–6), I. 192, II. 82.

‡ Herodot. IV. 181. *Cf.* Plin. Hist. Nat. V. 8.

are as void of intellectual suggestion as they are minute in describing every outward aspect and every minor particular of the object; and this very minuteness so fatigues and distracts the attention, that the main object is often obscured and hid from view. Awkward story-tellers have the like habit. Instead of going direct to the kernel of the story, they ramble away from it, and go into such long and minute explanations, that at length they do not themselves know what they had intended to communicate.

This redundancy of words is really a sign of a weak and uncritical understanding, unable to handle all its material by the principle of unity. Each phenomenon as it appears is taken to be *sui generis*, and is designated by a special name. Hence such languages, dependent as they are on the slightest external changes of objects, must be themselves ever changing, and the more so, as they are not fixed in writing. "In South African villages, where the children are left by themselves for months at a time, they often are found, when their parents return, to speak a language unintelligible to the latter, and the missionaries have observed that this language of the children is different for almost every generation of them. Among the Australian tribes, who taboo every word whose sound could remind them of a dead relative, and substitute a new term, this change of language must be of still more frequent occurrence. The savage coins new words as he needs them; and when the laws of grammar will not bend to his purpose, or when he is ignorant of them, he makes laws to suit himself. So long as languages are not consolidated and fixed in writing, they are ever in process of construction: and the elaborate grammars written by the old missionaries with the assistance of their ingenious penitents would be as unintelligible to the latter as the systems of religion attributed to them." * "The American languages, generally rich in grammatical forms and in compound words, but poor in expression, because the Indians do not think, are such incoherent conglomerates that when families or tribes break up, a notable divergence of language among the sundered fragments is the immediate consequence." * The reason of this is that each of the fragments finds itself amid conditions differing, if only slightly, from those surrounding the others. As the objects differ, so will the conceptions, and the languages in the same proportion; for *mind* and *world* are dependent on one another. Whenever a savage tribe is not tied down to its native soil by its possessions or by some law of necessity, and wherever its migrations are not checked by the previous occupation of the surrounding country, it readily breaks up into smaller clans, and each one of these will soon have its peculiar dialect. This is the case in America; and Prince Max von Neuwied gives specimens of thirty-three different North American languages which he himself had met with.† In what was once Spanish North America there are over twenty, and in all America about 500 languages entirely different from one another.‡

2. *The Morality of the Savage.*

We have seen how narrow and contracted is the intellectual sphere, the mental horizon of savage tribes, owing to the circumstances by which they are surrounded. Their mental power is not greater than that of the child. But besides mind, man is also possessed of will, and it is will that constitutes his moral character. Our present task therefore is to study the operations of the savage's will, his moral character.

* Bastian, S. 38, 39, 40.

* Max von Neuwied, Reise in Brasilien, II. S. 213.

† *Ib.* II. 445–645.

‡ Humboldt, Essai polit. I. 352; Adelung und Vater, Mithrid. III. 2, 370; V. Neuwied, II. 302; Beechey, Voy. to Pacific, II. 139. For Negro languages *cf.* Bowdich, 454.

Man's will cannot aim at an abstraction, or at the indefinite, but must always have its determinate object. In this it resembles the understanding, which must also have a definite object. But if the understanding has no conceptions, the will can have no objects; for only that which is the object of the understanding can be an object of the will. Hence the savage can desire only those things which are found in the world of which he has cognizance. But this world is different for different races: for one, it will contain many objects; for another, but few. As for the savage, his world is very contracted. Let us now consider what must be the effect upon the savage's will of a greater or a less number of objects.

That can be an object of will which is perceived by the understanding. The first object which a man is conscious of, and the one which, as being inseparable from himself, he must always have, is himself,* his own organism, and whatever necessarily has its rise in it. Man is an organism: whatever originates in this organism and becomes an object of consciousness—*e. g.*, the natural instincts and appetites (hunger, lust, desire of repose)—must necessarily be also an object for the will; and these objects of the will must exist in all men, whatever their culture, simply because man is an organism. But to these objects which are common to the whole race, others are appended which vary according to the conditions of life in which a man is placed; and in proportion as the world around him is rich or scant in objects, diversified or uniform, his consciousness will take in more or fewer objects.

Hence the objects of will may be divided into two classes: first, those which are inseparable from the organism, and which we may call the Instincts; second, those which are found in the world without. Man wills both of these: still it is clear that, all things else being equal, a man will expend less will-force upon individual objects, in proportion as their number is greater. Further, it is clear that in proportion as he exerts his will in one direction, he relaxes it in another. Hence the greater the number of objects found without the organism, and the stronger the energy of will with which they are desired, the more is the will withdrawn from those immediately connected with the organism, that is, from the natural instincts. Conversely, too, the fewer objects a man has, derived from the outer world, and the less his will is attracted by these, the more will he be controlled by his instincts, and the more time and attention will he devote to the gratification of these. Hence it is no wonder if the so-called civilized man controls his instincts more easily than the savage, seeing that his will is directed toward so many objects outside his organism. But on the other hand, we need not be surprised at finding savages, who are controlled by these instincts, committing excesses in the gratification of them, which to us appear to be brutal and shameless.

The savage has no intellectual objects, and consequently no intellectual occupations. He can occupy himself only with such objects as are given to him in consciousness; hence only with such as remain after we shut out all intellectual objects, viz.: hunger, lust, indolence. As objects in the external world he has none, or but few, he cannot occupy himself with them.

When he has appeased his hunger, there is nothing more for him to do, so he will play, or sleep, or engage in debauch; and as this is the only course open to him, he will go to excess. He must needs act thus, nor can he do otherwise; and surely that is not to be accounted a crime in him, which is the necessary product of his natural condition. The unrestrained gratification of natural instincts is as clearly right in the savage (taking his

* *Cf.* Schopenhauer, Vierfache Wurzel, 3 Aufl. § 22.

world into account) as it would be wrong in us, whose world is very different from his. Hence morality, as interpreted by us, has no application to the savage. Our refined distinctions in question of morals do not exist for him : his obtuseness of understanding is such that he cannot grasp them. Our definition of *good* and *evil* applies to him as little as to beasts, and it were unjust to measure him by such a standard, or to require him to conform to it. He can recognize no law save that of instinct, so long as his world remains contracted. Whatever his instincts require, that he seeks; what they reject, that he avoids. As his will is attached to trifling objects, they being the only objects he possesses, he must needs esteem as highly things of no value to us, as we esteem things of high importance to us, though of no account to him. Hence matters perfectly indifferent to us will have for him moral importance (if we may so speak); and conversely, what we take to be highly important will be indifferent to him, because his will is not directed toward it. By the aid of these principles we can explain such traits as the following: Certain Bushmen, being asked by a European what they meant by good and what by bad, could not give any reply: but they held fratricide to be perfectly harmless.* The Kamtchatdales hold that an act is sinful which is unlucky: for instance, to visit hot springs; to brush snow off the shoes out of doors; to seize a red-hot coal otherwise than with the fingers, when you would light your pipe; to bring home the first fox you have taken; to tread in the tracks of a bear, etc.† The Orangoo Negroes hold it sinful to spit on the earth,‡ while the natives of Labrador regard nothing as sinful save only the murder of an innocent man.§

* Burchell, I. 338, 340.

† G. W. Steller, Beschreibung von Kamtschatka. Frankfurt und Leipzig, 1774, S. 274.

‡ Bastian, 261.

§ Nachrichten aus der Brüdergemeinde, 835, No. 5.

In the gratification of his indolence, hunger and lust the savage can acknowledge no restraint, as he has no outward objects to counterbalance them. But here another point is to be considered, namely, that this unrestraint tends to grow from day to day. Egoism prompts each individual savage to assert his mastery over all others. Hence the quarrels and competitions of man against man, each striving to surpass the other. But since this competition must regard only those activities which occupy the savage, and as these three instincts furnish his chief occupation, it follows that the natural condition of unrestraint will be carried by competition to a truly bestial degree of perfection in indolence, gluttony and lust. The Missouri Indians used to practice promiscuous intercourse as a point of honor.* In like manner, in Tahiti and the adjacent islands, there was the association of the Arreoi, who made it a point of honor to practice unchastity in all its degrees.

The Indian never exerts himself except so far as strict necessity requires. After the hunt, unbroken repose. The women do all the work, as is the universal rule among savages. "An Indian chief once said to a white man, 'Oh, brother, you will never learn what happiness it is to think of nothing and to do nothing: this is, next after sleep, the most delightful thing on earth. That was our condition before we were born, and will be our condition after we die.' Then, after expressing his contempt for the restless life of the white man, he went on: 'But we live for the present moment. The past is but smoke driven by the wind. As for the future, where is it? As it has not yet come, we shall never see it perhaps. Let us then enjoy the day that is, for to-morrow it will be gone far from us!'" † It is plain that among such people, to whom the past has bequeathed no problems to be

* M. v. Neuwied, Nordamerika, II. 131.

† Crevecœur, Voy. dans la haute Pensylvanie et dans l'état de New-York. Par. 1801, Vol. I. p. 362.

solved, no tasks to be performed, and who will themselves bequeath none to futurity, there can be no advance in knowledge or in morals. "The boy accompanies his father: if the latter follows any pursuit—fishing, for instance—the son too learns the craft. But inasmuch as the Negroes pass the greater part of their time in doing nothing, the education thus obtained is of no importance." * In the South Sea Islands the grandees have the food put in their mouths bit by bit.† In Tahiti the missionaries, having endeavored to introduce the art of weaving, all the girls who had come to learn quit work after a few days, saying, "Why should we work? Have we not as much bread-fruit and cocoa-nuts as we can eat? You who need ships and fine clothes must work: but we are content with what we have." ‡

Lust and gluttony are regarded by all savages as the acme of earthly felicity. The inhabitants of Northern Asia perform wonderful feats of gormandizing. Three Yakuts will devour a reindeer at one meal, including the contents of the intestines, and a single Yakut once devoured 28 lbs. of porridge with 3 lbs. of butter.§ The baptized Kamtchatdales often say, as they recall the past when they were still heathen: "When do we ever have jovial days now? Time was when we used to bespew the whole floor of the hut three or four times a day, but now we can do it but rarely even once a day. Formerly we could wade ankle-deep in spew, now the soles of our feet even are not wetted."‖ "In all Negro languages the word *belly* is one of great import."¶ Politeness requires that one inquire if all is well with his neighbor's belly. The South Sea Islanders call thoughts, *words in the belly*. The stomach of one who dies is kept as a relic; and the Kroo Negroes hold that the stomach ascends into heaven after death.*

As regards the passion of lust, the absolute shamelessness of the savage almost surpasses belief. The Bushmen have only one word to signify girl, maiden and wife; they consort together like cattle, have no real marriage, and the men exchange their women freely.† "Woman is a chattel, to be bought and sold, having no rights of choice or of refusal. Being a mere possession, not the object of love, when by reason of age or for any other cause she can no longer minister to lust, she becomes a despised thing, without any rights, often contemned even by her own children, shut out from the ceremonies of religion, oftentimes even forbid to come near the sanctuary as being unclean, and in death she is esteemed unworthy of being lamented."‡ "In Nucahiva the bride is the property of all the male guests for the space of three days."§ Bushmen and California Indians make no account of blood-relationship, and incest is common among many Indian tribes.‖ Among the Aleutian Islanders brothers and sisters, children and parents, have sexual commerce with one another, alleging the example of the seal.¶ South American savages, the Puris, Botokuds and others, and most of the New Holland tribes, go entirely naked, while among the South Sea Islanders, at least the men, if not both sexes, wear no bodily covering. Some Indian tribes use clothing to protect them against the weather, but disregard the claims of modesty.** Sodo-

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* Halleur, das Leben der Neger West-Afrikais; Ein Vortrag. Berlin, 1850, S. 31. *Cf.* Bosmaun, R. nach Guinea, 1708, S. 148.

† Forster, S. 206.

‡ Beechey, I. 337.

§ Cochrane, Travels on Foot through Siberia, 155; J. Sarytschew, Achtjälhrige Reise im nordöstlichen Sibirien, auf dem Eismeere u. dem nordöstlichen Ocean. Aus d. Russischen übers. Leipz. 1805, I. S. 129.

‖ Steller, Kamtschatka, S. 286.

¶ Bastian, S. 35.

* *Ib.*, S. 207.

† Lichtenstein, R. in Afrika, II. 376; Campbell, 13.

‡ *Cf.* Wuttke, I. 177.

§ Langsdorff, Reise, I. 132.

‖ Eschwege, Journ. v. Brasilien, I. 121; Mackenzie, Travels through N. America, 108.

¶ Langsdorff, II. 5843.

** Mackenzie, 5471. *Cf.* Wuttke, I. 182.

my is wide-spread in certain tribes.* The South Sea Islanders abandon themselves at a very early age to the most unbridled licentiousness; and their songs, dances and shows are instinct with sensuality.† The Tungoos have wanton dances which conclude with the stripping off of all clothing and indulgence in unlimited debauchery;‡ and immoral dances prevail throughout all Northern Asia.§ The Greenlanders and Eskimos are notorious, but the life led by the Kamtchatdales in former times was bestial. All their thoughts and imaginations were concerned with unchastity, and even little children delighted their parents by licentious indulgence. Adultery was universal, and the women used to boast of it. Strangers were required to make return for any service they received, by ministering to the ruling passion; and men and women engaged in unnatural and sodomitic commerce. They were acquainted with syphilis, as they themselves admit, long before the advent of Europeans.||

Where there in no moral family life there can be no family, in our sense of the word, that is, with the members united together in love and friendship. Here the rule of the stronger prevails, and the man is everything. "The idea of the State is nowhere ¶ developed, and the individual, instead of gaining strength from union with others, imagines himself to be safe from danger only when he oppresses all around him. The father makes slaves of his children, and the husband enslaves the wife, in order that he himself may be free: and he is free so long as he does not meet some one mightier than he, for then the domestic tyrant falls himself under the control of an inexorable master. His neighbor he regards as his foe. In short, nothing can be more foreign to the savage mind and the state of savagery than the dogma of Universal Equality."* "The child has no rights, being simply the chattel of his parents, who can do with him as they please, without being bound to him by any obligations. Rarely do they exhibit any true parental love for their children, beyond the fondness of animals for their young; and when a child is born to them inopportunely, or when they take a dislike to it, it is put to death; and the fearful crimes of infanticide, fœticide, abortion, abandonment and sale, and even slaughter and eating of children, are so common as to explode all the sentimental idyllic tirades that have ever been sung about the innocent life of man in the state of nature."†

When such are the relations between parent and child, education is out of the question. The American Indians are pleased when they see the child strike its mother and refuse to obey her. "He will one day be a brave warrior," say they. Among them obedience and respect for parents are very rare.‡ Among the Kamtchatdales children never ask their parents for anything, but take it without more ado: and they never manifest joy on seeing their parents after a protracted separation from them.§ Among the Tungoos duels between father and son are frequent, and not seldom terminate fatally.|| The Arekuna, as in Guiana, bring up children and monkeys together. The monkeys are members of the family, eat with the other members, are suckled by the women, and have great affection for their human nurses.

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* Eschwege, I. 132; Franklin's First Voyage, 7273.

† Mackenzie, 108.

‡ Ermann, Reise um die Erde II. 36.

§ Cochrane, 298.

|| Steller, Kamtschatka, 287, 350, 357.

¶ Among savages.

* Bastian, S. 67, 68.

† Wuttke, Gesch. der Heidenthums, I. S. 185.

‡ M. v. Neuwied, Nordamerika, II. 129; Mackenzie, 106; Franklin, First Voy. 73; Eschwege, I. 121; Spix u. Martius, Reise, I. S. 380.

§ Steller, Kamtschatka, S. 353. *Cf.* Wuttke, I. 187, ff.

|| Georgi, Beschr. einer Reise durch das Russische Reich im J. 1772, S. 242. *Cf.* M. v. Neuwied, R. in Brasilien, I. 141, 146.

Oftentimes a woman is to be seen with a child and a monkey at the breast, the two nurselings quarreling.*

As the parents care little for the children, so in turn the children care little for the parents. When the American Indians go out on their hunting expeditions they often leave behind in a state of utter destitution the aged and the infirm who are unable to make the tramp: † and in most of the tribes it is customary for relatives to dispatch the old and the feeble without remonstrance from the victims. ‡ The Bechuanas have less regard for the aged than for cattle, and abandon them to their fate without compunction.§ Their neighbors, the Corannas, expose the old people to wild beasts, they being, as they say, of no account, and only serving to use up the provisions.‖ Among the Bushmen the daughter often turns her old mother out of the hut, and leaves her to be devoured by wild beasts. Sons put their fathers to death with impunity.¶ The Kamtchatdales often eject the sick from their house and cast them to the dogs; ** and the Eskimo often bury alive old sickly widows, and not unfrequently suffer old men to perish of hunger.††

3. *Conclusion.*

We have now set forth the intellectual and moral condition of the savage so far as was needful for our present purpose. Our criticism, aided by experimental investigation, unfolds before our eyes a picture very different from what certain enthusiasts would paint, who hold the present condition of civilized man to be a corruption, a degeneration from the primitive innocence and purity of man in his natural state. An indolent savage, who has neither objects nor aims nor ambitions to occupy his mind, can never be *moral.*

Of course the picture we have painted does not represent with equal fidelity all savages, for there are degrees of higher and lower even in savagery. We are not called upon here to ascertain the specific differences of these various degrees; it is sufficient if we have an idea of the average condition of the savage intellectually and morally considered.

The savage's world is narrow and contracted, presenting but few objects, and hence he has but few conceptions. But the fewer his conceptions the less does he distinguish between them; *i.e.*, the less he thinks, the less is his faculty of thought exercised, and the greater is his stupidity. Then, his will can be directed only upon the objects given him through his understanding. But since external objects there are none to engage it, of course all its energies must be expended upon internal objects, of which he is conscious through his organism. Hence he is as free from restraint as a beast in the gratification of his instincts. Such is the savage, and such he must be; for intellect, world and will are inseparable; one never stands without the others; they stand ever together, or they exist not at all. It is needless to inquire which has precedence, for they all three make up the essence of man. His intellect extends as far as his world, and his will extends only so far as his intellect, or his world. Conversely, too, his world extends only so far as his intellect and his will.

* R. Schomburgk in the "Ausland," No. 288.

† Mackenzie, 431; Franklin, First Voyage, 192; Second, 91.

‡ Robertson, History of America, I. 466; Mackenzie, ib.

§ Campbell, Trav. in S. Africa, 49, 245.

‖ *Ib.*, Second Journey, 258.

¶ *Ib.* 272.

** Steller, S. 271.

†† Cranz, Grönland, 201; Beechey, II. 394. Bastian makes a similar statement as to Negroes, S. 320.

CHAPTER III.

THE RELATION BETWEEN THE SAVAGE MIND AND ITS OBJECT.

In the preceding chapters we have been laying the foundation for a correct understanding of fetichism, and have ascertained the range of the savage intellect. As fetichism is really a mode of intellectual apprehension, we had first to study that particular phase of the understanding wherein a sensible object obtains significance as a fetich. It remains for us now in the present chapter to show what is the necessary relation of the savage mind to its object; for it is this relation which gives rise to the fetichistic apprehension of objects, and which accounts for it.

1. *The Value of Objects.*

As things are for us what we apprehend them to be, so their value for us will be in accordance with our apprehension of them. Now the mind has a clearer and more exact apprehension of objects in proportion as it distinguishes between them more clearly. Therefore the sharper the distinctions we can make with regard to the minutest details of an object, the more exactly can we determine its value. An object is distinctly apprehended, only when we can discriminate between it and other objects. If therefore I would form a clear understanding and an accurate estimate of a thing, I must also clearly understand all other objects related to it; and so I cannot rightly estimate anything without an acquaintance with a number of other things. My estimate of things will thus vary according to the number of objects of which I take cognizance. But since all things stand to each other in a causal relation, it follows that a *perfectly* exact estimate of any single object can only be had when the entire series is known. For the greater the number of the objects apprehended, the better do we understand the interrelations of them all, and so the causal value of each. On the contrary, the smaller the number of objects, the less accurate will be our estimate of each.

The mind, then, whose object-world is very contracted must of necessity form a very different estimate of things from that formed by a mind which has many objects, nor will its estimate be as exact as that of the latter. From all this it follows that the estimate formed of things by children as well as by savages must be very different from our estimate, as their world is very contracted and the number of their objects very limited.

The untutored intellect which, as having but few objects, is defective in the power of distinction, cannot estimate the true value of things. It is liable either to overestimate objects or to undervalue them. It can estimate only the objects which it has. As it knows only these and is ignorant of all others, it cannot compare the known with the unknown, and the known must of necessity be esteemed the best and the most precious. The peasant who has never left his native soil, regards his home as the most desirable place on earth, though the soil be half bog. Be the objects which the untutored mind contemplates never so lowly, and worthy only of contempt as viewed by a mind which has a wider range, still it will set an exorbitant value on them inasmuch as they are the only objects it contemplates. On the other hand, as there are many objects which do not occur to the undeveloped mind (*v.g.* objects of a purely intellectual value) these it will not estimate aright, or in other words, not according to their true worth. It will undervalue them. The peasant values his field of rye, not so the rare varieties of flowers growing in the neighborhood; he knows nothing about these. If his mind were stored with as many plant-objects as is that of the botanist; if he were acquainted with their different classes and their mutual relations, he would value these rare flowers; as it is, he plucks them up as weeds and casts them away. His undeveloped understanding does not apprehend distinctions between things, and as he cannot distinguish between them, they are all alike to him. For him leaves are leaves, and he knows no such distinctions as heart-shaped, lancet-shaped leaves, etc. Objects with which he is unacquainted he under-values in proportion to his ignorance of them.

The fewer and less important the objects which a man possesses, the more excessive will be his overestimate. He will discern valuable treasures in trifles which, to a mind of greater range, will appear as very nothings. If a man is worth a million of dollars, a few pence will be a trifle in his eyes; but if a man has only a few pence, then one penny will have a considerable value for him. If then we would determine what are the objects which a man will regard as valuable, we must take account of how many objects he has. What then are the objects that a child will prize? Those which he has. What are these? Let us consider those which he *has not.* He has none of those which lie within the domain of science or of art. He has none of those things which the adult values, steady occupation, its products, its remuneration, etc. He values only those things which he knows and has, and these are the merest trifles, his playthings.

Children must of necessity prize these trifles, for they have no knowledge of the more important objects known and prized by adults. It is worth while to observe how the understanding is enlarged in proportion to the number of objects to which it addresses itself. As it becomes acquainted with new and more important objects, its standard of values changes; yet so long as these new objects are unknown, it esteems as most important those objects which it already has. In youth we have a very different estimate of things from that which we have in old age, for youth does not value those things which are most prized by age. In like manner the child does not value the objects which are of importance to youth. The child values only the objects with which he is acquainted. But these must be of but little importance, for it is only by slow degrees that the mind comes to value objects of real importance. Inasmuch as every object is a novelty to the child, it is a necessity for him to take the same interest in trifling objects which we take in more important ones. The child is receiving an education, and has enough to occupy his mind in the contemplation of familiar household things. For these alone he has eyes, ears, attention. After a man is grown up and no longer admires, for instance, his watch, merely glancing at the dial to ascertain the time of the day, he forgets the time in the past when things now the most familiar were to him new and strange, and wonders that the child should want to look at the watch again and again, and to listen to its ticking. Yet nothing is more natural or more inevitable for as yet everything is a novelty to the child. We say that children *play* with things. If by *play* we mean simply pastime, amusement, we do not correctly describe the occupation of the child, who is as seriously employed with his toys as an adult might be in the management of state affairs. The child's play is work, study, acquisition of knowledge, and occupation of the mind suited to the measure of his faculties.

We have been somewhat prolix in describing the relation of the infantile intelligence to its objects, for the reason that it throws light upon the matter in hand, viz., the relations between the mind of the savage and its objects. The savage's mind is in the same embryonic state as that of the infant. It has but a limited range of objects, and therefore will value these, however inconsiderable they may be, as we value objects of greater moment. Let us take an inventory of the possessions of a naked savage, a Bushman, for instance. He has none of the products of industry or art; he weaves not, neither does he spin; he neither plants nor gathers in a harvest; he has not even a knife beyond some sharp-edged stone he chances to find. He knows nothing of such objects. Previous to his coming in contact with Europeans he has no idea of such a trifling thing even as a brass button, or a nail. What then does he possess? A few articles that he has chanced to find, that he has picked up off the ground, or found growing on trees, or taken from wild beasts. His possessions consist of stones, shells, a club, fruits, peltries, a dead carcass, skulls and bones, teeth, horns, gaudy feathers, fishbones—such is the sum total of his property. "The Bushmen have scarcely any possessions. If they steal a few head of cattle, they devour as much as they can, and leave the remainder on the ground." * The negroes of West Africa are more favored. "Simpler even than his house is the furniture—a bed made of leaves and rushes, a block of wood for a pillow, a few pots and bowls, a gun and a long knife, with a few large and small calabashes, the large ones used as wardrobes (his clothing being a few yards of cloth to wrap around the body), and as receptacles for ball, lead, powder, etc.; the small ones serving as flagons. And that is about all the furniture to be seen in a negro's hut." †

Beyond this inventory the savage neither has nor knows of any possessions. He must therefore overestimate these objects. Accordingly a fishbone will serve him for an ornament.‡ "They trick themselves out with feathers, shells and the like, which they consider things of beauty."§ If now they meet with some strange object, a nail, for instance, or a glass bead, or a bit of tinsel ornament, it excites their wonder, and they long to possess it. "The sister of a South Sea Island king whose subjects thought themselves highly civilized, stole a couple of iron nails from Cook's vessel, and her brother connived at the theft." * "A negro who wears European clothing at once ranks with Europeans, though he be as black as coal. There are gradations of rank, however: a fellow that wears only one article of European costume, the vest, for instance, or the hat, ranks as a mulatto. To hold rank as an out and out European, he must wear the full costume, his head being crowned with the hat." † "Oftentimes as I stood in the presence of ebon Majesty, the king would be possessed by the god of poesy, and my interpreter would inform me that he was singing my praise and great renown. This was extremely gratifying and of course flattered my vanity in no small degree. Unfortunately, however, my attention was on one occasion specially directed to the noble strains wherein the Greots, or bards, committed my fame to posterity; and it was suggested that the least I might do was to give them a kronthaler: so I had the curiosity to request of my interpreter a more minute analysis of the pæan. The Greots were lauding in transcendental metaphors, my hat, which just then was not according to the latest *mode de Paris;* and in its last days that hat cost me double the price I had paid for it new. The Lord of Shemba-Shemba I suppose sung the praises of my shoes, as shoes in that land are the prerogative of the Blood Royal. Princes alone are there permitted to wear shoes, to travel in mat hammocks, or to carry umbrellas." ‡ The inhabitants of the Pelew Islands used to append to their ears all the valuables they cribbed from Europeans, scraps of leather, bits of paper, etc.

This fact, which has a psychological basis in the intellect of the savage, must be taken into account in the study of fetichism; and this for two reasons, viz.: First, it will, in connec-

* Lichtenstein, Reise im Südl. Afrika, 1803–6. Berlin, 1811, II. 321, 83.
† Halleur, 23, 18.
‡ Bastian, 317.
§ Halleur, 19.

* Forster, Bemerkungen, S. 338.
† Halleur, 19.
‡ Bastian, S. Salv. 56.

tion with other facts, enable us to see how an object comes to be regarded as a fetich. Then it will guard us against the error of thinking that every object that the savage prizes is for him a fetich. It is true, any object may become a fetich; still, every object is not necessarily a fetich. We might here recall what Azara says about the savages of the Rio de la Plata: "When the ecclesiastics saw certain figures engraved or pictured on the pipes, bows, clubs and pottery of the Indians, they at once concluded these were idols, and burnt them up. The Indians still employ the same figures, but only to please the fancy, for they are without religion."*

2. *The Anthropopathic Apprehension of Objects.*

It is plain that in the view of the savage, objects will have a very different value from what they have for us. But furthermore, owing to the contracted range of the savage's mind and his consequent deficiency of mental power, or, which is the same thing, his defective faculty of distinction, an object, whether living or inanimate, will have for him a very different meaning from what it has for us.

The savage differs but little from the mere animal, nor does he himself draw the same line of distinction between the two which we draw. Inasmuch as his consciousness, which extends only as far as the objects which enter it, is extremely contracted, he is on this ground also less distinguished than we from the unconscious nature which surrounds him. He has but few objects, and so distinguishes but few; and thus his power of ascertaining substantial differences between things lies all unemployed, uninstructed and feeble. Consequently, he does not see things with the same distinctness as we do, and hence it is clear that in his view nature must appear more homogeneous than it does to us. But we must consider this point more closely.

We too regard all nature as one and homogeneous, and view all beings as essentially homogeneous, but yet on characteristic grounds very different from those of the savage. After having traveled in many devious paths, and so far even exaggerated the distinction between Man and Nature, as almost to dissolve the tie which binds them together, and thus established the characteristic differences between the two, we came to recognize the truth that in the last analysis man is not essentially distinct from nature, and we regard nature as homogeneous in all its parts, though for reasons very different from those of the savage. The difference lies in this, that we consider nature in its several parts: that we arrive at the knowledge of its homogeneity through the consideration of its distinctions and differences, and that nature lies before us as a very complex object, which has been investigated in many of its parts. The savage knows nothing of these distinctions and definitions: to him nature is all unknown; yet he too regards it as homogeneous, but on these grounds:

He is unacquainted with the peculiar nature of those things he comes in contact with, having never investigated them; he knows nothing of their inner specific properties and constitution. He recognizes a distinction only between their external phenomena, as regards their form, color, smell or taste. Then, he has never made his own being a subject of contemplation either from a psychological or from a physiological point of view. He is therefore ignorant of the distinction between himself and other beings. Accordingly his apprehensions of outward objects will picture them not according to their real nature, which he has never investigated, but in quite different shapes. It is impossible for him to attribute to objects properties he never yet has apprehended. He has no conception of the true, specific nature of things, and

* Azara, Voyage dans l'Amerique Meridionelle. Paris, 1809, T. II. p. 3.

consequently his apprehension of them is defective. Whatever object he perceives he invests with those properties of which he has already a notion, and then for him the two things are inseparable and identical. This process is inevitable, and the savage never doubts but that his perception is entirely correct, for he has no suspicion of having transferred to the object the incongruous impressions of his own mind. And indeed why should he doubt? In order to entertain a doubt whether or no his apprehension corresponds with the reality, the thought must first have arisen in his mind that perhaps the object might be apprehended differently: but this presupposes a mind furnished with a great variety of conceptions, and that has investigated much, so as to be possessed of a number of different actual and possible notions. Precisely because the cultured mind possesses such an abundance of varied notions, any one of which may appear to represent some new object which attracts its attention, it will not accept its first impression as absolutely correct and final, but will be skeptical for a time, while it sifts and weighs, in order to choose among many conceptions that which exactly fits the matter in hand. Now the savage has no such store of conceptions. He possesses but few himself, nor has he the slightest suspicion of any others. As the savage of Tierra del Fuego has no notion of Europe, Asia, Africa, etc., and just as he has not the remotest idea of what a magnifying glass is, so he is utterly unable to conceive of any other mode of apprehension but his own, and therefore he can entertain no doubt as to the correctness of his notions. Having no suspicion of the existence of any notions beyond those he himself possesses, he necessarily thinks his are the only ones possible. The adversaries of Columbus saw, according to the ideas they entertained, that his undertaking was chimerical: they regarded their own notions as the only correct and conceivable ones, and were free from all doubt. Who could have imagined the possibility of traveling by land without the employment of draught animals, before the invention of the steam-engine. It is impossible for the savage to doubt the correctness of his notions, as there are no others by means of which he might set them right. Having no suspicion of any others he is obliged to see all things in the light of his own understanding alone, and to transfer to everything he meets the impressions already existing in his mind.

Hence it is plain that the savage must regard all objects, as far as concerns their inner nature, as being endowed with those inner properties only, of which he has formed to himself some notion. Now what are these? Not the inner properties of the objects themselves, for of these he knows nothing. The only properties of this kind with which he is acquainted are those of his own mind. But how far does his knowledge of his own mind extend? He knows nothing of its psychological laws, nothing of its essential character, so to speak: he is acquainted only with accidental properties: his transient impressions and emotions, his momentary humors, and his aimless pursuits. These notions he necessarily transfers to exterior things, as their inner properties; for on the one hand he has no idea of the real inner nature of the objects, and on the other he is acquainted with no inner properties whatever, save those of his own mind. He must necessarily consider all nature, and not alone animals but even inanimate things, as living, thinking and willing, even as he himself lives and thinks and wills: that is to say, he takes an *anthropopathic* view of nature. We shall in the sequel find abundant proofs of this position, for it is a fact that has been time and again recognized, admitted and proclaimed. We have attempted only to assign its psychological grounds. It is the utter ignorance of the savage that directly leads him to view nature in this light, for we must bear in mind that for a man in the earliest stage of development, viz., a savage, everything, however trifling, is as novel, as unknown and as wonderful as a rattle is for the infant. As the man gradually advances toward civilization, this mode of viewing nature is given up, yet far more slowly and more grudgingly than we might be disposed to expect. For it is with this habit as with every system of ideas. If those who went before have adopted it, and their whole life long cherished it, and held it for true, it becomes implanted in their children into whom it was inculcated during their early years, and in them becomes a truth, resting on the authority of their ancestors. The belief grows stronger day by day, and finally becomes indisputable dogma which is not to be set aside even though it be in conflict with facts. Thus the anthropopathic view of objects endures even where men's acquaintance with nature is no longer in the lowest grade.

If we transfer ourselves into the narrow field within which the savage observes nature we shall find this result so inevitable, that any other result will appear to be impossible. Though I have said that we ourselves, no less than the savage, must regard man and nature as homogeneous, still we must admit this difference between our point of view and his: by investigating nature we have come to recognize man as a product of nature. We say, man is as the rest of the universe. But the savage knows neither the nature of other things, nor yet his own; as regards the latter, he is acquainted merely with his varying impressions and desires. Therefore he can only say: Nature is like Man, *i.e.*, has the same petty, individual and altogether subjective impressions and desires. When Schopenhauer says, The Universe is Will, for man in the last analysis is Will, and at the same time merely a part of the Universe, he asserts that the common being of *all* men is also the being of the Universe. On the contrary, the savage says: The individual being which pertains to one man, to me alone, to this particular savage creature, with all its petty, personal propensities, is the being of the universe. The distinction is broad. Schopenhauer says: The Substance of man is the being of the Universe. The savage says: Accidental properties (which differ for different individuals) are the being of the Universe.

Thus the intellectual status of the undeveloped man, the savage, necessitates a mode of contemplating nature very different from ours. He ascribes to all things essentially the same properties he possesses himself: he cannot avoid considering all things as being endowed with the same inner properties he discerns in himself, for he has no critical power of discriminating. For him, therefore, every object lives, wills, is kindly or unfriendly disposed; and thus everything inspires him with fear and awe, "so that he scarce ventures to touch any object: even the very plant which affords him nourishment he plucks from the ground with propitiatory rites." * In America and in Northern Asia all things are supposed to be possessed of souls—works of nature and of human art alike. These souls they consider as something dwelling in the object and inseparable from it, which can benefit or harm mankind." † The more these objects resemble man in their general appearance the more readily will they be regarded as actually human. First, therefore, would come the anthropopathic apprehension of animals, then of all the phenomena of motion—the sea, rivers, clouds, the wind, lightning, fire (which some savages regard as an animal, ‡ as did the ancient Egyptians, according to Herodotus); § plants would follow next, and then finally rocks and mountains. This subject we will consider in detail farther on. "Natural objects pass for mighty spirits. Thus, for instance,

* A. Bastian, Beiträge zur vergleichenden Psychol. S. 10.

† Meiners, Hennepin, Lafiteau, Steller, etc.

‡ Wuttke, I. 59.

§ Herod. III. 16.

among the Australians the rock-crystal is esteemed sacred; the savage attributes special good qualities to stones of bright colors. The bloodstone is supposed by the Indians of South America to be possessed of beneficent qualities. Even the products of human skill, such as watches, telescopes and the like, are inhabited by spirits. An intelligent Bechuana said, on first seeing the sea and a ship, 'This surely is no created thing, it has sprung into existence of itself, and was not made by man.' "* This anthropopathic view of nature is the very essence of poetry: and hence it is that the view which the savage takes of nature appears to us so poetical, though he himself is so accustomed to this mode of apprehension that he is utterly unconscious of the poetry.

As man can ascribe to objects only those notions and passions which he has himself, the savage attributes to his fetich precisely his own wild, unbridled desires in all their natural unconstraint, and magnified to the highest degree; his hunger and thirst, his love and hate, his anger and his rage. Still the object continues to be, in the mind of the savage, that which it is in its external form. It is not as if the savage in his anthropopathic apprehension represented to himself a self-existent superior Power, a self-existent soul, which merely assumed for a time the external shape of the fetich. No: the stone remains a stone, the river a river. The water itself, in its proper form and with its native properties is invested with anthropopathic characteristics. This is very different from a symbolic conception. Here the object as it presents itself in all its external manifestations, is identical with the anthropopathic conception. When a thing comes to be regarded as in some way the symbol of another and a different thing, then the mind has made a very considerable step in advance.

* Waitz, I. 457.

The object has therefore a greater value for the savage than for us, both as a commodity and as something anthropopathically regarded as possessing life. "One of the followers of the envoy Isbrand exhibited before a crowd of Ostiaks who wanted to sell fish to the embassy, a Nürnberg watch, fashioned in the shape of a bear. The Ostiaks viewed the article with great interest. But their joy and astonishment were increased when the watch began to go, and the bear began to strike the hours, and his head and eyes to be in motion. The Ostiaks bestowed on the watch the same honor they paid to their principal Saitan, and even gave it precedence over all their gods. They wanted to purchase it. 'If we had such a Saitan,' said they, 'we would clothe him with ermine and black sable.' "* "Father Hennepin, during his stay among the savages, had in his possession a compass and a large kettle in the form of a lion. Whenever he made the needle vibrate, the chief with whom he lodged assured all that were present that the white men are spirits and capable of doing extraordinary things. The savages had such fear of the kettle that they never would touch it, without having first wrapped it up in beaver pelts. If women happened to be present, the kettle had to be made fast to a tree. Hennepin offered the kettle to several chiefs as a present; but none of them would accept the gift, for it was thought that an evil spirit dwelt within it, who would slay the new owner." †

The same anthropopathic apprehension of things is to be observed in children. The little girl who in perfect seriousness regards her doll as a playmate, who strips and clothes it, feeds and chastises it, puts it to bed and hushes it to sleep, calls it by a personal name, etc., never imagines that all her care is expended on a

* Isbrand, Voyage de Moscou a la Chine, in Vol. VIII. of Voyages au Nord, p. 38.

† Hennepin, in the Voyages au Nord, IX. 332, 333. *Cf.* Constant, La Religion, I. p. 254.

lifeless thing. she does not make any such reflections as these: This is all merely an illusion that I indulge on purpose; a play that I engage in, but with the distinct understanding that it is only play. She has no thought that the doll is a lifeless thing; for her it is possessed of a human life, which is bestowed upon it by the child herself. The boy's hobby-horse is for him no mere symbol. This anthropopathic view of lifeless objects is to be seen among people everywhere. Especially do we observe it in the way people vent their rage in blows and abuse bestowed on inanimate things that have occasioned them some hurt. In the heat of passion, reflection and judgment are silenced, and then momentarily the mental range is contracted as it is in the savage permanently. An Indian who in his cups had received a burn expressed his indignation against the fire in the most abusive language, and then *mingens eum extinxit.**

3. *The Causal Connection of Objects.*

We now proceed to study the operations of the mind in its profoundest depths. The act of consciousness implies the perception of the principle of causality. We *perceive* objects by referring to outward phenomena, as to a *cause*, certain modifications produced in our nerves of sense, and we connect objects themselves with one another by the same causal nexus. In the latter process the mind arranges the objects in a certain orderly series, so that one shall appear as accounting for another, or explaining it. Thus one object would be cause, and another, effect. The mind invariably perceives this relation in all the objects which come under its cognizance; and even in the most trivial conversation the several conceptions are explanatory, illustrative, confirmatory of one another, and so inter-related causally. It is a law of the mind therefore that it shall regard its objects as standing to one another in the relation of cause and effect.

Now it is clear that the mind can discern this relation only between those objects of which it has consciousness. But the more restricted its range, the fewer will be its objects. A mind which possesses but few objects will be liable, owing to this very paucity of objects, to assume immediate causal relations where they do not exist: in the absence of the true cause, it will take for cause some object within its own range. This is the real ground of all error, and any erroneous apprehension whatsoever might serve as an example of what we here assert. In the course of this chapter we shall fall in with many examples, but we cite only the following in this place: The true cause of the so-called rain of blood in Southwestern Europe was long unknown. People accordingly connected this unknown and unexplained phenomenon with a conception which they already had, and said, "It rains blood," and so believed, until it was discovered that the color of the rain was owing to the presence in it of particles of sand from the Sahara.* "When the keel of Portuguese ships first furrowed the waters of the Atlantic, the savages viewed with consternation the white-winged ships driven along their coasts by a power to them incomprehensible." They had never seen a ship. What could this apparition be which was borne along as it were on wings? One only conception had they which could aid them in accounting for the motion, and they said, "They are cloud-birds come down on earth." † It is just because the mind can assign only those objects as causes, which it already possesses, that you hear men uttering so much nonsense when they discourse about things quite

* Adair, Hist. Amer. Indians. Lond. 1775, p. 117.

* M. Perty, Die Natur, p. 283.

† Bastian, S. Salvador, S. 269.

without their sphere, but which they try to explain by conceptions belonging within it. In short, this is the origin of all that science which would account for phenomena by an *à priori* theory, as when the motions of the planets were explained on the theories of Ptolemy or of Tycho Brahe. The common people from their stand-point could account for the occurrence of erratic blocks only on the theory that they were fragments of giants' clubs broken in battle, or that they were dropped by giantesses out of their aprons.† The explanations given by Playfair and Venetz lie quite beyond the popular apprehension.

So much therefore is clear, that the undeveloped understanding will of necessity connect in causal relation a number of objects which do not in reality stand to each other in the relation of cause and effect, reason and consequence. The question for such a mind is, to which of the objects of its consciousness it shall specially attribute causality.

The cause, as being the producer, will naturally be regarded as strong, powerful, effective, and so gifted with peculiar attributes: for only that which is possessed of power can produce. Whatever therefore we regard as preëminent in its kind, whatever appears to us as specially notable, peculiar or important, we rate as the cause of other phenomena which we regard as its effects, if only the circumstances of time and space permit such a view. This perception of causality the mind must get from objects within its own range. Now, as we have already seen, the narrower the mind's range, the higher will be its estimate of objects. Therefore, the more restricted the field of consciousness, the more inconsiderable will the objects be which pass for causes —inconsiderable in our view, though of high moment in that of the savage. If we now recall to our minds what has been already observed with regard to the savage's anthropopathic apprehension of objects, the following example will be readily understood, while at the same time it will serve to illustrate the preceding remarks. An iron anchor must be regarded by the savage as a very strange and peculiar object, for he could never mold such an instrument, nor does he see the like every day. "A Kaffir broke a piece off the anchor of a stranded vessel, and soon after died. Ever after the Kaffirs regarded the anchor as something divine, and did it honor by saluting it as they passed by, with a view to propitiate its wrath." * An anchor is, in the eyes of the savage, something so remarkable and so strange, and he is so utterly ignorant of the use it serves, that there was a concourse from all sides to see it, and all were filled with admiration. Their interest was as great as that of an astronomer when he discovers a new planet. That any man should have the hardihood to break off a piece of this singular object was no less matter of astonishment for the Kaffirs than the anchor itself. Well, the man died suddenly. What caused his death? They could find no natural cause: but there was the anchor, and this man had broken off a piece of it. Here were facts which spoke for themselves. So the anchor, the injury done to it, and the death of the Kaffir were without more ado ranged in the order of cause and effect, and the anchor was advanced in the estimation of the savages. The anchor had been injured and outraged and would have its revenge: here we have a specimen of anthropopathic apprehension of an inanimate thing. It slew the impious wretch: here we have an object that appears to be of some importance viewed as the cause of something else, viz.: the death of the transgressor. Henceforth that anchor is a dread and mighty Thing; so they greet it as they pass, to keep it in a good humor.

* Grimm, Deutsche Mythologie, I. Aufl. S. 306–7.

* Alberti, die Kaffern, S. 72; Lichtenstein, Reise, I. 412.

We find in this example four factors. First, the consideration of this strange object as something altogether peculiar, singular and important, simply *because* it is strange. Second, the anthropopathic apprehension of this object as something that lives, feels and wills.* Third, the establishment of the relation of cause and effect between this object and other things. Fourth, the apprehension of it as something mighty, which is therefore to be treated with reverence, to the end it may be friendly; or, in other words, as something which, in virtue of the inner nature attributed to it, becomes an object of veneration. We are now in a position to understand what is meant by a fetich. When an object is viewed in the fourfold manner above set forth, it is then a fetich, and fetiches are therefore objects in which these four factors are united.† The objects here are all sensible objects.

We have now empirically demonstrated that these are the necessary consequences of the savage's intellectual status, viz. : an over-estimate of inconsiderable objects, an anthropopathic apprehension of objects, an erroneous perception of causal relations, and the veneration of objects supposed to be causes. So the fetichistic mode of apprehending things flows quite naturally and inevitably from natural and empiric grounds. Granted only a contracted and undeveloped intelligence, and you have fetichism as the inevitable result. The mental status of the savage finds its natural expression in fetichism : fetichism is its System of the Universe, its philosophy, its religion; and hence fetichism, as being such System, Philosophy and Religion, finds its explanation when we have gained anything like correct notions of the savage intellect.

We will cite a few more examples to show how fetichism is made up of our four factors. "A negro of some distinction, an acquaintance of Römer's, was about to take refuge in a Danish fort, with his family and his valuables, to escape from the attack of a merciless enemy. On quitting his hut in the morning he stumbled on a stone with such violence that he suffered considerable pain. This accident caused him to regard the stone as a fetich. He at once picked it up, and never more parted with it, as through it he succeeded in escaping from the dangers which had threatened him."* "An American savage chose the crucifix and a little image of the Virgin that had come into his possession, for his Manitus. He never parted with them, after he had found, as he believed, that they protected him sundry times against the arrows of his enemy."† "As the Yakuts first saw a camel during an outbreak of the small-pox they pronounced that animal to be a hostile deity who had brought the disease among them.‡

The taboo of the South Sea Islanders is by many writers supposed to resemble the fetich, and even to be identical with it. Still the two things do not appear to be identical, if we accept the account which Gerland gives of the taboo. (Waitz's Anthropologie, Band. 5.) Waitz gives an excellent

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* Bastian, S. Salvador, S. 227.

† The first writer to employ the word fetich was De Brosses in his work "Du culte des dieux Fétiches," which appeared in 1760 anonymously, and without the name of the place of publication. As to the origin of the word he says: " . . . certain deities, whom Europeans call Fetiches, a word formed by our traders in Senegal, out of the Portuguese term Fetisso, *i.e.* enchanted, divine, oracular. It is from the Latin root fatum, fanum, fari." Winterbottom, in his "Account of the Native Africans in the Neighborhood of Sierra Leone," derives the word from the Port. Faticeira, witch, or Faticaria, witchcraft. The Negroes borrowed not only this but also another word, gree-gree, from the Portuguese. According to Bastian (S. Salv. S. 95) the universal name in West-Africa for a fetich is Enquizi. Another name is Mokisso, or Juju (*Ibid.* 254, 81); also Wong (Waitz, II. 183); among several Amer. tribes, Manitu.

* L. F. Römer's Nachrichten von der Küste Guinea. Kopenhagen, 1769, S. 63, 64.

† Charlevoix, Journal historique d'un Voyage de l'Amérique septentrionale. Paris, 1774, p. 387.

‡ Wuttke, Gesch. d. H. I. 72.

definition of the fetich: A fetich, says he, is an object of religious veneration, wherein the material thing and the spirit within it are regarded as one, the two being inseparable. As we have already said, the fetich is any object whatsoever, viewed anthropopathically, or regarded as endowed with human characteristics. Taboo, on the other hand, according to Gerland, is an object which receives religious veneration because it is the temporary abode of a spirit or of a Deity. "We know," says he, "the meaning of the taboo, the religious ban of Polynesia, and the question arises whether the same custom prevails also in Micronesia? It does; but though in the latter islands the belief in taboo is as universal as in Polynesia, still the taboo has not there so extensive a range of objects. (Gulick, Micronesia, in the *Nautical Magazine*, 1862, 417.)" The taboo attaches to meat and drink; and the notables of the Ladrones will not eat eels: the isolated inhabitants of Ponapi, the Marshall and the Gilbert Islands, etc., will not eat the flesh of this or that animal; the common people on those islands must not eat the kava, and on the island of Kusaie they must abstain from the cocoanut, etc.; several trees also are taboo, *i.e.* forbidden (Mertens, Recueil des Actes de la Séance, publ. de l'Acad. imp. Scientifique de St. Petersburg, 29 déc. 1829, 177); the rain-conjurers must not eat the blooms of the pandanus. Also places, temples and persons, *v.g.* great princes, are taboo for the commonalty. Whoever would go a fishing must be continent for the space of twenty-four hours. In conversing with women certain words were taboo: and thus we might go on rehearsing an interminable list of such prohibitions. The word taboo also is used in Micronesia (Kotzebue, Entdeckungsreise, II. 59; Hale, Ethnographie, in his Tarawa vocabulary, s. v. Tabu; Pickering, Memoir, s. v. Tabu, etc.), and in the isle of Morileu the word *pennant* is employed in the same sense. Thus a tree, or a locality, etc., would be *pennant* (Mertens, 134). Nor were the ceremonies employed in Micronesia to lift the taboo less imposing than those in use in Polynesia. Thus Cheyne describes a very protracted festival which he saw observed on the isle of Eap, the chief ceremony consisting of prayers addressed by the priests to the Sea-god, to induce him to quit a vessel that was taboo, and return to his native element. (Cheyne, "A Description of Islands," etc., 157 seq.) From this narrative we learn what is the meaning of Taboo. The god enters a thing and thus withdraws it from common use. The chieftains being of divine origin, their person and property are taboo to the commonalty, as is also whatever they are pleased to declare taboo.* This view of the taboo is very probably the correct one; yet we must not suppose that in Polynesia and in Micronesia the taboo is not also regarded in another light, and apprehended as a fetich. On the isle of Nukunono Fakaafo worship used to be paid to the Tui Tokelau, or Lord of Tokelau; and this was a stone wrapped up in matting and held so sacred that only the king durst view it, and even he only once a year, when it assumed a fresh suit of matting. (Turner, "Nineteen years in Polynesia," 527.) This stone idol, which was ten feet in height, stood in front of the temple, and was, at the time when Hale saw it, ten feet in circumference, owing to its thick wrappages of matting. (Hale, 158; Turner, 527). It was the Tui Tokelau that caused disease, so whoever was attacked would have a new mat wrapped about the god, to propitiate his wrath by means of this rather costly offering.† As this stone was considered so sacred, it was natural for the people to identify it with the deity. Whatever offerings they made to the stone, were made to the god: whatever petitions they had to address to the god, were addressed to the stone. Which is here the god,

* Waitz, Anthrop. Bd. V. Abtheil. 2; Gerland, S. 147.

† Waitz, Anthrop. V. Abth. 2, S. 195.

the stone or the deity? The better class of the islanders, those best instructed by the priests as to their religious belief, would perhaps regard the stone as only the habitation of the god, and consider the latter as distinct from the stone. But would the more ignorant sort make such a distinction? If not, the taboo was for them a fetich.

Here we have an observation to make. The so-called Religion of Nature, *i.e.*, the religion of the savage, has two aspects, which must be sharply defined and kept separate if we would have clear conceptions on the subject. Under one aspect sensible objects are worshiped; under the other, worship is paid to spirits. It is not asserted that either of these branches of Natural Religion arose prior to the other: they are both perfectly natural phenomena, springing inevitably out of an undeveloped state of intellect. The worship of sensible objects is founded on the relation subsisting betwen the mind and such objects: the worship of spirits is founded on the relation between the mind and the souls of the departed. These two systems run parallel to one another, and here and there unite their currents to form a single stream. This subject I propose to consider in another place. At present we have to do only with the worship of sensible objects, *i.e.*, with fetichism, and we purposely omit the consideration of the other branch of Natural Religion. We do not assert that the only religion of the Negro, for instance, is fetich-worship, though we study the Negro here only in so far as he is a fetichist. Just as in the higher grades of intelligence one individual will surpass another in mental development, so too will one savage excel another, and attain a higher grade of religious development, however contemptible his very highest grade may appear to be in our estimation. Thus the savage has already made one step in advance, as soon as he perceives that the object of his worship is not a being possessed of anthropopathic properties, that it cannot of itself perform those acts which he formerly attributed to it, or when he recognizes as ***inhabiting*** the object, a spirit separate from the material thing. Fetichism becomes thus elevated by means of the belief in spirits, and the fetich is advanced to the higher grade of the taboo. As the South Sea Islanders are raised above the very lowest stage of intelligence, the taboo is better adapted to them than the fetich. For the same reason, intelligent Negroes regard their fetich as taboo. Halleur gives the following as a specimen of Negro intelligence: "I wished to make a Negro understand the folly of offering to the fetich—a tree, for instance—food, drink, lemons, and palm-oil, as he himself must know that the tree made no use of them. 'Oh,' said the Negro, 'it is not the tree that is the fetich. The fetich is a spirit, and invisible, who lives in the tree. To be sure, he does not consume the material food, but he enjoys its spiritual portion, and rejects the material, which we see.'" * Here is the fetichist become a tabooist, supposing that the description of tabooism heretofore given is correct.

CHAPTER IV.

FETICHISM AS A RELIGION.

1. *The Belief in Fetiches.*

ACCIDENTAL coincidence determines whether or no an object shall be regarded as a fetich, as we have seen in the foregoing examples. The savage, however, cannot entertain a doubt as to the power of his fetich, for he has had evidence of this, and with his own eyes has seen how such and such an object brought about such and such an event: how the anchor slew the man, how the camel brought the smallpox. It is only after he has found

* Halleur, S. 39.

his fetich powerless in a considerable number of instances that he is undeceived. But it is a very difficult thing for him, owing to the obtuseness of his intellect, to suspect that the true cause may lie outside of his fetich. Even if his faith is shaken, it is impaired only so far as regards one special fetich, while it remains firm as to all others. He bases his judgment on the most superficial grounds. Thus, a plague broke out in Molembo soon after the death of a Portuguese ; the two things were arranged in the order of cause and effect, and as long as the memory of the plague lasted the people of Molembo were very careful that no European should die within the limits of their country.* When cases occur, wherein the savage, according to his way of judging, directly sees the action of his fetich, his belief is confirmed. "In a clearing in the woods," writes Bastian, "I observed on the side of the road a fetich-house, and wished to examine it more closely, but my black carriers could not be induced to carry me to the spot. As I alighted, to go on foot, they almost resorted to violence to withhold me from executing my purpose, and I read in their eyes, when I came back to them, that they regarded me as certain to die very soon. . . . Weary, I reached Quimolenzo toward night, when suddenly my sight failed me, and I felt myself sinking powerless to the ground. A violent fever raged in all my veins, and this continued through the entire night. The following day it was the same, and I was so weak I could not rise from the bed. My people exchanged knowing looks, as much as to say: The spell of the fetich is working ; and they were quite sure they would have to bury me before night." † "In front of the American's house (in Shemba-Shemba, West Africa) there was a crowd of people assembled, in the midst of whom a fetich-priest was running up and down with loud cries, jerking hither and thither a wooden puppet decked with tatters of every color, and beating it with a switch on the face and shoulders. I learned that a knife had been stolen from one of the Negroes, and he had applied for its recovery to this priest, who was the owner of a fetich in high repute as a detective of thieves. The unfortunate god appeared to me to have paid dearly for his reputation, seeing that he got a merciless whipping to begin with, to teach him the necessity of attending seriously to his business. The priest having wrought himself up to a high state of prophetic clairvoyance, announced to the spectators, in a tone of perfect assurance, that the next morning they would find the knife alongside the fetich, which he posted in front of the factory. In the morning there lay the knife, for the merchant, disliking a continuance of these ceremonies for an entire week, chose rather to confirm the infallibility of the fetich, than to expose his property to the risk of being plundered, if the people continued to flock around his establishment." *

The savage has never a doubt as to the efficiency of his fetich, and his faith is all the stronger because ever since he was a child he has seen every one entertaining the same belief, and so his mental fiber is, so to speak, saturated with it. Every one knows the force of early impressions ; how the great mass of mankind never emancipate themselves from their influence, and how it is only after many a painful inward conflict that a man escapes from their dominion. But this absolute faith of the savage in the power of his fetich, disposes him to view it with dread ; this dread in turn serves to exaggerate the apparent efficiency of the fetich and so to confirm more and more the man's belief in its power. "When a Negro has anything stolen from him he entreats some great fetich to discover the thief. The pomp of ceremony attending the consultation of the fetich oftentimes

* Bastian, S. Salv. S. 104.

† *Ibid.* S. 50, 53.

* Bastian, S. 61.

so fills the thief with consternation that he surrenders the property." * The thief being also convinced that the fetich has power to hurt him, gives back what he has stolen, or confesses the theft. "The rich frequently employ a Kassa potion to make their domestics confess their thefts." † In Great Bassam they merely lay a fetich-stick upon the body of the accused. If he is guilty, he is sure to confess; his fears will extort the admission.‡ Beneath the threshold of the king of Dahomey's palace is set a charm which causes his wives internal pains whenever they are guilty of misconduct, and so they often find themselves constrained to make a voluntary confession of their guilt.§ To this category of beliefs belongs the so-called *Judgment by the Lizard*, which is in vogue among the inhabitants of Senegal. A smith beats upon a lizard with his hammer; the fear of incurring the evil fortune which is supposed to follow from this performance is expected to bring the thief to a confession, and it usually does.‖ Many similar delusions are recorded in books of travel. But especially noteworthy is the Obeah of the West India Islands, particularly Jamaica, a baneful superstition for the eradication of which the most stringent enactments of law have proved insufficient. Its influence upon the minds of the Negroes is so great that at one period it notably increased mortality among them; at another, stirred them up to mutiny, by impressing them with a belief that they were invulnerable.¶

Thus fetiches serve for ordeals, which among the Negroes usually consist of poisonous potions, or of emetics and drastic agents.* The fetich has power to punish the guilty: the innocent he will not hurt. As the fetich must come into bodily contact with the subject of the ordeal, the latter is required to drink fetich-water,† or water in which the bark of the wild manioc, or some other substance has been steeped. According to Halleur, "fetich-water is prepared from the bark of the tree odum. It is supposed that, as this tree is always a fetich, when a person accused of crime drinks the water in which its bark has been steeped, the fetich enters into him and thus discovers either his guilt or his innocence. If the accused party vomits, it is a sign that the fetich has discovered his innocence, and is quitting his body: but if the fetich-water is retained, then the fetich has discovered his guilt, and will not quit him until he has been punished." ‡ "The accused may, under certain conditions, send a slave to take the questionable potion in his stead. Many, however, of their own accord apply to have the fetich-water administered to them, to be purified by the ordeal." § Very often the accused has the magical potion given to him without his knowledge, so that the savage lives in constant fear lest any one should employ this redoubtable form of fetich against him. The power of this spell may be estimated from the fact that the trading-post of Bimbia, between the Calabar and the Cameroons, and opposite to Fernando Po, which was at one time a missionary station, has become almost entirely depopulated, owing to the employment of the fetich-water during many years by the notables of the place on every slight occasion.‖ Nor is the ordeal by fire or that by water unknown in Africa. In Mada-

* Proyart's Geschichte von Loango, Kakongo u. s. w. Aus dem Französischen. Leipzig, 1777, I. 167.

† Bastian, S. Salv. 61.

‡ Hecquard, Reise an die Küste und in das Innere von Westafrika. Leipzig, 1854, S. 48.

§ Forbes, Dahomey and the Dahomans. Paris, 1851, p. 55.

‖ Boillat, Esquisses sénégaliques. Paris, 1853, p. 102.

¶ Bryan Edwards, Hist. des Colon. Anglaises, p. 266; Waitz, II. 190.

* Winterbottom, p. 172; Köler, Einige Notizen über Bonny. Göttingen, 1848, S. 127 seqq.; Cavazzi, Histor. Beschr. der Königreiche Congo, etc., 1694, 94, 108 seqq.; Proyart, S. 141.

† Bastian, San Salvador, S. 84, 306. *Cf.* S. 203.

‡ Halleur, S. 34.

§ Bastian, S. Salvador, S. 85.

‖ *Ibid.* S. 306.

gascar the accused person has to undergo the ordeal of red-hot iron.* Among the Malay Lapongs the glowing iron is applied to the tongue of the accused,† while among the Antaymours the ordeal requires him to swim across a stream inhabited by caymans.

If a fetich which first owed its distinction to accident, displays its power again on another occasion, it may easily transcend the rank of being one man's fetich and be adopted by an entire family, or even by a larger aggregation. For in America, Africa, and Siberia,‡ each individual has his separate fetich; each family, and even each tribe, their respective fetiches. The fetich of a tribe is honored with more pious and constant devotion than the inferior fetiches, as having for a longer period shown his efficiency.§ Thus there are Grand Fetiches, which are regarded with profound awe, and which, in the shape of mountains, trees, rocks, etc., protect the chiefs or the territory of the tribe.‖ The fate of mankind is by the American Indian thought to depend upon the belt of wampum. The chief of the Muemba is Chiti Muculo, "the Great Stick, the Great Tree," The center of religious and political life among the Wanikas is the Muansa, in whose honor the tribe celebrate roaring festivals, and which is to be approached only by the chief. This holy of holies is a wooden instrument which emits a peculiar buzzing sound.* The Grand Fetiches have their mysterious influence intensified, by being, as far as possible, withheld from the gaze of the profane. "The Grand Fetich," says Bastian, speaking of one in Congo, "dwells in the midst of the bush, where no man sees him, or can see him. When he dies, the fetich-priests carefully collect his bones, in order to reanimate them; and supply them with nourishment, so that the Fetich may anew gain flesh and blood." †

Nor do the Negroes regard the Christian religion as anything but the worship of a Grand Fetich. Thus San Salvador (called by the natives Congo dia Gunga—the tones of the bells—on account of the great number of its churches and convents) was widely known and feared throughout South Africa, as the home of a powerful fetich.‡ The negro is so rooted in this mode of apprehending things, that he is ever returning to it, or rather, he never quite gives it up. "It has ever been the study of the missionaries to check the abominable practices of fetichism, and with the aid of the civil power they have succeeded in abolishing the worst features of this Moloch worship, though not in substituting any other religion in its place, and the Negroes have advanced only so far toward conversion as to use salt." § The only reason however that induced them to go even thus far was, that they thought salt would cause their children to grow fat. But they soon refused salt again, first because the ceremony cost too dearly, and secondly, because, as they

* Leguével de Lacombe, Voy. à Madagascar (1823–30). Paris, 1840, I. 233.

† Waitz, Anthrop. V. Abth. I. S. 149. *Cf.* II. 523.

‡ Charlevoix, p. 344, 346. Lettres édif. Nouv. Ed. VI. 174. De Bry, Descriptio auriferi Regni Guineæ in Part VI. of India Orientalis, VI. 21. Oldendorp, Geschichte der Mission der evangelischen Brüder auf den caraibischen Inseln St. Thomas, St. Croix, und St. Jean, herausgegeben von J. J. Bassonet. Barby, 1777, I. 320 ff. Des Marchais, Voyage en Guinée, Isles voisines et à Cayenne en 1725–27 par le P. Labat. Amsterdam, 1731, II. 131, 152. Georgi, Beschreibung, S. 384.

§ J. B. Müller, Mœurs et Usages des Ostiakes, in the Recueil des Voyages au Nord. Amst. 1731, Tom. viii, 413, 414: "Les Ostiakes ont beaucoup plus de vénération pour leurs idoles publiques, qu'ils ne dépouillent pas et n'abandonnent pas comme les autres; mais ils les estiment au contraire, et les revèrent comme etant d'ancienne date et d'une autorité reçue et avérée.

‖ De Bry, vi. 21. Des Marchais, I. 297: "Les rois et les païs en ont d'autres qu'ils appellent les grands Fétiches, qui conservent le prince ou le païs: telle est quelquefois une grande montagne, un gros rocher, un grand arbree," etc.

* Waitz, Anthrop. III. 190; II. 422, 424.

† Bastian, S. Salv. S. 82.

‡ Bastian, S. Salv. S. 173.

§ *Ibid.* S. 96.

said, the elephant grows fat though he uses no salt. "In Congo, where the ruins of churches have served to perpetuate the memory of the Christian religion, the natives account for their ignorance of Christianity by saying that the Desu of the Portuguese is too mighty a fetich for common folk, and so was reserved for the king alone, while his subjects had more comfort in worshiping fetiches of the time of Chitome, Guardian of the Sacred Fire.* A Christian priest is for them only a fetich priest practicing peculiar fetich ceremonies. "When the slaves, torn from family and friends, were put on shipboard in chains, to drag out a miserable existence over sea beneath a foreign sky, and in foreign lands, the pious bishop of Loanda sat on the stone seat at the end of the wharf and assured them, with his apostolical benediction, of a future replete with joys unutterable, with which the brief period of their probation here below durst not be compared. The poor Negroes understood nothing of the ceremony but this, that the white man's fetich now deprived them of their last hope of ever again seeing their native place. Their names however were registered in the account presented to the Pope by the society de propaganda fide, to be by him duly authenticated and submitted to St. Peter."†

As all the savage's thoughts and the whole conduct of his life are governed by fetichism, he regards his fetiches as absolutely necessary to his existence. Any rude shock given to this system of ideas and usage, causes emotions in the mind of the savage, as painful as those aroused in men of other beliefs by the act of sacrilege, and the hatred of the blacks for the whites is largely owing to the disregard of this fact on the part of the latter, and to the daily and hourly insults which they thus offer to the black man's religion. Bastian wished to take a bath in a river near a certain Negro village. As he was on his way he was met by the Mafooka, the oldest man in the place, accompanied by the entire population. "On inquiring what he wanted, I found that he desired me not to go any nearer to the water; and he promised that my name should live for all time in the songs of that valley, if I would yield to his most humble entreaty. I scarce thought it worth while to pay any attention to the absurd request, which I judged to have been made simply with a view to deprive me of a pleasure I had long coveted, so I told the gabbing old man to betake him to a warmer region than his own country, and ordered my carriers to go on. This however it was impossible for them to do, for screaming children in swarms grasped them by the legs, and threw themselves upon the ground before them, to block up the way. In heart-rending tones of wailing the Mafooka, in the mean while, struck up a song of woe, the effect of which was increased to the most painful degree by the chorus, in which all joined. The expression of blank despair was visible on every countenance. Poor people! Small wonder it was so: for the next day, on further inquiry, I learned that had I looked upon the stream, its sources would have been dried up forever, and their only supply of water cut off! Rather than bring upon my soul the guilt of so great a catastrophe, I preferred to return unrefreshed. . . . . As we came near another village, my carriers halted, and the interpreter said my coming must be announced beforehand. I therefore dispatched him to make the announcement. On his return he informed me that the usages of that country did not permit any one to pass through the village in a hanging-mat. To avoid delay, I submitted to the regulation: but when he insisted on my going through the same formalities at the next village I ordered the bearers to move on. They hesitated, and only resumed the journey after repeated commands. Scarce had we reached the first hut, when with wild cries the entire popu-

* Bast. S. 96.
† *Ibid.* S. 98.

lation, armed with spears, sticks and muskets, surrounded my mat-palanquin and began to belabor the carriers. In the mean time I had distributed among my coolies the guns I had with me for presents, and, alighting at the moment of the attack, we soon had an unobstructed passage. I passed through the villages thereafter without difficulty, and so I saved much time which else had been wasted in the observance of ancient customs. Wherever I observed that this disregard for ceremony gave very deep offense, I distributed a few gifts among the seniors to appease them."*

Thus the savage is the abject slave of customs which to us appear ridiculous; and so little doubt has the Negro as to the truth of his fetichistic religion, that many of them ascribe the contempt of Europeans for the fetiches to the natural stupidity of the white man.† Every Negro, even the sternest autocrats and despots, bow in reverence before the fetich. "Every year the Duke and Duchess of Sundi were required to wage a symbolic contest with the chief fetich priest, by the sacred tree in Gimbo Amburi; they were always worsted, and obliged to acknowledge the fetich's power." ‡ Even if the Negroes do now and then admit the absurdity of their faith and worship, still they cling to them because tradition vouches for them and they themselves know of nothing better.§

2. *The Range of Fetich Influence.*

The efficiency of the fetich is, for the savage, beyond all question, and there is no limit assignable for its influence. I do not mean to say that each individual fetich possesses this unlimited power, but that there is nothing which is not subject to one fetich or another. The question for the savage is what kind of objects may be employed as fetiches to meet various contingencies. Not to speak of the daily discovery of fetich power in new objects, there are sundry things which have long been known as *fetich* for certain defined purposes, and which, as such, are received by all. Now a fetich may be either friendly or hostile toward me. First, he shows himself friendly toward me when he confers a benefit, or when he preserves me from evil. The Cabinda Negroes always carry their little idols (Manipancha) about with them; commune with them in a state of high nervous excitement; counsel with them as to the future; obtain from them news about home and family, and have firm faith in the revelations which they suppose they receive from their fetiches.* Some American Indians carry similar figures, carefully wrapped up, in their medicine-bags. On solemn occasions they are taken out and treated with great reverence.† In short, no action of any moment is commenced, whether the chase, or fishing, or war, without first consulting the fetiches as to its ultimate success and as to the best mode of commencing it.‡ As in the ordeal, the fetich here appears as a Being that knows hidden things: in the ordeal, things past, here things to come. This is the original of the Oracles. On the Gold Coast the most renowned Oracle is at Mankassim.§ But the fetiches confer other benefits, besides revealing the past and the future. They bring "luck;" and for this purpose they are carried on fishing and hunting expeditions and when the tribe goes to war. There are fetiches for river fish and for sea fish; for favoring winds; for a cheap market; for health; for clear sight, etc.‖

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* Bastian, 60, 108.
† Livingstone, Missionary Travs. (Germ. Trans.). Leipzig, 1858, II. 83.
‡ Bastian, 204.
§ Bosmann, III. 281.

* Bastian, S. 81; Tams, Die portug. Besitzungen in S. W. Afrika. Hamb. 1845, S. 89.
† Schoolcraft, Information, etc., V. 169.
‡ *Cf.* Meiners, Allg. Krit. Gesch. d. R. Bd. 1, S. 176.
§ Cruickshank, Eighteen years on Gold Coast (1834), p. 227.
‖ Bastian, S. Salv. S. 80; Des Marchais, II. 130 seqq., 152 seqq.; Bosmann, 179 ff.;

"The usual form of a fetich specially intended for those on a journey is a ball of red cloth, within which the fetich priest encloses some powerful medicine, generally the extract of some plant (milongo). Further, the Negro suspends all about his person cords with most complicated knots, roots, bullets, and in a word any object that strikes his fancy. The Bushman who acted as my guide in Shemba-Shemba had an image three feet long dangling from his belt, which he never would think of removing. In fact, the heavier the load with which you burden a Negro, the greater the number of fetiches he in turn will add, to make things even." * The ordinary fetich is generally a very unpretentious object—often a couple of leaves from a tree.† "The poorer Negroes of the interior are often quite content if they only have a cord to tie around the calf of the leg. Frequently this cord is of matebbe, which, like plumes in the hair, gives invulnerability. The Kroo Negroes almost universally wear this cord around the shank, but more loosely than the Caraibs. The Catholic missionaries were for a while much elated with the thought that they had rooted out this particular form of fetichism, by substituting for the common cord one twisted out of palm-leaves blessed on Palm Sunday."‡ Among the Kaffirs the warriors are rendered invulnerable by means of a black cross on their foreheads and black stripes on the cheeks, both painted by the Inyanga, or fetich-priest. This contrivance makes the warrior invisible, while it deprives the enemy of his sight and fills him with terror.§ The Negro's faith in his fetich which renders him invulnerable and disables his enemy's arm is so strong, that he will court danger, suffer arrows to be shot at him, and allow his arms and legs to be hewn off.*

But yet some discretion is to be used in the choice of the material which constitutes the fetich, and the savage will very naturally suffer his choice to be determined by the value of the object he selects. The natives of Siberia prefer metallic fetiches to all others, these being, as they suppose, by reason of their great age, possessed of a longer experience and a higher wisdom than are possessed by other materials less durable by nature.†

In warding off evil the fetich does but exhibit the other side of his beneficent disposition. There are fetiches against thunder; to extract thorns that have penetrated into the feet; against wild beasts; to save one from missing his path, etc.‡ By being employed against disease, the fetich becomes medicinal, and thus also the fetich-priest is at the same time necessarily a medicine-man, or physician.§ "When on Fernando Po contagious diseases break out among the children the skin of a snake is fastened to a pole in the middle of the market-place, and thither mothers bring their infants, to touch this fetich. In the village of Issapoo the renewal of this snake-skin in the Reossa (market-place) is the occasion of an annual festival, and it is first touched by the infants born during the preceding year." ‖ The savage, being ignorant of the real cause of disease, attributes it directly to the action of a hostile fetich, and always judges death to

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Proyart, I. 167; Oldendorp, I. 324; Georgi, S. 384; Voy. au Nord. VIII. 410–414; Charlevoix, p. 340, 348; Lettres édifiantes, Nouv. Ed. VI. 174 seqq.

* Bastian, S. 80.

† Halleur, 19. *Cf.* Waitz, II. S. 186.

‡ Bastian, S. 79.

§ Döhne, Zulu-Kafir Dictionary. Cape T. 1857, p. 303.

* Proyart, p. 192; Bowdich, p. 364 seqq.; Köler, S. 127.

† Voyages au Nord. VIII. 414. "Ils ont beaucoup de confiance en elles, surtout quand elles sont d'àirain, cela leur donnaut, à ce qu'ils imaginent, une sorte d'immortalité, parce qu'elles ont resisté à la corruption du temps immémorial, et qu'elles ont acquis, pendant tant d'années, beaucoup de lumières et d'expérience.

‡ Bastian, 80.

§ *Ibid.* 81, 138.

‖ Bastian, 318, 319.

be brought about by witchcraft.* Against such a power naught can avail, save counter charms, to be obtained by the priest or magician from their more potent fetiches. It is true, the Mandigoes employ many wholesome medicinal agents—herbs, potions, infusions—but yet they generally make only external applications of them.† As a lock of hair, or a few drops of blood, may be so enchanted as to throw a spell upon the person from whom they were taken, the Kaffirs, in order to avoid the suspicion of such practices, are always very careful to restore such articles—vermin included—to the owner, so that he may secretly bury them out of sight, or destroy them. ‡ "In case of sickness they call in a male or female conjurer; and of these there is one specially qualified to deal with each special class of diseases. The conjurer undertakes to blow counter to the evil wind sent from a distance by some enemy: if, however, he is unsuccessful in this, nor yet can prevail with the aid of music, then he gives up his patient to the wicked dæmon." § "When a Negro falls sick," says Halleur, who describes the scene more particularly, "his relatives apply to the fetich-priest. After he has got their offering of rum and cowries (for without these gifts the holy man is quite inaccessible) he inquires of his fetich, who it is that has bewitched the sick man: for they believe that disease is caused only by witchcraft. The priest next fashions out of clay an image of the conjurer named by the fetich and carries it into the forest." This same course is followed by the medicine-men among the American Indians. They stab the image with knives, or shoot arrows into it, whereby the witchcraft is turned against the conjurer himself. It frequently happens that he who is the bewitched actually regards himself as held by a spell, and soon dies of profound melancholy.* "But," continues Halleur, "if the spell is obstinate, and refuses to give way, then the rum-offering and the ceremonies of disenchantment must be repeated, and the patient treated with remedies prescribed by the fetich, and prepared by the priest. This treatment is followed up till the sick man either recovers, or succumbs to the power of the over-strong spell. The corpse is borne about the entire village previous to its interment in its former home. Oftentimes the bearers, when passing the house of one they dislike, or on meeting such a one on the street, halt suddenly, pretending that the corpse refuses to go any further. The priest asks of the dead man the reason of this unwillingness to proceed, and gets for answer that the occupant of the house or the passenger in question is the conjurer that bewitched him. The man is at once arrested and held to prove his innocence, after the funeral is over. This proof is made by the administration of the fetich-water. The punishment is death, in case the suspected murderer cannot prove his innocence, or if, when proved guilty, he cannot purchase life for a considerable sum." † "When the draught of fetich water proves fatal to the party accused, the priests search for the seat of the enchantment in the dead body, and exhibit to the people portions of the viscera forcibly torn from their place and now unrecognizable, as *corpora delicti*, just as the medicine-men pretend to extract a splinter or a stone.‡

Among the Bambarras, if one of the highest caste of the Kubaris fall

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* *Ibid.* 91; Halleur, S. 32; Waitz, II. 188, 503.

† Park, Voyage dans l'interieur de l'Afrique. Paris, an VIII. II. 27 seqq.; Cord.-Laing, Voyage dans le Timani, le Kouranko et le Soulimana (1822). Paris, 1826, p. 350.

‡ Steedman, Wandering and Adventures in the Interior of Africa. London, 1835, I. 266.

§ Bastian, 87.

* De la Potherie, Hist. de l'Amér. septentr. Paris, 1722, II. 39; Keating, Narr. of an Exped. to the Source of St. Peter's Riv. London, 1825, II. 159.

† Halleur, S. 32 ff.; Vignon in N. Ann. des Voy. 1856, IV. 299; Waitz, II. 189.

‡ Bastian, 85.

sick, the presumptive cause of his disorder is, that someone has, whether purposely or unawares, touched one of his wives. The offender, who must be discovered, and who is discovered by the great oracle of the Buri, is either banished or put to death.* It may, however, appear to the priest that the disease was due to the patient's own transgression, in having forsworn, or omitted the customary offerings.†

The fetich has power to heal bodily diseases; a draught of fetich-water can discover in the heart the proofs whether of guilt or of innocence; and it is therefore but natural that it should have also power to banish moral ills. During the festival of the First Fruits the men of the Creek tribe of American Indians used to take, after a prolonged fast, the war-medicine, being strong emetics and drastic agents,‡ while the women bathed and washed themselves. All offenses, with the exception of murder, were thus blotted out.§ It is beyond question that the idea of purification from sin attached to these ceremonies, but especially to the bath and the drinking of the "black draught" as it was called, an infusion of dried cassine-leaves. The taking of this draught was accompanied with peculiar rites; and it was intended also to "give courage and cement friendship." The Cherokees used a similar potion, "to wash their sins away," as they said.‖ "Though the superficial observer might here suspect a reminiscence of Christian doctrine, still if we look at the matter more nearly it will scarcely appear probable that so important and mystic a rite should have had such an origin, especially as we seek in vain among these tribes for any evidence of their having been ever in contact with the Christian religion."*

The savage attributes to fetich influence not alone disease and death, but every phenomenon he is unable to account for, as, for instance, storms and the changes of weather. He is thus furnished with an explanation for everything; and this explanation is entirely satisfactory to him. It is plain that this fact of the savage having ever ready at hand such unquestioned "ultimate reasons" to account for everything must check the development of his mind, or, in other words, must retard his progress toward civilization. For he knows *à priori* the cause of phenomena, and the means by which they are produced: hence it never occurs to him to study their natural causes and conditions: consequently he does not recognize the natural relations between things, and fails to discover that the supposed cause is no cause at all. His mind accordingly makes no advance, but is ever under the tyranny of hallucination. And every *à priori* principle has the like tendency to check the mind's development; for here it is all one whether it is the Negro that says: this is the work of the fetich; or whether it is the Mohammedan that says: this is Allah's work. A formula explains everything for them both, and by its very explanation leaves everything unexplained.

Fetiches also ward off evil spirits. When the women in Shemba-Shemba have occasion to quit their fields for a time, they strew them with fragments of pottery, for else the malign spirits would trample down the crop.† The Negroes of Whida post fetich images, five or six inches in height, at either end of their fields, at the doors of their houses, in their apartments, court-yards and cattle-stalls, being fully convinced that else evil-minded spirits or men would do them

* Raffenel, Voy. dans l'Afrique occid. (1843–4). Paris, 1846, I. 318.

† Bosmann, II. 184.

‡ Schoolcraft, Information resp. the History, Condition and Prospects of the Indian Tribes. Phila. 1851, V. 685.

§ Adair, Hist. Amer. Indians. Lond. 1775, p. 105, 120; Schoolcr. V. 266 seq.

‖ Memoirs of Timberlake. Lond. 1765, p. 78.

* Waitz, Anthr. III. 209. Similar rites among the Kaffirs, II. 414.

† Bastian, S. 62

injury.* The same custom is followed by the Polynesians of New Zealand, Hawaii, Nukahiva and other islands.† Burying-places, too, are protected by potsherds and little images.‡ A low, thin hedge encircles Negro villages, at a distance of about 100 paces from the huts, and this serves to keep aloof evil spirits.§ A line of twisted bast forms a cordon of defense round about a Boobie village in Fernando Po. Here also the natives employ mussel shells as fetiches. When the devil would come to do them harm, his feet are lacerated by the angular points of the shells.‖ Seeing that spirits have such fear of the fetiches with what dread thieves must regard them! "Over the doorway of the Negro hut are suspended roots and cast-off rags, and often broken egg-shells, as guardian fetiches. Others employ a block of wood with the likeness of a human face cut in it, and this they plant within the doorway of the hut, or in their fields; yet most of them are contented with a rather smoothly-dressed pole, on which they set a snail's shell, as a most potent fetich." "In a village near S. Salvador I saw wooden fetiches with lofty plumes, set up as guardians in front of the houses; in front of the main entrance to another village I saw an empty pot supported on a forked stick." "They have no locks to their doors, nor do they need them, for but rarely is there found a thief so foolhardy as to pass the fetich posted near the threshold." ¶ "The Negro avoids touching them, lest a curse should come upon him." * The following will show how dangerous a thing it is merely to touch a fetich. Captain Rytschkow, having entered a hut in a certain Wotiak village, observed lying on a board that was fastened to the wall something which he took to be dried grass. He approached to examine it, but scarcely had he taken it in hand when the owner of the hut and his wife, with loud cries of distress, ran to where he stood and begged him piteously not to touch their Modor, or household god. They explained to him how the most grievous misfortune would befall them if even one of the family, to say nothing of a stranger, were to touch the Modor. This Modor consisted of some sprigs of fir, which a certain aged Wotiak had alone the right to touch and to distribute among the several families.† But the guardian power of fetiches goes farther still: to them indeed the appeal is made, *Videant ne respublica detrimentum capiat.* They are the Protectors of the country ‡ and of its laws. "To give due sanction to a law, it is placed under the special protection of a fetich, whose duty it then is to punish violators of it, as also the one who, knowing of a violation, does not lodge a complaint against the offender." Furthermore, "when a priest administers an oath, he gives to both parties a draught of the *bitter water*, and this, laden as it is with the fetich's malediction, will slay the one who proves false."§ The Orang-Benuas in Malacca have similar usages, and indeed they prevail throughout the entire Malay race, being practiced especially when they form alliances. They drink some liquid mixed with blood, in which a dagger or the points

* Des Marchais, II. p. 153. Ce sont pour l'ordinaire des petits marmousets de terre rouge ou noire de cinq ou six pouces de hauteur; ils les mettent à la tête et à la queue de leurs champs, aux portes de leurs maisons, dans leurs chambres, dans leurs cours, dans leurs parcs à cochons, dans leurs pouliers; . . . ce sont pour eux des gardiens, des sauve-gardes à qui ils se croyent redevables du bien qu'ils ont, et d'être à couvert des malheurs qu'ils craignent. *Cf.* also Römer, Guinea, S. 38.

† Gerland, *ap.* Waitz, Anthr. V. 2, 225.

‡ Bastian, S. Salvador, S. 107, 124.

§ Halleur, S. 23.

‖ Bastian, S. 316, 348.

¶ *Cf.* Waitz, II. 422, 502.

* Waitz, 79, 186, 316, 78, 348. The same is related of the Loando Negroes by Proyart, I. 168, 169.

† Rytschkow, Tagebuch über seine Reise durch verschiedene Provinzen d. Russ. Reiches in. den Jahren, 1769–71, S. 166, 167.

‡ Des Marchais, I. 297.

§ Bastian, 293, 90; Waitz, II. 157; Meiners, B. I. 176.

of arrows have been dipped; these will kill the perjurer.* The Burats pay special worship to a lofty rock on the shore of Lake Baikal. They who take an oath must ascend this rock, and on its summit perform the usual rites. It is the firm belief of the natives that whosoever profanes by perjury the sacred mount can never come down again, and that the mountain slays him.†

Among the Africans, too, as among the Malays, alliances are consecrated and confirmed by being placed under the protection of a fetich. "At the conclusion of the meal, each Macota comes and kneels before the Yaga, who puts into the mouth of each a piece of human flesh reserved from the banquet, so that by partaking in common of the viand they may be all bound together by an indissoluble fetich. In Great Bassam, after the feticeros have ascertained the portents betokened by the entrails, the heart and liver of the victim sacrificed at the forming of a new village, together with the flesh of a hen, a she-goat and a fish are baked all together in a pot, and the entire community is required to eat of the mess, under penalty of dying within the year.‡

The fetich, by punishing perjurers, maintains the stability of oaths and of alliances. The fidelity of the savage depends upon his fear of the fetich: and were he to lose this fear, he would be free from every obligation. When therefore he would renounce these obligations, he must deprive the fetich of all power to do him injury, and break its ban if that can be done; or in case this is impossible, he must only disregard the obligations, and then depend upon gifts and sacrifice to appease the wrath of the offended deity. And either one or other of these two courses the savage in reality adopts. The spell of a mighty fetich may be broken by that of one mightier still; and an offended fetich may be appeased by gifts.* The priest undertakes to make the offering acceptable to the fetich, or to render him harmless. According to Cavazzi, the Ganga Nzi gave release from a sworn obligation, by erasing it, as it were, from the tongue, with the fruit of the palm-tree. Often, too, a fetich may be deprived of the power to hurt, by being imprisoned.†

The power of the fetich is great; great also is the fear which he inspires. Now, just as my fetich can do injury to other men, so may their fetiches injure me. The consequence is that I must be in a state of constant anxiety, and ever on my guard, for how can I say but that some one is possessed of a fetich hostile to me, which he may employ against me? "The savage anxiously scans a stranger, as the latter may perchance be the owner of a formidable fetich. He will be inclined to run away; or, in case he thinks himself strong enough, he will try to make away with the newcomer."‡ In this point of view the following occurrence is characteristic. One of Bastian's suite was attacked and robbed. "I sent a force to the Elder of the nearest village; and on his refusing to come of his own accord, they compelled him to come to me. As the attack took place within his jurisdiction, I held him accountable, and required him either to discover the robbers or himself to make reparation for the outrage. He protested his ignorance of the affair and his inability to comply with my demand. As I could not delay, I took out my note-book, to make a memorandum of the name of the place. So soon as I set pencil to paper he fell into a violent convulsive tremor, and prostrate at my feet, entreated me not to undo him with my fetich-

* Newbold, Account of the British Settlements in the Straits of Malacca. Lond. 1839, II. 395.

† Isbrand, Voy. au N. Tom. VIII.; Pallas, Mongol. Völker, I. 218.

‡ Bastian, S. 154.

* Bosmann, II. 54; Monrad, Gemälde v. d. Küste von Guinea (1805–9). Weimar, 1824, 37, *note*.

† Waitz, Anthr. II. 185.

‡ Bastian, S. 104.

book, for that he was ready to perform whatever I should require."*

Accordingly there are many tribes which have gained for themselves a certain degree of impunity through the terror inspired by their fetiches.†

"The ointment *magya sambo*, invented by Tumba Demba II., daughter of Donghi, and which was prepared from the body of an infant brayed in a mortar, made her warriors invulnerable, and so wrought on the fears of her enemies as to make them powerless."‡

The fortunate possessor of such a "Grand Fetich," which domineers over the fate and fortunes of others, will prize this more than all his other property. A woman held a fetich of this kind, owned by her, dearer than all her children, and refused the offer of five slaves, which was made to her for it.§

The hostile fetich may be concealed anywhere, and may be carried anywhere by an enemy; so that a man is never secure from danger. If the Negroes would take vengeance of any one, they get a feticero to bewitch a piece of meat or other food; and this they set in some place likely to be visited by their adversary, who will thus infallibly come by his death.‖ Accordingly the Negro, ever in dread of witchcraft, at every turn pronounces a counteracting charm. "The host must always first taste of a dish before it is passed to his guests, so as to 'extract the fetich,' and this custom is universal throughout Africa."¶ There are also other fetiches to meet this danger. "To guard against fetich-water, the more wealthy provide themselves with cups made of rhinoceros horn, which pass here, as also in India, for sure reagents against poison. In Bimbia the natives protect themselves against poison-water by burying in some remote valley of the interior a twig with which they mystically connect the duration of their lives, hoping thus to have placed the latter beyond the power of any fetichman."* Nor are fetiches themselves secure against one another, and so quite naturally you will see a fetich with a number of other fetiches attached to him, for protection.†

Ib. 225.
† *Ib.* 129.
‡ *Ib.* 234.
§ Cruikshank, 241 seqq.
‖ Bosmann, Guinea, S. 179.
¶ Bastian, 135.

3. *The Religiosity of Fetich Worshipers.*

The fetich being possessed of such powers, the bestower of so many benefits, the defense against so many ills, it will be the duty of the savage without delay to choose a fetich for his guardian. Accordingly the life of the new-born babe is immediately placed under such tutelage, and the fetich thus chosen as guardian of the infant watches over him through life. But the fetich will not care for his ward except on condition that he receives service in return. He requires of his charge submission, obedience; he exacts a vow,‡ and imposes a command, which his protégé is expected to perform with all fidelity. So long as he is faithfully served, the fetich preserves his ward from danger and misfortune; while, on the other hand, disobedience brings down his wrath, and is surely punished: "In sundry parts of Africa the babe is tattooed on the abdomen immediately after its birth, as a sign of its consecration to some fetich." § "Within a few days after it is born the child is brought to the Ganga (fetich priest), who imposes on it one or more vows; and the mother takes care to accustom her child, from its earliest years, to the performance of those vows, and gives it such instruction as to their obligation as will make it easier in after life to

* *Ibid.* 85, 306.
† Oldendorp, I. 324 ff.
‡ For the Amer. Indians, v. Charlevoix, 349; for the Negr., Moore, Travels into the Inland Parts of Africa, 91; for the Siberians, Georgi's Reise, 599 seqq.
§ Bastian, 77.

discharge them. In some tribes, however, this mystic union with the Mokisso is delayed until the critical period of youth, that of puberty, when, in Africa, the boy-colonies, who then begin to be visited by the ideal dreams of youth, retire into the woods, and when the Indian lad climbs his solitary tree. Important occurrences in one's life are also occasions for acknowledging the power of the fetich." *

Among the American Indians a youth's "life-dream" is of high importance for his successful transition from boyhood to manhood. During this dream he receives a special guardian spirit, his "medicine," which he ever after carries about with him, in the shape of some animal's skin. The youth of 14 or 15 years retires into solitude and there abstains from all food for a time, so that he may dream the better. His dream discloses to him his future destiny and his fortunes through life; and the celestial admonitions which are thus conveyed to him direct his course down to the day of his death.† Many curious names owe their origin to these dreams: "Hole in the Sky" was the name of an Indian whose guardian spirit appeared to him in an opening in the heavens.‡ It is essential that this guardian spirit be seen; and the fasting and dreaming must he continued until some animal makes its appearance. After the dreamer awakes, he tracks an animal of the same species, kills it, and carefully preserves the skin, or at least that part which was specially observed in the dream, and this he always carries about with him. To lose it would earn for him the ignominious title of "Man without medicine," and bring upon him untold misfortunes in later years.§ Families and tribes of Indians have also their guardian fetich in the shape of some animal, as a bear, a buffalo, a hawk, an otter, etc., and the Algonquins called this fetich the Totem.* The whole species represented in the totem was exempt from pursuit. Its name was adopted as that of the clan, and when an individual was questioned as to his own name, he would generally, with a sort of family pride, give that of the totem. Marriage was not to to be contracted between those of the same totem, just as the Negroes of Aquapim regard two families whose fetiches bear one name as related, and so forbidden to intermarry.†

The vows taken in honor of the fetich are of course very simple, and have reference merely to external acts. As specimens of different vows taken in Loango, Dapper gives the following, in addition to a series of minute directions as to costume: ‡ Not to eat such or such flesh, birds, fishes; such or such herbs, fruits, etc.: or if one ate of them, to do so all alone and afterward to bury the bones. Others bound themselves never to pass over water, even were the same in small quantity, or had fallen in the shape of rain, or had come from any other source. Others again were not to cross a river in a boat with their shoes on, though they might wade or cross on the back of an animal. Some were required to wear the hair of the head unshorn, others might cut off that as well as the beard, while others still were allowed to cut off only the one or the other. Some were not permitted to eat fruits, while others were required to eat all they got, and to refuse a share to any one,

* Bastian, 254.

† See examples of such dreams in Kohl, Kitchi-Gami, oder Erzählungen vom oberen See. Bremen, 1859.

‡ Schoolcraft, II. 160.

§ Catlin, Letters and Notes on the N. A. Indians, 4th Ed. Lond. 1844; Waitz, Anthr. III. 118; Charlevoix, p. 346; Hist. Buccaneers of America. Lond. 1741, I. 116; Lettres édifiantes, VI. 174.

* Waitz, Anthr. III. 119.

† Bas. Miss. Magazine, 1852, IV. 327.

‡ *Cf.* Dupuy, Journ. of a Resid. in Ashantee. Lond. 1824, p. 239; Bosmann, II. 66; Proyart, 195; Bowdich, 362, 524; Tuckey, Narr. of Exped. to explore Riv. Zaire in 1816. Lond. 1818, 124, 223.

no matter how much they had.* The Yagas (a tribe of warlike African savages) imposed upon themselves, according to Cavazzi,† strenuous practices of abstinence, similar to those found among American Indians, with a view to render themselves the worthy champions of the sacred Quixilles; and they thought that they entered the strife in earnest only after the first captive had been put to death as an atonement for the sins of the tribe. The sanctity of the royal palace was so rigidly maintained among them, that when once a baptized infant was by its mother brought within the enclosure, the chief ordered the palace to be torn down, burnt, and leveled with the ground, for such a profanation necessitated the erection of a new one. The flesh of swine, elephants and snakes was forbidden to the Yagas, and they would no more touch it than would the Australian touch the flesh of his kobong. Unfavorable seasons were ascribed to the indignation of the gods on account of the people's sins. Thus these savages, who sucked the brains out of the heads of their living foes, and who, by public licentiousness, cannibalism and infanticide, violated every article of the moral code, even they had an ideal which they called Virtue.‡ When on the Gold Coast the members of a family separate from one another, and they can no longer worship in common the family fetich, then the priest destroys the latter and prepares from it a draught, to be taken by them: and so the fetich enters their bodies. At the same time certain prohibitions as to food are enjoined, the observance of which is a religious duty.§

Thus each savage has his special guardian fetich and his own peculiar vows; thus, too, each has a religious belief peculiar to himself, and the principles governing his conduct in sundry contingencies are the reverse of those held by his neighbors. Consequently he must regard his neighbor's conduct as smacking of heresy, and his neighbor's person as a thing unclean. "The diversity of Mokissos made it necessary in the great caravanserai in the market-place of Loango that each person should bring his own cup from which to drink the palm-wine, so as not to be exposed to the danger of drinking unawares out of a heterodox cup." *

"In what manner soever the Mokisso has been selected, the whole after life of his worshiper is bound up in him. This is the source of all true contentment for the savage, and here he finds the solution of all those anxious questions which arise in his mind no less than in that of other men, who would be but ill content, however, with the very simple solution accepted by the Negro. The vow he has undertaken is for him the sum total of religion. So long as things go pleasantly for him, he is happy and contented under the guardianship of his Mokisso; he feels strong in the assurance of divine approval; ascribes to the divine complacency, his days of sunshine; indeed his judgment is strictly controlled by his wishes and desires. But if unintentionally or involuntarily he breaks his vow, the whole course of providence in his regard is at once and irrevocably altered. Then misfortune overtakes him; he is quickly overwhelmed with calamities, and his only escape lies through death and oblivion; for him there is no hope, no path leading to reconciliation and deliverance. The luckless wretch need not, in Africa at least, go far in search of death. The fiends who surround him, in the shape of fellow-men, quickly trample him to death, and with the last breath of the fetich-worshiper expires a System of the Universe, in smallest 12 mo. With the man perishes the god he himself made, and both go back into the night of Noth-

* Bastian, 253.
† *Ib.* 205 ff; Cavazzi, Relat. histor. de l'Ethiop. occid., trad. d. l'Ital. par le P. Labat. Paris, 1732.
‡ Bastian, 205 ff.; Cavazzi, *ubi supra.*
§ Cruikshank, 220.

* Bastian, 258.

ingness. Here, too, is shown the might of inexorable Fate. The devotee made the Mokisso what it was: but the Mokisso was bound to avenge the infraction of his commands; he annihilates his worshiper, and with him annihilates himself." *

But let us suppose that the savage observes his vow. "By studying the Negro when swelling with pride at his good fortune, we can get an insight into many other features of this kind of worship. His good Genius makes him overweening of himself, and he looks down upon his fellows with disdain; but he may attain a still more exalted degree of eminence, when by his virtues he attracts to his service still other Mokissos. With this view he assumes new vows, and enters into covenants with one Mokisso after another. His faith increases his courage and audacity, and *fortem fortuna adjuvat.* But now his rôle becomes hazardous, as it is difficult to perform the numerous vows he has taken;" † soon it will be quite impossible. But if he omits any, he offends and enrages the slighted fetiches, and the upshot of the matter will be, that he must follow the course we have already described.

The greater the number of the fetiches to which a savage is devoted, and the greater the number of his vows, the more will his time be occupied in paying them reverence. Thus only freemen, the rich and the powerful can afford to have many fetiches or to bind themselves by many obligations. The slave must bestow all his time and attention in his master's service, and the poor are sufficiently occupied in procuring a livelihood: neither of them have leisure for anything beyond the simplest devotions. The higher, therefore, a Negro's rank, the more fetiches he will possess, the more vows he will have to observe, and the more difficult will it be for him to live without offense. Römer fell in with a Negro who owned nearly 20,000 fetiches, many of which, however, he kept merely because they had belonged to his ancestors.* "The princes of Loango receive several years' schooling in a complicated form of fetich-worship, assuming new vows for each degree of initiation; and thus only are they qualified to rank among the Eligible Princes, who alone can ascend the throne. When an adult person is to adopt a new Mokisso, the Ganga is not governed by his own private inspiration, as he is when he imposes a vow on the new-born infant; but he puts himself in sympathetic *rapport* with the postulant, and hearkens to the words spoken by the latter in an ecstasy; and these words determine his choice." † Nor is this of little importance for the postulant and his future happiness. The Ganga might impose on him a vow entirely uncongenial to his tastes and inclinations. In that case, he would soon transgress against his obligations, and incur guilt. But the adult postulant has a well-defined character (if we may so speak of a savage) and the Ganga adapts to this the new fetich and the new vow, thus securing a good understanding between the fetich and the devotee, and insuring the happiness of the latter. Furthermore, "in the fact that the Ganga, in selecting a Mokisso for the new-born infant, takes into account the character of its parents' Mokisso, and seeks to establish between the two a sort of organic connection, we see the earliest effort toward a system transcending the individual." ‡ The power of the savage increases in proportion to the number of vows he faithfully performs, and of the fetiches who give him protection and strength. "Whenever the Ruling House succeed, by means of their fetiches, in establishing a strict line of separation between themselves and the rest of the tribe, they soon assume

* Bastian, 254, 55.
† *Ib.* 256.

* Römer, Guinea, S. 62.
† Bastian, S. 257.
‡ *Ib.* 65.

the most unlimited prerogatives. A prince of the blood may then at will enslave and sell an inferior, whenever he is in want of money."* "In the king of Loango, as being the personification of supreme human felicity, resides the most unlimited authority over the Mokissos, which are themselves the very expression of unbounded Might. It is his will that causes the sun to shine; by his command vegetation proceeds; a word from him were sufficient to annihilate the universe."† On the White Nile, as also in Benin and in Dahomey, a like opinion prevails.‡ For this reason certain exceptionally powerful fetiches, the Sea, for instance, are reserved for those who govern. "The king of Quinsembo has his palace, or Banza, some three miles inland, on the bank of the river Quinsembo, back of a line of sand-hills, and he never passes beyond that line of hills seaward, lest the sea should come within the range of his vision, and he should see it. Were he to behold the sea, the consequence would be his death, and the destruction of the kingdom, as he is forbidden by the fetich to look upon the sea. Many other kings along the coast are similarly restricted, while others will eat only the products of their native soil, and eschew all foreign articles of luxury in their attire." §

The savage puts fetters upon himself, in proportion to the number of vows he undertakes. Thus, the greater his power, as the owner of many fetiches, the more numerous the restrictions put upon his liberty; and so the very fact that he holds unlimited power curiously enough proves in the end his destruction. The dignity of kingship, for instance, involves the service of many fetiches and the performance of many vows.

* *Ibid.* 256.

† *Ibid.* 256; Proyart, 120; Brun-Rollet, in Bulletin de la Soc. géogr. 1852, II. 422.

‡ Palisot-Beauvais *apud* Labarthe, Voy. à la Côte de Guinée, 1803, p. 137 (German tr.).

§ Bastian, 33.

Should the king prove unfaithful, he brings disaster upon himself and upon his kingdom. In Congo if the king's white fez fell off his head, the accident foreboded evil to the state, just as the Japanese Dairi, should he happen by a shake of the head to alter in any way the position of his royal crown, would thereby alter the heavenly course of the sun, whose representative he was. Accordingly, all watch with the eyes of Argus, to see that the ruler discharges his vows. Wo to him if he be negligent! Then those over whom the despot once tyrannized would in turn become his tyrants. Of him may be said what Bastian affirms with regard to the entire Negro race: "No magistrate can by his prohibitions restrict him in the pursuit of his favorite enjoyments; but he will voluntarily take upon himself the shackles of his fetich. No tyrannical despot may prescribe a code of laws to govern his conduct. He makes his home wherever he pleases, and does as he likes, provided only he does not transgress the bounds set by tradition, or depart from the customs handed down from his own ancestors. But *hic hæret aqua:* for these customs surround him like a system of intricate snares, which it is not easy to escape. The slightest offense, when proved against him in a Palaver, is sufficient ground for irrevocably adjudging himself, his family and all his goods confiscated to the king; and the latter will have no scruple in selling him as a slave to the first trader that comes that way."* On the White Nile, when the rain fails, the king is put to death.† Among the Banyars, too, the king, who is also the high-priest—*i.e.*, chief conjurer—is held accountable for national calamities; yet he does not pay the penalty with his life, escaping with a sound pommeling.‡

* Bastian, 64.

† Proyart; Brun-Rollet, *ubi supr.*

‡ Hecquard, Reise au die Küste und in das Innere von W. Afrika. Leipz. 1854, S. 78; Waitz, Anthr. II. 129.

In this slavish obedience of the savage to his fetich we may recognize an important educational element. The savage imposes duties on himself—he curbs his passions. Herein he renounces, to a very slight degree, 'tis true, his natural willfulness. His motive is no doubt selfishness. With a view to power, he lays upon himself the burden of obligations. Yet it is a selfishness that is under restraint.

4. *Worship and Sacrifice.*

Such being the power of the fetich, whose good-will brings prosperity, but whose wrath is fatal, the chief study of the savage must be to propitiate him, to gain his favor and to avoid his anger. Now the savage can pay to his fetich only such homage as he is wont to render to those who claim his respect and submission. He shows obedience to his fetich, by performing his vow. He resorts to flattery, prayers, gifts: in other words, he adores his fetich, and offers to him sacrifice.

A man offers prayer and sacrifice, either in order to obtain the blessings of prosperity, or in thanksgiving for benefits received. The desire of a tranquil life is the direct expression of man's natural instinct of self-preservation. This instinct remains unchanged, whatever may be his grade in point of development and whatever may be the means which he chooses for the attainment of tranquillity. All men desire εὐ πράττειν, if not in this world, at least in the world to come. Knowledge, however, varies and grows. With the advance of knowledge, the objects which in a ruder age were worshiped as conferring the εὐ πράττειδν are changed for others. Hence the objects of worship in the different degrees of mental development vary widely: thus we have fetiches, the stars, gods, etc.; and yet the expression of the natural desire of prosperity is ever the same, viz., prayer and sacrifice, though in outward form there may be wide diversity, according to the degree of intellectual and moral culture.

The savage pays worship to his fetiches. The Negroes testified their respect for the anchor. The Ostiaks do honor to illustrious mountains and trees by shooting an arrow at them as they pass by. The Daurians planted rough posts in the center of their huts, winding around them the intestines of animals, and the occupants of the hut never passed by the fetich without a prostration and a prayer.* The Circassians slay a goat at the grave of a dead kinsman, consume the flesh, hang the skin on a stake, and make it an object of worship.† The offerings made to the fetich are often of very trifling value, being proportioned to the wealth of the devotee. Thus the Negroes and the *early* Peruvians, as also other American natives,‡ and the Siberians § seldom offer anything but potsherds, worthless rags, and worn-out boots and shoes. The Ostiaks clothe in silk their fetiches, which are made to resemble the human form, and to one side of the head they attach a bunch of hair, to the other a dish, into which they every day pour broth, which then flows down either side of the idol.‖ As a sign of their gratitude, the natives of Cabende eject from their mouths upon the fetich the first morsel of food they take at a meal, having first chewed it: and the idol is left unwashed and in this pitiable state until the meal is at an end.¶ Many fetiches have also localities specially assigned to them, where they receive offerings, and we find fetich altars of various descriptions.

Offerings are made to the fetiches with a view to obtain benefits from them. Thus the Negroes offer to their fetiches empty jugs when they wish

* Voy. au Nord. VIII. 103.

† *Ib.* X. 447. Isbrand affirms the same as to the Burats. Voy. au Nord. VIII. 64.

‡ Acosta, Hist. natur. et mor. des Indes occidentales. Paris, 1606, p. 206, 227; Charlevoix, 348.

§ Georgi, Russ. Völk. S. 389.

‖ Isbrand, Voy. au Nord. VII. 38.

¶ Bastian, 81. *Cf.* Halleur, 32.

for rain;¶ swords or daggers when they are going to war; fish-bones when they are bound on a fishing-expedition; small shears or knives when they desire store of palm-wine.* The savage is most liberal of his homage and of his gifts when he is in straits, but often times the fetich is utterly neglected in time of prosperity.† Finally, offering is made to the fetich, in thanksgiving for benefits received, after a successful fishing-expedition or warlike foray; after a prosperous chase or harvest; after the birth of a child; after recovery from sickness, and escape from danger.‡

Animals and even human beings § are offered to the fetiches. On perilous routes and rivers the American Indians make offerings of birds or of dogs, sometimes binding the legs of the latter together, and leaving them suspended from a tree to meet their fate.|| To such fetiches as bears or deer they offer maize; and to a maize-fetich they offer bears' flesh.¶ "In Bonny the most beautiful maiden is annually offered to Ihu-Ihu, or Yoo-Yoo**—a name denoting priest, temple, or place of sacrifice, as well as any guardian deity. Probably it here stands for the Sea, to which an offering is ever made on a fixed day. The maid chosen to be offered to the god has her every wish gratified, and whatsoever she touches becomes her property.†† The priest who performs the human sacrifices, bites a piece out of the neck of the victim, while life still remains. When captives are sacrificed, their heads are arranged in a row in front of the Yoo-Yoo house, and the remainder of the bodies are cut up, boiled in a cauldron and eaten.* The Kroos also occasionally sacrifice prisoners of war to their fetich-tree.† "They have many festivals whereon sacrifice is offered to the fetiches. Even days become fetiches for them, some being regarded as lucky, others as unlucky. In Ashantee there are but 150 or 160 lucky days in the whole year, when an enterprise of moment may be commenced with any hope of success.‡ On the Senegal Tuesday and Sunday are *dies atri*, but Friday is a still more unlucky day, and hence a certain Bambarra king had all children born to him on a Friday put to death.§

As a mark of respect for the fetiches their worshipers build houses to shelter them, temples. The Wotiaks || and the Ostiaks ¶ build for this purpose miserable huts, but the Abipones** and the Negroes affect some small regard for ornament. Bastian gives the following description of an African fetich-house: "The temple was quadrangular, constructed of straw matting, the entire front being of wooden framework, with three arched doorways. Each of the two side-doorways was surmounted by a pyramid, while over the middle one rose a cupola; and the door-posts were adorned with figures in black and green. Within was a simple mound of earth, on which stood three forked sticks painted red and white in alternate stripes."††

The Yoo-Yoo house in Bonny is 40 feet in length and 30 in width. At one end stands an altar 3 feet high, and a small table with a vessel holding *tombo*, a kind of spirituous drink.

* G. Loyer, Relat. du Voy. du Royaume d'Issiny. Par. 1714, p. 248.

† Charlevoix, 347; Bosmann, 445.

‡ De Bry, VI. 20; Loyer, 248; Charlevoix, 348; Georgi, 389; Valentyn, Oud en Nieuwoost Indien. Amsterdam, 1724, III. 10.

§ Charlevoix, 118; Georgi, 338; Valentyn, III. 10.

|| Charlevoix, 118, 348. *Cf.* Waitz, II. 207.

¶ Loskiel, Gesch. der Mission der evangel. Brüder unter den Indian. in N. Amerika. Barby, 1789, S. 53.

** Holman, Voyage round the World (1827–32). Lond. 1834, I. 378.

†† J. Smith, Trade and Travels in the Gulf of Guinea. London, 1851, p. 60, 68.

* *Ibid.* p. 82.

† Waitz, Anthr. II, 197 seq.

‡ Bowdich, p. 363 seq.; Dupuy, 213 *note*.

§ Raffenel, p. 183; Mungo Park, Sec. Journey (in Bütner's translation). Nordhausen, 1821, S. 315. *Cf.* Waitz, II. 201.

|| Rytschkow, Tagebuch, S. 166.

¶ Voy. au Nord. VIII. 103.

** Dobrizhofer, II. 99.

†† Bastian, 50.

There is abundance of wine and rum in glasses and flagons, and on the walls hang pictures, chiefly representing the Guana lizard. The foreigner is waited on by a priest; for in Bonny strangers have ready access to the temple, whereas elsewhere he is excluded. The priestly attendant mutters a few unintelligible words, makes a mark with moist clay between the visitor's eye-brows, and rings a bell. A glass of tombo is then handed to the stranger, and thus he is admitted to the mysteries, and initiated.* These fetich-houses are in many parts of Africa, asylums, especially for runaway slaves; † and in the medicine-huts of the American Indians even an enemy's life is safe.‡

Having done due honor to his fetich and made to him such offerings as his means allowed, the savage counts with certainty on a return. For though he stands in great awe of his fetich, still the relation between the two is not such as to make the devotee in all cases the bounden slave of the object he worships; nor is the fetich, when the worst comes, the superior of the man. The savage is too wild and passionate to submit to such absolute control; and the moral character which he attributes to his divinity is not such as to make the latter a paramount Destiny. A man's apprehension of another being cannot transcend the sum total of his actual conceptions. He cannot conceive of a being as possessed of attributes of which he has never formed any notion. Consequently the savage's fetich will be what the savage is himself. Now the savage is given to falsehood and treachery; he is usually cruel, selfish and wayward. From what he is himself he judges of human nature, and these same data make up his conception of the fetich. From a moral point of view the fetich is no better

* J. Smith, p. 60.

† Bowdich, p. 361; Monrad, 44.

‡ McCoy, Hist. Baptist Ind. Missions. Washington, 1840, p. 195; Perrin du Lac, Reise in die beiden Louisianen (1801–3). Leipz. 1807, I. 171.

than himself; like his worshiper, the fetich is a savage, and on occasion is to be treated as a mere savage. So, if despite prayers and gifts he refuses to grant what is asked of him, then he is to be handled roughly till he yield to force what he denies to entreaty. We have already seen how the fetich is pommeled in order to make him attend seriously to his business.* If the Ostiaks are unsuccessful in the chase or in fishing, they inflict severe chastisement on their fetiches for having led them away from the game, or for having failed to render assistance. The punishment over, they become reconciled again with the unfortunate culprits, give them a new suit of clothes and other gifts, in the hope that they will now do better. During the prevalence of an epidemic the natives of Kakongo entreated the fetiches for relief; but as the pestilence continued, they threw their fetiches into the fire.† The same was done by a Lapp who had in vain prayed to his fetich to perserve his reindeers from disease.‡

As the savage renounces fetiches which prove of no account, so he strives to get possession of those whose power is known. The fetich thus becomes an article of commerce and barter; and numerous instances might be cited of such articles being sold, exchanged, or even stolen.§ It is chiefly the priests that carry on this traffic; ‖ and both in Africa and in America the price of valuable fetiches is very high; indeed their owners are rarely willing to part with them at any price.¶

* The Cingalese have the same custom. *Vide* Knox, Histor. Relation of the I. of Ceylon. Lond. 1681, p. 83. Also the Madagascans. Flacourt, Hist. de la grande I. de Madagascar, 1658, p. 181; the Easter Islanders, Georgi, 385; the Ostiaks, Voy. au N. VIII. 413.

† Proyart, 310.

‡ Hoyström, S. 319. *Cf.* Waitz, Anthr. II. 185.

§ Bosmann, S. 99; Atkins, Voy. to Guinea, Brazil and the W. Indies. Lond. 1737, p. 104; Charlevoix, p. 347. *Cf.* Waitz, *ubi supra.*

‖ See following section.

¶ *Cf.* Waitz, III. 214.

5. *Fetich Priesthoods.*

Starting from small beginnings, but gaining strength as it advances, fetichism at last extends its influence over the whole life of the savage. We have soon no end of fetiches and fetich usages, the knowledge and understanding of which requires study, and can be acquired only by the initiated and those who devote their lives to this special branch of learning. The mere layman is quite inadequate to treat of so complicated a subject without making fatal errors. Only wise men are competent to expound so abstruse a science. The man who knows all the fetiches and the entire ritual, is by this very knowledge distinguished from the profane and ignorant multitude he is an eminent and reverend personage, as being master of many recondite arts all unknown to the generality. Thus if we take into account the low intellectual status of the savage, we shall see that those possessed of this mystic science will necessarily come to be regarded as priests, magicians, medicine-men, etc., or in short fetichmen—for all these terms have that one signification. The fetichman's importance and dignity are the natural corollary of the system to which he belongs.

The feticeros are sages. They understand the entire system, and are familiar with all the fetiches and the mode of preparing them; their respective powers and their names. In America it is the *Jongleurs* * (conjurers), in Siberia, the Shamans, † in Africa, the Gangas ‡ (different titles for fetichmen) that supply all the fetiches. That the trade in fetiches is remunerative we may judge from the fact that each Indian village has twenty or more fetichmen and women who thence get a living. In Africa, too, this trade yields a fair income.§

The fetichmen are also familiar with the ceremonies to be used in order that the fetich may be induced to exert his full power. They "know all the potent formulas for blessing the elements." * The safest course to pursue, therefore, is to have the feticeros themselves apply the fetich. Hence, the priest's influence is coextensive with that of the fetich. In assigning powerful fetiches for the cure of disease, and in applying these, he acts the part of a physician. When by his fetiches he constrains thieves, the winds, the clouds, spirits, etc., to do his bidding, he becomes a conjurer, or magician. Finally, inasmuch as he has special control over religious rites and sacrifices, and thus comes into close relations with the fetiches, he is strictly a priest. Yet at bottom all these functions are identical and are all implied in the one title of *fetichman*. The distinction, therefore, sometimes made between the fetich-priest and the conjurer is merely a relative one, as Bastian has well observed.† Hence among some inconsiderable Eskimo tribes a single priest will combine in his own person the various functions of the feticero, being at once physician, conjurer and priest; while under other conditions a division of labor takes place, determined by chance or by inclination. Thus in Negro tribes one fetichman devotes himself to the medicine-fetiches, and is a physician; another professes the art of rain-making, or some other branch of conjuring; a third is devoted chiefly to the ceremonies of religion. In North America the Jongleurs give counsel as to the manner of appeasing the fetiches or gaining their good-will, but do not offer sacrifice. This function is discharged by the chief on behalf of the tribe, and by the father on behalf of the family.‡ The same is stated as to the Tcheremissians and other Tartar tribes.§ On the other hand, in

* Charlevoix, p. 346; Lettres édif. VI. 174.
† Georgi, S. 384.
‡ Des Marchais, I. 296.
§ Waitz, II. 196, III. 213.

* Bastian, 85.
† *Ibid.*
‡ Charlevoix, Journ. Hist. d'un. Voy. de l'Am. Sept. p. 364.
§ Rytschkow, S. 92, 93.

sundry tribes of Siberians,* Kirghis † and Negroes ‡ the conjurers offer sacrifice. The Calmyks § and many Negro ‖ tribes recognize a distinction between conjurers and priests, while in some African and American tribes ¶ the conjurers assume all the functions of priests, and *vice versa.*

Of all the feticeros, those who are priests are usually held in the highest consideration. "Among the Yagas the Gangas have precedence of the Scingilli, or Rain-makers, and it is their duty, when a warlike expedition is to set out, to paint the Grand Yaga red and white, as he awaits the inspiration of the Mokisso, and to hand him his battle-ax, after he has banqueted off the body of an infant slain in sacrifice. When victory is proclaimed the Gangas obtain the trophies of the fallen enemy. At the period of the New Moon they offer the five-fold sacrifice, when, after the sacrificial fire has been sprinkled with the blood, the whole tribe join in a boisterous feast the victims' bones being carefully preserved for magical purposes; as is also the custom among the Tohungas of New Zealand. The Gangas have also to guard from profanation the Quilumbos, into the inner recesses of which no woman is ever admitted; and to expose in the woods the new-born children, as the army, like the corps of Mamelukes, is made up only of young slaves." ** Cavazzi, whose sojourn of 14 years in Angola and Congo gave him the best opportunities for acquiring a knowledge of Negro customs, describes a number of different classes of fetichmen with distinct functions pertaining to each class. The children of a man killed by lightning applied to the *Ganga Amaloco*, to get for themselves protection against a like visitation. The Mutinu-a-maya (Lord of Water) divined by means of a calabash cast into a stream. The *Molonga* prognosticated the issue of disease from boiling water; and the *Neoni* from revelations conveyed to him from his idol, through the mouth of the Nzazi. If these prophecies proved false, the priest laid the blame upon his Familiar Spirit, and procured another. The *Ngodi* professed to give speech to the dumb. The *Amabundu* could shield from harm seed sown in the ground. The *Ganga Mnene* could prevent evil spirits from eating up the grain after it had been harvested. The *Ganga Embugula* could by whistling overpower his enemies. The *Npungu*, the *Cabanzo* and the *Issaen* were associated together in the work of shielding the warriors from wounds, and took one another's places whenever one of themselves happened to be wounded. The *Ngurianambua* could charm elephants into the toils; the *Abacassu*, stampeded cows; and the *Npombolo*, all kinds of wild animals. The wealthy brought their deceased relatives to the *Nganga Matombola*, who by means of his magical figures caused them to rise from the bier, to move their limbs and to walk about.* "On the Gold Coast the *Wongmen* differ from the priests, properly so called. The Wongmen are possessed by the fetich, Wong, and any man may become a wongman provided he has learned to dance to the sound of the drum, to chant the songs which are sung when the oracle is consulted, and to perform the ritual of the medical art. There is another class of fetichmen, the Otutu-men, who also profess the art of healing, and who attend to the Ordeals. Then there are the Gbalo, or Talkers, who summon the spirits and question them. Finally there are the Hongpatchulo, who sell charms to people that wish a curse or an enchantment to befall their enemy. Besides priests some tribes have also priestesses. In the northern Negro countries, where a

* Gmelin, Reise durch Sibir. i. d. Jahren, 1733–37. Gött. 1751, II. 359, 360.

† Pallas, Reisen durch versch. Provinzen d. russ. Reiches. Petersburg, 1771, I. 393, 394.

‡ Oldendorp, I. 339.

§ Pallas, I. 359.

‖ Oldendorp, I. 339.

¶ Acosta, V. c. 26, 248; Cavazzi, I. 253 seqq.

** Bastian, 95.

* *Cf.* Bastian, 201.

nominal Mohammedanism prevails, there is not to be found such a variety of priests and conjuring physicians. Here we find the Marabouts, who, in addition to their priestly office, practice divination and drive a trade in Gree-Grees, though among these are many who have nothing to do with such jugglery, and whose study it is to gain a name for piety and beneficence. Hence the Joloffs make a wide distinction between the true Marabouts and the Thiedos (Unbelievers, Atheists, mercenaries), who believe in nothing save their gree-grees." *

Among the Kaffirs, too, the Conjurers, Inyanga, are divided into several classes, the highest being that of the Izanuse, or "Smellers," who extract the witchcraft from the sick by sniffing; while the inferior classes embrace the cow-doctors, the farriers and the fellers of timber.†

The conjurer-doctors, or medicine-men, who are common to Africa, Asia and America, either blow their breath upon that portion of the patient's body where the fetich locates the disorder, or rather the enchantment; or they resort to suction, friction or pressure on the diseased part, until finally they drive out the spell, which makes its appearance in the shape of hair, splinters of wood, thorns, bones, snakes' teeth, and the like.‡ They prescribe for their patients formidable remedies and regulate their diet. Should the sick man die they throw the blame upon him, as not having exactly carried out their prescriptions. If they see no chance of a patient's recovery they prescribe a course of treatment which he cannot possibly follow, such as violent jumping, or dancing, and thus they escape all responsibility for his death.* The Hottentot poison-doctors are famous. No snake can sting them, and not alone can they heal the bites of serpents by their sweat, but they can confer on others the same power.† A priest-physician in Congo had in his establishment five women to treat various diseases. His pharmacopœia, however, had but few medicaments for any complaint save for the *Mal Francez;* but abundance of magical formulæ.‡

As a matter of course, the fetich-priests are soothsayers, and the mouth-pieces of the oracles. The Lappish and Siberian Shamans divine by means of a ring which they place on the head of a magical drum. They beat a certain number of taps on the instrument and then observe on which one of the figures painted on the drum-head, the ring stands. Each figure has a special significance; and as this is known only to the priests themselves, the response will be whatever they choose to make it. Teleutian, Sajanian and Abinzian soothsayers divine by means of 40 small rods thrown upon the head of a magic drum; the Tungoos from the whir of tarrows shot from the bow, or from the vibrations of a tense bowstring.§ The N. American Jongleurs set fire to pulverized cedar charcoal, and divine from the direction in which the fire travels.‖

In Africa, the Npindi conjured the weather at the intersection of roadways. "The Rain-makers have at all times, and among every people, acted an important part, and many African populations invested their princes with this dignity, which was often as

* Waitz, II. 199.

† *Ibid.* 412.

‡ Greenlanders, Cranz, S. 270–74; Am. Ind., Charlevoix, 264–268; Hennepin, in Voy. au N. V. 293; California Ind. Begert, 142; Natchez, Petit, Relations, etc, in Voy. au N. IX. 26; Caribs, Biet, p. 387; Gumilla, hist. de l'Orinoque Avigum, 1708, II. 185; Du Tertre, Hist. gen. des Antilles, II. 366 seq.; Brazilians, Lery, p. 242–47. *Cf. supra*, Section II.

* Charlevoix, p. 368. Des qu'ils voyent un malade tourner à la mort, ils ne manquent jamais de faire une ordonnance dont l'exécution est si difficile, qu'ils ont à coup sûr leur recours sur ce qu'elle n'a pas été exactement suivie.

† Steedman, Thompson, v. Meyer, Reise in S. Afrika (1840). Hamb. 1843, S. 158; Kretzschmar, S. Afr. Skizzen. Leipz. 1853, 167 ff. *Cf.* Waitz, III. 213.

‡ Bastian, 202.

§ Georgi, Beschreib. S. 395.

‖ Charlevoix, p. 363.

full of danger for them as was the power over the harvests for the ancient kings of Sweden. The Emperor of China devolves upon his subjects the responsibility for his lack of power in this regard, assigning as the reason their wickedness. The hair and nails are plucked from the body of the Mani of Jumba, after his death, and preserved as infallible rain-makers. The Makoko of the Anzikos wished to get for the like purpose one-half of the beard worn by the missionaries; and would even agree to undergo the ceremony of baptism as the price of so potent a charm, just as the despot of Benin agreed to pay the same price for a white wife." * Bastian thus describes the manner of conjuring the rain; "The sky was overcast and the thunder rolled above the mountain-tops; but when I expressed my fears of a storm, my guide assured me that I need have no apprehension, as one of the officials who accompanied me was an accomplished rain-conjurer, and he had promised that he would not permit a single drop to fall. I was fain to accept the assurance, and the more so, as I saw my Zeus Aetherius rise to his feet, shake his raven locks, extend his hand menacingly toward the clouds, and point with his finger in every direction. My carriers, who looked on devoutly, thought the ceremony was now at an end, and made off with the tipoja (mat-palanquin): but scarce had we left the tree, beneath which I had hoped to be sheltered from the rain, when the floodgates of heaven were opened, and in an instant I was drenched to the skin."† Rain-makers are to be found everywhere in Africa, as, for instance, among the Bushmen‡ and the Kaffirs,§ who at first took the missionaries to be a new kind of rain-makers.

"The wind-maker, too, is an important personage ever since the Negroes have become accustomed to use European manufactures; as any delay in the arrival of the merchant-vessels may occasion suffering to the natives. Inasmuch as they do not themselves tempt the deep, the conjurer could find no market among them for Lappish Æolus-sacks; and instead, he retires into his hut, which smokes and rocks while he is engaged inside with his redoubtable incantations, conjuring up the favoring breezes which shall conduct to their shores the fleets of the white men." *

Such is the power which the feticero possesses over Nature, over Spirits, men and beasts.† The common people have full faith in this power; and as the priest himself is no less a savage than they, his faith is the same. Should his incantations fail to produce the desired effect, he accounts for the failure by supposing that counter incantations have been at work, or that the ritual has not been strictly observed, and this explanation satisfies not alone others, but also himself. There are even at this day plenty of people in civilized Europe who tell fortunes, who practice necromancy, who profess to cure diseases by the imposition of hands and other similar means; and who are themselves no less deceived than those who employ them. The records of courts of justice and the reports of asylums for the insane are sufficient evidence of this. "The Cazembe now in highest repute regards himself as immortal by reason of his magic arts, and says that his predecessor's death was due to a want of precaution. He is possessed of such an excess of magic power that its superabundance would at once annihilate whosoever should come in contact with him; and there is accordingly a curious ceremonial to be observed, in order to avoid such consequences. This ceremonial would almost appear as though plagiarized from the animal-magnetizers. In their system it is called

* Bastian, 116, 117, 118.
† *Ibid.*
‡ Lichtenstein, II. 102.
§ Campbell, 2nd Journey, 230, 236, 238; Thompson, Trav. and Adv. in S. Afr. I. 180.

* Bastian, *ub. supr.*
† Waitz, V. 1, 178.

Dorsal Manipulation, and its purpose is to re-isolate the somnambulic subject."*

Undoubtedly the priests are the first to detect the imposture and to discover the impotence of their idols and of their own arts. Still, lest the people should be shocked by the publication of this discovery, the priest will keep it to himself, henceforth acting the part of a conscious deceiver, from motives of selfish interest and ambition. With this view he will surround himself with a veil of mystery, and resort to all manner of tricks and fraud.

"The only kind of historic record to be found among African tribes is the traditional narrative of important events, and this is handed down from one fetich priest to another as a secret of the craft. Accordingly, when application is made to the priests for counsel, the knowledge which they possess of the past history of the various families of the tribe, gains for them the credit of inspiration." † They alone are privileged to hold converse with the great dread fetich who dwells in the recesses of the forest, and to tread the floor of his home, without being torn in pieces.‡ They are not men of the common mold; their origin is enveloped in mystery. Among the Dakotas the medicine-men and medicine-women first come into the world in the shape of pinnate seeds, something like the seeds of the thistle. Then they are driven about by the winds and thus come into relations with mighty spirits, whose preternatural science and power they make their own. Next they gain entrance into the womb of a woman, and in due time are born with human bodies; though after death they return to the society of the gods. After they have four times run their career in human shape they are annihilated. They may likewise be transformed into wild beasts.§ They can also cause ghosts to appear on occasion, to inspire the vulgar with due respect for the fetich and for his retreat in the woods. "The village was situate on the edge of a dense forest, and on learning that in the forest there was a fetich-house, I directed my men to advance by a circuitous foot-path leading to it. They stoutly refused, saying that not one of them could come back alive: and it was only by repeated threats that I could induce them to move. But as soon as the villagers were aware of my purpose, they surrounded my mat-palanquin *en masse*, entreating me not to expose myself to destruction: and threw themselves before the feet of my carriers, to prevent their advancing—a very unnecessary thing to do, as the carriers themselves showed no disposition to go forward. However, as I longed to examine a second fetich-house, I paid no attention to their entreaties, pushed back those that stood close around my palanquin, and repeated my command to move on, with some emphasis. The whole multitude then uttered the most pitiable cries. The women tore their hair, and beat their breasts, and the seniors rolled themselves in the dust alongside the palanquin, invoking the power of heaven and earth to check my progress. I was at length obliged to yield. As we went up the ravine which skirted the forest there went up a fearful bellowing, which seemed to issue now from one quarter, again from another, and which imitated all manner of indescribable noises. The Negroes, terrified by this outburst of fetich indignation, ran in all speed from the locality, to escape from the wrath of the god · for there great Pan is not yet dead." * The Great Spirit of the Shekani and the Bakele dwells in the bowels of the earth. At times he comes forth, and takes up his dwelling in a great house which has been built for him, and there he utters such frightful bellowings that

* Bastian, 293.
† *Ibid.* 100.
‡ Lettres édif. IX. 95; Dobrizhofer, II. 99.
§ Waitz, II. 180, 504; V. 2, 178.

* Bastian, 193.

women and children tremble with fear.*

The priests are deeply versed in the science of ghostly apparitions. "The Spirit-seers of America might get from African professors many practical rules for the converse with Spirits, which they could readily turn into hard cash. But they must make haste, for the courts of justice at Cape Coast Castle are beginning to shed light upon the mystic cloud of secrecy which involves Negro spiritism, and have already condemned more than one unmasked fetichman as an impostor. As society assumes definite shape in the colony, the more dangerous fetich practices are more and more brought under the control of the law; and the peaceable citizens adopt the policy of favoring and strengthening the Mylah ceremonial in opposition to that of the Obeah; thus, in the words of S. Augustine, patronizing *theurgy* in order to discredit *goety*." †

Nor must we omit to take note of the ceremonies performed by the feticeros. These are usually conducted in the most fearful style of wild and boisterous frenzy. In proportion as the rational faculty is developed, a man controls more and more the external bodily signs of emotion. His power of speech has attained that degree of perfectionment, that he can readily convey to others by that means all his sensations: he uses *language*. But the lower the grade of mental development, the weaker is the power of expressing in words the sensations and emotions of the mind. Clowns and children speak by means of gesture, and their whole body seems to express their emotions. With the savage accordingly, whose language is fragmentary, the lack of verbal expression must be made up by violent gesticulation. When the King of Dahomey would do honor to a foreign guest by chanting a song of praise, he must also give proof at the same time of his saltatory skill. When Bastian was entertained by the king of Shemba-Shemba, that potentate simply kept up a movement of the feet *a tempo*, and made frequent genuflections, in performing which he would slip partly out of his seat, and give his little cap of bast a graceful toss on his poll. Several nations resort to the mimic hieroglyph language of the dance.* It need not occasion surprise, then, if the savage, when under the stress of violent emotions, finds expression less in language than in cries and shouts, wild gestures, leaping and rolling on the ground. We have already seen many examples of this.† But whence does the priest or the conjurer derive his power over the objects against which his conjuring arts are directed? This power comes from his fetiches. They must endow him with the power they themselves possess and must in his person make display of it. Accordingly the conjurer becomes transformed, and pssessed of unwonted strength. He has to manifest the presence and efficiency of the Power which possesses him, and the expression which he gives to it, is the same as that by which he gives utterance to every strong and passionate emotion, viz., the wildest and most violent convulsive movements of the body. Maniacs are by savages regarded with great alarm, as being possessed by spirits.‡ It is perfectly natural, therefore, that the conjurer, when possessed by the spirit of the fetich, should become for the time being a maniac. When the priest has wrought his mind into the last degree of frenzy, he is judged then to have attained the height of his magic power, and to manifest to its full extent the dread might of the fetich. It is therefore the business of the priest to know how to arouse himself to this state of frenzy. If nature qualifies him for the task, so much the better; and for this reason the

* Wilson, Western Africa, etc., p. 391.
† Bastian, 101, 85.

* Bastian, 56.
† *Cf.* Waitz, II. 205 seq. 223.
‡ Georgi, Beschreibung, S. 376; Gmelin. IV. 109.

priests select children who are epileptics, to be trained to the priestly functions.* "The Shamans pass into the state of madness by a super-excitation of the motor system, and at the same time often become the subjects of hallucination, accompanied by complete mental alienation, owing to spiritual excitement. By careful training, children of feeble nervous constitution are educated to pass readily into this state of alienation and phantasy, and so attain in this art a degree of perfection unattainable under any other conditions. Just as jugglers perform feats of skill which fill us with astonishment, though an anatomist will show you, from the arrangement of the muscles, how such sleights are rendered possible: so the Shamans are a kind of psychical jugglers, who have in childhood been trained to perform several abnormal mental operations, which we neither can nor would imitate, or even countenance. On the contrary, we suppress all tendencies in that direction as quickly as they manifest themselves. But there may even be *normal* mental operations well-developed in the savage, which we lack; just as we lack some of his physical accomplishments, for instance, the power of employing the toes in place of the fingers, for the purpose of weaving, grasping, etc.: a faculty possessed by the Cochin-Chinese, Polynesians and other races." †

This faculty of psychical jugglery is enlarged by hereditary transmission. Inasmuch as epilepsy is heritable, it is not unusual for the office of Shaman to be handed down from father to son for from four to six generations; and a Shaman is esteemed in proportion to the antiquity of his Shaman ancestry.* The dexterity of the Shamans in performing their feats of psychical jugglery we may learn from the account given by Carver. He saw an elderly member of "the Friendly Society of the Spirit," which is an association of fetich-priests, throw at a young man who was to be elected into the society, a bean, or something that had the shape and color of a bean. "Instantly he fell motionless, as if he had been shot." He remained insensible for a considerable time, until he was brought to his senses by means of very violent friction and even blows. And even then, consciousness returned only after he had passed through a series of the most fearful convulsive fits.† The witches also, in the middle ages, fell to the ground, as though dead, when forced to anoint themselves with their witch's salve.‡ In proportion as the priestly office, having taken root in society, becomes a heritable privilege, and as the nervous predisposition, which at an earlier period determined the selection of the candidate, is lost under the influence of prosperity, the more difficult does it become to bring about the state of ecstasy by means of convulsive operations, and then resort has to be made to sundry contrivances, viz.: deafening music, violent jumping, inhalation of narcotic vapors, the repetition of monotonous sounds, excessive transpiration, protracted abstinence from food, partial strangulation, etc. These methods are universally employed by fetich-priests, to attain their purpose. The Jongleurs of the American Continent practice such contortions of body, and utter such hideous cries, that not alone the spectators are filled with consternation,§ but even women and

* As to the Siberians, Georgi, *ub. sup.;* Patagonians, Falkner, Descr. Patagon. Lond. 1774, p. 117: "They who are seized with fits of the falling sickness or the Chorea Sancti Viti, are immediately selected for this employment, as chosen by the demons themselves: whom they suppose to possess them and to cause all those convulsions and distortions common in epileptic paroxysms; Greenlanders, Cranz, S. 268, 270.

† Bastian, Die Seele u. s. w. S. IX.

* Gmelin, III. 331.

† Carver, Trav. through the Inter. Parts of N. America. Lond. 1778, p. 271, 274.

‡ Bodin, de la Demonomanie des Sorciers. Paris, 1581, p. 96–99; Malleus Malefic. Lugd. 1669, II. 69.

§ Charlevoix, p. 361 seqq.: On les y voit entrer dans des convulsions et des enthousiasmes, prendre des tons de voix et faire des children at a distance are thrown into convulsions of terror.* By means of similar contortions and shouting the Shamans of Siberia and the African feticeros work themselves up into the state of ecstasy.† To expedite matters they drink tobacco-juice, or resort to exhausting vapor-baths.‡ The Shamans of Siberia drink a decoction of toadstools or the urine of those who have become narcotized by eating that plant.§ The highly excited nervous condition produced in the conjurer by his fearful bodily exercitations is so exhausting that many refuse to go through them, even on promise of a considerable reward.‖ This artificial frenzy has such a serious effect upon the body, and more particularly the eyes, that many of the Shamans become blind: a circumstance which enhances the esteem in which they are held.¶

Among the means employed for the purpose of inspiring the beholders with awe we must reckon the attire of the fetichman. And first we have the conjurer's mantle and his magic drum,—apparatus which appear to be wanting to the Shaman men and women of Kamtschatka alone of all the Shamans of Siberia. The drum is a simple sieve, a sheepskin being drawn over one rim, and the inside of the frame having a lot of jingles and little idols suspended from it. The real purpose of this instrument—viz., to deaden the senses by its noise—is very different from that assigned by the Shamans. They assert that the gods and the spirits have a liking for this fearful music, and are attracted by it.* They therefore keep up a drumming until those beings make their appearance; *i. e.* until the drummer himself, by his violent exercise, has passed into the state of ecstasy. The drum is sometimes replaced by a staff hung with bells, or by some other noisy instrument.† The Dakotas, besides the drum and the clappers, employ a notched bone, with which they saw upon the edge of a tin dish: and thus they produce shrill, ear-rending sounds.‡ Isbrand gives the following description of the Shaman's leather conjuring mantle: A sort of long coat (casaque), adorned with pendent figures of iron, representing all kinds of birds, fishes, and wild beasts: arrows, saws, hammers, swords, clubs—in a word, every conceivable thing that is calculated to inspire fear.§ A mantle of this description is so heavy that a strong man can scarce lift it with one hand;‖ and when the Shaman, clothed in this garment, leaps and jumps about with all his might, there arises such a clangor that you might well imagine you had before you some fiend in chains.¶ And the remainder of his equipment is perfectly in keeping with his mantle: his headdress, the plumage of the owl and the eagle; the snake-skins and horns suspended here and there for effect, and the gloves, resembling the paws of a bear. African feticeros trick themselves out with the skins of tigers and lions. They daub their faces with white paint, and the rest of their bodies with other colors; or else they give themselves a true coat of tar and feathers. Then they suspend from their persons a number of little bells, animals' heads, wings and claws; drums, weapons, horns, herbs, roots, etc.** Thus weighted they

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actions, qui paraissent au-dessus des forces humaines et qui inspirent aux spectateurs les plus prévenus contre leurs impostures une horreur et un saisissement, dont ils ne sont pas les maîtres.

* De Lery, Hist. d'un Voy. fait en la Terre de Brésil. Génève, 1580, p. 242–47, 298.

† Georgi, Beschr. S. 320, 377, 378; Gmelin, Reisen, I. 285, 397, 398; Isbrand, in Voy. au N. VIII. 56 seqq.; Römer, 57, Bosmann, 260.

‡ Charlevoix, p. 361, 362.

§ Georgi, S. 329.

‖ Charlevoix, p. 362.

¶ Georgi, *ub. sup.*

* Georgi, Beschr. S. 378 and S. 13; Gmelin, II. 49.

† Georgi, S. 13, 378; Gmelin, I. 289.

‡ Schoolcraft, Illustrations, Pl. 75.

§ Isbrand, p. 56; Georgi, Beschr. S. 377; Gmelin, I. 397, 399; II. 83.

‖ *Ibidem.*

¶ Gmelin, I. 398.

** *Ibid.*

dance, howl, scream, and foam, as is related of the conjurers of Thibet: saltitant, torquentur in omnes partes, fremunt, furunt, strident, ululant, etc.* These operations they perform in the mystic gloom of some darksome hut, or in total darkness.† These conjurers often perform tricks of common jugglery. Thus they will perform a trick called "washing with fire," where they dexterously separate the fire from the ashes, suffering only the latter to touch their bodies; or they will tread barefoot upon hot coals, pierce their bodies with arrows, or knives, etc.‡

By such artifices as these the power and influence of the feticeros, which were already secured to them in popular estimation by their intimate converse with the fetiches, are enhanced enormously. The assistance of the fetich priest is indispensable on all occasions, whether public or private, and is always invoked. Hence at Fernando Po the Chief Priest, or Botakimaon, is "a weighty man in the state." Each village has its own Buyeh-rup, who gives counsel in domestic concerns. This Buyeh is, however, a far less important personage than the Botakimaon, at whose residence the Negroes assemble in the season of the Ripe Yams to celebrate the "Custom." It is the Botakimaon who crowns the king. According to Consul Hutchison (in his interesting work, Impressions of Western Africa), "the Botakimaon, previous to the ceremony of coronation, retires into a deep cavern, and there, through the intermediary of a Rukaruko (snake-demon) consults the demon Maon. He brings back to the king the message he receives, sprinkles him with a yellow powder called tsheoko, and puts upon his head the hat his father wore. Having once ascended the throne, the use of cocco (*arum acaule*) and of the flesh of the wild boar and the porcupine is interdicted to him."* The priest is also a jurist, giving judgment on cases where the individual comes in conflict with the laws of the state. "The only concession made in a primitive condition of society to the common weal by the Negro (who in all other respects is absolutely independent), is this, that he accepts the ancient traditions, and acknowledges their binding force: but now, even while he is determined that these shall place the least possible restriction on his liberty, he assigns to them a weight of authority which soon removes them beyond his control. He studies to keep them as far as possible in the background; he never meditates upon them, never strives to determine precisely what they are. The consequence is, that he is soon caught in the toils, and can extricate himself only by the aid of those who are skilled in legal technicalities, i.e., the priests. He thus is at their mercy, and becomes their slave."† In his capacity as jurist the priest administers oaths and conducts the ordeals. This latter function is in their hands an engine of boundless mischief. "As every case of death whose cause is in any way obscure, is ascribed to witchcraft, and the kindred of the deceased are obliged to avenge his death; the priests who conduct the ordeal are invested with formidable powers. The cause of death being obscure, the kinsman of the deceased has no course left, save to follow the directions given by those who are eminently fitted to be his guides. He accordingly applies to the fetichman and inquires of him what foe has done this deed. The priest ascertains dur-

* Cavazzi, II. 183, 196, 251. Same account given of the savage inhabitants of the isth. of Darien, California and Brazil by Wafer, Voyages où l'on trouve une description de l'isthme de Darien (*Apud* Dampier, Voyages, Tom. IV.) p. 176; Lery, 242, 247, 298; Begert, Nachrichten von Californien. Mannheim, 1712, S. 142, 159, 165.

† Alphab. Thibet. p. 243, 244.

‡ Gmelin, II. 87; III. (Vorrede) S. 7; III. 72

* *Cf.* Bastian, 318, 319. Tsheoko is a vegetable product, obtained, according to Hutchison, by collecting a creamy coat that is found on the waters at the mouth of some small rivers, evaporating the water and forming a chalky mass of the residue.

† Bastian, 167.

ing sleep or in a trance the response he is to make, and names the offender. Next the Ordeal-Water; or the body of the deceased, as the bearers halt before his hut; or the discovery of buried talismans, will put the guilt of the accused beyond question. By decree of the Palaver he is arrested, bound hand and foot, and hewed to pieces: for it is a religious duty, incumbent on every member of the community, to take part in the execution of the culprit. The tyrants of the Zulus availed themselves of this dogma, to further their political aims. On the faith of oracles which accorded with their own desires, they extinguished almost the entire aristocracy of their nation, and grew rich by confiscating the herds of the condemned." *

The priest obtains knowledge of what is to come by inspecting the entrails of victims, or by revelation from the fetich. He may, at his pleasure, predict a favorable or an unfavorable issue for an enterprise; and thus may put a stop to measures of which he disapproves. It is to him also that the fetich makes known his wishes as to what he would have done; and then the priest can forward what enterprise he will. "It is the will and command of the fetich:" such is the formula in which the priest's own desires find expression; and thus they become a law for the deluded people. This exaggeration of the fetich priestly power is specially exemplified in the family of the high-priest of Whida, and in the Chitome of Congo. The Negro of Whida worships, as his greatest fetich, the sacred serpent, of which we will speak in another place. It is death to refuse anything to the priests and priestesses of this fetich. They may carry off for their fetich whatsoever they will — cattle, men, treasure. The high-priest rules supreme, the king being only the chief of his servants.† But this absolute priestly power attains its highest development in the Chitome of Congo. He is not honored as the principal minister of the gods or fetiches: he is himself a god, a fetich. His person is incomparably more sacred than that of any king in Africa: his power greater, and his house more jealously guarded against profane intrusion. He may commit what crimes he will, but no man can so much as call him to account, far less seize his person or inflict punishment. Without his will and assent the king can undertake no business of importance, and no minister of the king can assume office. Newly-appointed governors visit, with a great retinue, the palace of the Chitome, and with all humility beg of him his gracious permission to enter on their duties. The prayer is never granted in the first instance, the Chitome obliging them to wait his pleasure until they have backed up their petition with a respectable amount of gifts. At length he comes forth out of his palace, sprinkles the suppliants with water, strews dust upon them, and orders them to lie on their backs upon the ground. He then treads several times on their bodies, to signify that they are his servants; and exacts from them an oath of implicit and prompt obedience to every command of the Chitome. The humbled governors consider themselves in luck if the high-priest gives them a brand from the sacred fire, which he keeps ever burning. Such brands he sells for the healing and prevention of disease. A portion of all the products of the field belongs to the Chitome. It is by his power that the universe is upheld— but here, too, unlimited power has its peculiar disadvantages. For since the universe is upheld only by the Chitome, and, were he to die, would undoubtedly go to destruction, therefore the Chitome must never die. Accordingly, when he falls dangerously sick, his successor forces his way into the palace, provided with a club and a halter; with the one or the other of which the Chitome is dispatched, as

* Bastian, 91.

† Bosmann, 458 ff.; Des Marchais, II. 144, 153.

he himself may elect. The old Chitome, having been by this act of high-handed violence put out of the way, his assassin is now Chitome, (le roi est mort: vive le roi !) and the universe is safe.* The Chitome is himself a fetich: all other fetich-priests base their authority upon the fetiches they possess, as do those of Whida, for instance, upon the Holy Serpent. Among the Kramantees a priest's successor is always that one of his sons who has the courage to take out of his dying father's mouth certain kernels, and to put them at once into his own.

Since the priests, by their conjuring arts, can do what they please, the people, when want or calamity oppresses them, attribute all their woes to the malice of their spiritual rulers. If they can but make away with the assumed cause, they believe that the effect will cease: and thus the belief in the power of the priest, which before brought him only advantage, now turns to his injury. The princes of the Kaffirs put to death all the conjurers they can lay hold of, whenever the country is visited by an obstinate and dangerous epidemic.† The Chiquites of Paraguay, having discovered that the priests do more mischief than good, exterminated them *en masse.* Still they continued in the belief that all diseases are brought on by magical arts. Lest, therefore, the people should be deprived in sickness of the assistance which used to be rendered by the conjurers the chiefs now practice the healing art, using the same forms previously used by the priests.‡ The extraordinary power wielded by the priests, makes them very bloodsuckers and tyrants; and the only remedy against their despotism is when the downtrodden people break their fetters, and take a fearful revenge. The arrogance of the priests of Whida led them to form a conspiracy against the king. But now the people forgot that a priest's person is sacred: the magnates of the kingdom, with one accord, rose to defend their prince, and a general and bloody persecution of the guilty priesthood was commenced.*

But the influence of the priest extends not alone to great affairs but even to the trifling concerns of private life. A man cannot take possession of a hut until it has first been exorcised of the powers of evil by the priest. For this purpose he must dwell in it for a season, purifying it by thurifications, and consecrating it to some guardian fetich.† In Congo he gives his sanction to marriage by giving to the pair two hens, to be dressed by bride and bridegroom respectively; that dressed by the bride to be eaten by the groom and *vice versa.*‡ When the wife finds herself *enceinte* she places herself and her unborn child under the protection of a fetich. "In Western Africa she makes an offering to the priest of a flagon of rum, and a certain quantity of cowries, and in return he fastens around her arm a bracelet made of the tail-feathers of a parrot." § "Between the 10th and the 12th year of their age the children are consecrated by the fetich-priest. The children to be consecrated assemble around the fetich-tree of their neighborhood, and then the priest offers to the fetich a white hen, by cutting off its head and suffering the blood to drop on the ground. He then distributes the feathers among the children, who form a circle all round, and lights a fire to prepare the hen for the fetich. The fetich gets a small portion and the remainder is taken to the house of the priest. With shouts and songs they then proceed to the

* Cavazzi, I. 254.

† Sparmann, R. nach dem Vorgebirge der guten Hoffmung im Jahre, 1772 (tr. from the Swedish). S. 198, 199. The Patagonians acted in like manner, on the outbreak of the small-pox: Falkner, p. 117; Barrere, Beschr. von Guiana. Götting. Samml. v. Reisen, II. 159.

‡ Lettr. édif. Nouv. Ed. VIII. 339–345.

* Bosmann, S. 463 seq.

† Bastian, 78.

‡ Bastian, 88. *Cf.* Loyer, p. 152.

§ Halleur, S. 29.

bathing place, where the priest washes the neophytes and marks each with a white stripe. The ceremony concludes with shouting and singing." * Education, such as it is, is altogether controlled by the priests. "Every year the priests assemble the boys who are entering the state of puberty, and take them into the forest. There they settle, and form an independent commonwealth, under very strict regulations, however: and every offense against the rules is sternly punished. The wound given in circumcision commonly heals in one week, yet they remain in the woods for a period of six months, cut off from all intercourse with the outside world, and in the meanwhile each receives separate instruction how to prepare his medicine-bag. Forever after each one is mystically united with the fetich who presides over his life. Even their nearest relatives are not allowed to visit the boys in this retreat; and women are threatened with the severest punishment if they be only found in the neighborhood of a forest containing such a boy-colony. When the priest declares the season of probation at an end, the boys return home, and are welcomed back with great rejoicings." † The children are subjected completely to the power of the priests, and the latter appear sometimes to give this power a highly mystical expression. Bastian thus recounts what he heard in Quindilu from the lips of an interpreter:

"In the country of Ambamba each person must die once, and come to life again. Accordingly when a fetich-priest shakes his calabash at a village, those men and youths whose hour has come, fall into a state of death-like torpor, from which they recover usually in the course of three days. But if there is any one that the fetich loves, him he takes into the bush and buries in the fetich-house. Oftentimes he remains buried for a long series of years. When he comes to life again, he begins to eat and drink as before, but his reason is gone, and the fetichman is obliged to train him, and instruct him in the simplest bodily movements, like a little child. At first the stick is the only instrument of education, but gradually his senses come back to him, and he begins to speak. As soon as his education is finished the priest restores him to his parents. They seldom recognize their son, but accept the express assurance of the feticero, who also reminds them of events in the past. In Ambamba a man who has not passed through the process of dying and coming to life again is held in contempt, nor is he permitted to join in the dance." * Bastian adds that the Batheniers of the Sheikh Al-Gebal, in Bamba, are subjected to a similar course of treatment.

Nor are adults exempt from the power of the priest. When the fetich demands the consecration of persons to his service these may be chosen, as in Loango, in the following manner: In that kingdom "annually a stated number of men, women, and children, 12 years of age, are dedicated by the chief of the Gangas to the fetich Maramba. These then keep a fast for several days in a dark hut, and are then dismissed with the admonition to observe strict silence for eight days. Torture is employed to test their resolution: but if this fails, and they refuse to open their mouths, the Ganga conducts them to the presence of the idol, and there making a crescent-shaped incision on the shoulder, requires them to swear, by the blood which flows from the wound, that they will be ever true to Maramba. He forbids them the use of certain meats, imposes upon them certain vows, and hangs around their necks, as a token of their consecration, a little case containing relics." † Persons thus devoted to

* *Ib.* 30. *Cf.* Waitz, I. 365.
† Bastian, 85.

* Bastian, 82.
† *Ib.* 86.

the fetich are, according to Halleur, inviolable: "They may do what they please, and may take what they wish: it is death to refuse them anything." The only drawback is that every year a few of them are offered in sacrifice.*

The priests are the Sages. Their science expatiates over the entire field of fetichism and gives the rules for the preparation and application of fetiches; the formulas of incantation; the methods of performing juggling tricks; the doctrine of souls and spirits and the rites of worship. Finally, their science embraces a knowledge of history and of jurisprudence, as we have seen,—a difficult course of study for the dull brain of the savage, who strives dumbfounded to grasp the profound thoughts, and the lucid definitions of his Master. Thus, *e.g.* "the distinctions between Spirit and Soul; their relations with the body, their pre-existence and their future existence are as nicely defined, as the functions of the three Spiritus familiares in Cornelius Agrippa." † As is ever the case when the mind is constantly occupied in the contemplation of one object, the priest, who is ever engaged with his fetich, enlarges and develops the primitive conception of the thing. He originates a multitude of new fetiches, and proposes them for the veneration of the common people, who take them up greedily. He elaborates distinctions and definitions, classifications and systems: in his hands the popular belief assumes scientific shape. It cannot be uninteresting to study minutely this dogmatic theology of the savage: but we must not expect to find here anything like logical consequence; for the savage, even though he dogmatize, is still a savage, and consequently his most elaborate system will be simply no system. As was to be expected, the various systems of Africa and America differ very widely from one another. Of course also the adherents of the different schools do not reduce their controversies to a courtly war of words, as is our custom; they prefer to demonstrate their theses by hard knocks. Such debates are not infrequent, and many a skull is cracked in the heat of argument. Thus, during Cavazzi's stay in Congo, two schools of doctors, the Macusa-Matamba and the Ngulungu-Nbazi, were continually at war, because they adhered to two different systems of medication.* Similar disputes divided the doctors of the Abipones, as also the piaches (conjurers) of the Caribs.†

The common people, of course, know nothing of fetichistic science. The notions peculiar to that science are as little comprehended by them as the nice points of dogmatic theology are understood by the masses here. Hence the very terminology of the savage *savant* is unintelligible to the savage layman. The feticeros among the Negro tribes, as also the Angekoks of the Greenlanders are said to have a language peculiar to themselves, which is entirely, or in great part, unintelligible to lay folk.‡ Even our common people do not understand the language of the learned. The Dakota priests use a peculiar language; the words are those of the common language of their nation, but employed in a sense different from that commonly given to them. The chiefs also use this esoteric language, in order to keep the common folk out of their secrets.§ In New Zealand, Tahiti, Hawaii and

* Halleur, 32.
† Bastian, 83, *Anm.*

* *Cf.* Bastian, 202.
† Dobrizhofer, II. 84; Du Tertre, II. 386: S'il arrive, qu' une personne invite plusieurs Boyez (pioches) et qu'ils fassent venir chacun leur dieu, c'est pire que la diablerie de Chaumont: car ces diables s'entredisputent, et se disent mille injures, et même, au dire des Sauvages, s'entrebattent si rudement, etc.
‡ Römer, S. 80 ff.; Cranz, 273; H. Egede (Bishop of Greenland), Beschr. von Grönland, S. 122. *Cf.* Bastian, 153.
§ Rigg's Grammar and Dict. of the Dakota lang. Washington, 1852. *Cf.* Waitz.

Mangareva we find also a sacred language—the priests use this language, though they now understand it only imperfectly.*

To propagate the knowledge of fetich science, the priests are "usually attended by a number of disciples, who prepare the fetiches, and who expect to succeed their masters." "Women who have long been barren, or who have lost their children, are wont to dedicate to the service of the fetich the unborn fruit of the womb, and to present to the village priest the new-born babe. He exercises it, at an early age, in those wild dances with deafening drum-accompaniment, by means of which he is accustomed to gain the requisite degree of spiritual exaltation; and in later years he instructs his pupil in the art of understanding, whilst his frame is racked with convulsions, the inspirations of the demon, and of giving fitting responses to questions proposed." † The Shamans, too, have their disciples; and Negro priests receive fees for instruction in their magical arts.‡

This priestly science, which makes its possessors men of redoubtable power, is kept a secret among themselves. It is only for the Initiated. Having thus doctrines in common, and being attached to one system, the priests constitute a society apart, a fraternity; an order, whose secrets are known only to the initiated, and whose mysterious power inspires the uninitiated with fear and terror. Such secret associations of priests are found in the organized priestly classes of Cabende and Loango.§ "To the South of Congo, we find a complete fetich-system only in Bamba. The king of Bamba, who was once the generalissimo of the kingdom of Congo, now lives in an almost inaccessible mountain district, entirely isolated from Portuguese influence, and permits no foreigner to enter his banza. Here is found one of those systems of religious mystery which exercise so fearful an influence along the western coast from Cameroons as far as the Gambia." The central object in this system is the Grand Fetich, already mentioned, who lives in the heart of the bush, perfectly inaccessible to all, who "usually conceals the mysteries of his worship in some remote cavern, but who also reserves to himself some localities lying near the highway, so as to remind terrified wayfarers of his power as often as they see the tokens of his occupancy." * In America too similar mystic fraternities are found.

New members are admitted only after a noviceship and probation of from one to ten years. When the candidate has given evidence of his fitness for promotion, by his observance of protracted fasts, by the performance of the frantic dances, by the violence of his convulsive paroxysms, and by drinking tobacco-juice, he is advanced by due degrees to full membership. Among the Caribs, the disciples of the Piaches receive full consecration as priests only after they have attained the age of 30 or 35 years.

The brethren form an alliance for mutual protection and defense, and their fidelity to one another is assured by the fact that the apostate is pursued with unrelenting hate.† The Dakota Indians have similar associations, whose mysteries consist of dances known only to the initiated.‡

The barbarous style in which these mysteries are celebrated, and instruction conveyed to the candidates, may be seen from the account which Bastian gives of the Yagas: "So soon as the death of the Yaga at Cassange became known throughout the country, the people and the Maquitas gathered around his corpse, which was

* Thomson, Story of N. Zealand. Lond. 1859, I. 80; Chamisso, 46; Moerenhout, 273; Voy. aux îles du grand ocean. Par. 1837, I. 484. *Cf.* Waitz, V. 2, 226 ff.

† Bastian, 85, 100.

‡ Cavazzi, II. 220, I. 294.

§ Bastian, 81.

* *Ib.* 82, 50.

† *Vide* Carver, p. 272; Charlevoix, 363; Du Tertre, II. 367 seq.; Biet, III. IV. 386, 387; Lafiteau, I. 336–344.

‡ Keating, I. 283.

seated on a high throne, arrayed in the feather-ornaments proper to a prince, and holding in its hand the Rilunga. They begged him to name his successor. Amid the din of uproarious music, the spirit of the deceased entered into the representative of the family of the Tendallas, who was lineally descended from the brother of the founder of the kingdom, and, in the ecstasy of wild inspirations, guided his hand to select the Chosen One out of the entire assembly. At once all the priests surrounded the Yaga-elect, and carried him off into the gloomy recesses of a distant forest, into which a layman could penetrate only at the cost of his life. In the mean time Magnates attended to the funeral rites of the dead Yaga, and after breaking out a tooth, which was regarded as something holy, they immured the body together with two of the favorite wives of the deceased, in a sepulchre previously drenched with the blood of a boy and a girl. The new Yaga, while receiving instructions in the fearful mysteries of the Catondos, was obliged to witness dark deeds of murder, so that his heart would not shudder at the contact of death, and was taught the poisonous and medicinal properties of herbs. At the end of one year he entered upon his office. All workmen who understand anything of the builder's art assemble to erect for him a palace. But before the work can be commenced, blood must be shed, to give firmness to the foundation-stone; and the one who is chosen to be the victim has his eyes and mouth carefully bandaged, lest a look or a cry should excite the compassion of the Yaga—for the slightest emotion of human feeling would break the spell, and bring down upon his head the wrath of his forefathers. His breast is steeled against pity; the head, as it is struck off, rolls into the stream, and the Yaga walks four times through the pool of blood which has flowed from the victim, and washes therein his feet and his whole person. He then plants his banner on the spot where his throne is to stand, and work on the palace begins. When it is completed, the new Yaga shows himself to the people, who receive him with loud cheering. On the evening of the third day the prince (Yaga) summons the magnates to his residence, and then takes place that banquet, of which we have already made mention, where by partaking in common of human flesh they are bound to one another by an inviolable fetich." *

Among the American Indians the religious mysteries of the various orders and secret associations of the priests are held in the highest veneration; but they lay most stress upon the art of conjuring spirits. Schoolcraft mentions three such associations, the Jossakeed, the Meda (Meday, Midé) and the Wabeno; the second of which is best known. "To the Meday belong individuals of different tribes and tongues: all are admitted without distinction to the assembly (of the order) provided they are acquainted with the Meday ritual.† The chief festival of the order is the Medawin; which, however, the Sioux keep in a manner slightly different from the Chippeways. The songs sung at this festival are preserved in symbolic pictures which form a secret written language. These writings can be deciphered only by the initiated, who are acquainted with the true signification of the pictures and who know the songs by heart, the symbols serving merely to suggest their general tenor. The right of membership in this association, which is granted even to young children, is conferred in a hut specially built for the purpose. On this occasion a priest makes an oration upon the goodness of the Great Spirit; then follows a procession of the members in a circle, with their medicine-bags, and the candidate receives in the face a puff of air from out of the bags. The power of the conjuring-

* Bastian, 150–154.

† Copway, Traditional Hist. of the Ojibway Nation. Lond. 1850, p. 168.

devil thus prostrates him as though he were dead: but another puff restores him. He then gets a medicine-bag of his own; with it is conferred on him the power of a Meday; and he at once puts his power to the test, touching others with the medicine-bag, which causes them to fall prostrate. When the candidate is a child he is set before each of the medicine-bags in turn, and he gets a new name in addition to his own, which he ever after bears as a member of the society." *

The power of these secret associations is so great that, like the Vehmgericht, their judgments and their penalties, which are ever executed with promptness and vigor, affect not alone their own members, but the people in general. They constitute an invisible police, that with its thousand eyes beholds every hidden thing, and in the face of which no man considers himself secure. The effectiveness of the police of Old Calabar, administered by the Egboords, has sometimes led European police-captains to seek admission into the lower grades; † for all, even slaves, may purchase admission, though the latter can enter only the inferior grades. On the great festival of Egbo, masked men go about the streets, armed with whips, drag offenders forth from their hiding-places and inflict punishment. On that day women are not permitted to quit their houses. The power of the order is felt along the Gold Coast and the Slave Coast. ‡ The terror of the Vehmgericht of the Belli-Paaro was spread throughout the old kingdom of Quoja. Now members were adopted only every twenty-five years, to keep up the association. Those who were cited to appear before this tribunal appeared thickly veiled, for a fearful death awaited whosoever with unhallowed eyes looked on the spirits who surrounded him there. When after three years of novitiate (concerning which the most direful stories were current among the common people) the new adept was for the first time suffered to quit the gloomy forest and to see the light of the sun, he made himself known to the Masters of the Society as a Brother by executing the figures of the Belli dance. He then took the brotherhood's "oath of vengeance."

We cannot determine whether, or how far, the African Purra and Semo associations are of a religious nature. Waitz gives this description of them: "Among the Mandingoes, especially those in the region of Sherbro, the Veis, the Timmanis and other tribes, the Purra association takes a very important part in the administration of justice. The Purra is a secret society, the nature of which is still obscure: so much however is known, that it is a kind of secret police, a secret tribunal, punishing theft, witchcraft and other secret misdeeds. Its ministers go masked, and surprise and seize culprits by night. Naturally this occasions grave abuses, still no man durst make any resistance. The society requires absolute obedience from its members and is made up of warriors divided into sundry classes. If any one by chance comes to a knowledge of their secrets, he is adopted a member by a terrible ceremonial, and threatened with death, should he divulge anything. Two parallel lines tattooed on the body are the insignia of membership. The Purra has also been described as a common federal tribunal having jurisdiction over different nations, and whose judgment is invoked in case of quarrels. The Purra then acts as judge or as mediator, and taking sides with one or other of the parties, decides the quarrel. The Semo among the Susus appears to resemble the Purra, and to have a similar purpose. The Semo has a sacred language peculiar to itself. Though Caillie * has written a long account of this associa-

* Schoolcraft, V. 430 seqq.; Kohl, I. 59, II. 71; Waitz, III. 215.

† Bastian, 294.

‡ Holman, I. 392.

* Caillie, Journ. d'un Voy. a Temboctou, etc. (1824–28), I. 228.

tion, still we know absolutely nothing of its true nature."* (Waitz, II. 135.)

6. *Fetichism among Non-Savages.*

The human mind, in its various stages of progress, must always exhibit phenomena answering to the degree of development to which it has attained. Even where a higher grade of intelligence generally prevails, still the lower grades will not be entirely excluded, for the whole community will not have reached the same degree of development, individuals differing from one another very widely in this respect. Even in civilized countries you will find those who are essentially no better than Bushmen or Negroes in point of mental culture, albeit in outward seeming they differ as widely from the savage as our world differs from that of the Bushman. The difference between the fetich-worshiper *κατ ἐξοχὴν* and the fetich-worshiper as he is found in civilized countries is just this: the former is simply, or at least primarily, a fetichist, but the latter is primarily something different, though secondarily he is a fetichist. He would be as thorough a fetichist as the other, were it not that he is something else besides a fetichist, and so his energies cannot all tend to fetichism. Our next chapter will treat of the fetichism which prevailed among our heathen forefathers.

Here are a few examples. Suppose a hunter has repeatedly met with extraordinary good-luck in the chase when he wore in his hat a conspicuously beautiful feather, and that, on a few occasions when the feather was wanting, he had no success at all. He will in the future, for luck, plant such a feather in his hat. Now the hunter will have his faith in the potency of his fetich increased in proportion as his assurance of good luck, which he gets from the sight of the feather and his conviction of its efficacy, increases his confidence in himself, and so adds to his dexterity: *possunt, quia posse videntur.* Some people take an umbrella with them, *so that it may not rain.* In short we need but run over the list of our popular superstitions, in order to see how far the fetichistic apprehension of object still endures amongst us. Thus, for instance, on every page of the Appendix to Grimm's "Mythologie" we meet with fetichism displaying all its characteristic features. I select only the following instances:

Useful fetiches: "If a man finds a horseshoe, or a piece of one, he is in luck.* He who takes in a large sum of money must mix with it a quantity of chalk, and then wicked people cannot take it back. (The fetich as caretaker.†) If a man eats a raw egg on Christmas morning, he will be able to carry heavy loads. Swallows' nests and crickets bring good luck to a house. If one finds a treasure, he must not cover it over with any garment used to cover the body, or he is a dead man: he must cover it with a pocket handkerchief, or with a crust of bread. Chase a hen thrice around a table, and mix with her food fragments of wood from three corners of a table, and she will stay at home. Fetich-medicine: Rain water will make children speak at an early age. A pulled tooth is to be driven into a

* Winterbottom, 180 seqq.; Golberry, R. durch das W. Afr. (1803) I. 56; Laing, 88 seqq.; Forbes, Six Months in Sierra Leone (Ger. Tr.) S. 84. *Cf.* Cæsar, B. G. VI. 13, 14: Fere de omnibus controversiis publicis privatisque constituunt; et si quod est admissum facinus, si cædes facta; si de hereditate, de finibus controversia, iidem concernunt, prœmia pœnasque constituunt. . . . Hi certo auni tempore in finibus Carnutum, que regio totius Galliæ media habetur, considunt in loco consecrato: huc omnes undique, qui controversias habent, conveniunt, eorumque decretis judiciisque parent. Si quis aut privatus aut publicus eorum decreto non steterit, sacrificiis interdicunt. Hæc pœna apud eos est gravissima. . . . Druides a bello abesse consueverunt, neque tributa una cum reliquis pendunt; militiæ vocationum omniumque rerum habent immunitatem. These Druids were also soothsayers, physicians, conjurers, etc. *Cf.* Tacitus Ann. XIV. 30; Hist. IV. 54; Germ. 7, 11; Plin. Hist. Natur. XXX. 4.

* Grimm, D. M. Anhang. Nr. 129.

† *Ib.* Nr. 5.

young tree, and covered with the bark. If the tree be cut down, the ache comes back. If you break a twig off a willow, and drive it into the aching tooth until the blood comes, and then restore the twig to its place, drawing the bark over it, the toothache goes away. The head of a mouse, bitten off from the body, or cut off with a knife of gold, assists a child in teething, when it is hung about his neck. If one is troubled with catarrh, let him drink a glass of water with a three-pronged fork. To cure debility in children: their urine is to be caught in a new pot: into this is to be put the egg of a coal-black hen bought without chaffering: the egg to be pierced with nine holes: the pot, wrapped in a linen cloth, to be buried after sunset, in an ant-hill that has been discovered without search. If any one afterward find the pot, he must not make any use of it, else he will take the complaint that was buried. Maleficent fetiches: It is unlucky to walk over *sweepings*. Fetich oracles: the grave-digger's mattock rattles when a new grave is to be dug. Charms and counter-charms: If one goes out of doors unwashed, he is easily bewitched. Never throw into the street hair that has come out in combing, or you will be always in danger from witchcraft. Old women often cut out a sod a foot long that has just been trod by their enemy: this they hang up in the chimney, and so cause their enemy to pine away. The whirlwind is caused by witches: throw a knife into the whirl and you will see them at work. Witches can produce rain and thunder: they can also raise winds to carry off linen that is bleaching, and hay that is curing in the sun. In the springtime when the cattle are first driven afield, axes, hatchets, saws and other iron implements are placed before the door of the barn; thus the cattle are guarded against witchcraft. When water is bewitched, and will not boil, place under the pot three sticks of different kinds of wood. A shirt spun by a girl of five to seven years of age is a sure protection against witchcraft. If your beast has been bewitched, go to the stable at midnight, and you will find on its back a straw: put the straw in a sack, call in the neighbors and give the sack a thrashing; the sack will then be seen to swell and the witch will utter a shriek. Our ancestors did not compare very favorably with savages: their treatment of witches was more cruel than the ferocity of any savages toward their conjurers; and the blazing fires of the Christian middle ages, lighted for the torturing of witches, were supposed to be the ministers of a Holy Spirit. Such blasphemy as this cannot be imputed to the savage. When we call to mind the rude and undeveloped state of intellect in which fetichism takes its rise, what a fearful light is thrown by these medieval phenomena upon the intellectual status of our forefathers whom it is still, in some quarters, the fashion to praise and to admire! Shall I recount the pitiable absurdities, the gossip of the dairy and of the spinning-room, which were held by judges who pored day and night over their musty folios evidence sufficient to justify them in tearing away from the bosom of their families, in torturing and putting to death with every circumstance of cruelty, weak old women, idiots and children? Need I recite the frantic harangues which called for the kindling of fires in the market-places of university-towns, and which occasioned the death of hundreds of thousands of innocent victims? As late as the year 1783 the portentous gleam of these fires was to be seen in Germany." * And who is to assure us of their final extinction; and that there are not beneath the ashes concealed fires, still living and full of danger, which may burst forth in flames afresh, carrying desolation throughout the land? For we still have mighty fetiches, and these act in Europe precisely as they do in Africa.

Plutarch relates that the Dictator

* Bastian, 93.

Sulla had no such faith in any god, as in a little image of Apollo which he constantly wore upon his breast. Suetonius says that Nero was Religionum usquequaque contemtor, præter unius deæ Syriæ. Hanc mox ita sprevit, ut urina contaminaret, alia superstitione captus, in qua sola pertinacissime hæsit. Siquidem icunculam puellarem, cum quasi remedium insidiarum a plebeio quodam et ignoto muneri accepisset, detecta confestim conjuratione, pro summo Numine trinisque in die sacrificiis colere perseveravit: volebatque credi monitione ejus futura prænoscere.*

The amulet differs from the fetich in this, that here the sensible object is not regarded as possessed of a power of its own (for then it would be a fetich), but only as the representative symbol of some higher power, which is the real efficient cause. The amulet therefore points back to a train of ideas which lie behind it: the fetich stands upon its own merits. Thus, for instance, in the Arab's amulet—a verse from the Koran on a strip of parchment—it is not the parchment and the ink that produce the effect he desires, but the omnipotence of Allah, of which the writing is regarded as the sensible sign. But yet the people, who wear such amulets as a protection against the powers of evil, very readily forget this distinction, confound the two things, and regard the sensible object as the efficient cause. Thus the amulet becomes a fetich. The Mohammedans of Senegambia write the potent verse on a tablet, then they wash off the inscription, and drink the water.† Thus again, so soon as the working of miracles is associated with the image of a saint, that image of necessity becomes a fetich; and will receive from its worshipers precisely the same usage, which other fetiches receive at the hands of savage devotees. In mediæval times it was no uncommon thing for people, when a saint withheld his assistance in time of need, to renounce his service, to break his image in pieces, or to cast it into a river or a swamp.* As late as the middle of the 17th century some Portuguese sailors pronounced dire threats against St. Antony of Padua during a calm: they would have bound him hand and foot, were it not that some one came to his assistance. At length they set his image on the tip of the bowsprit and thus addressed it, kneeling: "S. Antony, be so good as to stand there ever till you give us a favorable wind,to continue our voyage."† A Spanish ship's captain fastened a little image of the Virgin to the mast, saying she should remain in that position until he got from her a favorable wind.‡ The Neapolitans once called S. Gennaro *vecchio ladrone*, *birbone*, *scelerato*, because he had not checked a stream of lava. They even cudgeled the saint.§ Some Spanish peasants, during a protracted drought, threw the Virgin into a pond, and called her witch, wench, etc.|| When Russian peasants would do anything unbecoming in the presence of the saints' pictures, they cover the latter with cloths, to prevent their witnessing the deed.¶ A Russian peasant, who had harvested a poorer crop than his neighbor, borrowed from the latter his holy image, and mounted it on his plow, expecting thus to have better luck.** To this day Russian peasants whip saints' images; to this day images of the Virgin are put in prison by Italian peasants, precisely as the Negro does with his fetiches, when he would punish them, or keep them from harming him.††

* Suet. Nero, c. 56.
† Bastian, 197; Waitz, II. 187.

* Meiners, I. 181.
† Della Valle, Voy. VII. 409; Meiners *ub. supr.*
‡ Frezier, Rel. du Voy. de la Mer du Sud, p. 248.
§ Kotzebue, Reise nach Rom. I. 327.
|| Spanien, Wie es ist. 1797, II. 117.
¶ J. J. Straussen's Reisen, Amst. 1678, S. 84.
** Weber, Verändertes Russland, 1721, II 198.
†† Waitz, II. 185.

CHAPTER V.

THE VARIOUS OBJECTS OF FETICH-WORSHIP.

ANYTHING may become a fetich. An intelligent Dakota once said that "there is nothing that the Indians do not worship as a God."* For the Negroes of the Gold Coast, *Wongs* (objects of worship) are, first, the gods dwelling betwixt heaven and earth, who beget children, die, and come to life again. These deities are divided into distinct classes, which get their names from the functions they discharge, and these names are taken from the vocabulary of Negro state-craft. But then Wong is also, 1, the sea, with all its contents; 2, rivers, lakes, fountains; 3, certain enclosed areas of land, and all termite-hills; 4, the otutu (a little heap of earth raised over a buried sacrifice) and the drums belonging to a quarter of a town; 5, certain trees; 6, certain animals—the crocodile, ape, serpent, etc., while other animals are only sacred to the Wongs; 7, images carved and blessed by the fetichman; 8, certain combinations of cords, hairs, bones, etc.†

1. *Stones as Fetiches.*

All Nature is endowed with life: the savage mind apprehends even stones anthropopathically. The Lapps transfer to stones the domestic relations of Father, Mother and Child: they even fancy that stones roam about at night, after the manner of the "Roving Bell."‡ It is not only in Ovid's Metamorphoses that men are changed into stones; the natives of the Marianne Isles have a belief that the first Man was metamorphosed into a rock, which is still pointed out as an object of veneration.§ The worship of stones is to be found in all quarters of the globe; but in Africa it prevails most among the Gallas.* Men swear by stones and by rocks; for instance, the Somali in Africa,† not to speak of other nations. The ancient Germans and Gauls, as also the Celts, who, according to Grimm, were stone-worshipers *par excellence*, did the same.‡ Nulius Christianus ad fana aut ad petras, vel ad fontes, vel ad arbores luminaria faciat, aut vota reddere præsumat,—such is the exhortation given by S. Eloy in a sermon.§ The church in the middle ages never tires of condemning the "votum vovere ad lapidem, vel ad quamlibet rem." ‖ Offerings were made to stones by anointing them with oil, blood or wine.¶

The pagan inhabitants of Canaan worshiped stones in this manner.** De Brosses, in his work in the Bætylia shows that all the great nations of antiquity, not excepting the Greeks and Romans, worshiped stones. The inhabitants of Pharæ worshiped 30 square stones. *Τούτους σέβουσιν οἱ Φαρεῖς*, writes Pausanias, *ἑκάστου θεοῦ τινος ὄνομα ἐπιλέγοντες. Τὰ δὲ ἔτι παλαιότερα καὶ τοῖς πᾶσιν Ἕλλησι, τιμὰς θεῶν ἀντὶ αγαλμάτων εἶχον ἀργοὶ λίθοι*.†† In a higher state of intellectual development, when the notion of gods gained the ascendency, it was very easy to establish relation between some god and a stone, which previously had been worshiped on its own account. The Sacred Treasure of Jupiter at Tegea was a rough quadrangular stone. Meteoric stones were a special object of worship, being often regarded as incarnate rays of

* Waitz, III. 191.

† Bas, Missionary Magazine, 1856, II. 131; Waitz, II. 183.

‡ Requard, Voy. en Lappland, in Voy. au N. VI. p. 321.

§ Le Gobien, Hist. des Isles Marianes. Paris, 1700, p. 197.

* Rochet d'Héricourt, Voy. dans le roy. de Choa. Par. 1841, p. 167.

† Burton, First Footsteps in E. Afr. Lond. 1856, p. 113.

‡ J. Grimm, D. M. S. 370.

§ Vita Eligii by Andoenus Rotomagensis (d. 683 or 689), pub. by Achery, Spicileg, t. v. Paris, 1661, p. 215-219; Grimm, D. M. Anh. S. XXX.

‖ Grimm, D. M. Auh. S. XXXIII. XXXIV. XXXV.

¶ Meiners, Gesch. d. R. S. 150; De Brosses, Les Pierres Bætyles, 110, 123, 133, 135.

** *Cf.* Merx, s. v. Abgötterei, in Schenkel's Bibellexikon.

†† Pausan. VII. 22, VI. 22.

the sun.* Such ἀγάλματα διϊπετῆ (Bætylia, abadir) are the Stone Symbol of Diana, at Ephesus; of the Sun-God Elagabal, at Emissa, in Syria; of Mars, at Rome, and the Black Stone, the Kaaba, at Mecca.

Many savages regard stones as the children of Mother Earth,† for they have also an anthropopathic conception of the earth, and so worship her. According to Dapper, the King of Alé and his grandees used to hold council together, previous to a war, in a pit dug in the midst of the forest. The deliberations at an end, the pit was carefully filled up again, lest it should betray their secrets. The Iroquois and other Indian tribes believed themselves to be the children of Earth: they would never sit upon the bare ground, but always first covered the spot on which they sat, with a little grass, or with a branch of a tree.‡

Nam neque de cœlo cecidisse animalia possunt
Nec terrestria de salsis exisse lacunis:
Linquitur, ut merito maternum nomen adepta
Terra sit, e terra quoniam sunt cuncta creata.
Lucretius de R. N. v. 793 seqq.

2. *Mountains as Fetiches.*

Mountains are for many reasons objects of fetichistic worship. At one moment their summits are veiled in clouds, the next they are radiant in the fierce blaze of the sun; out of their caverns the winds issue forth, and down their sides are poured the torrents which fall from the rain-clouds enveloping their heads. All these phenomena are regarded by the untutored mind of the savage as produced by the agency of the mountain itself, and he accordingly pictures to himself the latter as endowed with a human will, and acting from human motives. In this respect he is a poet. He does not imagine any such thing as a Spirit of the mountain, a being merely inhabiting it; no, it is the Mountain itself, this tellurian mass that he worships. It is true, the fetichist sees in it something more than a heap of earth and rock. For him the mountain forms the clouds, and sends the storms. But why? From such motives as move men to action: now he is terribly wrathful; anon he is all smiles. So his worshipers will study to appease him, and for this purpose will make offerings to him.

The worship of mountains is found among several Siberian tribes, among Negroes and American Indians.* The Ural was worshiped by the nations dwelling around it. We must distinguish between this fetich worship and that respect paid to mountains, on the ground of their having once been the seat of a certain cultus, or the home of some god. In that case it is not the mountain but the god that is worshiped: and of this kind of veneration we do not treat here. As Jacob Grimm did not study fetichism in its psychological aspects, he doubted whether men ever could pay adoration to a mountain, and discredited all accounts which state that such a worship exists. I extract from his Deutsche Mythologie the passages which have a bearing on this subject, as so many proofs for the reality of Mountain-fetich worship.† "Many were the Sacred Mounts and Hills: but yet they do not appear to have been worshiped directly, but to have been venerated merely on account of the god who inhabited them (Wotan's and Donner's Berge). Though Agathias speaks of λόφοι and φάραγγες (hills and ravines) as being objects of worship, without any mention of any other object, we may suppose that he was an inaccurate observer, and that he failed to notice a worship of water or of fire having its sanctuary on the mountains. We might look for the worship of mountains among

* Bastian, Die Seele, u. s. w. S. 9.
† *Ibidem.*
‡ Tanner, Mémoires trad. pas E. de Blosseville. Paris, 1835, I. 250; Waitz, III. 184.

* The Yakutes, Sarytschew, I. 27; the Burats, Georgi, 318; Negroes, De Bry, VI. 21, Römer, 65; Peruvians, Acosta, 206; Mongolians, Isbrand, p. 111.
† Deutsche Mythol. S. 369.

the Goths, in whose language *fairguai* signifies *mountain*, if the explanation we have already * given of this word is correct. Dietmar of Merseburg gives an example of Sclavic mountain-worship (p. 237): Posita est autem hæc (civitas, i. e. Nemzi, Nimptsch) in pago Silensi, vocabulo hoc a *quodam monte*, nimis excelso et grandi, olim sibi indito: et hic *ob qualitatem suam et quantitatem*, cum execranda gentilitas ibi veneraretur, *ab incolis omnibus nimis honorabatur*. The commentators are of opinion that this mountain is the Zobtenberg."

3. *Water as a Fetich.*

Jacob Grimm gives a very full account of the worship paid to Water in the spring, the brook, the river, and the sea, and describes the religious observances of the people, as they "offered their prayers, lighted lamps, or made their sacrifices on the banks of the stream, or on the margin of the spring;" and these usages he traces from the remotest antiquity down into the Christian era.† "The pure, flowing, bubbling, evanescent water; the flaming, glowing, dying fire; the air, perceptible, not to the eye, but to the ear and to the touch; the Earth, which maintains all things and to which they all revert: these have ever been regarded by man as sacred and worshipful, and through them he has been wont to bestow a solemn consecration upon the customs, the pursuits and the events of his life. Their action upon the entire universe being steady and constant, the untutored mind pays them worship for their own sake without any reference to a deity residing in them." The anthropopathic apprehension of rivers, springs, and the sea is found among all savage nations. Many of the populations on the banks of the Niger regard its tributaries as the wives of the main stream.‡ In Acra a pitcher used to be cast into a pond which was thought to be the messenger of all the rivers in that country: the pond was then entreated to go abroad with the pitcher and purchase water of other ponds and streams: on returning home it was expected to bring sufficient water to irrigate all the fields.* The spring is regarded as the seat of all the river's life. Strangers must not come near it.† The Negro savage believes that the presence of the white traveler may enrage the River Spirit, or do him hurt, or even deprive him of life. Rivers are an object of worship not only in Africa,‡ but also in America § and in Northern Asia.‖ Whenever the Kamtchatdales sail across a dangerous whirlpool they cast into the water little pieces of wood neatly carved, and tobacco, and excuse their temerity by saying: "Be not angry with us for sailing over thee, as though we had forgotten our reverence for thee. We are not without reverence, but the Russians oblige us against our will to make this navigation." ¶ The ancient Russians worshiped the Don, the Dnieper (worshiped as the Borysthenes by the Scythians) and the Wolga—streams on which they depended for their existence. The ancient Mongolians would appear also to have been given to river-worship.** According to Agathias the Alamanni too worshiped rivers: *Δένδρα τε γάρ τινα ἱλάσκονται και ῥεῖθρα ποταμῶν καὶ λόφους καὶ φάραγγας, καὶ τούτοις ὥσπερ ὅσια δρῶντες.*†† Herodotus makes a similar statement as to the Persians:

* Deutsche Mythol. 116.

† D. M. 326–340.

‡ Clapperton, Tageb. seiner, zweiten R. p. 414.

* Allg. Gesch. der R. IV. 180; Waitz, Anthr. II. 177.

† Laing, p. 310; Bastian, 59 f. "In 1641 Hans Ohm of Sommerpahl built a mill over the brook: and as the succeeding year proved disastrous to the crops, everybody assigned as the cause, the profanation of the sacred brook, which was indignant at having been checked in its course. So they attacked the mill, and utterly destroyed it." Grimm, D. M. 338.

‡ Cavazzi, I. 363.

§ Charlevoix, p. 348.

‖ Georgi, Reise, S. 318; Steller, S. 21.

¶ Steller, S. 19.

** Wuttke, I. 214. *Cf.* Barrow, Trav. in China. Lond. 1804, p. 509.

†† Agath. 28. 4.

Ες ποταμὸν δὲ οὔτε ἐνουρέουσι οὔτε ἐμπτύουσι, οὐ χεῖρας ἐναπονίζονται, οὐδὲ ἄλλον ουδένα περιορέουσι, ἀλλὰ σέβονται ποταμοὺς μάλιστα. * Seneca says of the Romans: Magnorum fluminum capita veneramur: subita et ex abdito vasti amnis eruptio aras habet. Coluntur aquarum calentium fontes: et stagna quædam vel opacitas vel immensa altitudo sacravit.† The honor which the Hindus pay to the Ganges does not belong to this category. The Hindu apotheosis of Nature is pantheistic, not fetichistic. "O Mother Earth, Father Air, Friend Fire, Brother Water, I now in all reverence and for the last time address my prayers to you: I am about to enter into the Supreme Brahman, for owing to the surplus of good works which I have laid up during my intercourse with you, I have attained to immaculate knowledge and have so cast aside all power of straying from the Truth." ‡ We must however here remember that in the hands of the common people the amulet easily becomes a fetich.

The natives of Sumatra and of the Philippines worship the sea, as well as those of Africa. By the ancient Peruvians, before the time of the Incas, the sea was regarded as the supreme deity.§

The Kaffirs make offerings to a stream, of entrails, animals and millet, to secure immunity against disease.‖ Roman naval commanders offered sacrifice to the sea before setting sail.¶ Even in the last century Christian Greeks made offerings to rivers; and Turks regarded it as perfectly natural to throw overboard Christians and Jews, in a storm, to appease the wrath of the sea.** A tempest having broken up the first bridge of boats, Xerxes ordered three hundred lashes to be given to the Hellespont, and chains to be cast into it. Again he presented an offering on a dish of gold, and this, together with a golden goblet, he threw into the waters of the strait. Herodotus is undecided whether this was done in honor of the Sun, or to appease the offended Hellespont.*

4. *Wind and Fire as Fetiches.*

"The hurricane (called by the Congo Negroes, 'the Horse of the Boonzie') is regarded as a ravening, devouring monster—a giant like the Jötunns—whose wrath may be appeased by casting meal into the air. I regard this," says Jacob Grimm, "as a primitive superstition." † "In the popular traditions of Russia the four winds are the sons of one mother; and in the ancient Russian song of Igor the Winds are addressed as Lords, and are said to be the grandsons of Stribog, whose divine nature is implied in his name. In like manner in Oriental tales and poems the wind is represented as speaking and holding converse." ‡ Of the Payaguas of S. America Azara § says: "When a storm overturns their huts or casas, they take a brand from the fire, and run against the wind for some distance, threatening it with the brand. Others strike terror into the storm, by pummeling the air soundly." In Asia the Tcheremis used to make offerings to the winds.‖ In ancient times the same custom was in vogue among the Greeks and Romans, as well as other nations.¶

In every quarter of the globe we meet with the worship of Fire, that "mysterious element, ever restless,

* Herod. I. 138.
† Senec. Ep. 41; Cic. de N. Deor. III. 20.
‡ Otto Böhtlingk, Indische Sprüche, B. II. S. 97 (1 Aufl.).
§ Bosmann, S. 168; Atkins, Voy. to Guinea, Brazil and the W. Indies. Lond. 1737, p. 119; Sneligrave, Nouvelle Relation de la Guinée. Amst. 1735, p. 69; Marsden, 256, 258.
‖ Alberti, S. 72.
¶ Cicero, de N. Deor. III. 20.
** Shaw, Travels, or observations relating to sev. parts of Barbary and the Levant. Lond. 1757, p. 333; Guys, Voy. littéraire de la Grèce. Par. 1776, I. 466; Kleemann, Reisen in die Crimm. II. Wien, 1771, S. 113.

* Herod. VII. 34, 35, 54.
† D. M. 363. *Cf.* S. 360–368.
‡ D. M. 361.
§ Azara, II. 137.
‖ Rytschkow, S. 86.
¶ Herod. VII. 178, 189; Pausan. II. 12; Cic. de. N. Deor. III. 20.

ever consuming, ever brightly flaming Power of Nature." "Our Northern student lights his lamp with a match, spreads out before him the volumes written in the past, and traces in Hephæstus the root Phtha, or compares Vesta, Behram and Agni with one another. As I take it, this is commencing at the end and not at the beginning. The student does not consider that friction-matches are a very recent invention, and that anciently the production of fire was a very difficult process: as we may still see in the case of savages who often spend hours in getting fire.* The *lucifer* which has become for us a thing so familiar that we never stop to think about it, was once one of the most mysterious of wonders, a wonder which must have all the more forcibly impressed men's imaginations, inasmuch as it not alone promoted man's comfort, but even made life endurable, especially in cold climates. Hence we can understand why the Sacred Fire always burned in the shrine; why faithful guardians were appointed to care for it, and why this worship of Fire was recognized in public legislation, as well as in the concernments of private life." † "Fire, like water, is regarded as a thing of life;" ‡ and by many savage tribes it is held to be an animal. Τὸ πῦρ ϑηρίον ἔμψυχον, says Herodotus, describing the beliefs of the Egyptians (III. 16), and Cicero has, ignis animal. (De N. Deor. 3. 14.) Among the Damara, one of the rudest of savage tribes, who can scarcely count beyond the number three, and to whom the institution of marriage is unknown, the daughters of the chiefs are charged with the duty of keeping up the Sacred Fire, for Vestals are to be found in several religious systems, the duty of keeping up a sacred fire being an easy one, and best suited for women. When a family separated from the tribe and emigrated they took with them a brand of the sacred fire.

* *Cf.* Grimm, D. M 341 ff.
† Bastian, 343.
‡ D. M. S. 340.

Whenever the fire went out, on rekindling it, sacrifice was offered.* The Sioux called themselves Potowatomie, which means, we make fire,† and, like the Ojibways and other nations, they kept up an undying fire, as the symbol of their nationality.‡ According to Adair the word Cherokee is derived from Cheera, fire. The Muscogees gave to fire the highest Indian title of honor, *grandfather;* § and their priests were called "Fire-makers." The chief ceremony of their principal festival, "the First Fruits," was the Renewing of the Fire, a performance which, among the Mexicans, was repeated every 52 years. The old fires were then all extinguished, and it was only after they had practiced purificatory rites and fasted for the space of three days that the people supposed they had received the consecration which was needed for the kindling of the new Fire.‖

With the worship of fire that of Lightning and Thunder is closely allied. Perhaps among all the phenomena of Nature the worship of Thunder and Lightning is the most widely diffused. It is found among the rudest populations—the aborigines of Brazil, for instance.¶ The Betchuana worship the rain as it falls from the clouds. As their country is arid and barren, and their great curse drought, they hold Rain to be the Giver of all good. They begin and end every solemn discourse with the word *Puhla*, rain, and they have the greatest veneration for their Rain-makers.**

In some countries it is not the Rain itself but a Rain-giver that is worshiped; not the Thunder, but a Thunderer, who ranks above all other spirits by reason of the dread power of his voice and the awful, death-dealing force of his shaft, the Lightning.

* Anderson, Reise in S. W. Afrika bis zum Ngami. Leipz. 1858, I. 239.
† Keating, I. 89.
‡ Schoolcraft, II. 138.
§ Waitz, III. 208.
‖ *Ibid.* 208.
¶ M. v. Neuwied, S. 144.
** Thompson, I. 180; Campbell, 2d Journey, 230.

The Damara regard as their supreme deity Omakuru, the Rain-giver, who dwells in the distant North.* Some of the Damara even claim for themselves descent from the Rain, while others would have only birds, fishes and worms reckoned as Rain's progeny.† In the island of Ponapi the supreme Being vents his wrath in the thunder: ‡ and in the northern Sagas Lightning is called God's *Beard-speech*, for when Thor mutters words behind his red beard, the lightnings flash through the sky. Zeus shakes his ambrosial locks, and the heavens are moved. In the isle of Morileu navigators adored the rainbow, or perhaps the spirit of the rainbow.§

After the mind has attained some degree of development, the old objects of worship still remain, but they are then subordinated to the new, and pass for the symbols of the latter. As Zeus was thus connected with lightning and thunder, so among the Israelites Jehovah was connected with fire, as his appearance in the Burning Bush, in thunder and lightning on Sinai, and in the Pillar of Fire, clearly shows. Vulcan came into relation with the sacred fire of Vesta through the column of flame which shot up from Etna.

5. *Plants as Fetiches.*

"Heathendom regarded all Nature as living," says Jacob Grimm.‖ This view of Nature is very clearly expressed in the northern myth of Baldr. To ward off from the beloved God all danger, Frigg exacted an oath from Earth, from stones, water, fire, plants, beasts, birds, worms, and even from Pestilence, not to injure him. Only the young and and tender Mistletoe was by the goddess thought so weak and powerless that she did not require of it the oath. But when afterward Hödur, at the prompting of Loke, with this plant compassed the death of Baldr, all creatures wept—plants, beasts and men.

If inanimate stones are regarded as living beings, we are not to be surprised if plants are also thought to have souls, for their whole process of development, in growing and blooming, in bearing fruit and in withering, has many analogies in human life. This anthropopathic apprehension of plants is very evident in the belief entertained in popular superstition as to the powers of the magical plant Mandrake, which is mentioned under the name μανδραγόρας by Hippocrates, Xenophon, Plato, Theophrastus and others. It is described as shaped like a man. When it is plucked from the earth it utters a cry, a groan of pain so terrible as to cause the death of the one who plucks it out. But if it be displaced by a special manipulation of the surrounding earth, it must be then washed in red wine, wrapped in white and red bandages of silk, bathed every Friday, and vested in a fresh, white garment at each new moon. If questioned it will make known future and hidden things tending to the welfare and prosperity of the questioner, and if a piece of gold lies beside it through the night there will be found in the morning two: but its good-nature must not be imposed upon, however. The water in which it has been washed is to be poured upon the door-sill, or upon the cattle, and so the house and the stock are preserved from ill-luck. If barren women drink of it, they will be blessed with progeny. If a man wears the mandrake about his person he will always in suits at law defeat his opponent.*

This mandrake is of human origin,

* Anderson, I. 237.

† Rh. Missionsber, 1852, S. 235; Hahn, Grundzüge einer Grammatik des Herero. Berl. 1857, S. 152.

‡ Michelewa y Rojas, Viajes cientificos en todo el Mundo (1822–42). Madrid, 1843, p. 197.

§ V. Kittlitz, Denkwürdigk. auf einer R. n. d. russ. Am., Mikrones. und Kamtsch. (1826 ff). Gotha, 1858, II. 105.

‖ D. M., S. 371.

* Meiners, II. 600.

springing from a chaste youth's semen fallen to the ground. But on the other hand, men also spring from plants. There is a Micronesian story to the effect that Tangaloa's daughter, while yet the earth was parched and barren, assuming the form of a snipe alighted upon the earth, and made her home on a rock. From the rock a creeping plant sprung forth, and as this died away it produced at first worms, then men.* Some of the Damara tell of the descent of man and the larger beasts from a sacred tree, which they worship. In the German Song of Alexander (Alexanderlied) by Pfaff Lamprecht, "megede rehte vollencommen"—perfectly beauteous maidens—are spoken of as springing from flowers.

"Si giengen unde lebeten
Menschen sin si habeten."

As they spring from the flowers, with them they perish:

"Die blûmen gare verturben
Unde die scônen frowen sturben."

Daphne was changed into a bay-tree.

In speaking of the worship of plants, trees and woods, I do not give it Ovid's interpretation:

Stat vetus et multos incædua silva per annos,
Credibile est *illi numen inesse loco*.†

On the Coral Islands of Polynesia the *crinum* and the *dragon's blood* are held sacred. The Dayaks of Borneo worship also the *dragon's blood*, together with the *pancratium amboinense*.‡ Generally, however, it is large trees that are worshiped, such as the mighty *adansonia*. In Whidah the sick apply to the sacred trees, for the cure of their complaints.§ On the Zaire the public and the domestic council of the prince meet beneath the holy *ficus religiosa*,* a tree which plays an important part in the history of religion. In Congo it is planted in all the market-places, as an object of worship: its bark has fetich-craft; and any injury done to the tree is punished as a crime. The Somali worship certain trees,† and the Galla specially the wanzey-tree, though in the south of Shoa they regard the *wodanabe*-tree as their national Palladium, their "great Fetich." ‡ This same tree-worship is found in N. America and Northern Asia, for instance, among the Ostiaks, Wotiaks and the Tsheremis.§ The savages of Acadie worshiped an ancient tree on the sea-shore. This tree having fallen root and branch into the sea, they continued to worship it as long as any part of it remained visible.‖ The sacred tree of the Longobardi was the so-called blood-tree, and the ancient Germans worshiped chiefly the oak, though they had also great reverence for the alder: ¶ nor were the ancient Jews, Arabs ** or Persians †† without their fetich-trees. The goddess Ashera was originally worshiped under the form of a simple stock of wood.‡‡ "The Diana of the isle of Eubœa was a piece of unhewed wood, the Thespian Juno of Cytheron the trunk of a tree, she of Samos a simple slab of wood, as was also the Delian Latona; the Carian Diana was a cylinder of wood, and the Pallas, and the Ceres at Athens were rough stakes, sine effigie rudis palus, et informe lignum." §§

As single trees, so also whole groves, with their green, umbrageous aisles, their mystic gloom, and the tuneful rustling of their leaves would

* Turner, p. 244.
† Ovid, Amor. III. 1. 1.
‡ Gerland, in Waitz, V. 2. 10.
§ Bosmann, II. 64, 323, III. 153; Des Marchais, II. 132.

* Tuckey, p. 366.
† Waitz, II. 523.
‡ *Ib.* 518.
§ Rytschkow, S. 161.
‖ Charlevoix, p. 349.
¶ Grimm, D. M. S. 374.
** Merx, in Schenkel's Bibellex. Art. *Aschera* and *Astarte*.
†† Meiners, I. 152.
‡‡ Merx, *ubi supr.*
§§ De Brosses, p. 151.

make a most profound impression on the childlike fancy of the savage. The rustling of the leaves was regarded as the language of the trees: thus it was that the sacred oaks of Dodona spoke, and oracles were published founded on these words of the oaks. Athene, according to Apollodorus, fixed on the prow of the Argo a voiceful piece of wood from one of the Dodonian oaks (φονῆεν φηγου τῆς Δωδωνίδος ξύλον); and the wooden ships of the Phœacians were possessed of souls (τιτυσκόμεναι φρεσὶ νῆες).*

Among the ancient Germans single trees as well as entire forests were held in the greatest reverence.† Such sacred groves were not to be entered by the profane: such sacred trees were not to be stripped of their leaves or branches, or to be hewed down. Compare sacrum nemus, nemus castum, in Tacitus, and Lucus erat longo numquam violatus ab ævo, in Lucan.‡ Amongst the sacred groves of German lands were the forest of the Semnones, the nemus of Nerthus, the Sclavic lucus Zutibure and the Prussian grove Romowe. Amongst the Esthonians it was held impious to break off a twig in a sacred grove, nor would they even pluck a strawberry within its shadow.§ Long after the introduction of Christianity the violation of trees was sternly punished in Germany.‖ Of the Esthonians at the present day we have this account: Only a few years ago, in the parish of Harjel, they *made offerings* (opferten) under certain trees on the nights of S. George's, S. John's and S. Michael's day. they killed a black hen. According to the superstitious belief of the Wends of Lausitz there are forests which annually demand a human sacrifice (as do many rivers) · and one man must annually yield his life.¶ For an account of the ecclesiastical prohibitions, vota ad arbores facere aut ibi candelam seu quodlibet munus deferre, arborem colere, votum persolvere, consult Grimm, D. M. Anhang. XXXIII. XXXIV.

* Odyss. VIII. 556.
† *Cf.* Grimm, D. M. 371 ff.
‡ Pharsal. III. 399.
§ "Ut umbra pertingit." Grimm, R. A. 57, 105.
‖ Grimm, Weisthümer, III. S. 309, 18, IV. 366, 15, 699.
¶ Grimm, D. M. *ub. supr.*

6. *Animals as Fetiches.*

Christianity, that religion which sets the highest value upon the human individual, places a great abyss between man and nature. She isolates man and places him infinitely above nature. Christianity therefore regards the animal as in every respect far inferior to man. The religions of India regard Nature as only the outward aspect of Brahma; for them therefore the eternal Being is visible in the beast as well as in man. Consequently in the beast the Hindu recognizes a brother, of equal rights, and of like rank with himself. But the vtew which the savage takes of the animal world is different from both of these. He commonly regards the animal not simply as his equal, but as a superior being. Of the Negroes Waitz says: "In their view man has not his definitive place at the summit of Nature, and above the animals, but the latter appear to them as enigmatical beings whose nature is involved in obscurity and mystery, and whom they rank now as above themselves, again as beneath."* "The Indians," says the same author, "regard the animals as man's ancestors and kindred and ascribe to them a human understanding and human principles of action, or even sometimes a higher intelligence and superhuman capacities. Those animals, however, which neither inspire them with fear nor display any notable sagacity they despise." † To understand why the savage views the animal creation thus, we need but know the nature of his intellect and the conditions of life in which he is placed.

As the understanding reaches only as far as its objects, it will always be

* Anthrop. II. 177.
† Anthrop. III. 192.

enlarged as the number of these increases. The greater a man's intelligence, the wider is the line of distinction between him and beings possessed of none at all, or of a less degree than himself. But so long as the number of his objects does not exceed that possessed by animals; so long as they are the same in kind as those possessed by the animal, and not more numerous, in other words so long as his *world* is that of the animal; just so long the intellectual condition of the lowest savage will not be distinguishable from that of the beast.

The will can be exerted only upon the objects exhibited to it in the understanding. Hence, so long as these objects are no higher than those of the animal, the will of the savage cannot have any higher aims than has the will of the beast.

As we have already seen, the savage has a very small number of objects. From the lack of objects of a higher nature, we have shown that his will must be concentrated on those which are purely material. Hence his only stimulus, his only great interest is to satisfy his hunger, his lust, or his desire of repose.

Thus as regards his intellectual status and the range of his desires, the savage, even where he has made some little progress, differs but little from the animal, while at a lower stage he scarcely differs at all. The world of the animal is his world also, and their interests are the same. Hence there is hardly any difference between the savage and a highly-organized animal. But as he differs so little from them, it is impossible for him to regard himself as something quite distinct from them. His pursuits and those of the animal are identical; their wants, their motives are the same; the animal is the counterpart of the man; therefore the savage regards the animal as his equal, as his kindred.

Hence, for the simple reason that the savage and the animal are *de facto* scarcely distinguishable, they would be apprehended as standing on an equality. And as the savage cannot attribute to the beings around him any internal properties save those of which he already has consciousness, he is forced, as we have seen, to form anthropopathic apprehensions of objects. The more closely these beings resemble man in their nature and habits, the sooner will he attribute to them the self-same motives which excite himself. In fact his conduct differs very little from theirs; not alone does he closely resemble them, he is in many respects perfectly identical with them. Hence, as he must have anthropopathic apprehension of a mountain, a river, or a tree, he cannot help regarding the animal as of his kindred. In the eastern part of South Africa Monteiro's ass was a novelty to the natives, and they at once commenced to ask the donkey what he thought about things, always regarding the ass's doings as human performances.*

But not only must the savage regard all, or at least some animals as his equals, he will even assign them a superior rank. Intellectual qualities he values little, as he knows but little about them: but on the contrary, like all men of uncultured minds, like boys, like the old giants in the heroic legend, he prizes bodily strength above everything else. The great chief who with a blow can split the skull of his antagonist; whose powerful voice can be heard at enormous distances, whose nails are like the claws of a bear, who lays hold of a man and tears him in twain, who when hot coals fall upon his body in sleep, is not awakened, but treats them as gnats; who every day devours an entire sheep, and drinks a skin of fermented and distilled milk without being drunk: such is the savage's ideal of true greatness. But nowhere does he find such bodily strength and agility, such fiery courage and uncurbed fury as he does in wild beasts, the lion, tiger, wolf, bear,

* Zeitschrift f. allg. Erdkunde, VI. 407.

elephant, etc. They are the realization of what he might be himself: they are the ideals, the prototypes whose names he delights to assume, and which he chooses as his Totems, and his guardian spirits. They indeed are the mighty ones of his country: his weapons are often insufficient to protect him against their attack; he is at their mercy, and lives as it were by their favor. Then the colossal size of some of these beasts, or the majesty of their presence—the demon fascination of their gleaming eyes, must make on the savage a profounder impression than upon us, inasmuch as these are the very properties he is best acquainted with and which he values most highly.

Not only does this bodily strength inspire him with respect for the beast, as a being superior to himself; he attributes to him, furthermore, a higher degree of sagacity and circumspection. The unerring instinct of the animal: the cunning of the fox, the dog's acuteness of sense, the ingenuity of the beaver in constructing his house, of the bird in building its nest, of the bee in forming the comb: all this is in sharp contrast with the poverty and helplessness of man in the savage state. He knows nothing of the price the animals have to pay for the power they possess, nor reflects that they too do learn, and suffer anxiety and pain. Again the service rendered to him by several animals—as the ox, who with all his strengt his still so patient—disposes the savage to regard the beast as a being worthy of respect, and by no means as the pattern of stupidity.

This exposition of the relations between the savage and the brute which is based on the results of observation, is also confirmed on every side by observation. We find the best illustration of this in the Animal Legend (Thiersage), as it is found among our Germanic ancestors, "a form of composition which could have its origin only when men were in a very primitive state, and men and animals consorted together intimately and with a childlike ingenuousness." Vilmar's remarks on this subject are apposite:* "The root of this legend" (Reynard the Fox), says he, "lies in the guileless natural simplicity of primitive man; in the deep and kindly instincts of a sound and vigorous savage race. As they conceive a cordial and even passionate attachment for Nature in her varying phases; exulting with her in the mildness of the spring time and in the genial heat of summer, sharing the melancholy of autumn, and in winter giving themselves up to the torpor which reigns all around: as they attribute to these different phases of Nature an individuality like their own, with like emotions, and develop these conceptions in the form of grand myths, in which the creatures of imagination are represented now as kindly and gracious, again as awful and majestic, as they appear respectively in Siegfried and Brunhild: so, very naturally, they form a very close and affectionate attachment for the brute creation, their nearer neighbors and their closer kindred. Nay, more, they admit them to intimate association with themselves, as though they were truly and essentially, and not by adoption, or by imaginative fiction, members with themselves of one society. It is the pure, innocent delight which the savage takes in contemplating the brute creation—their lithe figure and flashing eye, their courage and ferocity, their cunning and agility; it is his knowledge of their habits derived from the daily experiences of a life lived in common with them that gave rise to these fables of animals, to the animal-epic. But such life-experience can be obtained by man, only when he studies the animal with a calm and affectionate interest; when he contemplates its inmost nature, its most recondite characteristics; when he not alone shares himself the nature of the animal, but also in turn gives to the animal a share in his own human faculties of thought and of speech,

* Vilmar, Literaturgeschichte, I. 244 ff. 8 Aufl.

and attributes to the animal's actions the same importance, the same intelligent direction, which he claims for his own. This mutual commerce of Brute and Man is the absolute condition of the Thiersage. The brute of the legend is not a mere brute, of nature quite diverse from man's, and having no psychic communion with him: but no more is it a man disguised in the form of a brute. In the former case, the brute could never be the object of poesy, or at least would not furnish the true material of poesy, *action*. In the latter case, such legends would be only tedious allegory. The charm of the legend lies precisely in this dark background where the brute and the man have so much in common; and on this background we must not suffer the lights of our better informed understanding to fall, else the very essence of the legend vanishes."

There is no form of poetry, as Meiners thinks, more agreeable to the uncultured mind than the fable; and in point of fact fables are extremely numerous among savages. Their ultimate basis is the anthropopathic apprehension of the brute creation, the dark background of which Vilmar speaks.* Lessing supposes the object of the fable is to give palpable shape to a moral truth. Even the Hottentots have a large collection of animal-fables, with the recital of which they amuse one another. The Negroes, too, "when they come together to smoke tobacco, or to quaff their palm-wine, entertain one another by telling fables, and they dress up every passing occurrence in the garb of legend or fable. 'The Spider,' to give one example, 'the Spider would lay out a plantation, and set to work about it vigorously without delay. But he had not got the ground ready, when the seeding-time was gone by: and the same thing occurred year after year. The Termite who would build him a palace, having noticed this, called together his neighbors, his slaves and his friends, to give him their aid; and lo! after a short time, the work was finished. Then said the Termite to the Spider: "If you had but done as I did, your plantation would have been laid out long ago." I once, in talking with a Negro named Quan, reproached his people with having killed off all the elephants for the sake of their ivory, and his answer was this: 'No, we have done no such thing. The elephants knew that the white man wanted the ivory, but they would not part with it without having something in return: so they went down to the coast, and sold their tusks for brandy. Having drunk the brandy, they were now left without anything—neither tusks nor brandy. So in their drunkenness they became desperate and all committed suicide, and that is why there are no longer elephants in Aquapin.' " *

"Man in his lowest stage of development considers himself and the brutes as almost alike, the difference between the two being, to his mind, rather external than internal and essential. The beast has a soul as well as man, and the soul of the beast is substantially the same as that of man. Men and animals belong to one race, and are identical with one another in sundry points." † How easy is the transition from man to animal, and *vice versa*, is shown in ancient German legends. "As in later times, after the grim legends of antiquity have been discredited, men become wolves and wolves are transformed into men, as we see in the belief in the Werewolf; so in primitive times men became dragons." ‡ The ancient ballads tell of Siegfrid's father and of his sister Signe, how they were transformed into wolves, and assumed all the savage instincts. This belief in "Marafilnas," the lycanthropi of the ancients, extends through Abyssinia, Senegambia and all eastern Negro lands as far as the Somali. Especially workers in

* *Cf.* Waitz, II. 180.

* *Ib.* 343.
† Wuttke, I. 107.
‡ Vilmar, I. 121.

iron are supposed to transform themselves at night into beasts, and then to feast on human flesh. In Fassokl the Marafilnas are even organized into secret guilds.* The Indians in the interior of Oregon regard beavers as human beings, metamorphosed by the Great Spirit, in punishment of their disobedience.† In Mexican mythology, too, we find instances of such transformations. Xapan was, for adultery, changed into a black scorpion, and Tlahuitzin, the woman, into a red scorpion; and Xaotl was changed into a grasshopper, for having overstepped the powers given to him by the gods.‡ Lycaon was by Zeus transformed into a wolf. A number of German myths speak of the mutual transformations of men and serpents.§ The Centaurs and the Sirens show also how readily man and beast coalesce in Grecian mythology.

We have already seen from the instance cited in Chapter II. (the Arekunas) that there is nothing to prevent the greatest familiarity between the savage and the wild beast. The Malays of Malacca, and the Orangs consider the stronger animals as their own equals—especially the shark, whom they regard as a friend and a brother, he being, like themselves, a pirate. A similar view is taken of the tiger and the crocodile, and this view prevails throughout many of the East India, Philippine and South-Sea Islands.* In the East India isles it is believed that sometimes women give birth, not alone to boys and girls, but also to crocodiles, and the latter are never killed, but carefully placed in a crocodile pond. Many of the natives have their crocodile relatives, duly acknowledged, and these they never injure.† Hence the savage does not hold it to be a disgrace to be descended from beasts; on the contrary, they boast of such descent. The Tlascalans used to say that the men who escaped in the Deluge were transformed into apes, but that they by degrees recovered the use of reason and speech.‡ Kadroma, a she-ape, wife of the ape Cenresi, was the ancestress of the whole population of Thibet. The Thibetians are proud of this descent, and of their ape-like ugliness of feature, which they trace to their ape ancestors.§ Some of the Orang-Benua trace their origin back to white apes.‖ According to the Aleutians¶ and the Chippeways** all men are descended from the dog, and hence the first men had canine paws. Other N. American Indians say that a woman that lived with a dog was the mother of the human race.†† The Delawares suppose themselves descended from the eagle; ‡‡ the Tonkaway trace their origin to the wolf, §§ others to the raven, ‖‖ the Osages to

* Waitz, II. 180, 504.

† Cox, Ross, The Columbia River, 3 ed. Lond. 1832, I. 231; Dunn, Hist. of Oregon Terr. Lond. 1844, p. 317.

‡ D. Francisco Saverio Clavigero, Hist. antigua de Mejico, l. vi. p. 240: Entre otras contaban que habiendo emprendido un hombre llamado Japan hacer penitencia en un monte, tentado por una mujer, cometio adulterio: por lo cual lo decapito immediatemente Jaotl, a quien habian dado los dioses el encargo de velar la conducta de Japan. Este fue transformado en escorpion negro. No contento Jaotl con aquel castigo, perseguia tambien a su mujer Tlahuitzin, la cual fue transformada en escorpion rubio, y el mismo Jaotl, por haber traspasado los limites de su encargo, quedó convertido en langosta. A la verguenza de aquel delito atribuyen la proprietad del escorpion de huir de la luz y de esconderse entre las piedras.

§ Grimm, D. M. 394 ff.

* J. Hawkesworth, Account of the voy. undertaken for making Discoveries in the S. Hemisphere by Capt. Byron Wallis, Carteret and Cook, 1773. Lond. III. 758; Marsden, Valentyn.

† Hawkesw. III. 756, 757.

‡ Clavigero, VI. p. 225. *Cf.* Garcia, Origen de los Indios.

§ Klaproth, Tabl. hist. p. 131.

‖ Borie, in Tydschr. voor indische taal, land en volkenkunde. Batavia, X. 415.

¶ Sarytschew. R. in Sibir. II. 164.

** Waitz, III. 191.

†† Hearne, Voyage from Fort Prince Wallis to the North Sea (Germ. tr.), p. 281.

‡‡ Schoolcraft, V. 683.

§§ Wrangell, Statist. und ethnograph. Nachrichten über die rüss. Besitz. in Am. (in Bär and Helmersen, Beitr. zur Kenntn. des russ. Reichs. Petersb. 1839) 100, 111, 93; Holmberg, Ethn. Skizzen üb. d. Völk. des russ.

‖‖ Schoolcraft, IV. 305.

a serpent transformed into a man, and married to the daughter of the beaver;* the Kayuse, Nez Percés, Walla-Wallas, and some other tribes are descended, according to a tradition held by them all, from the various members of the beaver:† some S. American aborigines from a fish, others from the toad, still others from the rattlesnake.‡

Conversely, several animals have a human origin. In Acra monkeys,—called "servants of the fetiches,"—are supposed to be men, whose creation miscarried; while among the Serracolets and on the Island of Madagascar they are supposed to be men who were metamorphosed on account of their sins.§ The Manitu of the Iroquois, to reward a man who, though sore pressed by hunger, had abstained from human flesh, transformed him into a beaver; and such is the origin of the Beaver totem. A Missouri Indian was changed into a snake that had the power of speech.‖ Owing to this close relationship beasts understand the language of man, and *vice versa*. In Bornu this mutual understanding of languages ceased when a man betrayed a secret to a woman.¶ In our legends and stories, too, animals speak, as did Diomed's steeds.

The souls of animals, and even of plants, enjoy the privilege of immortality.** The souls of men may pass into the bodies of animals, and animals' souls into men's bodies. Animals which root the bodies of dead men out of their graves thus make the souls of the deceased their own, devouring soul and body at once. This belief is oftentimes the foundation of the savage's reverence for animals, as is the case among the Kaffirs, who make an offering to the wild beasts of the bodies of the dead.††

* Wilkes. IV. 467, *apud* Waitz, III. 345.
† Azara, Voy. II. 138.
‡ Garcilasso, Commentar. reales, I. 18, 21.
§ *Ib.* 178.
‖ M. v. Neuwied, II. 230.
¶ Kölle, African Native Literature. Lond. 1854, p. 154.
** Steller, S. 269; Georgi, Beschr. S. 383.
†† Waitz, II. 177.

To the larger beasts the savage often attributes a higher intelligence than he claims for himself. A very intelligent Indian seriously assured Parkman that he held the beaver and the white man to be the most ingenious of people.* Especially the white beaver, an animal which appears to exist only in fable, is represented as endowed with superhuman powers.† On the Senegal, in Kordofan and in Brazil, monkeys are possessed of a human understanding. It is believed by many savages that monkeys can speak, but refuse to do so, lest they should be forced to work.‡ Dogs, too, can speak, and in primitive times did speak: but since the time when the descendants of the god Kutka sailed by them without replying to their inquiries, they have proudly refused to speak any more. It is only strangers that they bark at now, or rather it is only strangers to whom they now address the question, Who are you? Where are you going? So say the Kamtchatdales.§ The Kaffirs say that the chameleon and the salamander are messengers sent on important errands to man by the god Umkulunkulu.‖ The Chippeways, like the Atnas, Kenai and Kolush,¶ suppose the world was called into existence by a bird. In the beginning there was only a vast waste of water: above this was poised a monstrous bird, the beating of whose wings was as thunder, the flash of whose eye was as lightning. He swooped down and touched the sea, and at once the earth came to the surface and floated on the water.** Birds passed for beings gifted with extraordinary wisdom among the ancient Germans, Greeks and Romans.†† The American In-

* *Ib.* III. 193.
† Jones, Traditions of the N. Am. Ind., 2 ed. Lond. 1830, III. 69.
‡ Raffenel, p. 90; Rüppel, R. in Nubien, Kordofan, etc. Frankf. 1829, S. 115; Bosmann, II. 243; Bowdich, p. 195.
§ Steller, S. 280.
‖ Waitz, II. 410.
¶ Waitz, III. 179.
** M. v. Neuwied, II. 221.
†† *Cf.* Grimm, D. M. S. 388 ff.

dians credit the owl with greater intelligence than even the beaver or the rattlesnake, and treat him with the utmost reverence, call him "grandfather," and even incense him with tobacco-smoke — a solemn offering, with which oftentimes the morning sun is greeted. A legend represents the owl as one of the greatest benefactors of mankind, and he is considered to be the king or chief of the snakes.* In Mexican legend it was a dove that taught the dumb sons of Cojcoj, the Mexican Noah, to speak diverse tongues so that they could not understand one another.† On the mountain Kaf lives the monstrous bird Anka, endowed with reason and speech, known to the Persians under the name of Simorg, and in the Talmud called Jukneh. The books of the Zends tell of four sacred birds which are the guardians of the earth and of everything that lives thereon. Japanese mythology represents the bird Isi Tataki as the cause of the propagation of the human race; it was from him that the original divine pair got their knowledge of marriage rites. Chaldaic legend speaks of four worshipful beings, half man, half animal, which came out of the sea and made their appearance on the bank of the Euphrates near Babylon to give men instruction. The name of the first was Oannes, and he instructed them in those things which are pleasing to God, and gave to them religion, laws, science, culture; while it was the business of the other three to attend to the improvement of mankind by a repetition of the lessons given by the first. The Turks and the Arabs say that the cat meditates upon Mohammed's law, and that she will share with the faithful in the joys of Paradise, and they believe that the horse reads the Koran.*

From what has been already said not only will the fetichistic veneration of animals be placed in a clear light, but it will also appear that such veneration is necessarily incident to savage life. And it is the animal itself *in propria natura*, and without any reference to any divinity he may represent, that is worshiped. "The bear that is worshiped as a god is regarded as a true bear: the snake that is worshiped as a fetich is no mere passing theophania, but is ever a real snake."† It is not to be questioned that in the higher stages of development the worship of animals is connected with the *cultus* of spirits; and then the animals are considered as consecrated to the gods, and are on that ground worshiped: but that is beside our purpose.

The elephant is in Africa regarded as a superior being. The Kaffirs, out of respect to his understanding, will not eat his flesh. And yet they chase this animal, saying at the same time, "Do not kill us, great chief; do not trample on us, great chief."‡ In Dahomey he is the "great fetich" of the nation. Though the Dahomans are allowed to kill the animal, still they must perform a long purificatory ceremony after having slain one.§ In Siam the kings used once to appear seated on a white elephant, but that custom was abolished, for the elephant is as great a potentate as the king himself; and in him dwells a kingly soul. He has been even invested with imperial dignities.‖ The lion was worshiped in Arabia,¶ the tiger in New Calabar ** and in the East India islands. In Sumatra the natives give the tigers warning whenever Europeans set snares to catch

* Parkman, Hist. Conspir. Pontiac. Lond. 1851, II. 135; Jones, III. 69.

† Clavigero, Lib. VI. p. 225: . . . . tubieron muchos hijos, pero mudos, hasta que una paloma les communicó los idiomas desde las ramas de un arbol, pero tan diversos, que no podian entenderse entre si.

* Arvieux, Mém. mis en ordre par le P. Labat. Par. 1735, III. 223, 252.

† Wuttke, I. 82.

‡ Kay, Trav. and Researches in Kaffraria. Lond. 1833, p. 125, 138.

§ Forbes, p. 9; Kay, p. 341.

‖ Meiners, I. 221.

¶ *Ibid.* S. 192.

** Holman, I. 371; Köler. 61.

them: and we read of *Tiger-cities*, where the houses are thatched with women's hair. In Acra, too, where almost each village adores as its fetich some animal peculiar to itself, the hyena is regarded as sacred.* At the Cape of Good Hope they will not kill the leopard, even though the animal devour women and children. It is thought in Dahomey that those who are torn to pieces by leopards are peculiarly blest in the next life.† The principal object of worship of the West Africa negroes is the wolf. A soldier belonging to a Danish fort, who was not aware of the sacred character of these animals, killed one of them. The indignant natives demanded of the Fort Commandant a reparation of the offense; and he was compelled to yield to the demand, as the negroes threatened to quit the district if he refused to comply. If satisfaction were not made the murdered wolf would take a fearful revenge on them and their children. Accordingly the Commandant had the wolf's body wrapped in linen cloths, and provided gunpowder and brandy for the solemn rite of atonement. The natives having, during the grand obsequies, fired off the powder and drunk the brandy, the wolf was propitiated and avenged.‡ Some negroes worship goats, sheep and rams.§ In New Calabar the horse is worshiped, and in Wadai this animal is the subject of many wonderful stories, and of a multitude of superstitious beliefs.‖ Indeed the horse, as also the ox and the cow, have been regarded as sacred the world over. The religious views of many Indian tribes with regard to animal-fetiches are very curious. "The highest worship is paid to the Onkteri Gods who created the earth and man, and who instituted the medicine-dance. In form they resemble huge oxen: amongst them

* Bowdich, p. 362; Monrad, 33.
† Forbes, p. 35.
‡ Römer, S. 273 f.; Des Marchais, I. 297.
§ Bastian, 82, 208.
‖ Holman, Köler, ll. cc.

the Spirit of Earth holds the pre-eminence, and has subject to him the serpents, lizards, frogs, the owl, the eagle, the spirits of the dead, etc. Another class of gods, sub-divided multifariously, is that of the Wakinyan, who are ever at war with the Onkteri, and who are principally destructive war-gods, though they possess also the creative power. To them the wild rice and a certain kind of grass owe their origin. In form they bear a fantastical resemblance to birds, and their home is on a lofty mountain in the west. The eastern gate of their dwelling is guarded by a butterfly, the western by a bear, the northern by the moose, the southern by the beaver," * etc. The worship of the beaver is diffused throughout almost the whole of America.†

Among birds it is the owl which is most frequently chosen for a fetich,‡ and even among our Teutonic ancestors this bird, as well as many others, was esteemed sacred.§ Many ancient Arab tribes regarded the eagle as their Great Fetich,‖ and by the Syrians the dove was worshiped.¶

In Africa, especially in Bonny; and in the E. Indian Islands, in Sumatra, Celebes, Butong, and the Philippines the crocodile is the principal object of worship.** In performing this worship, the natives go down to the haunts of the crocodile, to the sound of music vocal and instrumental, and throw food and tobacco to the animals. Nay, even in Celebes and in Butong tamed crocodiles are kept in the houses,†† probably because their presence is deemed lucky; and for this same reason, the Negro of Africa is glad when he finds these venerated animals dwelling near his hut without fear.‡‡ In Madagascar the cayman, the guardian deity of Little

* Waitz, III. 190.
† *Ib.* III. 193.
‡ *Supra*, p. 77.
§ Grimm, D. M. 386–394.
‖ Meiners, I. 192.
¶ Xenoph. Anab. I. 4.
** Holman, Köler, ll. cc.
†† Hawkesworth, p. 757.
‡‡ Römer, 273 f.

Popo, is supposed to be an enchanted chieftain of old.* When the cayman takes any prey (so say the natives on the Senegal) he calls together his friends and kindred and counsels with them when the holiday is to be kept, for the distribution of the plunder. His most intimate friend is a bird, a kind of crane, which watches over him as he sleeps: and it is not permitted to kill this bird.†

In the E. India Islands,‡ as in Africa also,§ the shark is a mighty fetich along the sea-coast. Eels are worshiped in Cusaie and in the Marian Isles.‖ In the Carolines the God Mani is represented as a fish.¶ "At Eap there are kept in a pond of fresh water two fishes of extreme age, but yet only a span in length, which always stand in a right line, head to head, without moving. If any man touch them, and they are made to stand at right angles with each other, an earthquake is the result."** Xenophon states that the ancient Syrians paid worship to fishes;†† and whoever ate of a sacred fish, his body was at once covered with ulcers, his bowels shriveled up, and his bones crumbled away.‡‡

"Mysterious in its whole nature; amazingly agile though without limbs; strong and formidable though simple in form; of no great size and yet a match for the most powerful animals, owing to the instantaneousness of its attack; gorgeous in its variegated coat; silently and stealthily lying in wait for its victim, and then in an instant filling him with terror—the Serpent is an object of reverence to the savage, and is by him regarded as a mighty being of a higher order."* In America, Africa and Europe serpents have been worshiped, oftentimes, indeed, as being possessed by the souls of the departed, but often also as actual fetiches. The reverence paid by American Indians to the rattlesnake was the means of saving the life of the Count von Zinzendorf (1742). The Cayugas, with whom he was staying, were about to put him to death, supposing that his presence was productive of ill-luck to them. The Count was seated one night on a bundle of sticks, writing by the light of a small fire. Unknown to him a rattlesnake lay alongside him. When the Indians who were to take his life approached and observed the snake, they withdrew, firmly convinced that the stranger was of divine origin.† In Europe the Lithuanians worshiped serpents, kept them in their houses and made offerings to them: yet possibly they may have supposed them possessed by the souls of their departed kinsmen. We find mention of snake-worship as practiced by the Longobardi, in the Vita Sancti Barbati in "Acta Sanctorum."‡ Herodotus speaks of this worship among the Egyptians.§ The guardian of the Athenian Acropolis was a living serpent.‖ But Serpent-worship finds its highest development in Whida, in Africa.¶ The Egyptian Apis alone can compare for importance, power and sacredness with the marvelous serpent which once gave to the Negroes of Whida the victory over their enemies. This serpent, which never dies, is held so sacred that not even the king, but only the High-Priest, durst see him face to face. The sanctity of this one snake confers consecration and immunity upon all other snakes of the same species, which are naturally harmless;

* Leguével, II. 223.

† Raffenel, p. 29, 208.

‡ Marsden, Hawkesworth, ll. cc.

§ Holman, Köler, ll. cc.

‖ Dumont d'Urville, Voy. de l'Astrolabe. Par. 1830, V. 121.

¶ Schirren, Die Wandersagen der Neuseeländer und der Maurimythus. Riga, 1856, S. 70.

** Gerland, *ap.* Waitz, V. 2, 137; Chamisso, Bemerk. auf einer Enldeckungsreise (1815–18). Weimar, 1821, S. 132.

†† Anab. I. 4: *ἐπὶ τὸν Χάλον ποταμὸν πλήρη δ'ἰχθυων μεγάλων καὶ πραέων, οὓς οἱ Σύροι θεοὺς ἐνόμιζον καὶ ἀδικεῖν οὐκ εἴων οὐδὲ τὰς περιστεράς.*

‡‡ Meiners, I. 193.

* Wuttke, I. 82.

† Waitz, III. 192.

‡ Grimm, D. M. 395 ff.

§ II. 74.

‖ Herod. VIII. 41.

¶ Bosmann, 458 ff.; Des Marchais, II. 153.

and it is a high crime to kill them. While Bosmann was in Whida, a swine killed one of these snakes, and in punishment not alone was the individual transgressor put to death, but a general persecution broke out against the whole tribe of swine. Indeed they would have been utterly exterminated had not the Serpent granted an amnesty. Each time the crown is put upon a new head, the queen-mother and the new king himself make a solemn pilgrimage to the temple of the serpent. In the court of this temple the faithful pronounce their prayers, and offer valuable gifts. In case there be no earthquakes or other great calamities, which would necessitate special offerings to appease the wrath of the deity, there is annually held a grand festival, when hecatombs are offered. Still the High-Priest may at any time demand, in the name of the serpent, offerings of valuables, herds, and even human victims; and he must be denied nothing. There is engaged in the service of the temple a numerous host of priests and priestesses. The snake's harem is well stocked with beautiful girls. Every year the priestesses, armed with clubs, go about the country, picking out and carrying away girls from 8 to 12 years of age, for the service of the god. These children are kindly treated and instructed in songs and dances in majorem gloriam of his Snakeship. In due time they are consecrated by tattooing on their bodies certain figures, especially those of serpents. The Negroes suppose it is the snake himself that marks his elect thus. Having received their training and consecration, which are paid for by the parents according to their means, the children return home; and when they attain their majority are espoused to the Serpent. The happy brides, tricked out in festival array, are brought by their parents to the temple. When night comes, they are let down by twos or threes into pits where, as the priestesses aver, the authorized proxies of the snake await them. Meanwhile the old priestesses sing and dance around the pits. On the morning after the bridal night the girls are sent back to their homes; there these chosen maids have never been known to give birth to serpents, but only to perfectly human infants. During the remainder of their lives they enjoy eminent privileges, as being the lawful wives of the god, and receive a portion of all the sacrifices and gifts offered to him. They are permitted to marry a human spouse, and then their power over their husbands is unlimited. Should the latter presume to set themselves in opposition to the will of their divine helpmeets, they run the risk of being assassinated by the priestesses and by the other spouses of the god.

Traces of animal-fetichism are to be found even in the more highly-developed forms of religion. The Israelitish worship of the Golden Calf, and of the golden calves set up by Jeroboam is the product of a rude intelligence, as yet unfitted for the purer worship of Jahve, which belongs to a higher state of intellectual development.* The raising up of the Brazen Serpent by Moses, the sight of which healed the people of Israel, would appear to be a relic of ancient serpent-fetichism. (See above, *Fernando Po.*) Of the worship of animals among the Egyptians Bastian says:† "At Heliopolis and at Thebes, good care was taken lest travelers should peep behind the curtain. But when the specious cloak of philosophy, by means of which the Egyptians imposed on their neighbors, is stripped off, but little is to be seen beyond γόητες πάντες. What we should despise as stupid fetichism in a Negro tribe, was admired as the profoundest wisdom in the world's metropolis. The close connection between the usages of the ancient Egyptians, and those of the other African races, is too evident to be overlooked."

As we have already seen, the savage does not view his fetich as a being so exalted that in no case he may

* *Cf.* Merx, Art. *Abgottereei*, in Schenkel's Bibellexikon.

† San Salv. S. 300.

withhold from him obedience. His reverence for animals is all the more precarious, inasmuch as he is frequently brought into collision with them in the struggle for existence, as when hunger drives him to use their flesh for food, or when he is obliged to defend himself against the attacks of wild beasts. In such cases he kills the animal, how sacred soever it may be. The divine *nimbus*, however, which surrounds the animal is not thus dissipated, for the savage will pay due reverence to the body of the slaughtered beast, excusing his deed as best he may: having thus appeased the animal's soul, he contentedly feasts off its flesh, and clothes himself in its skin. "Hail, friend from the spirit-land," is the salutation with which the Indian greets the snake he meets; "we were unfortunate, and our friends yonder knew of it. The Great Spirit knew of it. Take this gift of tobacco (sprinkling tobacco dust on the snake's head); it will comfort you after your long journey." With these words he seizes the snake by the tail, passes his hand dexterously along the back, till he reaches the head, and then crushes the reptile to death. He strips off the skin, which he wears as a trophy.* "Be not angry with us," say the Indians to the bear they have killed, "for having slain you. You have understanding, and know that our children are hungry. They love you, and they want to eat your flesh. Is it not an honor for you to become food for the children of the great chief?" † Sometimes they appease the bear they have killed by placing in its mouth a tobacco-pipe, into the head of which they blow, filling the animal's throat with smoke, and meanwhile asking forgiveness. During a meal, of which the bear himself is the principal dish, they set up his head on an elevated place and chant songs of praise in his honor.‡ The Ostiaks attach the head of the bear to a tree, and pay it divine honor; then they utter their laments over its carcass, in doleful tones, inquiring, "Who has deprived you of life?" and immediately themselves giving the answer, "The Russians! Who cut off your head? The ax of the Russians. Who has stripped you of your hide? Some Russian's knife."* The inhabitants of Northern Europe, from a feeling of reverence, never call the bear by his own name, but only "the old man in the coat of fur." † When the Madagascans kill a whale calf, they make their excuses to its dam, and entreat her to go away,‡ just as the Kaffirs do, after they have captured an elephant.§

As fetiches generally, in accordance with the principles already explained (Ch. III.), are regarded as the causes of phenomena, which in point of fact stand to them not at all in the relation of effects, so too those animals which are worshiped are by their devotees arranged in causal relation with phenomena, whenever the true cause cannot be found. Hence the Yakutes regarded the camel as the cause of the small-pox (p. 24). The Mexicans first became acquainted on the one hand with the horse, on the other with ships, when the Spaniards came to their shores. The report and the flash coming from the guns of the latter they took to be thunder and lightning. Who produced these phenomena? Not men; of that they were quite sure. The horse, however, was something entirely new to them, and therefore they regarded the horse as the producer of the thunder and lightning, and on this ground worshiped him as a god. "At his departure Cortez left with these friendly people one of his horses that had received an injury in the foot. The Indians conceived a sentiment of reverence

* Waitz, III. 192.
† Lettr. édif. N. E. VI. 174.
‡ Charlevoix, p. 117, 300.

* Isbrand, Voy. au Nord. VIII. 411.
† Georgi, Beschr. S. 14, 21.
‡ Owen, Narr. of a Voy. to explore the Shores of Africa, Arabia and Madagascar. Lond. 1833, I. 170.
§ Moodie, Ten years in S. Africa. Lond. 1835, II. 333.

for the beast, as being in some way connected with the mysterious power of the white man. After their visitors had taken their leave, they offered flowers to the horse, and prepared for him, it is said, many savory dishes of poultry, such as they were wont to prepare for the sick. The poor beast starved to death with such novel food. The terrified Indians set up his image in stone, in one of their teocallis, and worshiped it as a god. When, in 1618, two Franciscans came to this locality (which was then as little known to the Spaniards as before Cortez's visit) to preach the gospel there, one of the most notable things they found was this image of a horse, which was worshiped by the devout Indians as the god of thunder and lightning." * Jacob Grimm cites numerous cases of animal-worship among the ancient Teutons. Thus, whoever kills the haus-otter (a small innoxious snake) will die within the year.† The killing of a swallow (which is a sacred bird) causes rain to fall for four weeks.‡ The giant eagle Hraesvelgr, in Northern mythology, causes the winds by beating his wings on the outer verge of the earth.§ The dew of morning is the foam that falls to the earth from the mouth of Hrîmfaxi, the black steed of the night.|| Sköll and Hati, two gigantic wolves, are ever chasing the sun and the moon,¶ and hence it is that the latter ever speed on—a thing they would not do, were it not that they feared being overtaken by the wolves. Eclipses of sun and moon occur when the wolves overtake their prey, and have commenced to gulp them down; but fortunately the victims have so far been always successful in making their escape. In Oriental fable the dragon takes the wolf's place. The serpent Jörmungandr, which lives in the sea, encloses the whole earth in his folds. When he drinks there is ebb: but when he ejects water, there is flow of tide. In the mythology of Japan and China, when the dragon Tat quits the sea to saunter through the air, we have the waterspout.

* Prescott, Conq. Mex. II. 369.
† D. M. Anh. Aberglaube Nr. 143.
‡ *Ib.* Nr. 378.
§ D. M. S. 361.
|| D. M. S. 368.
¶ D. M. S. 401.

7. *Men as Fetiches.*

A fetich is an object perceptible by the senses, to which, anthropopathically apprehended, man attributes causal power, and which he worships. Hence objects the most widely diverse becomes fetiches. Hence too, man himself, if the conditions unite in him, will be a fetich. Both in Africa and in America identical views are taken of those individuals who possess any extraordinary deformity, whether of body or of mind—for instance, albinos, dwarfs, hunchbacks, fools, etc. In Bornoo albinos are objects of fear, as beings gifted with supernatural power; * in Senegambia, if they are slaves, they are given their freedom, are exempted from all labor, and are cheerfully supported at others' expense.† In Congo the king keeps them in his palace, as "fetiches which give him influence over the Europeans." ‡ They are held in such respect that they may take whatever they will; and he who is deprived of his property by them, esteems himself honored. In Loango they are esteemed above the Gangas, and their hair is sold at a high price as a holy relic.§ Thus may a man become a fetich.

This fetichistic worship of man is a totally different thing from the respect which is paid to the man whose extraordinary power is due simply to the fact that he is the owner of certain mighty fetiches. This is the case with the ordinary fetich-priest, and with many kings, who by means of their fetiches may decree favorable or unfa-

* Kölle, p. 401.
† Raffenel, Nouv. Voy. dans le pays des Nègres. Par. 1856, I. 230.
‡ Bastian, 34.
§ Proyart, 172.

vorable weather, etc., as, for instance, when Ogautan and Möndull in the saga, by shaking their weather-bag (vedhrbelgr) cause wind and tempest; or when the Swedish king Eirîkr, surnamed Weather-hat (vedhrhattr), caused the wind to blow from the point toward which he turned his hat.* But if such power was attributed to the individuals themselves, and not to their fetiches, then they themselves became fetiches. Thus the Chitome of Congo is regarded as a fetich, as also, probably, the king of Usambara, whose power is so unlimited, that one of his subjects, describing the actual relation between ruler and subject, said: "We are all the slaves of the Zumbe (king) and he is our Mulungu (god)." † The Tamol of the western Caroline Islands appears to belong to the same class as the Chitome.‡ The nobility in those islands have unlimited power over the people, but they themselves in turn are subject to a Tamol in each separate island, and he is absolute monarch. Whoever approaches him on business, must come with his head bowed down to the level of his knees. He takes his position in silence, and awaits the Tamol's order to speak. The potentate's words pass for those of a god, and his hands and feet are kissed as often as a petition is addressed to him. The idolatrous worship of the princes of Tonga, whose touch suffices to make any object holy, also appears to be fetichistic. But of a different kind was the honor which, for instance, the Mexicans paid to Cortez; § the Sandwich Islanders to Captain Cook; ‖ the Kamtchatdales to the first Russian seen by them; ¶ the inhabitants of Cassegut to De Brue;** the Gilbert Islanders to the Scotchman Wood; †† the Oatafians to Captain Hale.* In these cases the motive was different: these white men were considered gods. Hence they were viewed not from the fetichistic standpoint, but from that of polytheism, the origin of which we have already pointed out. On this account the Gilbert Islanders carried Wood about in their arms, and the Oatafians entertained Hale (whose ship, as they thought, had come down from heaven) with solemn dances, lest they should offend the deity; and answered his questions in song. The white men were identified with deceased ancestors,† being supposed to be the latter either *in propriis personis* or in their ghosts. Accordingly, here we have no fetichistic worship.‡

* Grimm, D. M. S. 368.

† Krapf, Reisen in O. Afrika (1837–55). Stuttg. 1858, I. 291, note.

‡ Gerland *ap.* Waitz, V. 2, 116.

§ Acosta, p. 204.

‖ Cook's Last Voyage, III.

¶ Müller, Sammlung russ. gesch. III. 19.

** Labat, Voy. V. 172.

†† Gerland, V. 141.

* Hale, Eth. and Philol. (U. S. Exp.) Phil. 1846, 151 seq.

† *Cf.* Gerland, V. 141.

‡ This fifth chapter makes no pretension to an exhaustive treatment of its topics. Its object is simply to indicate the principal points of view, from which the various objects of fetich worship are to be regarded, with reference to the matter in hand. To collect and describe all the forms of fetichism in use among the various races of men, will furnish matter for as many special investigations as there are peoples and religions.

CHAPTER VI.

THE HIGHEST GRADE OF FETICHISM.

1. *The New Object.*

All the objects which we have so far considered as fetiches, how much soever they may differ among themselves, have this in common, that they exist in man's immediate environment: that they are within his reach, and almost all tangible. They are all circumscribed by the limits of earth, and mostly confined to the very spot which is the savage's own habitat: he necessarily comes in contact with them, nor is there any need of special search to find them out.

Furthermore, all the objects which the savage in the lowest stage of intellectual development considers useful or desirable, belong in like manner to the earth; as all his aspirations and all his interests are concerned with earthly things. For what interests has he? Those of a spiritual nature are unknown to him, and those which he does recognize have reference simply to his physical well-being; his bodily appetites are the only stimuli which excite his will, and engage his whole attention. But how is he to gratify these appetites? The sky with all its stars will not appease his hunger, nor has the firmament power to sate his lust. The gratification of these appetites is to be found only here below. It is the earth alone that can give him the objects of his desire, and he has no wish for the things lying beyond. For us these earthly objects are become also objects of higher, more spiritual interest, inasmuch as we have made them objects of knowledge; but they are not at all objects for the savage in this sense. He has no desire of knowledge for knowledge' sake: he desires things only so far as they can gratify his grosser passions. Whatsoever does not minister to these, is of no interest for him, is no object for him, does not arrest his attention; just as animals "in the state of freedom only have perfectly clear conceptions of the few things which are closely connected with their daily wants and with their daily life, but suffer everything else to pass by almost unnoticed."* A plant is an object for the savage only in so far as it may supply food: it has no value for him as a botanical specimen, and it is only as an article of food that it can interest him. These mere bodily interests of his are amply secured within the narrow earthly world with which he is acquainted. So long as he experiences none but simply physical interests, he rests content with his contracted world, and his mind remains confined within its narrow sphere. If therefore his world is to extend its limits, and his mind to take a broader range, he must experience some higher interest. But now the will is never without its object, never stands by itself as *will* simply, but always as will *determined*, always as will directed towards an *object:* and it ever extends just as far as its objects. If therefore a higher will, a higher interest is to be awakened, a new object must necessarily be attained, by impelling toward which the energies of the will we give them a new direction and elevate them. But of what kind must this object be, in order to awaken a new and a higher interest?

To arouse such interest in the savage mind it must be adapted to the savage's modes of apprehension. If it had no aspect which the savage mind might grasp, it could excite in it no interest. Let us see the mode and the measure of the savage's mental grasp. Abstract ideas, spiritual conceptions, purely mental phenomena are to him unintelligible, and consequently uninteresting, indifferent. He apprehends only what is apprehensible through the senses, or what he can *see.* The new object, therefore, if it is to excite an interest in his mind must be one that is apprehensible through the senses.

But the new object must awaken in him a higher interest than any he has hitherto known, and to this end the interests which hitherto have stimulated him must in some degree be repressed. Now it is the new object which has to do this. Let us see what kind of objects will *fail* to displace the old interests, or in other words the bodily appetites of hunger and lust, and the natural emotions such as joy and anger, which have been hitherto supreme. The savage has so far recognized only these, and has prized only such objects as answer to them. So long as he comes in contact with such objects as these, so long will this class of interests be served and go on growing. The objects therefore which answer to these appetites and passions will never tend to check the growth of inferior interests. They are only to be repressed

* Waitz, I. 329.

by some object not answering to them, nor tending to enhance them, but which, *nevertheless*, can engage the savage's attention. If it can do this without at all gratifying his bodily appetites, the will of the savage will be thereby to a certain degree weaned of these appetites and turned in a new direction, *i.e.*, will have a new interest. Therefore the new object must not serve in any way for the gratification of sensuous desire; for whatsoever has that tendency belongs to the sphere of the lower interests, and so to the sphere of pure savagery. And conversely, everything that has hitherto been comprised within the sphere of the savage serves, in so far as his interests are centered in it, to gratify these sensuous desires, they being as yet his only interests. Hence every object which lies within his immediate sphere is liable at any time to become merely the object of these desires. If then the new object is to be of such a nature that it will not answer to these desires, it must be so remote from the savage's immediate sphere that these sensuous desires can never in it find their gratification: and it must ever stand on a plane high *above* these, never *beneath* them. Such grand objects as a mountain or the sea do not, it is true, serve to appease hunger or to gratify lust, but still they may in some manner be subordinated to the savage's will and desire: he can ascend the mountain, set his foot upon its summit, break fragments of rock from it, etc.; he can sail upon the sea, take water out of it, scourge it, etc. And so every object upon the earth may be brought into subjection to his power; and hence the new object must lie entirely beyond the limits of earth, and beyond the sphere of his sensuous desires. But now since it can in no way gratify these desires, and still must excite an interest in the savage's breast, how is it to attain its end? As we have seen, it must not be an object of sensuous gratification, nor yet an object for use or for consumption. But if the savage cannot employ it for sensuous gratification, and yet is to make it an object of contemplation, his attitude towards it must be one of attention, gazing, observation. Hence the new object, which is to repress sensuous desire, must be of such a nature as to rivet the attention, and to draw upon itself the gaze of the savage. It must therefore be visible, and as has been already said, an object apprehensible by sense. Now what is that object of sense which alone can rivet his attention, and yet never be subordinated to man's use? Since it must not lie within the sphere of his sensuous desire, it must consequently lie without the earth: and yet it must be observable by the senses, and specially fitted to engage the attention—hence something noteworthy and wonderful which shall surpass all things else in splendor. But now if this object could be contemplated and its properties ascertained in a moment it could engage the attention of the savage only for a brief space, and then he would be again free to give himself up anew to merely sensuous gratification. The new object must therefore not alone surpass all others in magnitude and splendor, but it must also be so vast and stupendous, that man may find no end of contemplating it, that it shall lead him on to ever new contemplations, and so ever withdraw him from ministering to his sensuous appetites. If then there be found an object which irresistibly challenges his attention merely as an object of contemplation without in the least gratifying his lower passions, he has henceforth, in addition to his former sensuous interests, a new one which consists in observation, contemplation: and this new interest we call an intellectual one, as contrasted with the other, which is sensuous or materialistic.

Thus the savage could acquire an intellectual interest only through some object of sense lying without the sphere of his passions, and hence extra-terrestrial, which, however, was fitted to engage his attention by attracting his gaze: which should be possessed of preëminent sensuous splendor and be of such grand proportions that it might be contemplated forever and still ever invite to fresh contemplation. Now of all the objects in the universe there is but one which fulfills all these requirements, and that is the Firmament with its countless stars. The sky is the new object, being perceptible by the sense—the mightiest, grandest and most stupendous of all the objects of sense, with its blazing sun, its shining moon, its twinkling stars, its rosy blush at morn and eve, and the deep blue of its mighty arch. By the splendor of its ever-changing and sublime phenomena, it invites the savage to the contemplation of itself, without ministering to his lower nature. Thus this new object gives to his will a new direction, a new interest—that of contemplation, of thirst for knowledge: an intellectual interest.

We must go back in imagination to the time when man was without knowledge, when all was ignorance, when there was no school to give instruction, as instruction is given now. Then every step toward knowledge was an advance into the unknown land, and individual observation was the only schoolmaster. But observation was limited to those objects which Nature afforded: hence Nature was, after all, the true Teacher. Were it not that there was in the universe an object which irresistibly challenged attention, without ministering to man's lower passions, and which thus in some measure diminished the force of the latter, man could never have risen above his animal instincts, nor ever have conceived an intellectual interest. Hence wherever the savage has not yet made the heavens the object of his contemplation, we may be sure that his condition is that of extreme barbarism, which latter however diminishes, in proportion as his knowledge of the heavens advances. The firmament is the first object which awakens in him intellectual interest. It is only after he has with some interest contemplated this object, that his mind goes out to observe the universe, for knowledge' sake, and to study the other objects upon the earth, as objects of knowledge, which before were only objects of desire. This is perfectly consequent, for so soon as *one* thing is regarded with intellectual interest, all other things will be regarded from the like point of view, since they are all mutually related. Hence, of all the sciences worthy of the name, astronomy is the oldest and the first; and hence too do we find, even in the remotest historic times, and among the most ancient peoples, that the results of astronomy, such as the ascertainment of the year's length, and kindred facts, are more correctly apprehended than the results of any other science. The science of the heavens, so soon as there is any demand among savages for scientific knowledge, constitutes the first object of scientific instruction. I have said, *scientific* instruction, to distinguish it from religious, which no doubt precedes astronomical instruction: but this precedence of religious instruction is due simply to the fact that it is based upon a total ignorance of Nature, which of course is prior to knowledge. But the earliest scientific knowledge that man acquires is that of astronomy. Leaving out of view the instruction the savage gains as to the objects in daily use, even the rudest of savages oftentimes receives religious instruction, but never anything that can lay claim to the title of scientific education. If therefore we anywhere find scientific instruction given (and the first lessons will be always in astronomy) we may confidently assert that mental development has made considerable progress. This is verified in the case of the South-Sea Islanders in the Carolines. Canova, in describing the Caroline Islands, says, "In each district there are two places of public instruction, in the one of which the boys, and in the other the girls receive instruction in astronomy, as far as the natives' knowledge of that science goes. The master in giving his lessons uses a globe, on which the position of the principal stars is indicated with rude art." * Hence, too, astronomy is the first subject-matter of early scientific literature. The books of the Mexicans had on one page mythological figures, ritual directions, laws and the history of the country, while on the opposite page, out of all the objects of theoretical science, they set forth only those of astronomy and chronological calculations.† The "innumerable books" of the people of Yucatan, whose mental culture was about parallel with that of the Mexicans, give the constellations, chronological calculations, and the fauna and flora, and political history of the country.‡ Science in antiquity developed similar phenomena in its beginnings, and the library of a German peasant consists of a hymn book and an almanac.

We will suppose the savage, then, beginning to contemplate the heavenly bodies with some interest. The phenomena which these produce, viz., light and heat, and all the effects of these latter, have so wide an influence, and so intimately concern man himself, and further, it is so patent that these heavenly bodies are in truth the efficient causes of the phenomena, that man establishes a relation between them and his own life, between them and all Nature. There can be nothing on earth mightier than they, their influence pervading all space: they are supreme, they can account for everything, they are for man Ultimate Causes. But these causes do not for him operate through mechanical laws: they are not for him inanimate bodies, being, like all other objects, apprehended by him anthropopathically. Hence they have life and will, even as man himself—and thus they become the supreme fetiches. But their energies are not restricted to the production of storms and tempests: man sees his own fate as depending upon their decrees. The changes which he observes taking place among them he interprets as tokens of their good-will or their enmity, their favor or their displeasure; and hence it is that the early contemplation of the heavens, as being coupled with anthropopathic apprehension, is necessarily fetichistic, and that astronomy makes its first appearance as astrology; hence, too, the latter precedes the former chronologically.

2. *The Gradual Acquisition of Knowledge.*

Time was when the heavenly bodies were not yet an object of contemplation. We do not say that then man did not notice, did not see the sun, moon and stars—even brute beasts have so much cognizance of the heavens: but the time was when man had no definite notion of the heavenly bodies, when he knew nothing either of the mode or of the regularity of their movements, or of their periods: in short, when his knowledge of them was limited to the general sensuous impression. Later he comes to see in the heavens an object made up of distinct parts. Between the point of departure, nescience, and this term, knowledge, lies the period of gradual acquisition, where, starting from small beginnings, the mind advances step by step to knowledge. Let us form a clear conception of the order in which the heavenly bodies would by degrees come to be known to man, and we shall at the same time understand the order in which they presented themselves to him as objects of fetichistic contemplation.

When he begins to observe the sky with its various phenomena, his knowledge is limited to the sensuous impression. But in this case the observer is not one who has pushed his investigations deeply into other subjects, and now to this new investigation brings a disciplined mind which can keenly analyze the phenomena;

* Gerland *apud* Waitz, V. 2. 110.
† Waitz, IV. 171.
‡ Waitz, IV. 311.

he is only an overgrown infant, with powers of thought all undeveloped. Such an observer will be chiefly guided by the impression left by the object on his senses. Hence that heavenly body which appears most striking to the eye, which exhibits the greatest number of varying phases, and which is easiest observed, will first attract and rivet his attention. Now such an object is not the Sun, but the Moon: and hence we find that, among savages, the latter is worshiped at a much earlier period than the former, and is considered of higher importance.* This fact, which to us who can more truly estimate the relative importance of the two luminaries, appears at first glance unaccountable, admits of a very easy explication, when we consider on the one hand the exterior, sensible aspects of the two, and on the other hand the intellectual status of the savage.

In the first place the savage has in the day-time little leisure for the contemplation of Nature in general, or of the Sun in particular: he must needs find his daily provision, and this care engrosses all his attention. For the more perfect the means and the implements, the machinery he employs, the sooner can he supply his bodily wants, and the more leisure he has for mental development. But the less developed he is, the clumsier are the means at his command for taking his prey, and the more time does he consume in gathering together his daily provision; and hence a Tierra del Fuegian is his whole life long occupied with this one care, and this is his sole employment, viz., to gain his sustenance. As he neither sows nor plants, and as the desert region in which he lives yields him scarcely one natural product, he must needs be restricted to this one pursuit. If perchance he succeeds in finding a sufficiency for the present, the search has wearied him and he seeks repose in sleep: and when he awakes the renewed cravings of hunger compel him again to resume his search. Thus, if he would support life, he must through the day keep his eyes steadily fixed on the earth. And then the Sun is no such object as would through the day very forcibly claim the attention of a man whose mind is void of thought, and whose only care is to still the cries of hunger. All nature is now bathed in light; there are no dark shadows, no contrasts; and contrast it is which enables an object to make a very deep impression. Day with its light is a very common occurrence—it is indeed a fact of *daily* experience. But suppose that the man directs his gaze toward the sun: beyond its daily traversing the heavens, no phases are observable which might readily impress the savage mind. The Sun changes not like the Moon: those changes which we observe in the place of its rising, from solstice to solstice, take place so gradually, and require so long a period, that only close observation can detect them at all; and for this the savage has neither the will nor the perseverance. Hence the sun is an object rather of meditation than of contemplation; and to study it requires a rather highly developed understanding. It is very different with the moon. At night the savage has finished his daily toil; his wants are supplied: hence he is now at leisure. But, most important of all, the effect of contrast is here to be observed. The earth is wrapt in darkness; the superstitious savage meanwhile shudders with fear, while every nerve and every sense is on the stretch. Then emerges from beneath the horizon the bright orb of the full Moon, round as a wheel, red as fire. Then how manifold are its apparitions, the like of which are never to be seen in the Sun, and which are specially fitted to call forth the astonishment of man, and to invite him to reflection. Now she is fiery red, in a moment pale and wan; at one time a majestic full orb, at another wasted away, and resemb-

* *Cf.* Wuttke, I. 66.

ling a sickle. The dark spots upon her surface lead men to fancy that she has a human face, or give rise to other imaginations: oftentimes she is totally eclipsed. In short, several peculiar and directly visible phenomena are observed in the moon, which must attract the attention of man, and cause him thither to direct his gaze. He will also attempt to assign causes for these phenomena, and these attempts, how inept and anthropopathic soever they may be, still will at least have this effect, that they will connect notions together, *i.e.*, will serve as the first steps in thinking. Thus then we need not be at all surprised if when a rude people first begin to contemplate and to worship as fetiches the heavenly bodies, the Moon has precedence of the Sun.*

But after the Moon has become an object of man's contemplation, it is not now the Sun which he next studies, but certain stars which, as they appear in the gloom of night, affect him more sensibly and offer for his contemplation properties stranger and more easily observable than does the Sun. There are five stars and constellations † which first attract the notice of man, and which we always find recognized by such savages as have even made a beginning in the study of astronomy. The first is Venus, which with its brilliant light attracts attention, particularly by appearing first of all the stars in the evening, and vanishing last of all in the morning—the Morning and the Evening Star, which at first passed for two distinct luminaries, and which Pythagoras was the first among the Greeks to recognize as one.‡ Next is the Ursa Major, the Great Bear, or the Wain, which never drops below the horizon in the northern hemisphere; together with his counterpart, the Ursa Minor, the Little Bear; both of these being noticeable from their peculiar form. Then that chain of three brilliant stars, known to the Greeks as Orion, which the people in Upper Germany still call the Drei Mäder (Three Mowers), because they resemble three mowers standing in the meadow one behind the other.* Finally, the space so thickly gemmed with stars, situate between the shoulders of Taurus, and of which chiefly seven (more exactly six) are easily discernible — the Seven Pleiades, which are distinguished as being in the center of the glorious system of the Milky Way, and which gain all the higher eminence from the fact that the space all around them, to the extent of six of their diameters, is relatively poor in stars; and from this, that for many regions of the South these stars never set. These five are the first to be recognized: they are *popular* stars the world over. It is toward these that Odysseus directed his eyes when, quitting Calypso's isle, he takes his homeward course over sea:

Αὐτὰρ ὁ πηδαλίῳ ἰθύνετο τεχνηέντως
Ἥμενος· οὐδέ οἱ ὕπνος ἐπὶ βλεφάροισιν ἔπιπτεν
Πληιάδος τ' ἐσορῶντι καὶ ὀψὲ δύοντα Βοώτην
Ἄρκτον θ', ἣν και ἅμαξαν ἐπίκλησιν καλέυυσιν,
Ἥ τ' αὐτοῦ στρέφεται και τ' Ὠρίωνα δοκεύει,
Οἴη δ' ἄμμορός ἐστι λοετρῶν Ὠκεανοῖο.

Od. V. 270 seqq.

These Hephæstos represented on Achilles' shield (Il. xviii. 487 seqq.). Of these it is said: "Canst thou check the sweet influence of Chima (Pleiades) or loose the band of Kesil (Orion)? Canst thou order Mazzaroth (Sirius) in his period? or canst thou lead Aish (Arcturus) with his sons?" (Tob. xxxviii. 31.) "Who made Arcturus and Orion and the Pleiades and the chambers of the South?" (Tob. ix. 9.) These were the favorite stars of the Ancient Germans, the Sclavs and the Finns.†

That the Moon was the first among the heavenly bodies to be distinctly studied by man, and that the stars and the Sun followed after, is clearly

* *Cf.* W. Whewell, Hist. Inductive Sciences, Vol. I.

† *Cf.* Grimm, D. M. S. 416.

‡ Whewell, Hist. Induct. Sciences, Vol. I. 106.

* Grimm, D. M. 417.

† D. M. 416.

evinced by the different modes of reckoning time at various periods and in various nations. The mode of reckoning by Moons is the primitive one. We meet with it in the earliest historic records of all civilized nations, and hence we also find it wherever a nation is in the lower stages of development. Here we meet with reckonings by Moons, and by the movements of certain stars: but never by the sun's periods. Nations in this stage of development are raised very considerably above the condition of the rudest barbarism. Last comes the reckoning by the Sun, and this indicates an intellectual status which leaves far behind it the barbarism of savage tribes.

Not to speak of the civilized nations of Europe and Asia, who in early historic times reckoned by moons, this mode of reckoning time is to this day followed throughout Africa * by most of the Negro tribes, as also in America, by the aborigines. The Indians of the latter continent generally reckon thus, and their months bear the names of various objects in Nature, especially animals and the products of the earth.† "Like most of the other tribes, the Dakota Indians reckon twelve months, five each for Summer and Winter, and one each for Spring and Autumn, and add an intercalary month every second year. According to Carver (216) and Heckewelder this intercalation of a so-called "lost month" without a name, occurred every 30th month: but according to Kohl (I. 167), every year. Schoolcraft (V. 419) says that the Algonquins reckon only eleven months, which are brothers, and take to wife, in succession, one woman, the Moon. The Algonquins do not appear to find any difficulty in the fact that between winter and winter there are now 12 now 13 months.‡

The next step in astronomy is to reckon time by the moon and the stars together, excluding the sun, except for noting the hours of the day; and this mode of reckoning is found among some of the more advanced of the American tribes. The Iroquois and the Ojibbeways had special names for a number of stars; and the latter defined with precision the hours of the night by the rising and setting of these. The Osages, too, marked the progress of night by the stars, and recognized Venus, the three stars in Orion's belt, the Pleiades, and even the Polar Star and the apparent revolution of the neighboring stars around it.* But it is among the natives of the Marian and the Caroline Islands that we find this mode of reckoning time best developed. The Caroline islanders not alone define the periods of the night by the stars, but even divide the year into seasons according to the ascent of certain stars at fixed times; and into months, each having a fixed number of days, according to the moon's several phases. Not alone has each day, but also each division of the day, a distinct name.† "According to Freycinct (2. 105) the number of their months was ten, and of these, five (from June to November) constituted the season of winds and rains, and the other five the temperate season. But that writer himself doubts whether they had not two modes of reckoning the year, the one founded on climatic reasons, the other on lunations, and giving a greater number of months than the former." Among the natives of the Marian Islands there were two parties, one of them counting twelve, and the other thirteen lunations to the year; and their disputes once even led to a war. The Caroline men, besides traversing the sea all round their own group of islands for business or pleasure, visit also, whether singly or in squadrons, the Marian Islands. In making this voyage they direct their course according to the starry heavens, which they divide into twelve regions. Cantova makes mention of these twelve

* Waitz, II. 224.
† Waitz, III. 224.
‡ Waitz, III. 224.

* Nuttall, Journal of Travels into the Arkansas Territory. Phila. 1821, 172 seqq.
† Gerland *ap.* Waitz, V. 286.

regions and of the twelve winds named by the Caroline men. But they had also another division of the heavens into twenty-four regions, which took their names from the stars which rose and set in them. They guide their course at sea by these regions, as also by the sun, stars and constellations, whose rising and setting they can observe, and to which they give special names."* Of the astronomical instruction in vogue amongst them we have already spoken.

The reckoning of time by the sun is therefore of more recent origin than the reckoning by the moon and stars. Among the Mexicans, who reckoned solar years, many regarded the planet Venus to be more ancient than the sun.† The discovery of the solar year presupposes an extended and laborious observation of the sun, and so a high degree of spiritual interest. Hence we might à priori assert (and experience will confirm the assertion) that wherever the solar year is accepted as a measure of time, culture has gone far beyond its barbarous stages. We may go farther (and here too experience will come to our support) and assert that the worship of the sun is only possible where the mind has reached a degree of development far higher than that required for the worship of the moon and stars. The nations which have brought the worship of the sun to its highest perfection are civilized—the Persians, for instance, the Phœnicians, Carthaginians, Mexicans and Peruvians.

3. *The Worship of the Moon.*

The first and lowest stage of the worship of the heavenly bodies is that where the Moon is worshiped and regarded as of more importance than the Sun.

The Kamtchatdales have not yet reached this stage, worshiping, according to Steller, neither Sun nor Moon.‡ The Payaguas, of S. America, on perceiving the New Moon beat the air with their fists, to give expression, as they say, to their gladness. Azara, who relates this fact, further says: "Ce qui a donné lieu à quelques personnes de croire qu'ils l'adoraient ; mais le fait positif est, qu'ils ne rendent ni culte ni adoration à rien au monde et qu'ils n'ont aucune réligion."* This joy of the savage on beholding the luminous heavenly bodies leads him to contemplate them, and he soon begins to regard them as the causes of occurrences which in no wise depend upon them. The Botokuds think the moon is the cause of most of the phenomena of Nature.† In the Pelew Islands predictions are made from the appearance of the Moon.‡ Hence the Moon soon passes for a mighty fetich, and so is held in greater consideration than the Sun ; and accordingly the Moon would be naturally regarded as a Man, the Sun as a Woman. Bleek says, with respect to the Hottentots, "In the lowest stage of culture to be met with among nations having sexual language, the worship of the heavenly bodies acts a very unimportant part, for the reason that the knowledge possessed by savages of the motions of these bodies is too slight to give a basis for reverential contemplation. And yet we find even here the rudiments of the mythologic (*i.e.*, anthropopathic) conception. . . . For first the phases of the Moon will excite attention. Her gradual waxing and waning gives to the savage the notion of a Being which grows for a while, and then decays, and he readily personifies it. Hence it is not improbable that Moon-worship was the earliest phase of the worship of heavenly bodies. The Hottentots, as we are assured by Kolb, a competent witness, pay divine honor to the Moon. In their language ‖khãp §

* *Ibid.* 85.
† Waitz, IV. 146.
‡ Steller, Kamtschatka, S. 281.

* Azara, II. 137.
† Pr. M. v. Neuwied, R. n. Brasil, II. 58 f.
‡ Hockin, Supplem. to the Account of the Pelew Islands. Lond. 1803, p. 15.
§ ‖ expresses the lateral clicking sound; Kh is a guttural consonant, and ~ marks the nasal tone.

(Moon) is, as in ancient Teutonic, masculine, and the Sun feminine." The Namaquas, an offshoot of the Hottentots, regard the Sun as a lump of "clear fat," which seafarers attract to themselves by enchantment during the night, and then spurn after morning has come, and they have no further need of it. The Moon, on the other hand, they regard as a more important personage than even their own chief Spirit u-Tixo. He (the Moon) once commissioned the Hare to inform mankind that even as the Moon always recovers again his fullness after he has lost it, so they too may come to life again, after death. The hare mistook the message and told men that they must die away, even as the moon does. This was the origin of death. Old Namaquas never eat hare-flesh, probably because this animal is regarded as a divine messenger. The waning of the moon is due to his putting his hand up to his head when he has a headache.* The Mbocovies, neighbors of the Payaguas, take some of the stars for trees with luminous branches, and others for an ostrich pursued by dogs. (*Cf. supra*, Ch. III. § 3.) The Sun, they say, is a woman who once fell upon the Earth, and caused thereby great calamity: it was only with great difficulty that she was restored to her place. But the Moon is a man: and his eclipse is caused by a dog tearing out his bowels.† The Navajoes say that the Moon is a man riding on an ass: but that the Sun is set up in the heavens every morning by an old woman.‡ The Greenlanders say that Anningat, the Moon, is a man who is in pursuit of Mallina, the Sun, his sister, with whom he is in love.§ By the Lithuanians, Arabs ‖ and Hindus ¶ the Moon is also regarded as a man. Our Teutonic ancestors had the same opinion: "Audio veteres Germanos Lunum quoque deum coluisse et appellasse Hermon, id est, dominum Lunum (Herr Mond)." (Gesner, *Mithridates*, Tur. 1555, p. 28.) Hulderic. Eyben (De titulo nobilis. Hemst. 1677, 4, p. 136) says: "Qua etiam ratione in vetere idololatrico luna non domina, *dominus* appellatur:

Bis gottwillkommen, neuer mon, holder herr,
Mach mir meines Geldes mehr.

And Eligius: nullus *dominos* solem aut lunam vocet. The Sun, too, they regarded as a woman: Vetulam novi, quæ credidit solem esse deam, vocans eam sanctam dominam. (Nicolaus de Gawe *ap.* Grimm.)* The Greeks had for the Moon the two appellations μήν, masculine, and σελήνη, feminine, and μήν is the more ancient name. The Romans likewise had the two words Lunus and Luna.† The citizens of Carræ believed that whoever regarded the Moon as a male deity, would be lord over women: whoever held him to be female, would be their slave.‡ With regard to the utterly barbarous aborigines of New California Bägert§ states that not alone are they without social organization, but that not even the trace of any religion is to be found among them. Picolo's account contradicts this, for he says that they worship the Moon.‖ The Panches are by Gomara ¶ said to wor-

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* Waitz, II. 342.

† Guevara, Hist. Paraguay, Rio de la Plata y Tucuman, I. 15. *Cf.* Waitz, III. 472.

‡ Davis, El Gringo, or New Mexico and her People. N. Y. 1857, p. 414.

§ Grimm, D. M. 400.

‖ *Ibid.*

¶ Muir's Sanskrit Texts, vol. v. p. 76. "In Indian mythology the Moon is a god, not a goddess."

* D. M. 400 ff.

† Macrob. III. c. 8. *Cf.* Meiners, I. 389.

‡ Spartian. in Vit. Anton. Carac. c. 7. Et quoniam Dei Luni fecimus mentionem, sciendum, doctissimis quibusque id memoriæ traditum atque ita nunc quoque a Carrenis præcipue haberi, ut qui lunam fœmineo nomine ac sexu putaverit nuncupandam, is addictus mulieribus semper inserviat: at vero qui marem deum esse crediderit, is dominetur uxori, neque ullas muliebres patiatur insidias. Unde quamvis Græci vel Aegyptii eo genere quo fœmineam hominem, etiam Lunam deam dicunt, mystice tamen deum dicunt.

§ Bägert, Nachricht. v. Californ. S. 168.

‖ Ap. *Waitz*, IV. 250.

¶ Hist, gen. de las Indias, in Historiad. prim. de Ind. Madr. 1852, p. 202.

ship Sun and Moon, while Piedrahita * expressly affirms that they worship the Moon only. But these conflicting statements may perhaps be reconciled if we recollect that Piedrahita's account is of earlier date than Gomara's: thus Gomara's narrative would exhibit the progress to the worship of both Sun and Moon from simple Moon-worship. The difference between Bägert and Picolo admits of a similar explanation. With regard to the Kaffirs, too, we have accounts on the one hand asserting that they do not regard Sun or Moon as objects of worship, though they hold them to be animate beings; and on the other hand accounts affirming explicitly that they hold festival and conduct religious dances at the time of the New Moon.† The Maravi celebrate the return of the New Moon.‡ Traces of the old German moon-worship, in addition to those already mentioned, are found in the following passage from Nicolaus de Gawe's work *de Superstitionibus:* "Insuper hodie inveniuntur homines tam layci quam clerici, literati quam illiterati, et quod plus dolendum est, valde magni, qui cum *nouilunium primo viderint flexis genibus adorant: vel deposito capucio vel pileo inclinato capite honorant* alloquendo et suscipiendo. Ymmo eciam plures ieiunant ipso die novilunii, sive sit dies dominica in qua secundum ordinacionem ecclesiæ non est ieiunandum propter resurrectionis leticiam siue quacunque alia die, eciamsi esset dies dominice nativitatis. Quæ omnia habent speciem ydolatrie, ab ydolatris relicte." §

The Moon being an animated thing and regarded with such veneration, it cannot surprise us to find the liveliest sympathy excited in her favor, especially whenever she appeared in danger of perishing, *i. e.*, when she is eclipsed. We have already seen that several tribes of savages account for this phenomenon by attributing it to the attack of a wolf on the Moon. Hence they hasten to render her assistance by making a fearful noise, with a view to frighten the monster away.* "Nullus, si quando luna obscuratur, vociferare præsumat," says Eligius in a sermon. "Vince Luna," was the cry of the Romans, prompted by a similar belief: and we meet with the same usage in other nations, for instance, among the Christians of Abyssinia.† The Mbocovies, as we have seen, supposed that a dog was tearing out the entrails of the Man-Moon. Similar beliefs are entertained by American Indians, and this circumstance will explain their custom of beating their dogs, during an eclipse of the Moon, as the Hurons did, according to Charlevoix, and also the Peruvians. The Potowatomies, who are Sun-worshipers and who regard the moon as a maleficent deity, as compared with the Sun, suppose that in the Moon there dwells an old woman who weaves a basket, on the completion of which the world will come to an end: but the basket is always torn in pieces by a dog, before it is finished. Whenever the woman struggles with the dog there is a lunar eclipse.‡ Many of the South Sea Islanders explain this phenomenon differently,§ accounting for it in accordance with the dogmas of Soul-worship, which appears to overmaster their fetichism, and to force it into the background. According to them the Moon is the food of departed spirits, and by feasting off it, they make it smaller; just as the Dakota Indians say that the waning of the Moon is caused by the gnawing of a number of little mice (Mice-souls ?). But it ever waxes again. When therefore the Moon is eclipsed, these islanders

* Hist. de las conq. del nuevo reyno de Granada, I. parte. Amberes, 1688, V. 1.

† Waitz, II. 411 f.

‡ Monteiro in the Ztschr. f. Allg. Erdkunde, VI. 260 ff. Ausland, 1858, p. 260; Waitz, II. 419.

§ Grimm, D. M. Anhang. S. XLIV.

* *Cf.* Grimm, D. M. 401.

† Waitz, II. 503.

‡ De Smet, Missions de l'Oregon et Voyages aux. Montagnes rocheuses (1845). Gand. 1848, p. 298.

§ Turner, p. 529 seqq.

are alarmed, lest the souls should go without sustenance. To prevent so great a calamity they make a great offering of cocoa-nuts. On the island of Eap * it is a wizard that causes the Moon to wane, by his enchantments.

We need not be surprised if we find a well-developed worship of spirits among people who pay no worship to the stars. The conception and worship of ghosts and spirits belong to the lowest grades of human development, and are parallel with those phases of fetichism which have all their objects upon the earth itself. More recent than either of these is Star-worship; and to the highest grade of this, which is the climax of fetichism, answers polytheism, the climax of spirit-worship. Where the two intersect, monotheism results. But of course we can only state these points here as theses susceptible of proof.

4. *The Worship of the Stars.*

The Hottentots, who are Moon-worshipers, and who take the Sun to be a lump of fat, have names for several stars, yet do not worship them.† The ancient religion of the Moxos differed for each village. They worshiped severally the Sun, the Moon and the Stars, as well as spirits and fetiches of every description. Their principal objects of worship were the evil spirit Choquigua and the jaguar: yet they kept a festival at the time of the New Moon, and Carasco is inclined to consider Star-worship as their primitive religion.‡ The Abipones of S. America worshiped as fetiches the Pleiades, which for them never set. They regarded this constellation as the founder of their race, and gave to it the same name which they gave to their conjuring doctors, Keebet.§ The Pawnee Indians used to offer human sacrifice annually to the "great star" which they worshiped, viz., Venus; and the same planet had a chapel dedicated in its honor among the Mexicans, who held it to be more ancient than the Sun. The last sacrifice offered to the "Great Star" by the Pawnees was offered in 1837 or 1838. Then a Sioux girl was the victim, and she, after having been carefully tended and well fed, without any intimation of her fate being given her, was bound fast upon a funeral pile and shot to death with arrows. Whilst yet she lived, they carved pieces of flesh off her body, and suffered her blood to flow over the young shoots of corn.*

* Gerland *apud* Waitz, V. 2, 147.
† Campbell, First voyage.
‡ Waitz, III. 538.
§ Dobrizhofer, II, 80, 87 seqq. 317.

5. *The Transition to Sun-Worship.*

Wherever the Moon and the Stars are objects of worship, the Sun's claims to adoration will soon be recognized, and then the Sun and the Moon will at first receive equal veneration, to the prejudice of the stars, which will hold but a subordinate position. But when once attention has been directed to the Sun, it will quickly be seen that, as compared with the Moon, he is the superior Being, and then their mutual relations will be reversed, the Sun coming prominently into the foreground. Hence in the worship of Sun and Moon, we recognize two stages: in the one these two luminaries jointly receive equal worship; in the other they are both worshiped indeed, but still the Sun far outranks the Moon, and the religious halo surrounding the latter is as pale as her beams. For all these stages we can find representatives, and of the latter it is to be observed that their intellectual advancement will correspond with the progress they have made in the worship of the heavenly bodies.

The Comanche Indians † worship the Sun and Moon *ex æquo*. They call the Sun the God of Day, the Moon the God of Night, and the Earth, the Common Mother of all.

* De Smet; J. Irving, Indian sketches. Lond. 1835; Schoolcraft, IV. 50, V. 77.
† Waitz, IV. 213, ff.

In their view the Sun and the Moon are both *men:* they stand on terms of equality, not of subordination, which latter would not be the case were they regarded as Man and Woman. The savage considers woman to be immeasurably the inferior of man, and in the earlier stages of the worship of Sun and Moon the latter would be male, the former female. In that stage which the Comanches have reached they are both male: and it is only later that the Sun is held to be a man, the Moon a woman. As for the intellectual culture of these savages, it may be estimated from the following circumstances. On journeys they direct their course by the Polar Star. They do not follow agriculture, living solely by the chase. Their clothing is of tanned deer-skin. Their weapons are bows and arrows, the lasso and the shield; and now muskets. Each individual is allowed unrestricted freedom of action, but yet offenses are punished by decree of a council summoned annually by the chief. Debauchery is common, and polygamy prevails amongst them. They have no word meaning *virgin*, and it is simple politeness to offer to the stranger a female companion.

On the stage next above this, both Sun and Moon are also worshiped, but the Sun has precedence of the Moon, the latter being female, the former male. The Muzos say the Sun is their Father, the Moon their Mother. The natives of Cumana, one of the Caribees, used to worship Sun and Moon as man and wife.* The Sun goes on increasing in importance: thus the Potowatomies † hold the Moon to be an evil female deity (*supra*, p. 93); the Sun-worshiping Winnebagoes ‡ do not believe that the Moon has any power over mankind; while the Osages regard the Sun as the Great Spirit, ruling over Moon and Earth.* Here we reach that stage in the worship of the heavenly bodies, where the Sun assumes the unchallenged pre-eminence.

* Gomara, 208; Herrera, Descripcion de las Indias occidentales. Madrid, 1730, III. 4. 10 seq.

† Keating, I. 216.

‡ Schoolcraft, IV. 240.

6. *The Worship of the Sun.*

Almost all the tribes of American Indians worship the Sun as the Supreme Deity. In North America, according to Waitz (III. 180) this is true as regards all the tribes as far west as the Crows and the Blackfeet, and as far north as the Ottawas. In Florida the worship of the Sun reigned, and it extended thence to the Apache country. Sun-worship, however, reached its highest stage of development in Middle and South America, among the Mexicans and the Peruvians.

The Indians of Florida prayed to the Sun, whom they held to be a man, for victory in battle, and sang hymns of praise in his honor.† The chief offering made to the Sun by the Indians is tobacco-smoke from the pipe, and thus smoking is among them a religious rite. The Hurons, Mandans, Menitarees and other tribes held the tobacco-pipe, whose high importance as the pipe of peace is well known, to be the gift of the Sun: and they, as well as many tribes lying further south, offer this incense to the Sun, to the four cardinal points of the heavens, and to Mother Earth.‡ The chiefs of the Hudson's Bay Indians used to direct three puffs of smoke toward the rising Sun, and greet him with a reverential salutation.§ In the Council, the pipe is always passed around, following thus the Sun's course, as they say.‖ In Virginia, the aborigines used to crouch at sunrise and sunset, and direct their

* Morse, Rep. to Sec. of War, on Ind. Affairs. New Haven, 1822, Appendix, 229.

† Landonnière, Histoire notable de la Floride (1562–67). Par. 1853, S. 99; Herrera, VII. 1, 15, 2, 6; Buschmann *ap.* Abhandl. d. Akad. d. Wiss. zu Berl. 1854, S. 300.

‡ Lafitau, II. 134 seqq.; Lettr. édif. I. 763; Nuttall, 274; Keating, I. 408 *et alibi.*

§ De la Potherie, I. 121, 131, II. 106.

‖ Perrin du Lac, I. 179.

eyes and their hands toward that luminary.* The Osages † each morning pronounce a prayer to the Sun, and in the chants of the Algonquin prophets ‡ the Sun is honored as supreme Deity. The Potowatomies § used occasionally to get upon the roofs of their huts at the rising of the Sun and on bended knees make an offering to him of maize gruel. The Spokans call themselves "Sons of the Sun." We can estimate the intellectual status of these Indians from the grade of religious development which they have reached; and the notable researches made by Waitz show that the former is on the whole considerably higher than has been commonly supposed. The nearer we approach to Mexico, the higher is the development of Sun-worship, and the higher the intellectual status of the aborigines. Even the natives of the lower Colorado country,‖ who were Sun-worshipers, did not practice polygamy, jealously watched over the chastity of the young women previous to marriage, and were of mild manners, though warlike. The Pueblos,¶ dwelling in the N. E. part of New Mexico, whose chief god is the Sun, are very industrious farmers with well-constructed implements of husbandry; weave woolen and cotton fabrics; are well clothed, and build houses of stone and adobes, three or four stories in height. As well in geographical position as in culture and worship the Mexicans had for neighbors the Natchez of Louisiana, together with the kindred people of Texas, whose principal tribe was that of the Assinais.** Waitz says that among these is to be found "the truest and most definite expression of Sun-worship, in conjunction with a theocratic form of government." The Natchez lived under an absolute monarchy, and the royal family, descendants of the Sun, stood high above the common people, like the family of the Incas of Peru.

American Sun-worship found its highest development among the Mexicans and Peruvians. These races at the period of their coming in contact with Europeans were no longer savages, but civilized nations in the strict sense of the word, and capable of still further native development. This civilization would have produced the fairest fruit had it not been ruthlessly interrupted by the fanatic zeal of a Cortez and a Pizarro, and later purposely, persistently and violently stamped out by the barbarities of Christian tyrants.

Although polytheism was fully developed among the Mexicans,* still the Sun was their Supreme Deity, especially among the Toltecs, who were the authors of all Mexican culture. It has occasioned surprise to many to find polytheism and Sun-worship co-existent, as in the religion of Mexico. One explanation accounts for this by supposing that this religion had its origin among several diverse nations who coalesced into one, each importing its own religious ideas. But this supposition cannot be established on historical grounds, nor is it at all necessary. We have already more than once remarked that the worship of spirits and the worship of material objects are developed simultaneously and side-by-side. The one *never* arises alone, and unaccompanied by the other. The development of spirit-worship advances *pari passu* with that of matter-worship. Wherever the latter as-

* Strachey, Hist. of Trav. into Virginia Britannia. Lond. 1849, p. 93.

† Nuttall, 95.

‡ Schoolcraft, I. 399.

§ Journal étranger, 1762, Mai p. 7, *ap.* Waitz, III. 182.

‖ Castañeda, Relation du Voy. de Cibola (1540), éd. Ternaux. Par. 1838, p. 299 seqq.; Herrera, VI. 9, 14.

¶ Rivera, Diario y Derrotero de la Visita general de los Presidios de N. España. Guatemala, 1736; Villa-Señor, Teatro Americano, Descr. gen. de los Reynos y Provinc. de la N. España. Mex. 1746. *Cf.* Waitz, IV. 227.

** Waitz, III. 219 ff.

* *Cf.* Prescott, Conq. Mex. I.; Waitz, IV. S. 1–180; Wuttke, Gesch. d. Heidenth. S. 251–299; D. Fr. Saverio Clavigero, Hist. Antig. de Megico, sacada de los mejores historiadores españoles y de los manuscritos y de las pinturas indias, etc. Londres, 1826.

sumes the form of Sun-worship, the former becomes a complex polytheism; hence we find in the religion of Mexico not two incongruous elements, but rather the regular combination of two lines of objects of worship which constitute the inception of religious development in the mind of man. We have no need, therefore, of supposing that the Mexican religion came from different peoples: its two phases are rather the genuine products of the Mexican understanding itself.

The Sun's preëminence over the other gods is shown in the Mexican myth which traced the origin of the Sun, as also in the fact that the Mexicans called themselves "the Sun's children." This myth is given in full by Clavigero,* but we need here refer only to that portion which speaks of the heroes or demigods (heroes o semidioses), who, prior to the appearance of the Sun, ruled over men, and opposed that god when he began to run his course; but seeing that they could not make head against him, such of them as had not already been slain by the Sun made away with themselves, leaving him sole master. Quetzalcoatl, a sort of Mexican Christ,† is said to have been created by the breath of Tonacateotl, the Sun.‡ Whereas offerings were made to the other gods only four times a day, in the morning, at noon, in the evening and at midnight, there were nine daily offerings to the sun, four by day and five through the night, of copal or other fragrant gum, such as chapopotli § (called by Clavigero betun judaico, asphaltum). They offered also quails to the Sun at his rising, and solemnly greeted his appearance with music.‖ That their conception of the Sun was anthropopathic though a most exalted one we see from all their myths. At the solemn naming of the new-born infant, when ceremonies were used having a strange resemblance to those accompanying the baptismal rite in Christian churches—as, for instance, their sprinkling the babe with water and then entreating the deity "that he would cause these holy drops of water to wash away the sin which became the infant's heritage before the creation of the world, to the end that the babe might be born anew"*—the mother thus addressed the Sun and the Earth: "Thou Sun, Father of all that live, and thou Earth, our Mother, take ye this child and guard it as your son." † They often employed this solemn form of asseveration, "By the life of the Sun and of our Lady, the Earth."

The Mexicans, who thus paid supreme honor to the Sun, and made him the object of constant observation, gained an astonishing degree of accuracy in their knowledge of his course. All who have studied the matter are agreed ‡ that the Mexicans, who used sun-dials, calculated the length of the solar year with the utmost possible exactitude. First, their year consisted of 18 months having 20 days each—360 days. To the last month they added 5 days, which they called *nemontemi*, unemployed, as they did nothing on those days but pay visits.§ "But what is most wonderful in their reckonings, and what will appear scarce credible to those who are unacquainted with Mexican antiquities, is this," says Clavigero,‖ "that the difference of some hours between the civil and the solar years was noted by them, and that they resorted to intercalation to equalize them. There was, however,

* Lib. VI. p. 228, Apoteosis del Sol y de la Luna.

† *Cf.* Waitz, IV. 141 f.

‡ Kingsborough, Antiq. of Mex. Lond., 1831, V. 135, 184.

§ Clavigero, VI. 251: Al sol incensaban nueve veces, cuatro de dia y cinco de noche.

‖ *Ib.*, p. 260.

* *Vide* Prescott, I.

† Clavigero, p. 290: Tú, sol, decia la partera, padre de todos los vivientes, y tú, tierra, nuestra madre, acoged á este nino y protegedlo como á hijo vuestro.

‡ *Cf.* Prescott, I.; Waitz, IV. 174.

§ Gama, Descripcion Historica y Cronologica de los Dos Piedras. Mejico, 1832, II. 111 seqq.

‖ Libro, VI. p. 269.

between their mode of intercalation and that of Julius Cæsar which is adopted for the Roman Calendar, this difference, that instead of intercalating one day every fourth year, they added 13 days every fifty-second year. "They waited," says Prescott, "till the expiration of 52 years, when they interposed 13 days, or rather 12 days and a half, this being the number that had fallen in arrear. Had they inserted 13, it would have been too much, since the annual excess over 365 is about 11 minutes less than 6 hours. But as their calendar, at the time of the Conquest, was found to correspond with the European (making allowance for the subsequent Gregorian reform), they would seem to have adopted the shorter period of 12 days and a half, which brought them within an almost inappreciable fraction, to the exact length of the solar year, as established by the most accurate observations. (*Cf.* La Place; *Exposition*, p. 350.) Indeed, the intercalation of 25 days in every 104 years, shows a nicer adjustment of civil to solar time than is presented by any European calendar; since more than 5 centuries must elapse, before the loss of an entire day.* Such was the astonishing precision displayed by the Aztecs, or, perhaps, by their more polished Toltec predecessors, in these computations, so difficult as to have baffled, till a comparatively recent period, the most enlightened nations of Christendom!"

In addition to their solar year they had also a sacerdotal, or, so to speak, an ecclesiastical year of 20 times 13 days, and this year was called the Metzlapohualli (Lunar Reckoning), as distinguished from the civil year Tonalpohualli (Solar Reckoning).† This religious computation of time, which served to regulate the festivals, as also the circumstance that one word, Metzli, served to express both *month* and *moon*, are evidences of an earlier computation by Moons, which in fact Echevarria asserts to have been their more ancient mode of reckoning.*

But even as the Moon lost importance for computing time, so too did her worship decline. She came to be regarded as the wife of the Sun, as the Stars were his sisters.† As for her eclipses, the true cause of which they very probably recognized,‡ they were not regarded with the same emotions as by savages.§ Amid the countless temples and chapels of Mexico two were specially famous, the great temple of the Sun, and the smaller temple of the Moon at Teotihuacan, and around each of these stood a cluster of minor temples, probably dedicated to the worship of the Stars. ‖ The planet Venus had a temple called Ilhuicatitlan.¶ The Stars were objects especially of astrological observation, and were consulted with regard to the most trifling domestic affairs as well as the weightiest concerns of the State; ** even the kings were attentive observers of the stars, and one of them, Nezahualcoiotl, built for his own use an observatory.

The Mexican State was a carefully articulated organism, down even to its minutest subdivisions. The affairs of the army, the revenues, the courts of justice, the police, etc., were thoroughly organized. The king, vicegerent of God on earth, was possessed of powers limited only by divine authority and the prescriptions of religion. The prayers addressed by him to the deity, to obtain strength and light for the discharge of his important duties, sound like some of David's Psalms.

* Gama, parte 1, p. 23. El corto exceso de 4 hor. 38 min. 40 seg., que hay de mas de los 25 dias en el periodo de 104 años, no puede componer un dia entero, hasta que pasen mas de cinco de estos periodos máximos ó 538 años.

† *Cf.* Waitz, IV. 174.

* De Echevarria y Veitia, Hist. del Origen de las Gentes que poblaron la N. España (Ap. Kingsborough, VIII.) I. 4.

† *Cf.* Waitz, IV. 154.

‡ Humboldt, Vues des Cordillères, 282; Prescott, I.

§ Kingsborough, V. 156.

‖ Clavigero, I. 247 seq.

¶ Clavigero, p. 244.

** *Ibid.* I. 209 seqq. 271, 291, etc.

No Jewish prophet could use more impressive language than this, addressed to a Mexican King:* "Graciously and meekly receive all who come to you in anguish and distress; neither speak nor act from passion. Calmly and patiently listen to the complaints and reports that are brought to you. Silence not the speaker, for you are God's image, and his representative: he dwells in you, using you as the organ (flute) through which he speaks; and he hears through your ears. Punish no man without cause, for the right of inflicting punishment, which you hold, is of God:—it is as it were the talons and the teeth of God, to execute justice. Be just, and let who will be offended; for such is God's decree. Be it your care that in the tribunals all things be done according to order, and without precipitancy, and nothing in passion. Let it never enter your heart, to say, I am Master, and will do as I please; for that would tend to destroy your power, lower you in men's esteem, and impair your royal majesty. Suffer not your power and dignity to be to you the occasion of pride and arrogance, but let them rather remind you of the lowliness from which you have been raised, without any merit of yours. Be not given to sleep, nor to indolence and sensuality, nor to reveling. Squander not the sweat and the toil of your subjects. The favor which God has shown you, abuse not for profane and senseless purposes. Our Lord and King! God has his eye upon the rulers of States, and when they commit a fault, he laughs in scorn, but is silent: for he is God, and does what he will, and derides whom he will: for he holds us in his hand, tosses us from side to side, laughing at us when we totter and fall."

The material progress of the Mexican nation may be judged by the number and size of the cities. The city of Mexico had from fifty to sixty thousand families, or *houses*, as some authors suppose; Tezcuco was of equal magnitude; Tzimpantzinco had 20,000; Cholula, Huexocinco and Tepeaca, each 40,000; Xochimilco 80,000; According to Cortez himself Tlascala was in every respect a more opulent place than Granada in Spain. These cities all possessed buildings of considerable magnificence, and there were besides a number of smaller cities.*

The earnestness of their moral sentiments is evinced by the rigid discipline enforced as well in their domestic education as in that of their schools and seminaries, and by the exhortations, the prayers and the proverbs which were learned by rote. "Nothing," says Padre Acosta, "astonished me more or appeared to me more praiseworthy and notable, than the system followed by the Mexicans in the education of their children." "In truth it were difficult to find a nation," adds Clavigero, "that bestows more diligent care than they upon a matter which so nearly concerns the well-being of the state. Doubtless," he continues, "they disfigured their teaching with superstitions; but still the zeal they showed for education might well put to shame many a father of a family in Europe: and many of the instructions which they gave to the pupils would make profitable reading for our own young people." †

As a specimen of these I give the exhortation addressed by a Mexican to his son, which is admitted to be genuine by all the critics: ‡ "My son, you came forth out of your mother's

* Sahagun, *ap.* Waitz, IV. 68.

* *Cf.* Waitz, IV. 93.

† Clavigero, I. 299.

‡ I translate it from Clavigero's work (*ubi supra*). He says it came to his hands from those of Motolinia, Olmos and Sahagun, missionaries in Mexico, perfect masters of the language, and zealous students of Mexican manners, etc. Besides this address of the father to his son, Clavigero gives a similar address of the mother to her daughter, to be found in Prescott (Append. II.), and which is even a more charming composition than the address given in the text. (See the latter also in Waitz, IV. 125, who takes it from Sahagun, Hist. de N. España, VI. 18.)

womb as the chick from the egg, and as you grow you are like the chick preparing for your flight over the earth, nor is it given us to know how long Heaven will insure to us the jewel which we possess in you. However that may be, be it your care to lead a correct life, praying unceasingly to God for his support. It was he that created you, and he is your owner. He is your Father, and loves you more than I. Turn your thoughts God-ward, and let your aspirations rise to him by day and by night. Honor and greet those who are older than yourself, and never give them tokens of contempt. Be not deaf for the poor and the unfortunate, but rather make haste to console them with kindly words. Pay respect to all men, especially your parents, to whom you owe obedience, reverence and dutiful service. Have a care never to follow the examples of those wayward boys, who are like wild beasts void of reason, and who do not respect those who have given them their being, nor heed their admonitions, nor submit to correction: for whoso walks his own ways will come to a disastrous end, dying in blank despair: he will either be hurled down a precipice, or will fall under the claws of wild beasts. Make not merry, my son, over the aged, nor over those who have any bodily defect. Mock not those who happen to make a misstep, nor reproach them therewith; on the contrary be humble, and fear lest what offends you in others become your own. Go not whither you are not invited, nor meddle in affairs which are none of yours. In all that you say, and in all that you do, be it your study to show your good breeding. When you converse with any one, do not annoy him with your hands (mit den Händen belästigen) nor be too voluble: do not interrupt or disturb others with your remarks. If perchance you hear a man speaking foolishly, and it is not your business to correct him, hold your peace: but if it is your business, then consider first what you will say, and speak not arrogantly, that your corrections may avail the more. When any man addresses you, listen to him attentively and with proper demeanor, neither shuffling your feet, nor munching your mantle, nor spitting out, nor jumping up every moment if you are seated: for such conduct shows levity and bad breeding. When you are seated at table, eat not ravenously, nor betray signs of displeasure, if any dish fails to please you. If any one comes in while you are at table share with him what you have, and when one sits at your board, fix not your gaze upon him. When you go out, keep your eyes directed forward lest you hustle against those you meet. When any one approaches you, walking on the same path, give place a little that he may have room to pass. Never walk in advance of your superiors, except when necessity requires that you should, or they command it. When you eat in company with them, serve them with whatever they wish, and so you will gain their favor. If a man make you a gift, receive it with tokens of gratitude: if the gift is of great value, be not vain of it: if it is trifling, do not despise it, nor grow angry, nor anger the man who does you a friendly act. If you are rich, be not supercilious toward the poor and the needy: for the gods who refused riches to others in order to bestow them on you, disgusted at your arrogance, may strip you of them, and give them to others. Live by the fruits of your labor, and then your bread will taste sweet. Hitherto, my son, I have supported you with the sweat of my brow and I have discharged all the duties of a father; I have given you the necessaries of life, without wronging any man. Do you the same. Never tell a lie, for lying is a grievous sin. Whenever you recount to another what you yourself have heard, then tell the simple truth without adding anything. Speak not evil of any man. Conceal the misconduct of others, unless it be your duty to mend it. Avoid gossiping, sow not the seeds of discord. If you are the bearer of a message to any one, and he grows angry, and he vituperates the sender of the message, do not take back that reply, but strive rather to deprive it of its harshness, and if possible say not a word of what you have heard so that there may not be dissensions and disagreements, which you could only regret. Tarry not in the market-place longer than is needful, for such places afford frequent temptations to debauchery. If an office is tendered you, regard the offer as made with a view to test you: therefore do not accept at once, even though you know you are more capable than others; but excuse yourself, until they oblige you to accept: thus you will be all the more esteemed. Keep your passions in check, else the gods will be angered with you and cover you with disgrace. Repress your sensual desires, my son, for you are still young; and patiently await the time when the maid, whom the gods have chosen for your wife, shall have reached the required age. Leave such concerns to the care of the gods; they will do what is best for you. When the time comes for you to marry take no step without your parents' consent, else you will meet with an evil end. Steal not, rob not, if you would not disgrace your parents: it is your duty rather to reflect honor upon them and to show that they brought you up properly. That is all, my son; I have discharged my duty as father. It was my purpose to confirm you in good dispositions by this instruction. Do not despise my words: for your happiness through life depends upon your fidelity."

Prescott gives a number of Mexican proverbs,* which, according to him, may compare with any found in the moral codes of antiquity. He discovers in the following admonition "a most striking resemblance to Holy Writ": "Regard not curiously the walk and demeanor of the great, nor of women, especially married women, for the old proverb says: Whoso regards a woman with curiosity, commits adultery with his eyes." * Monogamy was the rule amongst the Mexicans, and in this respect they came up to that moral standard of marriage with which we are familiar. Nor was the idea they had of their gods unworthy of their moral code, and Clavigero, who compares Grecian and Roman Mythology with that of Mexico, thus expresses himself: "There is not to be found anywhere in Mexican Mythology a trace of those immoralities with which other nations have disgraced their gods. The Mexicans paid homage to virtue rather than to vice, in the objects of their religious veneration: in Huitzilapochli they honored valor; in Centeotl and others, benevolence; in Quetzalcoatl, chastity, justice and prudence. Though their gods were of both sexes, still they did not marry them to one another, nor did they attribute to them that love of obscenity with which the Greeks and Romans credited their gods. They represented them as averse to all kind of vicious indulgence and hence their worship was intended merely to appease the wrath of the gods, excited by the sins of mankind, and to secure their protection by repentance and religious service." It is no wonder if so enlightened a religious system as this surprised the Christian priests; and the latter would no doubt have preferred to find it of a lower type. The language of Mexico, rich in metaphysical and moral expressions, opposed no obstacle to the teaching of the Christian Doctrine, and Clavigero gives specimens of the writings of 84 European and Creole authors "who treated of Christian Doctrine and morals in the languages of Anahuac," as also a list of 49 Autores de Gramaticas y

* Vol. I.

* Sahagun, VI. 22. Tampoco mires con curiosidad el gesto y disposicion de la gente principal, mayormente de las mugeres, y sobre todo de las casadas, porque dice el refran, que él que curiosamente mira à la muger adultera con la vista.

Diccionarios de las lenguas de Anahuac.*

King Nezahualcoiotl endeavored to do away with the human sacrifices which were so frequent in Mexico, but without success, and the attempt only served to show him how difficult it is to convince the people of the falsity of ancient religious notions which have taken root in their affections. We may justly reproach the Mexicans with their religious fanaticism as displayed in these sacrifices: but we must not charge them with inhuman cruelty. In fact no action is *per se* either good or evil, but owes its moral quality to the motive which prompts it: and the same is to be said of human sacrifice. The Mexicans offered to the gods the most precious goods they possessed, *viz.*, themselves, human beings. No animal could suffice, and man alone was the becoming victim to atone for sin. And is not the profoundest teaching of Christianity based on that last and greatest human sacrifice? Hence the motive which led them to offer human victims was the profound earnestness of their religious convictions. Besides, as the Mexicans sacrificed only condemned criminals and prisoners of war, Montezuma could with some show of reason excuse this custom, as he did, by saying to Cortez: "We have the right, as you also have, of slaying our foes in battle. Where, then, is the injustice if we sacrifice in honor of our gods men already doomed to death?" †

That we should find remnants of the lower grades of fetichism in company with the worship of the Sun and of Gods, was to be expected. The Mexicans appear to have been largely given to Animal-fetichism. It included the frog, the God of fishery, as also the butterfly and other insects.‡ A grave containing the bones of some unknown animal, was found in 1790, and in it was also discovered the famous Calendar-Stone.*

Oajaca, Chiapas, Yucatan, Guatemala and Nicaragua † stand on the same level with Mexico, as regards religion and culture. The Peruvians, who were the equals of the Mexicans in intellectual and material advancement, surpassed them perhaps in moral culture.‡

Although the Peruvians, no less than the Mexicans, worshiped a multitude of gods § they too held the Sun to be supreme, none of the other gods coming near him in sanctity or eminence, except perhaps Pachacamac. Previous to the Inca period the Peruvians were by no means such savages as they are represented to have been by Garcilasso, who attributes to them all kinds of fetichism, and who asserts that Sun-worship was introduced by the Incas. On the contrary, the Sun was worshiped in Peru, before the time of the Incas, having been introduced by the Aymaras, "the predecessors and teachers of the Inca-Peruvians."‖ But the Incas, to whose family Garcilasso belonged, had an interest in ascribing to themselves the honor of having been the founders of the State and of the religion of Peru. The story which they told in confirmation of their claim is characteristic.¶ "The Sun, our Father, seeing the pitiable condition of mankind, was moved to compassion and sent to them from heaven two of his children, a son and a daughter, to teach them how to do him honor, and pay him divine worship. These two children of the Sun were further charged to give laws to men, and to direct them how to live like rational creatures, to acquire culture, to dwell in houses, to inhabit cities, till the soil, cultivate plants, save the harvest, breed cattle, enjoy

* Clavigero, II. 394.
† Clavigero, Tom. II. Append. VIII.
‡ Riétos Antiguos, Sacrificios e Idolatrias de los Ind. de la N. Esp. p. un frayle menor (1541) (ap. Kingsborough, IX.) 21; Gomara, 444.

* Gama, I. 12.
† *Cf.* Waitz, IV. 312.
‡ Prescott, Conq. of Peru, I. Book 1; Wuttke, Gesch. d. H. I. S. 303-336; Waitz, IV. 378-477; Garcilasso de la Vega, Hist. Gen. del Peru. Cordova, 1617.
§ *Cf.* Waitz, IV. 452 seqq.
‖ Waitz, IV. 447.
¶ Garcilasso, I. c. XV. XVI.

the benefits derived from all these sources, prepare the products of the soil for food : in a word, their mission was to teach the people how to live like men, rather than like wild beasts. It having pleased the Sun, our Father, to give his children such commands as these, he let them down upon the earth in the neighborhood of Lake Titicaca, bidding them to go whithersoever they would. They were however instructed to drive into the earth a golden staff wherever they thought of establishing their residence in any particular spot : if the staff on the first blow sank into the earth, it was the will of the Sun, our Father, that they should settle there. On coming to the spot where Cuzco was afterwards founded, the sign which had been foretold was given to them. The savages soon began to flock around them, gazing with wonder on the pair, who were arrayed in the precious apparel of the Sun, and who, no less by their speech than by the majesty of their countenance, gave evidence that they were the children of the Sun. Then the Inca instructed the men in all needful arts, such as house-building and agriculture ; while his sister and spouse gave instruction to the women in all kinds of feminine work, such as needlework, and the weaving of cotton and woolen cloth, the making of garments, etc. Furthermore, they both taught the natives the worship of the Sun, their Father."

Thus the Sun was worshiped, and we have now to ascertain in what light they regarded this object of religious veneration. Man can attribute to any object only those notions which he already possesses. The higher then his development, in an intellectual and in a moral sense, the nobler will be the conception he has of the object which he takes for his supreme ideal. The Peruvian will regard the Sun as combining all those virtues and properties which he has himself.

They were an industrious and an ingenious people. Agriculture formed the basis of the commonwealth, and was pursued with the greatest diligence and skill. No spot of ground was untilled, maize and potatoes being the chief products of the soil.* Even the stony sides of the mountains were turned into blooming gardens, by means of terracing, artificial irrigation and the use of guano as manure. They produced excellent cotton and woolen fabrics, and their metal manufactures, in gold, silver, copper and tin (they had no iron) bore the stamp of skillful workmanship. Every part of the country was connected with Cuzco, the capital, by means of excellent highways, some paved, others macadamized,† having well-constructed bridges, a service of posts and a sort of telegraphic system. The latter enabled them to send dispatches a distance of 900 miles in three or four hours.‡ Cuzco had a population of 200,000 souls, exclusive of an equal number dwelling in its suburbs. The other cities were smaller, and yet had a considerable population.§ By means of a division of the population into decads the most exemplary order was maintained.‖ The entire population formed one family, the Inca being its head. All labored and earned for the good of all. The state, not the individual, was an owner of property. Hence none were rich, but also none were poor. The contrast between proprietors and non-proprietors was done away, and all enjoyed prosperity. There were neither beggars nor drones.¶ The citizen's obligation to labor was correlative with that of the state, which owned his labor and its total product, to reward him for his toil. Under the guardian rule of the Incas, whose duties were prescribed to them by the Sun their Father, and who but rarely, as history attests, failed to exercise a paternal care for the commonwealth, the people lived in peace and happiness. Each conquered nation were

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* Prescott, I.
† Waitz, IV. 429.
‡ Garcilasso, VI. c. 7; Wuttke, I. 334.
§ *Cf.* Waitz, IV. 424.
‖ Prescott, I.
¶ *Ib.* I.

immediately allowed to share the rights and privileges of their conquerors. Indeed, it was the desire to extend civilization that led them to undertake wars of conquest.*

It is evident that such a constitution of the empire must have had many defects, and that it hindered individual development, as well as favored the abuse of power by a tyrannical Inca. It was for the interest of the Incas to keep the people in subjection, and hence they cut them off too jealously from all intellectual culture, the possession of which they reserved for themselves alone.

A state organized on such principle cannot subsist without a morality quite free from selfishness, that root of all evil. Their family-life was chaste and pure; their women were not chattels, as among savages, but persons who, as represented in the virgins of the Sun, held a high position in the ceremonies of religion. Intellectual culture, in the sense of erudition, was restricted to the Inca caste; still the education of the people was a function of the state. The picture-writing of the Mexicans was here replaced by that curious contrivance, the quipu,† which was employed by many scholars, and also, but in a less degree, by the people generally. Garcilasso speaks of maps of the whole country and of particular districts and of charts of cities. The learned class did not, as in Mexico, belong exclusively to the priesthood, and they were classed as astrologers, physicians, botanists, poets, designers, painters, etc.‡ The Quechua, like the Mexican language, contained a number of very abstract terms, such as *spirit*, *thought*, *eternal*, etc., which will enable us to form some notion of the degree of mental development attained by this people.§

As to the Peruvian mode of reckoning time we have not the same accurate information as we have with regard to that of the Mexicans. Humboldt * says that the year was made up of 12 lunar months, giving a total of 354d. 8h. 48m.; and according to Rivero and Tschudi,† 11 intercalary days were added at the end of each year, but according to Herrera ‡ there were 12 intercalary days, one being added at the end of each month. In the face of these statements Desjardins § maintains that the Peruvian computation was more exact than the Mexican, and Montesinos ‖ speaks of very precise intercalations, and of cycles of 10, of 100 and 1000 years. But Waitz has strong doubts as to these statements.

Prescott ranks the Peruvians above the Mexicans for skillful workmanship in house-building, tillage, and the construction of roads and canals. Their inferiority to the Mexicans in intellectual culture—for instance, in astronomy—he strives to explain by showing that the Mexicans owed their intellectual advancement, not to their own native qualities, but to that mysterious Toltec stock, which the eye of history fails to discern, and which Prescott supposes to have been equaled by the Peruvians in all other departments of culture.¶

Among a people, who have reached so high a degree of moral and intellectual development, the ideal object of worship must exhibit these moral characteristics in the highest degree. And such is here the case, for the Peruvians regarded the Sun "on the one hand, according to his position in Nature, as the great Power of the universe which upholds all things (a mere heavenly body); but on the other hand (anthropopathically) as a spiritual power, having mind and will. Not that there was supposed to be any spiritual object whose symbol

* *Ib.* I.
† *Cf.* Waitz, IV. 470.
‡ *Ib.* 473.
§ *Ib.*

* Vues des Cordillères, 129.
† Riv. y Tschudi, Antig. Peruanas. Viena, 1851, p. 127.
‡ Herrera, V. 4, 5.
§ Desj. Le Pérou avant la Conq. Espagn. Par. 1858, p. 122.
‖ *Ap.* Waitz, IV. 474.
¶ Prescott, Peru, I.

was the Sun (*i.e.*, the object of worship was not a spirit inhabiting the Sun); but the bright luminary itself (in his own proper form and shape) was truly and really the deity, though not as a simple, soulless sphere, but as a divine and animated body, imparting to all things around him light and life." * When once a monk expounded the Christian doctrine to the Inca Atahuallpa, and asked him to renounce his faith, the eyes of the prince flashed fire, and he exclaimed: "I will never change my faith. Your God was, as you say, put to death by the men he himself had created. But my God," said he, pointing to the Sun which was then setting in full splendor behind the mountains, "my God lives in the heavens, and looks down upon his children." † When the Sun sent his children down upon the earth he thus addressed them: "My children, when you have subjected these people to our obedience, it must be your study to hold them by the laws of reason, of piety, of mercy and of justice, doing for them all that a father is wont to do for the children whom he has begotten and whom he tenderly loves. Herein you will follow my example, for, as you know, I never cease to do good to all mortals. I illumine them with my light, to the end they may see and go about their affairs: when they are cold, I warm them; I make their fields and their meadows productive, bring forth fruit on their trees, increase their herds and send them rain and fair weather as need may be. Further, I journey around the world daily, to see what the earth needs, and to restore all things to order, for the comfort of its inhabitants. Therefore it is my will that ye follow my example, as most dear children, whom I send on earth for the welfare and the instruction of these poor men, who live like beasts. Hence I give you the title of kings, and I desire that your kingdom be extended over all the nations whom ye shall instruct in right principles and good morals, especially by your example and mild rule." * Through reverence for the Sun, even the Inca durst not look upon its face.†

The offerings made to the Sun consisted, besides the morning prayer, at his rising, of a libation (as among the Persians); then of fruits, herbs, flowers and animals, llamas especially.‡ Garcilasso expressly denies that they offered human sacrifices, and often mentions the laws which forbade the sacrifice of captives: still other accounts render it tolerably certain that on high festivals they sacrificed a child or a beautiful maiden.

Where Sun-worship is so highly developed, the worship of the other heavenly bodies holds a very subordinate position. They worshiped the Moon as the Sun's sister and spouse, and the stars (among which Venus and the Pleiades were specially observed) § were considered as their *suite.*‖ The most famous temple in Peru was that of the Sun, at Cuzco, which, on account of its fabulously rich endowments, was called Coricancha—Place of Gold;¶ and the temple next in renown was that of Pachacamac, also at Cuzco. The Temple of the Sun included a chapel plated all over with silver, and dedicated to the Moon, as also three other chapels, richly plated with gold and silver, and sacred to the Stars, to Thunder and Lightning, and to the Rainbow.

With the Peruvians we may class, from the religious point of view, first the Araucanians,** who dwell to the south, in Chile, and who reckoned a solar year of 12 months, each month having 30 days, and five days being intercalated through the year. They were able to determine the time of

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* Wuttke, I. 306 seq.
† Prescott, I. 3.

* Garcilasso, I. lib. I. c. XV.
† *Ib.* IX. c. X.
‡ *Ib.* II. c. VIII.
§ *Cf.* Waitz, IV. 475.
‖ Prescott, I.
¶ *Ib.*
** *Cf.* Waitz, III. 515 ff.

the solstices from the length of shadows. Then came a very advanced people, of higher culture than the Araucanians, viz., the Chibchas,* and their kinsmen, living in New Granada, a country whose antiquities bespeak for its inhabitants a relatively high degree of culture in very early times. Among the Chibchas the Sun held the same important position as among the Peruvians. There is no evidence to show that they imported from Peru their religion and their intellectual culture, but rather everything tends to prove that their development was of native growth.

7. *The Worship of the Heavens.*

In the view taken of the heavens by all men on the basis of the external appearances, the heavenly bodies pass for bright points fixed in the blue vault of the sky, rather than for spheres free-poised in infinite space. Sun, moon and stars are only parts of the celestial vault. Hence, howsoever they may differ from one another, still essentially they are of equal value, being all celestial. The supremacy therefore does not belong to this or to that one body, but to the entire firmament. It is therefore really no new standpoint, but rather the sum of the data already obtained, if now the religious consciousness considers no longer the sun, the moon, or the stars, but the sum-total of them all, the celestial vault, the sky itself, as the supreme fetich, the supreme god. And here too, as in all the objects of fetich-worship, it is the vault of heaven, as such, anthropopathically apprehended, and not any god supposed to be symbolized by it, that receives religious honors. But this worship of the entire heavens does by no means interfere with the worship of the individual heavenly bodies, but rather, on the contrary, favors it. Sun, moon and stars may each receive its peculiar worship and sacrifice; but no one of them has the absolute ascendency. That the people who stand on this stage of fetichism are, from a mental and moral point of view, very advanced, follows from what has been already said. As representatives of this stage we might cite the Persians, as described by Herodotus; also the Chinese.

"To erect statues of the gods, altars and temples," says Herodotus, "is not the custom of the Persians, and indeed they reproach those who do so with folly, and this, as it appears to me, for the reason that they do not believe, as do the Greeks, that the gods are anthropomorphic. On the contrary, they are wont to sacrifice to Zeus on the summits of high mountains, and to invoke the entire celestial vault as Zeus. They also sacrifice to the sun and the moon: to the earth, to fire and to the winds. . . . . The Persians have no holocausts, no libations, no meat-offering, no flutes, no garlands, no barley cakes: but whoever would sacrifice to one of these gods puts a crown of myrtle around his tiara, conducts the animal to some place free from pollution, and there prays to the god to whom he is about to make the offering. Still he prays not for himself alone, but prays rather that it may be well with all Persians and with the king. Then the animal is slain, cut up, seethed, and afterward spread upon the green sweet grass; the Magi then chaunt a song of consecration, standing by the side of the one who makes the offering, and the latter finally takes the flesh home, to make such use of it as he may wish. . . . . The Persians believe that the gods desire only the soul of the beast as a sacrifice, disdaining the flesh; hence they do not burn the flesh, lest they should pollute the fire, which is sacred to the gods: nay, even one durst not even blow on the fire, to quicken it, for that is an offense that is punished with death. As they make offerings to fire, so too do they to water, betaking themselves to some lake, or river, or fountain, and digging a trench in the vicinity, lest the blood should defile the water. There they

* *Ib.* IV. 532 ff.

slay the victim, and spread the pieces on sprigs of bay or myrtle; the magi, who are present, make libations of oil, milk or honey, and chaunt a sacred song; and the sacrificant takes away the flesh of the victim." This conception of sacrifice, where only the soul of the victim is accepted by the gods, (*gods* as defined by Herodotus himself) shows that the Persians no longer viewed their gods from the gross materialistic point of view, and subordinated the material to the spiritual. Their praying for all Persians and not for themselves individually is evidence that they stood high above the egotism of the savage, who cares only for himself.

As objects of religious contemplation, the sky is regarded as the Father, the Earth the Mother of all things by the Chinese, the religious views of the masses being but little affected by the more philosophical and abstract speculations of their later teachers.* Yang, the Sky, is procreative, strong, masculine; Yu, the Earth, is conceptive, weakly, feminine.† All things are the products of these two. "So soon as Yu and Yang unite, an actual existence results, and this is the work of Heaven and Earth." ‡ That this Sky-worship is most intimately connected with Sun-worship, nay, even that it derives its origin from Sun-worship, appears to be beyond question. The Y-King, for instance, says that Yang makes his most perfect apparition in the Sun.§ The movement of Yang, again says the Y-King, is in a circle, being accelerated from the beginning of spring until the solstice, and then retarded. He consists of an extremely subtle matter, invisible to our eyes, but yet most real, and has a fixed and never ceasing circular motion; and his form is spherical, whereas that of the earth is angular, and therefore less capable of motion.*

In the Spring and Summer, when the quickening power of the heavens is greatest, Yang bears sway, but in Autumn and Winter, when the quiescent earth predominates, Yu assumes rule. Yang is lord of the day, culminating at noon, and then gradually yielding to Yu, who rules the night.† All these functions of Yang belong more properly to the Sun than to the Sky.

"Wherever," says Wuttke,‡ "in accordance with our habits of thought, we expect to find mention of God in Chinese writings, it is always the Sky that we find named, sometimes Sky and Earth, but more commonly the Sky alone. And the Sky which is meant is the visible heavens, whose apparent revolution around the earth is held to be the cause of all life and movement. Sun, Moon and Stars are set in this blue Sky, which is the manifestation of deity." Uninfluenced by the nice distinctions which the philosophers of China have made as to the essence of the Heavens the popular mind takes the anthropopathic view, which, however, as was to have been expected of a people so advanced in moral culture as the Chinese, attributes to the Sky only the noblest and sublimest characteristics. They give to the Heavens the name Shang-to, "Sublime Ruler, Supreme Lord." § He is almighty and omnipresent. His all-embracing love is shown in the saying: "The Sublime Ruler of the Universe is to be feared and reverenced: he hates none. Who durst say that He hates any man?"‖ His justice is not to be bribed, and is as immutable as his celestial movement; great is his wrath against the unjust; ¶ from

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* *Cf.* Wuttke, Gesch. des H. Bd. II. S. 1–208; Bluntschli, Altasiatische Gottes-u. Weltideen S. 135–164; le Chou-King par Confucius, trad. par P. Gaubil, revu par M. de Guignes. Par. 1770, p. 88–150.

† Y-King, ex Interpr. Regis. Ed. Mohl, 1834, I. p. 165–169, II. p. 381.

‡ *Ib.* II. 547.

§ *Ib.* II. 406.

* *Ib.* II. 385 seq.; I. 203.

† *Ib.* I. 196, 214; Tschu-hi, übersetzt von Neumann, in Illgen's Zeitschr. 1837, Bd. I. 56, 74, 82.

‡ II. S. 25.

§ Chou-King, p. 13, Note 7; Y-King, II. p. 216.

‖ Confucii Chi-King, s. Liber Carminum, ex Lat. P. Lacharme Interpr. Ed. Jul. Mohl. Stuttg. 1830, II. 4, 8.

¶ *Ib.* II. 4, 8; II. 5, 1.

his omniscence naught is hidden.* And these things are all predicative of the blue vault above our heads, *v.g.* "O blue Sky, look down with scorn upon the proud, and have pity on the unfortunate," is a Chinese prayer.† The Sky so considered is man's moral prototype, which he must reproduce in his own life. "His four properties set forth the ideal of a prince: he is so great, that he encompasses all things; so mighty that he creates all things; so orderly that he adapts all things to their ends; so persistent that he never stands still, never ceases to be." ‡ The Sky is the supreme lord. He requires of man perfect righteousness and sinlessness. Being omniscient he knows when a man is guilty of sin. His wrath is enkindled against all injustice, and he manifests it on occasion by celestial phenomena and by the convulsions of Nature, which are thus brought into relations with the moral life of man. Eclipses of Sun and Moon, earthquakes, thunder and lightning and the other grave phenomena of Nature are warnings sent from Heaven to man.§ Crops fail on account of the sins of the people or of their rulers. "When virtue reigns," says Kitse in the 12th century B.C., "the rain falls betimes; when the sovereign rules justly, there is fair weather, etc.; when sin reigns, the rain falls incessantly, or else there is a drought," etc.‖ The guilty are oftentimes punished directly by the Heavens. An emperor of the second dynasty having defiantly shot arrows at the sky, and erected idols was slain by the lightning.¶ For the space of three days did the Heavens envelop the earth in dark clouds, because another emperor had committed a crime.* We might cite a multitude of similar instances; † but as our purpose here is only to define the position of China with regard to religious development, we refrain from any further illustration of this point.

However just the claim of the sky to the undivided worship of man, and howsoever strictly philosophico-religious speculation may show it to be the one object that deserves to be worshiped, still the popular mind will not renounce its own nature as a fecund principle, and so it fashions for itself notions of spirits and gods on purely empiric grounds. Hence in China, besides sky-worship there is a complex system of Spirit-worship and polytheism.‡ In addition to the Ancestral Spirits, which are the principal objects of veneration, there are the Celestial Spirits, which dwell in the heavenly bodies, in the Sun, the Moon, the Stars, the Earth; on mountains, in rivers; in the thunder and in the winds. There are the guardian Spirits of families, of houses, of communities, of cities, of provinces, of agriculture, etc., and we find mention of these even in remote times: yet they rank so far beneath the Sky that by an ancient law it was forbidden to make offerings to them such as were made to the Sky, and it was allowed only to make them gifts of food, and to show them a limited amount of reverence.§

In Africa, too, among the more advanced nations, we find traces of a growing Sun and Sky worship. In Dahomey, a country ruled with barbarous rigor, but yet possessing a well-organized monarchical government, the Sun is held to be the highest of all beings but yet is not worshiped.‖ The Duallas call the Sun and the Great Spirit by one name.¶

* Histoire Générale de la Chine, trad. du Kong-Kien-Kang-Mon par de Mailla, publ. par Grosier. Par. 1777, I. p. 92, 111.

† Chi-King, II. 5, 6.

‡ Wuttke, II. 26.

§ Chou-King, p. 13, 54, 87, 96, 99, 142, 160, 347; Chi-King, p. 291, II. 5, 6, 8; De Mailla, I. 78.

‖ Chou-King, p. 172.

¶ De Mailla, I. 227.

* Chou-King, p. 91.

† *Cf.* Wuttke, II. 55 ff.

‡ *Ib.* II. 36 ff.

§ De Mailla, Hist. gén. I. 33.

‖ Omboni, Viaggi nell' Africa Occidentale. Milano, 1845, p. 309.

¶ Allen and Thomson, Narr. of the Exped. to the R. Niger in 1841. Lond. 1848, II. 199, 395 *note.*

In Acra Römer discovered a sort of worship paid to the Sun.* The Negroes of the Gold Coast, at least their devotees and fetichmen, call Njongmo (the Sky), which is omnipresent and *ab ævo*, the Supreme God, and the Maker of the world.† "You may every day see," said a fetichman, "how the rain and sunshine sent by him cause the grass and grain and trees to grow: he must therefore be the Creator." Every morning they go down to the stream, wash themselves, dash a handful of water or sand on their heads, and with eyes turned to the sky, utter this prayer: "O God, give me this day rice and yams, gold and *agries:* give me slaves, wealth and health, and grant that I be quick and swift." The same belief, substantially, prevails in Akwapim, the Supreme Deity being the firmament, and the Earth, the Universal Mother, holding the second rank, while in the third rank stands Bosumbra, the head Fetich. Before embarking in any new enterprise the people of Akwapim offer a libation to these three, saying: "Creator, come, drink; Earth, come, drink; Bosumbra, come, drink." ‡

CHAPTER VII.

THE AIM OF FETICHISM.

HAVING traced the development of religious ideas from their earliest origin to their more advanced stages, we would now gather the results of our analyses in order to show the ulterior aim to which the system is directed.

1. *Retrospect.*

The understanding has cognizance only of its own conceptions, and these conceptions are its objects. Hence its range is limited to the conceptions and objects it has, and hence too it grows as the number of its objects is increased. If we would appreciate a man's intellectual status, we must know what are his conceptions, his *objects.* In his lowest condition man has but few objects: but as these are multiplied the more, the more does he advance in every respect.

It is a law of our mind that we shall range our conceptions in the order of cause and effect. But we can so range such conceptions as we possess. *Cause*, as being the efficient, the productive principle we can conceive of only as something possessed of power, of special efficiency. Accordingly that object or that conception will pass for causal and efficient, which appears to be the stronger, the more excellent. We have seen how, as the number of objects was greater or less, their values differed proportionally, and how the mind with few objects must set as high a value on trifles (as viewed from a higher standpoint) as a superior understanding sets upon its more important objects: for a relatively trifling object assumes importance when its surroundings are more trifling still than itself. Hence we have seen that because he has but few objects, and a very narrow *world*, the fetichist takes to be causal an object which for him is momentous, though insignificant for us. We have seen that as he increases the number of his conceptions, the number of assignable causes is increased in proportion; and then we considered the various objects regarded as fetiches: stocks, stones, mountains, plants, etc. All these lay in man's own sphere, and he was attached to them by bodily interest. A new and spiritual interest could be awakened only by an entirely new object, and this he found in the heavenly bodies, by the worship of which man stepped beyond simply material interests and entered a spiritual sphere.

In proportion as the spiritual interest increases the more is the will detached from the simply corporeal. Animal passions are repressed in proportion as objects of spiritual interest

* Römer, S. 84.
† Waitz, II. 170.
‡ *Ibidem.*

attract the will to themselves. But in order to devote himself to spiritual interests man had need of repose, tranquillity and bodily security. The higher this spiritual interest rises, the more is fierce and destructive egotism repressed. Life is more tranquil, more orderly. Man builds up commonwealths, and his thoughts are now no longer concerned about himself alone, but about the commonwealth also. But in proportion as he abandons egotism, the more does he acknowledge moral control. In the higher stages of the worship of heavenly bodies we therefore found a high degree of development, not only intellectually but also morally. For morality being will-stimulus, or will-direction, and the will being elevated only by gaining higher and ever higher objects, therefore morality is elevated in proportion to the elevation of the objects.

2. *The New Problem.*

Sky-worship, including Star and Sun-worship, is the highest grade of fetichism, not only because its objects are the most exalted, but also because it contains the nucleus of something altogether new. So far, man has been tracing causes from object to object, and in the pursuit of the final cause at length passed from earth to sky. But even there his final cause was found to belong to the order of sensuous things. His eyes discern his efficient causes; he *sees* them producing all phenomena, all objects. But the law of the mind is that he shall still search for a cause, and when once the mind has begun to question, it will never cease to question. What is the cause of A? it asks: and the answer is, B. But further it will ask, What then of B? and an answer it must have. Now so far it has taken the Stars, the Sun, the Sky for its ultimate cause: but the greater man's reverence for this cause, and the more he contemplates it, the more he learns as to its true nature. Soon all manner of thoughts will spring up, and he will observe contradictions between its actual, empirical phenomena and his own conception thereof, and of the mode in which it must operate. How is this? he will inquire. And when such and such effects are produced by the Sun, the question will come up, But what produced the Sun itself, with its phenomena? And in fact wherever this worship of heavenly bodies attains its highest stage, as among the Mexicans, Peruvians and Persians, this question did actually arise. The Persians not alone put this question, but they found the answer to it, and the result was a new religion, that of Zoroaster. But the Mexicans and the Peruvians had their development interrupted by the fanaticism of a Cortez and a Pizarro, and hence they could not reach a solution of the problem, though it was explicitly stated by some eminent minds among them, and the nation was in a fair way soon to enter on a new religious epoch.

But let us see how the problem must be solved by a people in their stage of development. As long as the objects of sense afforded the grounds for considering them as causes, so long did man ascend the series. But when the last link in that chain is reached, the senses fail; and the eye cannot penetrate beyond the blue vault of the heavens. Hence when he comes to inquire as to the cause of the sky itself, he cannot assign any sensible object, there being none that is greater than this. If therefore he would still pursue his search after a cause, he must needs go beyond the domain of sense, and assign causes not apprehensible to the senses, prætersensual or supersensual. But now he could not assign anything super-sensual as a cause, if he had no conception of the "supersensual." But his gods and spirits have furnished him with such a notion, and he has often held them to be the causes of sundry phenomena in the world of sense. All his conceptions are empirical, and his conception of gods also had an empirical origin. It is not our business here to account for the idea of gods and spirits: it suffices if we know that it exists. When therefore an ultimate cause is to be assigned for the ultimate of sensible causes, it will be a God. But just as when he looked for the ultimate Cause among sensible objects, that passed for ultimate which was unique, supreme, and above all things else in power and dominion: so too must this God be unique, supreme, exclusive. Here then is the point where, by the crossing of the two series of conceptions (referred to already at p. 26)—viz.: on the one hand sensible objects, and on the other spirits or gods, both in their highest state of development (Sun and Sky-worship, and Polytheism)—Monotheism is evolved. The proofs of this proposition are not in place in an essay on fetichism: it will be sufficient if we show from history that the *question* we have spoken of does actually arise where man has reached the highest stage of fetichism, and that it is answered precisely as we have said.

Of the famous Inca, Tupac Jupanqui,* Garcilasso states that "he was wont to say: Many hold that the sun is endowed with life, and that he is the creator of all things. But whoever creates a thing must be present when he creates it: but now sundry things are produced in the absence of the Sun: therefore the Sun is not the creator of all things. Furthermore, his never tiring is proof that he is not a living thing. If he had life, he would weary even as we: and were he free, he would visit other regions of heaven besides those in which his daily course now lies. He is, as it were, an object that is restricted in its movements, and which ever describes the self-same course; or like the arrow which flies in the direction in which it is shot, and which cannot choose its own course." Another Inca was once, upon the feast of Raymi, attentively contemplating the Sun. A priest having twice reminded him that the reverence due to that luminary forbade such conduct, the monarch replied: "I will put you two questions. I am your king and lord. Would any of you venture to order me to rise from my throne and set out on a long journey? And would any of my vassals be so bold as to refuse obedience, were I to command him forthwith to hasten off to Chile?" The priest having answered both questions in the negative, the monarch thus continued: "My word for it, there must be over the Sun, our Father, a master greater and mightier still, who requires him to perform his daily course: for were the Sun himself the Supreme Lord, he would not pursue forever the same daily path: he would rest when it pleased him, even though he had no need of rest."*

One of the most eminent of the Mexican kings, "an intellectual hero of the New World," was Nezahualcoyotl. "His enlightened mind, and the love he had for his subjects, largely contributed to make his court famous, and it was ever after regarded as the home of the arts and the center of refined culture. At Tezcuco, his capital, the Mexican language was spoken with the greatest purity and correctness; and there were always to be found the best artists, and a vast assemblage of poets, orators and historians. Not alone the Mexicans themselves, but many other nations received laws from Tezcuco, and hence we might say that Nezahualcoyotl was the Solon, and his capital the Athens of Anahuac."† Well-versed in the poetry of his native land, the king was himself a poet of some distinction, and as late as the 16th century sixty hymns composed by him in honor of the Creator of the heavens were held in high esteem even by the Spaniards. "But nothing possessed so deep an interest for Nezahualcoyotl as the study of Nature. He acquired a considerable

* Garcilasso, VIII. 8.

* Acosta, Balboa, 59; *apud* Waitz, IV. 449.

† Clavigero, I. p. 175 seq.

amount of astronomical knowledge from the numerous observations which he directed to be made of the courses of the stars. He also devoted much time to the study of botany and zoology, and those specimens which, as requiring a different climate, could not live at the capital, he had painted in the natural size on the walls of his palace. *He studied attentively the causes of the phenomena of Nature, and this study led him to recognize the worthlessness of idolatry.* He told his sons, in confidence, that whilst they paid exterior reverence to the idols, in deference to public sentiment, they should in their hearts abhor this contemptible worship of inanimate things. As for himself, he acknowledged no god save the Creator of the Heavens, but he did not forbid idolatry, much as he wished to do so, lest any man should charge him with setting himself in opposition to the teachings of his forefathers. He prohibited human sacrifices, but succeeded only so far as to limit them to the offering of prisoners of war." * To his "Unseen God," "the Unknown God, the Cause of Causes," † he dedicated a tower of nine stories, with roof painted blue, and studded with golden stars.*

At stated hours certain officials appointed for the purpose struck a sonorous metallic plate in the tower, at which signal the king knelt and recited a prayer. From the ornamentation of this tower, as well as from his poems,† it is plain that, as Prescott says, "he combined star-worship with worship of the Almighty;" or rather, by combining star-worship with Polytheism, he reached Monotheism. This is clear from what Ijtliljochitl says of him, viz., that although he "invoked the Almighty, by whose grace we live, and who hath in himself all things," still he also "acknowledged the sun to be his father and the earth his mother."‡

* Clavigero, I. p. 175 seq.

† "Al Dios no conocido, Causa de las Causas." M. S. de Ijtliljochitl apud Prescott, I. 155.

* "Su boveda estaba pintada de azul." Clavigero, I. 176.

† "Let us strive heavenward, for there all is everlasting and incorruptible." Aspiremos ál cielo, que allí todo es eterno y nada se corrompe. "The horrors of the grave are but the Sun's cradle; and the sombre shadows only brilliant lights for the stars." El horror del sepulcro es lisongera cuña para el, y las funestas sombras brillantes luces para los astros.

‡ *Apud* Prescott, I.

7

ANTHROPOLOGY.

BY

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I. SCOPE OF THE SCIENCE.

ANTHROPOLOGY (the *science of man*, ἄνθρωπος, λόγος) denotes the natural history of mankind. In the general classification of knowledge it stands as the highest section of zoology or the science of animals, itself the highest section of biology or the science of living beings. To anthropology contribute various sciences, which hold their own independent places in the field of knowledge. Thus anatomy and physiology display the structure and functions of the human body, while psychology investigates the operations of the human mind. Philology deals with the general principles of language, as well as with the relations between the languages of particular races and nations. Ethics or moral science treats of man's duty or rules of conduct toward his fellowmen. Lastly, under the names of sociology and the science of culture, are considered the origin and development of arts and sciences, opinions, beliefs, customs, laws, and institutions generally among mankind, their course in time being partly marked out by the direct record of history, while beyond the historical limit our information is continued by inferences from relics of early ages and remote districts, to interpret which is the task of præ-historic archæology and geology. Not only are these various sciences concerned largely with man, but several among them have in fact suffered by the almost entire exclusion of other animals from their scheme. It is undoubted that comparative anatomy and physiology, by treating the human species as one member of a long series of related organisms, have gained a higher and more perfect understanding of man himself and his place in the universe than could have been gained by the narrower investigation of his species by and for itself. It is to be regretted that hitherto certain other sciences—psychology, ethics, and even philology and sociology—have so little followed so profitable an example. No doubt the phenomena of intellect appear in vastly higher and more complete organization in man than in beings below him in the scale of nature, that beasts and birds only attain to language in its lower rudiments, and that only the germs of moral tendency and social law are discernible among the lower animals. Yet though the mental and moral interval between man and the nearest animals may be vast, the break is not absolute, and the investigation of the laws of reason and instinct throughout the zoological system, which is already casting some scattered rays of light on the study of man's highest organization, may be destined henceforth to throw brighter illumination into its very recesses. Now this condition of things, as well as the accepted order in which the sciences have arranged themselves by their mode of growth, make it desirable that anthropology should not too ambitiously strive to include within itself the sciences which provide so much of its wealth, but that each science should pursue its own subject through the whole range of living beings, rendering to anthropology an account of so much of its results as concerns man. Such results it is the office of anthropology to collect and co-ordinate, so as to elaborate as completely as may be the synopsis of man's bodily and mental nature, and the theory of his whole course of life and action from his first appearance on earth. As will be seen from the following summary, the information to be thus brought together from contributing sciences is widely different both in accuracy and in soundness. While much of the descriptive detail is already clear and well filled in, the general principles of its order are still but vaguely to be discerned, and as our view quits the comparatively distinct region near ourselves, the prospect fades more and more into the dimness of conjecture.

II. MAN'S PLACE IN NATURE.

It is now more than thirty years since Dr. Prichard, who perhaps of all others merits the title of founder of modern anthropology, stated in the following forcible passage, which opens his *Natural History of Man*, the closeness of man's physical relation to the lower animals :—

"The organized world presents no contrasts and resemblances more remarkable than those which we discover on comparing mankind with the inferior tribes. That creatures should exist so nearly approaching to each other in all the particulars of their physical structure, and yet differing so immeasurably in their endowments and capabilities, would be a fact hard to believe, if it were not manifest to our observation. The differences are everywhere striking: the resemblances are less obvious in the fullness of their extent, and they are never contemplated without wonder by those who, in the study of anatomy and physiology, are first made aware how near is man in his physical constitution to the brutes. In all the principles of his internal structure, in the composition and functions of his parts, man is but an animal. The lord of the earth, who contemplates the eternal order of the universe, and aspires to communion with its invisible Maker, is a being composed of the same materials, and framed on the same principles, as the creatures which he has tamed to be the servile instruments of his will, or slays for his daily food. The points of resemblance are innumerable; they extend to the most recondite arrangements of that mechanism which maintains instrumentally the physical life of the body, which brings forward its early development and admits, after a given period, its decay, and by means of which is prepared a succession of similar beings destined to perpetuate the race."

It is admitted that the higher apes come nearest to man in bodily formation, and that it is essential to determine their zoological resemblances and differences as a step toward ascertaining their absolute relation in nature. "At this point," writes Professor Owen in a paper on the "Osteology of the Apes," "every deviation from the human structure indicates with precision its real peculiarities, and we then possess the true means of appreciating those modifications by which a material organism is especially adapted to become the seat and instrument of a rational and responsible soul." (On the "Osteology of the Chimpanzee and Orang Utan," in *Proc. Zool. Soc.*, vol. i.) Professor Huxley, in his *Man's Place in Nature*, comparing man with order after order of the mammalia, decides "There would remain then but one order for comparison, that of the Apes (using that word in its broadest sense), and the question for discussion would narrow itself to this—is Man so different from any of these Apes that he must form an order by himself? Or does he differ less from them than they differ from one another, and hence must take his place in the same order with them?" This anatomist states the anatomical relations between man and ape in untechnical terms suited to the present purpose, and which would be in great measure accepted by zoologists and anthropologists, whether agreeing or not with his ulterior views. The relations are most readily stated in comparison with the gorilla, as on the whole the most anthropomorphous ape. In the general proportions of the body and limbs there is a marked difference between the gorilla and man, which at once strikes the eye. The gorilla's brain-case is smaller, its trunk larger, its lower limbs shorter, its upper limbs longer in proportion than those of man. The differences between a gorilla's skull and a man's are truly immense. In the gorilla, the face, formed largely by the massive jawbones, predominates over the brain-case or cranium; in the man these proportions are reversed. In man the occipital foramen, through which passes the spinal cord, is placed just behind the center of the base of the skull, which is thus evenly balanced in the erect posture, whereas the gorilla, which goes habitually on all fours, and whose skull is inclined forward, in accordance with this posture has the foramen further back. In man the surface of the skull is comparatively smooth, and the brow-ridges project but little, while in the gorilla these ridges overhang the cavernous orbits like penthouse roofs. The absolute capacity of the cranium of the gorilla is far less than that of man; the smallest adult human cranium hardly measuring less than 63 cubic inches, while the largest gorilla cranium measured had a content of only 34½ cubic inches. The large proportional size of the facial bones, and the great projection of the jaws, confer on the gorilla's skull its small facial angle and brutal character, while its teeth differ from man's in relative size and number of fangs. Comparing the lengths of the extremities, it is seen that the gorilla's arm is of enormous length, in fact about one-sixth longer than the spine, whereas a man's arm is one-fifth shorter than the spine; both hand and foot are proportionally much longer in the gorilla than in man; the leg does not so much differ. The vertebral column of the gorilla differs from that of man in its curvature and other characters, as also does the conformation of its narrow pelvis. The hand of the gorilla corresponds essentially as to bones and muscles with that of man, but is clumsier and heavier; its thumb is "opposable" like a human thumb, that is, it can easily meet with its extremity the extremities of the other fingers, thus possessing a character which does much to make the human hand so admirable an instrument; but the gorilla's thumb is proportionately shorter than man's. The foot of the higher apes, though often spoken of as a hand, is anatomically not such, but a prehensile foot. It is argued by Professor Owen and others that the position of the great toe converts the foot of the higher apes into a hand, an extremely important distinction from man; but against this Professor Huxley maintains that it has the characteristic structure of a foot, with a very movable great toe. The external unlikeness of the apes to man depends much on their hairiness, but this and some other characteristics have no great zoological value. No doubt the difference between man and the apes depends, of all things, on the relative size and organization of the brain. While similar as to their general arrangement to the human brain, those of the higher apes, such as the chimpanzee, are much less complex in their convolutions, as well as much less both in absolute and relative weight—the weight of a gorilla's brain hardly exceeding 20 ounces and a man's brain hardly weighing less than 32 ounces, although the gorilla is considerably the larger animal of the two.

These anatomical distinctions are undoubtedly of great moment, and it is an interesting question whether they suffice to place man in a zoological order by himself. It is plain that some eminent zoologists, regarding man as absolutely differing as to mind and spirit from any other animal, have had their discrimination of mere bodily differences unconsciously sharpened, and have been led to give differences, such as in the brain or even the foot of the apes and man, somewhat more importance than if they had merely distinguished two species of apes. Among the present generation of naturalists, however, there is an evident tendency to fall in with the opinion, that the anatomical differences which separate the gorilla or chimpanzee from man are in some respects less than those which separate these man-like apes from apes lower in the scale. Yet naturalists agree to class both the higher and lower apes in the same order. This is Professor Huxley's argument, some prominent points of which are the following:—As regards the proportion of limbs, the hylobates or gibbon is as much longer in the arms than the gorilla as the gorilla is than the man, while on the other hand, it is as much longer in the legs than the man as the man is than the gorilla. As to the vertebral column and pelvis, the lower apes differ from the gorilla as much as or more than, it differs from man. As to the capacity of the cranium, men differ from one another so extremely that the largest known human skull holds nearly twice the measure of the smallest, a larger proportion than that in which man surpasses the gorilla; while, with proper allowance for difference of size of the various species, it appears that some of the lower apes fall nearly as much below the higher apes. The projection of the muzzle, which gives the character of brutality to the gorilla as distinguished from the man, is yet further exaggerated in the lemurs, as is also the backward position of the occipital foramen. In characters of such importance as the structure of the hand and foot, the lower apes diverge extremely from the gorilla; thus the thumb ceases to be opposable in the American monkeys, and in the marmosets is directed forward, and armed with a curved claw like the other digits, the great toe in these latter being insignificant in proportion. The same argument can be extended to other points of anatomical structure, and, what is of more consequence, it appears true of the brain. A series of the apes, arranged from lower to higher orders, shows gradations from a brain little higher than that of a rat, to a brain like a small and imperfect imitation of a man's; and the greatest structural break in the series lies not between man and the man-like apes, but between the apes and monkeys on one side, and the lemurs on the other. On these grounds Professor Huxley, restoring in principle the Linnean classification, desires to include man in the order of *Primates*. This order he divides into seven families: first, the *Anthropini*, consisting of man only; second, the *Catarhini*, or Old World apes; third, the *Platyrhini*, all New World apes, except the marmosets; forth, the *Arctopithecini*, or marmosets; fifth, the *Lemurini*, or lemurs; sixth and seventh, the *Cheiromyini* and *Galeopithecini*. It seems likely that, so far as naturalists are disposed to class man with other animals on purely zoological grounds, some such classification as this may, in the present state of comparative anatomy, be generally adopted.

It is in assigning to man his place in nature on psychological grounds that the greater difficulty comes into view. The same naturalist, whose argument has just been summarized against an absolute structural line of demarkation between man and the creatures next in the scale, readily acknowledges an immeasurable and practically infinite divergence, ending in the present enormous gulf between the family of apes and the family of man. To account for this intellectual chasm as possibly due to some minor structural difference, is, however, a view strongly opposed to the prevailing judgment. The opinion is deeply rooted in modern as in ancient thought, that only a distinctively human element of the highest import can account for the severance between man and the highest animal below him. Differences in the mechanical organs, such as the perfection of the human hand as an instrument, or the adaptability of the human voice to the expression of human thought, are indeed of great value. But they have not of themselves such value, that to endow an ape with the hand and vocal organs of a man would be likely to raise it through any large part of the interval that now separates it from humanity. Much more is to be said for the view that man's larger and more highly organized brain accounts for those mental powers in which he so absolutely surpasses the brutes.

The distinction does not seem to lie principally in the range and delicacy of direct sensation, as may be judged from such well-known facts as man's inferiority to the eagle in sight, or to the dog in scent. At the same time, it seems that the human sensory organs may have in various respects acuteness beyond those of other creatures. But, beyond a doubt, man possesses, and in some way possesses by virtue of his superior brain, a power of co-ordinating the impressions of his senses, which enables him to understand the world he lives in, and by understanding to use, resist, and even in a measure rule it. No human art shows the nature of this human attribute more clearly than does language. Man shares with the mammalia and birds the direct expression of the feelings by emotional tones and interjectional cries; the parrot's power of articulate utterance almost equals his own; and, by association of ideas in some measure, some of the lower animals have even learnt to recognize words he utters. But, to use words in themselves unmeaning, as symbols by which to conduct and convey the complex intellectual processes in which mental conceptions are suggested, compared, combined, and even analyzed, and new ones created—this is a faculty which is scarcely to be traced in any lower animal. The view that this, with other mental processes, is a function of the brain, is remarkably corroborated by modern investigation of the disease of aphasia, where the power of thinking remains, but the power is lost of recalling the word corresponding to the thought, and this mental defect is found to accompany a diseased state of a particular locality of the brain.* This may stand among the most perfect of the many evidences that, in Professor Bain's words, "the brain is the principal, though not the sole organ of mind." As the brains of vertebrate animals form an ascending scale, more and more approaching man's in their arrangement, the fact here finds its explanation, that lower animals perform mental processes corresponding in their nature to our own, though of generally less power and complexity. The full evidence of this correspondence will be found in such works as Brehm's *Thierleben*; and some of the salient points are set forth by Mr. Darwin, in the chapter on "Mental Powers," in his *Descent of Man*. Such are the similar effects of terror on man and the lower animals, causing the muscles to tremble, the heart to palpitate, the sphincters to be relaxed, and the hair to stand on end. The phenomena of memory, both as to persons and places, is strong in animals, as is manifest by their recognition of their masters, and their returning at once to habits disused for many years, but of which their brain has not lost the stored-up impressions. Such facts as that dogs "hunt in dreams," make it likely that their minds are not only sensible to actual events, present and past, but

* See "Diseases of Memory," by Th. Ribot, No. 46 HUMBOLDT LIBRARY.

can, like our minds, combine revived sensations into ideal scenes in which they are actors,—that is to say, they have the faculty of imagination. As for the reasoning powers in animals, the accounts of monkeys learning by experience to break eggs carefully, and pick off bits of shell, so as not to lose the contents, or of the way in which rats or martens after awhile can no longer be caught by the same kind of trap, with innumerable similar facts show in the plainest way that the reason of animals goes so far as to form by new experience a new hypothesis of cause and effect which will henceforth guide their actions. The employment of mechanical instruments, of which instances of monkeys using sticks and stones, and some other similar cases, furnish the only rudimentary traces among the lower animals, is one of the often quoted distinctive powers of man. With this comes the whole vast and ever-widening range of inventive and adaptive art, where the uniform hereditary instinct of the cell-forming bee and the nest-building bird are supplanted by multiform processes and constructions, often at first rude and clumsy in comparison to those of the lower instinct, but carried on by the faculty of improvement and new invention into ever higher stages. "From the moment," writes Mr. Wallace (*Natural Selection*, p. 325), "when the first skin was used as a covering, when the first rude spear was formed to assist in the chase, when fire was first used to cook his food, when the first seed was sown or shoot planted, a grand revolution was effected in nature, a revolution which in all the previous ages of the earth's history had had no parallel; for a being had arisen who was no longer necessarily subject to change with the changing universe,—a being who was in some degree superior to nature, inasmuch as he knew how to control and regulate her action, and could keep himself in harmony with her, not by a change in body, but by an advance of mind."

As to the lower instincts tending directly to self-preservation, it is acknowledged on all hands that man has them in a less developed state than other animals; in fact, the natural defenselessness of the human being, and the long-continued care and teaching of the young by the elders, are among the commonest themes of moral discourse. Parental tenderness and care for the young are strongly marked among the lower animals, though so inferior in scope and duration to the human qualities; and the same may be said of the mutual forbearance and defense which bind together in a rudimentary social bond the families and herds of animals. Philosophy seeking knowledge for its own sake; morality, manifested in the sense of truth, right, and virtue; and religion, the belief in and communion with superhuman powers ruling and pervading the universe, are human characters, of which it is instructive to trace, if possible, the earliest symptoms in the lower animals, but which can there show at most only faint and rudimentary signs of their wondrous development in mankind. That the tracing of physical and even intellectual continuity between the lower animals and our own race, does not necessarily lead the anthropologist to lower the rank of man in the scale of nature, cannot be better shown than by citing one of the authors of the development theory, Mr. A. R. Wallace (*op. cit.*, p. 324). Man, he considers, is to be placed "apart, as not only the head and culminating point of the grand series of organic nature, but as in some degree a new and distinct order of being."

To regard the intellectual functions of the brain and nervous system as alone to be considered in the psychological comparison of man with the lower animals, is a view satisfactory to those thinkers who hold materialistic views. According to this school, man is a machine, no doubt the most complex and wonderfully adapted of all known machines, but still neither more nor less than an instrument whose energy is provided by force from without, and which, when set in action, performs the various operations for which its structure fits it, namely, to live, move, feel, and think. This doctrine, which may be followed up from Descartes's theory of animal life into the systems of modern writers of the school of Moleschott and Büchner, underlies the *Lectures on Man* of Professor Carl Vogt, one of the ablest of modern anthropologists (English translation published by Anthropological Society, London, 1864). Such views, however, always have been and are strongly opposed by those who accept on theological grounds a spiritualistic doctrine, or what is, perhaps, more usual, a theory which combines spiritualism and materialism in the doctrine of a composite nature in man, animal as to the body and in some measure as to the mind, spiritual as to the soul. It may be useful, as an illustration of one opinion on this subject, to continue here from an earlier page the citation of Dr. Prichard's comparison between man and the lower animals:—

"If it be inquired in what the still more remarkable difference consists, it is by no means easy to reply. By some it will be said that man while similar in the organization of his body to the lower tribes, is distinguished from them by the possession of an immaterial soul, a principle capable of conscious feeling, of intellect and thought. To many persons it will appear paradoxical to ascribe the endowment of a soul to the inferior tribes in the creation, yet it is difficult to discover a valid argument that limits the possession of an immaterial principle to man. The phenomena of feeling, of desire and aversion, of love and hatred, of fear and revenge, and the perception of external relations manifested in the life of brutes, imply, not only through the analogy which they display to the human faculties, but likewise from all that we can learn or conjecture of their particular nature, the superadded existence of a principle distinct from the mere mechanism of material bodies. That such a principle must exist in all beings capable of sensation, or of anything analogous to human passions and feelings, will hardly be denied by those who perceive the force of arguments which metaphysically demonstrate the immaterial nature of the mind. There may be no rational grounds for the ancient dogma that the souls of the lower animals were imperishable, like the soul of man; this is, however, a problem which we are not called upon to discuss; and we may venture to conjecture that there may be immaterial essences of divers kinds, and endowed with various attributes and capabilities. But the real nature of these unseen principles eludes our research: they are only known to us by their external manifestations. These manifestations are the various powers and capabilities, or rather the habitudes of action, which characterize the different orders of being, diversified according to their several destinations."

Dr. Prichard here puts forward distinctly the time-honored doctrine which refers the mental faculties to the operation of the soul. The view maintained by a distinguished comparative anatomist, Professor Mivart, in his *Genesis of Species*, ch. xii., may fairly follow. "Man, according to the old scholastic definition, is 'a rational animal' (*animal rationale*), and his animality is distinct in nature from his rationality, though inseparably joined, during life, in one common personality. Man's animal body must have had a different source from that of the spiritual soul which informs it, owing to the distinctness of the two orders to which those two existences severally belong." Not to pursue into its details a doctrine which has its place rather in a theological than an anthropological article, it remains to be remarked that the two extracts just given, however significant in themselves, fail to render an account of the view of the human constitution which would probably, among the theological and scholastic leaders of public opinion, count the largest weight of adherence. According to this view, not only life but thought are functions of the animal system, in which man excels all other animals as to height of organization; but beyond this, man embodies an immaterial and immortal spiritual principle which no lower creature possesses, and which makes the resemblance of the apes to him but a mocking simulance. To pronounce any absolute decision on these conflicting doctrines is foreign to our present purpose, which is to show that all of them count among their adherents men of high rank in science.

III. ORIGIN OF MAN.

AVAILABLE information on this great problem has been multiplied tenfold during the present generation, and the positive dicta of the older authorities are now more and more supplanted by hypotheses based on biological evidence. Opinion as to the genesis of man is divided between the theories of the two great schools of biology, that of creation and that of evolution. In both schools the ancient doctrine of the contemporaneous appearance on earth of all species of animals having been abandoned under the positive evidence of geology, it is admitted that the animal kingdom, past and present, includes a vast series of successive forms, whose appearances and disappearances have taken place at intervals during an immense lapse of ages. The line of inquiry has thus been directed to ascertaining what formative relation subsists among these species and genera, the last link of the argument reaching to the relation between man and the lower creatures preceding him in time. On both the theories here concerned it would be admitted, in the words of Agassiz (*Principles of Zoology*, pp. 205–6), that "there is a manifest progress in the succession of beings on the surface of the earth. This progress consists in an increasing similarity of the living fauna, and, among the vertebrates especially, in their increasing resemblance to man." Agassiz continues, however, in terms characteristic of the creationist school: "But this connection is not the consequence of a direct lineage between the faunas of different ages. There is nothing like parental descent connecting them. The fishes of the Palæozoic age are in no respect the ancestors of the reptiles of the Secondary age, nor does man descend from the mammals which preceded him in the Tertiary age. The link by which they are connected is of a higher and immaterial nature; and their connection is to be sought in the view of the Creator himself, whose aim in forming the earth, in allowing it to undergo the successive changes which geology has pointed out, and in creating successively all the different types of animals which have passed away, was to introduce man upon the surface of our globe. Man is the end toward which all the animal creation has tended from the first appearance of the first Palæozoic fishes." The evolutionist school, on the contrary, maintains that different successive species of animals are in fact connected by parental descent, having become modified in the course of successive generations. Mr. Darwin, with whose name and that of Mr. Wallace the modern development theory is especially associated, in the preface to his *Descent of Man* (1871), gives precedence among naturalists to Lamarck, as having long ago come to the conclusion "that man is the co-descendant with other species of some ancient, lower, and extinct form." Professor Huxley, remarking (*Man's Place in Nature*) on the crudeness and even absurdity of some of Lamarck's views, dates from Darwin the scientific existence of the development theory. The result of Darwin's application of this theory to man may be given in his own words (*Descent of Man*, part i. ch. 6):—

> "The Catarhine and Platyrhine monkeys agree in a multitude of characters, as is shown by their unquestionably belonging to one and the same Order. The many characters which they possess in common can hardly have been independently acquired by so many distinct species; so that these characters must have been inherited. But an ancient form which possessed many characters common to the Catarhine and Platyrhine monkeys, and others in an intermediate condition, and some few perhaps distinct from those now present in either group, would undoubtedly have been ranked, if seen by a naturalist, as an ape or a monkey. And as man under a genealogical point of view belongs to the Catarhine or Old World stock, we must conclude, however much the conclusion may revolt our pride, that our early progenitors would have been properly thus designated. But we must not fall into the error of supposing that the early progenitor of the whole Simian stock, including man, was identical with, or even closely resembled, any existing ape or monkey."

The problem of the origin of man cannot be properly discussed apart from the full problem of the origin of species. The homologies between man and other animals which both schools try to account for; the explanation of the intervals, with apparent want of intermediate forms, which seem to the creationists so absolute a separation between species; the evidence of useless "rudimentary organs," such as in man the external shell of the ear, and the muscle which enables some individuals to twitch their ears, which rudimentary parts the evolutionists claim to be only explicable as relics of an earlier specific condition,—these, which are the main points of the argument on the origin of man, belong to general biology. The philosophical principles which underlie the two theories stand for the most part in strong contrast, the theory of evolution tending toward the supposition of ordinary causes, such as "natural selection," producing modifications in species, whether by gradual accumulation or more sudden leaps, while the theory of creation is prone to have recourse to acts of supernatural intervention (see the Duke of Argyll, *Reign of Law*, ch. v.). A theory has been propounded by Mr. Mivart (*Genesis of Species*, 1871) of a natural evolution of man as to his body, combined with a supernatural creation as to his soul; but this attempt to meet the difficulties on both sides seems at present not to have satisfied either. Anthropology waits to see whether the discovery of intermediate forms, which has of late years reduced so many asserted species to mere varieties, will go on till it produces a disbelief in any real separation between neighboring species, and especially whether geology can furnish traces of the hypothetical animal, man's near ancestor, but not as yet man. In the present state of the argument it may here suffice to have briefly indicated the positions held on either side. (Among other works relating to the development theory as applied to man, see Vogt, *Lectures on Man*; Haeckel, *Natürliche Schöpfungsgeschichte*, 2d ed., 1871.

IV. RACES OF MANKIND.

The classification of mankind into a number of permanent varieties or races, rests on grounds which are within limits not only obvious but definite. Whether from a popular or a scientific point of view, it would be admitted that a Negro, a Chinese, and an Australian, belong to three such permanent varieties of men, all plainly distinguishable from one another and from any European. Moreover, such a division takes for granted the idea which is involved in the word race, that each of these varieties is due to special ancestry, each race thus representing an ancient breed or stock, however these breeds or stocks may have had their origin. The anthropological classification of mankind is thus zoological in its nature, like that of the varieties or species of any other animal group, and the characters on which it is based are in great measure physical, though intellectual and traditional peculiarities, such as moral habit and language, furnish important aid. Among the best-marked race-characters are the following:—

The color of the skin has always been held as specially distinctive. The colored race-portraits of ancient Egypt remain to prove the permanence of complexion during a lapse of a hundred generations, distinguishing coarsely but clearly the types of the red-brown Egyptian, the yellow-brown Canaanite, the comparatively fair Libyan, and the Negro (see Wilkinson, *Ancient Eg.*; Brugsch, *Geogr. Inschr. Altägypt. Denkm.*, vol. ii.) These broad distinctions have the same kind of value as the popular terms describing white, yellow, brown, and black races, which often occur in ancient writings, and are still used. But for scientific purposes greater accuracy is required, and this is now satisfactorily attained by the use of Dr. Broca's graduated series of colors as a standard (*Mémoires de la Société d'Anthropologie de Paris*, ii.). By this table the varieties of the human skin may be followed from the fairest hue of the Swede and the darker tint of the Provençal, to the withered-leaf brown of the Hottentot, the chocolate brown of the Mexican, and the brown-black of the West-African. The color of the eyes and hair is also to be defined accurately by Broca's table. This affords, however, less means of distinction, from the extent in which dark tints of hair and iris are common to races whose skins are more perceptibly different; yet some varieties are characteristic, such as the blue eyes and flaxen hair of the fair race of Northern Europe.

As to the hair, its structure and arrangement is a better indication of race than its tint. The hair differs in quantity between scantiness on the body of the Mongul and profusion on the body of the Aino; while as to the arrangement on the scalp, the tufts of the Bushman contrast with the more equal distribution on the European head. The straight hair of the North American or Malay is recognizable at once as different from the waving or curling hair of the European and both from the naturally frizzed hair of the Negro. These marked differences are due to the structure of the hair, which, examined in sections under the microscope, varies from the circular section proper to the straight-haired races, to the more or less symmetrically oval or reniform sections belonging to races with curled and twisted hair (see Pruner-Bey in *Mém. de la Soc. Anthrop.*, vol. ii.).

Stature is by no means a general criterion of race, and it would not, for instance, be difficult to choose groups of Englishmen, Kafirs, and North American Indians, whose mean height should hardly differ. Yet in many cases it is a valuable means of distinction, as between the tall Patagonians and the stunted Fuegians, and even as a help in minuter problems, such as separating the Teutonic and Keltic ancestry in the population of England (see Beddoe, "Stature and Bulk of Man in the British Isles," in *Mem. Anthrop. Soc. London*, vol. iii.). Proportions of the limbs, compared in length with the trunk, have been claimed as constituting peculiarities of African and American races; and other anatomical points, such as the conformation of the pelvis, have speciality. But inferences of this class have hardly attained to sufficient certainty and generality to be set down in the form of rules.

The conformation of the skull is second only to the color of the skin as a criterion for the distinction of race. The principal modes of estimating the differences of skulls are the following:—The skull being seen from above, the proportions of the two diameters are estimated on the principle employed by Retzius: taking the longer diameter from front to back as 100, if the shorter or cross diameter falls below 80, the skull may be classed as long (dolichocephalic); while if it exceeds 80, the skull may be classed as broad (brachycephalic); or a third division may be introduced between these as intermediate (Mesocephalic), comprehending skulls with a proportionate breadth of 75 to 80, or thereabout. The percentage of breadth to length measured in this manner is known as the cephalic index; thus, the cephalic index of a Negro or Australian may be as low as 72, and that of a Tatar as high as 88, while the majority of Europeans have an index not departing in either direction very far from 78. The cephalic height is measured in the same way as a percentage of the length. The back view (norma occipitalis) of the skull is distinguished as rounded, pentagonic, etc., and the base view of the skull shows the position of the occipital foramen and the zygomatic arches. The position of the jaws is recognized as important, races being described as prognathous when the jaws project far, as in the Australian or Negro, in contradistinction to the orthognathous type, which is that of the ordinary well-shaped European skull. On this distinction in great measure depends the celebrated "facial angle," measured by Camper as a test of low and high races; but this angle is objectionable as resulting partly from the development of the forehead and partly from the position of the jaws. The capacity of the cranium is estimated in cubic measure by filling it with sand, etc., with the general result that the civilized white man is found to have a larger brain than the barbarian or savage.

Classification of races on cranial measurements has long been attempted by eminent anatomists, such as Blumenbach and Retzius, while the later labors of Von Baer, Welcker, Davis, Broca, Busk, Lucae, and many others, have brought the distinctions to extreme minuteness. In certain cases great reliance may be placed on such measurements. Thus the skulls of an Australian and a Negro would be generally distinguished by their narrowness and the projection of the jaw from that of any Englishman; while, although both the Australian and Negro are thus dolichocephalic and prognathous, the first would usually differ perceptibly from the second in its upright sides and strong orbital ridges. The relation of height to breadth may furnish a valuable test; thus both the Kafir and the Bushman are dolichocephalic, with an index of about 72, but they differ in the index of height, which may be 73 and 71 respectively, in the one case more than the width and in the other less. It is, however, acknowledged by all experienced craniologists, that the shape of the skull may vary so much within the same tribe, and even the same family, that it must be used with extreme caution, and if possible only in conjunction with other criteria of race.

The general contour of the face, in part dependent on the form of the skull, varies much in different races, among whom it is loosely defined as oval, lozenge-shaped, pentagonal, etc. Of particular features, some of the most marked contrasts to European types are seen in the oblique Chinese eyes, the broad-set Kamchadal cheeks, the pointed Arab chin, the snub Kirghis nose, the fleshy protuberant Negro lips, and the broad Kalmuk ear. Taken altogether, the features have a typical character which popular observation seizes with some degree of correctness, as in the recognition of the Jewish countenance in a European city.

The state of adaptation in which each people stands to its native climate forms a definite race-character. In its extreme form this is instanced in the harmful effect of the climate of India on children of European parents, and the corresponding danger in transporting natives of tropical climates to England. Typical instances of the trelation of race-constitutions to particular diseases are seen in the liability of Europeans in the West Indies to yellow fever, from which Negroes are exempt, and in the habitation by tribes in India of so-called "unhealthy districts," whose climate is deadly to Europeans, and even to natives of neighboring regions. Even the vermin infesting different races of men are classified by Mr. A. Murray (*Trans. R. Soc. Edin.*, vol. xxii.) as distinct.

The physical capabilities of different races are known to differ widely, but it is not easy to discriminate here between hereditary race-differences and those due to particular food and habit of life. A similar difficulty has hitherto stood in the way of any definite classification of the emotional, moral, and intellectual characters of races. Some of the most confident judgments which have been delivered on this subject have been dictated by prejudice or wilful slander, as in the many lamentable cases in which slaveholders and conquerors have excused their ill-treatment of subject and invaded races on the ground of their being creatures of bestial nature in mind and morals. Two of the best-marked contrasts of mental type recorded among races are Mr. A. R. Wallace's distinction between the shy, reserved, and impassive Malay and the sociable and demonstrative Papuan (*Tr. Eth. Soc.*, vol iii. p. 200), and the very similar difference pointed out by Spix and Martius between the dull and morose natives of the Brazilian forests, and the lively sensuous African Negroes brought into contact with them (*Reise in Brasilien*, vol. i.) In general, however, descriptions of national or racial character are so vitiated by the confusion of peculiarity of natural character with stage of civilization, that they can only be made use of with the greatest reserve.

The relation of language to race is discussed below. (Section VI.)

Were the race-characters indicated in the foregoing paragraphs constant in degree or even in kind, the classification of races would be an easy task. In fact it is not so, for every division of mankind presents in every character wide deviations from a standard. Thus the Negro race, well marked as it may seem at the first glance, proves on closer examination to include several shades of complexion and features, in some districts varying far from the accepted Negro type; while the examination of a series of native American tribes shows that, notwithstanding their asserted uniformity of type, they differ in stature, color, features, and proportions of skull. (See Prichard, *Nat. Hist. of Man;* Waitz, *Anthropology*, part i. sec. 5.). Detailed anthropological research, indeed, more and more justifies Blumenbach's words, that "innumerable varieties of mankind run into one another by insensible degrees." This state of things, due partly to mixture and crossing of races, and partly to independent variation of types, makes the attempt to arrange the whole human species within exactly bounded divisions an apparently hopeless task. It does not follow, however, that the attempt to distinguish special races should be given up, for there at least exist several definable types, each of which so far prevails in a certain population as to be taken as its standard. M. Quetelet's plan of defining such types will probably meet with general acceptance as the scientific method proper to this branch of anthropology. It consists in the determination of the standard, or typical "mean man" (*homme moyen*) of a population, with reference to any particular quality, such as stature, weight, complexion, etc. In the case of stature, this would be done by measuring a sufficient number of men, and counting how many of them belong to each height on the scale. If it be thus ascertained, as it might be in an English district, that the 5 ft. 7 in. men form the most numerous group, while the 5 ft. 6 in. and 5 ft. 8 in. men are less in number, and the 5 ft. 5 in. and 5 ft. 9 in. still fewer, and so on until the extremely small number of extremely short or tall individuals of 5 ft. or 7 ft. is reached, it will thus be ascertained that the stature of the mean or typical man is to be taken as 5 ft. 7 in. The method is thus that of selecting as the standard the most numerous group, on both sides of which the groups decrease in number as they vary in type. Such classification may show the existence of two or more types in a community, as, for instance, the population of a Californian settlement made up of Whites and Chinese might show two predominant groups (one of 5 ft. 8 in., the other of 5 ft. 4 in.) corresponding to these two racial types. It need hardly be said that this method of determining the mean type of a race, as being that of its really existing and most numerous class, is altogether superior to the mere calculation of an average, which may actually be represented by comparatively few individuals, and those the exceptional ones. For instance, the average stature of the mixed European and Chinese population just referred to might be 5 ft. 6 in.—a worthless and, indeed, misleading result. (For particulars of Quetelet's method, see his *Physique Sociale*, 1869, and *Anthropométrie*, 1870.) The measurement and description of the various races of men are now carried to great minuteness (the tables in Scherzer and Schwarz, *Reise der Novara*, and those of Fritsch, *Die Eingeborenen Süd-Afrika's*, 1872, may be cited as examples of modern method), so that race-classification is rapidly improving as to both scope and accuracy. Even where comparatively loose observations have been made, it is possible, by inspection of considerable numbers of individuals, to define the prevalent type of a race with tolerable approximation to the real mean or standard man. It is in this way that the subdivision of mankind into races, so far as it has been done to any purpose, has been carried out by anthropologists.

These classifications have been numerous, and though, regarded as systems, most of them are now seen at the first glance to be unsatisfactory, yet they have been of great value in systematizing knowledge, and are all more or less based on indisputable distinctions. Blumenbach's division, though published nearly a century ago (1781), has had the greatest influence. He reckons five races, viz., Caucasian, Mongolian, Ethiopian, American, Malay (see the collected edition of his *Treatises*, p. 264, published by the Anthropological Society). The ill-chosen name of Caucasian, used by Blumenbach to denote what may be called white men, is still current; it brings into one race peoples such as the Arabs and Swedes, although these are scarcely less different than the Americans and Malays, who are set down as two distinct races. Again, two of the best-marked varieties of mankind are the Australians and the Bushmen, neither of whom, however, seem to have a natural place in Blumenbach's series. The yet simpler classification by Cuvier into Caucasian, Mongol, and Negro, corresponds in some measure with a division by mere complexion into white, yellow, and black races; but neither this threefold division, nor the ancient classification into Semitic, Hamitic, and Japhetic nations can be regarded as separating the human types either justly or sufficiently (see Prichard, *Natural History of Man*, sec. 15; Waitz, *Anthropology*, vol. i. part i. sec. 5). Schemes which set up a larger number of distinct races, such as the eleven of Pickering, the fifteen of Bory de St. Vincent, and the sixteen of Desmoulins, have the advantage of finding niches for most well-defined human varieties; but no modern naturalist would be likely to adopt any one of these as it stands. In criticism of Pickering's system, it is sufficient to point out that he divides the white nations into two races, entitled the Arab and the Abyssinian (Pickering, *Races of Man*, chap. i.) Agassiz, Nott, Crawfurd, and others who have assumed a much larger number of races or species of man, are not considered to have satisfactorily defined a corresponding number of distinguishable types. On the whole, Professor Huxley's recent scheme (*Journal of the Ethnological Society*, vol. ii. p. 404, 1870) probably approaches more nearly than any other to such a tentative classification as may be accepted in definition of the principal varieties of mankind, regarded from a zoological point of view, though anthropologists may be disposed to erect into separate races several of his widely-differing subraces. He distinguishes four principal types of mankind, the Australioid, Negroid, Mongoloid, and Xanthochroic, adding a fifth variety, the Melanochroic.

The special points of the Australioid are a chocolate-brown skin, dark brown or black eyes, black hair (usually wavy), narrow (dolichocephalic) skull, brow-ridges strongly developed, projecting jaw, coarse lips, and broad nose. This type is best represented by the natives of Australia, and next to them, by the indigenous tribes of Southern India, the so-called coolies. The Egyptians to some degree approach this type; they are, however, held by good authorities to be a modified African race.

The Negroid type is primarily represented by the Negro of Africa, between the Sahara and the Cape district, including Madagascar. The skin varies from dark brown to brown-black, with eyes of similar dark hue, and hair usually black, and always crisp or woolly. The skull is narrow (dolichocephalic), with orbital ridges not prominent, prognathous, with depressed nasal bones, causing the nose to be flat as well as broad; and the lips are coarse and projecting. Two important families are classed in this system as special modifications of the Negroid type. First, the Bushman of South Africa is diminutive in stature, and of yellowish-brown complexion; the Hottentot is supposed to be the result of crossing between the Bushman and ordinary Negroid. Second, the Negritos of the Andaman Islands, the peninsula of Malacca, the Philippines and other islands, to New Caledonia and Tasmania, are mostly dolichocephalic, with dark skins and woolly hair. In various districts they tend toward other types, and show traces of mixture.

The Mongoloid type prevails over the vast area lying east of a line drawn from Lapland to Siam. Its definition includes a short, squat build, a yellowish brown complexion, with black eyes and black straight hair, a broad (brachycephalic) skull, usually without prominent brow-ridges, flat small nose, and oblique eyes. The dolichocephalic Chinese and Japanese in other respects correspond. Various other important branches of the human species are brought into connection with the Mongoloid type, though on this view the differences they present raise difficult problems of gradual variation, as well as of mixture of race; these are the Dyak-Malys, the Polynesians, and the Americans.

The Xanthochroi, or fair whites—tall, with almost colorless skin, blue or gray eyes, hair from straw color to chestnut, and skulls varying as to proportionate width—are the prevalent inhabitants of Northern Europe, and the type may be traced into North Africa, and eastward as far as Hindostan. On the south and west it mixes with that of the Melanochroi, or dark whites, and on the north and east with that of the Mongoloids.

The Melanochroi, or dark whites, differ from the fair whites in the darkening of the complexion to brownish and olive, and of the eyes and hair to black, while the stature is somewhat lower and the frame lighter. To this class belong a large part of those classed as Kelts, and of the populations of Southern Europe, such as Spaniards, Greeks, and Arabs, extending as far as India; while endless intermediate grades between the two white types testify to ages of intermingling. Professor Huxley is disposed to account for the Melanochroi as themselves the result of crossing between the Xanthochroi and the Australioids. Whatever ground there may be for his view, it is obviously desirable to place them in a class by themselves, distinguishing them by an appropriate name.

In determining whether the races of mankind are to be classed as varieties of one species, it is important to decide whether every two races can unite to produce fertile offspring. It is settled by experience that the most numerous and well-known crossed races, such as the Mulattos, descended from Europeans and Negroes—the Mestizos, from Europeans and American indigenes—the Zambos, from these American indigenes, and Negroes, etc., are permanently fertile. They practically constitute sub-races, with a general blending of the characters of the two parents, and only differing from fully established races in more or less tendency to revert to one or other of the original types. It has been argued, on the other hand, that not all such mixed breeds are permanent, and especially that the cross between Europeans and Australian indigenes is almost sterile; but this assertion, when examined with the care demanded by its bearing on the general question of hybridity, has distinctly broken down. On the whole, the general evidence favors the opinion that any two races may combine to produce a new sub-race, which again may combine with any other variety. (See Waitz, *Anthropology*, vol. i. part i. sec. 3; Darwin, *Descent of Man*, part i. ch. 7; Prichard, *Nat. Hist. of Man*, sect. 5; on the other hand, Broca, *Phenomena of Hybridity in the Genus Homo*, 1864.) Thus, if the existence of a small number of distinct races of mankind be taken as a starting-point, it is obvious that their crossing would produce an indefinite number of secondary varieties, such as the population of the world actually presents. The working out in detail of the problem, how far the differences among complex nations, such as those of Europe, may have been brought about by hybridity, is still, however, a task of almost hopeless intricacy. Among the boldest attempts to account for distinctly-marked populations as resulting from the intermixture of two races, are Professor Huxley's view that the Hottentots are hybrid between the Bushmen and the Negroes, and his more important suggestion, that the Melanochroic peoples of Southern Europe are of mixed Xanthochroic and Australioid stock.

The problem of ascertaining how the small number of races, distinct enough to be called primary, can have assumed their different types, has been for years the most disputed field of anthropology, the battle-ground of the rival schools of monogenists and polygenists. The one has claimed all mankind to be descended from one original stock, and generally from a single pair; the other has contended for the several primary races being separate species of independent origin. It is not merely as a question of natural history that the matter has been argued. Biblical authority has been appealed to, mostly on the side of the monogenists, as recording the descent of mankind from a single pair. (See, for example, Horne's *Introduction to the Scriptures;* the Speaker's Commentary, Gen. i.) On the other hand, however, the polygenists not less confidently claim passages from which they infer the existence of non-Adamite, as well as Adamite races of man. (See, for example, R. S. Poole, *Genesis of the Earth and Man.*) Nor have political considerations been without influence, as where, for instance, one American school of ethnologists have been thought to have formed, under the bias of a social system recognizing slavery, their opinion that the Negro and the white man are of different species. (See Morton, *Crania Americana*; Nott and Gliddon, *Types of Mankind.*) Of the older school of scientific monogenists, Blumenbach and Prichard are eminent representatives, as is Quatrefages of the more modern. The great problem of the monogenist theory is to explain by what course of variation the so different races of man have arisen from a single stock. In ancient times little difficulty was felt in this, authorities such as Aristotle and Vitruvius seeing in climate and circumstance the natural cause of racial differences, the Ethiopian having been blackened by the tropical sun, etc. Later and closer observations, however, have shown such influences to be, at any rate, far slighter in amount and slower in operation than was once supposed. M. de Quatrefages brings forward (*Unité de l'Espèce Humaine*, Paris, 1861, ch. 13) his strongest arguments for the variability of races under change of climate, etc., (*action du milieu*,) instancing the asserted alteration in complexion, constitution, and character of Negroes in America, and Englishmen in America and Australia. But although the reality of some such modification is not disputed, especially as to stature and constitution, its amount is not enough to upset the counter-proposition of the remarkable permanence of type displayed by races ages after they have been transported to climates extremely different from that of their former home. Moreover, physically different races, such as the Bushmen and Negroids in Africa, show no signs of approximation under the influence of the same climate; while, on the other hand, the coast tribes of Tierra del Fuego and forest tribes of tropical Brazil continue to resemble one another, in spite of extreme differences of climate and food. Mr. Darwin, than whom no naturalist could be more competent to appraise the variation of a species, is moderate in his estimation of the changes produced on races of man by climate and mode of life within the range of history (*Descent of Man*, part i. ch. 4 and 7). The slightness and slowness of variation in human races having become known, a great difficulty of the monogenist theory was seen to lie in the shortness of the chronology with which it was formerly associated. Inasmuch as several well-marked races of mankind, such as the Egyptian, Phœnician, Ethiopian, etc., were much the same three or four thousand years ago as now, their variation from a single stock in the course of any like period could hardly be accounted for without a miracle. This difficulty was escaped by the polygenist theory, which, till a few years since, was gaining ground. (See Pouchet, *Plurality of the Human Race*, 2d ed., 1864, Introd.) Two modern views have, however, intervened which have tended to restore, though under a new aspect, the doctrine of a single human stock. One has been the recognition of man having existed during a vast period of time (see sec. IV., *Antiquity of Man*), which made it more easy to assume the continuance of very slow natural variation as having differenced even the white man and the Negro among the decendants of a common progenitor. The other view is that of the evolution or development of species, at the present day so strongly upheld among naturalists. It does not follow necessarily from a theory of evolution of species that mankind must have descended from a single stock, for the hypothesis of development admits of the argument, that several simious species may have culminated in several races of man (Vogt, *Lectures on Man*, London, 1864, p. 463). The general tendency of the development theory, however, is against constituting separate species where the differences are moderate enough to be accounted for as due to variation from a single type. Mr. Darwin's summing up of the evidence as to unity of type throughout the races of mankind is as distinctly a monogenist argument as those of Blumenbach, Prichard, or Quatrefages—

"Although the existing races of man differ in many respects, as in color, hair, shape of skull, proportions of the body, etc., yet, if their whole organization be taken in consideration they are found to resemble each other closely in a multitude of points. Many of these points are of so unimportant, or of so singular a nature, that it is extremely improbable that they should have been independently acquired by aboriginally distinct species or races. The same remark holds good with equal or greater force with respect to the numerous points of mental similarity between the most distinct races of man. . . . Now, when naturalists observe a close agreement in numerous small details of habits, tastes, and dispositions between two or more domestic races, or between nearly allied natural forms, they use this fact as an argument that all are descended from a common progenitor, who was thus endowed; and, consequently, that all should be classed under the same species. The same argument may be applied with much force to the races of man."—(Darwin, *Descent of Man*, part i. ch. 7.)

A suggestion by Mr. A. R. Wallace has great importance in the application of the development theory to the origin of the various races of man; it is aimed to meet the main difficulty of the monogenist school, how races which have remained comparatively fixed in type during the long period of history, such as the white man and the Negro, should have, in even a far longer period, passed by variation from a common original. Mr. Wallace's view is substantially that the remotely ancient representatives of the human species, being as yet animals too low in mind to have developed those arts of maintenance and social ordinances by which man holds his own against influences from climate and circumstance, were in their then wild state much more plastic than now to external nature; so that "natural selection" and other causes met with but feeble resistance in forming the permanent varieties or races of man, whose complexion and structure still remain fixed in their descendants. (See Wallace, *Contributions to the Theory of Natural Selection*, p. 319.) On the whole, it may be asserted that the doctrine of the unity of mankind now stands on a firmer basis than in previous ages. It would be premature to judge how far the problem of the origin of races may be capable of exact solution; but the experience of the last few years countenances Mr. Darwin's prophecy, that before long the dispute between the monogenists and the polygenists will die a silent and unobserved death.

V. ANTIQUITY OF MAN.

It was until of late years commonly held among the educated classes, that man's first appearance on earth might be treated on a historical basis as matter of record. It is true that the schemes drawn up by chronologists differed widely, as was naturally the case, considering the variety and inconsistenty of their documentary data. On the whole, the scheme of Archbishop Usher, who computed that the earth and man were created in 4004 B.C., was the most popular. It is no longer necessary, however, to discuss these chronologies, inasmuch as new evidence has so changed the aspect of the subject, that the quasi-historical schemes of the last century would now hardly be maintained by any competent authority of any school. Geology, notwithstanding the imperfection of its results, has made it manifest that our earth must have been the seat of vegetable and animal life for an immense period of time; while the first appearance of man, though comparatively recent, is positively so remote, that an estimate between twenty and a hundred thousand years may fairly be taken as a minimum. This geological claim for a vast antiquity of the human race is supported by the similar claims of prehistoric archæology and the science of culture, the evidence of all three departments of inquiry being intimately connected, and in perfect harmony.

During the last half century, the fact has been established that human bones and objects of human manufacture occur in such geological relation to the remains of fossil species of elephant, rhinoceros, hyæna, bear, etc., as to lead to the distinct inference that man already existed during the ancient period of these now extinct mammalia. The not quite conclusive researches of MM. Tournal and Christol in limestone caverns of the south of France date back to 1828. About the same time Dr. Schmerling of Liége was exploring the ossiferous caverns of the valley of the Meuse, and satisfied himself that the men whose bones he found beneath the stalagmite floors, together with bones cut and flints shaped by human workmanship, had inhabited this Belgian district at the same time with the cave-bear and several other extinct animals whose bones were imbedded with them (*Recherches sur les Ossements fossiles découverts dans les Cavernes de la Province de Liége*, Liége, 1833–34). This evidence, however, met with little acceptance among scientific men. Nor, at first, was more credit given to the discovery by M. Boucher de Perthes, about 1841, of rude flint hatchets in a sand-bed containing remains of mammoth and rhinoceros at Menchecourt near Abbeville, which first find was followed by others in the same district (see Boucher de Perthes, *De l'Industrie Primitive, ou les Arts à leur Origine*, 1846; *Antiquités Celtiques et Antédiluviennes*, Paris, 1847, etc.); between 1850 and 1860 competent French and English geologists, among them Rigollot, Falconer, Prestwich, and Evans, were induced to examine into the facts, and found the evidence irresistible that man existed and used rude implements of chipped flint during the Quaternary or Drift period. Further investigations were now made, and overlooked results of older ones reviewed. In describing Kent's Hole, near Torquay, Mr. Godwin-Austen had maintained, as early as 1840 (*Proc. Geo. Soc. London*, vol. iii. p. 286), that the human bones and worked flints had been deposited indiscriminately together with the remains of fossil elephant, rhinoceros, etc.; a minute exploration of this cavern has since been carried on under the superintendence of Messrs. Vivian, Pengelly, and others, fully justifying Mr. Godwin-Austen's early remark, that "there is no *a priori* reason why man and the several animals whose remains occur in caves and in gravel should not have lived here at some remote time" (see Pengelly, "Literature of Kent's Cavern," in *Trans. Devonshire Association*, 1868). Especially certain caves and rock-shelters in the province of Dordogne, in central France, were examined by a French and an English archæologist, Mons. Edouard Lartet and Mr. Henry Christy, the remains discovered showing the former prevalence of the rein-deer in this region, at that time inhabited by savages, whose bone and stone implements indicate a habit of life similar to that of the Esquimaux. Moreover, the co-existence of man with a fauna now extinct or confined to other districts was brought to yet clearer demonstration, by the discovery in these caves of certain drawings and carvings of the animals done by the ancient inhabitants themselves, such as a group of rein-deer on a piece of rein-deer horn, and a sketch of a mammoth, showing this elephant's long hair, on a piece of a mammoth's tusk from La Madeleine (Lartet and Christy, *Reliquiæ Aquitanicæ*, ed. by T. R. Jones, London, 1865, etc.). These are among the earliest and principal of a series of discoveries of human relics belonging to what may be termed geological antiquity, with which should be mentioned Mr. Boyd Dawkins's examination of the hyæna den of Wokey Hole, Dr. Lund's researches in the caves of Brazil, those in the south of France by the Marquis de Vibraye and MM. Garrigou and Filhol, those in Sicily by Dr. Falconer, and Mr. Bruce Foote's discovery of rude quartzite implements in the laterite of India. Fuller details of the general subject will be found in Sir C. Lyell's *Antiquity of Man*, 4th ed., London, 1873; Sir John Lubbock's *Prehistoric Times*, 3d ed., London, 1873; Dr. H. Falconer's *Palæontological Memoirs*, London, 1868; the volumes of *Proceedings of the International Congress of Prehistoric Archæology;* and the periodical *Matériaux pour l'Histoire Primitive et Naturelle de l'Homme*, edited at first by De Mortillet, and since by Trutat and Cartailhac.

This evidence is now generally accepted by geologists as carrying back the existence of man into the period of the post-glacial drift, in what is now called the Quaternary period. That this indicates an antiquity at least of tens of thousands of years may be judged in several ways. The very position in which these rude instruments were found showed that they belonged to a time quite separate from that of history. Thus, at St. Acheul flint hatchets occur in a gravel-bed immediately overlying the chalk, which bed is covered by some 12 feet of sand and marl, capped by a layer of soil, which is shown by graves of the Gallo-Roman period to have been hardly altered during the last 1500 years. This distinction between the drift deposits and those containing relics of historic ages is, as a general rule evident at a glance. Next, the succession of ages to which different classes of remains belong is well marked; the drift implements belong to the palæolithic or old stone age, when as yet the implements were extremely rude, and not ground or polished; above these in deposit, and therefore later in time, come the artistically shaped and polished celts of the neolithic or new stone age; above these, again, relics of the bronze and early iron ages, with which historical antiquity in Europe begins. Again, the animals of the Quaternary period, whose bones are found with the rude stone implements, comprise several species of mammalia which have since become extinct, such as the mammoth, the hairy rhinoceros, and the Irish elk, while others, such as the rein-deer and musk-ox, now only inhabit remote districts. It is generally considered that such a fauna indicates, at any rate during part of the Quaternary period, a severer climate than now prevails in France and England. This difference from the present conditions seems to confirm the view, that the twenty centuries of French and English history form but a fraction of the time which has elapsed since the stone implements of prehistoric tribes were first buried under beds of gravel and sand by the rivers now represented by the Thames or the Somme. Still vaster, however, is the idea of antiquity suggested by the geographical conformation of such valleys as those in which these rivers flow. The drift-beds lie on their sides often 100 to 200 feet, and even more, above the present flood-levels. As such highest deposits seem to mark the time when the rivers flowed at heights so far above the present channels, it follows that the drift-beds, and the men whose works they enclose, must have existed during a great part of the time occupied by the rivers in excavating their valleys down to their present beds. Granting it as possible that the rivers by which this enormous operation was performed were of greater volume and proportionately still greater power in flood-time than the present streams, which seem so utterly inadequate to their valleys, and granting also, that under different conditions of climate the causing of debâcles by ground-ice may have been a powerful excavating agent, nevertheless, with all such allowances the reckoning of ages seems vastly out of proportion to historical chronology. It is not convenient to discuss here Mr. Prestwich's division of the drift gravels into high and low level beds, nor Mr. A. Tylor's argument against this division, nor the latter's theory of a Pluvial period succeeding the Glacial period (see *Quart. Journ. Geol. Soc.*, vol. xxiv. part 2, vol. xxv. part 1). The geology of the Quaternary or Post-tertiary gravels, on which the geological argument for the high antiquity of man mainly rests, has been especially treated by Prestwich in the *Philos. Trans.*, 1860, p. 277, and 1864, p. 247; see also J. Evans, *Ancient Stone Impts.*, ch. 25; references to the writings of other geologists will be found in the already mentioned works of Lyell and Lubbock.

Beside these arguments, which suggest high antiquity rather than offer means of calculation, certain inferences (accounts of which are also given in the last-named works) have been tentatively made from the depth of mud, earth, peat, etc., which has accumulated above relics of human art imbedded in ancient times. Among these is Mr. Horner's argument from the numerous borings made in the alluvium of the Nile valley to a depth of 60 feet, where down to the lowest level fragments of burnt brick and pottery were always found, showing that people advanced enough in the arts to bake brick and pottery have inhabited the valley during the long period required for the Nile inundations to deposit 60 feet of mud, at a rate probably not averaging more than a few inches in a century. Another argument is that of Professor von Morlot, based on a railway section through a conical accumulation of gravel and alluvium, which the torrent of the Tinière has gradually built up where it enters the Lake of Geneva near Villeneuve. Here three layers of vegetable soil appear, proved by the objects imbedded in them to have been the successive surface-soils in two prehistoric periods and in the Roman period, and which now lie 4, 10, and 19 feet underground; on this it is computed that if 4 feet of soil were formed in the 1500 years since the Roman period, we must go 5000 years farther back for the date of the earliest human inhabitants. Calculations of this kind, loose as they are, deserve attention.

The interval between the Quaternary or Drift period and the period of historical antiquity is to some extent bridged over by relics of various intermediate civilizations, mostly of the lower grades, and in some cases reaching back to remote dates. The lake dwellings of Switzerland are perhaps among the more recent of these. They were villages of huts built on piles in the water at some distance from the shore, for security from attack—in fact, fortified water settlements of the same nature as those of Lake Prasias in the time of Herodotus, and as those still inhabited in New Guinea and West Africa. The remains of these Swiss villages are found with the stumps of the piles still standing, often imbedded in an accumulation of mud or growth of peat which has preserved a kind of illustrative museum of the arts and habits of the lake men. From examination of the sites, it appears that the settlements are of various dates, from the neolithic or polished stone period, when instruments of metal were still unknown, to the time when bronze was introduced, and beyond this into the later age marked by the use of iron. A few of the lake villages lasted on till the Roman dominion, as is proved by the presence of Roman coins and pottery, but they were soon afterward abandoned, so that their very existence was forgotten, and their rediscovery only dates from 1853, when the workmen excavating a bed of mud on the shore of the Lake of Zurich found themselves standing among the piles of a lake settlement. In Germany, Italy, and other countries, similar remains of a long pre-Roman civilization have been found. (The special works on lake habitations are Dr. Keller's *Lake Dwellings*, translated by J. E. Lee, London, 1866; and Troyon's *Habitations Lacustres*.) Indications of man's antiquity, extending farther back into prehistoric times, are furnished by the Danish shell-heaps or "kjökkenmödding," which term, meaning "kitchen refuse-heap," has been Anglicized in "kitchen midden" (the word "midden," a dung-heap, being still current in the north of England). Along the shores of nearly all the Danish islands extensive beds or low mounds, like raised beaches, may be seen, consisting chiefly of innumerable cast-away shells, intermingled with bones, etc. Such shell-heaps are found in all quarters of the globe by the sea-shore, and may be sometimes seen in process of formation: they are simply the accumulations of shells and refuse thrown away near the huts of rude tribes subsisting principally on shellfish. The Danish kitchen middens, however, are proved to belong to a very ancient time, by the remains of the quadrupeds, birds, and fish, which served as the food of these rude hunters and fishers; among these are bones of the wild bull, beaver, seal, and great auk, all now extinct or rare in this region. Moreover, a striking proof of the antiquity of these shell-heaps is, that the shells of the common oyster are found of full size, whereas it cannot live at present in the brackish waters of the Baltic except near its entrance, so that it is inferred that the shores where the oyster at that time flourished were open to the salt sea. Thus, also, the eatable cockle, mussel, and periwinkle abounding in the kitchen middens are of full ocean size, whereas those now living in the adjoining waters are dwarfed to a third of their natural size by the want of saltness. It thus appears that the connection between the ocean and the Baltic has notably changed since the time of these rude stone-age people. (See the reports by Forchhammer, Steenstrup, and Worsaae on the kjökkenmöddings, made to the Copenhagen Academy of Sciences.) Various other evidence is adduced in this part of the argument, such as that from the Danish peat-mosses, which show the existence of man at a time when the Scotch fir was abundant; at a later period the firs were succeeded by oaks, which have again been almost superseded by beeches, a succession of changes which indicate a considerable lapse of time. For further references to special accounts, the reader may consult the already mentioned general works on the antiquity of prehistoric man.

Lastly, chronicles and documentary records, taken in connection with archæological relics of the historical period, carry back into distant ages the starting-point of actual history, behind which lies the evidently vast period only known by inferences from the relations of languages and the stages of development of civilization. Thus, Egypt affords some basis for estimating a minimum date for its ancient population. The hieroglyphic inscriptions, the most ancient written records of the world, preserve direct memorials of a time which can hardly be less, and may be much more, than 3000 years before the Christian era. With all the doubt which besets the attempt to extract a definite chronology from the Egyptian names of kings and lists of dynasties (see EGYPT), their salient points fit with the historical records of other nations. Thus, the great Ramesside dynasty, known among Egyptologists as the 19th dynasty, corresponds with the mention of the building of the city of Raamses in Exod. i. 11; Amenophis III., called by the Greeks Memnon, belongs to the previous 18th dynasty; while the three pyramid kings, whom Herodotus mentions as Cheops, Chephren, and Mykerinos, and whose actual Egyptian names are read in the hieroglyphic lists as Chufu, Chafra, and Menkaura, are set down in the 4th dynasty. Lepsius may not be over-estimating when he dates this dynasty back as far as 3124 B.C., and carries the more dubious previous dynasties back to 3892 B.C. before reaching what are known as the mythical dynasties, which probably have their bases rather in astronomical calculations than in history (Lepsius, *Königsbuch der alten Ægypter*, Berlin, 1858; compare the computations of Brugsch, Bunsen, Hincks, Wilkinson, etc.).

The Greeks of the classic period could discuss the Egyptian chronologies with priests and scribes who perpetuated the languages and records of their earliest dynasties; and as the Septuagint translation of the Bible was made at Alexandria, it is not impossible that its giving to man a considerably greater antiquity than that of the Hebrew text may have been due to the influence of the Egyptian chronology. Even if the lowest admissible calculations be taken, this will not invalidate the main fact, that above 4000 years ago the Egyptian nation already stood at a high level of industrial and social culture. The records of several other nations show that as early or not much later than this they had attained to a national civilization. The Bible, whose earliest books are among the earliest existing chronicles, shows an Israelite nation existing in a state of patriarchal civilization previous to the already mentioned time of contact with Egypt. In ancient Chaldæa, the inscribed bricks of Urukh's temples probably belong to a date beyond 2000 years B.C. (G. Rawlinson, *Five Great Monarchies of the Ancient Eastern World*, London, 1862, etc., vol. i. ch. 8).

The Chinese dynasties, like those of Egypt, begin with an obviously mythical portion, and continue into actual history; the difficulty is to draw the line where genuine record begins. Those who reckon authentic history only from the dynasty of Chow, beginning about 1100 B.C., during which Confucius lived, will at any rate hardly deny the existence of the earlier dynasty of Shang, previous to which the yet earlier dynasty of Hea is recorded; so that, though much that is related of these periods may be fabulous, it seems certain that there was a Chinese nation and a Chinese civilization reaching back beyond 2000 B.C. (see Sir John Davis, *The Chinese;* Pauthier, *Livres Sacrés de l'Orient;* Shu-King, etc.)

Till of late it was a commonly received opinion that the early state of society was one of comparatively high culture, and those who held this opinion felt no difficulty in assigning the origin of man to a time but little beyond the range of historical records and monuments. At present, however, the view has become paramount that the civilization of the world has been gradually developed from an original stone-age culture, such as characterizes modern savage life. To hold this opinion necessitates the adding to the 4000 or 5000 years to which the ancient civilizations of Egypt, Babylon, and China date back, a probably much greater length of time, during which the knowledge, arts, and institutions of these countries attained to their remarkably high level. The evidence of comparative philology corroborates this judgment. Thus, Hebrew and Arabic are closely related languages, neither of them the original of the other, but both sprung from some parent language more ancient than either. When, therefore, the Hebrew records have carried back to the most ancient admissible date the existence of the Hebrew language, this date must have been long preceded by that of the extinct parent language of the whole Semitic family; while this again was no doubt the descendant of languages slowly shaping themselves through ages into this peculiar type. Yet more striking is the evidence of the Aryan or Indo-European family of languages. The Hindus, Medes, Persians, Greeks, Romans, Germans, Kelts, and Slaves make their appearance at more or less remote dates as nations separate in language as in history. Nevertheless, it is now acknowledged that at some far remoter time, before these nations were divided from the parent stock, and distributed over Asia and Europe by the Aryan dispersion, a single barbaric people stood as physical and political representative of the nascent Aryan race, speaking a now extinct Aryan language, from which, by a series of modifications not to be estimated as possible within many thousands of years, there arose languages which have been mutually unintelligible since the dawn of history, and between which it was only possible for an age of advanced philology to trace the fundamental relationship.

From the combination of these considerations, it will be seen that the farthest date to which documentary record extends, is now generally regarded by anthropologists as but the earliest distinctly visible point of the historic period, beyond which stretches back a vast indefinite series of prehistoric ages.

VI. LANGUAGE.

In examining how the science of language bears on the general problems of anthropology, it is not necessary to discuss at length the critical questions which arise. Philology is especially appealed to by anthropologists as contributing to the following lines of argument. A primary mental similarity of all branches of the human race is evidenced by their common faculty of speech, while at the same time secondary diversities of race-character and history are marked by difference of grammatical structure and of vocabularies. The existence of groups or families of allied languages, each group being evidently descended from a single language, affords one of the principal aids in classifying nations and races. The adoption by one language of words originally belonging to another, proving as it does the fact of intercourse between two races, and even to some extent indicating the results of such intercourse, affords a valuable clue through obscure regions of the history of civilization.

Communication by gesture-signs,

between persons unable to converse in vocal language, is an effective system of expression common to all mankind. Thus, the signs used to ask a deaf and dumb child about his meals and lessons, or to communicate with a savage met in the desert about game or enemies, belong to codes of gesture-signa s identical in principle, and to a great extent independent both of nationality and education; there is even a natural syntax, or order of succession, in such gesture-signs. To these gestures let there be added the use of the interjectional cries, such as *oh! ugh! hey!* and imitative sounds to represent the cat's *mew*, the *click* of a trigger, the *clap* or *thud* of a blow, etc. The total result of this combination of gesture and significant sound will be a general system of expression, imperfect but serviceable, and naturally intelligible to all mankind without distinction of race. Nor is such a system of communication only theoretically conceivable; it is, and always has been, in practical operation between people ignorant of one another's language, and as such is largely used in the intercourse of savage tribes. It is true that to some extent these means of utterance are common to the lower animals, the power of expressing emotion by cries and tones extending far down in the scale of animal life, while rudimentary gesture-signs are made by various mammals and birds. Still, the lower animals make no approach to the human system of natural utterance by gesture-signs and emotional-imitative sounds, while the practical identity of this human system among races physically so unlike as the Englishman and the native of the Australian bush, indicates extreme closeness of mental similarity throughout the human species.

When, however, the Englishman and the Australian speak each in his native tongue, only such words as belong to the interjectional and imitative classes will be naturally intelligible, and as it were instinctive to both. Thus the savage, uttering the sound *waow!* as an explanation of surprise and warning, might be answered by the white man with the not less evidently significant *sh!* of silence, and the two speakers would be on common ground when the native indicated by the name *bwirri* his cudgel, flung *whirring* through the air at a flock of birds, or when the native described as a *jakkal-yakkal* the bird called by the foreigner a *cockatoo*. With these, and other very limited classes of natural words, however, resemblance in vocabulary practically ceases. The Australian and English languages each consist mainly of a series of words having no apparent connection with the ideas they signify, and differing utterly; of course, accidental coincidences and borrowed words must be excluded from such comparisons. It would be easy to enumerate other languages of the world, such as Basque, Turkish, Hebrew, Malay, Mexican, all devoid of traceable resemblance to Australian and English, and to one another. There is, moreover, extreme difference in the grammatical structure both of words and sentences in various languages. The question then arises, how far the employment of different vocabularies, and that to a great extent on different grammatical principles, is compatible with similarity of the speaker's minds, or how far does diversity of speech indicate diversity of mental nature? The obvious answer is, that the power of using words as signs to express thoughts with which their sound does not directly connect them, in fact as arbitrary symbols, is the highest grade of the special human faculty in language, the presence of which binds together all races of mankind in substantial mental unity. The measure of this unity is, that any child of any race can be brought up to speak the language of any other race.

To ascertain the causes to which languages owe their unlikeness in material and structure, how far to essential differences of mental type among the races of mankind, and how far to minor causes of variation, which may be called secondary, is a problem of extreme difficulty, toward the precise solution of which little has yet been done. One of the most remarkable of linguistic differences is the tendency of some languages to isolate their words, and of others to form elaborate inflections. The extremes may be seen, on the one hand, in an ordinary Chinese sentence of isolated monosyllables, such as "*yu tsze nien chiu tsin, tung chu*," etc., *i.e.*, "in this year autumn ended, winter begun," etc.; and, on the other hand, in one of the monstrous polysyllables into which the Greenlanders will agglutinate a whole phrase, *inilertorniarpatdlisarqôrpâ*, *i.e.*, "he will probably try too much to get it done soon." Among languages which form grammatical combinations or inflexions, the modes of so doing are as various as possible. Thus, in Africa, the Hottentot noun forms its plural by a suffix, as *khoi*, "man;" *khoin*, "men;" while the Zulu employs prefixes to distinguish its numbers, as *umu-ntu*, "a man;" *aba-ntu*, "men." The Dinka may supply examples of forming the plural by internal change, *ran*, "man," *ror*, "men." Nor are the differences of syntax in different tongues less absolute. In non-inflecting languages one of the most vital points is the relative position of two nouns, of which the one stands as substantive, and the other as defining it by an attribute. This may be illustrated by English compounds, such as *work-house* and *house-work*. Here our rule is to place the attribute-noun first, while, of two neighboring languages of Asia, the Burmese and the Siamese, the one settles this question in our way, the other in exactly the opposite. The Siamese expression for sailors, *luk rua*, means "sons of the ship," just as the Burmese expression for villagers, *rwa tha*, means "children of the village," but in the first case the construction is "sons ship," whereas in the second it is "village children." Again, for reasons not yet fully explained, some languages place the adjective before the substantive, as Chinese *pe ma*, "white horse;" while other languages reverse this construction, as Maori, *rakau roa*, "tree long" (*i.e.*, tall tree). These are but examples of possible divergences in linguistic structure, and no prudent ethnologist would assert that racial peculiarities have nothing to do with such various tendencies. At the same time, there is no proof but that they may have resulted from historical circumstances more or less independently of race. Our own Aryan family of nations and languages affords what must always be prominent evidence in this argument. It is acknowledged that Sanskrit, Russian, Greek, Latin, Welsh, English, etc., are, philologically speaking, dialects of a single Aryan speech, which no doubt at some ancient period was spoken by a single tribe or nation. Yet the languages sprung from this original Aryan tongue, by various courses of development and accretion, are mutually unintelligible. If a Greek sentence be taken at random, such as this, "Οὐ χρὴ παννύχιον εὕδειν βουληφόρον ἄνδρα," and it be translated even too verbally into English, "A counsel-bearing man ought not to sleep all night," the traces of linguistic connection between the Greek and English words (*phoros*, *bear; nux*, *night*) are hardly perceptible except to philologists. Even the essential character of the two languages is seen to be different, for the construction of the Greek sentence depends mainly on the inflections of the words, while in English such inflections are almost discarded, and their effect is produced by the syntax and the auxiliary particles. Moreover, as to some most important points of syntax, Aryan languages differ widely from one another; thus, to use a familiar instance, French and English take contradictory lines as to the relative position of the adjective and substantive, as also of the object-pronoun and verb,—"*c'est un cheval blanc*, *je le vois*," "it is a white horse, I see him." So Hindustani and English, though both Aryan tongues, reverse the positions of the verb and object, as "*ghorā lāo*" ("horse bring"), *i.e.*, "bring the horse!" Thus on the whole, the endless variety in vocabulary and structure among the languages of the world affords important evidence as to the mental diversities of the nations speaking those languages. But the unity of the faculty of speech in man stands as the primary fact, while the character of the grammar and dictionary belonging to any one nation represents only a secondary fact, such as might be fairly set down as resulting from their particular stage and circumstances of linguistic development.

The principles of the development of a family of languages from a single parent tongue are laid down in special treatises on Language. It has here to be noticed that the evidence on which such linguistic groups may be treated as allied by descent is of various degrees of fullness and strength. The most perfect available case is that of the Romance languages, comprising Italian, Spanish, French, etc.; inasmuch as not only does the classic Latin remain substantially the representative of their common original, but the very stages of their development from it are preserved in documents of successive ages. Thus, in comparing the vocabularies of Italian and French, it is, in the first place, seen that they to a great extent correspond,—this correspondence extending to words which one language is least likely to borrow from another, viz., pronouns, the lower numerals, and names of the most universal and familiar objects. It is only, however, by etymological analysis that their depth of correspondence comes fully into view, it being seen that the ultimate elements or roots are largely common to the two languages, as are also the grammatical affixes by which words are formed from these roots, while general similarity of linguistic structure pervades both tongues. Such intimate correspondence could only result from derivation from a common parent language, which in this case exists in Latin. In other groups of languages the existence of the common parent may be inferred from correspondence of this highest order. Thus there must have existed, at some period, what may be called the parent Slavonic, whence descend the Russian, Polish, Bohemian, etc.; and the parent Keltic, whence descend Welsh, Gaelic, Breton, etc., while behind the various branches of the whole Aryan family are dimly to be discerned the outlines of a primitive Aryan speech. In like manner, a comparison of the Arabic, Hebrew, Syriac, etc., shows that these must be all derived from a primitive Semitic speech, containing many of the simple root forms, which still exist in its modern descendants, and being already characterized by the principle of internal inflection. Beyond the limits of these two, the most important linguistic families, various others have been satisfactorily made out, though hardly with the same completeness of proof. In the Turanian or Tatar family are included the Turkish, Mongol, Hungarian, Finnish, Ostyak, etc.; the Dravidian family takes in the Tamil, Telugu, and various other South Indian dialects: the Polynesian family comprises the languages of the higher race of the South Sea Islands; the Negro-Kafir family consists of the prefixing languages spoken by most African tribes from the equatorial regions southward; the Guarani family in South America, the Algonquin and Athapascan families in North America, and the Australian family, each includes a number of tribes ranging over a vast extent of territory, and so on. As to smaller divisions, it is common for languages to occur in groups of several connected dialects, though not forming part of one of the wider linguistic families; thus the Aztec and Nicaraguan are closely related dialects, as are the Quichua and Aymara, while what philologists describe as isolated languages, as the Basque appears to be. are rather isolated groups of dialects, with no known analogues beyond a limited district.

If the present state of the philological classification of mankind be compared with that of half a century ago, it will be seen that much progress has been made in referring groups of languages each to a common ancestral tongue. At the same time, greater cogency of proof is now demanded in such classification. The method of comparing a short vocabulary of twenty words or so in two languages is now abandoned, for where an extensive connection really exists, this is much better proved by a systematic comparison, while a few imperfect resemblances in the two lists might be due to accident, or the adoption of words. Nothing short of a similarity in the roots or elements of two languages, as well as in their grammatical structure, too strong to be explained by any independent causes, is now admitted as valid proof of common descent. This limitation, however, by no means amounts to a denial of the possibility of such descent. Thus it is often argued, on the strength of some similarities between Hebrew and Indo-European roots, that the two so distinct Semitic and Aryan families of language are themselves sprung from some yet more remotely ancient tongue. Thus also it has been attempted to connect the Malay and Tatar groups of languages. Either or both of these opinions may be true; but the general verdict of philologists is, that they are not satisfactorily made out, and therefore cannot be recognized.

Under the present standard of evidence in comparing languages and tracing allied groups to a common origin, the crude speculations as to a single primeval language of mankind, which formerly occupied so much attention, are acknowledged to be worthless. Increased knowledge and accuracy of method have as yet only left the way open to the most widely divergent suppositions. For all that known dialects prove to the contrary, on the other hand, there may have been one primitive language, from which the descendant languages have varied so widely, that neither their words nor their formation now indicate their unity in long past ages, while, on the other hand, the primitive tongues of mankind may have been numerous, and the extreme unlikeness of such languages as Basque, Chinese, Peruvian, Hottentot, and Sanskrit, may arise from absolute independence of origin.

The language spoken by any tribe or nation is not of itself absolute evidence as to its race-affinities. This is clearly shown in extreme cases. Thus the Jews in Europe have almost lost the use of Hebrew, but speak as their vernacular the language of their adopted nation, whatever it may be; even the Jewish-German dialect, though consisting so largely of Hebrew words, is philologically German, as any sentence shows: "*Ich hab noch hojom lo geachelt*," "I have not yet eaten to-day." The mixture of the Israelites in Europe by marriage with other nations is probably much greater than is acknowledged by them; yet, on the whole, the race has been preserved with extraordinary strictness, as its physical characteristics sufficiently show. Language thus here fails conspicuously as a test of race, and even of national history. Not much less conclusive is the case of the predominantly Negro populations of the West India Islands, who, nevertheless, speak as their native tongues dialects of English or French, in which the number of intermingled native African words is very scanty: "*Dem hitti netti na ini watra bikasi dem de fisiman*," "They cast a net into the water, because they were fishermen." (Surinam Negro-Eng.) "*Bef pas ca jamain lasse poter cônes li.*" "Le bœuf n'est jamais las de porter ses cornes." (Haytian Negro-Fr.) If it be objected that the linguistic conditions of these two races are more artificial than has been usual in the history of the world, less extreme cases may be seen in countries where the ordinary results of conquest-colonization have taken place. The

Mestizos, who form so large a fraction of the population of modern Mexico, numbering several millions, afford a convenient test in this respect, inasmuch as their intermediate complexion separates them from both their ancestral races, the Spaniard, and the chocolate-brown indigenous Aztec or other Mexican. The mother-tongue of this mixed race is Spanish, with an infusion of Mexican words; and a large proportion cannot speak any native dialect. In most or all nations of mankind, crossing or intermarriage of races has thus taken place between the conquering invader and the conquered native, so that the language spoken by the nation may represent the results of conquest as much or more than of ancestry. The supersession of the Keltic Cornish by English, and of the Slavonic Old-Prussian by German, are but examples of a process which has for untold ages been supplanting native dialects, whose very names have mostly disappeared. On the other hand, the language of the warlike invader or peaceful immigrant may yield, in a few generations, to the tongue of the mass of the population, as the Northman's was replaced by French, and modern German gives way to English in the United States. Judging, then, by the extirpation and adoption of languages within the range of history, it is obvious that to classify mankind into races, Aryan, Semitic, Turanian, Polynesian, Kafir, etc., on the mere evidence of language, is an intrinsically unsound method. From the earliest times in which nations have been classified by languages, its unrestricted use has vitiated sound ethnology.

Nevertheless, under proper restrictions, speech affords information as to the affinities of races only second in value to that derived from physical characteristics. As a rule, language at least proves some proportion of ancestry. It could hardly happen that one people should come into so close a relation to another as to supplant its language, without strong intermixture of race in the next generation. This is true in the extreme case of the West Indian colored population, among whom the majority are now crossed with European blood, so that in each succeeding generation the proportion of absolutely pure Negro families becomes less. Still more fully is it true of colored races in Mexico or Brazil, whose Spanish or Portuguese language represents at least a large European element of ancestry. Thus in India many millions of people, whose blood is predominantly that of the darker indigenous race, nevertheless speak dialects of the languages of the fairer Aryans; but then they are for the most part distinctly mixed races of partly Aryan ancestry. With these facts before us, it is not difficult to determine the principles on which the ethnologist may use language as partial evidence of race. In the first place, it strengthens the evidence of bodily characters. Thus in South Africa the Zulu seems by color, features, shape of skull, etc., to be, if not an absolute Negro of a mixed and modified Negro type. This view of his origin is strengthened by the fact that the Zulu language belongs to the peculiar prefixing family which extends so widely among the Negro nations farther north. So the Hottentot language, in its evident connection with that of the Bushmen, adds its weight to the physical argument, that these two are decendants more or less mixed and varied from a single race, small, yellow, crisp-haired, and speaking an inflectional monosyllabic language, articulated with clicks. In the second place, language may prove race-connection where bodily characteristics, though they do not contradict, do not suffice. Thus, comparing the dark Andalusian with the fair Swede we ask the question, whether there is distinguishable common parentage between these two varieties of the white man? The anatomist might hesitate here. Nor, indeed, is the physical problem nearly solved, but at least a partial solution is involved in the philologist's proof that the two peoples speak languages inherited at some remote period from a common Aryan tongue, and must therefore have had a common element in their ancestry of at least sufficient strength to carry language with it. Thus each linguistic family affords at least partial evidence of race, proving, for instance, the existence of a common ancestry of the Irishman and the Russian, of the Jew and the Maltese, of the Tahitian and the Malagasy, though in such pairs of races the actual amount of common ancestry may be less than that of the different race-elements with which it has combined.

As regards political nationality and the history of civilization, the evidence of speech is of still greater weight. In many cases of the mixture of nations the language of the dominant civilization prevails, as where Latin dialects superseded the native tongues in Western Europe, and Germanic languages encroached on Turanian in Finland, on Slavonic in Russia, and on Keltic in the Scotch Highlands. In other cases, where one nation has received elements of civilization from another, language is apt to keep record of the process by adopting foreign words and ideas together. Thus the language of the barbarian Turks has absorbed masses of Arabic, which itself had in like manner absorbed Persian, when Persia was the fountain-head of early Moslem culture. In the same manner Dravidian languages of South India have been saturated with words and phrases from Sanskrit and its related dialects, so that a page of Tamil literature is of itself the proof of a non-Ayran race having received from an Aryan race a whole system of religion, philosophy and social order. The most extreme cases of such verbal indication of foreign influence are to be found in languages of low races of America and the Pacific, which have adopted from European languages not only terms for imported arts and ideas, but names of such numerals as 6 and 7, previously expressed by more clumsy native combinations. Thus the language of any people, though less effective than was once believed as a means of determining its place in the classified order of mankind, does, to some extent, indicate its physical, and, to a still greater extent, its intellectual ancestry.

VII. DEVELOPMENT OF CIVILIZATION.

THE conditions of man at the lowest and highest known levels of culture are separated by a vast interval; but this interval is so nearly filled by known intermediate stages, that the line of continuity between the lowest savagery and the highest civilization is unbroken at any critical point. The Australians and forest Indians of Brazil may be taken as the lowest modern savages whose thought and life have been investigated with any thoroughness; while other less accurately-studied tribes are in some respects inferior even to these. An examination of the details of savage life shows not only that there is an immeasurable difference between the rudest man and the highest lower animal, but also that the least cultured savages have themselves advanced far beyond the lowest intellectual and moral state at which human tribes can be conceived as capable of existing, when placed under favorable circumstances of warm climate, abundant food, and security from too severe destructive influences. In fact, the Australian or Brazilian savage has already attained to rudimentary stages in many of the characteristic functions of civilized life. His language, expressing thoughts by conventional articulate sounds, is the same in essential principle as the most cultivated philosophic dialect, only less exact and copious. His weapons, tools, and other appliances, such as the hammer, hatchet, spear, knife, awl, thread, net, canoe, etc., are the evident rudimentary analogues of what still remains in use among Europeans. His structures, such as the hut, fence, stockade, earthwork, etc., may be poor and clumsy, but they are of the same nature as our own. In the simple arts of broiling and roasting meat, the use of hides and furs for covering, the plaiting of mats and baskets, the devices of hunting, trapping, and fishing, the pleasure taken in personal ornament, the touches of artistic decoration on objects of daily use, the savage differs in degree but not in kind from the civilized man. The domestic and social affections, the kindly care of the young and the old, some acknowledgment of marital and parental obligation, the duty of mutual defense in the tribe, the authority of the elders, and general respect to traditional custom as the regulator of life and duty, are more or less well marked in every savage tribe which is not disorganized and falling to pieces. Lastly, there is usually to be discerned among such lower races a belief in unseen powers pervading the universe, this belief shaping itself into an animistic or spiritualistic theology, mostly resulting in some kind of worship. If, again, high savage or low barbaric types be selected, as among the North American Indians, Polynesians, and Kafirs of South Africa, the same elements of culture appear, but at a more advanced stage, namely, a more full and accurate language, more knowledge of the laws of nature, more serviceable implements, more perfect industrial processes, more definite and fixed social order and frame of government, more systematic and philosophic schemes of religion, and a more elaborate and ceremonial worship. At intervals new arts and ideas appear, such as agriculture and pasturage, the manufacture of pottery, the use of metal implements, and the device of record and communication by picture-writing. Along such stages of improvement and invention the bridge is fairly made between savage and barbaric culture; and this once attained to, the remainder of the series of stages of civilization lies within the range of common knowledge.

The teaching of history, during the three to four thousand years of which contemporary chronicles have been preserved, is that civilization is gradually developed in the course of ages by enlargement and increased precision of knowledge, invention and improvement of arts, and the progression of social and political habits and institutions toward general well-being. The conditions of such races as the older Jews, Greeks, and Germans, are known to us by ancient chronicles, and by poetry and myth even more valuable than chronicle in the details they unconsciously preserve of the state of society at the time whence they have been handed down. Starting from the recorded condition of such barbaric nations, and following the general course of culture into the modern world, all the great processes of mental and social development may be seen at work. Falling back or decay also takes place, but only to a limited extent destroys the results of growth in culture. It is thus matter of actual record, that the ancestors of civilized nations were barbaric tribes, and the inference seems reasonable that the same process of development had gone on during previous ages outside the domain of direct history, so that barbaric culture itself arose out of an earlier and ruder condition of primitive culture, more or less corresponding with the state of modern savage tribes. The failure of direct record of this passage from savagery upward to barbarism was to be expected from the circumstances of the case. No people civilized enough to preserve history could have watched the age-long process of a savage tribe developing its culture; indeed, experience shows that independent progress could hardly have taken place among an uncivilized in contact with a civilized race. Nor could a barbaric nation, though it had really and independently risen from savagery within some few thousand years, give any valid account of this gradual advancement, for the very reason of its having taken place while the nation was yet in, or but little removed from, the savage state, one part of the very definition of which is that it has no trustworthy means of preserving the history of events even for a single century, much less for the long period required for so vast a development. This view of the low origin and progressive development of civilization was already held in ancient times, as in the well-known speculations of the Epicurean school on the condition of the earliest men, who roved like wild animals, seeking their food from the uncultured earth, till arts and social laws arose among them (Lucret., *De Rerum Nat.*, v. 923; Horat., *Sat.*, i. 3); or where the like idea has taken in China the form of ancient legend, recording the time when their nation was taught to use skins for clothing, to make fire, and to dwell in houses (Pauthier, *Livres Sacrés de l'Orient*, p. 26.) In opposition to such views of primeval rudeness, traditions of a pristine state of human excellence have long been cherished, such as the "golden age" (Hesiod., *Op. et Dies*, 108). Till of late wide acceptance has been given to arguments, partly based on theological and partly on anthropological grounds, as to man's incapability of rising from a savage state, and the consequent necessity of a supernatural bestowal of culture on the first men, from whose high level savages are supposed by advocates of this theory to have degenerated. The anthropological evidence adduced in support of this doctrine is, however, too weak for citation, and even obviously erroneous arguments have been relied on (see, for example, Archbishop Whately, *Essay on the Origin of Civilization*, and remarks on its evidence in Tylor, *Early Hist. of Man*, p. 163). It has been especially the evidence of prehistoric archæology which, within the last few years, has given to the natural development-theory of civilization a predominance hardly disputed on anthropological grounds. The stone implements, which form the staple proof of man's existence at the period of the river-drift, are of extreme rudeness as compared even with ordinary savage types, so that it is obvious that the most ancient known tribes were, as to the industrial arts, at a low savage level. The remains in the caverns justify this opinion, especially where in central France more precision is given to the idea of prehistoric life by the discovery of bone weapons for hunting and fishing, which suggest a rude condition resembling that of the Esquimaux (see the preceding section V., *Antiquity of Man*). The finding of ancient stone implements buried in the ground in almost every habitable district of the world, including the seats of the great ancient civilizations, such as Egypt, Assyria, India, China, Greece, etc., may be adduced to show that the inhabitants of these regions had at some time belonged to the stone age. This argument goes far to prove that the ancestors of all nations, high and low, were once in that uncultured condition as to knowledge, arts, and manners generally, which within our experience accompanies the use of stone implements and the want of metals. No valid refutation of this reasoning has been offered, and it is corroborated by arguments to be drawn from study of the facts of civilization, of which some will be here mentioned for their bearing on the theory of development.

History shows how development of the arts takes place by efforts of skill and insight, as where Phidias rose above the clumsier sculptors of the time before him, or where the earliest gnomon—a mere staff set up in order to have its shadow measured—passed into the graduated sun-dial; or adaptations of old contrivances produce new results, as when the ancient Pan's pipes, blown by a bellows, became the organ, when the earlier block-printing led up to the use of movable types, and when the magnetic-needle was taken out of the mariner's compass to find a new office on the telegraph-dial; or lastly, more absolutely original inventions arise, the triumphs of the scientific imagination, such as the pendulum and the steam-engine. In the evolution of science the new knowledge ever starts from the old, whether its results be to improve, to shift, or to supersede it. The history of astronomy extends far enough back to show its barbaric stages, when the earth was regarded as a flat surface, overarched by a solid dome or firmament; and when not only was the sun considered to move round the earth, but its motions, as well as the moon's, were referred to the guidance and even the impulse of personal deities. Beginning with this first stage of the science, there lies before us the whole record of the exacter observation and closer reasoning which have gradually replaced these childlike savage conceptions by the most perfect of physical theories. Thus, again, the history of medicine shows improvement after improvement on the rude surgical appliances and the meager list of efficient drugs which the barbaric leech had at his disposal, while its theory has changed even more absolutely than its practice; for medical history begins with the ancient world holding fast to the savage doctrine that madness, epilepsy, fever, and other diseases, are caused by demons possessing the patient—a belief which is still that of half the human race, but which it has been the slow but successful task of scientific pathology to supercede in the civilized world. In like manner, the history of judicial and administrative institutions may be appealed to for illustrations of the modes in which old social formations are reshaped to meet new requirements, new regulations are made, and new officers are constituted to perform the more complex duties of modern society, while from time to time institutions of past ages, which have lost their original purpose, and become obsolete or hurtful, are swept away.

That processes of development similar to these had already been effective to raise culture from the savage to the barbaric level, two considerations especially tend to prove. First, there are numerous points in the culture even of rude races which are not explicable otherwise than on the theory of development. Thus, though difficult or superfluous arts may easily be lost, it is hard to imagine the abandonment of contrivances of practical daily utility, where little skill is required, and materials are easily accessible. Had the Australians or New Zealanders, for instance, ever possessed the potter's art, they could hardly have forgotten it. The inference that these tribes represent the stage of culture before the invention of pottery is confirmed by the absence of buried fragments of pottery in the districts they inhabit (Lubbock, in *Report of British Association*, Dundee, 1867, p. 121). The same races who were found making thread by the laborious process of twisting with the hand, would hardly have disused if they had ever possessed it, so simple a labor-saving device as the spindle, which consists merely of a small stick weighted at one end; the spindle may, accordingly, be regarded as an instrument invented somewhere between the lowest and highest savage levels (Tylor, *Early Hist. of Mankind*, p. 193). Again, many devices of civilization bear unmistakable marks of derivation from a lower source; thus the ancient Egyptian and Assyrian harps, which differ from ours in having no front pillar, appear certainly to owe this remarkable defect to having grown up through intermediate forms from the simple strung bow, the still used type of the most primitive stringed instrument (Engel, *Music of the most Ancient Nations*, pp. 17, 30.) In this way the history of numeral words furnishes actual proof of that independent intellectual progress among savage tribes which some writers have rashly denied. Such words as *hand*, *hands*, *foot*, *man*, etc., are used as numerals signifying 5, 10, 15, 20, etc., among many savage and barbaric peoples; thus Polynesian *lima*, *i.e.*, "hand," means 5; Zulu, *tatisitupa*, *i.e.*, "taking the thumb," means 6; Greenlandish, *arfersanek-pingasut*, *i.e.*, "on the other foot three," means 18; Tamanac, *tevin itoto*, *i.e.*, "one man," means 20, etc., etc. The existence of such expressions demonstrates that the people who use them had originally no spoken names for these numbers, but once merely counted them by gesture on their fingers and toes in low savage fashion, till they obtained higher numerals by the inventive process of describing in words these counting-gestures (Tylor, in *Journal Royal Inst.*, March 15, 1867; *Primitive Culture*, chap. vii.). Second, the process of "survival in culture" has caused the preservation in each stage of society of phenomena belonging to an earlier period, but kept up by force of custom into the later, thus supplying evidence of the modern condition being derived from the ancient. Thus the mitre over an English bishop's coat-of-arms is a survival which indicates him as the successor of bishops who actually wore mitres, while armorial bearings themselves, and the whole craft of heraldry, are survivals bearing record of a state of warfare and social order whence our present state was by vast modification evolved. Evidence of this class, proving the derivation of modern civilization, not only from ancient barbarism, but beyond this, from primeval savagery, is immensely plentiful, especially in rites and ceremonies, where the survival of ancient habits is peculiarly favored. Thus the modern Hindu, though using civilized means for lighting his household fire, retains the savage "fire-drill" for obtaining fire by friction of wood when what he considers pure or sacred fire has to be produced for sacrificial purposes; while in Europe into modern times the same primitive process has been kept up in producing the sacred and magical "need-fire," which was lighted to deliver cattle from a murrain. Again, the funeral offerings of food, clothing, weapons, etc., to the dead are absolutely intelligible and purposeful among savage races, who believe that the souls of the departed are ethereal beings, capable of consuming food, and of receiving and using the souls or phantoms of any objects sacrificed for their use. The primitive philosophy to which these conceptions belong has to a great degree been discredited by modern science; yet the clear survivals of such ancient and savage rites may still be seen in Europe, where the Bretons leave the remains of the All Souls' supper on the table for the ghosts of the dead kinsfolk to partake of, and Russian peasants set out cakes for the ancestral manes on the ledge which supports the holy pictures, and make dough ladders to assist the ghosts of the dead to ascend out of their graves and start on their journey for the future world; while other provision for the same spiritual journey is made when the coin is still put in the hand of the corpse at an Irish wake. In like manner magic still exists in the civilized world as a survival from the savage and barbaric times to which it originally belongs, and in which is found the natural source and proper home of utterly savage practices still carried on by ignorant peasants in our own country, such as taking omens from the cries of animals, or bewitching an enemy by sticking full of pins and hanging up to shrivel in the smoke an image or other object, that similar destruction may fall on the hated person represented by the symbol (Tylor, *Primitive Culture*, chap. i., iii., iv., xi., xii.; *Early Hist. of Man*, chap. vi.).

To conclude, the comparative science of civilization thus not only generalizes the data of history, but supplements its information by laying down the lines of development along which the lowest prehistoric culture has gradually risen to the highest modern level. Among the most clearly marked of these lines is that which follows the succession of the stone, bronze, and iron ages. The stone age represents the early condition of mankind in general, and has remained in savage districts up to modern times, while the introduction of metals need not at once supersede the use of the old stone hatchets and arrows, which have often long continued in dwindling survival by the side of the new bronze and even iron ones. The bronze age had its most important place among ancient nations of Asia and Europe, and among them was only succeeded after many centuries by the iron age; while in other districts, such as Polynesia and Central and South Africa, and America (except Mexico and Peru), the native tribes were moved directly from the stone to the iron age without passing through the bronze age at all. Although the three divisions of savage, barbaric, and civilized man do not correspond at all perfectly with the stone, bronze, and iron ages, the classification of civilization thus introduced by Nilsson and Thomsen has proved a guide of extraordinary value in arranging in their proper order of culture the nations of the Old World. Another great line of progress has been followed by tribes passing from the primitive state of the wild hunter, fisher, and fruit-gatherer, to that of the settled tiller of the soil, for to this change of habit may be plainly in great part traced the expansion of industrial arts and the creation of higher social and political institutions. These, again, have followed their proper lines along the course of time. Among such are the immense legal development by which the primitive law of personal vengeance passed gradually away, leaving but a few surviving relics in the modern civilized world, and being replaced by the higher doctrine that crime is an offense against society, to be repressed for the public good. Another vast social change has been that from the patriarchal condition, in which the unit is the family under the despotic rule of its head, to the systems in which individuals make up a society whose government is centralized in a chief or king. In the growth of systematic civilization, the art of writing has had an influence so intense, that of all tests to distinguish the barbaric from the civilized state, none is so generally effective as this, whether they have but the failing link with the past which mere memory furnishes, or can have recourse to written records of past history and written constitutions of present order. Lastly, still following the main lines of human culture, the primitive germs of religious institutions have to be traced in the childish faith and rude rites of savage life, and thence followed in their expansion into the vast systems administered by patriarchs and priests, henceforth taking under their charge the precepts of morality and enforcing them under divine sanction, while also exercising in political life, an authority beside or above the civil law. These illustrations may suffice to make it clear that although the science of culture is still but rudimentary and imperfect, it indicates the one sound and indispensable method for the study of human arts and institutions, that of placing each at its proper stage in a line of evolution, and explaining it by the action of new conditions upon the previous stage whence it was derived.

ARCHÆOLOGY.

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THE term *Archæology*, like that of *Antiquities*, has been employed, until a very recent period, in a sense so restricted and arbitrary as strikingly to contrast with the latitude admissible according to the original derivation of the word. Literally it signifies the study of antiquity or ancient things; but its precise significance has been determined from time to time by the range of study and research most in favor. To some extent it has always been recognized as embracing whatever pertained to the early history of any nation, but in its details it was applied almost exclusively to the study of Greek and Roman art, or of classical antiquities generally. The progress of geology, and the application of sound principles of induction to the study of primitive antiquities, have wrought a great revolution, and few studies now rival archæology in comprehensive interest.

In looking at the succession of strata of the earth's crust it was assumed till recently that the student of man and his remains is limited to the latest superficial formation of post-tertiary strata. To the palæontologist was assigned all ancient animal life of the fossiliferous strata, while the archæologist treated of man and his works as things essentially distinct. The diverse functions of the two sciences are still clearly recognized; but the archæologist is no longer supposed to be excluded either from quaternary or tertiary strata in his search not only for the remains of human art, but for the osteological evidences of man's presence contemporaneous with the fauna of such geological periods. One class of archæologists, accordingly, confidently anticipate the recovery not only of works of art, but of the fossil remains of man himself, in the pliocene, or even the miocene strata. So far, however, as any reliable evidence can guide opinion, it scarcely admits of question that neither has hitherto been found in older deposits than the later tertiary, or quaternary.

The actual remains of man, the specific form of his osseous structure, and above all of his skull, now receive the minutest attention, and the department of anthropology to which such investigations are specially assigned has latterly acquired a fresh interest from the inquiries suggested by novel theories as to the possible evolution of man from lower animal organizations. Nevertheless, the researches of the palæontologist and of the archæologist are based on essentially distinct evidence. The life of geological periods is investigated by means of the fossil bones and teeth which alone survive. Or if to these have to be added such illustrations of habits, food, and structure as are furnished by means of footprints, coprolites, and the like subsidiary evidence, still all are traceable, directly or indirectly, to the living organism.. Man, on the contrary, in times altogether preceding history, is chiefly studied by means of his works. Archæology thus forms the intermediate link between geology and history, though the reaction, at the revival of learning in the 16th century, which tended for a time to subordinate arts and science alike to classical authority, reduced it within greatly narrower limits. Nevertheless, the fitness of the term for the most comprehensive definition in relation to all which pertains to the past could not be entirely overlooked, and it is even employed repeatedly by Dr. Prichard as nearly synonymous with palæontology. In this, however, he has not been followed, and the name is now universally adopted to designate the science which deduces the history of man from the relics of the past.

The innate cravings of the human mind for an insight into the future have shaped themselves into many forms of divination and astrology. But this desire is not more universal than that which prompts man to aim at a recovery of the secrets of the past. The question *Whence?* even more than that of *Whither?* is found to give shape to the mythic legends of the rude barbarian, and to constitute an important element in the poetry and mythology of every nation's oral and written history. With the progress of society such indices of the past are subjected anew to critical analyses; and we accordingly find abundant traces of an archæological spirit in the literature of every civilized nation. The influence of the same craving for a mastery of the past is seen adapting itself to the spirit of the age at every epoch of great progress. The revival of art and letters in the 14th and 15th centuries was signalized by a renewed appreciation of Greek and Roman models; and while the progress of opinion in the 16th century was accompanied by an abandonment of mediæval for classic art, the tendency of Europe in our own day, amid many elements of progress, has been singularly consentaneous in the return not merely to mediæval art, but to mediæval modes and standards of thought, and in the attempt to attain to higher excellence than has been yet achieved by a more perfect development of the ideal of the middle ages.

The alliance of archæology with geology, and the direction of geological research to the evidences of the antiquity of man, have largely contributed to its expansion, until in its comprehensive unity it embraces the entire range of human progress from the infantile stage of primeval arts to the earliest periods of written records. It has thus been developed into a systematic science, by which the intelligent investigator is enabled to pursue his researches with the aid of evidence older than all written chronicles, and to recover chapters of national infancy and youth heretofore deemed beyond recall. The geologist, with no aid from written records, follows out his inquiries through successive periods of the earth's history, and reveals the changes it has undergone, and the character of the living beings which animated epochs of the globe ages before man was called into being. Beginning with the traces of life in the primary fossiliferous strata, he passes on from system to system, disclosing a vast succession of long extinct life, until in the latest diluvial formations he points to the remains of animals identical with existing species, and even to traces of human art—the evidence of the close of geological and the beginning of archæological periods. Here archæological science ought to be ready to take up the narrative, and with a more comprehensive minuteness of detail and greater certainty as to the conclusions arrived at. Such, however, until very recently, has not been the case. The geologist himself long confused the records of the transitional period by his mistaken reference of all diluvial traces to the Noachian deluge; and when, pausing, as he thus believed, at the dawn of the historic period, he turned to the archæologist for the subsequent chapters of the history of life on our globe, it was only to receive a record of Roman traces at best but meagerly supplementing the minuter details of the historian. Nearly the same was the case with all historic antiquity, with the single exception of the wonderful monuments of Egypt, which preserve to us the records of a civilization in which we can recognize the origin of arts, letters, and all else to which the culture of the oldest historical nations may be traced.

Nevertheless, the evidences of the primitive arts, and the traces of a native civilization originating among the prehistoric races of Europe, had been long familiar to the antiquary, though he failed to form any intelligent conception of their significance as historical records. Their interpretation on an intelligent and systematic principle is mainly due to the archæologists and ethnologists of Denmark and Sweden, who from their very geographical position were happily freed from the confusing element of classical prejudices, and were compelled to seek in other than Roman sources an origin for the abundant traces of metallurgic art. Zealous British coadjutors speedily caught the hint, and freed themselves from the trammels which had so long narrowed their aim; the remains of primitive art were referred to true sources, or at least arranged under an intelligent system of chronological sequence; and thus the desultory and ofted misdirected labors of the antiquary have given place to researches characterized by scientific accuracy.

The system of primitive archæology thus introduced has since been modified and carried out into ampler details, as the fruit of more extended discoveries, chiefly effected in France and England; but the three primary divisions, the Stone, the Bronze, and the Iron Periods, are still retained. The arrangement is warranted alike by evidence and by its practical convenience, though later research has given to the stone period a comprehensiveness undreamt of before, and so led to its subdivision into two ages of prolonged duration, with distinctive characteristics of primitive art. (1.) The Stone Period, as the name implies, is that in which the rude aboriginal arts, which the commonest necessities of man call into operation, are assumed to have been employed entirely on such available materials as stone, horn, bone, etc. (2.) The Bronze Period may in like manner admit of subdivision, though the term is conveniently employed, in its most comprehensive sense, for that era of progress in which the metallurgic arts appear to have been introduced and slowly developed—first, by the simple use of native copper, followed by the application of fire, the construction of molds, and the discovery of such chemical processes as the alloying of copper and tin, and the consequent production of the beautiful and useful alloy which gives name to this the earlier metallurgic era. (3.) The Iron Period marks the era of matured metallurgic arts, and the accompanying progress consequent on the degree of civilization which is the inevitable concomitant of such a state of things. While, however, those divisions hold good in their general application, they must not in every case be applied too rigidly. The archæologist is constantly recalled to the distinction between the researches of the palæontologist, as dealing with the traces of organic life, and his own study of the works of a rational being marked by all the diversities traceable to the reasoning and volition of the individual workman. Local facilities have also modified the arts of primitive man in various ways. In some localities, as in North America, pure native copper abounds; while on the other hand, in certain districts of Africa iron occurs in such a condition that it appears to have been wrought by the primitive metallurgist from very remote times.

All those periods embrace eras concerning which no contemporary written records exist; and in relation to most of them nearly as little is known directly as of the older periods with which the geologist exclusively deals. It need not therefore excite surprise that the process of induction established on this basis has been challenged by historical writers of high standing, but whose exclusive labors on the records of periods admitting of documentary evidence and charter proof render them little disposed to sympathize with a course of reasoning relative to the history of man, such as has, in the hands of the geologist, revealed so much in relation to more ancient life. The further, however, that research is pursued, alike into the habits of living races of savages, and into the characteristics of the oldest traces of primitive art, the more clearly does such a process of development, from the first rude working in stone to the highest arts of the skilled metallurgist, become manifest.

The Australians, the Maories of New Zealand, and the whole widely-scattered races of the Polynesian Islands, the Caribs and other natives of the American archipelago, with all the nomade tribes of the New World, from Patagonia to the Arctic circle, were, when first discovered, without any knowledge of the metals as such, and supplied their wants by means of implements and weapons of stone, shell, bone, or wood. The civilized Mexicans and Peruvians, on the contrary, when first visited by the Spaniards in the 16th century, were familiar with the working of copper as well as gold,—though totally ignorant of iron, and also retaining for common purposes many of the primitive stone weapons and implements, only substituting the abundant obsidian of their volcanic region for flint. Greece passed from its bronze to its iron age within the period embraced in its literary history; and the mastery of the art of working the intractable iron ore is traceable with tolerable clearness in the early history of Rome, not very long before it came in contact with the trans-Alpine barbarians. Among most of the Germanic and Celtic tribes iron appears to have been already known when they first came in contact with the aggressive civilization of the south; and from one of them, the Norici (in whose country, in the Austrian valleys of the Danube, this metal is still wrought with the highest skill,) there is reason to believe that the Romans acquired the art of making steel.

If history is only to begin, as that of Britain has been made to do, with the date of the first collision with invading Rome, then, no doubt, stone and bronze periods are as meaningless as are eocene and miocene periods to the geologist who assigns the Mosaic deluge as the source of the earliest phenomena of his science. To those, however, who are willing to follow inductive reasoning to its legitimate conclusions it must be apparent that it is no visionary theory, but a system founded in well-established truth, which arranges the archæological records of primitive history and the remains of human art into stone, bronze, and iron periods. Even here, however, an important distinction in the employment of such materials as a basis of inductive reasoning indicates the greatness of the revolution involved in the introduction among the living creatures inhabiting this earth of a being endowed with intelligence, and supplementing the natural resources of animal life by arts even of the most primitive kind. It must indeed be born in remembrance that geological and historical chronology are very different things, and that the idea implied in the contemporaneousness of strata bears a very slight approximation to the coincidence of contemporaneous events and productions of an historical era. The doctrine of geological continuity is indeed challenged in certain respects; but on the whole, the geological formations, with their included organic remains, may be assumed to obey a natural and unvarying order; and so, within the compass of geological periods, to be of contemporaneous origin. But, notwithstanding certain extreme assumptions, based on the theory of evolution, and involving the consequent existence of man in remote geological eras, so far as all actual evidence can yet guide us, it is correct to say that, geologically speaking, the entire history of man is embraced in one period. But in the works of art, which form the bases of archæological induction, a new element—that of mind, or the reasoning faculty, along with the imitative and social arts—is introduced, and greatly complicates its subdivisions. The stone period of Britain or Denmark is analogous to that of the Polynesian Islands. So closely do their tools and weapons resemble each other that it requires a practiced eye to distinguish the stone axe or flint lance-head found in an ancient British barrow from implements brought by some recent voyager from the islands of the Southern Ocean. Nor could the most experienced archæologist undertake in every case to discriminate between the flint arrow-head dug from some primitive barrow of undated centuries before the Christian era, and the corresponding weapon brought by some recent traveler from Tierra del Fuego or regions beyond the Rocky Mountains. The inference is therefore legitimate, that in those Polynesians, Fuegians, or Indians of the North-West, we have examples of tribes in the same primitive stage as were the aborigines of Europe during its stone period. Chronologically, however, the stone period of Europe and that of the Pacific islands or the American continent are separated by thousands of years. In like manner, the bronze age of Mexico was undisturbed by all later elements when first brought into contact with the matured civilization of Europe in the 16th century, while the close of that of Britain preceded the 1st century of our era. The same rule is applicable to the primitive archæology of all countries; and a fertile source of error and misconception has already had its rise in the assumption that because Greece and Italy, Germany, Gaul, Scandinavia, and Britain, have all had their primitive stone and bronze periods, therefore the whole must have been contemporaneous. It cannot therefore be too strongly enforced as one of the most essential points of variance in the reasoning of the geologist and the archæologist, that the periods of the latter, though synonymous, are not necessarily synchronous; but that, on the contrary, nearly all the phenomena which pertain to the *natural history* of man, and to the historic development of the race, may be witnessed in their various stages in contemporary races of our own day—from rudimentary barbarism, and the absence of all arts essential to the first dawn of civilization to a state of greatest advancement in the knowledge and employment of such arts.

Some progress has already been made in an approximation to certain chronological data of much importance relative to such primitive periods of the history of nations. But the archæologist, as well as the geologist, is learning to deal with periods of time which cannot always be measured either by years or centuries, but rather must be gauged by those chronological stages in the history of our planet in which epochs and periods take the place of definite subdivisions of solar time. Nevertheless, geological evidence of changes which are known to have occurred within the historic period supplies an important key to the approximate duration of certain eras characterized by traces of human art; and while by the intelligent observation of such remains in the superficial strata, mingling with the fossil evidences of extinct and familiar species of animal life, the link is supplied by which man takes his place in an unbroken chain of creative existence, sweeping back into so remote a past, the evidences of matured art pertaining to periods unrecorded by history supply later links of the same chain, and reunite the present with all former ages.

The system of primitive archæology which is found applicable to British antiquities so closely corresponds in all its essential features to that of Europe prior to the era of authentic history, that the purpose of such an abstract as this will be most conveniently accomplished by presenting its leading points as examples of the whole, illustrating these in passing by the analogous remains discovered in other countries. The apparent simplicity of a primitive stone period has been considerably modified by recent research; and the careful study of the remains of ancient art, in their relation to accompanying geological phenomena, or of the evidences of artificial deposition in caves, barrows, chambered cromlechs, cairns, or other sepulchral structures, suggests the subdivision of prehistoric archæology into a succession of epochs included within the period of nonmetallurgic arts.

But before defining the archæological subdivisions of time it is indispensable to glance at the palæontological elements of the question, and the evidences they supply in relation to comparative chronology. One of the most remarkable phenomena affecting the conditions of life in Europe in recent geological epochs is the existence of a period, of long duration throughout the northern hemisphere, of a temperature resembling that of the Arctic regions at the present time. After a period more nearly approximating in its conditions the heat of the tropics at the present day, though otherwise under varying states toward the end of the tertiary epoch the temperature of the whole northern hemisphere gradually diminished, until the mountainous regions of Scotland and Wales—then probably of a much higher elevation—resembled Greenland at the present time; and this Arctic temperature gradually extended southward to the Alps and the Pyrenees. The glaciers formed under the influence of perpetual frost and snow descended from those and other mountains into the valleys and plains over the greater portion of central Europe and northern Asia; and this condition of things, pertaining to what is known as the *glacial period*, was one of greatly prolonged duration.

After some partial modifications of this low temperature, and a consequent advance and retrocession of the glacial influences in France and elsewhere, along what was then the border lines of a north temperate zone, the glacial period drew to a close; a gradual but persistent rise of temperature carried the lines of ice and perpetual snow further and further northward, excepting in regions of great elevation, as in the Swiss Alps. This was necessarily accompanied by the melting of the vast glaciers accumulated in the mountain valleys throughout the protracted period of cold. The broken rocks and soil of the highlands were swept into the valleys by torrents of melted ice and snow; the lower valleys were hollowed out and re-formed under this novel agent; and the landscape received its present outlines of valley, estuary, and riverbeds from the changes wrought in this *diluvian epoch*. The enormous power of the torrents thus acting continuously throughout a period of prolonged duration, and the vast deposits of sand, gravel, and clay, with the embedded remains of contemporaneous animal and vegetable life with which they everywhere covered the plains, were viewed till recently solely in relation to the Mosaic narrative of a universal deluge, and were referred implicitly to that source. But recent though the epoch is when compared with older geological periods, its antiquity is enormous in relation to historic chronology; and instead of being the product of a sudden cataclysm of brief duration, it represents phenomena which required a period of long protracted centuries for their evolution.

Within this late tertiary, or quaternary, period are found the remains of animal life contemporary with primeval man and his earliest arts. The very characteristics of some of the fossil mammals of the period, so diverse from all that we have been accustomed to associate with man, help to suggest ideas of even an exaggerated antiquity for the era to which they are assignable, and to relegate it to the remotest conceivable antiquity consistent with all other evidence of the oldest traces of man or his arts seemingly contemporaneous with them. Of those now wholly extinct, the mammoth or *Elephas primigenius*, the *Elephas antiquus*, the *Rhinoceros tichorinus*, the *Hippopotamus major*, and such great cave carnivora as the *Ursus spelæus* and the *Felis spelæa*, are most noticeable for their great size, and in some cases for their enormous destructive powers, in striking contrast to the seemingly helpless condition of primitive man. Yet even some of those formidable mammalia probably owed their extinction fully as much to the presence of man as to any change in temperature and consequent alteration in the required conditions of climate and habitat. We are accustomed to regard the lion, tiger, leopard, panther, and others of the great *Felidæ* as pertaining exclusively to tropical countries. They are in reality limited to tropical jungles and uncultivated regions of great extent, where the abundance of wild vegetable-feeding animals supplies their food. The existence of neither is compatible with the presence of man in any great numbers; but in his absence those beasts of prey greatly extend their range. The Indian tiger not only follows the antelope and deer in the Himalayan chain to the verge of perpetual snow, but the tiger, leopard, panther, and cheetah hunt their prey beyond that mountain range, even into Siberia.

The influence of man in the extirpation of the wild fauna is illustrated by another class of extinct animals of many historical regions, which yet survive in more favorable localities. The discovery of abundant evidence of a period in the history of central and southern France when the reindeer (*Cervus tarandus*) formed one of the chief sources both for the food of man and for the materials from which his weapons and implements were made, seems to carry us back to an era inconceivably remote, when central France was in the condition of Lapland in mediæval or still earlier centuries. But the climate of North Britain is not even now incompatible with the existence of the reindeer, and its favorite moss abounds in many parts of the Highlands. It need not therefore surprise us to learn that traces of the reindeer are by no means rare in Scotland; and numerous examples of its horns have recently been recovered in more than one Caithness locality, with the marks of sawing and cutting for artificial use, and lying among other remains in stone-built structures of a primitive population of North Britain. How old they are may not be strictly determinable, but they help us to the acceptance of a very modern date for the presence of the reindeer there; for Torfæus states that so recently as the twelfth century the Jarls of Orkney were wont to cross the Pentland Firth to chase the roe and the reindeer in the wilds of Caithness. At the same date also we find the skin of the beaver rated for customs duties amongst articles of Scottish export specified in an Act of the reign of David I.

Another very characteristic animal pertaining to the prehistoric era of European man is the *Megaceros Hibernicus*, or gigantic Irish elk. Its bones occurred with those of the *Elephas primigenius*, the *Rhinoceros tichorinus*, the *Ursus spelæus*, and other extinct mammals, alongside of human remains and works of art, in the famous Aurignac cave of the Pyrenees; and in the recently-explored Brixham cave, on the Devonshire coast, similar remains of the fossil rhinoceros, horse, and reindeer, as well as of several extinct carnivora, lay embedded in the same breccia with flint knives. And not only have the horns and bones of the *Megaceros Hibernicus* been recovered from Irish bogs and marl-pits, with marks of artificial cutting, but a rude Irish lyre, found in the moat of Desmond Castle, Adare, has been pronounced by Professor Owen to be made from the bone of this extinct deer.

So is it with the ancient *Bovidæ*, not only adapted for the chase, but suitable for domestication; such as the *Bos primigenius*, the *Bos longifrons*, and the *Bison priscus*. Their remains have been found in submarine forests, or mingling in the drift or cave deposits with the *Elephas primigenius*, the *Felis spelæa*, and others of the most gigantic fossil mammals; while abundant traces reveal their existence not merely contemporaneous with man, but within definite historical periods.

The great alluvial valley of the river Forth has yielded another class of relics connecting the gigantic fossil mammalia of a prehistoric epoch with man. The disclosures of the Carse of Falkirk have repeatedly included remains of the *Elephas primigenius*: and in at least one case its tusks were found in such perfect condition as to be available for the ivory-turner, though lying embedded at a depth of 20 feet in the boulder clay. But in the neighboring valley of the Forth the fossil whale (*Balænoptera*) has not only been repeatedly found far inland, buried in the alluvial soil, at levels varying from 20 to 25 feet above high-water mark, but in at least two instances the rude lance or harpoon of deer's horn lay alongside of the skeletons; and near another of them were found pieces of stag's horn, artificially cut, and one of them perforated with a hole about an inch in diameter. Flint implements, an oaken quern, and other ingenious traces of primitive art, recovered from the same alluvial soil, all tell of a time when the British savage hunted the whale in the shallows of a tide at the base of the Ochil hills, now between 20 and 30 feet above the highest tides and 7 miles distant from the sea.

There is no doubt that the disappearance of the whale from the British shores, like the reindeer from its northern valleys, is due far more to the presence of man than to any change of temperature so greatly affecting the conditions of life as to involve their extinction. Nevertheless it is convenient to recognize in the disappearance of such emigrant species from the historic areas the close of the palæontological age. The Urus, the Aurochs, the *Bos longifrons*, or native ox of the Roman period, and others of that important class of animals which man first began to turn to account for domestication, have also ceased to exist among European fauna; but this is clearly traceable to the destructive presence of man. Within three or four centuries the Urus (*Bos primigenius*) was still known in Germany; the Aurochs (*Bos priscus*) is even now preserved under special protection in Lithuania; and herds of British wild cattle in Cadzow forest, Lanarkshire, and at Chillingham Park, Northumberland, perpetuate varieties otherwise extinct.

Reverting, then, to the classification which prehistoric archæology admits of, in the light of its most recent disclosures, it appears to be divisible into four distinct epochs, of which the first two embrace successive stages of the age of stone implements.

1. The *Palæolithic Period* is that which has also been designated the Drift Period. The troglodytes, or cave-dwellers, of this primitive era were to all appearance contemporaneous with the mammoth, the woolly-haired rhinoceros, and the great cave carnivora already named. In England, France, Belgium, and other countries of Europe, numerous caves have been explored which were undoubtedly the habitations and workshops of the men of this period. These caverns vary in character and dimensions according to the geological features of the localities where they occur, but all alike involve the simple feature of recesses, more or less ample, affording comparatively dry and commodious shelter, and so being resorted to as places of habitation alike by wild animals and by man himself. But the most valuable for the purposes of the archæologist are a class of caverns which occur in limestone districts, and which, from the combined mechanical action of

the water operating on a rock easily eroded, and its chemical action when charged with a certain amount of carbonic acid in dissolving the calcareous rock, are found expanded into long galleries and chambers of large dimensions. There the same chemical agents, acting under other circumstances, have dissolved the limestone rock, and sealed up the ancient flooring at successive intervals, thereby furnishing a test of the duration of long periods of alternate action and repose, and yielding evidence of the most indisputable kind as to the order of succession of the various deposits and their included bones and implements.

In Belgium, at Dordogne, and in some parts of the south of France, the caves and rock-recesses are of a much simpler character. Yet there also favoring circumstances have preserved contemporary deposits of the ancient cave-dwellers, their works of art, the remains of their food, and even their cooking hearths.

The caves of the drift period accordingly present peculiarly favorable conditions for the study of the post-pliocene period. Some of these caverns were evidently first occupied by the extinct carnivora of that period, as in the case of the famous Kent's Hole Cave of Devonshire, of which the lowest deposit is a breccia of water-worn rock and red clay, interspersed with numerous bones of the *Ursus spelæus*, or great cave-bear. Over this a stalagmitic flooring had been formed, in some places to a depth of several feet, by the long-protracted deposition of carbonate of lime held in solution in the drippings from the roof. Above this ancient flooring, itself a work of centuries, later floods had superimposed a thick layer of "cave-earth," in some cases even entirely filling up extensive galleries with a deposit of drift-mud and stones, within which are embedded the evidences of contemporaneous life—bones and teeth of the fossil elephant, rhinoceros, horse, cave-bear, hyæna, reindeer, and Irish elk; and along with these, numerous weapons and implements of chipped flint, horn, and bone—the unmistakable proofs of the presence of man. These, again, have been sealed down, in another prolonged period of rest, by a new flooring of stalagmite; and thus the peculiar circumstances of those cave deposits render them specially favorable for the preservation of a coherent record of the period. Here are the evidences of the animal life contemporaneous with the men of the caves during the drift period; here also are many of their smaller flint implements—the flint-cores and the chips and flint-flakes, showing where their actual manufacture was carried on; and the lances, bodkins, and needles of bone, which could only have been preserved under such favoring circumstances.

But besides the actual deposits in the caves, the river gravels of the same period have their distinct disclosures. The spear-heads, discs, scrapers, and other large implements of chipped flint are of rare occurrence in the cave breccia. Their size was sufficient to prevent their being readily dropt and buried beyond reach of recovery in the muddy flooring of the old cave dwelling; and the same cause preserved them from destruction when exposed to the violence involved in the accumulation of the old river drifts. In the north of France, and in England from Bedfordshire southward to the English Channel, in beds of ancient gravel, sand, and clay of the river valleys, numerous discoveries of large flint implements have been made—from the year 1797, when the first noted flint implements of the drift were discovered in the same stratified gravel of Hoxne, in Suffolk, in which lay bones of the fossil elephants and other extinct mammalia. The characteristics of the river-drift implements, as well as of the whole art of the stone age, have been minutely described and illustrated in various works, but especially in Evans's *Ancient Stone Implements, Weapons, and*

Ornaments of Great Britain. It is sufficient, therefore, to refer to such authorities for details.

But besides the numerous specimens of the manufactures in flint, horn, and bone, illustrative of the mechanical ingenuity of this primitive era, special attention is due to the actual evidences of imitative and artistic skill of the sculptors and draughtsmen of the same period.

Different attempts have been made, especially by French *savans*, to subdivide the palæontologic age of man into a succession of periods, based chiefly on the character of the mammalian remains accompanying primitive works of art; and the two great subdivisions of the elephantine or mammoth age and the reindeer age have been specially favored. Among the works of art of the cave-men of Perigord, in central France, contemporary with the reindeer, various drawings of animals, including the reindeer itself, have been found incised on bone and stone, apparently with a pointed implement of flint. But the most remarkable of all is the portrait of a mammoth, seemingly executed from the life, outlined on a plate of ivory found in the Madelaine Cave, on the river Vezère, by M. Lartet, when in company with M. Verneuil and Dr. Falconer. If genuine—and the circumstances of the discovery, no less than the character of the explorers, seem to place it above suspicion—this most ancient work of art is of extreme value. The skulls and other remains of five individuals have been found to illustrate the men of this period. The cerebral development is good, and alike in features and form of head they compare favorably with later savage races. Their drawings embrace animals, single and in groups, including the mammoth, reindeer, horse, ox, fish of different kinds, flowers, ornamental patterns, and also ruder attempts at the human form. They also carved in bone and ivory. Some of the delineations are as rude as any recent specimens of savage art, others exhibit considerable skill; but the most remarkable of all is the representation of the mammoth. It has been repeatedly engraved, and as, to all appearance, a genuine contemporary effort at the portraiture of that remarkable animal, its worth is considerable. But this sinks into insignificance in comparison with its value as a gauge of the intellectual capacity of the men of that remote age. It represents the extinct elephant, sketched with great freedom of hand, and with an artistic boldness in striking contrast to the labored efforts of an untutored draughtsman. Whatever other inference be deduced from it, this is obvious, that in intellectual aptitude the palæolithic men of the reindeer period of central France were in no degree inferior to the average Frenchman of the 19th century.

2. This first, or palæolithic period, with its characteristic implements of chipped flint, belonging to an epoch in which man occupied central Europe contemporaneously with the mammoth, the cave-bear, and other long-extinct mammals, was followed by the second or *Neolithic Period*, or, as it has been sometimes called, the Surface-Stone Period, in contradiction to the Drift Period, characterized by weapons of polished flint and stone. The discovery and exploration of the ancient *Pfahlbauten* or lake villages of Switzerland and other countries, including the crannoges of Ireland and Scotland, and of the *kjökken-möddings* or refuse-heaps of Denmark, Scotland, and elsewhere, have greatly extended the illustrations of this period, and given definiteness to the evidences of its antiquity. But while it thus includes works of a very remote epoch, it also embraces those of later regular sepulture, with the sepulchral pottery of rudest type, the personal ornaments and other remains of the prehistoric races of Europe, onward to the dawn of history. It even includes the first traces of the use of the metals, in the employment of gold for personal adornment, though with no intelligent

recognition of its distinction from the flint and stone in which the workmen of this neolithic period chiefly wrought.

The nearly indestructible nature of the materials in which the manufacturers alike of the palæolithic and the neolithic period chiefly wrought, helps to account for the immense number of weapons and implements of the two prolonged ages of stone-working which have been recovered. The specimens now accumulated in the famous collection of the Christiansborg Palace at Copenhagen amount to several thousands. The Royal Irish Academy, the Society of Antiquaries of Scotland, the British Museum, and other collections, in like manner include many hundreds of specimens, ranging from the remotest periods of the cave and drift men of western Europe to the dawn of definite history within the same European area. They include hatchets, adzes, gouges, chisels, scrapers, disks, and other tools in considerable variety; axes, lances, spear and arrow heads, mauls, hammers, and other weapons and implements of war and the chase; besides a variety of utensils, implements, and ornaments, with regard to which we can but vaguely guess the design of their construction. Many of these are merely chipped into shape, sometimes with much ingenuity, in other cases as rudely as the most barbarous and massive implements of the palæolithic period. But from their association, in graves or other clearly-recognized deposits of the later period, with ground and polished implements, and even occasionally with the first traces of a time when the metals were coming into use, there is no room to question their later origin. In part they may be legitimately recognized, like the whole elements of archæological classification, to mark different degrees of rudeness in successive steps toward civilization; in part they indicate, as in manufactures of our own day, the economy of labor in roughly-fashioned implements designed only for the rudest work, or for missiles the use of which involved their loss.

To the same primitive period of rude savage life must be assigned the rudiments of architectural skill pertaining to the *Megalithic Age.* Everywhere we find traces, alike throughout the seats of oldest civilization and in earliest written records, including the historical books of the Old Testament Scriptures, of the erection of the simple monolith, or unhewn pillar of stone, as a record of events, a monumental memorial, or a landmark. There is the Tanist Stone, or kingly memorial, like that set up in Shechem when Abimelech was made king; the Hoar Stone, or boundary-stone, like "the stone of Bohan, the son of Reuben," and other ancient landmarks of Bible story; the Cat Stone, or battle-stone, a memorial of some great victory; and the stone set up as the evidence of some special treaty or agreement, like Laban and Jacob's pillar of witness at Galeed. To the same primitive stage of architecture belong the cromlech, the cairn, the chambered barrow, and other sepulchral structures of unhewn stone; as well as the weems, or megalithic subterranean dwellings common in Scotland and elsewhere, until, with the introduction of metals and the gradual mastery of metallurgic art, we reach the period of partially hewn and symmetrical structures, of which the great temple of Stonehenge is the most remarkable example. But it is in Egypt that megalithic architecture is seen in its most matured stage, with all the massiveness which so aptly symbolizes barbarian power, but also with a grandeur, due to artistic taste and refinement, in which the ponderous solidity of vast megalithic structures is relieved by the graces of colossal sculpture and of an inexhaustible variety of architectural detail. There appears to be a stage in the development of the human mind in its progress toward civilization when an unconscious aim at the expression of abstract power tends to beget an era of megalithic art. The huge cromlechs, monoliths, and circles still abounding in many centers of European civilization perpetuate the evidence of such a transitional stage among its prehistoric races. But it was in Egypt that an isolation, begot by the peculiar conditions of its unique physical geography, though also perhaps ascribable in part to certain ethnical characteristics of its people, permitted this megalithic art to mature into the highest perfection of which it is capable. There the rude unhewn monolith became the graceful obelisk, the cairn was transformed into the symmetrical pyramid, and the stone circles of Avebury and Stonehenge, or the megalithic labyrinths of Carnac in Brittany, developed into colonnaded avenues and temples, like those of Denderah and Edfu, or the colossal sphinx avenue of Luxor.

Elaborately-finished axes, hammerheads, cups, and vases of the late neolithic era serve to illustrate the high stage to which the arts of a purely stone period could be advanced, in the absence of any process of arrestment or change. But long before such a tendency to development into ornamental detail and symmetrical regularity of construction could be brought to bear on the megalithic architecture of the same era, the metallurgic sources of all later civilization had begun to supersede its rude arts. To such remote eras we strive in vain to apply any definite chronology. At best we work our way backward from the modern or known into the mysterious darkness of remotest antiquity, where it links itself to unmeasured ages of geological time. But by such means science has been able to add a curious chapter to the beginnings of British and of European story, involving questions of mysterious interest in relation to the earliest stages in the history of man. The very characteristics which distinguish him in his rudest stage from all other animals have helped from remotest times to perpetuate the record of his progress.

The evidences of the various acquirements and degrees of civilization of the prehistoric races of Britain are derived not only from weapons, implements, pottery, and personal ornaments found deposited in ancient dwellings and sepulchres; but from still older traces supplied by chance discoveries of the agriculturist, miner, and builder, such as the implements of the ancient whalers of the Forth, or the monoxylous oaken canoes dug up from time to time in the valley of the Clyde, or even beneath some of the most ancient civic foundations of Glasgow. Both alike pertain to areas of well-defined historical antiquity, from the very dawn of written history, or of literate chronicles in any form; and both also have their geological records, preserving the evidence of changes of level in unrecorded centuries subsequent to the advent of man, when the whales of the Forth and the canoes of the Clyde were embedded in the alluvium of those river-valleys, and elevated above the ancient tide-marks of their estuaries. Another change of level, possibly in uninterrupted continuance of the ancient upheaval, has been in progress since the Roman invaders constructed their military roads, and built their wall between the Forth and the Clyde, in the 1st and 2d centuries of the Christian era.

By evidence such as this a starting-point is gained whence we may confidently deduce the colonization of the British Islands, and of the north of Europe, at periods separated by many centuries from that in which our island first figures in history. The researches of the ethnologist add to our knowledge of this unrecorded era, by disclosing some of the physical characteristics of the aboriginal races, derived from human remains recovered in cave-drifts, ancient mining shafts, bogs, and marl-pits, or found in the most ancient sepulchres, accompanied by rudest evidences of art; and the researches of Nilsson, Eschricht, Gosse, Rathke, Broca, and other Continental ethnologists, along with those which have been carried on with minute care in the British Islands, disclose characteristic cranial types indicating a succession of prehistoric races different from the predominant types belonging to the historical period of Europe; and some of them probably contemporaneous with the changes indicated in the periods of archæological time.

The very latest stage of archæological antiquity, when it seems to come in contact with the dawn of historic time, was unquestionably one of complete barbarism, as is sufficiently apparent from its correspondence to that which the intercourse with European voyagers is bringing to a close among the islands of the Pacific. The ancient Scottish subterranean dwellings termed weems (Gaelic *uamhah*, a cave), or "Picts' houses," have been frequently found, apparently in the state in which they must have been abandoned by their original occupants; and from those we learn that their principal aliment must have been shell-fish and crustacea, derived from the neighboring sea-beach, along with the chance products of the chase. The large accumulations of the common shell-fish of our coasts found in some of those subterranean dwellings is remarkable; though along with such remains the stone quern or hand-mill, as well as the ruder corn-crusher or pestle and mortar, repeatedly occur; supplying the important evidence that the primitive nomade had not been altogether ignorant of the value of the cereal grains.

The source of change in Britain, and throughout Europe, from this rude state of barbarism, is clearly traceable to the introduction of metals and the discovery of the art of smelting ores. Gold was probably the earliest metal wrought both from its attractive appearance, and from its superficial deposits, and the condition in which it is frequently found, rendering its working an easy process. Tin also, in the south of Britain, was wrought at the very dawn of history: and, with the copper which abounds in the same district of country, supplied the elements of the new and important compound metal, bronze.

3. This accordingly indicates the transition from the later stone age to the third or *Bronze Period*, which, beginning apparently with the recognition of the native copper as a malleable metal, and then as a material capable of being melted and molded into form by the application of heat, was followed up by the art of smelting the crude ores so as to extract the metal, and that of mixing metals in diverse proportions so as to prepare an alloy of requisite ductility or hardness, according to the special aims of the artificer.

Along with the full mastery of the working in copper and bronze the skill of the goldsmith was correspondingly developed; and the ornaments of this period, including torques, armlets, beads, and other personal decorations and insignia of office, wrought in gold, are numerous, and often of great beauty. The pottery of the same period exhibits corresponding improvement in material, form, and ornamentation; though considering the mimetic and artistic skill shown in the drawings and carvings of the remotest periods, it is remarkable that the primitive pottery of Europe is limited, alike in shape and decoration, to purely arbitrary forms. This in its crudest conventionalism consists almost exclusively of varieties of zigzag patterns scratched or indented on the soft clay. This primitive ornamentation seems so natural, as the first æsthetic promptings of the human mind, that it is difficult, if not in some cases impossible, to distinguish between the simple pottery of comparatively recent origin, recovered on the sites of old American Indian villages, and primitive pottery obtained from British barrows pertaining to centuries long prior to the Christian era. But the fictile ware exhibits an improvement in some degree corresponding to that of the metallurgic art, which everywhere throughout Europe furnishes weapons, implements, and personal ornaments of the bronze period, characterized by much grace and delicacy in form, and by an ornamentation peculiar in style, but not unworthy of the novel forms and material.

It was long assumed, alike by historians and antiquaries, that the beautiful bronze swords, spear-heads, shields, torques, armillæ, etc., so frequently discovered, were mere relics of foreign conquest or barter, and they were variously assigned to Egyptian, Phœnician, Roman, or Danish origin. But this gratuitous assumption has been disproved by the repeated discovery of the molds for making them, as well as of the refuse castings, and even of beds of charcoal, scoriæ, and other indications of metallurgy, on the sites where they have been found. It has not escaped notice, however, that the transition appears to be an abrupt one from stone to bronze, an alloy requiring skill and experience for its use; and that few examples are recorded of the discovery of copper tools or weapons, though copper is a metal so easily wrought as to have been in use among the Red Indians of America. The inference from this fact is one which all elements of probability tend to confirm, viz., that the metallurgic arts of the north of Europe are derived from a foreign source, whether by conquest or traffic; and that in the beautiful bronze relics so abundant, especially in the British Islands and in Denmark, we see the fruits of that experience which the more ancient civilization of Egypt and Phœnicia had diffused. The direct intercourse between the countries on the Mediterranean and the Cassiterides, or Tin Islands,—as the only known parts of the British Islands are called in the earliest allusions which are made to them by Herodotus, Aristotle, and Polybius,—abundantly accounts for the introduction of such knowledge to the native Britons at a very remote period. Phœnician and Carthaginian merchant ships traded to Cornwall centuries before the white cliffs of Albion were first seen from the Roman war-galleys. Greece also, not improbably, proved a mediator in this all-important transfer. It is at least to be noted that the forms of weapons, and especially of the beautiful "leaf-shaped sword," as figured on the most ancient painted Greek vases, closely correspond to the most characteristic relics of the bronze period in the north of Europe and the British Isles.

In reviewing the characteristics of this bronze period, the disclosures of native art on the American continent supply some singularly interesting and suggestive illustrations. There, throughout the whole northern regions of the North American continent and in the ruder areas of South America, as well as in the West Indian archipelago, a population was found consisting exclusively of rude nomad hunters, in a pure stone period of primitive savage art. Nor does it at all conflict with this that they were to a certain extent familiar with the resources of the rich copper regions of Lake Superior, where that metal is found in enormous masses in a malleable state. This they procured, and not only themselves employed it in the manufacture of weapons, implements, and personal ornaments, but distributed it by barter far down the Ohio and Mississippi valleys, and eastward to the great lakes, to the St. Lawrence valley, and to the Hudson river. Silver and lead are also found in the same rich mineral region in metallic crystals, and were not unknown to the native tribes. But everywhere those metals were cold-wrought, as a mere malleable stone capable of being hammered into any desired shape, but in total ignorance of the influence of fire or the use of alloys.

But wholly distinct from its rude Indian tribes, North America had its semi-civilized Mexicans and South America its more highly civilized Peruvians, who had learned to mine and smelt the ores of the Andes, and make metallic alloys wherewith to fashion for themselves bronze tools of requisite hardness for quarrying and hewing the solid rock. With these they sculptured the statues of their gods, and reared palaces, temples, and pyramids, graven with elaborate sculptures and hieroglyphics by a people wholly ignorant of iron, which have not unjustly suggested many striking analogies with the megalithic art of ancient Egypt. The *huacas*, or tombs of the Incas of Peru, and also their royal depositories of treasure, have disclosed many remarkable specimens of elaborate metallurgic skill,—bracelets, collars, and other personal ornaments of gold; vases of the same abundant precious metal, and also of silver; mirrors of burnished silver, as well as of obsidian; finely-adjusted silver balances; bells both of silver and bronze; and numerous common articles and tools of copper, or of the more efficient alloy of copper and tin,—all illustrative of the arts and civilization of a purely bronze age.

4. The fourth or *Iron Period* is that in which the art of smelting the ores of the most abundant metal had at length been mastered; and so iron superseded bronze for arms, sword-blades, spear-heads, axes, daggers, knives, etc. Bronze, however, continued to be applied to many purposes of personal ornament, horse furniture, the handles of swords and other weapons; nor must it be overlooked that flint and stone were still employed for lance and arrow-heads, sling-stones, and other common purposes of warfare or the chase, not only throughout the whole bronze period, but far into the age of iron. The discovery of numerous arrow-heads, or flakes of black flint, on the plain of Marathon, has been assumed with good reason to point to the use of such rude weapons by the barbarian host of Darius; and the inference is confirmed by the facts which Herodotus records, that Ethiopian auxiliaries of the army of Xerxes, ten years later, were armed with arrows tipped with stone.

The essential change resulting from the maturing of the iron period lies in the unlimited supply of the new metal. Had bronze been obtainable in sufficient quantity to admit of its application to the endless purposes for which iron has since been employed, the mere change of metal would have been of slight significance. But the opposite was the case. The beautiful alloy was scarce and costly; and hence the arts of the neolithic period continued to be practiced throughout the whole duration of the age of bronze. But iron, though so abundant in its ores, requires great labor and intense heat to fuse it; and it needed the prolonged schooling of the previous metallurgic era to prepare the way for the discovery of the properties of the ironstone, and the processes requisite to turn it to account. Iron, moreover, though so abundant, and relatively of comparatively recent introduction, is at the same time the most perishable of metals. It rapidly oxidizes unless protected from air and moisture, and hence few relics of this metal belonging to the prehistoric period have been preserved in such a state as to illustrate the skill and artistic taste of the fabricators of that last pagan era, in the way that the implements of the three previous periods reveal to us the habits and intellectual status of those older times.

But the iron is the symbol of a period in which pottery, personal ornaments of the precious metals, works in bronze, in stone, and other durable materials, supply ample means of gauging the civilization of the era, and recognizing the progress of man in the arts, until we come at length to connect their practice with definite historical localities and nations, and the names of Egypt and Phœnicia, of Gadir, Massilia, the Cassiterides, and Noricum, illuminate the old darkness, and we catch the first streak of dawn on a definite historical horizon. Thus, with the mastery of the metallurgic arts is seen the gradual development of those elements of progress whereby the triumphs of civilization have been finally achieved, and man has advanced toward that stage in which the inductive reasonings of the archæologist are displaced by records more definite, though not always more trustworthy, as the historian begins his researches with the aid of monumental records, inscriptions, poems, and national chronicles.

Within the later iron period, accordingly, we reach the era of authentic history. There is no room for doubt that, whatever impetus the Roman invasion may have given to the working of the metals in Britain, iron was known there prior to the landing of Julius Cæsar. Within this archæological period, however, the examples of Roman art and the influences of Roman civilization begin to play a prominent part. To this period succeed the Saxon and Scandinavian eras of invasion, with no less characteristic peculiarities of art workmanship, as well as of sepulchral rites and social usages. In these later periods definite history comes to the aid of archæological induction, while those intermediate elements of historical re-edification, the inscriptions on stone and metal, and the numismatic series of chronological records, all unite to complete a picture of the past replete with important elements for the historian.

The connection between archæology and geology has been indicated, but that between archæology and ethnology is of much more essential significance, and is every day being brought into clearer view. By the investigation of the tombs of ancient races, and the elucidation of their sepulchral rites, remarkable traces of unsuspected national affinities are brought to light; while a still more obvious correspondence of arts in certain stages of society, among races separated alike by time and by space, reveals a uniformity in the operation of certain *human instincts*, when developed under nearly similar circumstances, such as goes far to supply a new argument in proof of the unity of the human race.

The self-evident truths confirmatory of the principles upon which this system of primitive archæology is based, may be thus briefly summed up:—Man, in a savage state, is to a great extent an isolated being; co-operation for mutual and remote advantage, except in war and the chase, is scarcely possible; and hence experience at best but slowly adds to the common stock of knowledge. In this primitive stage of society the implements and weapons which necessity renders indispensable are invariably supplied from the sources at hand; and the element of time being of little moment, the rude workman fashions his stone axe or hammer, or his lance of flint, with an expenditure of labor such as, with the appliances of civilization, would suffice for the manufacture of hundreds of such implements.

The discovery of the metallurgic arts, by diminishing labor and supplying a material more susceptible of varied forms as well as of ornamentation, and also one originating co-operation by means of the new wants it calls into being, inevitably begets social progress. The new material, moreover, being limited in supply, and found only in a few localities, soon leads to barter, and thence to regular trade; and thus the first steps toward a division of labor and mutual co-operation are made. So long, however, as the metal is copper or bronze, the limited supply must greatly restrict this social progress, while the facilities for working it admit of that isolation so natural to man in a rude state; and these, added to the frequent discovery of copper, in its natural condition much more nearly resembling a ductile metal than the ironstone, abundantly account for its use having preceded that of the more abundant metal.

Great experience must have been acquired in earlier metallurgy before the iron ore was attempted to be wrought. In this, co-operation was indispensable; but that once secured, and the first difficulties overcome, the other results appear inevitable. The supply is inexhaustible, widely diffused, and procurable without excessive labor. The material elements of civilization were thereby rendered available, and all succeeding progress might be said to depend on the capacity of the race.

The simplicity which characterizes the archæological disclosures of Scandinavia, Germany, Ireland, and other regions of trans-Alpine Europe lying outside of the range of ancient Greek or Roman influences, has contributed some important aids to the study of prehistoric arts; but the full significance of their teachings has yet to be tested by comparison with the primitive arts pertaining to Egypt, Greece, Asia Minor, and other ancient centers of earliest civilization. To this certain singularly interesting disclosures of very recent date, which some have regarded as at variance with the foregoing classification of archæological epochs, help to furnish the desired materials. The researches of Dr. Heinrich Schliemann on one of the most memorable sites which epic poetry has selected for the mythic beginnings of history, have brought to light what he believes to be actual remains of the Troy of the *Iliad.* Dr. Schliemann began his systematic explorations in 1871, and pursued them, during the available seasons, till the month of June, 1873. With patient assiduity the accumulated debris on the scene of ancient civic settlement was sifted and opened up by regular excavations, till the natural rock was exposed at a depth of upward of 50 feet. Throughout the whole of this, abundant traces of former occupation were brought to light; and so great an accumulation of debris and rubbish upon an elevated site affords undoubted evidence of the vicissitudes of a long-settled center of population. To this specific evidence lent additional confirmation. The foundations of a temple, supposed to be that of the Ilian Athena of the time of Alexander, along with coins, inscriptions, and numerous remains of architecture and sculpture, combined to fix the era of an ancient, but strictly historical, period. At a further depth of upward of 6 feet, broken pottery, implements of bronze, and charred wood and ashes, showed the traces of an older settlement which had perished by fire. But the artificial character of the debris encouraged further research; and when the excavations had been carried to about double the depth, Dr. Schliemann came upon a deposit rich in what may be styled neolithic remains: axes, hammers, spear-heads, and other implements of polished diorite or other stone, weights of granite, querns of lava, and knives and saws of flint abounded, associated with plain, well-executed pottery, but with only two pins of copper or bronze to indicate any knowledge of metal. Continued excavations brought to light additional stone implements and weapons; until at a depth of some 33 feet, well-wrought implements and weapons of bronze, and pottery of fine quality and execution, revealed the traces of an earlier civilization on the same ancient site.

In all this, while there is much to interest, there is nothing to surprise us. Here, near the shores of the Hellespont, at a point accessible to the oldest known centers of civilization,—to Egypt, Phœnicia, Assyria, Greece, Carthage, and Rome,—a civilized community, familiar with the arts of the bronze period of the Mediterranean shores, appears to have yielded to vicissitudes familiar enough to the student of ancient history. After a time the desolated locality tempted the settlement of some barbarian Asiatic horde, such as the steppes of that continent could furnish even now. They were ignorant of metallurgic arts; though probably, like the savage tribes of the New World at the present time, not wholly unaware of the manufacture of implements and weapons of bronze or other metals. Such a local alternation of bronze and stone periods in a region lying in close proximity alike to vast areas of Asiatic barbarism, and to the most important centers of ancient civilization, in no degree conflicts with a general system of succession of archæological periods. Mexico and Peru, while in a purely bronze age, were overthrown by Spanish invaders. Large portions of their ancient territories were abandoned to utter barbarism, and even now are in the occupation of savage tribes. But the ancient city of Montezuma has been made the capital of a civilized state; the beds of its canals have been filled up, burying therein obsidian, stone, and bronze implements, pottery, sculptures, and much else pertaining to its ante-Columbian era; and it only requires such a fate as its modern history renders conceivable enough, to leave for future ages the buried strata of a civic site revealing similar evidences of the alternation of semi-civilized, barbarian, and civilized ages, on the same long-inhabited site of Toltecans and Aztecs, Indian savages, and modern Mexicans and Spaniards.

That man has everywhere preceded history is a self-evident truth. So long as no scientific evidence seemed to conflict with a long-accepted chronology in reference to the antiquity assigned to the human race, it remained unchallenged, though the like computation had been universally rejected in reference to the earth as the theater of his history, and we were content to regard the prehistoric era of man as no more than a brief infancy of the race. But the investigations and disclosures of recent years in reference to the whole prehistoric period have involved of necessity a reconsideration of the grounds on which a definite antiquity of comparatively brief duration has been assigned to man; and the tendency at present is rather to exaggerate than to diminish the apparent antiquity of the race. The nature and extent of the evidence which has thus far rewarded intelligent research have been sufficiently indicated above; and as it is still far from complete, the student of archæology will act wisely in pushing forward his researches, and accumulating and comparing all available evidence, without hastily pronouncing any absolute verdict on this question. But, without attempting to connect with any historic chronology the men of the English drift, or the troglodytes of the mammoth or reindeer periods of France, it may be useful, in concluding this summary of primitive archæology, to glance at the origin of civilization, and the evidences of the antiquity of what appear to constitute its essential elements.

Everywhere man seems to have passed through the same progressive stages: First, that of the *savage* or purely *hunter state*; a condition of precarious instability, in which man is most nearly in the state of a mere animal subsisting on its prey. It is the condition of nomad life, incompatible with a numerous or settled population; exhausting the resources of national being in the mere struggle for existence, and therefore inimical to all accumulation of the knowledge and experience on which human progress depends. In this primitive state, man is disclosed to us by the evidence with which the archæologist now deals. He appears everywhere in this first stage as the savage occupant of a thinly-peopled continent, warring with seemingly inadequate means against gigantic carnivora, the contemporary existence of which is known to us only by the disclosures of geological strata or ossiferous caves, where also the remains of still more gigantic herbivora confirm the idea of man's exhaustive struggle for existence. The nearest analogy to such a state of life is that of the modern Esquimaux, warring with the monstrous polar bear, and making a prey of the gigantic cetaceæ of Arctic seas. Through how many ages this unhistoric night of European man may have preceded the dawn of civilization it is at present vain to speculate. But this is noticeable, that there is no inherent element of progress in a people in the condition of the Esquimaux. To all appearance, if uninfluenced by external impulse, or unaffected by any great amelioration of climate, they are likely to prolong the mere struggle for existence through unnumbered centuries, armed, as now, with weapons and implements ingeniously wrought of bone, ivory, and stone, the product of the neolithic arts of this 19th century.

To this succeeds the second or *pastoral state*, with its flocks and herds, its domesticated animals, and its ideas of personal property, including in its earlier stages that of property in man himself. It pertains to the open regions and warmer climates of the temperate zone, and to the elevated steppes and valleys of semi-tropical countries, where the changing seasons involve of necessity the wandering life of the shepherd. This accordingly prevents the development of the arts of settled life, especially those of architecture; and precludes all idea of personal property in the soil. But the conditions of pastoral life are by no means incompatible with frequent leisure, reflection, and consequent intellectual progress. Astronomy has its origin assigned to the ancient shepherds of Asia; and the contemplative pastoral life of the patriarchs Job and Abraham has had its counterpart in many an Arab chief of later times.

The third or *agricultural stage* is that of the tillers of the soil, the Aryans, the ploughers and lords of the earth, among whom are developed the elements of settled social life involved in the personal homestead and all the ideas of individual property in land. The process was gradual. The ancient Germans, according to the description of Tacitus, led the life of agricultural nomads; and such was the state of the Visigoths and Ostrogoths of later centuries. But this was in part due to the physical conditions of trans-Alpine Europe in those earlier centuries. Long ages before that, as the ancient Sanscrit language proves, the great Aryan family, of which those are offshoots, had passed from the condition of agricultural nomads to that of lords of the soil among a settled agricultural people. They had followed up the art of plowing the soil with that of shipbuilding and "plowing" the waves. They were skilled in sewing, in weaving, in the potter's art, and in masonry. Their use of numbers was carried as high at least as a hundred before they settled down from their nomad life. They had domesticated the cow, the sheep, the horse, and the dog; and their *pâsu* or feeders already constituted their *pecus*, their wealth, before the *pecunia* assumed its later forms of currency. They had also passed through their *bronze* and into their *iron* period; for their language shows that they were already acquainted with the most useful metals as well as with the most valuable grains.

The whole evidence of history points to the seats of earliest civilization in warm climates, on the banks of the Nile, the Euphrates, the Tigris, the Indus, and the Ganges. The shores of the Mediterranean succeeded in later centuries to their inheritance, and were the seats of long-enduring empires, whose intellectual bequests are the life of all later civilization. But trans-Alpine Europe, which is now yielding up to us the records of its prehistoric ages, is entirely of modern growth so far as its historic civilization is concerned, and wherever it extends toward the northern verge of the temperate zone it is even now in its infancy. Here, then, we trace our way back to the first progressive efforts of reason, and find man primeval, in a state of nature, in the midst of the abundance pertaining to a genial and fertile climate, which rather stimulates his æsthetic faculty than enforces him by any rigorous necessity to cultivate the arts for the purposes of clothing and building. Thus employing his intellectual leisure, he begins that progressive elevation which is as consistent with his natural endowments as a rational being as it is foreign to the instincts of all other animals. He increases and multiplies, spreads abroad over the face of the earth, clears its forests, drains its swamps, makes its rivers and seas his highways, and its valleys and plains his fertile fields and pasture-grounds. Cities rise, with all the fostering influences of accumulated wealth and settled leisure, and with all the stimulating influences of acquired tastes and luxurious desires. The rude pictorial art—not ruder on the graven ivory of the troglodytes of the Madelaine cave than on many a hieroglyphic drawing of the catacombs and temples of Egypt—employed in picture-writing, passes by a natural and inevitable transition from the literal representations of objects to the symbolic suggestion of ideas, to a word-alphabet, and then to pure phonetic signs. The whole process is manifest from the very infancy of Egyptian picture-writing, as crude as that with which the Indian savage still records his deeds of arms on his buffalo-robe, or carves the honors of the buried warrior on his grave-post. Letters lie at the foundation of all high and enduring civilization, yet we can thus trace them back to their infantile origin ; and so onward in their slow transformations, as in the mingled pictorial and phonetic writing of the Rosetta stone hieroglyphics of the age of the Ptolemies. Through Phœnician, Greek, and Roman modifications, they have come down to us as the arbitrary symbols of sounds which the voice combines into articulate speech.

And as it is with letters so it is with man's *arts*,—his drawing, carving, sculpture, architecture, weaving, pottery, metallurgy ; and so with his *science*,—his astrology, astronomy, geometry, alchemy, and all else. The beginnings of all of them lie within our reach. We can trace back the measurements of solar time to the crudest beginnings of more than one ancient nation, with a year of 360 days. This, corrected to the definite approximation to the true solar year of a period of 365 days, became the vague year of the Egyptians, with the great Sothiac cycle of 1460 years, clearly pointing to a system of chronology which could not have been perpetuated through many centuries without conflicting with the most obvious astronomical phenomena as well as with the recurring seasons of the year.

Man is, after all, according to the boldest speculations of the geologist, among the most modern of living creatures. If indeed the theory of evolution from lower forms of animal life is accepted as the true history of his origin, time may well be prolonged through unnumbered ages to admit of the process which is to develop the irrational brute into man. But regarding him still as a being called into existence as the lord of creation endowed with reason, the demonstration of a prolonged existence of the race, with all its known varieties, its diversities of language, and its wide geographical distribution under conditions so diverse, tends to remove greater difficulties than it creates. No essential doctrine, or principle in morals, is involved in the acceptance or rejection of any term of duration for the human race ; and the idea of its unity, which for a time was scornfully rejected from the creed of the ethnologist, is now advocated by the evolutionist as alone consistent with the physical, mental, and moral characteristics common to savage and civilized man, whether we study him amid the traces of palæolithic osteology and arts or among the most diverse races of living men.

The process of research and inductive reasoning thus applied by the archæologist to the traces of primitive art and the dawn of civilization, is no less applicable to all periods. The songs and legends of the peasantry, the half-obliterated traces of ancient manners, the fragments of older languages, the relics of obsolete art, are all parts of what has been fitly styled "unwritten history," and furnish the means of recovering many records of past periods which must remain forever a blank to those who will recognize none but written or monumental evidence.

Proceeding to the investigation of this later, and in most of the higher requirements of history, this more important branch of historical evidence, the archæologist has still his own special departments of investigation. Tracing the various alphabets in their gradual development through Phœnician, Greek, Roman and other sources, and the changing forms which followed under the influences of Byzantine and mediæval art, a complete system of palæography has been deduced, calculated to prove an important auxiliary in the investigation of monumental and written records. Palæography has its own rules of criticism, supplying an element of chronological classification altogether independent of style in works of art, or of internal evidence in graven or written inscriptions, and a test of genuineness often invaluable to the historian.

Architecture, sculpture, and pottery have each their historical value, their periods of pure and mixed art, their successions of style, and their traces of borrowed forms and ornamentation, suggestive of Indian, Assyrian, Egyptian, Phœnician, Punic, Greek, Etruscan, Roman, Arabian, Byzantine, Norman or Renaissance influences. Subordinate to those are the pictorial arts combined with sculpture and pottery, from earliest Egyptian, Greek, or Etruscan art to the frescoes and paintings of mediæval centuries; and the rise of the art of the engraver, traceable through ancient chasing on metals, mediæval niello-work, graven sepulchral brasses, and so on to the wood blocks, whence at length the art of printing with movable types originated. And as in the Old World, so in the New, the progress of man is traceable from rudest arts of stone and copper to the bronze period of Mexico and Peru, where also architecture, sculpture, and pottery preserve for us invaluable materials for the elucidation of that prehistoric time which only came to an end there in the year 1492 A.D.

Heraldry is another element by means of which archæology provides trustworthy canons of criticism in relation to written and unwritten mediæval records. The seals and matrices, sepulchral sculptures, and engraved brasses, along with an extensive class of the decorations of ecclesiastical and domestic architecture, all supply evidence whereby names and dates, with confirmatory collateral evidence of various kinds, are frequently recoverable. From the same sources also the changing costume of successive periods can be traced, and thus a new light be thrown on the manners and customs of past ages. The enthusiastic devotee is indeed apt at times to attach an undue importance to such auxiliary branches of study; but it is a still greater excess to pronounce them valueless, and to reject the useful aids they are capable of affording.

No less important are the illustrations of history, and the guides in the right course of research, which numismatics supplies, both in relation to early and mediæval times. On many of those points the historian and the archæologist necessarily occupy the same field; and indeed, when that primitive period wherein archæology deals with the whole elements of our knowledge regarding it as a branch of inductive science, and not of critical history, is past, the student of antiquities becomes to a great extent the pioneer of the historian. He deals with the raw materials: the charters, deeds, wills, grants of land, of privileges or immunities, the royal, monastic and baronial accounts of expenditure, and like trustworthy documents; by means of their palæography, seals, illuminations, and other evidence, he fixes their dates, traces out the genealogical relationships of their authors, and in various ways prepares and sifts the evidence which is to be employed anew by the historian in revivifying the past. Architecture and all departments of the fine arts, in like manner, supply much evidence which, when investigated and systematized by a similar process, adds valuable materials to the stock of the historian, and furnishes new sources for the illumination of past ages. Such is a sketch of the comprehensive investigations embraced under the name of archæology, which, carried on by many independent laborers, and in widely varied fields of research have contributed important chapters of human history, and revivified ages long buried in oblivion, or at best but dimly seen through distorting media of myth and fable.

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ÆSTHETICS.

BY JAMES SULLY, M.A.

Æsthetics is the term now employed to designate the theory of the Fine Arts—the science of the Beautiful, with its allied conceptions and emotions. The province of the science is not, however, very definitely fixed, and there is still some ambiguity about the meaning of the term, arising from its etymology and various use. The word æsthetic, in its original Greek form (αἰσθητικός), means anything that has to do with perception by the senses, and this wider connotation was retained by Kant, who, under the title Transcendental Æsthetic, treats of the *à priori* principles of all sensuous knowledge. The limitation of the term to the comparatively narrow class of sensations and perceptions occupied with the Beautiful and its allied properties is due to the Germans, and primarily to Baumgarten, who started from the supposition that, just as truth is the end and perfection of pure knowledge or the understanding, and good that of the will, so Beauty must be the supreme aim of all sensuous knowledge. Yet, spite of these sources of vagueness in the subject and its name, some considerable part of the theory can be looked upon as pretty clearly defined, and it may be possible, by means of careful reflection on this ascertainable quantity, to indicate, roughly at least, the extent and boundaries of a complete system of æsthetic doctrine.

A very brief survey of what has been written under the name æsthetics is sufficient to show that it includes, as its first and foremost problem, the determination of the nature and laws of Beauty, including along with the Beautiful, in its narrower signification, its kindred subjects, the Sublime and the Ludicrous. To discover what it is in things which makes them beautiful or ugly, sublime or ludicrous, is one constant factor in the æsthetic problem. Intimately connected with this objective question is the subjective and psychological inquiry into the nature of the feelings and ideas that have beauty for their object. Further, it will be found that all attempts to construct a complete æsthetic theory aim at determining the highest ends of the Fine Arts (which obviously concern themselves largely, if not exclusively, with the Beautiful), and at marking out the distinctions and tracing the dependencies of natural and artistic beauty. All this part of the field of æsthetic inquiry seems fairly agreed on, and it is only when we approach other sides of the Fine Arts that the precise scope of the science appears obscure. But while there is this measure of agreement as to the proper subject matter of æsthetics, we find two diametrically opposed methods of approaching it, which distinctly color all parts of the doctrine arrived at, and impose different limitations to the boundaries of the subject. The first is the metaphysical or *à priori* method; the second the scientific or empirical method. The one reasons deductively from ultra-scientific conceptions respecting the ultimate nature of the universe and human intelligence, and seeks to explain the phenomena of beauty and art by help of these. The other proceeds inductively from the consideration of these phenomena, as facts capable of being compared, classified, and brought under certain uniformities. At the same time, it must not be supposed that either method is customarily pursued in complete independence of the other. The most subtle exponent of transcendentalism in art appeals to generalizations drawn from the facts of art; nor have the professedly scientific critics often abstained from introducing conceptions and hypotheses of a metaphysical character.

(A.) METAPHYSICAL PROBLEMS.

Metaphysical speculation in æsthetics centers about the objective nature of beauty, and arises somewhat in the following manner:—The appreciation of the Beautiful is a mode of perception. In estimating a beautiful landscape or a beautiful statue, the mind perceives the beauty as a property of the object. It is, moreover, a single property; the name beautiful always denoting the same essential thing, whatever this may be. Now we find that it is not a simple property of matter known through one particular class of sensations, as color; and the question arises, what it really is in itself, whether inherent in and inseparable from matter, or something superior to it, and if so, how revealed through it. The directions of this inquiry have been almost as numerous as the systems of metaphysical thought. On the supposition of a real substance, matter, independent of all intelligence, human or divine, writers have attempted to discover the essential principle which beautifies it. It has been universally considered by metaphysicians that matter in itself is devoid of beauty, if not positively ugly, and the only question arises as to the extraneous principle which imparts beauty to it. This has been conceived either as a simple force distinct from matter, yet setting it in motion, vivifying it, and reducing it to forms, as by Lévêque; or, as a divine being, whose volition directly invests material objects with all their beautiful aspects, as by Reid; or, lastly, as self-existent forms or ideas superinduced upon matter, which are in truth the beauty of objects, as by Plato and his modern followers.

In the prevailing German systems of æsthetics, which are based on an ontological idealism, the independent existence of matter has been denied. These writers conceive an absolute Thought or Idea as the ultimate reality, of which matter and consciousness are but the two sides. Matter is conceived as the negative or limiting principle in the action or self-movement of the Absolute. The problem of objective beauty becomes on this hypothesis the determination of the particular mode in which the Beautiful is a manifestation of the supreme thought; for the Good and the True are equally revelations of the Unconditioned, and it is necessary to mark off beauty from these. Various definitions of the Beautiful, based on this mode of conception, may be found in the systems of Hegel, Weisse, and the Hegelians. The second great problem in the metaphysics of æsthetics is to coordinate the species of the æsthetic genus, namely, the Beautiful (in its narrow sense), the Ugly, the Sublime, and the Ridiculous. This has been undertaken by the Hegelians, and their attempts to construct what they call the dialectics of æsthetics are among the most curious products of metaphysical thought. It being assumed that there is some one ontological process running through every manifestation of the æsthetic Idea, these writers have sought to determine how each of the subaltern notions is related to this process. The last problem in the scheme of metaphysical æsthetics relates to the nature and functions of Art, looked at on one side as a reproduction in altered form of the beauty of Nature, and, on the other, as the conscious product of æsthetic intuition in the human mind. First of all, the arts are appreciated and classified according to the several modes in which they body forth the Idea to our minds. Secondly, since the Absolute may be spoken of as revealing itself to human intelligence, so human intelligence may be looked on as groping through long ages after the Absolute, and thus the historical evolution of art finds its place in a complete metaphysic of æsthetics. In concluding this preliminary sketch of the metaphysical systems, it should be added that they can be adequately estimated and criticised only in connection with the whole systems of thought of which they are organic parts. Within the scope of a purely scientific criticism it is only possible to point out any inconsistencies in the application of these ideas to beauty and art, and to show how much or how little they effect, as hypothetical instruments, in helping us more clearly to understand the phenomena.

(A.) SCIENTIFIC PROBLEMS.

In the scientific discussion of æsthetic subjects, the antithesis of subject and object in human cognition is accepted as a phenomenal distinction, without any inquiry into its ontological meaning. Inquirers no longer discuss the essence of beauty, looked on as a transcendental conception above all experience, but seek to determine in what the Beautiful, as a series of phenomena, clearly and visibly consists. Æsthetic speculation becomes, accordingly, more purely psychological. First of all, the unity of beauty is questioned. It is asked whether all objects which appear beautiful are so because of some one ultimate property, or combination of properties, running through all examples of beauty, or whether they are so called simply because they produce some common pleasurable feeling in the mind. This is a question of induction from facts and consequent definition lying at the very threshold of æsthetic science. It has been most vigorously disputed by British writers on the subject, and many of them have decided in favor of the plurality and diversity of elements in beauty. Again, it has been asked in which category of our experience, objective or subjective, beauty originates. By some it has been referred to an objective source, whether to sensation, as a direct result of physiological action, as by Burke, or to something distinctly perceived by means of sensation, as a certain relation of unity, symmetry, etc., among the parts of an object, its colors, forms, and so on, as probably by Aristotle, Diderot, Hogarth, and most writers. By others the source of beauty has been sought in the inner life of the mind itself, in certain ideas and emotions which have become reflected on external objects by association. This is the doctrine of Alison. A third class recognize both of these sources, attributing the effects of beauty partly to the pleasurable effects of external stimulation, partly to the activities of perception, and partly to multitudinous associations of ideas and feelings from past experience. This class includes Dugald Stewart, Professor Bain, and Mr. Herbert Spencer. A third question in the general scientific theory of beauty which is closely related to the last and largely determined by it, is the precise nature of the mental faculty or activity concerned in the perception and appreciation of the Beautiful. This, too, has been widely discussed by English writers,—answers to the other two questions frequently appearing as the necessary implications of the solution of this one. By those who affirm that beauty is a simple property or conjunction of properties in external objects, the subjective perception of this property has been regarded either as a unique faculty (the internal sense), or as the rational principle acting in a certain way. By the school of Alison, who find the source of beauty in a certain flow of ideas suggested by an object, the perception of the same, as a property of the object, would be explained as the result of inseparable association, producing a kind of momentary delusion. And this same effect of association, in producing an apparent intuition of one simple property, would be made use of by those later writers who resolve the nature of beauty into both objective and subjective elements. It is noticeable, too, that while some writers have treated the appreciation of beauty as purely intellectual, others have confined themselves to the emotional element of pleasure. With respect to the Ludicrous and the Sublime, as distinguished from the Beautiful, there seems to have been a tacit agreement that both of these are unique and single properties, whether originally in the object of sense, or reflected on it from the mind; and various theories have been suggested in explanation of the characteristic effects of these properties on human sensibility and thought.

What strikes one most, perhaps, in these discussions is the vagueness due to the great diversity of conception as to the real extent of the Beautiful—the number of objects it may be supposed to denote. While one class of writers appears to limit the term to the highest and most refined examples of beauty in nature and art, others have looked on it as properly including the lower and more vulgarly recognized instances. There is certainly a great want of definiteness as to the legitimate scope of æsthetic theory. It will be seen, too, how closely this point bears on the question of the relativity of æsthetic impressions, whether there is any form of beauty which pleases universally and necessarily, as Kant affirms. The true method of resolving this difficulty would appear to be to look on æsthetic impressions more as a growth, rising, with the advance of intellectual culture, from the crude enjoyments of sensation to the more refined and subtle delights of the cultivated mind. The problem of the universal and necessary would then resolve itself into an inquiry into a general tendency. It would be asked what kinds of objects, and what elements of sensation, idea, and emotion, tend to become conspicuous in æsthetic pleasures, in proportion as the mind advances in general emotional and intellectual culture. Another defect in nearly all the theories of the Beautiful that have been proposed, refers to the precise relation of the intellectual element in the æsthetic impression. In opposing the narrow view, that the appreciation of beauty is a purely intellectual act, a cold intuition of reason, writers have fallen sometimes into another narrowness, in resolving the whole of the effect into emotional elements, or certain species of pleasure. Unless beauty is, as Hutcheson affirmed, a simple property of objects like color, the perception of it as objective, which all must allow to be a mental fact, can only be explained by means of certain intellectual activities, by force of which the pleasurable effects come to be referred to such a seemingly simple property. The solution of this point would doubtless be found in a more complete discussion of the perceptive or discriminative and assimulative activities of the intellect which are invariably called into play by complex objects, and which correspond to the attributes of proportion, unity in variety, etc., on which so much stress has been laid by the intuitivists. Not only so, but any theory of æsthetic operations must be incomplete which does not give prominence to those more subtle and exalted intellectual activities that are involved in the imaginative side of æsthetic appreciation, as in detecting the curious half-hidden implications which make up the essence of a refined humor, in constructing those vague yet impressive ideas which enter into our intuition of sublimity and infinity, and even in appreciating such seemingly simple qualities as purity of color and tone, or the perfectly graduated blending of two adjacent colors. Such activities of the mind constitute, among other things, the symbolic aspect of the Beautiful, and give, as Mr. Mill suggests, a basis of truth to such seemingly fanciful notions respecting the meaning of beautiful qualities as one finds in the works of Mr. Ruskin.

But comparatively little has been done in a purely scientific manner to determine the nature and functions of Art so as to fix the relations of the different arts to simple or natural beauty. Aristotle supplied a few valuable doctrines, which have been rendered still more precise by Lessing and others. Yet there seems even now no consensus of opinion as to the precise aims of art, how far it has simply to reproduce and constructively vary the beauties of nature, or how far to seek modes of pleasurable effect wider than those supplied by natural objects. A theory of art at all comparable in scientific precision to existing theories of morals has yet to be constructed. The few attempts to establish a basis for art of a non-metaphysical kind are characterized by great one-sidedness. Thus, for example, the theory that the function of art is to imitate nature, has been broached again and again with scarcely any reference to music, merely, as it seems, out of an impatience for some one defining property. Without attempting to sketch a complete doctrine of art, a suggestion may be offered as to the right direction of inquiry. First of all, then, the widest possible generalizations on the various emotional susceptibilities to which art can appeal must be collected, from a study both of mental phenomena as a whole, and of all varieties of pleasurable feeling actually ministered by the several forms of art. This would fix the end of the fine arts in the widest sense, marking it off from the ends of utility and morality. Secondly, the highest aims of art, or the ideal of art, would have to be determined by a consideration of the laws of compatibility and incompatibility among these various orders of gratification, the requirements of quantity, variety, and harmony, in any lofty æsthetic impression, and the relative value of the sensational, intellectual, and emotional elements in æsthetic effect. This part of the subject would include the discussion of the value and universal necessity of the real and the ideal in art, truth to nature and imaginative transformation. These conclusions would require verification by means of the widest and most accurate study of the development of the arts, in which could be traced the gradual tentative progress of the artistic mind toward the highest achievements of art, as well as the permanent superiority of all those forms of art which most clearly embody this tendency. This part of the theory of art would clearly connect itself with the problem of the general law or tendency in æsthetic development already referred to. The proper determination of these two ideas, the whole range of possible æsthetic delight, and the direction of the highest, purest, and most permanent delight of cultivated minds, would at once dispose of many narrow conceptions of art, by recognizing the need of the widest possible diversity and grades of artistic value, if only as experiments requisite to the discovery of its highest function. At the same time the meaning and limits of the universal and necessary in art would be defined, and the unsuggestive and dreary conflicts between an unbending absolutism and a lawless individualism shown to be irrelevant. The validity of canons of art, and their limitations, would in this manner be fixed, and the impatient exaltation of certain schools and directions of taste reduced to a modest assertion of a purely relative truth. The aims of art as a whole being thus determined, the next thing would be to define and classify the individual arts of painting, music, poetry, etc., according to their respective powers of embodying these aims. This would require a careful consideration of the material or medium of expression employed by each art, and the limitations imposed by it as to the mode of representation. The determination of this part of æsthetic theory, which Lessing commenced, would require not only technical but considerable psychological knowledge. Similarly, any conclusion arrived at on this subject would need to be verified by a reference to the history of the arts, as exemplifying both the successes of a right conception of the scope and possibilities of the particular art, and the failures resulting from a mistaken conception. Many other points, such as the nature of genius, the function and bounds of criticism, the relation of æsthetic culture to intellectual, moral, and social progress, would be included in a complete scheme of art doctrine.

(C.) HISTORY OF SYSTEMS.

In the following brief account of the most important contributions to æsthetic doctrine, only such writings will be recognized as aim at some general conception of Art and the Beautiful. Much that passes in current literature for æsthetic speculation, namely, a certain thoughtful way of criticising special works of art, is simply the application of recognized principles to new cases. Sometimes, however, in the hands of a philosophic critic the mere appreciation of a single poem or the works of a particular artist may become a luminous discussion of some general principle, and this method of constructing æsthetic theory from the criticism of a single work or series of works was rendered very productive by Lessing.

I. *Greek Speculations.*—Ancient Greece supplies us with the first speculations on the Beautiful and the aims of the fine arts. Nor is it surprising that among a people so productive of noble artistic creations, and at the same time so speculative, numerous attempts to theorize on these subjects should have been made. We have in classic writings many allusions to works of an æsthetic character now lost, such as a series on poetry, harmony, and even painting, by Democritus. It is to be gathered, too, from Plato's Dialogues that the Sophists made the principles of beauty a special department in their teaching. The first Greek thinker, however, whose views on these subjects are at all known is Socrates. Accepting Xenophon's account of his views in the *Memorabilia* and the *Symposion*, we find that he regarded the Beautiful as coincident with the Good, and both of them as resolvable into the Useful. Every beautiful object is so called because it serves some rational end, whether the security or gratification of man. It looks as though Socrates rather disparaged the immediate gratification which a beautiful object affords to perception and contemplation, and emphasized rather its power of furthering the more necessary ends of life. Thus he said that pictures and other purposeless works of art, when used to adorn a house, hindered rather than furthered enjoyment, because of the space they took from useful objects. This mode of estimating the value of beauty is, however, no necessary consequence of the theory that the whole nature of beauty is to minister pleasure. It arises from undue attention to mere material comfort as a condition of happiness. The really valuable point which Socrates distinctly brought to light is the relativity of beauty. Unlike his illustrious disciple, he recognized no self-beauty (*αὐτὸ τὸ καλόν*) existing absolutely and out of all relation to a percipient mind.

Of the precise views of Plato on this subject, even if they were really formed, it is very difficult to gain a just conception from the Dialogues. In some of these, called by Mr. Grote the Dialogues of Research, as the *Hippias Major*, he ventures on no dogmatic theory of Beauty, and several definitions of the Beautiful proposed are rejected as inadequate by the Platonic Socrates. At the same time we may conclude that Plato's mind leaned decidedly to a theory of an absolute Beauty, this, indeed, being but one side of his remarkable scheme of Ideas or self-existing Forms. In the *Symposion* he describes how love (Eros) produces aspiration toward the pure idea of beauty. It is only this absolute beauty, he tells us, which deserves the name of beauty; and this is beautiful in every manner, and the ground of beauty in all things. It is nothing discoverable as an attribute in another thing, whether living being, earth, or heaven; for these are only beautiful things, not the Beautiful itself. It is the eternal and perfect existence contrasted with the oscillations between existence and non-existence in the phenomenal world. In the *Phædrus*, again, he treats the soul's intuition of the self-beautiful as a reminiscence of its prænatal existence, undefiled by union with the body. With respect to the precise forms in which the idea of beauty reveals itself, Plato is very undecided. Of course his theory of an absolute Beauty is incompatible with the notion of its ministering simply a variety of sensuous pleasure, to which he appears to lean in the *Gorgias* and even the *Hippias Major*. Further, his peculiar system of ideas naturally led him to confuse the self-beautiful with other general conceptions of the true and the good, and so arose the Platonic formula καλοκάγαθία, expressive of the intimate union of the two principles. So far as his writings embody the notion of any distinguishing element in beautiful objects, it is proportion, harmony, or unity among the parts of an object. The superior beauty of proportion is taught in the *Philebus*, and in the *Phædon* it is applied to virtue. As a closely-related view, we see him emphasizing unity in its simplest aspect of evenness and purity, the need of variety being overlooked. Thus in the *Philebus* he states his preference for regular and mathematical forms, as the straight line and the circle. So he selected among colors pure white, among tones the pure and equal, and among impressions of touch the smooth. At the same time the Dialogues evince many other tentative distinctions in the Beautiful, as, for example, the recognition in the *Politics* of two opposed classes of beautiful things, those characterized by force and velocity, and those by a certain slowness and softness; which points to a contrast between the stimulative and the restful in sensation, since enlarged upon by English psychologists. Elsewhere he descants on the beauty of the mind, and seems to think, in the *Republic*, that the highest beauty of proportion is seen in the union of a beautiful mind with a beautiful body. In spite of his lofty theory of the origin and nature of beauty, Plato seems to have imperfectly appreciated the worth of art as an independent end in human life and culture. He found the end of art in imitation (μίμησις), but estimated the creative activity of art as a clever knack, little higher in intellectual value than the tricks of a juggler. He tended to regard the effects of art as devoid of all serious value, and as promoting indolence and the supremacy of the sensual elements of human nature. (See the *Sophistes*, *Gorgias*, and *Republic*.) Accordingly, in his scheme for an ideal republic, he provided for the most inexorable censorship on poets, etc., so as to make art as far as possible a mere instrument of moral and political training. As to particular arts, Plato appears to have allowed a certain ethical value to music, in combination with dance and song, if of a certain character, as expressing either the worthy and manly, or the quiet and orderly. With respect to poetry, his views, as expressed in the *Republic* and elsewhere, were very uncertain. Thus at times he condemns tragedy and comedy *in toto;* at other times he admits the claims of a lofty dramatic poetry. He seems not to have fully considered the aims and influences of painting and sculpture, which he constantly disparages.

A loftier conception of the aims of poetry was afforded by the strictures of Aristophanes in the *Frogs* and elsewhere. But the one Greek who, as far as we know, fully appreciated and clearly set forth the ends of the fine arts, considered, independently of ethical and political aims, as the vehicles to the mind of the ideas and delights of beauty, was Aristotle. Unlike Plato, he proceeded less metaphysically and more scientifically to investigate the phenomena of beauty by a careful analysis of the principles of art. In his treatises on poetry and rhetoric, he gives us, along with a theory of these arts, certain principles of beauty in general; and scattered among his other writings we find many valuable suggestions on the same subject. First of all, Aristotle ignores all conceptions of an absolute Beauty, and at the same time seeks to distinguish the Beautiful from the Good. Thus, although in the more popular exposition, the *Rhetoric*, he somewhat incorrectly makes praiseworthiness a distinguishing mark of the Beautiful, regarded as a species of the Agreeable or Desirable, he seeks in the *Metaphysics* to distinguish the Good and the Beautiful thus: the Good is always in action (ἐν πράξει); the Beautiful, however, may exist in motionless things as well (ἐν ἀκινήτοις). Elsewhere he distinctly teaches that the Good and the Beautiful are different (ἕτερον,) although the Good, under certain conditions, can be called beautiful. He thus looked on the two spheres as co-ordinate species, having a certain area in common. It should be noticed that the habit of the Greek mind, in estimating the value of moral nobleness and elevation of character by their power of gratifying and impressing a spectator, gave rise to a certain ambiguity in the meaning of τὸ καλόν, which accounts for the prominence the Greek thinkers gave to the connection between the Beautiful and the Good or morally Worthy. Aristotle further distinguished the Beautiful from the Fit, and in a passage of the *Politics* set Beauty above the Useful and Necessary. Another characteristic of the Beautiful fixed by this thinker in the *Rhetoric* is the absence of all lust or desire in the pleasure it bestows. This is an important point, as suggesting the disinterested and unmonopolizing side of æsthetic pleasure. The universal elements of beauty, again, Aristotle finds in the *Metaphysics* to be order τάξις), symmetry, and definiteness or determinateness (τὸ ὡρισμένον). In the *Poetics* he adds another essential, namely, a certain magnitude, it being desirable, for a synoptic and single view of the parts, that the object, whether a natural body or a work of art, should not be too large, while clearness of perception requires that it should not be too small. At the same time he seems to think that, provided the whole be visible as such, the greater magnitude of an object is itself an element of beauty. This is probably to be understood by help of a passage in the *Politics*, which lays down the need of a number of beautiful parts or aspects in a highly beautiful object, as the human body. With respect to art, Aristotle's views are an immense advance on those of Plato. He distinctly recognized, in the *Politics* and elsewhere, that its aim is simply to give immediate pleasure, and so it does not need to seek the useful like the mechanical arts. The essence of art, considered as an activity, Aristotle found in imitation, which, unlike Plato, he considers not as an unworthy trick, but as including knowledge and discovery. The celebrated passage in the *Poetics* where he declares poetry to be more philosophic and serious a matter (σπουδαιότερον) than philosophy, best shows the contrast between Plato and Aristotle in their estimates of the dignity of artistic labor. In the *Poetics* he tells us that the objects to be imitated by the poet are of three kinds—(1.) Those things or events which have been or still are; (2.) The things which are said to be and seem probable; (3.) The things which necessarily are (εἶναι δεῖ). The last points, as Schasler supposes, to the ideal character of imitation as opposed to mere copying of individual objects or events, and accounts for the lofty value assigned to it by Aristotle. More particularly the objects of imitation in poetry and music, if not in all art, are dispositions (ἤθη), passions, and actions. Aristotle gives us some interesting speculations on the nature of the artist's mind, and distinguishes two varieties of the poetic imagination—the easy and versatile conceptive power of a man of natural genius (εὐφυής), and the more emotional and lively temperament of an inspired man (μανικός). He gives us no complete classification of the fine arts, and it is doubtful how far his principles are to be taken as applicable to other than the poetic art. He seems, however, to distinguish poetry, music, and dancing—all of which are supposed to imitate some element of human nature, some feeling or action—by the means they employ, namely, rhythm, harmony, melody, and vocal sound. Painting and sculpture are spoken of as imitative arts, but their special aims are not defined. Architecture seems ignored by Aristotle as non-imitative. His peculiar theory of poetry can only be just glanced at here. Its aim, he says, is to imitate dispositions and actions. Metrical form is hardly looked on as an essential. Poetic imitation, as including the selection of the universal in human nature and history, is ably treated; and from this part of Aristotle's theory all modern ideas of poetic truth are more or less derivable. He distinguishes, somewhat superficially, the epic poem, the drama, and a third variety not named, but apparently lyric poetry, by the manner in which the poet speaks in each variety, whether in his own person, or in that of another, or in both alternately. The epic and the dramatic poem require unity of action, a certain magnitude, with beginning, middle, and end, and also those changes of fortune and recognitions that make up the thrilling character of plot. The end of tragedy Aristotle defines as the effecting, by means of pity and fear, of a purification of these passions; and this is perhaps the point of greatest interest for æsthetics in the whole of his theory of poetry. Whether he is referring to any moral influence of tragedy on the emotions, bringing both fear and pity in the spectator's mind to their proper ethical mean, as Lessing and others conceive; whether he simply means the elimination of all painful ingredients in these feelings, either by the recognition of the imaginary nature of the evil represented, or by the simultaneous satisfaction of other and deeper feelings as moral approval or wide human sympathy; or, finally, whether by "purification" we are to understand the grateful relief by artificial means of a recurring emotion needing periodic vent, as Ueberweg argues,—this subtle point may be left to the student to decide. It would be interesting to know how far Aristotle attributed something analogous to this κάθαρσις to the other arts. In the *Politics* he certainly speaks of a purifying effect in certain kinds of music in quieting the wilder forms of excitement. Finally, it might perhaps be conjectured from his definition of the Ludicrous, as something faulty and disgraceful, yet free from pain, and not destructive, that he would find in the laughter of comedy something analogous to this purification, namely, the gradual resolution of the more painful feelings of contempt or disgust into the genial moods of pure hilarity.

Omitting to notice the few valuable remarks on æsthetic subjects of the later Greeks and their Roman contemporaries, one may briefly refer to the views of the Alexandrian mystic and Neo-Platonist Plotinus, not only because of their intrinsic interest, but on account of their resemblance to certain modern systems. His theory is to be found in an essay on the Beautiful in the series of discourses called *Enneades*. His philosophy differs from the Platonic in the recognition of an objective νοῦς, the direct emanation from the absolute Good, in which the ideas or notions (λόγοι), which are the prototypes of real things, are immanent. This Reason, as self-moving, becomes the formative influence reducing matter, which in itself is dead, to form. Matter thus formed becomes a notion (λόγος), and this form is beauty. Objects are ugly so far as they are unacted upon by Reason, and so remain formless. The creative νοῦς is absolute Beauty, and is called the more than beautiful (τὸ ὑπέρκαλλον). There are three degrees or stages of the Beautiful in manifestation, namely, the beauty of subjective νοῦς, or human reason, which is the highest; that of the human soul, which is less perfect through the connection of the soul with a material body; and that of real objects, which is the lowest manifestation of all. As to the characteristic form of beauty, he supposed, in opposition to Aristotle, that a single thing not divisible into parts might be beautiful through its unity and simplicity. He attached special worth to the beauty of colors in which material darkness is overpowered by light and warmth. In reference to artistic beauty, he said that when the artist has λογοι as models for his creations, these may become more beautiful than natural objects. This is a very curious divergence of opinion from the Platonic.

After Plotinus there is little speculation on æsthetic subjects till we come to modern writers. St. Augustine wrote a treatise on the Beautiful, now lost, in which he appears to have reproduced Platonic ideas under a Christian guise. He taught that unity is the form of all beauty ("omnis porro pulchritudinis forma unitas est"). Infinite goodness, truth and beauty are the attributes of the Deity, and communicated by him to things. But passing from these fragmentary utterances, we may consider more fully the modern theories, beginning with the German systems, as being the most metaphysical, and having most affinity with ancient speculation. In German literature the two divisions of metaphysical deduction and critical construction of æsthetic principles are very sharply contrasted, and nearly every writer on the subject is easily referred to one or other of the classes. On the one hand, we have the laborious systematic philosophers, as Kant and Hegel; and on the other, men who entered upon æsthetic speculation either as connoisseurs of some special department, as Winckelmann and Lessing, or even as productive artists—for example, Schiller and Goethe.

II. *German Writers.*—The first of the Germans who attempted to fit a theory of the Beautiful and of Art into a complete system of philosophy was Baumgarten. Adopting the Wolffian principles of knowledge, as modified by Leibnitz, he thought he was completing that system by setting over against logical knowledge, whose object is truth, æsthetic knowledge, which has to do with beauty. The former is conceptive knowledge (*begreifendes Erkennen*), the act of the understanding, and its result as the science of clear conceptions, is embodied in logic. Æsthetic has to do, not with clear, but confused conceptions (*verworrene Vorstellungen*), namely, sensuous knowledge. The beautiful is defined by Baumgarten as the perfection of sensuous knowledge, and the ugly is that which struggles against this perfection; and, consistently with this view, he first employed the term æsthetic (*æsthetica*) to denote a theory of the Beautiful. He held that perfection, as harmony of object with its conception or notion (*Begriff*), presents itself under three aspects:—(1.) As truth for pure knowledge; (2.) As beauty for obscure perception; (3.) As goodness for the capacities of desire or will. It will be seen at once by the thoughtful student that this mode of dealing with impressions of beauty, etc., simply as intellectual elements (confused conceptions), must fail to account for their emotional aspects—feeling, which is the very soul of the æsthetic impression, being radically distinct from conception and knowledge. Still Baumgarten did service in separating so sharply the provinces of logic, ethics, and æsthetics, and in connecting the latter with the impressions of the senses. The details of his æsthetics are mostly unimportant. From Leibnitz's theory of a pre-established harmony, and its consequence that the world is the best possible, Baumgarten concluded that nature is the highest embodiment of beauty, and that art must seek as its highest function the strictest possible imitation of nature. Baumgarten had several disciples in this conception of æsthetics, as Sulzer and Moses Mendelssohn.

The next original philosophical scheme of æsthetics is that of Kant. His system of knowledge falls into three branches—the critique of pure reason, which has to determine what are the *à priori* elements in the knowledge of objects; the critique of practical reason, which inquires into the *à priori* determinations of the will; and the critique of judgment, which he regards as a connecting link between the other two, and which has to do with any *à priori* principles of emotion (pleasure and pain), as the middle term between cognition and volition. This judgment Kant divides into the æsthetic, when pleasure or pain is felt immediately on presentation of an object; and the teleological, which implies a pre-existing notion, to which the object is expected to conform. He attempts, in a somewhat strained manner, to define the Beautiful by help of his four categories. In *quality* beauty is that which pleases without interest or pleasure in the existence of the object. This distinguishes it from the simply Agreeable and the Good, the former stimulating desire, and the latter giving motive to the will. In *quantity* it is a universal pleasure. Under the aspect of *relation*, the Beautiful is the form of adaptation (*Zweckmässigkeit*) without any end being conceived. Finally, in *modality* it is a necessary satisfaction, pleasing not by a universal rule, this being unassignable, but by a *sensus communis*, or agreement of taste. Kant is not very consistent in carrying out these distinctions. Thus, for example, he recognizes in fitness a particular species of beauty, namely, "adhering" as distinguished from "free" or intrinsic beauty, without recognizing that this implies the presence of a notion. So, in discussing the objective validity of our æsthetic impressions, he decides that the highest meaning of beauty is to symbolize moral good; and, in even a more fanciful manner than that of Mr. Ruskin, he attaches moral ideas, as modesty, frankness, courage, etc., to the seven primary colors of the Newtonian system. Yet he does not admit that the perception of this symbolic function involves any notion. Once more, he attributes beauty to a single color or tone by reason of its purity. But such a definition of the form of the Beautiful clearly involves some notion in the percipient mind. Kant further applies his four categories, with still less of fruitful suggestion, to the Sublime. The satisfaction of the Sublime is a kind of negative pleasure created through the feeling of a momentary restraint (*Hemmung*) of vital force, and of a subsequent outpouring of the same in greater intensity. The feeling of the inadequacy of the imagination is succeeded by a consciousness of the superiority of reason to imagination. The sentiment is thus a kind of wonder or awe. Sublimity is either mathematical, that of magnitude, or dynamical, that of nature's might. He allows no sublimity to passions, as rage or revenge. Kant has, too, a theory of the Ridiculous, the effect of which he lays, oddly enough in respect to the rest of his doctrine, in a grateful action of the body, the muscles of the diaphragm, etc., giving a sense of health. This action takes place on the sudden relaxation of the understanding when kept in a state of tension by expectation. The cause of laughter, or the Ridiculous, may hence be defined as "the sudden transformation of a tense expectation into nothing." He placed the beauty of nature above that of art, which can be of value only mediately, not as an end in itself. He classifies the arts according as they express the æsthetic idea—whatever this may mean after his exclusion of all definite conception from the perception of beauty. Just as expression in speech consists of articulation, gesticulation, and modulation, answering to thought, intuition (*Anschauung*), and feeling, so we have three kinds of art—(1.) Those proceeding orally (*redende*), oratory and poetry; (2.) Those of visible image (*bildende*), plastic art and painting; and (3.) "the art of the play of feelings," namely, music and "color art," which last is not defined. Kant's system is very defective, and some of its inconsistencies were pointed out by Herder in his *Kalligone*, who lacked, however, philosophic accuracy. Herder denied Kant's distinctions between the Beautiful, the Good, and the Agreeable, saying that the first must be desired as well as satisfying, and the second be loved as well as prized. Yet herein Kant is decidedly superior to his critic. Herder held, in opposition to Kant, that all beauty includes significance (*Bedeutsamkeit*), and cannot affect us apart from a notion of perfection. But here, too, Kant is to be preferred, since his theory does not assume all beautiful objects to contain some one element or form capable of being detected. Kant's real additions to æsthetic theory consist in the better separation of the Beautiful from the Good and Agreeable, in the prominence given to the emotional side of æsthetic impressions, and in the partial recognition of the relativity of æsthetic judgment, more especially in the case of the Sublime.

After Kant the next philosopher to discuss the metaphysics of the Beautiful and art is Schelling. He sought to engraft art upon his curious system of transcendental idealism in a manner which can only be faintly indicated here. In Schelling's metaphysical system the relation of subject and object is conceived as identity. Each exists, yet not independently of the other, but identified in a higher, the absolute. They may be conceived as two poles representing different directions, but yet inseparably joined. All knowledge rests on this agreement. Either nature, the object, may be conceived as the *prius*, and the subject constructed out of it; or the subject may be taken as the *prius*, and the object constructed from it. These are the two poles of knowledge, and constitute the philosophy of nature and the transcendental philosophy. The latter, like Kant's philosophy of mind, is based on a threefold conception of the powers of human nature. It consists of —(1.) Theoretic philosophy, dealing with perception; (2.) Practical philosophy, discussing the will and freedom; and (3.) The philosophy of art. The aim of the last is thus expressed: The *ego* must succeed in actually perceiving the concord of subject and object, which is half disguised in perception and volition. This concord is seen within the limits of the *ego* in artistic perception only. Just as the product of nature is an unconscious product like a conscious one, in its designfulness, so the product of art is a conscious product like an unconscious one. Only in the work of art does intelligence reach a perfect perception of its real self. This is accompanied by a feeling of infinite satisfaction, all mystery being solved. Through the creative activity of the artist the absolute reveals itself in the perfect indentity of subject and object. Art is therefore higher than philosophy. Schelling thus sets the beauty of art far above that of nature. As to the form of the beautiful he is very vague, leaning now to a conception of harmony in the totality of the world (*Weltall*), and now to a Platonic conception of primitive forms (*Urbilder*) of perfection. He has a very intricate classification of the arts, based on his antithesis of object and subject, reality and ideality. A curious feature of Schelling's theory is his application of his one fundamental idea to tragedy. The essence of tragedy is, he thinks, an actual conflict of liberty in the subject with objective necessity, in which both being conquered and conquering, appear at once in the perfect indifference. Antique tragedy he holds, accordingly, to be the most perfect composition of all arts.

Passing over Solger, whose æsthetic doctrine is little more than a revival of Platonism, we come to Hegel. His system of philosophy falls into three parts, all based on the self-movement of the idea or absolute :—(1.) The logic discussing the pure universal notions which are the logical evolution of the absolute, as pure thought; (2.) Philosophy of nature—the disruption of thought, the idea, into the particular and external ; (3.) Philosophy of the spirit—the return of thought or the absolute from this self-alienation to itself in self-cognizant thought. Just as the absolute, so has spirit a series of three grades to traverse—(*a.*) Subjective spirit or intelligence, relating itself to the rational object as something given ; (*b.*) Objective spirit or will, which converts the subjectivized theoretical matter (truth) into objectivity; (*c.*) Absolute spirit, which is the return of the spirit from objectivity to the ideality of cognition, to the perception of the absolute idea. This again has three stages—(1.) Art, in which the absolute is immediately present to sensuous perception ; (2.) Religion, which embodies certainty of the idea as above all immediate reality ; and (3.) Philosophy, the unity of these. According to this conception, the beautiful is defined as the shining of the idea through a sensuous medium (as color or tone). It is said to have its life in shining or appearance (*Schein*), and so differs from the true, which is not real sensuous existence, but the universal idea contained in it for thought. He defines the form of the Beautiful as unity of the manifold. The notion (*Begriff*) gives necessity in mutual dependence of parts (unity), while the reality demands the appearance or semblance (*Schein*) of liberty in the parts. He discusses very fully the beauty of nature as immediate unity of notion and reality, and lays great emphasis on the beauty of organic life. But it is in art that, like Schelling, he finds the highest revelation of the Beautiful. Art makes up the deficiencies of natural beauty by bringing the idea into clearer light, by showing the external in its life and spiritual animation. The various forms of art depend on the various combinations of matter and form. In Oriental or symbolical art matter is predominant, and the thought is struggling through with pain so as to reveal the ideal. In the classical form the ideal has attained an adequate existence, form and matter being absolutely commensurate. Lastly, in the romantic form, the matter is reduced to a mere show, and the ideal is supreme. Hegel classifies the individual arts according to this same principle of the relative supremacy of form and matter—(1.) The beginning of art is architecture, in which as a symbolic art the sensuous material is in excess. (2.) Sculpture is less subjected to matter, and, as representing the living body, is a step toward a higher ideality. (3.) Painting, which is the romantic art κατ' ἐξοχήν, expresses the full life of the soul. By the elimination of the third dimension of space, and the employment of a colored plane, painting rids itself of the coarse material substrate of sculpture, and produces only a semblance of materiality. (4.) In music, which employs pure tone, all the elements of space are suppressed, and hence its content is the inner emotional nature (*Gemüth*). Music is the most subjective of the arts. (5.) Poetry has the privilege of universal expression. It contains all the other arts in itself, namely, the plastic art in the epos, music in the ode, and the unity of both in the drama.

Several systems of æsthetics, more or less Hegelian in character, can only be referred to in passing. Weisse defined æsthetics as the science of the idea of beauty, and explained the Beautiful as the entrance of the universal or of the essence into the limited and finite, that is, the cancelling or annulling of truth (*die aufgehobene Wahrheit*). By thus recognizing an internal contradiction in all beauty, he sought to develop, by a curious dialectical process, the ideas of the Ugly, the Sublime, and the Ludicrous. He treats each of these three in immediate contrast to beauty. Ugliness is the immediate existence of beauty. It appears as the negative moment in the Sublime, and in the Ludicrous this negativity is again cancelled and resolved into affirmation so as to constitute a return to the Beautiful. A like attempt to determine the relations of the Ugly, Comic, etc., as moments of the self-revealing idea was made by several Hegelians. Thus Ruge, in his *Abhandlung über das Komische*, teaches that sublimity is the æsthetic idea striving to find itself, together with the satisfaction of this striving. If, however, the idea lose itself, sinking away in a kind of swoon, we have the Ugly. Finally, when the idea recovers from the swoon, its new birth is attended with a feeling of amusement (*Erheiterung*), and then we have the effect of the Ludicrous. Rosenkranz in his *Æsthetik des Hässlichen*, conceives the Ugly as the negation of the Beautiful, or as the middle between the Beautiful and the Ludicrous, and seeks to trace out its various manifestations in formlessness in nature, incorrectness in artistic representation, and deformity or the disorganization of the Beautiful in caricature. Schasler, again, seems to hold that the Ugly is co-ordinate with the Beautiful, being the motor principle that drives the Beautiful from the unconditional rest of the Platonic idea, from the sphere of empty abstractness to actuality. This fundamental contradiction reveals itself as the contrast of matter and spirit, rigid motionlessness and motion, and appears in art as the antithesis of the sublime and graceful (*das Anmuthige*), the latter containing the Naïf, the Pretty, and the Ridiculous. Finally, Theodor Vischer seeks to settle these subtle relationships, in this manner: He supposes the Sublime to be the sundering of the æsthetic idea and its sensuous image (*Gebild*) from the state of unity constituting the Beautiful, the idea reaching as the infinite over against the finite of the image. The image now resists the sudden rupture, and in asserting itself as a totality in defiance of the idea beomes the Ugly. The Comic, again, is the result of some partial and apparently involuntary recognition of the rights of the idea by the rebellious image. Schasler says, in criticising the views of Vischer, that it is difficult not to be satirical in describing the dialectic artifices to which the idea is here compelled, little suspecting how easily any similar attempt to adjust relations between these ideas looked at objectively as movements of the supreme idea, may appear equally naïf and funny to a mind not already oppressed with the resisting burden of its own abstractions.

Theodor Vischer, the last of the

Hegelians named here, has produced the largest and most laborious system of metaphysical æsthetics, and a brief account of its scope must be given to complete our history of the German systems. He defines æsthetics as the science of the Beautiful. His system falls into three parts: (1.) Metaphysic of the Beautiful; (2.) The Beautiful as one-sided existence—beauty of nature and the human imagination; (3.) The subjective-objective actuality of the Beautiful — Art. The metaphysic again falls into two parts—the theory of simple beauty, and that of the Beautiful in the resistance of its moments (the Sublime and Ridiculous). He defines the Beautiful as "the idea in the form of limited appearance." His discussions of the various beauties of nature, the organic and inorganic world, are very full and suggestive, and his elaboration of the principles of art (excepting those of music, which he left another to elucidate), is marked by a wide and accurate knowledge. He divides the arts into—(1.) The objective, or eye arts (architecture, sculpture and painting); (2.) Subjective, or ear arts (music); (3.) Subjective-objective arts, or those of sensuous conception (poetry). He subdivides the first into those of measuring sight (architecture), touching sight (sculpture), and sight proper (painting). Vischer's style is very labored. His propositions fall into the form of mathematical theorems, and are made exceedingly incomprehensible by the excessive subtleties of his metaphysical nomenclature.

There are several other systems of æsthetics which deserve mention here but space does not allow of a full account of them. Of these the most important are the theories of Herbart, Schopenhauer, and von Kirchmann. Herbart's views are based on his curious psychological conceptions. He ignores any function in the Beautiful as expressive of the idea, and seeks simply to determine the simplest forms or the elementary judgments of beauty. Schopenhauer's discussions, connecting beauty with his peculiar conception of the universe as volition, are a curious contribution to the subject. As a specimen of his speculations, one may give his definition of tragedy as the representation of the horrible side of life, the scornful dominion of accident, and the inevitable fall of the just and innocent, this containing a significant glimpse into the nature of the world and existence. Von Kirchmann has written a two-volume work on æsthetics, which is interesting as a reaction against the Hegelian method. It professes to be an attempt to base the science on a realistic foundation, and to apply the principles of observation and induction long acted upon in natural science.

The German æsthetic speculations not elaborated into complete systems are too numerous to be fully represented here. Only a few of the most valuable contributions to the theory will be alluded to. Winckelmann's services to the development of plastic art do not directly concern us. Of his theory of plastic beauty, based exclusively on the principles of Greek sculpture, little requires to be said. He first pointed to the real sources of superiority in antique creations, by emphasizing the distinction between natural and ideal beauty, the æsthetic value of contour as an ideal element, the beauty of expression as the manifestation of an elevated soul, and consisting of a noble simplicity and a quiet grandeur. But by too exclusive an attention to Greek art, and indeed to sculpture, his theory, as an attempt to generalize on art, lacks completeness, making little room for the many-sidedness of art, and narrowing it down to one, though an exalted, ideal.

Lessing's services to the scientific theory of art are far greater than those of Winckelmann. He is the first modern who has sought to deduce the special function of an art from a consideration of the means at its disposal. In his *Laokoon* he defines the boundaries of poetry and painting in a manner which has scarcely been improved on since. In slight divergence from Winckelmann, who had said that the representation of crying was excluded from sculpture by the ancients as unworthy of a great soul, Lessing sought to prove that it was prohibited by reason of its incompatibility with the conditions of plastic beauty. He reasoned from the example of the celebrated group, the Laokoon. Visible beauty was, he said, the first law of ancient sculpture and painting. These arts, as employing the co-existent and permanent in space, are much more limited than poetry, which employs the transitory and successive impressions of sound. Hence, expression is to poetry what corporeal beauty is to the arts of visible form and color. The former has to do with actions, the latter with bodies,—that is, objects whose parts co-exist. Poetry can only *suggest* material objects and visible scenery by means of actions; as for example, when Homer pictures Juno's chariot by a description of its formation piece by piece. Painting and sculpture, again, can only suggest actions by means of bodies. From this it follows that the range of expression in poetry is far greater than in visible art. Just as corporeal beauty loses much of its charm, so the visible Ugly loses much of its repulsiveness by the successive and transient character of the poetic medium. Hence poetry may introduce it, while painting is forbidden to represent it. Even the Disgusting may be skilfully employed in poetry to strengthen the impression of the Horrible or Ridiculous; while painting can only attempt this at its peril, as in Pordenone's Interment of Christ, in which a figure is represented as holding its nose. Visible imitation being immediate and permanent, the painful element cannot be softened and disguised by other and pleasing ingredients (the Laughable, etc.), as in poetry. As Schasler says, Lessing's theory hardly makes room for the effects of individuality of character as one aim of pictorial as well as of poetic art. Yet as a broad distinction between the two heterogeneous arts, limiting, on the one hand, pictorial description in poetry, and the representation of the painful, low, and revolting in the arts of vision, it is unassailable, and constitutes a real discovery in æsthetics. Lessing's principles of the drama, as scattered through the critiques of the *Hamburg Dramaturgy*, are for the most part a further elucidation of Aristotelian principles, of great value to the progress of art, but adding comparatively little to the theory. Its conspicuous points are the determination of poetic truth as shadowed forth by Aristotle, and the difference between tragedy and comedy in respect to liberty of invention both of fable and of character; secondly, the reassertion that both fear and pity, and not simply one of these, are the effects of every tragedy, and that it is false dramatic art to attempt to represent either the sufferings of a perfect martyr, or the actions of some monstrous horror of wickedness, as Corneille and the French school had urged; lastly, the interpretation of Aristotle's purification of the passions as referring to this very fear and pity, and pointing to a certain desirable mean between excessive sensibility and excessive callousness. Schasler says that if Lessing had had an Aristotle to lean on in the *Laokoon* as in the *Dramaturgy*, it would have been more valuable. Others might be disposed to say that if he had been as free from the traditions of authority in the *Dramaturgy* as he in the *Laokoon*, the former might have contained as much in the way of real discovery as the latter.

The partial contributions to æsthetics after Lessing need not long detain us. Goethe wrote several tracts on æsthetic topics, as well as many aphorisms. He attempts to mediate between the claims of ideal beauty, as taught by Wincklemann, and the aims of individualization.

Schiller discusses, in a number of disconnected essays and letters, some of the principal questions in the philosophy or art. He looks at art as a side of culture and the forces of human nature, and finds in an æsthetically cultivated soul the reconciliation of the sensual and rational. His letters on æsthetic education (*Ueber die æsthetische Erziehung des Menschen*) are very valuable, and bring out the connection between æsthetic activity and the universal impulse to play (*Spieltrieb*). This impulse is formed from the union of two other impulses —the material (*Stofftrieb*) and the formal (*Formtrieb*)—the former of which seeks to make real the inner thought, the latter to form or fashion this reality. Schiller's thoughts on this topic are cast in a highly metaphysical mould, and he makes no attempt to trace the gradual development of the first crude play of children into the æsthetic pleasures of a cultivated maturity. He fixes as the two conditions of æsthetic growth, moral freedom of the individual and sociability. The philosophic basis of Schiller's speculation is the system of Kant. Another example of this kind of reflective discussion of art by literary men is afforded us in the *Vorschule der Æsthetik* of Jean Paul Richter. This is a rather ambitious discussion of the Sublime and the Ludicrous, and contains much valuable matter on the nature of humor in romantic poetry. Jean Paul is by no means exact or systematic, and his language is highly poetic. His definitions strike one as hasty and inadequate: for example, that the Sublime is the applied Infinite, or that the Ludicrous is the infinitely Small. Other writers of this class, as Wilhelm von Humboldt, the two Schlegels, Gervinus, though they have helped to form juster views of the several kinds of poetry, etc., have contributed little to the general theory of art. F. Schlegel's determination of the principle of romantic poetry as the Interesting, in opposition to the objectivity of antique poetry, may be cited as a good example of this group of speculations.

No account of German æsthetics can be complete without some reference to the attempts recently made by one or two naturalists to determine experimentally the physical conditions and the net sensational element of artistic impression. Of these, the most imposing is the development by Helmholtz of a large part of the laws of musical composition, harmony, tone, modulation, etc., from a simple physical hypothesis as to the complex character of what appear to us as elementary tones. Another interesting experimental inquiry has been instituted by Fechner into the alleged superiority of "the golden section" as a visible proportion. Zeising, the author of this theory, asserts that the most pleasing division of a line, say in a cross, is the golden section, where the smaller division is to the larger as the latter to the sum. Fechner describes in his contribution *Zur experimentalen Æsthetik* a series of experiments on a large number of different persons, in which he supposes he eliminated all effects of individual association, and decides in favor of the hypothesis. He, however, assumes that this visible form must please primarily, and does not recognize that any constant association growing up in all minds alike would give precisely the same results. Finally, allusion may be made to some ingenious but very forced attempts of Unger and others to discover harmonic and melodious relations among the elementary colors.

III. *French Writers on Æsthetics.*— In passing from German to French writers on æsthetical topics we find, as might be expected, much less of metaphysical assumption and a clearer perception of the scientific character of the problem. At the same time, the authors are but few, and their works mostly of a fragmentary character. Passing by the Jesuit André, who sought to rehabilitate Augustin's theory of the Beautiful, we first light on the name of Batteux. In his

Cours de Belles Lettres (1765) he seeks to determine the aims of art by elucidating the meaning and value of the imitation of nature. He classifies the arts according to the forms of space and time, those of either division being capable of combining among themselves, but not with those of the other. Thus architecture, sculpture, and painting may co-operate in one visible effect; also music, poetry, and the dance. Diderot, again in the *Encyclopedie*, sought to define beauty by making it to consist in the perception of relations. In his *Essais sur la Peinture* he follows Batteux in extolling naturalness, or fidelity to nature. Another very inadequate theory of beauty was propounded by Père Buffier. He said it is the type of a species which gives the measure of beauty. A beautiful face, though rare, is nevertheless the model after which the largest number is formed. Not unlike this theory is a doctrine propounded by H. Taine. In his work, *De l'Ideal dans l'Art*, he proceeds in the manner of a botanist to determine a scale of characters in the physical and moral man, according to the embodiment of which a work of art becomes ideal. The degree of universality or importance, and the degree of beneficence or adaptation to the ends of life in a character, give it its measure of æsthetic value, and render the work of art, which seeks to represent it in its purity, an ideal work.

The only elaborated systems of æsthetics in French literature are those constructed by the *spiritualistes*, that is, the philosophic followers of Reid and D. Stewart on the one hand, and the German idealists on the other, who constituted a reaction against the crude sensationalism of the 18th century. They aim at elucidating what they call the higher and spiritual element in æsthetic impressions, and wholly ignore any capability in material substance or external sensation of affording the peculiar delights of beauty. The lectures of Cousin, entitled *Du Vrai, du Beau, et du Bien*, the *Cours d'Esthétique* of Jouffroy, and the systematic treatise of Lévêque, *La Science du Beau*, are the principal works of this school. The last, as the most elaborate, will afford the student the best insight into this mode of speculation. The system of Lévêque falls into four parts—(1.) The psychological observation and classification of the effects of the Beautiful on human intelligence and sensibility; (2.) The metaphysic of beauty, which determines whether it has a real objective existence, and if so, what is the internal principle or substance of this objective entity; and further seeks to adjust the relations of the Beautiful, the Sublime, the Ugly, and the Ridiculous in relation to this principle; (3.) The application of these psychological and metaphysical principles to the beauty of nature, animate and inanimate, and to that of the Deity; (4). Their application to the arts. The influence of the Germans in this mode of systematizing is apparent. All the characters of beauty in external objects, as a flower, of which the principal are size, unity, and variety of parts, intensity of color, grace or flexibility, and correspondence to environment, may be summed up as the ideal grandeur and order of the species. These are perceived by reason to be the manifestations of an invisible vital force. Similarly the beauties of inorganic nature are translatable as the grand and orderly displays of an immaterial physical force. Thus all beauty is in its objective essence either spirit or unconscious force acting with fullness and in order. It is curious that Lévêque in this way modifies the strictly spiritual theory of beauty by the admission of an unconscious physical force, equally with spirit or mind, as an objective substratum of the Beautiful. He seeks, however, to assimilate this as nearly as possible to conscious energy, as immaterial and indivisible. The aim of art is to reproduce this beauty of nature in a beautiful man ner, and the individual arts may be classified according to the degree of beautiful force or spirit expressed, and the degree of power with which this is interpreted. Accordingly, they are arranged by Lévêque in the same order as by Hegel.

IV. *Italian and Dutch Writers.*—There are a few writers on æsthetic subjects to be found in Italian and Dutch literature, but they have little of original speculation. The Italian, as Pagano and Muratori, follow French and English writers. One Dutch writer, Franz Hemsterhuis (18th century), is worth naming. His philosophic views are an attempt at reconciliation between the sensational and the intuitive systems of knowledge. The only faculty of true knowledge is an internal sense, nevertheless all true knowledge comes *through* the senses. The soul, desiring immediate and complete knowledge, and being limited by its union with the senses, which are incapable of perfectly simultaneous action, strives to gain the greatest number of the elements of cognition or ideas in the shortest possible time. In proportion as this effort is successful, the knowledge is attended with enjoyment. The highest measure of this delight is given by beauty, wherefore it may be defined as that which affords the largest number of ideas in the shortest time.

V. *English Writers.*—In the æsthetic speculations of English writers, we find still less of metaphysical construction and systematization than in those of French thinkers. Indeed, it may be said that there is nothing answering to the German conception of æsthetic in our literature. The inquiries of English and Scotch thinkers have been directed for the most part to very definite and strictly scientific problems, such as the psychological processes in the perception of the Beautiful. The more moderate metaphysical impulses of our countrymen have never reached beyond the bare assertion of an objective and independent beauty. Hence we find that the German historians regard these special and limited discussions as so many empirical reflections, wholly devoid of the rational element in true philosophy. Schasler speaks of these essays as "empiristic æsthetics," tending in one direction to raw materialism, in the other, by want of method, never lifting itself above the plane of "an æstheticising dilettanteism." English writers are easily divisible into two groups—(1.) Those who lean to the conception of a primitive objective beauty, not resolvable into any simpler ingredients of sensation or simple emotion, which is perceived intuitively either by reason or by some special faculty, an internal sense; (2.) Those who, tracing the genesis of beauty to the union of simple impressions, have been chiefly concerned with a psychological discussion of the origin and growth of our æsthetic perceptions and emotions.

Lord Shaftesbury is the first of the intuitive writers on beauty. His views are highly metaphysical and Platonic in character. The Beautiful and the Good are combined in one ideal conception, much as with Plato. Matter in itself is ugly. The order of the world, wherein all beauty really resides, is a spiritual principle, all motion and life being the product of spirit. The principle of beauty is perceived not with the outer senses, but with an internal—that is, the moral—sense (which perceives the Good as well). This perception affords the only true delight, namely, spiritual enjoyment. Shaftesbury distinguishes three grades of the Beautiful, namely, (1.) Inanimate objects, including works of art; (2.) Living forms, which reveal the spiritual formative force; and (3.) The source from which these forms spring, God.

In his *Inquiry into the Original of our Ideas of Beauty and Virtue*, Hutcheson follows many of Shaftesbury's ideas. Yet he distinctly disclaims any independent self-existing beauty in objects apart from percipient minds. "All beauty," he says, "is relative to the sense of some mind perceiving it." The cause of beauty is not any simple sensation from an object, as color, tone, but a certain order among the parts, or "uniformity amidst variety." The faculty by which this principle is known is an internal sense which is defined as "a passive power of receiving ideas of beauty from all objects in which there is uniformity in variety." Thus Hutcheson seems to have supposed that beauty, though always residing in uniformity in variety as its form, was still something distinct from this, and so in need of a peculiar sense distinct from reason for the appreciation of it. But his meaning on this point is not clear. This faculty is called a sense, because it resembles the external senses in the immediateness of the pleasure it experiences. The perception of beauty, and the delight attending it, are quite as independent of considerations of principles, causes, or usefulness in the object, as the pleasurable sensation of a sweet taste. Further, the effect of a beautiful object is like the impression of our senses in its necessity; a beautiful thing being always, whether we will or no, beautiful. In the second place, this sense is called internal, because the appreciation of beauty is clearly distinct from the ordinary sensibility of the eye and ear, whether emotional or intellectual and discriminative, many persons who possess the latter intact being totally destitute of the former. Another reason is, that in some affairs which have little to do with the external senses, beauty is perceived, as in theorems, universal truths, and general causes. Hutcheson discusses two kinds of beauty—absolute or original, and relative or comparative. The former is independent of all comparison of the beautiful object with another object of which it may be an imitation. The latter perceived in an object considered as an imitation or resemblance of something else. He distinctly states that "an exact imitation may still be beautiful though the original were entirely devoid of it; but, curiously enough, will not allow that this proves his previous definition of beauty as "uniformity amidst variety" to be too narrow. He seems to conceive that the original sense of beauty may be "varied and overbalanced" with the secondary and subordinate kind. Hutcheson spends a good deal of time in proving the universality of this sense of beauty, by showing that all men, in proportion to the enlargement of their intellectual capacity, are more delighted with uniformity than the contrary. He argues against the supposition that custom and education are sources of our perception of beauty, though he admits that they may enlarge the capacity of our minds to retain and compare, and so may add to the delight of beauty.

The next writer of consequence on the intuitive side is Reid. In the eighth of his *Essays on the Intellectual Powers* he discusses the faculty of taste. He held, on the ground of common sense, that beauty must exist in objects independently of our minds. As to the nature of the Beautiful, he taught that all beauty resides primarily in the faculties of the mind, intellectual and moral. The beauty which is spread over the face of visible nature is an emanation from this spiritual beauty, and is beautiful because it symbolizes and expresses it. Thus the beauty of a plant resides in its perfection for its end, as an expression of the wisdom of its Creator. Reid's theory of beauty is thus purely spiritual.

The celebrated *Lectures on Metaphysics* of Sir W. Hamilton do not, unfortunately, contain more than a slight preliminary sketch of the writer's theory of the emotional activities. He defines pleasure, following very closely the theory of Aristotle, as "a reflex of the spontaneous and unimpeded exertion of a power of whose energy we are conscious" (vol. ii. p. 440).

And, in perfect agreement with this conception, he divides the various feelings according to the faculties or powers, bodily or mental, of which they are the concomitants. In the scheme thus faintly shadowed forth, the sentiments of Taste are regarded as subserving both the subsidiary and the elaborative faculties in cognition, in other words, the Imagination and the Understanding. The activity of the former corresponds to the element of variety in the beautiful object, while that of the latter is concerned with its unity. A beautiful thing is accordingly defined "as one whose form occupies the Imagination and Understanding in a free and full, and, consequently, in an agreeable activity" (p. 512). In this way, the writer conceives, he comprehends all pre-existing definitions of beauty. He explicitly excludes all other varieties of pleasure, such as the sensuous, from the proper gratification of beauty. The æsthetic sentiment is thus regarded as unique and not resolvable into simpler feelings. Similarly, he denies any proper attribute of beauty to fitness. The essence of the sentiment of sublimity he finds, much in the same way as Kant, in a mingled pleasure and pain; "of pleasure in the consciousness of the strong energy, of pain in the consciousness that this energy is vain." He recognizes three forms of Sublimity: those of Extension or space, of Protension or time, and of Intension or power. Finally, he thinks that the Picturesque differs from the Beautiful in appealing simply to the imagination. A picturesque object is one whose parts are so palpably unconnected that the understanding is not stimulated to the perception of unity.

A very like interpretation of beauty, as spiritual and typical of divine attributes, has been given by Mr. Ruskin in the second volume of his *Modern Painters*. This part of his work, bearing the title "Of Ideas of Beauty," has a very systematic appearance, but is in fact a singularly desultory series of æsthetic ideas put into a very charming language, and colored by strong emotion. Mr. Ruskin distinguishes between the theoretic faculty concerned in the moral perception and appreciation of ideas of beauty and the imaginative or artistic faculty, which is employed in regarding in a certain way and combining the ideas received from external nature. The former, he thinks, is wrongly named the *æsthetic* faculty, as though it were a mere operation of sense. The object of the faculty is beauty, which Mr. Ruskin divides into typical and vital beauty. The former is the external quality of bodies that typifies some divine attribute. The latter consists in "the appearance of felicitous fulfilment of function in living things." The forms of typical beauty are—(1.) Infinity, the type of the divine incomprehensibility; (2.) Unity, the type of the divine comprehensiveness; (3.) Repose, the type of the divine permanence; (4.) Symmetry, the type of the divine justice; (5.) Purity, the type of the divine energy; and (6.) Moderation, the type of government by law. Vital beauty, again, is regarded as relative when the degree of exaltation of the function is estimated, or generic if only the degree of conformity of an individual to the appointed functions of the species is taken into account. Mr. Ruskin's wide knowledge and fine æsthetic perception make his works replete with valuable suggestions, though he appears wanting in scientific accuracy, and lacks, as Mr. Mill has pointed out, all appreciation of the explanatory power of association with respect to the ideal elements of typical beauty.

Of the more analytic writers on the effects of the Beautiful, Addison deserves a passing mention, less, however, for the scientific precision of his definitions, than for the charm of his style. His Essays on the Imagination, contributed to the *Spectator*, are admirable specimens of popular æsthetic reflection. Addison means by the pleasures of imagination those which arise originally from sight, and he divides them into two classes—(1.) Primary pleasures, which entirely proceed from objects before our eyes; and (2.) Secondary pleasures, flowing from ideas of visible objects. The original sources of pleasure in visible objects are greatness, novelty, and beauty. This, it may be said, is a valuable distinction, as pointing to the plurality of sources in the æsthetic impression, but the threefold division is only a very rough tentative, and destitute of all logical value, novelty of impression being always a condition of beauty. The secondary pleasures, he rightly remarks, are rendered far more extended than the original by the addition of the proper enjoyment of resemblance, which is at the basis of all mimicry and wit. Addison recognizes, too, the effects of association in the suggestion of whole scenes, and their accompaniments by some single circumstance. He has some curious hints as to the physiological seat of these mental processes, and seeks, somewhat naïvely, to connect these pleasures with teleological considerations.

In the *Elements of Criticism* of Lord Kames, another attempt is made to affiliate æsthetic phenomena to simpler pleasures of experience. Beauty and ugliness are simply the pleasant and the unpleasant in the higher senses of sight and hearing. By "higher" he means more intellectual, and he conceives these two senses to be placed midway between the lower senses and the understanding. He appears to admit no more general feature in beautiful objects than this pleasurable quality. Like Hutcheson, he divides beauty into intrinsic and relative, but understands by the latter ideas of fitness and utility, which were excluded from the Beautiful by Hutcheson. He illustrates the English tendency to connect mental processes with physiological conditions, by referring the main elements of the feeling of sublimity to the effect of height in objects in compelling the spectator to stand on tiptoe, by which the chest is expanded and muscular movements produced which give rise to the peculiar emotion.

Passing by the name of Sir Joshua Reynolds, whose theory of beauty closely resembles that of Père Buffier, we come to the speculations of another artist and painter, Hogarth. He discusses in his *Analysis of Beauty* all the elements of visible beauty, both form and color, often manifesting great speculative skill, and always showing a wide and accurate knowledge of art. He finds altogether six elements in beauty, namely—(1.) Fitness of the parts to some design, as of the limbs for support and movement; (2.) Variety in as many ways as possible, thus in form, length, and direction of line, shape, and magnitude of figure, etc; (3.) Uniformity, regularity, or symmetry, which is only beautiful when it helps to preserve the character of fitness; (4.) Simplicity or distinctness, which gives pleasure not in itself, but through its enabling the eye to enjoy variety with ease; (5.) Intricacy, which provides employment for our active energies, ever eager for pursuit, and leads the eye "a wanton kind of chase;" (6.) Quantity or magnitude, which draws our attention, and produces admiration and awe. The beauty of proportion he very acutely resolves into the needs of fitness. Hogarth applies these principles to the determination of degrees of beauty in lines and figures, and compositions of forms. Among lines he singles out for special honor the serpentine (formed by drawing a line once round from the base to the apex of a long slender cone) as the line of grace or beauty *par excellence.* Its superiority he places in its many varieties of direction or curvature, though he adds that more suddenly curving lines displease by their grossness, while straighter lines appear lean and poor. In this last remark Hogarth tacitly allows another principle in graceful line, namely, gentleness, as opposed to suddenness, of change in direction, though he does not give it distinct recognition in his theory, as Burke did. Hogarth's opinions are of great value as a set-off against the extreme views of Alison and the association school, since he distinctly attributes a great part of the effects of beauty in form, as in color, to the satisfaction of primitive susceptibilities of the mind, though he had not the requisite psychological knowledge to reduce them to their simplest expression. In his remarks on intricacy he shows clearly enough that he understood the pleasures of movement to be involved in all visual perception of form.

Burke's speculations on the Beautiful, in his *Philosophical Inquiry into the Origin of our Ideas of the Sublime and Beautiful*, are curious as introducing physiological considerations into the explanation of the feelings of beauty. They illustrate, moreover, the tendency of English writers to treat the problem as a psychological one. He finds the elements of beauty to be—(1.) Smallness of size; (2.) Smoothness of surface; (3.) Gradual variation of direction of outline, by which he means gentle curves; (4.) Delicacy, or the appearance of fragility; (5.) Brightness, purity and softness of color. The Sublime he resolves, not very carefully, into astonishment, which he thinks always contains an element of terror. Thus "infinity has a tendency to fill the mind with a delightful horror." Burke seeks what he calls "efficient causes" for these phenomena in certain affections of the nerves of sight, which he compares with the operations of taste, smell, and touch. Terror produces "an unnatural tension and certain violent emotions of the nerves," hence any objects of sight which produce this tension awaken the feeling of the Sublime, which is a kind of terror. Beautiful objects affect the nerves of sight just as smooth surfaces the nerves of touch, sweet tastes and odors the corresponding nerve fibres, namely, by relaxing them, and so producing a soothing effect on the mind. The arbitrariness and narrowness of this theory, looked at as a complete explanation of beauty, cannot well escape the reader's attention.

Alison, in his well-known *Essays on the Nature and Principles of Taste*, proceeds on an exactly opposite method to that of Hogarth and Burke. He considers and seeks to analyze the mental process which goes on when we experience the emotion of beauty or sublimity. He finds that this consists in a peculiar operation of the imagination, namely, the flow of a train of ideas through the mind, which ideas are not arbitrarily determined, but always correspond to some simple affection or emotion (as cheerfulness, sadness, awe), awakened by the object. He thus makes association the sole source of the Beautiful, and denies any such attribute to the simple impressions of the senses. His exposition, which is very extensive, contains many ingenious and valuable contributions to the ideal or association side of æsthetic effects, both of nature and of art; but his total exclusion of delight (by which name he distinguishes æsthetic pleasure) from the immediate effects of color, visible form, and tone, makes his theory appear very incomplete. This is especially applicable to music, where the delight of mere sensation is perhaps most conspicuous. He fails, too, to see that in the emotional harmony of the ideas, which according to his view, make up an impression of beauty, there is a distinct source of pleasure over and above that supplied by the simple feeling and by the ideas themselves.

Jeffrey's *Essay on Beauty* is little more than a modification of Alison's views. He defines the sense of beauty as consisting in the suggestion of agreeable and interesting sensations previously experienced by means of our various pleasurable sensibilities. He thus retains the necessity of ideal suggestion, but at the same time discards the supposed requirement of a *train* of ideas. Jeffrey distinctly saw that this theory excludes the hypothesis of an independent beauty inherent in objects. He fails as completely as Alison to disprove the existence of a sensuous or organic beautiful, and, like him, is avowedly concerned to show the presence of some one, and only one, determining principle in all forms of the Beautiful.

D. Stewart's chief merit in the æsthetic discussions contained in his *Philosophical Essays*, consists in pointing out this unwarranted assumption of some single quality (other than that of producing a certain refined pleasure) running through all beautiful objects, and constituting the essence of beauty. He shows very ingeniously how the successive transitions and generalizations in the meaning of the term beauty may have arisen. He thinks it must originally have connoted the pleasure of color, which he recognizes as primitive. His criticisms on the one-sided schemes of other writers, as Burke and Alison, are very able, though he himself hardly attempts any complete theory of beauty. His conception of the Sublime, suggested by the etymology of the word, renders prominent the element of height in objects, which he conceives as an upward direction of motion, and which operates on the mind as an exhibition of power, namely, triumph over gravity.

Of the association psychologists James Mill did little more toward the analysis of the sentiments of beauty than re-state Alison's doctrine. On the other hand, Professor Bain, in his treatise *The Emotions and the Will*, carries this examination considerably further. He asserts with Stewart that no one generalization will comprehend all varieties of beautiful objects. He thinks, however, that the æsthetic emotions, those involved in the fine arts, may be roughly circumscribed and marked off from other modes of enjoyment by means of three characteristics—(1.) Their not serving to keep up existence, but being gratifications sought for themselves only; (2.) Their purity from all repulsive ingredients; (3.) Their eminently sympathetic or sharable nature in contrast to the exclusive pleasures of the individual in eating, etc. The pleasures of art are divided, according to Mr. Bain's general plan of the mind, into (1.) The elements of sensation—sights and sounds; (2.) The extension of these by intellectual revival—ideal suggestions of muscular impression, touch, odor, and other pleasurable sensations; (3.) The revival, in ideal form also, of pleasurable emotions, as tenderness and power, and in a softened measure of emotions painful in reality, as fear; (4.) The immediate gratification, that is in actual form, of certain wide emotional susceptibilities reaching beyond art, namely, the elating effect of all change of impression under the forms of artistic contrast and variety; and, secondly, the peculiar delight springing from harmony among impressions and feelings, under its several æsthetic aspects, musical harmony and melody, proportion, etc. The details in Mr. Bain's exposition are rich and varied in relation to the psychology of the subject. He finds the effect of sublimity in the manifestation of superior power in its highest degrees, which manifestation excites a sympathetic elation in the beholder. The Ludicrous, again, is defined by Mr. Bain, improving on Aristotle and Hobbes, as the degradation of something possessing dignity in circumstances that excite no other strong emotion. The pleasure accompanying the impression may be referred either to the elation of a sense of power or superiority ideally or sympathetically excited, or to a sense of freedom from restraint, both of which have in common the element of a joyous rebound from pressure. Thus it will be seen that Professor Bain recognizes no new mental principle in æsthetic effects, but regards them as peculiar combinations and transformations, according to known psychological laws, of other and simpler feelings.

An interesting turn has been given to the psychology of æsthetics by Mr. Herbert Spencer. In some of his essays as the one entitled *The Origin and Function of Music*," and more fully in the concluding chapter of his *Psychology* (second edition), on the Æsthetic Sentiments, he offers a new theory of the genesis of the pleasures of beauty and art, based on his doctrine of evolution. He takes up Schiller's idea of the connection between æsthetic activity and play, only he deals with this latter not as an ideal tendency, but as a phenomenal reality seeking to make it the actual starting-point in the order of evolution of æsthetic action. Play or sport is defined as the superfluous and useless exercise of faculties that have been quiescent for a time, and have in this way become so ready to discharge as to relieve themselves by *simulated* actions. Æsthetic activities yield to the higher powers of perception and emotion the substituted exercise which play yields to the lower impulses, agreeing with play in not directly subserving any processes conducive to life, but being gratifications sought for themselves only. This point of affinity between the two classes of pleasures is a valuable addition to æsthetic theory, and helps one to understand how the artistic impulse first arose. At the same time it is doubtful how far all present æsthetic pleasures, as the passive enjoyments of color and tone, can be interpreted as substituted activities in Mr. Spencer's sense. They seem rather to be original and instinctive modes of gratification not dependent on any previous exercises of life-function, except so far as the structure and functions of the senses as a whole may be viewed as the product of multitudinous life-processes in animal evolution. Mr. Spencer, moreover, forms a hierarchy of æsthetic pleasures, the standard of height being either the number of powers duly exercised, or what comes to the same thing, the degree of complexity of the emotional faculty thus exercised. The first and lowest class of pleasures, are those of simple sensation as tone and color, which are partly organic and partly the results of association. The second class are the pleasures of perception, as employed upon the combination of colors, etc. The highest order of pleasures are those of the æsthetic sentiments proper, consisting of the multitudinous emotions ideally excited by æsthetic objects, natural and artistic. Among these vaguely and partially revived emotions Mr. Spencer reckons not only those of the individual, but also many of the constant feelings of the race. Thus he would attribute the vagueness and apparent depth of musical emotion to associations with vocal tones, built up during the course of vast ages. This graduated scheme is evidently dictated by the assumption that the higher the stage of evolution the higher the pleasure. Yet Mr. Spencer admits that this measure of æsthetic value will not suffice alone, and he adds, that the most perfect form of æsthetic gratification is realized when sensation, perception, and emotion, are present in fullest and most pleasurable action. Mr. Spencer's supposition, that much of the pleasure of æsthetic emotion is referable to transmittted experience, offers a very ingenious, even if not very definite mode of explaining many of the mysterious effects of tone, and even of color.

DREAMS.

BY JAMES SULLY, M.A.

Dreams are a variety of a large class of mental phenomena which may be roughly defined as states of mind which, though not the result of the action of external objects, resume the form of objective perceptions.

To this class belong the fleeting images which occasionally present themselves during waking hours, and especially before sleep, the "visions" which occur in certain exalted emotional conditions, as in religious ecstasy, the hallucinations of the insane, the mental phenomena observable in certain artificially produced states (hypnotism), etc. These and other mental conditions resemble one another in many important respects, to be spoken of by and by. At the same time they are roughly marked off by certain special circumstances. Thus, dreaming may be distinguished from the other species of the class as depending on the most complete withdrawal of the mind from the external world. All products of the imagination which take the aspect of objective perceptions must, it is clear, involve a partial aberration of the intellectual processes. Yet in all cases except that of dreaming—including even somnambulism—the mind preserves certain limited relations to external objects. In dreams, on the contrary, the exclusion of the external world from consciousness is for the most part complete. Sleep has under normal circumstances the effect both of closing the avenues (sensory nerves) by which external impressions are conveyed to consciousness, and of cutting off from the mind that mechanism (the voluntary motor nerves and mucles) through which it maintains and regulates its varying relations to the outer world. Dreams cover a great variety of mental states from fleeting momentary fancies to extended series of imaginations. Again, dreams have certain constant or approximately constant features, while in other respects they manifest wide diversity. Among the most general characteristics is to be named the apparent objectivity of dream-experience. The presence of this objective element in dreams is clearly indicated in their familiar appellation "visions," which also points to the well-recognized fact that a large part of our dream-imagination simulates the form of *visual* perception. The next general characteristic of dreams is that, though resembling waking experience in many respects, they seem never exactly to reproduce the order of this experience. Most of our dreams differ very widely from any events ever known to us in waking life, and even those which most closely resemble certain portions of this life introduce numerous changes in detail. These deviations involve one or two distinct elements. First of all, there is a great confusion of the order in time, space, etc., which holds among real objects and events. Widely remote places and events are brought together, persons set in new relations to one another, and so on. Secondly, the objects and scenes are apt to assume a greatly exaggerated intensity. They take a firmer hold of us, so to speak, than our waking experience. We may when awake think of dreams as unsubstantial and unreal, but to the dreamer at the moment his imagined surroundings are more real, more impressive, than the actual ones which he perceives when awake. Dream-fancy exaggerates the various aspects of objects, makes what is large still larger, what is striking still more striking what is beautiful still more beautiful, and so on.

Having touched on these approximately universal characteristics of dreams, we will now specify a few of the more variable features. For example, in a large number of our dreams we appear to be passive spectators of events which we are incapable, or rather do not think, of controlling in any way. In other dreams, again, we seem to be lively actors in the scene,—talking, moving, etc., as we are wont to do in waking life. In a class of dreams lying midway between these two extremes we appear to be impelled to act, to be struggling to seize some offered good or to avert some threatening evil, yet to be unable to execute our wishes.

Once more, dreams differ very much as to their degree of reasonableness. It is certain that in many cases the dreamer is easily imposed on, sees no contradictions, does not seek to understand the events which unfold themselves before his fancy, and so on. In some instances, indeed, the mind of the dreamer loses even the sense of identity in objects, and metamorphizes persons in the most capricious manner; and this confusion of identity may embrace the dreamer himself, so that he imagines himself to be somebody else, or projects a part of himself, so to speak, into another personality, which thus becomes an *alter ego* and an object for the contemplation of the remaining self. Yet though it is true that many, probably a large proportion, of our dreams, are thus unintelligible to waking thought, there is a number of well-authenticated dreams in which persons have proved themselves to be possessed not only of their ordinary, but even of an extraordinary, power of reflection. We refer to the well-known stories of the intellectual achievements of Condillac, Condorcet, Coleridge, etc., when dreaming. Once more, great differences are observable in dreams with respect to the feelings excited by the visionary experiences. Sometimes the circumstanees in which we find ourselves affect us much as in waking life;—danger terrifies us, beauty delights us, and so on. At other times, however we are not thus affected; what would puzzle, confuse, or shock our minds in waking experience fails to do so in dream-life. Finally, there are certain exceptional features of dream-life, as a vague consciousness of dreaming, which assumes the form of a dream within a dream, and the repetition of the images of previous dreams with a recognition of the familiarity of the dream-scenes. It need hardly be added that dreaming varies greatly both in quantity and in quality, according to individual temperament, habits of thought, etc.

Theories of Dreaming.—From the slight sketch of the character of the dreaming process just given, it might be conjectured that the human mind at all times would be profoundly impressed with the fact of dreaming, and seek to arrive at some explanation of what on the surface is undoubtedly so mysterious and so wonderful a phenomenon. And as a matter of history we find that men have in all the known stages of their intellectual development endeavored to account for the visions of the night. The various theories thus put forward fall into two main classes—the supernatural and the natural. By the former we mean all explanations which assume the action of forces unknown to our waking experience; by the latter those which make no such assumption, but seek to interpret dream-phenomena as products of forces familiar to waking perception. The supernatural hypothesis, again, falls into two divisions, according as the dream is regarded as the immediate effect of some reality corresponding to the actual world of our waking experience, or as it is conceived as a mediate result depending on the volition and command of some absent being. We thus have three main methods of explaining dreams:—(*a*) The naïve objective explanation; (*b*) the religious explanation; (*c*) the scientific explanation.

(*a*) *The Dream as Immediate Objective Experience.*—According to recent researches the savage mind regards dreaming as no less real an objective experience than waking. The objects and scenes which flit before the dreaming fancy of the primitive man are real material existences, the sounds he seems to hear are real external sounds, the dream figures which stand before his imagination and converse with him are real persons. How then does he conceive the relation of this dream-world to the world of waking experience? This question has lately been answered by Mr. E. B. Tylor and Mr. Herbert Spencer. The belief in the objective reality of dreams requires the savage to conceive a double nature both for objects (animate and inanimate) external to himself and for himself. The vision of dead ancestors, of material objects long since lost or destroyed, easily suggests the idea of a duplicate of the original person or thing, a second self or soul. On the other hand, when the savage dreams that he goes forth to accustomed scenes, to hunt, to fight, and so on, he accounts for the dream by the supposition that his own second self or soul leaves the body and passes forth to the particular locality. Thus the dream-life shapes itself to our primitive philosopher as an intercourse of souls or duplicate selves, co-ordinate with, and of equal reality with, the experience of waking life. It appears to follow from the unfamiliarity of dream scenes, personages, etc., that the region visited during sleep will be projected by the savage mind quite outside the world of waking observation. Mr. Spencer connects with this fact the earliest theories of another world or a spiritual state. (For a fuller account of the part played by dreams in primitive ideas consult E. B. Tylor, *Primitive Culture*, vol. i. chap. xi.; H. Spencer, *Principles of Sociology*, i. ch. x. *et seq.*)

(*b*) *The Dream as a Communication from a Supernatural Being.*—It is plain that even in the savage's conception of dreaming there is room for the thought of a divine announcement. When once the idéa of superior beings, deities, demons, etc., is reached, it becomes natural to regard the visit of some departed soul as the dispatch of a messenger to the dreamer. In this way the first mode of explanation passes insensibly into the second. In higher stages of religious thought the view of a dream as a divine revelation takes a less crude form. The immediate object present to the dreamer is no longer conceived as possessing the same degree of materiality. Something is still present, no doubt, and so the dream is in a sense objective; but the reality is less like a tangible material object, and is transformed more or less completely into something unsubstantial, spiritual, and phantasmal. On the other hand, the dream is objective in the sense of being a message or revelation from some actual divine personage. The essence of the dream, so to speak, lies in the fact that it conveys to the dreamer something which the divine personage wishes him to know, whether it be the will of this being in the shape of a command or a prohibition, or some fact as yet unknown (past or future), the knowledge of which will be of practical utility to the recipient. We may distinguish three stages in this conception of dreams:—(1) The deity sends a messenger or angel who is vaguely conceived as a spiritual being clothed in a thin material vestment; (2) the divine communicator, dispensing with the medium of a material appearance, lets his message be heard by the dreamer as the utterance of an external voice; (3) he discloses his purpose by causing to pass before the soul a vision which is not distinctly conceived as objective, but rather as something mysteriously imprinted on the mind.

The divine communication which thus makes use of the medium of a dream will, it is plain, vary considerably in the degree of its intelligibility. Sometimes the meaning of the message is obvious and unmistakable. The actions to be performed and the facts to be known are revealed plainly and directly. This will be the case for the most part with the first and second forms of dream-communication. At times, too, the divinely-created vision may distinctly picture some coming event in the individual or national life. On the other hand, the communication may be disguised and only partially divulged by symbol, in which case there arises the necessity of an art of interpretation. Thus at times the oral utterance may assume the form of a dim oracular declaration which calls for careful attention and a certain skill in the application of verbal figures. It is, however, in the last form of dream-revelation that we find the greatest demands made on the interpreter's art. It follows from what has been said respecting the novelty of dream-combinations that many of the visual images which make up so large a bulk of our dreams cannot easily be fitted to any actual order of events. Hence, if such dreams are to be interpreted as having a bearing on actual events, they must be regarded as figurative and symbolic. Accordingly we find that the symbolic function of dreams has been fully recognized in all the theories of dreaming now dealt with. It seems to have been assumed that the normal mode of divine communication to man during sleep was that of such a figurative dream. And agreeably with this supposition the task of deciphering dream-symbols gradually grew into a skilled art, which became the prerogative of a certain class of experts,—as prophets, divinators, or magicians.

A very brief historical review of this religious theory of dreams must here suffice. Among the Oriental peoples this view of dreams was the prevailing one. We find, however, great differences in the mode of interpretation adopted. Among the ancient Hebrews, for example, we find all the three forms of dream-communication mentioned above. As to interpretation there seem to have been no definite rules, and the procedure followed resolves itself into an attempt to discover the most natural or least forced application of the persons, objects, and relations of the dream to some existing persons, social circumstances and events. This mode of interpretation clearly left wide scope for individual skill. In the Persian scheme of interpretation on the other hand, so far as we can judge of it from the compilations of a later age, the art of dream-interpretation, oneirocritics, or oneiromancy, was defined and fixed in a number of rules. Thus in the work known under the name of the *Sifat-i-Sirozah*, minute and elaborate prescriptions are given for interpreting various classes of dreams according to the particular day of the month on which they occur. A similar systematization of the rules of dream-interpretation is to be met with among the Arabs (see *L'Onirocrite Mussulman*, par Gabdorrhachaman, traduction de Pierre Vattier). In such cases, it is plain, the interpretation of dreams involved less of individual genius or inspiration, and became a more mechanical process, involving only careful knowledge of formulæ, and one which could be easily communicated. Such a state of things points to the transition of dream-lore from the stage of an esoteric mystery to that of a communicable science. Among the Greeks and Romans the religious view of dreams is to be found in popular literature as well as in philosophic writings. In Homer, dreams are distinctly said to be sent by the gods and goddesses, as in the expression θεῖος ὄνειρος, and it is implied that they may be intended to deceive the subject of them (*e.g.*, Agamemnon's dream, *Iliad*, book ii.). Similarly the dramatists frequently speak of foreknowledge divinely communicated by dreams (*e.g.*, Clytemnæstra's prescience as to the fall of Troy in the *Agamemnon* of Æschylus is ascribed to a dream). The popular view was countenanced to a certain extent by philosophers. Thus Plato found room in his mystic scheme of knowledge for the idea of a divine manifestation to the soul in sleep. In the *Timæus* (chaps. xlvi. and xlvii.) a prophetic character is distinctly assigned to the images of dreams. These divine inspirations (divinations) are not, however, given to the rational soul, but to the lower appetitive soul through the medium of the sensible images of rational truths which are reflected on the liver, an organ contiguous with the bodily seat of the appetitive soul. These prophetic visions are received only when the reasoning faculty is fettered by sleep or alienated by disease and enthusiasm. In this way, the divine artificer has given to the inferior regions of the soul a certain substitute for rational knowledge. At the same time the interpretation of the visions requires intelligence, and hence the business of receiving them, and of interpreting them does not properly belong to the same persons. Even Aristotle treats the supposition of divine revelation in dreams very considerately when he writes, in the treatise περὶ μαντικῆς τῆς ἐν τοῖς ὕπνοις, "that there is a divination concerning some things in dreams is not incredible." The Stoics, again, to judge from Cicero's account of their views in his *De Divinatione*, reasoned *à priori* that the gods, if they love men and are omniscient as well as all-powerful, will certainly disclose their purposes to man in sleep. Chrysippus is, on the same authority, said to have written a volume on the interpretation of dreams as divine portents. Cicero's brother Quintus, who here defends the orthodox theory of dreams, speaks of a skilled interpretation of dreams which is a true divination, even though, like all other arts in which men have to proceed on conjecture and on artificial rules, it is not infallible. The current views of dreams of classic antiquity are supposed to be to some extent embodied in the Ὀνειροκριτικά of Daldianus Artemidorus of Ephesus (written about the year 170.) Here the interpretation of dreams is reduced to a body of elaborate rules. To dream of a particular element, as fire, air, etc., of a particular plant, part of the body, and so on, always signifies the same kind of event for the same kind of person. It is the overlooking of the age, social condition, etc., of the dreamer which in the view of Artemidorus, leads to the abuse of drama interpretation. He attempts to draw a distinction between ὄγειρος, a vision having a real bearing on events, and ἐούπνιον, a mere dream having no actual significance; but this does not according to Liddell and Scott, correspond with classical usage. The divine origin of dreams became a doctrine of the Christian church. It appears in the writings of the fathers, being defended partly on biblical, partly on classic, authority. Synesius of Cyrene (born 375) has left a treatise on dreams (περὶ ἐνυπνίων). He puts forward certain psychological hypotheses drawn largely from Plato and Plotinus, and ascribes to the imagination (which is intermediate between the soul and the animal part) the power of accompanying the soul in its flights to the celestial regions, and so of sharing in the contemplation of divine truths. Synesius exalts the rank of dreaming among the arts of divination, setting it far above other modes of prophecy as being most simple and sure, open to all, unencumbered with expensive and laborious preparations, and so on. He affirms that he has repeatedly found dreams of service in arranging his ideas, and in improving his style of composition. Mediæval and modern Christian theologians have continued to attribute dreams, or, more accurately, certain orders of dream, to the intermediate agency of the divine Being. The popular theory of dreams to be met with among the later European peoples bears the impress of that folk-lore which developed itself in the Middle Ages under influences partly Christian, partly pagan. Dreams were referred to a variety of supernatural agencies, including not only God and the devil, but also subordinate beings, as fairy, fiend (incubus), etc. Further, the art of interpreting dreams according to definite rules (oneiromancy) was developed to a very high point. (See Brand, *Popular Antiquities*, vol. iii. *Dictionary of Dreams*). In our own times certain restricted classes of dreams are customarily associated with the action of benevolent or malignant beings. On the other hand, people are now wont to interpret dreams as omens or signs without distinctly attributing them to any supernatural agent. This view of dreams forms the transition-point between the religious and the scientific theories.

(*c*) *The Dream as a Subjective Phenomenon Dependent on Natural Causes.*—While the theory of the divine or supernatural origin of dreams has thus held its ground so long, there has been gradually growing up from an early period of human history a more scientific conception of the phenomenon as dependent on natural laws (of mind and body). Psychologists and Physiologists alike have approached the subject from their respective points of view, and sought to explain the phenomena of dreaming as natural events. The first germs of a scientific theory of dreams are to be found in antiquity. Thus Democritus, from whom the Epicureans derived their theory, held that dreams are the product of the simulacra or phantasms of corporeal objects which are constantly floating in the atmosphere, and which attack the soul during repose. Again, Plato speaks in the *Republic* of dreaming as illustrating the dominant mental impulses and habits of the individual (unchecked appetite, and temperance with intellectual pursuits), and thus connects it with the normal waking operations of feeling and thought. Aristotle in his short treatise on dreams (περὶ ἐνυπνίων) refers dreaming to the action of objects of outward sense which leave behind impressions on the soul and bodily frame. Dreaming is said to be the function of the sensitive part of the mind, but of this so far as fantastic; and a dream is defined as "the phantasm arising from the motion of sensible perceptions when it presents itself to him who is asleep." Aristotle further has some correct observations on the immediate bodily conditions of dreaming, and on the exaggeration of sensation in this condition of mind. Thus, he says, we fancy it thunders and lightens when a small sound is produced in our ears; we imagine that we are eating honey in consequence of a defluxion of the least quantity of phlegm. In the *De Divinatione* of Cicero we have almost an unique instance among classic writings of a complete rejection of the doctrine of the supernatural origin of dreams, and of a full and consistent adoption of the natural method of explaining the phenomena. Cicero's position stands in marked contrast to that of partial sceptics, as for example, Pliny, who seems content to exclude from the supernatural method of explanation certain of the more obviously natural dreams, such as those occurring immediately after food and wine, or when one has just fallen asleep after waking (*Nat. Hist.*).

While philosophers were thus learning to regard dreams as natural processes, physicians, on the other side, had their attention called to dreaming in its relation to pathological bodily conditions. It seems probable, indeed, that men occupied in studying bodily diseases were among the first to suspect the true nature and origin of dreaming. Thus Hippocrates, while inclined to admit that some dreams may be divine, distinctly says that others arise from the action of the mind and the body. Hippocrates, too, appears to have been the first to supply a scientific basis for the premonitory character of certain kinds of dreams. There are dreams, he says, which announce beforehand the affections of the body. This idea has, as we shall see presently, been confirmed by modern pathological observations. It is easy to understand that this prognostic side of dreams was in the early stages of knowledge greatly exaggerated. This appears to be true of the speculations of Galen, who held that to dream one's thigh was turned into stone signified the approaching loss of this member. This belief in the premonitory character of dreams was only one side of a general doctrine of dreams according to which they arise from bodily disturbances, and so may serve as symptoms which the physician has to include in the complete diagnosis of a disease.

This idea, which is recognized by modern physiologists as true within certain limits, led in the first crude stages of scientific investigation to exaggerated and fanciful conclusions. Thus a new system of dream-interpretation came into vogue according to which to dream of a certain thing always means a disturbance in one particular organ. In the doctrines of Oriental physicians (the Hindus and Chinese) dreams are thus referred to pathological states of the five organs—heart, lungs, kidneys, spleen, and liver. Thus to dream of war and fighting signifies a bad state of the lungs; of fire, smoke, etc., a bad state of the heart, and so on.

Modern Theory of Dreams.—Under this head we shall give an account of the principal results of modern investigations, psychological and physiological, on the nature and conditions of dreams. Respecting many points there is still considerable diversity of view. Certain questions of fact yet remain unanswered, the reason of this being the inaccessibility of dream-phenomena to accurate and adequate observation. Further, owing to the divided condition of psychological principles, the explanation of dreaming assumes very different forms with different writers. On the one hand there are those who conceive the mind as an independent spiritual substance, which employs the body as its instrument, but is not dependent on this. With these, dreams will naturally wear the aspect of products of some spiritual faculty or faculties which are not involved in the sleep of the body and the senses. At the other extreme are those who regard mental phenomena as an outcome of bodily changes, as a refined result of physical processes. By these, dreams will be regarded as given off, so to speak, by the various organs of the body during sleep. Midway between the spiritualist and materialist hypotheses is the scientific view in its narrower sense, namely, the doctrine that the mental and the bodily are perfectly dissimilar regions of phenomena, which are yet connected in such a way that bodily events appear as the conditions of mental events. In the following account of modern dream-theory we shall confine ourselves for the most part to the last stand-point, though indicating here and there how the other theories of the relation of mind to body lead to divergent conclusions.

On the very threshold of our inquiry we are met by a much-disputed question—What is the relation of dreaming to sleep? Is dreaming an indication of imperfect sleep which must cease as soon as the higher nervous centers reach a complete repose? Is it, on the other hand, something wholly spiritual and independent of sleep as a bodily condition? Here we have two different views arising from different theories of the relation of mind and body. These distinct views of the subject have commonly appeared as answers to the question of fact—Are we when asleep always dreaming? This question was first raised by philosophers in connection with certain conceptions of the soul and its activity. Descartes, who regarded thought as of the essence of personal existence, was naturally led to maintain that the mind is always thinking. "I am," he says, "I exist, that is certain; but for how long? as long as I think; for perhaps even it might happen that if I ceased wholly to think I should cease at the same time wholly to exist (*Meditation* ii.) Among the Cartesians the proposition, the mind is always thinking, became a leading tenet. Locke argues against this supposition. He contends that in sleep men do not always think, or they would be conscious of it. If it is asserted that they dream but they forget it, he replies it is "hard to be conceived" that "the soul in a sleeping man should be this moment busy a-thinking, and the next moment in a waking man not remember nor be able to recollect one jot of all those thoughts." To suppose that in sleep the soul thinks apart from the body involves the absurdity of a double mind, and is further contradicted by the irrationality of dreams (*Essay*, book ii. ch. i.). Locke was answered by Leibnitz in the *Nouveaux Essais*, who upheld the Cartesian affirmation, and maintained that during sleep the mind has always some "little perceptions" or "confused sentiments," though, according to his doctrine of unconscious perceptions, these need not become objects of conscious attention. That we never sleep without dreaming is further maintained by Kant in his *Anthropologie*, by Jouffroy and others. In his *Lectures on Metaphysics*, Sir W. Hamilton argues fully for the same idea. He says that during sleep the mind "is never either inactive or wholly unconscious." He seeks to refute the argument of Locke, that we ought to remember our dreams, by calling attention to the fact that the somnambulist has no recollection of his dream, and that persons who betray in their expression and utterance the fact of dreaming retain no recollection of the state. He further holds that the continuity of dreaming is proved by the fact that whenever we are suddenly roused from sleep we find ourselves dreaming.

While metaphysicians have thus in the main affirmed the continuity of dreams, those who regard mental phenomena as invariably connected with bodily conditions have for the most part viewed dreaming as only an occasional accompaniment of sleep. By some, indeed, dreaming is viewed as confined to the transition state from sleeping to waking, though this view is now rejected by physiologists no less than by metaphysicians. It is true that the great rapidity of dream-thought has been proved, *e.g.*, by the experience of Lord Holland, who fell asleep when listening to somebody reading, had a long dream, and yet awoke in time to hear the conclusion of the sentence of which he remembered the beginning. And this takes off from the value of Hamilton's argument that we always find ourselves dreaming when wakened, for such dreaming may clearly be an incident of the transition state. Yet the other facts emphasized by Hamilton, as well as the results of Maury's experiments, to be spoken of presently, show that we may dream when soundly sleeping. On the other hand, we cannot, it is certain, directly prove that we are always dreaming during sleep. Many physiologists are disposed to regard dreaming as the accompaniment of some slight disturbance, whether arising from the lower organs or from an undue excitability of the brain and its nervous connections; and according to this view the continuity of dreaming would seem to be an improbable supposition. To the physiologist the idea of perfectly unconscious sleep presents no difficulties. The results of experiment show him that the lower bodily (vegetative) functions are independent of cerebral activity; and the phenomena of swooning, the effects of anæsthetics, etc., familiarize him with the temporary suspension of the conscious activity of the brain. Hence the view commonly adopted by physiologists seems to be that dreaming is only an occasional incident of sleep. See, the article on "Sleep and Dreams" by Dr. Carpenter in Todd's *Ency. of Anat. and Physiol.* At the same time certain physiologists, as Sir H. Holland (*Chapters on Ment. Physiol.*) and Sir Benj. Brodie (*Psychological Inquiries*), are disposed to think that dreaming is the rule and not the exception.

The question whether we are always dreaming during sleep leads up naturally to the inquiry into the causes or conditions of dreams. This question has been approached from different sides. On the one side, metaphysicians have sought to account for dreaming by some simple theory of a suspension of certain mental faculties. On the other side, writers have tried to explain dreaming as a result of simple bodily operations. We will just glance at one or two of these simple hypotheses. A common view among metaphysicians is that the nature of dreaming is amply explained by the absence or suspension of the will. The importance of the cessation of the will's action has been emphasized by Dugald Stewart (*Elements of the Phil. of the Human Mind*, vol. i. chap. v. sect. 5). Stewart does not mean that the will is wholly dormant in sleep, but that it loses its hold on the faculties. By this supposition he seeks to account not only for the incoherence but also for the apparent reality of dream-images. That the absence of the normal processes of volition, especially as involved in attention, constitutes one important factor in the explanation of dreaming seems to be admitted by all writers,—for example, Dr. Darwin (*Zoonomia*), Sir Benj. Brodie, Dr. Carpenter, and M. Alf. Maury (*Le Sommeil et les Rêves*). It is doubtful, however, whether this simple hypothesis explains all that Stewart refers to it. Maury objects to Stewart's theory that the will does does not wholly lose its command of the bodily organs, etc., in dreams.

While great stress has thus been laid by some writers on this negative condition, the suspension of will, others have sought to construct a simple theory of dreaming by supposing the unimpeded action of some special mental faculty. Thus Cudworth (*Treatise concerning Eternal and Immutable Morality*) reasons, from the orderly coherence of dream-imaginations and the novelty of their combinations, that this state of mind arises from the action of "the fantastical power of the soul," and not from "any fortuitous dancings of the spirits." A very curious theory of dreaming as depending on a particular circumscribed faculty of the soul is to be found in Scherner's *Das Leben des Traumes*. Dreaming is a decentralization of the movement of life. In waking consciousness the central force, the ego spontaneity, is supreme,—in dreaming the activity of the ego becomes purely receptive. The central ego is now merely the point about which the peripheral life plays in perfect freedom. Thus the will (the spontaneous ego) is suspended, and thought loses its categories. On the other hand, the imagination now freed from the ego reaches its perfect unrestrained function. And this function is seen in the symbolic representation both of the bodily parts and of the mental stimuli which influence consciousness in sleep. A similar conception of the action of the creative fancy in dreaming is adopted by Dr. Johannes Volkelt (*Die Traum-phantasie.*)

In addition to these simple metaphysical and psychological theories of dreaming, there are to be found no less simple physiolgical hypotheses. Among these we may take the opinion of Hobbes (*Leviathan*), that the imaginations of dreams all proceed from "the agitation of the inward parts of a man's body," the disturbance of which parts, owing to their connections with the brain, serves to keep the latter in motion. Another simple physiological hypothesis for explaining dreams is offered by Schopenhauer. According to this writer, the exciting causes of dreams are impressions received from the internal regions of the organism through the sympathetic nervous system. These impressions are afterward worked up by the mind into quasi-realities by means of its "forms" of space, time, etc.

This simple and "geometric" method of explaining dreams, though it may be valuable up to a certain point, must necessarily fail to account for all the phenomena concerned. As we have shown in our preliminary description of dreams, their contents vary within very wide limits, and cannot therefore all be referred to one or two simple principles, whether mental faculties or body stimuli; also, it is by no means safe to affirm of any mental function that it is universally absent in dreams, since the second mental processes, as Sir H. Holland and M. Maury point out, enter in very unequal degrees into different dreams.

A full and exhaustive theory of dreaming would seem to include several distinct lines of inquiry. Among these there are three which have already been well defined by recent writers on the subject. The first relates to the sources of dream-imaginations, or the stimulations which are the immediate causes of these. The second question has to do with the order or form of dream-combinations, and seeks to determine the conditions of the peculiar arrangements, simultaneous and successive, which are observable in dreams. The last problem is that of accounting for the objective reality, and generally for the intensity and impressiveness of dream-fancies.

In briefly opening up each of these lines of inquiry we shall seek to keep in mind the variable as well as the constant features of dreaming; also we shall proceed as far as possible, according to that double method of study, the psychological and the physiological (subjective and objective), which offers itself to those who accept the idea of a perfect parallelism between mental and bodily events.

(*A*) *The Sources of Dream-Materials.*—The numerous images which make up the ever-renewed current of a dream appear sometimes to come from the internal depths of the mind itself. In other cases, as even the ancients recognized, they depend on a stimulation of the brain arising from varying conditions of the bodily organs. According to the view that all mental events have their physical accompaniments, the first class of imaginations must also be referred to certain conditions of the brain and nervous system. These various sources of dream-activity are roughly classified by Hartley in his *Observations on Man.* Dream-images, he tells us, are deducible from three causes:—(1) impressions and ideas lately received; (2) present state of the body (especially the stomach and the brain); (3) association. The large part played by bodily states in our dream-life is recognized not only by physiologists, as Maury, but also by those who ascribe dreams in part to occult spiritual faculties, as Scherner. By help of the results of recent researches we are able to improve a little on Hartley's classification. The exciting causes of dream-images fall into two main classes:—(I.) peripheral, and (II.) central stimulations. The latter arise in the outlying parts of the nervous system, namely, the organs of sense, the muscular apparatus, the internal bodily organs, together with the external portions of the nerves connected with these. Central stimulations are such as arise mainly, if not entirely, within the encephalic region. These again are either (α) direct, or (β) indirect. The first depend on the condition of the nerve-elements acted upon, and the unknown influences (possibly connected with the condition of the circulation) brought to bear on these at the moment. The indirect stimulations arise as a result of some preceding excitation in a connected region of the brain. The former underlie the apparently spontaneous imaginations of dreaming, as well as those which are the echo of a recent waking experience. The latter are the physical counterpart of images or ideas called up by association with preceding images or thoughts.

(I.) Among peripheral stimulations are to be noticed (a) those which arise from the action of external objects on the organs of sensation. Recent researches show that these may play an important part in dreams. Dr. Beattie speaks of a man who could be made to dream about a subject by whispering into his ear. Experiments were made by M. Giron de Buzareingues (*Journal de Physiol.* tom. viii.) as to the effects of external impressions on dreaming. Thus, by leaving his knee uncovered during sleep, he dreamt he was traveling in a diligence (where knees are apt to get cold). The most elaborate experiments bearing on this point have been carried on by Alf. Maury, with the help of an assistant. The latter produces some external stimulation while the experimenter sleeps; he is then wakened up so as to record the dream immediately resulting. By this means important results were reached. When, for example, his lips were tickled, he dreamt that he was subjected to horrible tortures—that pitch plaster was applied to his face and then torn off. Sensations of hearing, smell, and taste were also followed by appropriate though greatly exaggerated images. Wundt (*Physiologische Psychologie*) thinks that cutaneous sensations, arising from the varying pressure and temperature of the bodily surface, are frequent excitants of dream-images. (β) Along with such objective sensations must be reckoned subjective sensations which arise in the absence of external stimuli, and which have as their physical basis certain actions in the peripheral as well as the central regions of the nerves. Of such are the visual images (*Schlummerbilder*) seen by J. Müller, Goethe, Purkinje, and others, when the body is disposed to sleep. These are called the dream-chaos by Gruithuisen, since they are supposed to form the raw material of dreams. Maury gives a full account of these phenomena, which he terms "hypnagogic hallucinations," and which appear to include not only visual images, but also subjective sensations of sound, touch, etc. He attaches great importance to the action of these subjective sensations in dreams. The predominance of visual imagery in dreaming appears to be connected with the great activity of the organ of sight and its consequent excitability. It is to be added that one can only roughly distinguish these subjective sensations, which involve the peripheral regions of the nervous system, from images supposed to be confined to the central regions. (γ) The conditions of our muscles during sleep, which somehow convey impressions to the brain, affect consciousness, and so influence dreaming. To this source we must refer the active phenomena of dreams, as running, flying, resisting, struggling, etc. It is probable, as Wundt remarks, that the movements of the body during sleep, as those of breathing and the extensions and contractions of the limbs, give rise to dream-fancies, and painful conditions of the muscles due to an awkward position of the limbs may also serve to excite images. (δ) Among the most frequent excitants of dreams are organic or systematic sensations connected with the varying states of the internal bodily organs. The prominence given to this source of dreaming in ancient and modern systems of medicine has already been referred to. States of the stomach, lungs, heart, secretory organs, teeth and gums, etc., are, as we all know, powerful provocatives of dreams. Owing to the close connection of dreams with these organic conditions they may serve as important elements in the diagnosis of bodily disease. Thus M. Macario (*Du Sommeil, des Rêves, et du Somnambulisme*) recognizes among the morbid class of dreams those which are "prodromic," or premonitory (*e.g.*, a dream of sanguinary conflict before hæmorrhage), as well as those which are symptomatic of existing bodily and mental disorders.

(II.) We pass to internal or cerebral excitations. Under (a), the direct excitations, are to be included all dream-ideas which do not arise from bodily stimuli or through association with preceding feelings and ideas. It seems fairly certain that many of our dream-images are thus occasioned by a kind of "automatic excitation" of the cerebral regions. The dreams which clearly arise from an after-effect in the brain of recent perceptions, especially those of the previous day, appear to illustrate this process. Also, many of the images which correspond to persons and scenes supposed to be long since forgotten may be due to some such local automatic cerebral "sub-excitation." Maury distinctly recognizes this factor in dream-stimulation. It appears from experiences recorded by him that by means of these automatic central excitations images may sometimes be called up of objects which have never been distinctly perceived, and which yet have left a trace of their action on the cerebral substance.

(β) The indirect central stimulations include, no doubt, a large number of our dream-fancies. When once a starting-point is reached, whether through a peripheral or a central automatic (direct) excitation, the nervous connections which answer to mental associations provide a vast range of new cerebration. It is to be added that the very same causes which excite particular cerebral regions to automatic action must affect other and connected parts in a less degree, producing a powerful predisposition to activity. Hence it is to be supposed that links of association which are insufficient to restore an idea to consciousness in the waking state may suffice to do so in sleep.

(*B*) *The Order of Dream-Combinations.*—Dreams are commonly said to be incoherent, and this is no doubt frequently the case. On the other hand many dreams appear to simulate orderly arrangements of objects and successions of events. It must follow that no simple theory, such as that the mind has lost the forms of thought—as space, time, and causation (which, as we have seen, is contradicted by Schopenhauer)—will cover all the facts. The absence of volition and voluntary attention goes far to throw light on dream-combinations. In dreaming, as Maury observes, attention, instead of dominating the images which present themselves, is itself dominated by these. At the same time, as we shall see presently, the action of attention, though no longer controlled by the will and directed to some practical end, plays an important part in dream-construction. In order, if possible, to get at the laws of dream-structure, we may roughly divide dreams into two classes:—(α) the disconnected and incoherent, and (β) the coherent.

(α) The want of coherence in disorderly dreams appears to arise from thè play of association acting on all the heterogeneous and disconnected elements supplied by peripheral and central (direct) stimulation at the time, there being no volitional control (dominating attention) to interfere with the process. Supposing that these two primary sources are continually sending forth new and disconnected images to the dream-consciousness, and that owing to the extreme excitability of the brain during sleep numerous paths of association open themselves up in connection with every such image, we may see how it is that objects group themselves and events succeed one another in such a chaotic manner. It is not correct to say that we here dispense with the "forms" of space and time; objects are viewed in space, and events "intuited" in time, it is only that the particular positions of things in space and time are overlooked. On the other hand, it is true that there is in these loosely-threaded dreams, if not in all dreams, a suspension of the reasoning process by which objects are intuited in a causal relation. In these dreams, then the mind is passive, and consciousness is made up of a flux of images and feelings which is not analyzed and rationalized as it is in the normal processes of waking perception.

(β) Let us now consider the more coherent class of dreams. These, as we have seen, have by some been accounted for as the prodúcts of some occult power of the soul, as the "fantastical power" of Cudworth and the symbolic plastic fantasy of Scherner. There is no doubt that in many of the more elaborate and pictorial of our dreams a result is reached very similar to the products of the waking imagination. Can this operation be analyzed into simple processes? First of all, the images, however disconnected their corresponding objects may be, group themselves in a certain arrangement. This process would be described by psychologists of the Kantian school as the superposition on the dream-materials of certain mental forms. On the other hand, it may perhaps be explained as a result of association. When two orders of impression—for example, the sight of the human form and the sound of a human voice—have been habitually associated, there arises what may be called a general associative disposition to connect some variety of one order of impression with any particular variety of the order which happens to present itself to the mind; and so, when dreaming, the mind is disposed to add to images of color certain relations of space, position, magnitude, etc., to images of human beings some form of the appropriate human actions, relations, etc. By this means the intuitive clearness and completeness of our dream-imaginations may largely be accounted for. It is to be added that these general associative tendencies do not determine what particular relations or actions are to be attributed to the images of sleep. These latter depend on the particular circumstances of the moment, as, for example, the locality of the optic fibres involved, the varying excitability of the central regions, etc.

In this factor of our dream-constructions the mind seems to be wholly passive. We have now to turn to a second influence, which involves to some extent the active side of the mind, namely, the play of attention under the influence, not of the will, but of certain vague emotional impulses. The chief of these are the feeling for unity, and the instinct of emotional harmony. First of all, there seems to be a tendency in the more orderly dreams to bring new images into some intelligible connection or relation of unity with the pre-existing ones. This vague impulse, acting through the processes of expectation and attention, becomes selective, leading to a detention of those members of the ever-renewed flux of images which are fitted to enter into the dream-scene as consistent factors. In certain cases, indeed, this process seems to rise to something like a conscious voluntary exertion. We occasionally remember that we strove in our dream to discover a consistency in the variegated and confused scene presented to consciousness. Secondly, the unity of dream-structure is largely determined by the need of emotional harmony. A large part, if not all, of our dream-fancies are attended with a feeling of pleasure or of pain. Now when a certain state of emotion has been excited in the mind, there is a tendency to reject all ideas which conflict with this feeling, and to accept any which harmonize with it. The emotion controls the movements of anticipation and of intellectual attention, so that suitable ideas are at once recognized and detained. The unity of our most complex dreams appears to arise very largely from this source. In dreams described by Scherner, Volkelt, and Wundt the successions of imaginary events are clearly strung together by a thread of emotion, as joy, terror, and so on. The commonest example of such a dominating emotional tone in dreaming occurs when there is a current of pleasurable or painful feeling contributed by the condition of some of the internal organs of the body. These bodily sensations become the basis of complex groups of images, each new scene being connected with some analogous shade of feeling, "bodily" or "mental."

(*C*) *The Objective Reality and Intensity of Dream-Imaginations.*—These are explained by Hartley by two circumstances,—first, the absence of any other reality to oppose to the ideas which offer themselves; and secondly, the greater vividness of the visible ideas which occur in dreams as measured by the corresponding waking ideas. This last fact may, he thinks, be partly accounted for by an increased heat of the brain. As already remarked, Dugald Stewart explains the reality of dreams through the suspension of the ordinary action of volition. In waking life, he says, we distinguish objective impressions from ideas by finding that the former are independent of volition, while the latter are dependent on the same. Hence, in dreaming, when the will no longer controls ideas, these are mistaken for realities. The chief influences here concerned appear to be included in Hartley's theory, though the circumstances emphasized by Stewart may be a secondary element in the case. That the reality of dream-images depends in large part on the absence of external impressions has been recognized by most recent writers. Among others M. Taine (*De l'Intelligence*) dwells on the function of external sensation as a corrective to internal imaginations, keeping these below the illusory stage. External impressions are distinguished from ideas in the waking state, in part at least, by their greater intensity. When this relation is no longer recognized by reason either of the ideas acquiring preternatural vividness or of the sensations being withdrawn, illusion follows. Waking hallucinations depend on the first circumstance, dream-illusions on the second, perhaps also on the first as well. This leads us to the reflection that during sleep the ideas arising in consciousness undergo an increase of absolute as well as of relative vividness. That is to say, they are in themselves more intense states of consciousness than waking ideas. This seems to point, as Maury observes, to an increased excitability of the nervous substance in sleep. This same circumstance, too, helps to account for the preternatural impressiveness and the exaggeration which meet us in dream-life. If the brain is during sleep peculiarly excitable it will follow that all sensational stimuli, external and internal alike, will produce an exaggerated result. Thus the intensity of sensations will be augmented, and their volume, and so the apparent magnitude of dream-images be increased. Again, if in dreaming the stream of fancies be a rapid one, if images simultaneously and successively crowd in on consciousness, we may understand how space and time may appear to swell to unusual proportions. Once more, the peculiar excitability of the brain will manifest itself in an exaggeration of all feeling. Slight bodily discomforts, for example, will be transformed, as in Maury's experiments, into huge sufferings, and so locally circumscribed bodily sensations of pleasure may expand into preternatural forms of emotional delight.

We are now perhaps in a position to explain the symbolic function of dreams so much emphasized by Scherner. He considers that our dream-fantasy habitually represents the seat of bodily sensations under the symbol of a house and its parts, and the silent processes of thought as the audible conversation of living persons. The latter remark is probably correct, and its truth follows from a consideration of the close association between thought and audible speech. The former observation is surely an exaggerated statement, as has been shown by his friendly critic Volkelt. Yet though bodily sensations do not as a rule reveal themselves under the symbol of a building or mass of buildings, they undoubtedly do appear in consciousness disguised and transformed; and the reasons of this are plain. Even in the waking condition we have but a vague consciousness of the seat of the bodily sensations, and in sleep this can hardly be present at all. In addition to this, the exaggerating influences just referred to must tend to disguise the real nature of bodily sensations, and so to remove all consciousness of their locality. Hence bodily sensations do as a rule clothe themselves in a disguise appearing under the form of emotional experiences. And the particular pleasurable or painful images selected, which will vary with the individual's emotional nature and experience, will be apt to recur as a "symbolic expression" of this variety of bodily feeling. It will follow, too, from the predominance of visual ideas in dreams, that these emotional fancies will commonly take the shape of alluring or alarming visual perceptions.

Dreaming is a subject of great interest by reason of its points of contact with other mental conditions. Thus the common suspension of many of the higher processes of emotion, thought, and volition suggests an analogy between the dreaming state and the instinctive stage of mental growth as observable in children, primitive men, and the lower animals. This aspect of dreams has been treated by Maury.

Again, dreaming has many curious resemblances to the mental states of the insane. The differences which mark off dreaming from these states have already been given. The resemblances between them are no less important. In the illusory intensity of its internal images, in the rapidity of its flux of ideas, and in the wildness and incoherence of its combinations, the dream stands very close to the whole class of hallucinations and illusions of waking life. In truth, a systematic psychological treatment of dreams must connect them with other forms of illusion. This is done, for example, by Wundt, who refers all these groups of phenomena to an increased excitability of the sensory regions of the brain. Maury seems disposed to regard dreaming as the incipient stage of a pathological mental condition of which somnambulism, insanity, etc., are more fully developed forms. Among other writers who have discussed dreams in relation to these other abnormal states of mind are Macario (*op. cit.*), Brierre de Boismont (*Les Hallucinations*), J. Moreau (*Du Haschisch et d'Aliénation Mentale*), also Sir H. Holland, and Dr. Carpenter (*Mental Physiology*).

ASSOCIATION OF IDEAS.

BY PROF. GEO. CROOM ROBERTSON.

Association of Ideas or Mental Association, is a general name used in psychology to express the conditions under which representations arise in consciousness, and also is the name of a principle of explanation put forward by an important school of thinkers to account generally for the facts of mental life. The more common expression, from the time of Locke, who seems to have first employed it, has been Association of Ideas; but it is allowed or urged on all hands that this phrase contains too narrow a reference; association, in either of the senses above noted, extending beyond ideas or thoughts proper to every class of mental states. In the long and erudite Note D**, appended by Sir W. Hamilton to his edition of *Reid's Works*, and offered as a contribution toward a history of the doctrine of mental suggestion or association, many anticipations of modern statements are cited from the works of ancient or mediæval thinkers, and for Aristotle, in particular, the glory is claimed of having at once originated the doctrine and practically brought it to perfection. Aristotle's enunciation of the doctrine is certainly very remarkable. As translated by Hamilton, but without his interpolations, the classical passage from the tract *De Memoria et Reminiscentia* runs as follows:—

"When, therefore, we accomplish an act of reminiscence, we pass through a certain series of precursive movements, until we arrive at a movement on which the one we are in quest of is habitually consequent Hence, too, it is that we hunt through the mental train, excogitating from the present or some other, and from similar or contrary or coadjacent. Through this process reminiscence takes place. For the movements are, in these cases, sometimes at the same time, sometimes parts of the same whole, so that the subsequent movement is already more than half accomplished."

The passage is obscure (leaving open to Hamilton to suggest a peculiar interpretation of it, that may be noticed in connection with the elaborate doctrine of association put forward by himself, as if to evince the shortcomings rather than the perfection of Aristotle's), but it does in any case indicate the various principles commonly termed Contiguity, Similarity, and Contrast; and, though the statement of these cannot be said to be followed up by an effective exposition or application, it quite equals in scope the observations of many a modern inquirer. Zeno the Stoic also, and Epicurus, according to the report of Diogenes Laertius (vii. § 52, x. § 32, overlooked by Hamilton), enumerated similar principles of mental association. By St. Augustin, at the end of his long rhapsody on the wonders of memory in book x. of his *Confessions*, it was noted (c. 19) that the mind, when it tries to remember something it knows it has forgotten has, as it were, hold of part and thence makes quest after the other part. Meanwhile and later, Aristotle's doctrine received a more or less intelligent expansion and illustration from the ancient commentators and the schoolmen; and in the still later period of transition from the age of scholasticism to the time of modern philosophy, prolonged in the works of some writers far into the 16th century, Hamilton, from the stores of his learning, is able to adduce not a few philosphical authorities who gave prominence to the general fact of mental association—the Spaniard Ludovicus Vives (1492–1540) especially being most exhaustive in his account of the conditions of memory. This act of justice, however, once rendered to earlier inquirers, it is to modern views of association that attention may fairly be confined.

In Hobbe's psychology so much importance is assigned to what he called, variously, the succession, sequence, series, consequence, coherence, train, etc., of imaginations or thoughts in mental discourse, that he has not seldom been regarded, by those who did not look farther back, as the founder of the theory of mental association. He did, indeed, vividly conceive and illustrate the principle of Contiguity, but, as Hamilton conclusively shows, he reproduced in his exposition but a part of the Aristotelian doctrine, nor even this without wavering; representing the sequence of images, in such states as dreams, now (in his *Human Nature*) as casual or incoherent, now (in *Leviathan*), following Aristotle, as simply unguided. Not before Hume, among the moderns, is there express question as to a number of distinct principles of association. Locke had, meanwhile, introduced the phrase Association of Ideas as the title of a supplementary chapter incorporated with the fourth edition of his *Essay*, meaning it, however, only as the name of a principle accounting for the mental peculiarities of individuals, with little or no suggestion of its general psychological import. Of this last Hume had the strongest impression, and thinking himself, in forgetfulness or ignorance of Aristotle's doctrine of reminiscence, the first inquirer that had ever attempted to enumerate all the modes of normal association among mental states, he brought them to three—Resemblance, Contiguity in time and place, Cause and (or) Effect. Without professing to arrive at this result otherwise than by an inductive consideration of instances, he yet believed his enumeration to be exhaustive, and sought to prove it so by resolving Contrast—one of Aristotle's heads, commonly received—as a mixture of causation and resemblance. Viewed in relation to his general philosophical position, it must always remain a perplexing feature of Hume's list of principles, that he specified Causation as a principle distinct from Contiguity in time, while otherwise the list has no superiority to Aristotle's. Hume's fellow-countrymen, Gerard and Beattie, in opposition to him, recurred accordingly to the traditional enumeration; and, in like manner, Dugald Stewart put forward Resemblance, Contrariety, and Vicinity in time and place, though he added, as another obvious principle, accidental coincidence in the sounds of Words, and farther noted three other cases of relation, namely, Cause and Effect, Means and End, and Premisses and Conclusion, as holding among the trains of thought under circumstances of special attention. Reid, preceding Stewart, was rather disposed, for his own part, to make light of the subject of association, vaguely remarking that it seems to require no other original quality of mind but the power of habit to explain the spontaneous recurrence of trains of thinking, when become familiar by frequent repetition (*Intellectual Powers*, p., 387). The counter-observation of his editor, Hamilton, that we can as well explain habit by association as association by habit, might with reason have been pointed more sharply.

Hamilton's own theory of mental reproduction, suggestion, or association, given in outline in Note D***, following the historical note before mentioned, at the end of his edition of *Reid's Works*, calls for more special notice, as perhaps the most elaborate expression yet devised for the principles involved in the phenomena of mental representation. It is a development, greatly modified, of the doctrine expounded in his *Lectures on Metaphysics* (vol. ii. p. 223, *seq.*), which in agreement with some foreign authorities, reduced the principles of association first to two —Simultaneity and Affinity, and these farther to one supreme principle of Redintegration or Totality. In the ultimate scheme he posits no less than four general laws of mental succession concerned in reproduction: (1.) Associability or possible co-suggestion (all thoughts of the same mental subject are associable, or capable of suggesting each other); (2.) Repetition or direct remembrance (thoughts coidentical in modification, but differing in time, tend to suggest each other); (3.) Redintegration, direct remembrance or reminiscence (thoughts once coidentical in time, are, however, different as mental modes, again suggestive of each other, and that in the mutual order which they originally held); (4.) Preference (thoughts are suggested not merely by force of the general subjective relation subsisting between themselves, they are also suggested in proportion to the relation of interest, from whatever source, in which they stand to the individual mind). Upon these follow, as special laws: —A, Primary—modes of the laws of Repetition and Redintegration—(1), law of Similars (Analogy, Affinity); (2), law of contrast; (3), law of Coadjacency (Cause and Effect, etc.); B, Secondary—modes of the law of Preference, under the law of Possibility—(1), laws of Immediacy and Homogeneity; (2), law of Facility. Such is the scheme: and now may be understood what interpretation Hamilton desires to put upon Aristotle's doctrine, when he finds or seeks in it a parallel relation to that established by himself between the general laws, more especially Redintegration, and his special ones. But, though the commentary of Themistius, which he cites, lends some kind of support to the position, it cannot be maintained without putting the greatest strain on Aristotle's language, and in one place it is as good as surrendered by Hamilton himself (foot note, p. 900, *b*). Nor is the ascription of such a meaning at all necessary to establish Aristotle's credit as regards the doctrine of mental association.

Thus far the principles of association have been considered only as involved in mental reproduction and representation. There has grown up, however, especially in England, the psychological school above mentioned, which aims at explaining all mental acquisitions, and the more complex mental processes generally, under laws not other than those determining simple reproduction. Hamilton also, though professing, in the title of his outline just noticed, to deal with reproduction only, formulates a number of still more general laws of mental succession—law of Succession, law of Variation, law of Dependence, law of Relativity or Integration (involving law of Conditioned), and, finally, law of Intrinsic or objective Relativity—as the highest to which human consciousness is subject; but it is in a sense quite different that the psychologists of the so-called Associationist School intend their appropriation of the principle or principles commonly signalized. As far as can be judged from imperfect records, they were anticipated to some extent by the experientialists of ancient times, both Stoic and Epicurean (*cf.* Diogenes Laertius, as above). In the modern period, Hobbes is the first thinker of permanent note to whom the doctrine may be traced. Though he took, as has been seen, anything but an exhaustive view of the phenomena of mental succession, yet, after dealing with trains of imagination, or what he called mental discourse, he sought in the higher departments of intellect to explain reasoning as a discourse in words, dependent upon an arbitrary system of marks, each associated with, or standing for, a variety of imaginations; and, save for a general assertion that reasoning is a reckoning—otherwise, a compounding and resolving—he had no other account of knowledge to give. The whole emotional side of mind, or, in his language, the passions, he, in like manner, resolved into an expectation of consequences based on past experience of pleasures and pains of sense. Thus, though he made no serious attempt to justify his analysis in detail, he is undoubtedly to be classed with the associationists of the next century—Hartley and the others. They, however, were wont to trace the first beginnings of their psychological theory no farther back than to Locke's *Essay*. If this seems strange, when Locke did little more than supply them with the word Association, it must be remembered in what ill repute the name of Hobbes stood, and also that Locke's work, though not directly concerned with the question of psychological development, being rather of metaphysical or logical import, was eminently psychological in spirit, and might fairly be held to contain in an implicit form the principle or principles evolved later by the associationists. Berkeley, dealing immediately after Locke and altogether in Locke's spirit, with the special psychological problem of visual perception, was driven to posit expressly a principle of suggestion or association in these terms:—"That one idea may suggest another to the mind, it will suffice that they have been observed to go together, without any demonstration of the necessity of their co-existence, or so much as knowing what it is that makes them so to co-exist" (*New Theory of Vision*, § 25); and to support the obvious amplication of the principle to the case of the sensations of sight and touch before him, he constantly urged that association of sound and sense of language which the later school has always put in the foreground, whether as illustrating the principle in general or in explanation of the supreme importance of language for knowledge. It was natural, then, that Hume, coming after Berkeley, and assuming Berkeley's results, though he reverted to the larger inquiry of Locke, should be more explicit in his reference to association; and, not only explicit, he was original also, when he spoke of it as a "kind of attraction which in the mental world will be found to have as extraordinary effects as in the natural, and to show itself in as many and as various forms" (*Human Nature*, i. 1,

§ 4). Other inquirers were, in fact, appearing about the same time, who conceived of association with this breadth of view, and set themselves to track, as psychologists, its effects in detail.

Hartley's *Observations on Man*, published in 1749 (eleven years after the *Human Nature*, and one year after the better-known *Inquiry*, of Hume), opened the path for all the investigations of like nature that have since that time become so characteristic of the English name in psychology. According to his own statement, his attention was first turned to the subject about eighteen years before, through what he heard of an opinion of the "Rev. Mr. Gay," that it was possible to deduce all our intellectual pleasures and pains from association. Gay is known only by a dissertation on the fundamental principles of virtue, prefixed, at first anonymously, in 1731, to Archdeacon (afterward Bishop) Law's translation of King's *Origin of Evil*, wherein it was maintained, with considerable force, that by association the feelings belonging to ends may come to attach themselves to means, and give rise to action for the means as if they were ends, as seen (the instance has become a commonplace) in the passion for money-making. In this vein, but on a very different scale, Hartley proceeded to work. A physician by profession, and otherwise well versed in science, he sought to combine with an elaborate theory of mental association a minutely detailed hypothesis as to the corresponding action of the nervous system, based upon the suggestion of a vibratory motion within the nerves thrown out by Newton in the last paragraph of the *Principia*. So far, however, from promoting the acceptance of the psychological theory, this physical hypothesis proved to have rather the opposite effect, and it began to be dropped by Hartley's followers (as Priestley, in his abridged edition of the *Observations*, 1775) before it was seriously impugned from without. When it is studied in the original, and not taken upon the report of hostile critics, who would not, or could not—at all events, who did not—understand it, no little importance must still be accorded to the first attempt, not seldom a curiously felicitous one, to carry through that parallelism of the physical and psychical, which since then has come to count for more and more in the science of mind. Nor should it be forgotten that Hartley himself, for all his paternal interest in the doctrine of vibrations, was careful to keep separate from its fortunes the cause of his other doctrine of mental association. Of this the point lay in no mere restatement, with new precision, of a principle of coherence among "Ideas," but in its being taken as a clew by which to follow the progressive development of the mind's powers. Holding that mental states could be scientifically understood only as they were analyzed, Hartley sought for a principle of synthesis to explain the complexity exhibited not only in trains of representative images, but alike in the most involved combinations of reasonings and (as Berkeley had seen) in the apparently simple phenomena of objective perception, as well as in the varied play of the emotions, or again, in the manifold conscious adjustments of the motor system. One principle appeared to him sufficient for all, running, as enunciated for the simplest case, thus: "Any sensations A, B, C, etc., by being associated with one another a sufficient number of times, get such a power over the corresponding ideas (called by Hartley also vestiges, types, images) *a*, *b*, *c*, etc., that any one of the sensations A, when impressed alone, shall be able to excite in the mind *b*, *c*, etc., the ideas of the rest." To render the principle applicable in the cases where the associated elements are neither sensations nor simple ideas of sensations, Hartley's first care was to determine the conditions under which states other than these simplest ones have their rise in the mind, becoming the matter of ever higher and higher combinations. The principle itself supplied the key to the difficulty, when coupled with the notion, already implied in Berkeley's investigations, of a coalescence of simple ideas of sensation into one complex idea, which may cease to bear any obvious relation to its constituents. So far from being content, like Hobbes, to make a rough generalization to all mind from the phenomena of developed memory, as if these might be straightway assumed, Hartley made a point of referring them, in a subordinate place of their own, to his universal principle of mental synthesis. He expressly put forward the law of association, endued with such scope, as supplying what was wanting to Locke's doctrine in its more strictly psychological aspect, and thus marks by his work a distinct advance on the line of development of the experiential philosophy.

The new doctrine received warm support from some, as Law and Priestley, who both, like Hume and Hartley himself, took the principle of association as having the like import for the science of mind that gravitation had acquired for the science of matter. The principle began also, if not always with direct reference to Hartley, yet, doubtless, owing to his impressive advocacy of it, to be applied systematically in special directions, as by Tucker (1768) to morals, and by Alison (1790) to æsthetics. Thomas Brown (d. 1820) subjected anew to discussion the question of theory. Hardly less unjust to Hartley than Reid or Stewart had been, and forward to proclaim all that was different in his own position, Brown must yet be ranked with the associationists before and after him for the prominence he assigned to the associative principle in sense-perception (what he called external affections of mind), and for his reference of all other mental states (internal affections) to the two generic capacities, or susceptibilities of Simple and Relative Suggestion. He preferred the word Suggestion to Association, which seemed to him to imply some prior connecting process, whereof there was no evidence in many of the most important cases of suggestion, nor even, strictly speaking, in the case of contiguity in time where the term seemed least inapplicable. According to him, all that could be assumed was a general constitutional tendency of the mind to exist successively in states that have certain relations to each other, of itself only, and without any external cause or any influence previous to that operating at the moment of the suggestion. Brown's chief contribution to the general doctrine of mental association, besides what he did for the theory of perception, was, perhaps, his analysis of voluntary reminiscence and constructive imagination—faculties that appear at first sight to lie altogether beyond the explanatory range of the principle. In James Mill's *Analysis of the Phenomena of the Human Mind* (1829), the principle, much as Hartley had conceived it, was carried out with characteristic consequence, over the psychological field. With a much enlarged and more varied conception of association, Professor Bain has re-executed the general psychological task in the present generation, while Mr. Herbert Spencer has revised the doctrine from the new point of view of the evolution-hypothesis. John Stuart Mill made only occasional excursions into the region of psychology proper, but sought, in his *System of Logic* (1843), to determine the conditions of objective truth from the point of view of the associationist theory, and, thus or otherwise being drawn into general philosophical discussion, spread wider than any one before him its repute.

It is remarkable that the Associationist School has been composed chiefly of British thinkers, but in France also it has had distinguished representatives. Of these it will suffice to mention Condillac, the author of the sensationalist movement in the 18th century, who professed to explain all knowledge from the single principle of association (*liaison*) of ideas, operating through a previous association with signs, verbal or other. At the present day the later English school counts important adherents among the younger French thinkers. In Germany, before the time of Kant, mental association was generally treated in the traditional manner, as by Wolff. Kant's inquiry into the foundations of knowledge, agreeing in its general purport with Locke's, however it differed in its critical procedure, brought him face to face with the newer doctrine that had been grafted on Locke's philosophy; and to account for the fact of synthesis in cognition, in express opposition to associationism, as represented by Hume, was, in truth, his prime object, starting, as he did, from the assumption that there was that in knowledge which no mere association of experiences could explain. To the extent, therefore, that his influence prevailed, all such inquiries as the English associationists went on to prosecute were discounted in Germany. Notwithstanding, under the very shadow of his authority a corresponding, if not related, movement was initiated by Herbart. Peculiar, and widely different from anything conceived by the associationists, as Herbart's metaphysical opinions were, he was at one with them, and at variance with Kant, in assigning fundamental importance to the psychological investigation of the development of consciousness, nor was his conception of the laws determining the interaction and flow of mental presentations and representations, when taken in its bare psychological import, essentially different from theirs. In Beneke's psychology also, and in more recent inquiries conducted mainly by physiologists, mental association has been understood in its wider scope, as a general principle of explanation.

Associationists differ not a little among themselves in the statement of their principle, or, when they adduce several principles, in their conception of the relative importance of these. Hartley took account only of Contiguity, or the repetition of impressions synchronous or immediately successive; and the like is true of James Mill, though, incidentally, he made an express attempt to resolve the received principle of Similarity, and through this the other principle of Contrast, into his fundamental law—law of Frequency, as he sometimes called it, because upon frequency, in conjunction with vividness of impressions, the strength of association, in his view, depended. In a sense of his own, Brown also, while accepting the common Aristotelian enumeration of principles, inclined to the opinion that "all suggestion may be found to depend on prior co-existence, or at least on such proximity as is itself very probably a modification of co-existence," provided account be taken of "the influence of emotions and other feelings that are very different from ideas, as when an analogous object suggests an analogous object by the influence of an emotion which each separately may have produced before, and which is, therefore, common to both." (Upon which view it obviously occurs to remark, that, except in the particular case, plainly not intended, where the objects are experienced in actual succession with the emotion common to both, a suggestion through *similar* emotions must still be presumed.) To the contrary effect, Mr. Spencer maintains that the fundamental law of all mental association is that presentations aggregate or cohere with their like in past experience, and that, besides this law, there is in strictness no other, all further phenomena of association being incidental. Thus in particular, he would explain association by Contiguity as due to the circumstance of imperfect assimilation of the present to the past in consciousness; a presentation in as far as it is distinctly cognized is in fact recognized through cohering with its like in past experience, but there is always, in consequence of the imperfection of our perceptions, a certain range within which the classing of the present experience with past is doubtful—a certain cluster of relations nearly like the one perceived, which become nascent in consciousnessin the act of assimilation; now contiguity is likeness of relation in time or in space, or in both, and, when the classing, which as long as it is general, goes easily and infallibly forward, becomes specific, a presentation may well arouse the merely contiguous, instead of the identical, from former experience. Midway between these opposed views should be noted, finally the position of Professor Bain, who regards Contiguity and Similarity, logically, as perfectly distinct principles, though in actual psychological occurrence they blend intimately with each other; contiguous trains being started by a first (it may be, implicit) representation through Similarity, while the express assimilation of present to past in consciousness is always, or tends to be, followed by the revival of what was presented in contiguity with that past.

That Similarity is an ultimate ground of mental association cannot seriously be questioned, and to neglect or discount it, in the manner of the older representatives of the school, is to render the associationist theory quite inadequate for purposes of general psychological explanation. It is simply impossible to overrate the importance of the principle, and, when Mr. Spencer, by way of supporting his position, maintains farther, that the psychological fact of conscious assimilation corresponds with the fundamentally simple physiological fact of re-excitation of the same nervous structures, the force as well as pertinence of the observation is at once evident. Nevertheless, it is one question whether a representation, upon a particular occasion, shall be evoked by Similarity, and another question what shall be raised into consciousness along with it; nor for this is there any help but in positing a distinct principle of Contiguity. The phenomena of presentative cognition or objective perception on which Mr. Spencer bases his argument, are precisely those in which the function of Contiguity is least explicitly manifested, but only because of the certainty and fixity it has assumed through the great uniformity and frequency of such experience. Let the series of presentative elements, as in formal education, be less constant in composition, and less frequently recurrent, than are those aggregates of sensible impressions that, in the natural course of experience, become to us objects in space with a character comparatively fixed, and then the function of Contiguity starts out with sufficient prominence, being found as often as not to fail in determining a revival of the corresponding representative series. All the phenomena, too, of coalescence, in which a variety of elements become fused to a result in consciousness as heterogeneous as any chemical compound in relation to its constituents—phenomena that have remained the very property of the Associationist School since they first were distinctly noted by Hartley—how are these to be explained by the principle of Similarity? Involved as it incontestably is in every repeated apprehension, whether of the elements, or of the product, or of the relation between them, Similarity of itself is powerless to determine a relation the essence of which lies not more in the heterogeneous character of the result than in the diversity of the elements brought together. Nor, in order to support the claim of the principle of Contiguity to an equally fundamental position with that of Similarity, is it more difficult to find an expression in terms of physiology corresponding with the subjective process. The fact that different nerve-centers are excited together, synchronously or successively, along definite lines of connection, will leave them, being so connected, in a state of relative instability, which, other things equal, will vary in proportion to the frequency and strength of the excitation; and thus, when one of them is, in whatever way, again aroused, the rest will tend to be re-affected also by reason of the instability that has remained. The process of psychological representation, running parallel with the nervous events here supposed, involves assimilation at every stage from and including the first; it is also constantly happening, in contiguous trains, that a break occurs at a particular stage through an express suggestion, by Similarity, of something foreign to the train. But in the one case, as in the other—alike coincident with the implicit action of Similarity, and in the pauses of express assimilation—the principle of Contiguity has a part to play, not to be denied or confounded with any other.

A minor question, also disputed, is whether by the side of Contiguity and Similarity, Contrast should be held, as by Aristotle, an independent principle of association. That things contrasted may and do often suggest each other in consciousness is on all hands allowed, but ever since Hume attempted, however infelicitously, to resolve the principle into others, its independence has not ceased to lie under suspicion. When the question is approached without prejudice, it cannot but appear strange that mental states which suggest each other because of likeness, should suggest each other because of unlikeness also. In that case anything might suggest everything else, since like and unlike conscious states are all that are possible; nay, unlike states alone are all, as there must always be some difference between any two. Now it is true, in one sense, that anything may suggest anything be it ever so unlike, namely, if the things have been once or repeatedly experienced in conjunction; but then the bond of association is the contiguity, and not the unlikeness, which obviously cannot be a ground for suggesting this one other thing more than any other thing. By contrast, however, is not generally meant bare unlikeness. Genuine contrasts, as black-white, giant-dwarf, up-down, are peculiar in having under the difference a foundation of similarity, the two members lying within the sphere of a common higher notion, and only being distinguished the more impressively by reason of the accompanying unlikeness. Clearly, in the case of mutual suggestion, if it be not the similarity itself that is here the ground of association, it may again be Contiguity, the sharpest experience of each member of the contrast having been when there was experience also of the other; or both grounds may conspire towards the result, the association being then what Professor Bain has marked as Compound. On the whole, it must be concluded that only in a secondary sense can Contrast be admitted as a principle of mental association.

The highest philosophical interest, as distinguished from that which is more strictly psychological, attaches to the mode of mental association called Inseparable. The coalescence of mental states noted by Hartley, as it had been assumed by Berkeley, was farther formulated by James Mill in these terms:—

"Some ideas are by frequency and strength of association so closely combined that they cannot be separated; if one exists, the other exists along with it in spite of whatever effort we make to disjoin them."—(*Analysis of the Human Mind*, 2d ed. vol. i. p. 93.)

J. S. Mill's statement is more guarded and particular:—

"When two phenomena have been very often experienced in conjunction, and have not, in any single instance, occurred separately either in experience or in thought, there is produced between them what has been called inseparable, or, less correctly, indissoluble, association; by which is not meant that the association must inevitably last to the end of life—that no subsequent experience or process of thought can possibly avail to dissolve it; but only that as long as no such experience or process of thought has taken place, the association is irresistible; it is impossible for us to think the one thing disjoined from the other." — (*Examination of Hamilton's Philosophy*, 2d ed. p. 191.)

Even this statement, howevever, is somewhat lacking in precision, since there never is any impossibility of thinking the things apart, in the sense of considering them as logically distinct; the very fact of association implies at least such distinctness, while there may be evident, besides, a positive difference of psychological origin, as when, in the case of visual extension, the color of the field is referred to the passive sensibility of the eye, and the expanse to its mobility. The impossibility is of representation, apart, not of logical consideration or thought. It is chiefly by J. S. Mill that the philosophical application of the principle has been made. The first and most obvious application is to so-called necessary truths—such, namely, as are not merely analytic judgments but involve a synthesis of distinct notions. Again, the same thinker has sought, in the work just cited, to prove Inseparable Association the ground of belief in an external objective world. The former application, especially, is facilitated when the experience through which the association is supposed to be constituted is understood as cumulative in the race, and transmissible as original endowment to individuals—endowment that may be expressed either, subjectively, as latent intelligence, or, objectively, as fixed nervous connections. Mr. Spencer, as before suggested, is the author of this extended view of mental association.

For a detailed exposition of the psychological theory of the Associationist School, the reader is referred to the works of its latest representatives named above. The question is still under discussion, how far the theory avails to account for the fact of intelligence, not to say the complex phases of mental life in general in all their variety; nor were the theory carried out farther than it has yet been by any one, and formulated in terms commanding more general assent than any expression of it has yet obtained even from professed adherents, is it likely to be raised above dispute. Yet it must be allowed to stand forward with a special claim to the scientific character; as already in his time Laplace (who, though an outsider, could well judge) bore witness, when, speaking of the principle of association (Contiguity) as applied to the explanation of knowledge, he declared it *la partie réelle de la métaphysique* (*Essai phil. sur les Probabilités*, *Œuvres*, vol. vii. p. cxxxvii.) If in the physical sciences the object of the inquirer is confined to establishing laws expressive of the relations subsisting amongst phenomena, then, however different be the internal world of mind—however short such treatment may seem to come of expressing the depth and fulness even of its phenomenal nature—a corresponding object is as much as the scientific psychologist can well set to himself. The laws of association express undoubted relations holding among particular mental states, that are the real or actual facts with which the psychologist has to deal, and it becomes a strictly scientific task to inquire how far the whole complexity of the internal life may receive an explanation therefrom. Understood in this sense, Hume's likening of the laws of mental association to the principle of gravitation in external nature is perfectly justifiable. It is to the credit of the associationists to have grasped early, and steadily maintained, such a conception of psychological inquiry, and, whatever their defects of execution may have been or remain, their work retains a permanent value as a serious attempt to get beyond barren description of abstract mental faculties to real and effective explanation. The pyschologists that, in the related point of view, have earned the title of the Analytical School, from holding before their eyes the exemplar of the method of the positive sciences, are precisely those that have fastened upon the principles of association as the ground of mental synthesis; and, till it is shown that the whole method of procedure is inapplicable to such a subject as mind, their conception is entitled to rank as a truly scientific one.

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