STRANGE PHENOMENA

A SOURCEBOOK OF UNUSUAL NATURAL PHENOMENA

WILLIAM R. CORLISS
COMPILER

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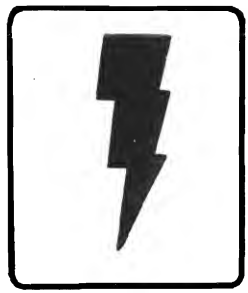

A SOURCEBOOK OF UNUSUAL NATURAL PHENOMENA

Compiled by

WILLIAM R. CORLISS

VOLUME G-1

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PREFACE

I have always been intrigued with the tailings from the mine of science. I mean those facts that do not fit the mold, those anomalies that should not exist, those sports, those wild points that lie far off the curve. One of my hobbies is collecting and organizing these homeless facts. These waifs are curious and most intriguing. Either they are false or science still has much fundamental work to do. But I leave such problems to the reader. All I have done is collect, categorize, and reprint this anomalous information. The result is this first volume of geophysical curiosities. Perhaps you can make something out of them. At the very least, I hope you will be excited by the unknown territory that still lies ahead of us.

I have devoted a great deal of thought to the organization of this volume. The format is flexible. More material may be added within the framework of categories from any source and any period. Seemingly disparate data are correlated through the indexes and annotations. Whole new categories can be added if it appears necessary.

The literature dealing with mysterious geophysical phenomena has been merely scratched. Volume G1, the present volume, represents only a small portion of my collection. Volume G2 is well along in preparation, as are volumes in the fields of ancient man and unresolved geological problems.

The data included have been filtered only slightly. Doubtless some hoaxes and honest misinterpretations will be found in the pages that follow. This is unavoidable in a project of this scope. Indeed, it is unavoidable in all phases of inquiry, especially those relying heavily upon observational evidence. Data were selected for inclusion according to their "strangeness" and their tendency to contradict current scientific hypotheses or stretch them beyond their present bounds. There has also been a deliberate effort to gather in observations from the 19th Century that have gathered dust too long on library shelves. Anomalous events are too rare to let them be discarded merely because they are old or money cannot be found to put them into computerized data systems.

The collecting net I flung into the literature was a broad one. It had to be because: (1) valid data and good theories are often published outside the mainstream of scientific thought; and (2) people were just as observant a century or two ago as they are today. Quotations in this volume will demonstrate that they viewed the world with great curiosity and if they sometimes misinterpreted things perhaps they also saw the cosmos through less biased eyes.

Some of the material included here will be labelled "pseudoscience," but some of the data so castigated will be legitimate science a decade hence. Meteorites are, of course, a classic case in point. The reader should bear in mind that many items are inserted with the express purpose of "rocking the boat."

I should also add that I have deliberately introduced data---perhaps 25% of the whole---from outside the scientific literature. This was not done because of any lack of material but rather to insure the widest possible spectrum of observations.

Being that this is a sourcebook, I must acknowledge the many writers of papers, books, letters-to-the-editor, and sundry publications that form the foundation of the book. Where lengthy quotations are taken from publications still protected by copyright, permission has been obtained from the copyright holder.

William R. Corliss

Glen Arm, Maryland
October 4, 1973

CONTENTS

*A breakdown of the subsections within these categories follows. Use the headings at the tops of the pages to locate specific subsections and entries.

Section Code and Title		Subsection Code and Title	
GE	Electromagnetic phenomena	GEB	Brocken Spectres, glories, etc.
		*GEG	Radar angels
		*GEM	Unusual mirages
		*GER	Planetary resonances
		*GET	Transmission phenomena
GF	Falling material	*GFA	Webs and "angel hair"
		*GFB	Falls of birds
		GFC	Chemicals
		GFF	Fish, reptiles, insects
		GFG	Gelatin
		*GFI	Ice falls
		GFL	Leaves, hay, pollen
		*GFT	Thunderstones

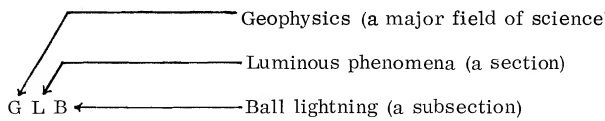
GG	Gravitational and temporal phenomena	*GGG	Gravity anomalies
		*GGT	Time anomalies
GH	Hydrospheric anomalies	*GHG	Geysers and wells
		*GHP	White and "milky" seas
		*GHS	Lake oscillations
		*GHT	Anomalous tides
		*GHW	Unusual waves
GI	Incendiary phenomena	*GIC	Unexplained fires
		*GIF	Firestorms
GL	Luminous phenomena	GLA	Aurora-like phenomena
		GLB	Ball lightning
		GLD	Electric discharge
		GLL	Lightning
		GLM	Meteor-like phenomena
		GLN	Nocturnal lights
		GLW	Light wheels
GM	Magnetic and electrical phenomena	*GMA	Atmospheric electricity
		*GME	Earth currents
		*GMG	Magnetic anomalies
GO	Odors	*GOS	Sulfurous odors
		*GOT	Unexplained stenches
GQ	Crustal movements	GQE	Earthquake phenomena
		*GQF	Fault phenomena
		*GQG	Geographical correlations
		*GQS	Solar and lunar effects
GS	Sounds	GSD	Strange detonations
		GSG	Infrasonic sound
		GSH	Hums, hisses, etc.
		GSM	Music, bells, etc.
GV	Volcanic phenomena	*GVT	Geothermal phenomena
		*GVV	Volcanic phenomena
GW	Weather phenomena	*GWC	Strange clouds
		*GWD	Dark days
		*GWF	Peculiar fogs
		GWP	Precipitation oddities
		*GWR	Temperature oddities
		*GWS	Solar and lunar effects
		*GWT	Tornadoes and waterspouts
		*GWW	Whirlwinds and dust devils

*This subsection not represented in Volume G1.

ORGANIZATION OF THE SOURCEBOOKS

All sourcebook entries are labelled with three letters and a number; viz., GLB-012. The three letters indicate a category of phenomena. GLB, for example, designates a subsection of the book containing accounts of ball lightning. The number following the letters is simply an acquisition number within that subsection. Thus, entry GLB-012 is the 12th entry in the ball lightning category. The indexes at the back of each sourcebook and all cross references are keyed to the entry number rather than page number.

There is a plan to the assignment of letter codes. The first letter indicates a broad, general field of science, such as geophysics, G. The second and third letters are assigned to sections and subsections within this general field, as illustrated below:



The sections denoted by the second letters are based upon the primary physical sensation evoked by the phenomenon at hand. Ball lightning is primarily a luminous event and thus bears the GL label. Of course, ball lightning also makes noise on occasion and sometimes leaves an odor behind, but these are secondary attributes.

The subsections (third letters) are narrower in scope than the sections. Experience, however, has shown that subsections must be broad to encompass the great variety of phenomena in a reasonable number of categories. They cannot be too broad, though, or a structureless hodgepodge results. The subsections have been selected and named with great care to avoid suggesting explanations of the phenomena. A complete list of sections and subsections now in use precedes this page and also functions as a table of contents. Detailed descriptions of the subsections are placed at the beginnings of the sections.

When searching for a specific entry, scan the running heads at the tops of the pages; they give the entry numbers as well as the subsection titles. The person who reads for curiosity's sake will find that each subsection is much like a chapter, with many related items grouped together.

Some larger works, especially books, cover so much ground that their contents have been split up into the appropriate subsections.

The loose-leaf format of the sourcebooks makes it possible to combine material subsection by subsection as new volumes are issued.

Each volume is indexed by subject, by time-of-event, by place-of-event, by author, and by data source. Each volume is self-contained. With the issuance of future volumes, cumulative indexes will be compiled. There will be no necessity to hunt through several indexes to find something. Because some major fields are interrelated, it will doubtless prove useful to cumulate indexes from volumes on geophysics, astronomy, geology, and so on.

ORGANIZATION OF THE SOURCEBOOKS

References, annotations, and Compiler's Summaries are printed full-width, while all direct quotes are indented.

Being a sourcebook, the core of this volume consists of the direct quotations from eye-witnesses and key investigators. The text herein faithfully retains the old spellings, punctuations, and even a few typos. After all, only the eye-witness' own words convey the facts as he perceived them. Regurgitations and surveys, so common these days, are already once or twice removed from the event. The whole object of these sourcebooks is to give the reader and researcher an organized collection of original writings on the unusual facets of nature. Much of this unique information is being lost as libraries become more highly computerized. Data selected for the data banks must have current relevance and be acceptable to the science of the day. Hopefully, these sourcebooks will preserve something of value and help focus the diverse, widely dispersed anomalies on the frontiers of science. They should also be interesting reading.

SECTION GE:
ELECTROMAGNETIC PHENOMENA

Included here are those unusual geophysical phenomena that apparently depend upon the reflection, refraction, and transmission of electromagnetic radiation. The descriptions of the subsections that follow elaborate on what is and what is not included.

GEB Brocken Spectres, glories, and similar phenomena. The following are not included: haloes, sun pillars, mock suns, and mock moons. These phenomena are considered common and fairly well understood.

*GEG Radar angels. Unexplained radar echoes, including studies of insects and temperature anomalies as possible causes.

*GEM Unusual mirages. Fata Morgana, cities in the sky, marching troops, etc., with explanations, where possible. Most mirages are easily explained and will not be included.

*GER Planetary resonances. Behavior of electromagnetic waves in the earth's ionospheric cavity. Whole-earth as a resonator.

*GET Transmission phenomena. Unusual radio reception. Delayed echoes.

*This subsection is not represented in Volume G1.

This page is reserved for the expansion of the preceding categories in future volumes.

GEB-001 SPECTRE OF THE BROCKEN AT HOME

Rogers, J. Innes; Nature, 22:559, October 14, 1880.

> Having occasion ten days ago to go into my garden about half past ten o'clock at night I found there was a thick white fog, through which, however, a star could be seen here and there. I had an ordinary bedroom candlestick in my hand with the candle lighted, in order to find the object I wanted. To my great surprise I found that the lighted candle projected a fantastic image of myself on the fog, the shadow being about twelve feet high, and of an oddly distorted character, just as the spectre of the Brocken is said to be. It is of course usual on going into the open air to use a lantern with a solid back for any light that may be wanted, and with this, of course, such a shadow would not be seen; but in this charmingly foggy valley of the Thames, and in these days of "Physics without Apparatus," the effect I saw can probably be seen only too often. May not the gigantic spirits of the Ossianic heroes, whose form is composed of mist, through which the stars can be seen, be derived from the fantastic images thrown upon the mountain fogs from the camp fires of the ancient Gaels?

The famous Brocken Spectre is a similar phenomenon seen on the Brocken, a mountain peak in Europe. See also GEB-003.

GEB-002 THE GREEN RAY

Botley, C. M.; Weather, 26:354-357, 1971.

Compiler's Summary: Known by the ancient Egyptians, the so-called "green ray" has always excited great curiosity. Some believe it a sign of good weather; others, bad; the Scots believe that those who are fortunate enough to see it will never fail in affairs of the heart.

The green ray or flash is seen just before sunrise and requires a very pure atmosphere. When the atmosphere is extremely pure, the flash may be a "glorious violet" instead of green. Blue is also seen on occasion.

Following a historical review of various observations of this phenomenon, Botley concludes that abnormal atmospheric refraction, including mirage effects, play a great part in producing the green flash.

GEB-003 MIRAGE ON SNOWDON

Wetenhall, H.J.; Nature, 12:292, August 12, 1875.

Despite the title, this letter probably describes the Brocken Spectre phenomenon.

> On Monday, July 12, I, with a party, ascended Snowdon. The atmosphere was clear until we had reached within half a mile of the summit, when a light cloud rising stealthily from amongst the southern peaks enveloped it. Drifting towards us, when very near, the cloud dropped over the eastern shoulder of

the mountain just where it dips towards Capel Curig. As we stood watching, great was our surprise and delight as we beheld painted upon it, not the arc-en-ciel with which we are familiar, but a complete and brilliant prismatic circle, apparently about thirty feet in diameter, in the very centre of which we ourselves were depicted, the image being somewhat enlarged but clearly defined; as we arranged the party in groups, or bowed to each other, every form and movement was faithfully reproduced in the picture. It was now about 8 o'clock, with the sun nearly in a line with us. Our guide, who had made some hundreds of ascents, had never witnessed such a sight before.

GEB-004 METEOROLOGICAL PHENOMENON CALLED CROWN FLASH

Graves, Maurice, et. al.; Nature, 231:258, May 23, 1971.

Gall and Graves described a gound observation of a sudden brightening effect around the top of an active cumulonimbus cloud. Each brightening began concurrently with a lightning stroke in the main cloud mass and rippled upward and outward during a substantial fraction of a second.

Subsequent to this report, brief prior discussions of unusual optical phenomena of this kind have been noted in the literature. These observations deal with the sudden disappearances of apparent cloud streamers which sometimes seem to reform. References to earlier "flachenblitz" observations imply that such reports may have a long history.

A very tenable explanation of this class of visual sighting was proposed by Vonnegut in terms of changes in orientation of ice crystals. with their mirror-like reflexions, around the crests of thunder clouds. Such changes are postulated to occur when a relatively strong electric field induces electric dipoles in the ice crystals, with their resulting tilting forces. For example, if the visual effect is a streamer disappearance, a rapid, lightning-induced change in ice crystal orientation has taken place, destroying a slowly built up electric field and ice crystal alignment.

The possible orientation of atmospheric ice crystals by electrostatic forces is a concept which may apply to the various glows and light beams presented in Section GLD.

SECTION GF: FALLING MATERIAL

Falls of fish, large chunks of ice, "manna," and other materials have been reported for thousands of years. Some of these materials are unquestionably picked up and later deposited by atmospheric disturbances; other substances may have meteoric origins. Be this as it may, many falls are not easily explained, as this section will demonstrate. The subsection descriptions follow.

*GFA Webs and "angel hair." Includes unusual concentrations of gossamer and web-borne spiders. Hair-like deposits left behind by geophysical phenomena.

*GFB Falls of birds. Falls of large numbers of birds, usually dead or dying.

GFC Chemicals. Salt, sulfur, sand, dust, and other inorganic substances.

GFF Fish, reptiles, insects. Falls of any animals not normally air-borne.

GFG Gelatin. Gelatinous masses and droplets---often associated with meteor-like phenomena.

*GFI Ice falls. Large chunks of ice apparently not associated with hailstorms or other atmospheric disturbances.

GFL Leaves, hay, pollen. Unusual falls of organic material---frequently from a clear sky---and unexplained deposits, such as "manna." Pollen, of course, is sometimes associated with the yellow and red rains appearing in GWP.

*GFT Thunderstones. Strange correlations of stones (possibly meteorites in some instances) with thunderstorms.

*This subsection not represented in Volume G1.

This page reserved for the expansion of the preceding categories in future volumes.

GFC-001 HAILSTONES OF SALT AND SULFIDE OF IRON

Anonymous; American Journal of Science, 3:3:239, 1872.

Prof. Kenngott, of Zurich, states that in a hailstorm, lasting five minutes, on the 20th of last August, the stones, some of which weighed twelve grains consisted essentially of common salt, mainly in imperfect cubical crystals. He supposes that the salt had been taken up from the salt plains of Africa, and brought over the Mediterranean.

Hailstones containing each a small crystal of sulphide of iron are reported as having fallen recently, by Prof. Eversmann of Kasan. The crystals were probably weathered out of some rocks in the vicinity.

This item was taken from Nature, January 11, supposedly 1872.

GFC-002 REPORT ON OBSERVATIONS OF LUMINOUS METEORS DURING THE YEAR 1873-1874

Glaisher, James, et al; Report of the British Association, 269–359, 1874.

[June 17, 1873; Hungary and Austria] It is remarkable that perfectly authentic statements were received of the deposition, soon after, or about the time of, the meteor's explosion over Zittau and its neighborhood, of a mass of melted and burning sulfur the size of a man's fist, on the roadway of a village, Proschwitz, about 4 miles south of Reichenberg, where the meteor exploded nearly in the zenith. It was stamped out by a crowd of the villagers, who could give no other explanation of its appearance on the spot than that it had proceeded from the meteor; on examination at Breslau some remnants of the substance proved to be pure sulfur. With regard to the calculated course, the meteor must, however, have passed quite 12 or 14 miles south-westwards from the place where this event is said to have occurred; and its questionable connexion with the fireball is accordingly rendered very doubtful from the great distance of the locality immediately below the meteor's course. In Chladni's work on Fiery Meteors and Stone-falls, only one similar instance is recorded, from ancient chronicles, where burning sulfur fell at Magdeburg, of the size of a man's fist, on the castle-roof at Loburg, 18 miles from Magdeburg, in June of the year 1642. The fact of this large fireball having deposited any stony or other aerolitic matter cannot there-yet be regarded as decidedly established. (p. 272)

GFC-003 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Science, 1:26:132–174, 1834.

The St. Petersburg Academical Gazette, contains the following account of an extraordinary phenomenon from a letter dated Moscow, May 2, 1832. "In March last, there fell in the fields of the village of Kourianof, thirteen versts from Solokolamsk, a combustible substance of a yellowish color, at least two inches thick, and covering a superficies of between six and seven hundred square feet. The inhabitants, at first, thought it was snow, but on examina-

tion, it appeared to have the properties of cotton, having, on being torn, the same tenacity; but, on being put into a vessel full of water, it assumed the consistence of rosin. On being put to the fire, in its primitive state, it burnt and sent forth a flame like spirits of wine; but in its resinous state, it boiled on the fire, without becoming inflamed, probably because it was mixed with some portion of snow, from which it had been taken. After a more minute examination, the rosin had the color of amber, was elastic like indian rubber, and smelt like prepared oil, mixed with wax."

The above item was taken from the Annual Register for 1832.

GFC-004 ON A SUBSTANCE CALLED INFLAMMABLE SNOW

Hermann, M.; American Journal of Science, 1:28:361, 1835.

(Ann. de Pog. tome 28. p.566.) J.G.---This substance fell from the sky on the 11th April, 1832, 13 werstes from the town of Wolokalamsk, and covered to the thickness of 1 to 2 inches a space of 8 to 10 square rultres.

It was of a wine yellow, transparent, soft, and smelling like rancid oil. Its sp. gr. was 1.1. It melted in a close vessel, and yielded the common products of vegetable substances, leaving a brilliant charcoal. It burnt with a blue flame, without smoke. It is insoluble in cold water, but melts in boiling water, and then swims on the fluid. Boiling alcohol dissolves it. It dissolves also in carbonate of soda, and the acids separate from the solution a yellow viscous substance, soluble in cold alcohol, and which contains a peculiar acid.

The analysis, by oxide of copper, gave

Carbon	0.615
Hydrogen	0.070
Oxygen	0.315
	1.000

which corresponds to the formula 10CH plus 40H. I gave it the name of d'ral elaine, which signifies sky oil.

GFC-005 [ANALYSIS OF BLOOD RAIN]

Silvestri, O.; Chemical News, 25:300, June 21, 1872.

Chemico-Microscopic Research of a Peculiar Substance which Accompanied the Meteoric Dust which Fell in Sicily on 9th, 10th, and 11th March Last.--The peculiar substance, designated popularly as blood-rain, was found to consist of 100 parts of red iron ochre, 75.1; carbonate of lime, 11.7; organic matter, 13.2.

GFF-001 NOTICE ON THE APPEARANCE OF FISH AND LIZARDS IN EXTRAORDINARY CIRCUMSTANCES

Muse, Joseph E.; American Journal of Science, 1:16:41-44, 1829.

The late notice in an English paper, of a shower of herrings witnessed by a Major McKenzie, as he traversed a field on his farm, leads me to communicate to you a most singular instance of the apparently playful aberrations of nature from those laws, which she had prescribed for herself, and under whose influence, she most usually, and most wisely operates.

In the course of the last summer I ordered a ditch to be cut of large dimensions, on a line of my farm near Cambridge: the line was a plane, ten feet above the level of the neighboring river, and at least one mile from it, at the nearest point of the line; a portion of the ditch being done, the work was interrupted by rain for ten or twelve days; when the work was resumed, on examining the performance, I discovered that the rain water which had filled the ditch, thus recently cut, contained hundreds of fish, consisting of two kinds of perch which are common in our waters the "sun perch" and the "jack perch;" the usual size of the former is from six to twelve inches, the latter varies from ten to fifteen inches long; those in the ditch were from four to seven inches: by what possible means could these fish have been transported so far from their native waters? There is no water communication on the surface, to conduct them there; the elevation and extent of the plane, in regard to the rivers, utterly prohibit the idea; the eggs, if placed there by a water-spout, could not have suffered so rapid a transmigration; no such phenomena had been observed, and the adjacency of the line to the dwelling, would have rendered the occurrence, impossible, without notice.

. . . . . .

A similar occurrence a few years ago, I witnessed on the same farm; in a very large ditch, cut on lower lands, on a line equally unconnected with any river, pond, or other surface-water, there were, under very similar circumstances, numerous perch, which afforded fine angling to my children. On a diary which I keep, I have entered, that several of them measured as much as twelve inches in length, and that the time since their arrival there, could not possibly have exceeded a fortnight. The fall of meteorolites from the heavens has been recorded by the historian, from the earliest ages, and as often discredited, from philosophic vanity. The frequent recurrence of this seeming physical paradox, having been finally established on the fullest evidence, should guard the philosopher against vain presumption, and fortify him in other cases, in the hope of successful research.

GFF-002 FALL OF FISHES FROM THE ATMOSPHERE IN INDIA

Princep, M.; American Journal of Science, 1: 32:199-200, 1837.

As for myself, my credulity is compelled to yield to the discovery I made one day of a small fish, in my pluviometer, which was situated on an isolated pile of stones about five feet high, in my garden at Benares. A note from M. Cameron informs me that a rain of fishes occurred on the 19th of February, 1830, near Feridpoor. This fact was asserted before a magistrate, by many ocular witnesses, and it was their concurring testimony that towards noon of the above mentioned day, the sky was obscured, the rain commenced to fall,

and shortly after, fishes of various sizes fell from the atmosphere. A large number were collected by several witnesses; some were found destitute of a head, and had commenced to putrefy; others were entire and fresh, but no one dared to eat them.---Bib. Universelle, No. 3, Mars, 1836.

GFF-003 EXTRAORDINARY PHENOMENON AT DERBY

Anonymous; The Athenaeum, 542, July 17, 1841.

On Thursday week, during a heavy thunderstorm, the rain poured down in torrents mixed with half-melted ice, and, incredible as it may appear, hundreds of small fishes and frogs in great abundance descended with the torrents of rain. The fish were from half an inch to two inches long, and a few considerably larger, one weighing three ounces; some of the fish have very hard pointed spikes on their backs, and are commonly called suttle-backs. Many were picked up alive. The frogs were from the size of a horse-bean to that of a garden-bean; numbers of them came down alive, and jumped away as fast as they could, but the bulk of them were killed by the fall on the hard pavement. We have seen some alive today, which appear to enjoy themselves, in a glass with water and leaves in it. ---Sheffield Patriot.

GFF-004 SNOW WORMS

Anonymous; Scientific American, 64:116, February 21, 1891.

A puzzling phenomenon has been noted frequently in some parts of Valley Bend District, Randolph County, Va., this winter. The crust of the snow has been covered two or three times with worms, resembling ordinary cutworms. Where they come from, unless they fall with the snow, is inexplicable. The snow is two feet deep, and the crust is too strong for them to have come up out of the ground. A square foot of snow can scarcely be found some days without a dozen of these worms on it.

GFF-005 [SHOWER OF FROGS]

Anonymous; Scientific American, 29:17, July 12, 1873.

A shower of frogs, which darkened the air and covered the ground for a long distance, is the reported result of a recent rain storm at Kansas City, Mo.

GFG-001 A CATALOGUE OF OBSERVATIONS OF LUMINOUS METEORS

Powell, Baden; Reports of the British Association, 94, 1855.

1844, October 8th, near Coblentz, a German gentleman (a friend of Mr. Greg's), accompanied by another person, late in the evening, after dark, walking in a dry ploughed field, saw a luminous body descent straight down close to them (not 20 yards off), and heard it distinctly strike the ground with a noise; they marked the spot, and returning early the next morning as nearly as possible where it seemed to fall, they found a gelatinous mass of a greyish colour so viscid as "to tremble all over" when poked with a stick. It had no appearance of being organic. They, however, took no further care to preserve it.

GFG-002 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Science, 1:26:132-174, 1834.

The following item was credited to the London Quarterly Journal, 24:488.

3. Gelatinous matter fell with a globe of fire, in the isle of Lethy in India, in 1718. A viscous matter fell in Lusatia, in 1796, along with a meteor. About the first of April 1826, the atmosphere being very clear and the sun shining brightly, a noise resembling rolling thunder, was heard at Saarbruck, and the environs. During the sound, a greyish object about three feet and a half in height, was seen in the air, rapidly approaching the earth, and then expanding itself like a sheet; there was then silence for about a minute; after which another sound resembling thunder was heard, as if it had originated at the place where the meteor fell. No residuum, or deposit was found.

GFG-003 A CATALOGUE OF METEORITES AND FIREBALLS

Gregg, R. P.; Report of the British Association, 62-63, 1860.

January 21, 1803. Silesia. A shooting star, got larger and larger until it fell to earth. Between Barsdorf and Freiburg. Seemed to pass close to ground; a whizzing noise was heard, then it seemed to lie burning on the ground; next day a jelly-like mass found on the snow. Curious, if true.

GFG-004 ACCOUNT OF A GELATINOUS METEOR

Graves, Rufus; American Journal of Science, 1:2:335-337, 1819.

On the evening of the thirteenth day of August, 1819, between the hours of eight and nine o'clock, was seen in the atmosphere, at Amherst, Massachusetts, a falling meteor or fire ball, of the size, as represented by an intelligent spectator, of a man's hat, or a large blown bladder, of a brilliant white light re-

sembling burnished silver.

The position of this spectator being in a direct line of the street where the luminous ball appeared, and at the distance of not more than five hundred yards, with the sight bounded by the buildings, there could be no deception relative to the direction that it took. Its altitude, at its first discovery, was two or three times the height of the houses; it fell slowly in a perpendicular direction, emitting great light, till it appeared to strike the earth in front of the buildings, and was instantly extinguished, with a heavy explosion. At the same instant, as appeared from the report, and from the ringing of the church bell, an unusually white light was seen a few minutes afterwards, by two ladies in a chamber of Mr. Erastus Dewey. While they were sitting with two candles burning in the room, a bright luminous circular spot suddenly appeared on the side wall of the chamber near the upper floor in front of them, of the size of a two feet stand-table leaf. This spectrum descended slowly with a tremulous motion nearly to the lower floor and disappeared.

In critically examining the chamber where the foregoing phenomenon was observed, it appeared that the light must have entered through the east front window in a diagonal direction, and impinged on the north wall of the chamber back of the ladies, and thence reflected to the south wall in front of them, forming the circular spectrum, with the corresponding tremulous motion of the meteor, and descending with it in the same direction, according to the fixed laws of incidence and reflection.

Early on the ensuing morning, was discovered in the door yard of the above mentioned Erastus Dewey, at about twenty feet from the front of the house, a substance unlike anything before observed by any one who saw it. The situation in which it was found, being exactly in the direction in which the luminous body was first seen, and in the only position to have thrown its light into the chamber, (as before remarked,) leaves no reasonable doubt that the substance found was the residuum of the meteoric body.

This substance when first seen by the writer was entire, no part of it having been removed. It was in a circular form, resembling a sauce or sallad dish bottom upwards, about eight inches in diameter, and something more than one in thickness, of a bright buff colour, with a fine nap upon it similar to that on milled cloth, which seemed to defend it from the action of the air. On removing the villous coat, a buff coloured pulpy substance of the consistence of good soft soap, of an offensive, suffocating smell appeared; and on a near approach to it, or when immediately over it, the smell became almost insupportable, producing nausea and dizziness. A few minutes exposure to the atmosphere changed the buff into a livid colour resembling venous blood. It was observed to attract moisture very readily from the air. A half-pint tumbler was nearly half filled with the substance. It soon began to liquify and form a mucilaginous substance of the consistence, colour, and feeling of starch when prepared for domestic use. The tumbler was then set in a safe place, where it remained undisturbed for two or three days; and when examined afterwards, the substance was found to have all evaporated, except a small dark coloured residuum, adhering to the bottom and sides of the glass, which, when rubbed between the fingers, produced a fine ash-coloured powder without taste or smell; the whole of which might have been included in a lady's thimble.

The place where the substance was first found was examined, and nothing was to be seen but a thin membranous substance adhering to the ground similar to that found on the glass.

This singular substance was submitted to the action of acids. With the muriatic and nitric acids, both concentrated and diluted, no chemical action was observed, and the matter remained unchanged. With the concentrated

sulphuric acid a violent effervescence ensued, a gaseous body was evolved, and nearly the whole substance dissolved. There being no chemical apparatus at hand, the evolving gas was not preserved, or its properties examined.

GFG-005 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Science, 1:25:363-411, 1834.

9. MATTER SUPPOSED TO COME FROM THE METEORS.--In several instances, material substances were supposed by the observers to fall upon the earth; and in a number of cases, matter was found which was supposed to have proceeded from the meteors.

(1.) We have received a communication from Mr. H. H. Garland, of Nelson Co., who states, that on hearing a large drop of water fall on the roof of a coop, he immediately looked, and discovered a substance of about the circumference of a twenty five cent piece, of the consistence and appearance of the white of an egg made hot, or perhaps, animal jelly broken into fragments would be a better comparison. (Richmond Enquirer.)

(2.) Persons in this town saw particles of "fiery rain" strike the ground, and on examination, discovered lumps of jelly, as they term them. (Rahway, New Jersey Advocate.)

(3.) After sun-rise, a mass of gelatinous matter was found, which, from its singular texture, is supposed to have formed one of the large meteors. Its appearance resembled soft soap. It possessed little elasticity, and on the application of heat, evaporated as readily as water. The manner in which this substance fell of the ground, indicated that it had fallen with prodigious force. (Newark, N. J. paper.)

(4.) A woman at this place (West Point) who was milking about sunrise, on the 13th, saw something come down "with a splosh" before her. On looking she found a round flattened mass, about a tea cup or coffee cup full, looking like boiled starch, so clear that she could see the ground through it. At 10 o' clock, she went out to show it to some persons, and no vestige of it remained. A boy observed some minute white particles on the spot, as large as small shot, or pin' s heads, of irregular shape, and falling to powder, and disappearing when he went to take them up. I went to the spot with the woman and boy, and concluded that if I heard of any analogous facts from other quarters, I would consider this as entitled to notice, but not otherwise. (Mr. Alexander C. Twining to Prof. Olmsted.)

(5.) One of our citizens was awakened by a ball of fire falling against his window. (Hartford Times.)

.....

9. It seems difficult to determine whether or not any substance was found, that was probably a deposit or residuum from the meteors. The fact, however, that the supposed deposits were so uniformly described as gelatinous substances, forms a presumption in favor of the supposition that they had the origin ascribed to them. This quality, it is worthy of remark, was mentioned by observers of very different classes, some of whom (as in the instance mentioned by Mr. Twining, p. 396) could hardly be supposed to have ever heard, that to fire-balls of this description had been assigned such a chemical constitution.

Taking it as established, that such a residuum as has been mentioned, was deposited by the meteors, we may infer, that the matter of which the meteors

were composed was both highly volatile and transparent,--qualities that are apt to be united in very inflammable substances. We know of hardly any thing else, except bodies analogous to the metallic bases of the alkalies, potassium for example which could have undergone combustion under the circumstances in which the meteors appeared to undergo this process. Could bodies constituted like the known aerolites, falling from any supposed height in space into the atmosphere, generate heat sufficient, by the abrasion or condensation of the air, to dissipate them in a cloud of smoke before they reached the earth?

If we could establish the affirmative of this question, we should at once be able to trace the ground of connexion between phenomena of this kind and magnetism, since aerolites are known to consist in a great measure of native iron. A number of other very interesting results would follow, respecting the aurora borealis.

GFG-006 JELLY RAIN

Hill, M. D.; Nature, 87:10, July 6, 1911.

On the morning of Saturday, June 24, the ground here was found to be covered with small masses of jelly about as large as a pea. There had been heavy rain on Friday night, and it was raining at 7 a.m., when, so far as I can ascertain, the phenomenon was first seen. On being examined microscopically the lumps of jelly turned out to contain numerous ova of some insect, with an advanced embryo in each. The egg itself is very minute---an elongated oval 0.04 mm. in length. Yesterday and the day before many larvae emerged, and were obviously those of some species of Chironomus, though colourless, having no hemoglobin, as is the case with the larvae of C. plumosus. Not being an entomologist, I am at a loss to understand how these egg-masses could have appeared where they did unless they were conveyed by the rain, as it does not seem likely that the midges would have laid their eggs on pavements, gravel paths, tombstones, &c., even had they been wet; nor has any large number of adult insects been seen in the locality. It would be interesting to hear whether the same thing was observed elsewhere, and whether the phenomenon often occurs. Showers of algae, small snails, and even frogs have been recorded from time to time, but I cannot recall a like instance to the above.

Although this entry is properly an "insect fall," it is included here because it may bear some relation to the falls of gelatinous matter.

GFL-001 SHOW OF RED MATTER LIKE BLOOD AND MUSCLE

Anonymous; American Journal of Science, 1:41:403-404, 1841.

We are indebted to Prof. Troust, of Nashville, Tennessee, for an interesting notice of a remarkable event. It appears from communications made to that gentleman, that on Friday, August 17, between one and two o'clock, p.m., the negroes of Mr. Chandler, near Lebanon, Wilson County, Tennessee, came in and reported that it had been raining blood in the tobacco field where they had been at work; that near noon there was a rattling noise like rain or hail, and drops of blood, as they supposed, which fell from a red cloud which was flying over. Intelligent men visited the ground, and observed drops apparently of blood on the upper surface of the tobacco leaves, and portions of flesh and fat---one piece one and a half inches long, emitting a very offensive smell over the field.

The drops evidently fell perpendicularly over a space from forty to sixty yards broad, and six or eight hundred yards long. Some particles appeared to have been clear blood uncombined with anything else; others, blood united with muscular fibre and fat. Dr. Troost, after visiting the place, is decidedly of the opinion that it was animal matter, but he thinks not blood; although he distinctly distinguished muscular fibres, or maceration of the matter in water, which separated longitudinally, as in the case of dried beef; they were of a reddish brown color. The pieces supposed to be blood were brown and resembled glue. There was a distinct smell of animal matter in a state of putrefaction.

Both the muscular part and that which had been called blood, were heated in a glass tube, and were similarly affected as beef would have been in the same circumstances; there was a movement in the mass, a brown fluid rose, and a black animal charcoal remained. Dr. Troost concluded, that without doubt this is animal matter, and belongs to our globe. He cites many instances of red rain, red dust, red sand, red snow, showers of blood, so called, &c. in various centuries from 472 of our era to 1814, and gives the authorities. There is now no room to relate or discuss these statements, and it remains only to give the conclusion of Dr. Troost.

After alluding to the well known power of wind to raise materials high into the atmosphere and to transport them to the distance of many miles, (and even in some cases, as in volcanic eruptions, hundreds of miles,) he observes: "Such a wind might have taken up part of an animal which was in a state of decomposition, and have brought it in contact with an electric cloud, in which it was kept in a state of partial fluidity or viscosity. In this case, the cloud which was seen by the negroes, as well as the state in which the materials were, is accounted for."

Dr. Troost gives many cases of transported seeds, pollen, and similar things---which have been taken for showers of sulphur. When we remember that even fishes have fallen in showers, we cannot doubt that whirlwinds may elevate and transport parts of animals and deposit them in distant places.

GFL-002 YELLOW SHOWERS OF POLLEN

Bailey, J.W.; American Journal of Science, 1:42:195-197, 1842.

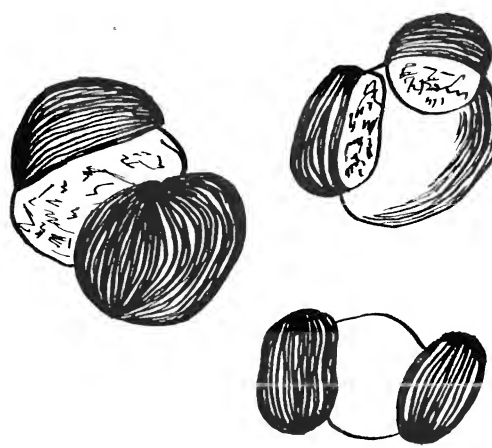
Last June our respected correspondent, Mr. W.H. Blake, of Boston, sent

us an account of a shower of yellow matter which fell on board a vessel in Pictou harbor, on a serene night in June, and was collected by the bucket full and thrown overboard; some small portions came into Mr. Blake's hands, and was by him examined chemically. It was found, on subjecting it to destructive distillation, to give off nitrogen and ammonia, and an animal odor; to form hydrocyanic acid by passing through hydrochloric acid, and to leave a considerable amount of phosphate of lime on incineration. From these facts, Mr. Blake was inclined to infer that it might be of animal origin---perhaps the ova of some insect.

From the occurrence of these showers always in May or June, or about the time of the inflorescence of trees, we were inclined to believe that they were due to the pollen of plants, while the fact that nitrogen exists always in the albuminous parts of plants, served to account sufficiently for the chemical observations of Mr. Blake. We therefore sent to our friend, Prof. J. W. Bailey, both the powders of Troy and Pictou, that he might examine them by his powerful microscopes. In return we received the following satisfactory letter, addressed to the junior editor.

West Point, September 22, 1841

My dear Sir---I received a few days since, your letter of the 17th, and its enclosures, which I hastened to subject, as you requested, to microscopic examination. The powder which fell at Pictou, proved to be, as you suggested, of vegetable origin, being wholly composed of the pollen of some species of pine. That this is its real nature, there can be no doubt; to convince you of this, I send you the following comparative sketches.



Grains of the yellow powder that fell at Pictou. They closely resemble the pollen grains of Pinus rigida. (Adapted from GFL-002, Fig. 2)

SECTION GL: LUMINOUS PHENOMENA

Unusual lights in the sky are rather common. Such lights were the primary basis of the UFO rage of the 1950s and 1960s. Although most strange lights are simple reflections or misinterpretations of common events, there are still many luminous phenomena that are not readily explained in conventional terms. It is in this section that these strange lights, glows, flashes and other luminous structures are gathered.

GLA Aurora-like phenomena. Glows, bands, and shafts of light seen in the sky, sometimes very close to the earth's surface, but with characteristics not found in the usual aurora.

GLB Ball lightning.

GLD Electric discharge. Glows, flames, sparks, and spheres of light that apparently, but not necessarily, originate in electrical discharges. Included are mountain-top glows, St. Elmo's fire, earthquake lights, and tornado lights.

GLL Lightning. Unusual forms of lightning (excluding ball lightning). Silent lightning and lightning without clouds. The "pranks" of lightning.

GLM Meteor-like phenomena. Slow fireballs; fireballs that change course or follow anomalous trajectories. Supposed "meteors" that cause unexpected geophysical effects, such as strange sounds, odors, and precipitation.

GLN Nocturnal lights. Maneuvering lights appearing in specific locations, often over periods of many years. Included are "spooklights" and will-o'-wisps (ignis fatuus).

GLW Light wheels. The luminous wheel-like structures seen most often in the Indian Ocean.

This page reserved for the expansion of the preceding categories in future volumes.

GLA-001 A REMARKABLE PHENOMENON SEEN AT SULFUR SPRINGS, OHIO

Anonymous; Scientific American, 50:97, February 16, 1884.

> A correspondent in Sulphur Springs, Ohio, refers to The Scientific American of the 19th of January, which contained an account of a remarkable phenomenon seen in Porto Rico on the 21st of November. He also describes a wonder of the sky seen about that time in Sulphur Springs, though he is not certain as to the exact date. The phenomenon was witnessed by several observers besides himself.
>
> The object was seen in the southwest in a vertical position. It consisted of a bright nucleus in the center with two tails, one pointing downward and the other upward. The nucleus, observed in a four-inch refracting telescope, under a power of 20, was ruddy in color and quite bright, Our correspondent incloses a sketch, giving the general view as it appeared to the naked eye, though the nucleus is represented as it was seen in the telescope.

So little is revealed about this object that it could be classified as either auroral or astronomical.

GLA-002 THE LUMINOUS PORTENTS OF EARTHQUAKES

Reid, Frank J.; Fate, 18:90–92, November 1965.

Compiler's Summary: Reid's article is well-researched and based mainly on studies reported in the Japanese Bulletin of the Earthquake Institute. Reid notes, however, that many scientists still do not recognize earthquake lights as physically real, believing them to be independent natural phenomena, such as lightning or meteors, or perhaps arising from electric power lines damaged during the shock. In contrast, the Japanese scientist Torahiko Terada feels that earthquake lights may be some "pseudo-aurora" created when earthquakes generate large electrical currents which, in turn, greatly increase the atmospheric electrical potential gradient. The phenomenon of triboluminescence, which is light generated when solid surfaces are violently separated, may also play a role. The blue flash that occurs when a sugar cube is broken apart in the dark is a practical illustration of triboluminescence.

The only case history in Reid's article is summarized below.

November 25, 1930; Tango, Japan. A strange, unseasonable "rainbow" is seen in the clear morning sky. The next morning an earthquake hits the Idu Peninsula. Witnesses of the earthquake reported flashes of light, bluish flames, and aurora-like afterglows. Near the epicenter, fireballs, light beams, funnel-shaped lights, and moving columns of light were seen.

> "When the quake was at its height," another witness attested, "a straight row of round masses of light was seen toward Manpukuzi Temple. Each of these luminous bodies was seen to be revolving in motion. The brightness was considerable."

GLA-003 A WONDERFUL LIGHT IN THE SKY

Rigel; English Mechanic, 104:71, August 18, 1916.

The following letter from "An Observer," Ballinasloe, appears in the Irish Independent:

"Sir,---On the night of July 31 a wonderful light appeared in the sky just above the horizon. I saw it a little after 11 p.m., and it looked like an immense fire. At 11.15 p.m. the light moved along the sky to the North-east, and then it appeared as a great luminous star. At 12 p.m. it moved back again in a Northerly direction, and showed as a great blaze of fire in the same place as I first saw it, and there it shone until 4 a.m. the following morning, when it disappeared. It was a marvellous phenomenon, the like of which I never beheld before last night."

The time of the year is wrong for a true aurora. A real fire would not move around the horizon.

Re the light seen by "An Observer," Ballinasloe, I have just come upon some old notes which show that I saw a similar but fainter light on the night of December 24, 1909. On the night I saw it the whole sky was cloudy. At 8.30 p.m. I observed a ball of light, which was nearly as bright as Jupiter, rise from the North-eastern horizon and slowly move to the South. At 8.50 p.m. it reached its highest point in the sky. At that time it was due East about 30° from the zenith. At 9 p.m. I examined it with a telescope, and did not find any difference between it and a star or rather a planet. At 9.20 p.m. it again slowly descended in the North-east and disappeared beneath the horizon in the same place from which it rose. The nature of this light still remains a mystery.

GLA-004 AURORA AND METEOR DISPLAY OF SEPTEMBER 14

Packer, D. E.; English Mechanic, 88:211, October 2, 1908.

1908. September 14, 8:40 p.m.---Sky clear generally, and faintly luminous, owing to moonrise in N. E. A bright, horizontal cloud observed stretching across the fore part of Irsa Major and superposed upon a dark cloud or darkness, so intense as to appear almost black in the general twilight. The bright cloud was in a constant state of fluctuation, flashing up and fading with almost the same rapidity as the well-known scintillation effect observed in bright stars. The colour was a pale white, and, as far as could be judged, the cloud was stationary over the magnetic meridian during the whole period of observation. At 8:45 a meteor from Perseus approached it, and on entering the cloud at its eastern extremity burst out with extraordinary splendour, far surpassing Venus in lustre; and exhibiting a string of many smaller nuclei on each side of the main nucleus. At 8:50 the cloud at this point had thrown out a streamer, which was traceable between Auriga and Perseus into Aries. At 9 p.m. the streamer had faded, and the cloud showed signs of disruption into two separate masses, united by a narrow neck; also there now appeared evidences of other clouds forming in the neighbourhood, less luminous than the main cloud, and more difficult of observation, owing to the increasing moonlight. Subsequently

the main cloud became more compact as at first, the fluctuations became less pronounced, and by 9:30 no traces of the phenomenon were visible.

The above observation occurred in England. Three phenomenon, generally considered independent, occur together here: an aurora, a meteor, and a cloud that may be of the noctilucent type.

GLA-005 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Science, 1:25:363-411, 1834.

Below are reported aurora-like appearances associated with the great 1833 meteor display. Meteors may be electrically charged and it is known that they creat ionized trails high in the atmosphere, but were they the cause of the coincident auroral phenomena mentioned by Olmsted?

11. AURORAL APPEARANCES. -- Phenomena resembling more or less the Aurora Borealis, were visible in some places, although in many other places no appearances of the kind were observed.

(1.) A bank of auroral light, resembling day-break, was observed at New Haven, by Mr. Palmer the greater part of the night.

(2.) There was a vapor in the atmosphere, visible round the horizon, which, in the southeast, assumed a very beautiful appearance half an hour before sun rise.

. . . . . .

(4.) At Dover, (N. H.) there was an appearance of the Aurora Borealis, early in the preceding evening, which continued until 4 o' clock in the morning, when it suddenly broke out into streams of strong light, spreading into columns, changing into a thousand different shapes, varying their colors through all tints of the rainbow, and shooting from the horizon almost to the zenith. This scene was followed by a splendid exhibition of fireworks. Luminous balls might be seen darting about with great velocity, leaving behind them a train resembling that of a comet. The whole was closed by the formation of a triumphal arch which vanished before the coming light of morning.

. . . . . .

Of the several facts collected under the head of concurrent phenomena, possibly no one may prove of any importance; and yet the contrary is also possible. The fall of rain without clouds at Harvard, was an interesting meteorological fact, and may have had a strict connexion with the meteors, a connexion which may be more fully developed when the cause of meteors shall be better understood. The luminous appearances in the west following twilight, are also remarkable. The same appearance has been exhibited as late as the evening of December 29th, in a form much more imposing than on either of the preceding occasions. It was observed immediately after the twilight, (which ended at eighteen minutes after six,) and lasted until fifteen minutes before eight. It illuminated all the western sky and strongly resembled the twilight, being brighter than the zodiacal light, not lenticular like that, and not extending along the Zodiac, but having its apex in a vertical circle near Alpha Pegasi. Ridges of dark clouds, (cumulo-stratus) with intervals of clear sky, contributed to heighten the effect by contrast; and higher than these, was a thin vapor that became visible as it crossed Jupiter, which was near the meridian, being illuminated in a circular space around the planet, and presenting much the same

appearance as the light in the west, a circumstance which led to the conjecture that the latter was owing to the same vapor elevated so high as to fall into the sun's light, after the ordinary cause of twilight had ceased to operate. The vapor was so thin as hardly to diminish the light of Jupiter. Was this vapor such as remained from the combustion of the meteors?

An aurora borealis of moderate height was visible in the north at the same time, and faded away simultaneously with the western aurora.

The fall of rain at Harvard and vapors, both apparently associated with the meteors should be connected with recent attempts to correlate rainfall with lunar position and its effects on meteoric influx. (See GWP-004.)

GLA-006 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH 1833

Olmsted, Denison; American Journal of Science, 1:26:132-174, 1835.

The following observation was printed in the Annual Register of 1832 and reprinted in Olmsted's article.

7. "Soon after six o'clock in the morning of the 14th of November, 1832, (says a letter from Bruneck, in the Tyrol) a broad stream of light suddenly descended from the center of the firmament nearly down to the ground, and was then drawn gradually up again to the middle of the sky, whence, for several seconds, it stretched itself out towards the north in a long train of light, which first appeared in a straight, and then changed into a wavy line; after this, it gathered into a light orb resembling a white cloud, and remained stationary in the center of the firmament for a full quarter of an hour, when it disappeared with the break of day. The appearance was accompanied with so vivid a degree of illumination that the smallest pebble in the road was readily distinguishable, and those who were abroad at this time, were completely panic struck. The sky, instead of being muddy with vapor, as is common at this season, and at this time in the morning, was clear and cloudless, and the air remarkably serene and tranquil. Between five and six o'clock, however, an unusual number of falling stars were observed in various parts of the heavens."

GLA-007 THE MAGNETIC STORM AND AURORA

Capron, J. Rand, et al; Nature, 27:82-87, November 23, 1882.

From the many letters sent to Nature reporting the strange atmospheric phenomenon of November 17, a few of the most interesting and descriptive are quoted below:

.....I happened to turn to the south, where the moon (with a very pronounced lumiere cendree on its dark part) was nearly on the meridian, when I saw a spindle-shaped beam of glowing white light, quite unlike an auroral ray, had formed in the east. As I looked this slowly mounted from its position, rose to the zenith, and passed it, gradually crossing apparently above the moon, and then sank into the west, slowly lessening in size and brilliancy as it did so, and fading away as it reached the horizon. The peculiar long spindle shape, slow gliding motion and glowing sliver light, and the marked isolation of this cloud

from the other portions of the aurora made it a most remarkable object, and I do not recollect in any former aurora to have seen anything similar. About 6 o'clock the aurora gradually died away, to revive again at 9 in the shape of a white semi-circle of light in a point north by west, which did not last long. Owing to moon-light, but little could be done with the spectroscope with a wide slit on the most glowing parts of the red patches only the usual green line, with a faint continuous spectrum towards the violet could be made out. At times I thought I caught traces of other lines, but with no certainty at all. The spindle-shaped beam was also examined with the spectroscope, but only gave the green line. Even in the bright-est parts of the red glow, the red line could not be made out. The peculiarity of the moving beam of light was its absolute southern position. Its apparent passage across the sky was only a few degrees above the moon, then at a comparatively low altitude. (J. Rand Capron)

. . . . . At 5.25 a green arch suddenly shot across south of the crimson areas, very defined $1\text{-}1/2^{o}$ to 2^{o} broad, from west-south-west to east-south-east, passing just over the moon. It lasted hardly a minute; the crimson cloud was then bright. Just such a "bar" "shot out" from the south-east at Street, soon after 6, "of yellowish light; it quickly increased in size and brilliancy, and went right across the heavens to the south-west," passing across in less than four min-utes. It passed south of the moon (i.e. apparent altitude really the same as that at 5.25, Leeds being nearly 3^{o}, 6 diameters of the moon, north of Street). My cousin continued:--"There seemed to be a dark something before the bright bar, which showed the path it would take, also a dark streak where it passed. The postmaster tells me that the telegraph-needle worked very badly this afternoon, turning to the right hand constantly." (J. Edmund Clark)

. . . . . The sky was every where very clear, even close to the horizon, and the auroral arch was very conspicuous in the north; its summit lying between the stars Delta and Epsilon in the Great Bear. At 3 minutes past six o'clock a brilliant elongated patch of greenish white light appeared suddenly in the east, below Saturn and to the right of it, the centre of the patch being about 8 degrees from Saturn on a line drawn through the planet at an angle of 45^{o} with the hori-zon. When first seen the patch was about 6 degrees in length and half a degree in width and the ends had a rough splintered appearance. It rapidly increased in length and less rapidly in thickness, till it closely resembled in general appearance the great Nebula in Andromeda as seen with a good telescope, and the length of the conspicuously luminous portion was apparently about as great as the distance between the stars Alpha Pegasi and Delta Andromedae, i.e., about 27 degrees. The breadth at the centre seemed about equal to twice the moon's diameter. I expected it to lengthen out into an arch across the sky like other fainter ones, which were visible at the time between it and the arch to which I have already referred, but instead of doing so the patch began to shift rapidly across the sky end foremost, as if ascending the eastern slope of the arch which I had expected it to form, then after reaching the summit where its length was horizontal, it rapidly descended the western slope and disappeared near the horizon, passing close under the moon at a distance which I estima-ted immediately afterwards as rather less than three times the moon's diameter, (measuring from the centre of the luminosity to the moon's lower cusp). The duration of the phenomenon was hardly a minute and its brilliance far exceeded that of any other portion of the display. (A. M. Worthington)

. . . . . At 6h. 5m., when the display was at its maximum, a remarkable phenom-enon was seen---a bright greenish-white band of a lenticular form, about 20^{o} in length and 5^{o} broad (its axis being parallel to the horizon in the south), passed from the south-east to the south-west horizon, attaining an altitude, when due south, of about 20^{o}. It occupied about six seconds in passing from

horizon to horizon, and its brightness seemed to be but slightly affected by the light of the moon, which was shining in the south, and below which it moved. (Thos. Gwyn Elger)

I beg to hand you an account of the extraordinary apparition of Friday evening last, November 17, as seen at Clevedor, during a brilliant rose-coloured aurora. The time was about 6.15 p.m. There rose suddenly, through the haze in the east, a beam of light, at an angle of some 60^{o} with the horizon. It crossed the cloudless sky rather below the moon, and sank in the west, occupying about eighty seconds in the transit. The trajectory was much flatter than that of the stars, &c., but was at right angles to the meridian, which was crossed at an approximate altitude of 22^{o}. I estimated the length of the beam at 35^{o}, and the breadth at the middle to be 3^{o}; from whence it tapered gradually to a point at each end. The colour was uniform throughout---a very pale yellowish white, without coruscation or change; and there was no indication of a trail, or of any sort of atmospheric disturbance. The impression conveyed to me was that the beam was stationary in space, and comparatively near, and that we were being carried past it by the rotation of the earth. The major axis lay on the apparent path, but in the earlier and latter parts of the course it was much foreshortened; and as the western horizon was approached, a formation of a similar character, perhaps 7^{o} northward, and running on a parallel track, was visible for several seconds before both were lost in the trees. This second object was also noticed by others whose view westward was less interrupted. I watched the whole evening without seeing any tendency to a repetition of the phenomenon. The sky remained cloudless, with the temperature at the freezing point. There was no wind; and the aurora, which continued off and on until past eleven o'clock, at no time threw out any considerable rays or streamers. The strange visitor caused great commotion among the many who were out of doors looking at the aurora, some of them fearing that the supposed runaway comet was coming into collision with the moon, then half an hour past the meridian, and relieved when it passed below it. (Stephen H. Saxby)

I am unable to explain the following occurrence which I observed this evening at 6h. 5m. p.m. It appeared to be a well-defined spindle-shaped body of a cloudy consistency, having a brilliant white colour. It subtended a visual angle of about 20 degrees. I first observed it due east, and immediately noticed that it was moving with very great rapidity, as in less than one minute it had disappeared below the horizon in the south-south-west. There was a rosy aurora visible at the time in the north, which, however, was in no way connected with it. The atmosphere was perfectly clear in that part of the heavens traversed by the phenomenon, though in other parts of the sky there were a few stationary clouds visible. (A. S. P.)

At about 6.5 p.m. on Friday a bright, white, cloud-like object, in shape like a fish-torpedo or a weaver's shuttle, was observed to cross the heavens from east to west. Its length was roughly about 30^{o}, and its breadth about 4^{o}. I noted it first shoot up, like a strong electric ray in a fog, a little south of Aldebaran, and slowly, as it were, slide along at the same N. P. D. across the face of the moon (which was shining brightly at the time), and disappear in the west under Atair. Its surface had a mottled appearance; its colour white; its motion was slow, being visible, from horizon to horizon, upwards of 50 seconds; its brightness was strong, and did not seem to fade, even when crossing the moon, and it seemed preceded and followed by a strong black margin; though this I suppose was the effect of contrast and subjective only. (John L. Dobson)

See further discussions of this event in GLA-011, GLA-012, GLA-014, and GLA-015.

GLA-008 THE LUMINOUS BEAM OF AUGUST 18

Packer, David E.; English Mechanic, 82:88, September 1, 1905.

On the night of August 18, at 12.30 p.m., a luminous beam was seen traversing the eastern part of the sky. At the time when it was first seen, the sky everywhere was very clear, and the moon shining brightly. The beam resembled a nearly horizontal ray of pearly white light, about 80° in length and $1/2^{\circ}$ in breadth, stretching across the constellation Pisces Australis (above Fomalhaut), through Cetus to Eridanus, or from 330°---25° to 50°---10°. It moved slowly south by east, and at 12.45 transited Fomalhaut, which shone through it with undiminished brilliancy. As its altitude decreased, it became more parallel to the horizon. Its southern border was more defined than its northern, and its preceding termination in Eridanus was slightly broader and less defined than its following termination. It bore a great resemblance to the tail of a comet. No nucleus or decided condensation was seen at either end to justify a cometary origin, although it is well known that several large comets---notably, the great comets of 1880 and 1887---have been seen without nuclei as mere rays similar to the appearance above-mentioned. Traces of the beam were visible at 13h. 20m. p.m. It could not have been a cirrus cloud, as its appearance was too regular and defined, nor was it due to a searchlight, as it revealed distinct motion along its entire length. I hope it may have been observed elsewhere.

GLA-009 A SINGULAR PHENOMENON

Gape, Charles; English Mechanic, 21:488, July 23, 1875.

On Friday evening, June 25th, between 9 and 10 o'clock, I observed in the E.S.E. very frequent flashes, or rather very narrow streaks of a pale blue colour, keep darting up from the earth towards the heavens, something like those of an Aurora Borealis. The day had been rather dull, hot, and close, and there had been distant thunder. I merely went out to see if I could discern any sheet lightning, but saw the above instead. In the E.S.E. it was rather dark, but overhead, and everywhere else it was clear and starry.

Flashes, such as those reported above, are sometimes seen during auroras and earthquakes.

GLA–010 AURORA

Veeder, M. A.; Nature, 35:54, November 18, 1886.

Last evening (November 2), between the hours of seven and eight o'clock, a bright aurora was visible in this vicinity. At intervals later in the evening, patches of cirrus clouds in the northern sky became luminous. The disturbance of the suspended magnet was at its height early in the evening, when the aurora was brightest. It is interesting to note the fact that this aurora

was twenty-six days removed from that of October 7 and 8, corresponding to the time of the revolution of the sun on his axis. It is noteworthy, also, that very near to the time of the appearance of each aurora there was a slight renewal of earthquake activity in South Carolina and other localities.

The coincidence of auroras and earthquakes may derive from a common cause; i.e., the sun.

GLA-011 THE AURORA

Taylor, Charles J.; Nature, 27:99-100, November 30, 1882.

At Ilford, Essex, on the 17th instant, at 6h. 4m. p.m. by a watch which was within 2m. of G.M.T., I witnessed during the auroral display, the extremely singular phenomnon which has been described by several of your correspondents. It looked exactly like a white cloud, about 20^{o} long and 2^{o} wide, tapered somewhat from the middle to each end; but it was more luminous than a cloud could well have been at that time. When first seen, its nearest end may have been 30^{o} east of the moon. Its length was nearly parallel to the horizon, and continued so till lost sight of about as much to the west of the moon; and its passage over an area of some 80^{o} occupied probably less than a minute. It passed very near to the moon, but I cannot say whether over it or not.

Batson, Alfred; Nature, 27:99-100, November 30, 1882.

My observation at Ramsbury, near Hungerford, was to the effect that while watching the northern aurora, my attention was called, at ten minutes past six, to this monster meteor, then slowly approaching in a direct line to the moon, which was shining most brilliantly. It seemed to pass exactly over the disc, and reappeared on the other side, much reduced in size, as if going away from us; and at a distance of about 6^{o} from the moon, scarcely seemed to measure more than 5^{o} in length, it being then about 6h. 8m., which corresponds with the position over Sidemouth at that time. It was very definite in form, like a torpedo. I estimated its length at 15^{o}, and 3^{o} in breadth.....

GLA–012 REMARKS AND OBSERVATIONS OF THE METEORIC AURORAL PHENOMENON OF NOVEMBER 17, 1882

Groneman, H. J. H.: Nature, 27:296-298, January 25, 1883.

After studying data from England and the Continent, Groneman states the following:

The conclusion to which we come after all, regretting earnestly the want of French observations, is that we have here probably a meteoric object, moving, according to the calculations of Mr. H. D. Taylor (vol. xxvii. p. 140), with great velocity through the upper strata of the atmosphere and at the same time of auroral character, as the spectrum observation of Mr. Rand Capron (vol. xxvii. p. 84), makes out beyond any doubt. The separation and the feather-like forms, observed at Utrecht, make it probable that

it was a mass of meteoric dust, passing through our atmosphere like an accumulation of little shooting stars. In this way the phenomenon of November 17 brings a confirmation of my own theory of aurorae, proposed by me in the "Apperdice alle Memorie della Societa degli Spettrocopisti Italiani," 1878, vol. ii., and received with sympathy by many of the German and Dutch astronomers; but as it seems little known in England, though referred to by Mr. Rand Capron on p. 64 of his beautiful work, "Aurorae." In this theory most of the properties of aurorae are deduced from cosmic dust entering into the atmosphere of the earth. I take the liberty to direct attention to the unexpected argument, that the brilliant object of November 17, 1882, has brought forth in favour of my "Theorie Cosmique," to which I had already the opportunity to refer in this Journal in my article "On Dust, Fogs, and Clouds" (vol. xxiii. p. 195).

Furthermore, I think that this object is not the only example of such a phenomenon. On November 2, 1871, there was seen in Groningen and several places of Germany a strange, brilliant arch, striped parallel to its well defined sides and changing its curve during its two hours of existence. The beginning of the phenomenon (of which I gave a description in the Dutch journal Isis) was seen by a student, Mr. Gratama, like an elliptic patch of light round the Pleiades. Dr. Vogel, who observed the same arch at Bothkamp, determined its auroral character by the spectrum. Otherwise it resembled very much the bright spur of a gigantic meteor or fireball. Also it disappeared slowly, beginning at the east end, as the illustration shows. A faint aurora, with dark segment, was visible in the north. The height of this arch was calculated by me approximately at 127 kilometres or 79 miles. I think that the only difference between these two feather-like phenomena of November 2, 1871, and of November 17, 1882, consisted in the different apparent velocity and in the greater mass of meteoric dust, forming in the case of November 17, 1882, but a short, and in that of November 2, 1871, a very long train of incandescent matter.

. . . . . .

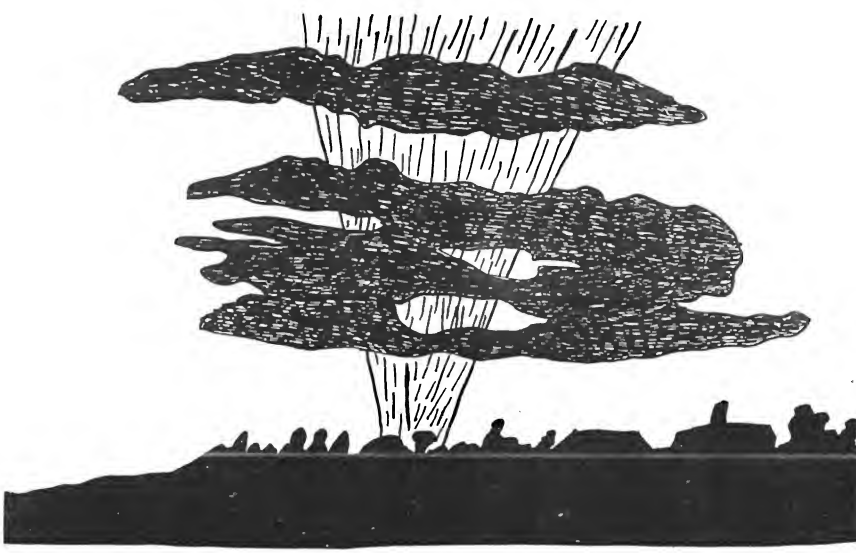
Returning to the meteoric phenomena, visible simultaneously with aurorae, it seems that such phenomena were seen during the marvellous aurora of January 7, 1831, described in Poggendorff's Annalen of the same year. We read (p. 440) that Bergrath Senff, in Colberg, at 6.30 o'clock, saw above the west horizon a bright yellow streak, rising upward with a common cloud-velocity, passing at 30° N. Zen. D., and forming an arch from W. to E., beginning to disappear from the west end, almost at the same moment that it reached the east horizon. At p. 458 we see that Prof. Rudberg, at Upsala, December 7, 1830, saw a very bright patch of double the dimensions of the moon's disc, moving with great velocity behind the common auroral beams. Further, Prof. Bischoff, in Burgbrohl (p. 461), observed, on the occasion of the aurora of January 7, 1831, a moving cloud as bright as the milky way, from E. to W., in five minutes. Prof. Moll saw, in Utrecht a similar object rising from N. E., through the Pleiades, to S. E. (S. W. ?). Similar observations are to be found during the same aurora, p. 471 (one advancing arch), p. 472 (four similar arches, and a dark streak).

GLA-013 A CURIOUS PHENOMENON

Noble, William; Knowledge, 4:173, September 14, 1883.

GLA–013 AURORA–LIKE PHENOMENA

Can any of my brother readers of Knowledge offer a feasible explanation of a very remarkable phenomenon which I witnessed at 10h. 35m. p.m. on Tuesday, August 28? I was just coming out of my observatory when, on the E. N. E. point of the horizon beneath the Pleiades, I saw a bright light. My first thought was that the moon was rising, but an instant's reflection sufficed to remind me that she would not be up for the next two hours. As I watched the light becoming brighter and brighter, I saw that it threw a kind of radial illumination upward, the effect of which I have tried to reproduce in the accompanying rough little sketch. As will be seen, a few distant cumulo-stratus clouds, close to the horizon, crossed it. For a moment I imagined that I was viewing the apparition of a new and most glorious comet; but, as I watched, the "tail" disappeared. and what would represent the nucleus flashed up brilliantly. Then I made up my mind that some distant house, barn, or haystack was on fire, and returned to the observatory for a 3 inch telescope, which I keep for looking over the landscape. Before I had time, however, to enter the door, every vestige of illumination disappeared as suddenly as it had come into view, and after waiting in vain for some time, I left the observatory and came into the house. I have diligently inquired if there was a fire anywhere in this part of Sussex on the night of which I am speaking, but there was none.



A curious phenomenon. (Adapted from GLA-013)

GLA-014 METEOR OF NOVEMBER 17

Taylor, H. Dennis; Nature, 27:365, February 15, 1883.

I think now that more observations of the remarkable phenomenon of November 17 have been brought forward, that we cannot but candidly acknowledge that the evidence is extremely contradictory and impossible to reconcile, that is as applying to one and the same object. Altogether there is something mysterious about it. It is evident that since it appeared to reach the greatest apparent length of about 30° at York, then from all places further south it ought to have attained a length exceeding this, the more so the further south they are. The ends of the beam appeared very well defined from here, and there was very little room for estimates varying according to the observer's sensitiveness to light. If we take the observations made from Clifton, Cirencester, East Clevedon, Woodbridge, and Windsor, as they nearly, all agree in estimating the length as over 30°, some considerably over, then these may all relate to the same object. But its appearance from York is flatly contradicted by Mr. Batson's observation from Hungerford, that from Halstead, Essex (which seems to agree with Mr. Batson's), also those from Lincoln's Inn Fields, Greenwich, and Cambridge. All these agree in contradicting the others named above, by assigning a much smaller angular length.

For other accounts of this event, see GLA-007, GLA-011, GLA-015, and GLA-012.

GLA-015 THE AURORAL "METEORIC PHENOMENA" OF NOVEMBER 17, 1882

Batson, Alfred; Nature, 27:412-413, March 1, 1883.

It is much to be desired that the increasing interest concerning this great phenomenon should supply the only way of obviating the paucity and incompleteness of observations, by having a meeting of observers and advanced nature-students either at London or Bristol. The Utrecht observation says: "When this arch had obtained the length of 90° (which lasted only a few seconds), a separation was made in the middle of its length," &c. I think this accounts for many of the discrepancies.

M. Groneman writes: "The Dutch observations confirm the English, only the phenomenon seems to have been of greater apparent size and therefore nearer." I used to think this for the same reason he gives, but I now think it probable that it was further from the earth when it first approached.

From Bordeaux I learn the sky was cloudy, but the aurora was well seen from Rome, Spezia, and Florence, and I have hopes of observations from the north of Italy.

The logical position is that we must lay aside all preconceived opinions; that we must be prepared to receive fresh ideas from our new views of the action of intense heat on gases and meteorites.

GLA-016 A CURIOUS PHENOMENON

Bradgate, W. K.; Knowledge, 4:207, September 28, 1883.

The remarkable phenomenon which Mr. Noble described in No. 98 of Knowledge (GLA-013) was also witnessed by me in Liverpool on August 29, at 12 h. 40 m. a. m. I had just been looking at Saturn, when, for the first time, I saw a bright divergent cone of light about 7° above the horizon; the entire length of the cone was about 5°. The apex or nucleus displayed such a degree of concentration that I thought it was the planet Jupiter. I turned my telescope, a 2-inch, armed with a power of 30, on the point where the apex should be (it was now obscured by a cloud), with the expectation of being able to unravel the mystery, but was disappointed, as the cloud was too dense. I then ran my telescope along the major axis of the cone, and the field of view was so faintly illuminated that the brightest part could hardly be said to equal the lumiere cedree seen under similar conditions. It gradually faded from view, after having been visible for thirteen minutes. I continued watching the part of the heavens where it had disappeared, with the confident hope that it would return, but was at last obliged to give it up, as a great bank of clouds precluded all further observation.

It could hardly have been an auroral streamer, as the point where it appeared is 67° east of North.

See also GLA-017.

GLA-017 JUPITER---STRANGE LIGHT IN THE SKY

Mee, Arthur; English Mechanic, 81:220, April 14, 1905.

Did anyone see a strange light in the southern heavens about ten o'clock on the evening of March 29? Several people in the neighbourhood of Cardiff saw an appearance like a vertical beam of light, which was not due (they say) to a searchlight or any such cause! Unfortunately, I did not see the phenomenon myself; perhaps some of your readers may have been more furtunate. It was on the S. E. horizon as seen from Cardiff.

For similar events, see GLA-013 and GLA-016.

GLA-018 THE RECENT NOCTURNAL GLOWS

Brauner, Bohuslav; Nature, 78:221, July 9, 1908.

The peculiar light phenomenon at midnight on June 30, which was seen, according to the papers, on the northern part of the sky at Copenhagen, Konigsberg, Berlin, Vienna, Biala, and other places, was also observed by me at Prague. At 1h. 30m. a. m. on July 1, I saw in the direction N. E. and N. N. E. a peculiar strong orange-yellow light over the horizon, the

colour of which was more orange in its lower parts and more yellow in its higher parts. Its upper limit was lying twenty to thirty degrees above the horizon. The whole sky was cloudless. Other people saw it here at 11 p.m. on June 30.

It is reported that magnetic disturbances were experienced on the telegraphic lines, but I saw no trace of the characteristic auroral bands or columns. I may be allowed to add that, according to Arrhenius, this time of the year corresponds to the minimum of auroral display (activity). Interesting is the fact that a high barometric maximum was lying in the north, and that we had winds from that direction for a whole week.

GLA-019 A STUDY OF THE REMARKABLE ILLUMINATION OF THE SKY ON MARCH 27, 1908

Ellis, Wilmot E.; Science, 28:51-53, July 10, 1908.

The 27th of March was a remarkably clear and warm day, the temperature mounting well above 70 degrees. The evening was also clear, but decidedly cooler. There was no moon, but Venus shone unusually bright in the western sky. This last fact is mentioned particularly, because the best authorities state that the light of a brilliant evening star is sufficient to preclude any marked illumination like that observed. Everyone whom I have interviewed informs me that he had never before witnessed any such display. With the exception of one eye-witness at Millburn, N.J., all of my information has been obtained from observers at Sandy Hook, N.J. I was so unfortunate as to witness the last part of the spectacle, only. Details beyond my own knowledge are furnished from accounts given me by army officers stationed at Sandy Hook and members of their respective households.

The illumination was first noted at about 7:45 p.m. It consisted of a bright nebulous band rising north of west from about twenty degrees above the horizon. The light extended across the sky to near the north of east horizon, diminishing in brightness from west to east, the bands in the east and west being connected by three separate bands. At about 8:15, the illumination faded, except the western solid band, which persisted for about ten minutes. Before it disappeared, however, a series of short narrow shafts, nearly parallel to one another, appeared about fifty degrees above the horizon in a direction slightly west of north. The eastern-western illumination was steady, while the northern shafts were "trembly," somewhat suggesting the aurora borealis. It should be remembered, however, that there were no lights of whatever nature in the north, except these detached shafts.

It would seem plausible on first thought to attribute this display to the zodiacal light, or the aurora borealis, or to a combination of the two.

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the zodiacal light hypothesis fails to account for the detached shafts high above the horizon to the west of north. Some writers appear to make a distinction between auroral displays ("fictitious" auroras, as it were), and the characteristic aurora borealis. Reports of the simultaneous displays of the zodiacal light and auroral phenomena are matters of authentic record. In the case under discussion, there is a chance that two independent phenomena were occurring at the same time, but the chance was infinitesimally small. Moreover, one of the most pronounced sensations

of the beholder was that he was witnessing one phenomenon, with one cause.

The only other comment about these glows and shafts of light that seems reasonable in the terms of present knowledge is that they are electrical phenomena. But in this article we go back a century in time to when everything unusual was ascribed to electricity.

GLA-020 ANOMALOUS AND SPORADIC AURORAS

Anonymous; Monthly Weather Review, 26:260–261, June 1898.

The following observation from Key West stimulated the Editor of the Monthly Weather Review, Cleveland Abbe, to suggest the possibility of low intensity atmospheric electrical discharges as the causes of luminous beams and low altitude auroras. The famous Andes Glow and other mountain-top luminous effects are probably closely related.

In a letter, dated Key West, November 10, 1897, Mr. H. B. Boyer, observer, Weather Bureau, said:

I have the honor to report that the following described phenomenon was observed on the 8th instant, and it is requested that its character be determined, if possible. The description is taken from the daily journal:

A singular phenomenon was observed between 9 and 10 p. m. This consisted of a beam of well-defined light stretching across the sky, similar to the rays projected by an electric searchlight. At first it was thought that such it was, as there are two men-of-war in the harbor; but the position and permanency of the beam precluded this idea, and it was afterwards found that the phenomenon was noted on the war vessels.

The luminous beam began at a point in azimuth 230° (counting from south to west) and stretched southward across the heavens to a point in azimuth 330°, with a slight upward tendency and a slight widening. At its northern extremity its width was about $1/2^{\circ}$, broadening to about 1° at its southern extremity. It remained fixed as regards its position relative to terrestrial objects, and it was noted that stars, in their upward course, were plainly visible through it. The inclination and altitude may be determined from the following: As the constellation of Orion passed the beam it was observed that at 9:50 p. m. the uppermost star in the "belt" and "Rigel" passed through simultaneously; in other words, a line drawn from "Rigel" to the uppermost star in the "belt" of Orion coincided with the axis of the luminous beam. The phenomenon began to fade about 9:45 p. m., and by 10:10 p. m. had disappeared, the fading process beginning at the northern end. By some the beam was seen to vibrate.

.....

The item on page 297 of the Monthly Weather Review for August, 1895, is almost a parallel to the case reported by Mr. Boyer at Key West. It describes an auroral arch and streamer, as seen at Charleston, S. C., on August 26. The phenomenon was so unusual as to have given rise to many suspicions, but eventually it was seen there could be no doubt that this was a case of a very local aurora, such as the Editor calls "sporadic auroras," occurring beyond the confines of a region in which thunderstorms were prevailing at the time. These sporadic and local auroras must be considered as one of the mildest forms of electrical discharge in the atmosphere. It may be that the electricity distrib-

uted all over the surface of a globule of water in a cloudy mass or in a hazy sky is collected at the extremities of the spicule of ice when that globule is frozen. The auroral light therefore emanates from definite points and lines located near or above that layer in the atmosphere at which freezing temperature has just occurred. (Small globules may cool far below 32° F. before they freeze to ice needles.) This may be, and undoubtedly is a very irregular surface, but must have a close analogy to the shape that we see depicted in the clouds and auroras themselves. The beautiful streamers of cirrus haze, as observed in the daytime, have often been compared with the beams, arches, and folds of auroral light, as seen at nighttime. It is quite plausible that both at Charleston, August 26, 1895, and at Key West, November 8, 1897, a discharge of electricity was taking place horizontally outward in all directions from an area of low pressure or cyclonic disturbance central in the Ohio and Mississippi watersheds.

GLA-021 AURORAL LIGHT

Abbe, Cleveland; Monthly Weather Review, 29:512, November 1901.

The following extracts are from the Climate and Crop Section reports, November, 1901:

Laporte, Ind.---About 5.30 p.m. on the 28th, the observer noticed a peculiar light in the western heavens. The sky was covered with broken clouds, through which the light shone.

Huntington, Ind.---A peculiar streak of light was observed in the northwest about 6 p.m. on the 28th.

Stiffenville, Lewis County, Mo.---An aurora observed on the 28th.

The aurora borealis appears in every form, from the most magnificent display to the most insignificant patches of light that appear for a few moments and fade away forever. The above phenomena may well have been of the latter auroral character. Laporte, Ind., is from 50 to 75 miles northwest of Huntington. A northeast wind had been blowing from out an area of high pressure; the sky was covered with cumulostratus clouds at Laporte, but was probably clear at Huntington. These are the conditions that generally accompany auroras and we may assume that there was a faint one on the present occasion, although it was not observed elsewhere in the United States or in Canada.

GLA–022 ELECTRICAL PHENOMENA; INCANDESCENT CLOUD

Anonymous: Monthly Weather Review, 29:466, October 1901.

In a letter dated Braidentown, Florida, August 28, 1901, Mr. H. H. Broeck sends the following account of electrical phenomena observed by him:

About 9 p.m. of May 30, 1901, I saw some clouds pulsating with light like that of an aurora. They were small and very thin, showing stars through them, and drifting slowly eastward overhead. On turning from them for a few moments they became plainer, and I saw they were lambent like the streamers of an aurora. I watched them for several minutes, during which they varied in light about every fifteen seconds. I then noted a larger, much denser cloud about west-northwest 20°, which showed the same action of auroral light. A bank of

clouds covered the whole northern sky to some 20° above the horizon, they were very bright, but showed no variation in their light. A few scattered clouds in the south also were free from variation. There was nowhere any trace of streamers. A violent storm followed the next night, which in eighteen hours discharged nearly 7 inches of rain, a very unusual amount for the time of year. I have nowhere seen its equal in nine years.

I have also noted more lightning without thunder. I reported some instances a few months ago in the Monthly Weather Review. I saw a flash recently going from one cloud to another. It was about two miles long and very bright. I expected a violent clap of thunder, but none came. I have often seen such discharges followed by loud thunder which sometimes lasts over a minute before it dies away.

The preceding observations by Mr. Ten Broeck seem especially interesting because they harmonize with several similar experiences by the Editor. Anyone may frequently observe at night during a storm, clouds floating along and becoming now bright and now dark---the different parts of the same cloud may be bright and dark alternately. It will be easy to perceive thereby that this cloud light is not reflected from terrestrial sources. There seems but one explanation; the cloud is under the influence of an electrical discharge and is rendered luminous by it. Either the cloud particles are incandescent, as in the ordinary incandescent electric light or the air between the particles is incandescent, as in intense lightning and the ordinary arc lights; in either case we may speak of an incandescent cloud, as distinguished from the "phosphorescent," "iridescent," "fluorescent," "luminescent" clouds that have been observed very high in the atmosphere and which apparently become luminous by reflecting distant twilight.

In his analysis, the Editor of Monthly Weather Review postulates electrical discharges within individual clouds. This feature may be related to the electrical activity sometimes associated with tornadoes, waterspouts and whirlwinds.

GLA-023 ATMOSPHERIC ELECTRICITY

Tomlinson, C.; Nature, 40:102, May 30, 1889.

The following observation would probably be relegated to the UFO literature today.

Mr. Jabez Brown, while ascending one of the sharp hills near Boscastle, in November, at 9 p.m., was suddenly surrounded by a bright and powerful light, which passed him a little quicker than the ordinary pace of a man's walking, leaving it as dark as before. The light was seen by the sailors in the harbour, coming in from the sea, and passing up the valley in a low cloud. A similar one occurred in Scotland last year.

GLB-001 FLAMES FROM THE SKY

Gaddis, Vincent; Invisible Horizons, Chilton Books, Philadelphia, 1965, pp. 192-199.

Compiler's Summary: Gaddis devotes this chapter to fireballs; and some of these are very strange objects. Two of the most interesting are summarized below.

February 7, 1955; Carribean area. Hundreds of people on the ground and two pilots see a huge fireball streak across the sky. To avoid the object, the two pilots had to increase their altitudes. Motorists near Miami said they had to swerve to keep from being hit. Other odd lights were also reported in the area. Some were perfectly round with fuzzy edges. Newspapers called these phenomena "meteoritic."

September 2, 1954; coastal waters off Ensenda, CA. A Honduran freighter reported a strange fireball that skipped over the surface of the water and vanished, leaving a trail of white smoke behind.

Several of the other fireball events reported by Gaddis are taken from sources quoted directly in this volume.

GLB-002 BALL LIGHTNING AS AN OPTICAL ILLUSION

Argyle, Edward; Nature, 230:179-180, March 19, 1971.

Compiler's Summary: Argyle first points out that two well-known students of ball lightning, Humphreys and Schonland, believed it to be only an optical illusion. The phenomenon of visual afterimages is next reviewed, emphasizing that any bright light, such as the terminus of any lightning flash can create an afterimage. This afterimage will seem to drift like ball lightning, as the observer tries to center the image in his eye. It will then disappear silently. Argyle notes that afterimages and ball lightning have the following common properties:

1. Same size and shape
2. Same colors
3. Same lifetimes (2-10 sec)
4. Same sort of motion
5. Frequent lack of physical damage
6. Sudden disappearance
7. Same ability to materialize from nowhere

The frequent reports of ball lightning detonations are probably due to the observer's imagination---just as auroral sounds are imaginary [?]. Odors are also imagined. In view of the fact that science seems completely at a loss to explain ball lightning using ordinary physical principles, Argyle thinks illusions the only admissible solutions. But, he admits, illusions may not be the complete answer because there are many reports of physical damage and other loose ends.

GLB-003 IS BALL LIGHTNING CAUSED BY ANTIMATTER METEORITES?

Ashby, E. T. F., and Whitehead, C.; Nature, 230:180-182, March 19, 1971.

The theory depends on the postulate that antimatter can be comparatively stable in the presence of ordinary matter. Annihilation of a speck of antimatter of 5 μm radius and 5 x 10^{-10} g would liberate 10^5 J: ionization produced in the surrounding air by this annihilation could be expected to have the optical proper-

ties attributed to ball lightning.

The authors next propose a mechanism by which the flux of antimatter meteorites arriving from outer space could be concentrated by terrestrial electrical storms.

> ..... The dust particles will tend to charge negatively due to the emission of positrons by photo-emission and by secondary emission caused by recoiling fragments. This negative charge will give them a tendency to descend in the vicinity of thunderstorms, which continually bring negative charge from the upper atmosphere down to ground level.....

An experiment set up to detect the annihilation radiation of antimatter in the atmosphere is described next. Four events, one correlated with a severe thunderstorm and three others after an exceptionally intense period of thunderstorm activity, were observed. No ball lightning was seen during the period, however. Ashby and Whitehead hope that their experiment will stimulate further research into the possibility of antimatter meteorites, although they admit their experiment does not prove that ball lightning and antimatter are really connected.

[The mechanism suggested above may have a bearing on tornado formation, auroral activity, mountain-top glows, and other supposedly electrical luminous phenomena.]

GLB-004 BALL LIGHTNING

Barry, J. Dale; Journal of Atmospheric and Terrestrial Physics, 29:1095-1101, 1967.

This is one of the more important modern surveys of ball lightning. First, Barry's conclusions are quoted.

> This survey indicates that a natural phenomenon described as ball lightning most certainly exists. It is associated with thunderstorms, earthquakes, cyclones and other natural atmospheric disturbances. The phenomenon is observed most often during thunderstorms and is generally considered to be the result of an electrical discharge or due to some electrically related formation mechanism.
>
> Ball lightning is most commonly observed as a ball shaped object with a burning appearance, and radial dimensions less than 40 cm. Although it appears similar to a burning globule, its surface is generally dimly illuminated with a lack of protruding flames. It is generally first observed in a slow descending motion, apparently from a thundercloud, but does not fall directly to the ground. It commonly assumes random motions a few decameters above the ground, or a slow horizontal flight.
>
> It appears to behave independently of external forces, as it is frequently observed to be unaffected by conductors. It does, however, seem to have an occasional affinity for enclosures. It can deviate from a straight path to enter a room through a doorway or a partially opened window.
>
> The ball lightning is sometimes accompanied by the presence of a sharp repugnant odor, such as that associated with an electrical discharge. The ball lightning has a short lifetime, usually only a few seconds. It can decay silently or explosively, although the latter decay mode is most frequent.
>
> Since the ball lightning is assumed to be a lightning form, it is considered to be dangerous to life, although this is not confirmed statistically. Its appearance suggests that caution and common sense would be wise during an observation. It

appears to be a potentially powerful phenomenon. The energy density of the natural ball lightning was calculated to be greater than 2.5 kJ/cm^3. [2,500 joules per cubic centimeter]

The conclusions presented by Barry and quoted above are widely accepted by scientists today. Barry, though, is perhaps more positive than most. His conclusions do not reflect some other properties of ball lightning mentioned in his paper:

1. A rare, rod-like type of ball lightning exists which is usually purple or violet.
2. Prior to explosive disappearance, the color of ball lightning sometimes changes from red, violet, or yellow to white.
3. One variety of ball lightning has a dull reflecting surface, 30–50 cm in diameter. Another kind rotates, apparently, and a third type has a burning appearance.
4. A hissing sound is heard on occasion.
5. A residue is found rarely after detonations.
6. About 10% of ball lightning has an affinity for enclosures, decaying explosively and usually with no physical damage.

GLB–005 SLOW LIGHTNING

Ley, Willy; On Earth and in the Sky, Ace Books, Inc., New York, 1957.

Compiler's Summary: Ley devotes Chapter 5 to ball lightning. He first mentions the critical features of ball lightning, noting that it is far more common in Europe than North America---the reverse of tornadoes. He dwells on Kapitsa's theory; namely, that ball lightning is an ionized zone of air fed energy by the electromagnetic waves associated with an electrical storm. Ley does not feel this theory is adequate.

Several interesting case histories are presented, from which the following have been selected:

1. July 5, 1852; Paris. Shortly following a strong thunderclap, a tailor sitting in his fourth-floor apartment saw a fireball the size of a human head emerge from a fireplace, as if driven by a gust of wind. The frame covering the fireplace during the summer was pushed aside. The ball was bright but no heat was evident. It moved toward the man's feet "like a cat." He pulled his feet back and the ball moved around into the center of the room. It suddenly rose, flew to the chimney, climbed slowly up, and detonated, destroying the top part of the chimney.
2. No date; East Prussia. Immediately after lightning struck a beer garden, the owner perceived a reddish, rotating ball, about 16 inches in diameter, appear at eye level. Rotating all the time, it passed by a number of people, followed along the electric bell wire, and finally moved along the wire to the stable where it exploded.
3. Day of the Pentecost, 1890; East Prussia. A man was driving down a road lined by wire fences. His carriage had four ironrimmed wheels and iron axles. There was no rain, but the sky was cloudy. Two head-sized balls appeared on the fences on both sides of the road, following the carriage along. When the carriage increased its speed, so did the balls. At the ends of the fences the balls collapsed with a noise like crumpling paper. [This may have been an electric discharge phenomenon rather than true ball lightning.]
4. April 29, 1925; Saxony. A barrel-like object fell from a cloud and broke into small strokes of lightning. One hit a nearby school. Meanwhile, the trees looked

as if they had candles at the tips of the twigs. The "bolt" that hit the school made neat, round entrance and exit holes in a teacher's room and threw him to the floor in the process. The rest of the lightning strokes damaged trees, telephone poles, and melted telephone wires. No one noticed any noise at all during the entire event.
5. 1925 or 1926; Pennsylvania. Following a severe thunderstorm, a camper saw a yellow-golden ball of fire the size of a basketball enter an open window and leave by the window opposite. There was no noise and no damage.
6. No date; British Columbia. In a jet fighter at 48,000 feet flying over the tops of spectacular cumulonimbus towers, the pilot and a friend saw and photographed a luminous object in a black thundercloud. The size was about that of the fighter. Although it appeared sharply defined to the viewers, the photos displayed fuzzy edges.

GLB-006 BALL LIGHTNING

Wood, R. W.; Nature, 126:723, November 8, 1930.

Summer of 1929; East Hampton, England, a large summer residence.

> The ball discharge appeared in the kitchen in the centre of the room (just over the furnace pipes), about three feet above the floor, and within three or four feet of the cook, who was standing up and facing the point at which it appeared. She told me that it appeared just after the thunder crash, was yellow like a flame, about five inches in diameter, and was spinning like a top. She was very positive about the whirling, and was looking down on the thing at very close range. I asked her whether it faded away or exploded. She said, "I didn't wait to see---I jumped for the cellar door and ran down the stairs!" There was no sound of an explosion. She also stated that the room was full of a smoky haze when she returned, and that there was a strong smell. I asked her whether it was 'like sulphur' (the popular description), and she said, "No, it was acid-like." This suggests an oxide of nitrogen. No marks of the flash could be found in the kitchen, but there had evidently been a heavy electrical disturbance below the floor. The cook was near enough to the ball to touch it, and it is regrettable that she neglected the opportunity of making a valuable contribution to our knowledge of this mysterious electrical phenomenon! I think that I should have reached for it, but am not sure.

GLB-007 BALL LIGHTNING

Russell, A.; Nature, 126:809, November 23, 1930.

> Prof. Wood [GLB–006] quotes an eye-witness who said that the flashes struck in the water, coming nearer and nearer like advancing shell-fire. This reminds me of a typical case published in the Phil. Trans. for 1781, p. 42. It is related how the tenant of a large three-story house facing the sea at Eastbourne was standing and looking through the window at an ominous black cloud. He saw several balls of fire drop successively out of the cloud into the sea. Suddenly he was thrown violently backwards by what he described as a flash of fire. Many people outside the house at that instant saw something which in

form and flame they all agreed was like an immense 'sky rocket' strike the house. The tenant's clothes were torn, and pieces of metal he had about him were melted. Every pane of glass in the room was completely smashed. On the ground floor the coachman and a footman were killed, and on the top floor a lady and her maid were rendered insensible. All the bell wires in the house were deflagrated.

I have an impression that globular lightning makes a slight noise as it drifts about. It has been compared to the purring of a cat.

GLB-008 WEIRD PHANTOMS OF THE AIR

Anonymous; Popular Mechanics, 48:979-982, December 1927.

This article presents a short summary of the characteristics of ball lightning and St. Elmo's fire. The only case history of interest follows:

> During the progress of the tornado that struck Louisville, Ky., in March, 1890, numerous balls of living fire, the size of oranges, added to the fright of the terror-stricken victims. In the darkness, all of the lights of the city having been put out, they rolled about the streets and along telephone wires and the cornices of buildings, and finally exploded with tremendous reports.

GLB-009 CURIOUS PHENOMENON IN VENEZUELA

Cowgill, Warner; Scientific American, 55:389, December 18, 1886.

During the night of the 24th of October last, which was rainy and tempestuous, a family of nine persons, sleeping in a hut a few leagues from Maracaibo, were awakened by a loud humming noise and a vivid, dazzling light, which brilliantly illuminated the interior of the house.

The occupants, completely terror stricken, and believing, as they relate, that the end of the world had come, threw themselves on their knees and commenced to pray, but their devotions were almost immediately interrupted by violent vomitings, and extensive swellings commenced to appear in the upper part of their bodies, this being particularly noticeable about the face and lips.

It is to be noted that the brilliant light was not accompanied by a sensation of heat, although there was a smoky appearance and a peculiar smell.

The next morning the swellings had subsided, leaving upon the face and body large black blotches. No special pain was felt until the ninth day, when the skin peeled off, and these blotches were transformed into virulent raw sores.

The hair of the head fell off upon the side which happened to be underneath when the phenomenon occurred, the same side of the body being, in all nine cases, the more seriously injured.

The remarkable part of the occurrence is that the house was uninjured, all doors and windows being closed at the time.

No trace of lightning could afterward be observed in any part of the building, and all the sufferers unite in saying that there was no detonation, but

only the loud humming already mentioned.

Another curious attendant circumstance is that the trees around the house showed no signs of injury until the ninth day, when they suddenly withered, almost simultaneously with the development of the sores upon the bodies of the occupants of the house.

This is perhaps a mere coincidence, but it is remarkable that the same lapse of time, should be observed in both animal and vegetable organisms.

I have visited the sufferers, who are now in one of the hospitals of this city; and although their appearance is truly horrible, yet it is hoped that in no case will the injuries prove fatal.

Cowgill was attached to the U. S. Consulate at Maracaibo at the time. This apparition has many attributes of ball lightning, but the physiological effects are unusual. It sounds almost as if radioactivity were involved.

GLB-010 ON THE PHENOMENA OF THE LIGHTNING DISCHARGE, AS ILLUSTRATED BY THE STRIKING OF A HOUSE IN COSSIPORE, CALCUTTA

McMillan, Walter G.; Nature, 40:295-296, July 25, 1889.

After a lengthy description of the path taken and damage done within the house by the lightning, the author added the following:

Mr. Viney happened to be facing in such a direction that he could watch the progress of the discharge. He describes the effect as that of an intensely brilliant ball of yellow fire, about 6 or 7 inches in diameter, which passed from one end of the room to the other at a pace just sufficiently slow to allow it to be readily followed by the eye; about half-way across, it appeared to be momentarily checked, and then, seeming to burst with a deafening report which shook the whole house, it scattered and passed onward.

About certain points he is absolutely certain: there was no premonitory warning, no sound of a brush discharge or odour of ozone, the first intimation being the entrance of the fire-ball itself. Again, the direction taken was from the staircase to the bell (that is, from cloud to earth), and the direction was uniform, and no second ball was seen to enter from the opposite side to meet the first and so produce the apparent explosion, nor after the concussion was there any other phenomenon than the passing on of the ball.

Again, it has long been known that the passage of high tension discharges through mixtures of oxygen and nitrogen induced combination of these elements: I therefore asked Mr. Viney as to the after appearances, and as to the presence of unusual coloured gases, or of a suffocating sensation. He at once said that the whole house seemed to be filled with an orange-coloured gas (mixed, of course, with clouds of dust), the breathing of which was perfectly stifling, and was equivalent to inhaling the fumes from burning sulphur. I have since asked him to report upon a sample of nitrogen tetroxide highly diluted with air: he declared that the gas in his house was of a brighter orange shade, and of a somewhat similar yet not identical odour; on presenting him, however, with a stronger mixture, he was quite confident that both in colour and in smell the two gases were identical.

GLB-011 GLOBULAR LIGHTNING

Hare, A. T.; Nature, 40:415, August 29, 1889.

On Monday, the 5th instant, at midday, this district was visited by a violent storm of rain, which lasted half an hour, and was accompanied by thunder and lightning. When the storm had passed over and the sky was getting bright, a rod-like object was seen to descend from the sky. It is described as being of a pale yellow colour, like hot iron, and apparently about 15 inches long by 5 inches across. These dimensions are given by an observer who estimated its distance (about correctly, as it subsequently appeared) at 100 yards, and are not therefore affected by the uncertainty attached to estimates of the sizes of objects whose distance is quite unknown. This object descended "moderately slowly," "not too fast to be followed by the eye" and quite vertically.

On reaching a point about 40 feet from the ground, and in close proximity with a chimney-stack belonging to a house in Twickenham Park, the object seemed to "flash out horizontally as if it burst," showing an intensely white light in the centre and a rosy red towards the outer parts. At the same instant a violent explosion was heard, and soon afterwards a strong smell was perceived, which is described by the observers as "resembling that of burning sulphur," for which the smell of ozone and nitric oxide might easily be mistaken.

. . . . . .

"The explosion filled the kitchen with smoke and soot. The dining-room also was filled with smoke and soot, though no fire was burning in it.

"The master of the house was just coming into the dining-room from the conservatory when he heard the detonation and simultaneously saw a bright flash of light. He staggered back a moment, and then ran through the smoke and soot to the hall, and called out to know if anyone was hurt. Finding all safe he returned into the dining-room. A Japanese umbrella set upon as an ornament in the empty grate, but not fixed in any way, was undisturbed, though the hub of it was hot to the touch. Piles of soot spread out in a semi-circle to the centres of the side walls of the room, and an arm-chair, which had been standing close to the fire-place, was 6 feet from its previous position, and had evidently been turned round and thrust against the wall. In the bed-room, on the first floor, soot was on the floor and in the fire-place. The slab of marble forming the architrave under the mantel shelf, and extending the whole width of the fire-place, had been thrust out from its setting, and was, with a number of bricks, lying 6 feet away on the floor."

Other minor damage is described in the remainder of the report.

GLB-012 ON THE FACTS OF EARTHQUAKE PHENOMENA

Mallet, Robert; Reports of the British Association, 143, 1853, and 134-135, 1854.

August 13, 1761; Geneva. A slight shock. Accompanied by a dull noise. A meteor of the form of an immense globe, which afterwards changed to a train of light and disappeared with an explosion, was observed at the same time. [Note that a "meteor" in 1761 meant any atmospheric phenomenon.]

November 22, 1821; Italy. A strong shock from E. to W., followed rather slowly by seven others. Accompanied by : A luminous meteor moving in the same direction as that taken by the shock was observed just before.

November 17, 1831; Sweden. A shock from S. to N. During a violent storm from the north. The shock was accompanied by a loud explosive noise, which was also heard in the villages Mornao and Zenger, and at Fahlun. An extraordinary light appeared in the northern horizon.

November 19, 1831; Thuringerwald. A severe vibratory shock. Accompanied by a very loud rolling noise passing from S. to N., and lasting five or six seconds. On the day of the earthquake, before and after the shocks, and on the day before, a calm prevailed, but the preceding days had been stormy. The Werra was unusually high. According to some accounts, a fireball, apparently as large as the moon, was seen passing towards the west.

GLB-013 THEORIES OF BALL LIGHTNING

Anonymous; Scientific American Supplement, 68:376-377, December 11, 1909.

Seneca, in ancient times, asserted that the luminous bodies of ball lightning contain compressed air. Faraday denied the existence of ball lightning, and many other physicists have regarded most of the observed phenomena as subjective, and due to the effect of the intense light of lightning upon the retina.

Two classes of theories, chemical and physical, have been advanced to explain ball lightning. The chemical theories are the older. Muschenbrock, in 1769, regarded ball lightning as an agglomeration of inflammable substances which, after rising from the earth as vapors, condense in the upper atmosphere, and in some way become ignited as they fall. In 1886 Pfeil attempted to revive this theory, and asserted that ball lightning has very little connection with ordinary lightning. Arago conjectured that globe lightning is an agglomeration of ponderable matter strongly impregnated with the matter of lightning. Besnon, in 1852, attributed ball lightning to an accumulation of nitrogen iodide. According to De la Rive and Hildenbrandsson, ball lightning consists of mixed hydrogen and oxygen produced by the electrolysis of water. This theory accounts for the explosion which often terminates the phenomenon. Raasche regards ball lightning as an incandescent mass of gas evolved by electric discharge.

The researches of Tait, Cecil, Calland, Faye, and others have led to the enunciation of several physical theories of ball lightning. Suchsland, for example, regards a thunder cloud as an electric battery of an immense number of cells, each composed of a drop of rain and the oxygen and nitrogen of the atmosphere, and asserts that ball lightning consists of detached cells of this character. Other physical theories have been founded on attempts to reproduce the phenomena of ball lightning in the laboratory. The most important of these experiments were made by Plante and have been repeated and extended by other physicists, including Toepler, who made a systematic study of electric discharges in free air and discovered a form intermediate between the ordinary brush discharge and the voltaic arc, to which he gave the name of brush arc. On these experiments Toepler based a theory, already vaguely foreshadowed by Du Moncel and Plante,

which regards globe lightning as a variety of brush discharge. Although Toepler's theory leaves numerous phenomena unexplained, it appears to contain the germ of the complete explanation of globe lightning. Prof. Trowbridge in this country has also experimentally studied the subject, and the results of his researches have been published in these columns.

GLB-014 NATURE OF BALL LIGHTNING

Wolf, Karl; Scientific American Supplement, 80:54-55, July 24, 1915.

In the choice of its path ball lightning behaves in a very contradictory manner, sometimes performing the most incomprehensible turns and jumps. In one case it will slavishly obey a metallic conductor, such as a lightning rod, wandering slowly along it; in another with objects and rebound, and bounce up and down as if made of rubber. It penetrates obstacles and comes out on the other side; squeezes through chinks and keyholes and reappears, apparently unaffected by the process; it goes up or down chimneys; it floats lightly in the air like a toy balloon; it advances against the wind, or again obeys the least gust of the latter. It passes through tiles or bricks, leaving a hole behind it; moves through several rooms of a house; in short, its movements seem to be altogether eccentric and unaccountable. It moves cautiously, like a cat, among human beings, and likes to linger on points, corners, and angles. At times it halts in its course, or moves backward; accelerates or retards its speed.

In some cases the ball of lightning disappears quietly, while in others it explodes with a terrific noise, shooting fiery sheafs like the rays from a skyrocket in all directions. Again, the ball may resolve itself into a string of bead-like sparks. Ball lightning is rarely destructive or harmful to neighboring objects. No sensible radiation of heat from it has been reported. If these wandering balls come in contact with the human body, however, they may produce wounds and cramp-like sensations at the points of contact. A smell of sulphur is often reported and is sometimes said to be stifling in intensity. This may probably be ascribed to ozonized air.

It may be regarded as certain that ball lightning is the result of strong electrical discharges, and it must, therefore, consist of electrons, which would manifest themselves by their ability to fuse a conductor carrying an electrical current. If, however, the so-called ball is filled with electrons the latter must be in rotation; otherwise their collisions would soon break up the ball. The shape of the phenomenon cannot be really globular, notwithstanding the fact that many persons---whose surprise or terror impaired the accuracy of their observations---have so described it. Assuming a rotation of the electrons along their individual paths, the spherical shape would be quickly deformed, and if we assume a rotation in one direction around one and the same axis, the shape would become that of a vortex filament.

GLB-015 A REPORT ON BALL LIGHTNING

Anderson, F.J.; Journal of Geophysical Research, 77:3928-3930, July 20, 1972.

Compiler's Summary: Lightning hit a home in Minneapolis in August 1971, leaving a path of burned grass across the lawn after first striking a large red oak. It entered the house through a yard light. No one saw the ball, leaving some doubt that this was actually ball lightning, but neighbors observed a red-orange glow in the vicinity of the oak tree that persisted for 2-3 sec. An estimate of the energy required to create the burned path through the wet grass was made by applying a heater to duplicate the burning effects.

> .....Since the path showed no indication that the ball was weakening along it, the energy density in the ball would have to be considerably greater than 9×10^8 joules/560 cm^3 = 1.6×10^3 joules/cm^3.
>
> .....Our determined energy of 1×10^3 joules/cm^3 is much greater than that of a ball of ionized nitrogen gas. We cannot offer an explanation for such a large energy density.

GLB-016 BALL LIGHTNING

Jensen, J.C.; Scientific Monthly, 37:190-192, August 1933.

The report below describes observations made by a team of scientists on the evening of August 30, 1930 in Nebraska. The group was busy making measurements and photographs in connection with an approaching line squall.

> The cold air rushing ahead of the nimbus cloud was filled with a swirling mass of dust, but nevertheless brilliant flashes were seen descending in rapid succession from the cloud to the earth when the first films were exposed at 9:40 P.M. In the wake of one of these flashes there appeared a shapeless mass of lavender color which seemed to float slowly downwards. The writer was so occupied with the details of the photographic routine, which required the operation of shutters, the use of a stopwatch for timing the lightning-thunder interval, entering data in the notebook and telephoning to the assistant who had charge of the electrical recording apparatus in the laboratory, that there was little opportunity for close observation of this beautiful but unexpected display. The rose-colored mass seemed most brilliant near the ground and gave the impression of a gigantic pyrotechnic exhibition. Two or three of the globular structures seemed to roll along a pair of 2,300 volt power lines for 100 feet or more, then bounce down on the ground and disappear with a loud report.

Jensen also adds the following observation:

> A tornado which occurred on the evening of July 9, 1932, near Rock Rapids, Iowa, gave evidence of a closely related type of luminous display according to the report of Mr. George Raveling, U.S. Weather Bureau observer. From the sides of the boiling dust laden cloud a fiery stream poured like water through a sieve, breaking into spheres of irregular shape as they descended. No streak lightning of the usual type was observed and no noise attended the fire-balls other than the usual roar of the storm.

GLB-017 GLOBULAR LIGHTNING

Hill, E.; Nature, 56:293, July 29, 1897.

During the thunderstorm of July 20, with which the drought broke up, an elderly man, Thomas Smith, residing in this parish about half a mile from the railway station, was watching the lightning from his cottage door, between 5 and 6 p.m., when he noticed a white ball, "about the size of an egg," dancing about in the air "like rooks when at play." He watched it through the intervals between two or three lightning flashes, therefore during several seconds. After some interval (perhaps a few minutes), he still standing at the door, his wife just coming down the stairs to him, something seemed to pass between them which felt hot to their faces. Simultaneously Miss Downes, schoolmistress, sitting on the landing above the stairs, felt something hot pass her hair behind, and then in a small bedroom, with open door adjoining, a loud detonation took place; whitewash from the ceiling covered bed and floor, the wall-paper was torn, the plaster fissured, and the house filled with a "sulphurous" smell.

There is a draught up the stairs, but no apparent reason why what it brought should enter the little bedroom. The cottage stands alone, on high ground, but not the highest, and there is nothing exceptional in its construction or its surroundings.

GLB-018 MYSTERIOUS BURNINGS

Fuller, Curtis; Fate, 13:18, November 1960.

Mrs. Matthews was lying on her living room sofa recently when she looked up and saw a huge red ball of fire come through the closed living room window and through the Venetian blind without harming either.

Her first thought was that the atomic bomb had fallen. She buried her face in the sofa and said: "Oh! Lord, not like this!"

The ball of fire continued through the living room, passed into the dining room and went out the closed dining room window, making a sizzling noise as it moved through the house.

Mrs. Matthews telephoned her husband who came home from work, took one look at her and began to cry because of Mrs. Matthews' proof. Earlier that day, Mrs. Matthews had a full head of hair. As the ball of fire passed she had felt a tingling sensation in the back of her head and put her hand up.

The back of her hand was burned; and all the hair fell out of the back of her head, leaving it hard and as clean as her face.

There were burned places on her scalp.

GLB-019 BALL LIGHTNING

Powell, James R., and Finkelstein, David; American Scientist, 58:262–279, May–June 1970.

Compiler's Summary: The usual properties of ball lightning are reviewed first. Three of the case histories presented are interesting enough to give here in capsule form.

1. July 27, 1952; Hamburg, Germany. Several seconds after a lightning stroke in the neighborhood, several witnesses observed a bright, gleaming ball the size of

a fist moving downward in short, snake-like movements. The ball was initially seen outside the window. It then penetrated the glass window, without damaging it, and entered the room. After moving a meter into the room it executed a 90° turn, moved another meter, and exploded. The ball was purplish with a reddish cast and lasted about 3 seconds. After the detonation, an odor typical of electrical discharges was noted.
2. Ball lightning emerged into a room through the openings in a wooden screen. It moved across the room, exited through a pane of glass, melting an almost perfect circular hole 28-cm in diameter. It detonated outside. The ball was bluish-white, had a fuzzy outline, and seemed to possess internal motion.
3. 1753; St. Petersburg, Russia. G. W. Richman was an early experimenter with lightning, like Ben Franklin. His apparatus consisted of an ungrounded lightning rod leading into his laboratory electrometer. I. Sokolov was present in the laboratory with Richman when a thunderstorm approached. Sokolov saw a pale blue fist-sized ball leave the rod and float silently through the air to Richman's face. It detonated, and Sokolov lost then consciousness. He awoke to the smell of acrid smoke. Richman was dead, with a red spot on his forehead and two holes in one of his shoes. The detonation of the ball lightning was detected several houses away by an instrument measuring atmospheric electric force.

The authors also review the many theories that have been proposed to explain ball lightning, eliminating all but those involving radio-frequency generated luminosities. Electroluminescence occurs in lightning channels, and Powell and Finkelstein feel that the power available in the lightning stroke could easily create detached spheres of glowing air.

GLB-020 FIREBALL CUTS OFF 2500 TV SETS

Gordon, A. H.; Weather, 25:85, 1970.

Scores of people in Sidmouth reported seeing "a red ball of fire" in the sky above the town during a violent thunderstorm at 6.30 on Tuesday morning (12 August).

It made crackling noises for a few seconds and then suddenly exploded with a deafening report, sending jagged flashes of lightning towards the ground.

At the same time, the Viewline network of cables, which brings television signals down into the town from aerials mounted in the hills, was seriously damaged. Nearly 300 residents all over Sidmouth were burnt out by the lightning, and 2500 television sets became cut off from the network.

GLB-021 BALL LIGHTNING IN A CLOUD

Anonymous; American Meteorological Society, Bulletin, 23:88, February 1942.

In a recent issue of Life the following appears in an account of "I bomb Britain", in an October flight. "... At length we got out of the ice zone but only to run into a washtub of clouds over the Channel. We had hardly been

swallowed up in this soup, when a terrific blow ripped my crate on one side. A moment later flowing white snakes shot past the fuselage of our plane, one following another in a gruesome chase of white, blue, bluish-green flashes. Everything was dipped in this devilish green color never seen before on any painting. Every second new bluish-green balls of fire came racing head on. Instantly they grew to the size of apples, then burst. The whirling propellers stood like some futuristic circular shadows in this glare of light. The air was putrid with the stink of sulphur. Instruments no longer functioned."

GLB-022 BALL LIGHTNING

Lewis, Harold W.; Scientific American, 208:106-108+, March 1963.

Compiler's Summary: Lewis presents a general summary of the characteristics of ball lightning and the hypotheses advanced to explain it. Kapitza's theory is given particular prominence. Lewis, like many other investigators, finds that no single theory explains all the features of ball lightning. No case histories are presented that have not already been acquired elsewhere for this sourcebook.

GLB-023 SOME COMMENTS ON BALL LIGHTNING

Uman, M. A.; Journal of Atmospheric and Terrestrial Physics, 30:1245-1246, June 1968.

What follows is an exact transcription of a letter received from the pilot of a KC-97 USAF tanker aircraft.

"Dear Sirs:

Was reading an account in June 16 Nashville Tennessean re Kugelblitz studies.

I had an interesting experience in 1960 which I will describe to you on the premise that it may be of some interest to you.

I was at the controls of a KC-97 USAF tanker aircraft, heavily loaded with JP-4 fuel for offload to B-47 bombers. En route to the refueling rendezvous (Elko, Nevada vicinity) we were in the clouds at 18,000'. There was light precipitation, temp. was above freezing and there was no turbulence.

I recall that St. Elmo's fire was dancing around the edges of the aircraft front windows. (This is a not too uncommon occurrence but may have some significance to you.) The crew was experienced in all phases of all-weather operation and not concerned or apprehensive about any portion of the mission to be accomplished.

As I was concentrating on the instruments on the panel (no outside visual references were visible) a ball of yellow-white color approximately 18" in diameter emerged through the windshield center panels and passed at a rate about that of a fast run between my left seat and the co-pilot's right seat, down the cabin passageway past the Navigator and Engineer. I had been struck by lightning 2 times through the years in previous flights and recall waiting for the explosion of the ball of light! I was unable to turn around and watch

the progress of the ball as it proceeded to the rear of the Aircraft, as I was expecting the explosion with a full load of JP-4 fuel aboard and concentrated on flying the aircraft. After approximately 3 seconds of amazingly quiet reaction by the 4 crew members in the flight compartment, the Boom operator sitting in the rear of the aircraft called on the interphone in an excited voice describing a ball of fire that came rolling through the aft cargo compartment abeam the wings, then danced out over the right wing and rolling off into the night and clouds! No noise accompanied the arrival or departure of the phenomenon."

This and several other reports of ball lightning appearing inside enclosures may indicate that ball lightning may be induced by electrical forces.

GLB—024 BALL LIGHTNING AT SALINA, KANS.

Anonymous; Monthly Weather Review, 47·728, October 1919.

At about 6.30 p.m., October 8, 1919, a brilliant display of ball lightning occurred at Salina, Kans., on one of the most frequented street intersections of the town. Eyewitnesses described it as "a ball of fire as large as a washtub floating low in the air." It struck the northwest corner of the Campbell Building, corner Santa Fe and Iron Avenue, about midway to the top of the building, which is 35 feet high, tore out some brick, demolished a second-story window, and then exploded with a bang that resembled the noise made by the discharge of a large pistol, filling the air with balls of fire as large as baseballs, which floated away in all directions. Some of these balls followed trolley and electric-light wires in a snaky sort of manner and some simply floated off through the air independently of any objects near by. An electric switch box across the street was ripped open and a transformer destroyed, leaving the east side of the town in darkness.

The explosion of this large ball of fire into several smaller balls is an intriguing feature. See also GLB-005, GLB-016, and GLB-020.

GLB-025 LABORATORY BALL LIGHTNING

Barry, J. Dale; Journal of Atmospheric and Terrestrial Physics, 30:313-317, February 1968.

Abstract---A mechanism for the formation of ball lightning is discussed. It is suggested that the presence of a low density of simple hydrocarbons in the atmosphere, coupled with an atmospheric electrical discharge, may be sufficient to form the phenomenon. A simple calculation establishes a theoretical diameter of approximately 6-130 cm. A laboratory experiment is described in which a ball of fire was formed. The phenomenon appeared to possess many properties of natural ball lightning, including existence for a finite time without an external energy source.

GLB-026 BALL LIGHTNING AS A PHYSICAL PHENOMENON

Hill, E. L.; Journal of Geophysical Research, 65:1947-1952, July 1960.

Abstract. Ball lightning has not been produced in the laboratory as yet, but its existence as a real natural phenomenon seems to be assured. The evidence concerning its physical nature is reviewed in the light of known information on atmospheric electricity and the lightning discharge. It is concluded that it is unlikely that ball lightning is a plasma phenomenon, as it is frequently assumed to be. More probably it is a region containing a strongly inhomogeneous distribution of space charge in the form of highly ionized gas, the ionization being primarily in the molecular form, with few free electrons. Occluded material such as dust, water vapor, and combustible gases may play a significant role in its behavior.

GLB-027 A TRULY REMARKABLE FLY

Mohr, Frederick B.; Science, 151:634, February 11, 1966. (Copyright 1966 by the American Association for the Advancement of Science.)

Coincidences associated with so rare a phenomenon as ball lightning tend to be interesting but not significant. A case which has recently come to my attention would seem to follow that rule.

On 25 August 1965, I was editing an article entitled "Soviet research on ball lightning" prepared by Arsen Iwanovsky of this division for publication in the September issue of the Foreign Science Bulletin. We discussed at some length the unusual behavior of ball lightning and the fact that the very few eyewitness reports available contained conflicting statements.

On the same day my uncle and aunt, Mr. and Mrs. Robert B. Greenlee, were relaxing on their fiberglass-screened, roofed patio in Dunnellon, Florida. The temperature was in the 90's, the sky was overcast, and there was a slight drizzle; the Greenlees had heard thunder some distance to the west of their immediate vicinity. Mrs. Greenlee and a neighbor, Mrs. Riggs, were seated a few feet apart in aluminum chairs, and Mr. Greenlee was standing about three feet from Mrs. Greenlee. Mrs. Greenlee had just swatted a fly when a ball of lightning the size of a basketball appeared immediately in front of her. The ball was later described as being of a color and brightness comparable to the flash seen in arc welding, with a fuzzy appearance around the edges. Mrs. Riggs did not see the ball itself, but saw the fly-swatter "edged in fire" dropping on the floor. The movement of the ball to the floor was accompanied by a report "like a shotgun blast." The entire incident was over in seconds.

None of the witnesses felt any heat from the ball, and Mrs. Greenlee showed no signs of external injuries, although she complained of pain in the back of her neck and has had occasional headaches since. The explosion was heard by a neighbor about 150 feet away, and it was subsequently learned that another neighbor's electric range had been shorted out at the same time. There was no damage of any sort at the Greenlees, nor were there any marks on the patio floor where the flyswatter had fallen.

With regard to the fly, Mrs. Riggs commented, "You sure got him that time."

The neck pains and headaches suffered by Mrs. Greenlee may be related to the physiological effects of the Venezuela case (GLB-009). Also, electrical effects far from the ball itself are rather common. (GLB-019)

GLB-028 BALL LIGHTNING

Felsher, Murray; Nature, 227:982, August 29, 1970.

On May 15, 1970, at a point some 80 to 150 km east of St. Louis, an aircraft in which I was a passenger was forced to fly into and through a thick dark storm-cloud mass. Extreme turbulence resulted in a rather violent movement of the wings of the aircraft (a Boeing 727). All this time the aircraft was descending, and an electrical display was lighting the surrounding clouds in a diffuse glow. The frequency of electrical discharges (no actual strokes were seen) increased with the increasing turbulence. At (what seemed) the moment of maximum turbulence and electric discharge, while the aircraft was still descending through the storm, a sequence of events took place that I list below. The whole took not more than 5 s, and I must admit that the order, save for numbers 4 and 6, is not necessarily chronological. 1, The turbulence ceased altogether. 2, The surrounding electrical discharges (glows) ceased altogether. 3, The wing stopped buckling altogether. 4, A white glowing sphere (ball lightning?) appeared on the port wing tip. I do not know if it was actually touching the wing. Its diameter was less than 1 m and more than 10 cm. Its boundary was "fuzzy" and not distinct. 5, There was a soft "pop." 6, The ball lightning (?) vanished.

Regarding the accompanying noise (5) I recorded it at the time. Shortly afterwards my scientific upbringing and I both decided that an outside noise was not likely to be heard within a moving jet aircraft, and that my eye, seeing the ball go, insisted to my ear that it should do so accompanied by a noise. Nonetheless, I record it now, as I recorded it then.

The appearance of ball lightning during a calm interlude has been reported from ships at sea. See GLB-056 and GLB-063.

GLB-029 BALL LIGHTNING

Bromley, K. A.; Nature, 226:253, April 18, 1970.

A similar incident occurred in the Meteorological Office, Boscombe Down, Wiltshire, in the northern summer of 1938. There was a vivid flash with simultaneous thunder. It was assumed that the Dines pressure-tube anemometer, which passed through the roof and was supported by four heavy steel supports embedded in the floor, was struck.

Immediately after the lightning flash, a brilliant white sphere, with a diameter of about 20 cm and diffuse edges, was observed hovering near the anemometer supports. The diameter, symmetry and absence of structure agree with Jennison's description. (GLB-030) No heat radiation was noted. The motion differed from Jennison's case. The object followed an irregular course; it travelled from one anemometer leg to the other, and then from the anemometer to a radio receiver/transmitter which was being operated at the time. The distance from the anemometer to the radio set would be about 2 m, and the height above the floor about 1.5 m. The object disappeared as it reached the radio set, perhaps 3–5 s after its appearance.

GLB-030 BALL LIGHTNING

Jennison, R. C. ; Nature, 224:895, November 29, 1969.

I was seated near the front of the passenger cabin of an all-metal airliner (Eastern Airlines Flight EA 539) on a late night flight from New York to Washington. The aircraft encountered an electrical storm during which it was enveloped in a sudden bright and loud electrical discharge (0005 h EST, March 19, 1963). Some seconds after this a glowing sphere a little more than 20 cm in diameter emerged from the pilot's cabin and passed down the aisle of the aircraft approximately 50 cm from me, maintaining the same height and course for the whole distance over which it could be observed.

The observation was remarkable for the following reasons. (i) The appearance of the phenomenon in an almost totally screened environment; (ii) the relative velocity of the ball to that of the containing aircraft was 1.5 ± 0.5 m s^{-1}, typical of most ground observations; (iii) the object seemed perfectly symmetrical in all three dimensions and had no polar or torroidal structure; (iv)it was slightly limb darkened having an almost solid appearance and indicating that it was optically thick; (v) the object did not seem to radiate heat; (vi) the optical output could be assessed as approximately 5 to 10 W and its colour was blue-white; (vii) the diameter was 22 ± 2 cm, assessed by eye relative to the surroundings; (viii) the height above the floor was approximately 75 cm; (ix) the course was straight down the whole central aisle of the aircraft; (x) the object seemed to be in perfect equilibrium; (xi) the symmetry of the object was such that it was not possible to assess whether or not it was spinning.

It is not easy to reconcile the symmetry of the ball and the lack of radiant heat with many of the theories that have been proposed for ball lightning, though these aspects of the observations are consistent with many other cases reported by Singer.

GLB-031 BALL LIGHTNING

Covington, Arthur E. ; Nature, 226:252-253, April 18, 1970.

Jennison's report [GLB-030] of ball lightning inside an airliner reminds me of an observation of my own. It took place on a summer evening in either 1928 or 1929 during a severe electrical storm in the Kootenay Lake Valley 10 miles from Nelson, B. C. The event, in two parts, was seen by a group watching from a sheltered porch and a second (of which I was a member) inside a wooden cottage in a forested area by the lakeside.

Some distance from the shore the first group saw a ball of light drop from the clouds towards our side of the lake. It did not strike the mountainside but came to a stop, floating above the forest. The main road and electrical transmission line along the lakeside were here built parallel to but away from the shore, and led down into a smaller open valley stretching from the lakeside into the mountainside. The ball continued downwards, drifting above the road and the transmission line until it reached the bottom of the valley. Here it drifted to the lake shore and struck one of the piles of a small wharf jutting into the lake. It shattered the pile into long splinters and produced a large detonation.

The indoor group had not been watching the storm. While listening in the living-room to the thunder, we saw a ball of light, similar to Jennison's,

emerge from the fireplace and slowly drift across the room. It appeared to pass through a curtained, closed door without making any noise above the rumble of the storm or causing any damage. A loud detonation was heard a few moments after the ball vanished.

We did not know about the first ball until the next morning. At one time the neighbour who had seen it was concerned that it might strike our cottage, but it had carried on to the pile some 200 or 300 feet away. I infer that the first ball, clearly of high energy, induced in some way the formation of the second, low energy ball that emerged from our fireplace.

Jennison's description corresponds to my memory of the indoor ball. It is remarkable that the different surroundings should produce or be accompanied by similar balls: one inside a metal aircraft moving within an electrically disturbed cloud, and the other inside a wooden cottage with a high energy ball moving overhead.

GLB-032 METEOR

Fortescue, C.; Nature, 28:541, October 4, 1883.

It may interest some of your readers to know that a meteor was seen here this evening during a thunderstorm, and immediately after a flash of lightning. It appeared about the size of an ordinary cricket ball, and was of a brilliant yellow colour, and moved very slowly in an upward northerly direction from about east-south-east. As it moved along, it gradually decreased to the size of an ordinary star, and was then lost to my view. The storm began about 7 o'clock, and lasted about half an hour, during which time the lightning was very vivid. A very thick fog (that arose suddenly) preceded the storm, but disappeared before its commencement. The weather during the day had been close, with heavy showers at intervals. (Date: September 20th)

The "meteor" described above was more likely ball lightning.

GLB-033 IS BALL LIGHTNING A NUCLEAR PHENOMENON?

Altschuler, M. D., et al; Nature, 228:545-547, November 7, 1970.

Compiler's Summary: The authors are most concerned with the energy contained in the lightning ball. They refer to a case where red ball lightning, about 60 cm in diameter, dug a trench 100 m long and 1.2 m deep in soft soil and then tore 25 m of a stream bank away. This, they conclude, required at least 10^7 joules of energy, or an energy density exceeding 10^8 joules/m^3. Because of this high density, they postulate a nuclear energy source, originating perhaps when protons are accelerated down a lightning channel and create radioisotopes in the air. The disintegration of these radioisotopes then liberate the energy needed by the ball lightning. They note that the biological effects of such a radiation source could be severe.

According to the nuclear hypothesis, an observer standing within 2 m of high energy ball lightning (10^7 J) for a few seconds might receive a radiation dosage of a few hundred rad, enough to cause radiation sickness or death. Most ball lightning, however, is probably 10 to 100 times less energetic, so that the

radiation dosage would not cause biological effects.

Such radiation might explain the physiological effects noted in GLB-009 and GLB-027. The authors, however, admit many problems exist with the nuclear hypothesis, such as the difficulty of localizing the radioactivity within a ball. The nuclear theory is similar to the antimatter theory mentioned in GLB-003.

GLB-034 THE UNSOLVED PROBLEM OF BALL LIGHTNING

Singer, Stanley; Nature, 198:745-747, May 25, 1963.

Compiler's Summary: Singer reviews ball lightning's well-known properties and the theories proposed to explain them. His summary is succinct and comprehensive. After examining the electromagnetic, chemical, and nuclear energy theories, he concludes that none is adequate.

GLB-035 [FIREBALL RISES OUT OF SEA]

Anonymous; Nature, 37:187, December 22, 1887.

From the Pilot Chart of the North Atlantic Ocean for December 1887.

> .....One of the rare and inexplicable cases of globular lightning. On November 12, at midnight, near Cape Race, a large ball of fire seemed to rise out of the sea to a height of about 50 feet, coming against the wind close up to the ship, and then running away to the south-east, lasting altogether about five minutes.

This phenomenon hardly seems ball lightning; its lifetime is too long and it moves against the wind. It has more in common with modern UFO reports.

GLB-036 THE BALL LIGHTNING CONTROVERSY

Anonymous; Chemistry, 44·22-23, June 1971.

This article reviews the recent literature on the subject and summarizes the main properties of ball lightning. No case histories of significance.

GLB-037 A FIREBALL

Minchin, George M.; Scientific American, 73:374, 1895.

> A recent number of Nature gives the following:
> I place on record an instance of damage done by a fire ball or globular lightning. About five weeks ago, when I was in Londonderry, the circumstances were related to me by Mr. James Harvey, of Northland Road in

that city. Mr. Harvey was staying during the month of August at Culdaff, on the north coast of Donegal; and on the 24th of that month at about 4 p. m., a little boy named Robert Alcorn, whose parents occupied a house near Mr. Harvey's, was desired by his father to go into the yard and drive away some fowls from the door. On going out of the house, the boy saw a large bright object in the sky about the size of the table in his bedroom (I give his own account, leaving out necessary considerations of distances, etc.), or apparently about six square feet in area. The object came toward his house from the west or northwest; and when it came close, it partly burst with a report like that of a gun. He put his hands over his face to shield himself from "the spark," and after the explosion the bulk of the ball appeared to continue its course toward the east, low down. When it burst, however, it struck him, shattering the thumb and the first and second fingers of the left hand, cutting, scratching and blackening the right hand and left cheek, and shattering into fragments several bone buttons on his coat. Very soon afterward, Dr. R. Young, of Culdaff, and Dr. Newell, of Moville, attended the boy, and amputated the fingers and a portion of the thumb.

No one near the place saw the ball (except the boy, of course), but the parents and several others heard the report, and the boy's father rushed out immediately and caught his son as he was falling. Mr. Harvey soon afterward examined the place, and could find no further trace of the fire ball, except that a piece of bark had been knocked off a small tree within a few feet of the place where the boy was struck. The local police made exhaustive inquiry as regards the possibility of any one's having fired a gun at the boy, or of his having had any explosive in his possession; but nothing of the kind transpired.

It is well to add that at Redcastle (about eight miles away), one of the residents saw, on the same day, a bright object in the sky, which object he took to be a fire ball. The day was stormy, with heavy showers, but no thunder.

GLB-038 THE ELECTRIC PHENOMENA OF THUNDERSTORMS

Gold, E.; Nature, 169:561-563, April 5, 1952.

Mr. J. Durward, deputy director, Meteorological Office, contributed two observations of unusual phenomena. In the summer of 1934 he was motoring along the south bank of Loch Tummel. It began to rain heavily, with slight or moderate thunder and lightning. His son, a boy of twelve, was opening the iron gates, spaced at regular intervals on this road, and found one difficult to open. Mr. Durward, while walking the short distance from the motor-car to the gate to assist his son, saw among the pine trees on his left what looked like a ball of fire about 12 in. in diameter moving towards them. It struck the iron gate-post farthest from the latch. There was no noise, but the boy, who had his hand on the latch gave a yell; for the next few hours he was unable to lower his arm. The second incident was in the late summer of 1938 en route for Iraq in a B. O. A. C. flying-boat. Just after passing the Toulouse gap, in dense nimbostratus cloud at a height of 8,500 ft., what appeared to be a ball of fire entered the rear cabin and burst with a loud explosion. The captain of the aircraft told Mr. Durward about one or two minutes after the explosion that he had had the cockpit window open, for visibility, that the ball of fire entered by the

open window, burned off his eyebrows, some of his hair, a hole in his safety belt and dispatch case. From the cockpit the ball passed through the dispatch clerk's 'office' and the forward passenger cabin without harming anybody or anything---only in the rear cabin was there an explosion.

The same two case histories are summarized in: Anonymous; Ball Lightning is Real, Science Digest, 32:80, July 1952.

GLB-039 BALL LIGHTNING DUE TO LEAK IN STROKE AT JOINT

Anonymous; Science News Letter, 85:392, June 20, 1964.

Dr. Bruce believes that when a flash of lightning sharply changes its direction, the hole in the magnetic field that could be formed at such a bend allows the escape of an electrically charged jet of hot gas under high pressure. Since the escaping and expanding gas is flowing across a magnetic field, it would be rolled into a ball.

GLB-040 NEW THEORETICAL MODEL FOR BALL LIGHTNING

Anonymous; Science News Letter, 86:199, September 26, 1964.

Ball lightning is the result of a concentration around a conductor of the high electrical fields found during a thunderstorm, Dr. David Finkelstein of Yeshiva University, New York, and graduate student, Julio Rubinstein, believe.

The electrical conductor can be air that has previously been ionized, or stripped of electrons, by ordinary lightning, or it can be a pointed object such as a lightning rod. The so-called St. Elmo's fire may be a form of ball lightning.

GLB-041 BALL LIGHTNING

Anonymous; Nature, 15:539, April 19, 1877

A very fine display of this interesting meteor was witnessed at Vence, in the south-east of France, on the night of March 21-22, by M. Ed. Blanc, of which an interesting detailed account has just appeared in the Comptes Rendus of the French Academy, p. 666. Toward midnight there was observed, about eleven miles north-east of Vence, a large black thundery cloud, in a state of extreme agitation, and continually raising and lowering its position. At the upper part of this cloud three or four balls of fire issued every two minutes, as if from the invisible centre of the cloud, diverging in all directions, and after running a course of from six to eight degrees, broke silently with effulgent brightness. Their apparent diameter, as seen at a distance of eleven miles, was about a degree. They were mostly of a reddish colour, a few, however, being of a yellowish tinge, but all of them assumed a white

colour in the act of bursting. Their course, which was horizontal and parallel to the plane of the cloud, was relatively slow, not exceeding two degrees per second, and they bore a strong resemblance to immense soap-bubbles, both as regards apparent lightness and general appearance. From time to time a discharge of lightning passed through the cloud from above downwards, followed some seconds after by a dull rumbling sound. The cloud, with its fine display of fire-balls, took a course from east to west, passing about a league to the north of Vence. The glimmering of the lightning with its low dull thunderous sound continued for more than an hour, after which the sky became darker and darker; rain mixed with hailstones fell, and lightning, accompanied with thunder, furrowed the sky in all directions.

GLB-042 GLOBULAR LIGHTNING DISCHARGE

Chattock, A. P.; Nature, 109:106-107, January 26, 1922.

The two ladies were sitting at table about 8 p.m., with the window open. It was raining heavily at the time, and there was no wind. Stormy clouds were about, but it was not unusually hot. Thunder and lightning at the same time were afterwards reported from London---a distance of, say, 50 miles---but there was no thunderstorm at Eastbourne. There had been no rain during the few preceding days. As one of the ladies took up a knife to cut bread the ball of light was seen to flash past the knife (without touching it) on to the table, travelling a distance of about 9 in. at an average height of about 3 in. from the table, but moving towards the latter.

When the ball touched the tablecloth it "went out with a spitting sound," leaving no mark or trace of any sort. Until it touched the cloth there was no sound, and the whole thing was over in such a "flash of time" that it was impossible to say how fast the ball travelled. There seems to have been an impression that the ball came from the direction of the open window, but it was only under dependable observation during its 9-in. path from the bread-knife to the tablecloth.

As to the appearance of the ball itself, it was "about the size of a pea, the light encircling it being about the size of a golf ball. The light was white and intensely bright, like electricity." "Too dazzling to see through."

GLB–043 THE LATEST CONCEPTION OF "BALL LIGHTNING"

Anonymous; Current Literature, 51:389, October 1911.

This is a review of an article in the Philosophical Magazine, by W. M. Thornton, who suggests that ball lightning is a sphere of dissociated ozone and oxygen.

GLB-044 A PECULIAR DISCHARGE OF LIGHTNING

Brew, William; Nature, 48:370, August 17, 1893.

On the afternoon of Wednesday, July 26, during a storm at about 5:30, a blue flame was observed by some of the inhabitants of Epping to approach and shatter the chimney of a house upon the hill occupied by Mrs. Brown and family at the time.

. . . . . .

Mrs. Brown, who was seated in the front room, states that a few seconds before the house was struck she noticed what appeared to be a darkened space, surrounded by a crimson fringe of flame in the corner (perhaps a brush discharge), and her son in the kitchen at the time testifies to having seen a similar thing previous to what appeared to be the bursting of the luminous mass, which occurred with a loud report, filling the house with smoke and the usual accompanying smell of ozone. The walls are much damaged, and the polarity of a small compass in a drawer of a sideboard nearest the path of discharge was reversed. I considered the apparent forewarning of the brush discharge of sufficient interest to justify this letter.

GLB-045 THUNDERBOLT IN WARWICKSHIRE

Cumming, L.; Nature, 48:341-342, August 10, 1893.

July 2, 1893, Warwickshire, England. Following a description of the very considerable damage done to a tree and nearby house. The author relates the characteristics of the ball lightning itself.

The explosion is said to have been quite unlike thunder, and to have resembled the report of a heavy piece of ordnance. It is probable that the report was heard here in Rugby, as I find that two persons who happened to be in my house at the time remember hearing a double report at about the same hour, which they remarked upon to each other as being like the distant firing of a cannon.

As to the evidence of the agent of destruction being a fireball, I have, through the kind help of Mr. Harrison, been enabled to examine four witnesses, all of whom agree that during an interval of two minutes before the explosion a large fiery globe was seen travelling through the air, and emitting light of such dazzling brilliancy that the only one of them who was out of doors at the time was for a moment blinded and dazed and felt for some short time afterwards a sensation of pain in the back of the head and the neck.

A fifth witness, whom I did not see, was at the time of the explosion in a room overlooking the lawn on which the tree grew, and states that she saw through the drawn blind the reflection of a fiery round ball at the instant of eruption.

The ball seems to have been larger than any hitherto observed, all speaking of it as appearing larger than the sun or moon, and one of them said it was as large as an ordinary fire-balloon when seen at a short distance. The colour is said to have been of an intense fiery red, but a person who did not see the ball was startled almost at the instant of the explosion by the lighting up of a long passage in Dunchurch Hall by an intense blue light.

Once again physiological effects on a nearby human. The double report is also interesting and infers that some mysterious detonations might be due to atmospheric electrical phenomena.

GLB-046 BALL LIGHTNING AT SEA

Anonymous; Scientific American, 86:36, January 18, 1902.

This note is merely a summary of GLB-063.

GLB-047 BALL LIGHTNING APPARENTLY CONNECTED WITH DUST

Anonymous; Science News Letter, 24:323-324, November 18, 1933.

Jensen's observations reported in GLB-016 are reviewed. The suggestion is made that dust may somehow be involved, but no details are given in this brief announcement.

GLB-048 A FIRE-BALL

Hunneman, Mary E.; Science, 86:244, September 10, 1937.

> The electrical phenomenon known as a "fire-ball" is rather a rare occurrence. Therefore one that I saw at Fitzwilliam, New Hampshire, at 5 p.m. on August 10 may be worthy of record. I was seated on a second story porch enclosed with glass watching the storm. A radio aerial extends from a distant tree to a point on the side of the house some distance from the porch. Coincident with a crash of thunder, the fire-ball appeared. I cannot say that it followed the wire or came from the sky. It just came out of space and seemed to move directly toward the window and then fell as though to enter the cellar of the house. It was a round, bronze, glistening ball with gleaming rays shooting from the top and sides; by its beauty and brilliance reminding one of an ornament at the top of a Christmas tree. Such was my fleeting sight of a fire-ball. Probably at the same instant, all electric fuses in the house blew out with unusual violence.

GLB-049 BALL LIGHTNING PHENOMENON

Anonymous; Science, 78:sup 9, October 27, 1933.

This is a slightly different version of GLB-047 in which Jensen's description of a descending lavender mass is presented.

GLB-050 BALL LIGHTNING

Kaiser, John; Science, 60:293-294, September 26, 1924

> Several years ago my home was struck by lightning. A ball of fire seemingly about nine inches in diameter was thrown into the center of my bedroom and exploded with a terrific noise, just as if a bomb had been

exploded. Brilliant particles seemed to have been hurled into every direction, but I felt no effect other than that of sound and sight.

The electric wires throughout the house were affected, and there is an inch hole through the plastered wall on the ground floor where an electric spark seems to have found its path between the radiator in the room and the metal support to the water spout on the outside of the building.

GLB-051 A NEW THEORY OF BALL LIGHTNING

Anonymous; Literary Digest, 107:27, October 11, 1930.

A new explanation of this phenomenon, offered by a German physicist, Professor Meissner, is given in Kosmos (Stuttgart).....

.....

"Every lightning discharge causes a strong air-current, for its path is a stream of luminous gases. When two lightning-paths cross one another in opposite directions, there rises a whirl of luminous gas, which takes the form of a globe. Here we have the 'ball' or 'globe' lightning.

.....

"In the interior of ball lightning there is an exhausted space; as it were, it is 'hollow.' The incandescent gases circle with great velocity--five miles a second or more--and they are driven outward by the centrifugal force. On the other hand, the pressure of the air restrains them on the outside, so that the lightning-ball remains for some time in a state of equilibrium and retains its form. When finally the equilibrium is disturbed, the air penetrates the ball and the lightning vanishes.

GLB-052 BALL LIGHTNING

Plunkett, G. T.; English Mechanic, 90:140, September 10, 1909.

About two months ago my wife and I both saw, in this house, about 10 p. m., what must have been a form of globe lightning. It was a fine evening, and there was no thunderstorm that day or night; the electric lights were on in my study, in the hall, and elsewhere. I was in my study, seated at the bureau, and at about 7 ft. to my left and 6 to the front, the door into the hall was wide open. My wife, coming across the hall when at about 7 ft. from the door, exclaimed. "What was that?" and as I looked up towards the door, I saw a bright flash, and heard a slight report, rather as if someone had flashed a little guncotton. My wife said that she had seen a globe of light, about 4 or 5 in. in diameter, which seemed to rest for a brief period on the back of a chair half-way between the open door and myself, and then burst with a report. Apparently, I had looked up too late to see the occurrence clearly.

GLB-053 ON THUNDER AND LIGHTNING

Arago, M.; Edinburgh New Philosophical Journal, 26:81-144, 1838.

The lightning, which appears in the form of balls, or fireballs, of which we have collected so many examples, afterwards to be produced, and which are so extraordinary, first of all, by the slowness and uncertainty of their motions, and then by the extent of the devastation they occasion in bursting, appear to me at present, among the most inexplicable phenomena in physics. These balls, or globes of fire, appear to be agglomerations of ponderable substances strongly impregnated with the very essence of the thunderbolt. How, then, are these conglomerations formed? in what regions are they produced? whence do they obtain the substances which compose them? what is their nature? and why are they sometimes suspended for a long period, only that they may precipitate themselves with the greater rapidity? &c. &c. To all these inquiries, science remains mute, and can make no reply.

GLB-054 BALL LIGHTNING

Anonymous; Monthly Weather Review, 26:358, August 1898.

The phenomenon described in the letters below should doubtless be classified as a nocturnal light due to its long lifetime and "inclination" to follow the train.

The Editor has received the two letters following from Mr. C. N. Crotsenburg, Crow Agency, Montana dated August 22 and September 6, 1898, respectively, and submits his own suggested explanation, but thinks it worth while to publish the whole in full, in order that the attention of others may be drawn to the subject, since, if his own explanation is correct, the phenomenon must be frequently seen by others:

As you expressed a desire to hear from those who had observed "ball lightning" at various times, I will relate an experience which befell me in the summer of 1896. I was then employed as a railway postal clerk on the line of the Chicago, Rock Island and Pacific Railway, between Davenport, Iowa, and Leavenworth, Kans.

One very dark night, about the middle of the summer, our train was going northward between Trenton, Mo., and Lineville, Iowa. Just before reaching Princeton, in Mercer County, a heavy rain began falling, which necessitated the closing of the doors on the east side of the mail car. Soon after leaving that station, at 10:35 p. m., my companion (Mr. R. C. Corbin) lay down for a short sleep. The work being very light that night, I sat in a chair, looking out of the car door to the west. The darkness was intense; not a ray of light was visible from any point, except from the train. When a few miles out from Princeton, and while traveling almost due north, I observed a peculiar light low down on the western horizon. It appeared to be perfectly round and about a foot in diameter, of a dull rose color, or, possibly, like a piece of live coal. When first observed it seemed to be floating within a hundred feet of the earth, but soon rose to a height about midway between the horizon and the zenith. For a time it floated very steadily, but soon began to oscillate up and down, at times even dropping out of sight behind hills. The wind was quite strong from the east, but the light traveled in an almost true north course. Its speed varied, sometimes seeming to outrun the train considerably, and at others it would fall behind, but never far enough to be lost to sight. Most of the time it appeared to be nearly abreast of the train and apparently from half a mile to a mile distant. Soon after it was first observed by me, my compan-

ion arose, and we both watched it closely until the town of Lineville, Iowa, was reached. There it passed out of sight behind the depot, and we saw it no more. During all the time it was in sight there was a heavy fall of rain, but very little lightning. It seemed to follow a course parallel to the Grand River, moving upstream. We had no idea at the time what caused the light, but I have since become convinced that it was "ball lightning."

Replying to your letter of August 30, and referring to my own of August 22: I have no means of ascertaining the date of the occurrence related. It made a very deep impression upon me at the time, and Mr. Corbin and myself often talked about it afterward, but I made no note of the date. We made many inquiries concerning the phenomenon which we observed, but never obtained a satisfactory explanation. We thought of distant electric light, but found that none existed within the range of our vision on that portion of the road. Since beginning this I remember that we remarked that if it had occurred a few nights before we should have felt certain that it was the light from a balloon sent up from some Fourth of July celebration, so probably it was within a week of July 4, 1896.

But even then, it would have been remarkable, as the light traveled almost directly north and kept an even course, while the wind blew quite strongly from the east. It was so very strange that I should never have mentioned it, even to my friends, had it not been corroborated by a reliable witness. I have sought for an explanation whenever and wherever I have had an opportunity, and from what I have been able to learn I had come to the conclusion that it was most probably "ball lightning."

Although my conclusions may be entirely erroneous, I have no more plausible theory to advance.

The fact that it was observed by both of us at the same time, had the same appearance to his eyes as it had to mine before he saw it is very good evidence that it was a reality and not a hallucination. He observed it as he was passing the open door, and before I had spoken to him. In fact the thing was so unreal that I hesitated to speak of it, fearing that it was some freak of my imagination, but when he too saw it the same, I could no longer doubt its existence as a reality; and we both observed it closely while the train was running at least 15 miles. When it disappeared it was at least a mile from us, as the buildings of the town were plainly visible and it was some distance farther west than any of them.

. . . . . .

The preceding account of a phenomenon by Mssrs. Crotsenburg and Corbin does not harmonize with the ordinary descriptions of ball lightning well enough to justify applying that term to it, and the editor believes that some other explanation of the phenomenon must be found. If there were a mass of falling rain, or fog, or haze at a little distance west of the train in which they were traveling, or indeed if there were groves or forests, the leaves of which were covered with rain drops, these would undoubtedly send back to the observer's eye a faint reflection or more properly an antisolar corona, which would be barely visible on a dark night. It would necessarily appear to float along with the train, as the Crotsenburg phenomena did. There can be no doubt but what the light observed in this case was some form of reflection of the light of the train itself, as it certainly had none of the characteristics of ball lightning.

GLB-055 FIREBALL

Fuller, Curtis; Fate, 15:22, January 1962.

Mrs. Doris Will was in the kitchen of her home in Cheltenham, Australia, one day recently watching a thunderstorm outside when she "felt this great thing over my shoulder."

Mrs. Will looked around and let out a yawp. There was a fireball. She raced through the dining room and headed for the stairs. The fireball followed her, passing her in the stairwell.

Mrs. Will was so confused she continued on up the stairs, now the pursuer instead of the pursued. She arrived at the top of the stairs just in time to see the fireball enter a bedroom.

Her brothers Des and Noel were still abed. They heard a crash "like thunder amplified 10 times." And before their terrified eyes the fireball escaped through the open window of their room.

This account of ball lightning is a little breathless, but the characteristics are very much the same as those reported by scientists fortunate enough to view the phenomenon.

GLB-056 A CATALOGUE OF OBSERVATIONS OF LUMINOUS METEORS

Powell, Baden; Report of the British Association, 30-31, 1861.

From the Malta Mail. The brig 'Victoria' saw this extraordinary appearance when in latitude 36°40' 56" north, and 13°44' 36" east, being becalmed and without any appearance of bad weather; her topgallant and royal masts suddenly went over the side, as if carried away by a sudden squall; and two hours after it blew very hard from the south and east, but suddenly again fell calm, with an overpowering stench of sulphur and an unbearable heat. At this moment three luminous bodies were seen to issue from the sea at the distance of about half a mile from the vessel, which remained visible for about 10 minutes; soon after it came on to blow hard from the south-east, and the vessel ran into a current of air the reverse of that just experienced (900 miles west of Adalia).

Letter from Amab, on Mount Lebanon. On the same day, about half an hour after sunset (very nearly the same time), the heavens presented an extraordinary and beautiful appearance. A fiery meteor, composed of two luminous bodies, each appearing at least five times larger than the moon, with streamers and appendages to each, joining the two, and looking like large flags blown out by a gentle breeze, appeared in the west, remained visible for an hour, and taking an easterly course gradually disappeared. The appendages appeared to shine from the reflected light of the main bodies, which it was painful to look at for any length of time. The moon had risen half an hour before, and there was scarcely any wind (350 miles south-east of Adalia).

Adalia is in Asia Minor. All of the observations above were compiled in connection with a remarkable meteor seen June 11, 1845. It is not clear from the accounts whether all phenomena were seen precisely on that date. The luminous phenomena little resemble true meteors; they are more like modern UFOs. See also GLB-028 and GLB-063.

GLB-057 ON A SHOOTING METEOR

Shepard, Charles U.; American Journal of Science, 2:28:270-276, 1859.

Mr. Sparkman R. Scriven, aged about 17, and clerk in the dry goods store of Messrs. Browning & Ketchum of King Street, Charleston, a young man of excellent character, was the principal observer of the phenomenon. He had just returned at half past 8 in the evening of Nov. 16th, 1857, to the residence of his father (Mr. J. M. Scriven) in Morris street, three doors west of King, and having occasion to step into the portico, he saw a red, fiery ball of the size and shape of an orange, slowly descending through a distance apparently of 20 or 30 feet, to the ground. Its fall was scarcely more rapid than that of a soap bubble, giving him time to call his sister, a little girl, to see it strike a high wooden fence, distant about fifty or sixty feet from the portico, and which separated the door-yard from a church enclosure adjoining. It seemed to adhere for an instant to the board against which it struck, and then separated into three parts and disappeared. The evening was dark, it having followed a rainy afternoon, though at the time of the fall, it had ceased to rain and become very foggy.

Nothing further would probably have been heard of the phenomenon but for the accidental reading, by an elder sister the next day at the breakfast table, of a paragraph from the newspaper, relating to a meteoric fall, where the specimens picked up were said to have possessed a strong odor of sulphur. This induced young Scriven, who had never before heard of meteoric falls, at once to examine the fence against which the ball had struck. The fence was eight feet high, and formed of long strips of horizontally disposed boards. It was near the extremity of an uppermost board, that had been detached and bent around so as to present its flat side uppermost, that the body had been seen to impinge. And here it was, that he discovered adhering, a small bristling mass of black fibres. These he detached and carried into the house.

. . . . . .

Dr. Pettigrew immediately called to acquaint me of the case; but not finding me at home, we did not meet until the forenoon of the 20th, when he presented me the specimen gathered by Scriven, and took me to the spot.

I heard the statements repeated from the different members of the family, corroborative of those above presented, and examined the place upon the board, from whence the fibres had been gathered. It presented no discoloration or appearance of having been heated or charred, though for many inches on either side, it was slightly blackened in spots. This perhaps was not strange, as heavy rains had fallen since the occurrence; and it might fairly be presumed, that all foreign matter would have been effectually detached. I examined the grass and soil on both sides of the fence, without finding anything beyond little fragments of charcoal, which are common enough in most places about the premises of houses. We then took pains to find the individual to whom had been given the principal portion of the fibrous matter obtained from the fence; but had the mortification to discover, that having worn it in a paper wrapper for several days in his vest pocket, he had finally mislaid or lost it. Thus little more than a microscopically visible specimen of the shooting star remained for study and examination. Its entire weight is probably less than one-tenth of a grain. When viewed by a single pocket-lens, it seems to be a confused aggregate of short clippings of the finest black hair, varying in length from one-tenth to one-third of an inch. Each portion is straight or only slightly curved. Except in color, they remind one most of that variety of pumice stone from the Sandwich Islands, known as volcanic hair, or as "Pele's hair." They do not seem very prone to break in handling, and appear slightly elastic.

They have been examined under compound microscopes of high power by several persons accustomed to the use of this instrument; but hitherto no one has ventured to suggest a relationship in their properties, to any known form

of organic or inorganic matter. The following description is from a note, handed to me by my friend, Dr. F. W. Porcher of Charleston. "Black elongated bodies, perfectly opaque, round and solid; amorphous, not properly smooth, surfaces often furnished with warty dots or projections; rather glossy."

.....

I could spare only a few of them for a chemical trial. These were introduced into a small glass test-tube (previously well dried), and heated by contact of the flame of the blowpipe. They suddenly glowed with a brilliant light, at the same time emitting an odor most nearly resembling the bituminous. A distinct greyish skeleton of each fibre was left adhering to the glass. Barytic water being thrown into the tube was instantly rendered milky, thereby proving the existence of carbonic acid; and the subsequent addition of hydrochloric acid slowly caused the separation of the skeletons from the glass, which led me to infer the presence of silica as a part of the earthy residuum. The little bodies however were not annihilated by the process; but greatly to my surprise were easily seen, by the aid of a single lens, still floating through the clear liquid, preserving in a great measure their original form, with the exception only, of being rendered here and there transparent, as if about one-half of the black matter had been eaten out and dissolved, leaving the remainder sufficiently connected to maintain the original figure of the body.

GLB-058 A POSSIBLE CASE OF BALL LIGHTNING

Alexander, William H.; Monthly Weather Review, 36:310, July 1907.

The large torpedo-shaped mass described below may have been a parent body which subsequently split into several balls. Large disintegrating bodies like this are described in GLB-005, GLB-016, GLB-020, GLB-024, GLB-037, GLB-057, GLB-059.

[July 2, 1907; Burlington, VT] Bishop John S. Michaud says:

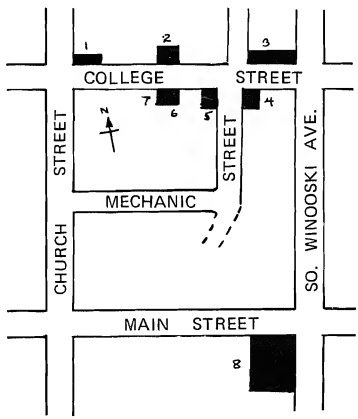
I was standing on the corner of Church and College streets, just in front of the Howard Bank and facing east, engaged in conversation with Ex-Governor Woodbury and Mr. A. A. Buell, when, without the slightest indication or warning, we were startled by what sounded like a most unusual and terrific explosion, evidently very near by. Raising my eyes and looking eastward along College Street, I observed a torpedo-shaped body some 300 feet away, stationary in appearance and suspended in the air about 50 feet above the tops of the buildings. In size, it was about 6 feet long by 8 inches in diameter, the shell or cover having a dark appearance, with here and there tongues of fire issuing from spots on the surface resembling red-hot unburnished copper. Altho stationary when first noticed this object soon began to move, rather slowly, and disappeared over Dolan Brothers' store, southward. As it moved, the covering seemed rupturing in places and thru these intensely red flames issued. My first impression was that it was some explosive shot from the upper portion of the Hall furniture store. When first seen it was surrounded by a halo of dim light, some 20 feet in diameter. There was no odor that I am aware of perceptible after the disappearance of the phenomenon, nor was there any damage done so far as known to me. Altho the sky was entirely clear overhead, there was any angry-looking cumulo-nimbus cloud approaching from the northwest; otherwise there was absolutely nothing to lead us to expect anything so remarkable. And, strange to say, altho the downpour of rain following this phenomenon, perhaps twenty

minutes later, lasted at least half an hour, there was no indication of any other flash of lightning or sound of thunder.

Four weeks have passed since the occurrence of this event, but the picture of that scene and the terrific concussion caused by it are vividly before me, while the crashing sound still rings in my ears. I hope I may never hear or see a similar phenomenon, at least at such close range.

Mr. Alvaro Adsit says:

I was standing in my store door facing the north; my attention was attracted by this "ball of fire" apparently descending toward a point on the opposite side of the street in front of the Hall furniture store; when within 18 or 20 feet of the ground the ball exploded with a deafening sound; the ball, before the explosion, was apparently 8 or 10 inches in diameter; the halo of light resulting from the explosion was 8 or 10 feet in diameter; the light had a yellowish tinge, somewhat like a candle light; no noise or sound was heard before or after the explosion; no damage was done so far as known to me.



Plan of streets and buildings described in GLB-058. (1) Howard National Bank; (2) National Biscuit Co.; (3) Hall's Furniture Co.; (4) Ferguson & Adsit's store; (5) Dolan Brothers; (6) Equitable Life Insurance Co.; (7) Standard Coal and Ice Co.; (8) Strong Theater. (Adapted from GLB-058)

GLB-059 A CATALOGUE OF OBSERVATIONS OF LUMINOUS METEORS, 1848-1849

Powell, Baden; Reports of the British Association, 152-153, 1858.

May 4, 1848, Quainton, England. Ignited globe. Fell down into a barnyard. Exploded with a loud report; incandescent fragments flew in different directions; one hit a cow. Smell of sulfur. No hole found, but the straw disturbed and turned up where it fell.

GLB-060 BALL LIGHTNING

Humphreys, W. J. ; American Philosophical Society, Proceedings, 76:613-626, 1936.

W. J. Humphreys, a noted meteorologist of his time, solicited accounts of ball lightning from the scientific community and any others who cared to contribute. He then summarized his findings in several reports such as this one. His survey made Humphreys very skeptical about the reality of ball lightning, as suggested by his quickness to classify case histories according to supposedly well-explained phenomena. The case histories below are quoted with the permission of the American Philosophical Society.

Persistence of Vision. Here is an interesting account written on Jan. 19, 1925, at Tauranga, New Zealand, by Mr. G. H. Bell: "Years ago," he says, "while milking cows in an open shed a thunderstorm came over and I 'saw' a fireball some feet in diameter shoot towards me. Lost a moment behind logs it reappeared in the stockyard and I felt a hot glow as it glided past a few feet from me right through the shed. I failed to determine its course after that as my sight seemed confused, and I congratulated myself on a narrow escape from death.

"Now a most remarkable feature of the incident was that the cows, the most nervous of animals, gave not the slightest heed to it, and long did I ponder on this aspect. Years afterwards while closely staring at an electric light point the light was switched off, but I still 'saw' the bright globe slowly moving on the wall. Only then did it occur to me that my 'lightning ball' of years before had been 'all my eye' in the truest sense of the term."

Here is another interesting case that appears to involve persistence of vision, quoted in full because of the scientific training and ability of the observer, Mr. G. W. Lewis, Director Aeronautical Research, National Advisory Committee for Aeronautics. He says:

"One afternoon in the spring of 1923, following a rather severe thunderstorm, I was surprised to see, from my home in Chevy Chase, Md., a ball of light about the size of a toy balloon approximately 125 feet away in the adjacent woods. It was 8 feet, roughly, from the ground, and in a few seconds had moved in my direction 100 feet, or so, when, at the height of 7 feet, it came in contact with a tulip tree. At this place a cloud of dust was formed by a dynamitelike explosion so loud that neighbors came out of their houses to see what had happened.

"I immediately examined the tree and found that the explosion had occurred where two nails had been driven into the trunk. There were no wires or connections of any kind attached to the tree. The bark was shattered at the place struck and so loosened from the trunk all around that the tree died."

Lightning Discharge Outdoors along a Broken Conductor. On Sunday afternoon, June 8, 1924, Mr. C. P. Thomas, a white mail carrier of Washington, D. C., parked his automobile on the side of the road to Fairfax, Va., pending the passage of a severe thunderstorm. When it was nearly over, a moderate flash of lightning was instantly followed by a ball of fire the size of one's double fist that swiftly passed 100 feet or so along the opposite side of the road, but within 20 feet of him. At one point on its course there was a sharp explosion with flying sparks followed by smoke.

On the following Thursday afternoon Mr. Thomas kindly took me to the scene of the ball lightning. There we at once found along the course the ball had taken the badly rusted remnants of an abandoned wire fence. The upper

strand, about two feet above the ground and more or less covered by weeds, was partially fused in various places, especially where it was in contact with another wire, and at one place burned entirely in two. About 20 feet beyond the place the ball was last seen, and in the direction it seemed to be going, the wire terminated in a large tree, presumably overgrown where it had been attached years before. Near the place the automobile had been parked the wire turned off at right angles to the road, went through woods some 75 feet and terminated on a tree that had been struck by lightning very recently as evidenced by the freshness of the skinned bark, plowed up dirt and wilted leaves. Quite evidently, then, a portion of the discharge that hit this tree turned off along the rusted wire and made the flashes that produced the impression of a swiftly passing ball of fire.

Will-o'-the-wisp. Mr. Charles L. Searcy, writing from the University of Nevada on February 1, 1926, reports that in 1885 he and several others saw ball lightning one calm sultry night in Indiana. It looked like a ball of fire two to four feet in diameter, and moved in an irregular course near the surface of a long meadow ridge. At times it appeared to brush the ground and then quickly rose to the height of 10 to 15 feet. It passed by some 200 feet distant, and was visible three quarters of a mile away. Several neighbors also saw it. Its speed was moderate, something like that of a slow moving airplane.

For a recollection of 40 years this is a most excellent description of one of the recognized varieties of the will-o'-the-wisp, namely, an owl out on a hunting flight and covered with fox fire from a decaying hollow tree in which he had spent the day.

The size and behavior place this in the category of nocturnal lights.

Lightning Seen End on. Mr. J. W. Bernard, writing from Dermott, Ark., on July 18, 1931, says that in 1902 or 1903 a severe thunderstorm came on while he was in a field plowing. He was hurrying to the end of the row where he could unhitch his mule and find shelter, but before getting there sensed a pungent odor and heard a swishing sound that appeared to be behind him. On looking back to see what could be making this noise, he saw, he says, "a ball of lightning, about the size of a man's head, starting in my direction. I dodged down against the plow, or rung in the plow handles. The lightning seemed to burst between me and the mule. I felt the jar of the plow as it was jarred out of the earth, perhaps six inches. One plow handle was split off and remained in my hand; the other handle was split but remained on the plow. The mule fell to its knees, then sprang up and ran across the field. As the mule sprang to its feet I fell to the ground. I did not lose consciousness, but could not rise at once. I was shocked but not injured in any way."

I have one more variety of ball lightning to report, but only a single occurrence of it has come to my attention, and I do not know how even to classify that, let alone explain it. It was described by Dr. Joseph S. Ames, long-time professor of physics at the Johns Hopkins University. In his letter of June 19, 1924, quoted with his explicit permission, he says: "Mrs. Ames was standing on a rug during a thunderstorm with her hand at her waist, one finger more or less extended. I was about five feet away and noticed the air between her finger and the floor was quivering so that it looked just like the hot air over a field. I noticed something rise slowly from the floor up towards her finger and then there was for an instant a small oblong fireball about the size of a pecan attached to her finger. It was not very bright and appeared to shine through a haze. There came a flood of lightning outside and the fireball disappeared."

The following was experienced by Leonard B. Loeb, later a physicist, when he was 8-10 years old. The toy balloon analogy is found in many reports of ball lightning.

"It was during a summer thundershower in Springfield, Massachusetts, and must have been around 1898 or 1899. It was an afternoon thundershower, occurring, as near as I can remember, between three and five o'clock, probably at about four. The phenomenon occurred at the beginning of the storm, that is, as the main thundercloud was approaching; it was already fairly dark. I was indoors on account of the impending shower and was observing it from the front window of my grandfather's house. It occurred coincident with a striking of the lightning on the cornice or roof of a house across the street and one or two doors up. It preceded the thunderclap and the flash. As I looked out of the window I noticed a ball of what I would now describe as the color of active nitrogen or possibly slightly darker, as it seemed to me, descending from somewhat the direction of the neighbor's house in a light graceful curve. Its diameter appeared to be about double that of the toy balloons which one sees and its motion through the air was quite analogous to the motion of the type of air-inflated balloons which are used so frequently in modern dinner parties. It had a translatory motion in my direction and seemed to descend down an inclined plane from the approximate location mentioned. It appeared to strike on the lawn, bounced slightly once and then disappeared. Its disappearance was followed, better accompanied, by a tremendous clap of thunder and flash of lightning which appeared simultaneously. This was the flash which struck the cornice.

"There was no visible after effect and its outline, so far as I remember, was more or less indistinct, although it was quite spherical in shape. In the question of the sharpness of outline I am no longer definitely certain. As regards the direction of the wind, I am inclined to believe that it might have followed the direction of the wind, although at that particular time the lull between the up-draft and the thunderstorm wind was on.

It has been my impression, as I have thought of it in later years, that the phenomenon was caused by some type of intense glow discharge caused by the effect of the field of the approaching cloud on the cornice or some projecting angle of the building. It has been my impression in thinking of it that the so-called ball was internally in rapid rotation of some sort or that there was a vortex which gave it its shape. The color was definitely that of active nitrogen, as I have since seen active nitrogen in the laboratory."

I fully concur in the supposition that this phenomenon was started by an intense glow, or brush discharge, but strongly suspect that its graceful fall was the familiar travel of an after image, and its bouncing just what any "born" physicist would expect a ball to do and, if it were an after image, "see" it do. The crash of thunder distracted attention and the ball, doubtless already fading, was lost to sight.

I have other similar accounts of this variety of ball lightning---lightning seen end on. One of them, a somewhat detailed account by a man killed by this variety of ball lightning, deserves being quoted. Oh yes, he came to two or three hours later, but he had gone through all the experience of being killed, and doubtless would have been buried without further consciousness if he had not come to. The man in question is Mr. Newton J. Dominy, postmaster at Dublin, Ohio, whose account is dated August 18, 1931. He says the occurrence was about 4 miles southwest of Dublin, Ohio, in August 1896 and at 11:45 p. m. The ball which made a hissing roar and left a strong odor of burning sulphur (Effects, both of them, obviously of the precursory brush discharge) was fiery red, changing to white, round and seemed to be about a foot in diameter.

He further states that he was driving a horse and buggy in darkness that was pitch black, save only as relieved by frequent lightning, when suddenly this ball appeared with a streak of fire behind it. There was a hissing noise (due, presumably, to a precursory brush discharge, as explained above) and then suddenly the ball hit the left fore wheel of the buggy, knocking him, buggy, and horse into a ditch along the road fence. The horse was thrown on her back, the harness broken, the wheel struck torn off, and all its spokes except three jerked out of the hub, and they out of the felly. He remained in the buggy, hips on the seat, body bent forward between his legs, and top of head on the foot rest on the floor. Here he remained unconscious two and a half hours. The horse, still on her back, finally was gotten up but seemed dazed for days afterwards, and from that time on afraid of lightning.

The most spectacular display of the brush discharge that has come to my attention occurred in January 1924, on the ridge of a barn some 200 feet away from the observers, directly across a road and parallel thereto. The following account, written on December 16 of the same year, kindly was sent to me by one of the eye witnesses, Mrs. R. Gilchrist.

"At six o'clock a.m. Mr. Gilchrist observed a light that appeared to be reflected from the barn through our window and remarked that a car might be coming. However, as the light persisted I arose and stepped to the window where my eyes were hurt by the glare. I immediately rushed to the phone to inform the owner of the barn that it was on fire, but in passing the large bay window in the living room I was so attracted by the light that I looked at it again and then saw that instead of the barn being ablaze there were balls of fire atop the roof. Mr. Gilchrist and our adopted son Edward were there by this time and we all gazed in astonishment at the wonderful spectacle. "There were six incandescent globes or disks or hemispheres, it is impossible to state exactly which, upon the ridge of the barn, seemingly about three feet in diameter and spaced exactly even with a distance of six inches between their edges---for a distance of four rods around the barn everything was clearly illuminated.

"Edward then called our rapt attention to the disk on the north end of the barn with the exclamation: 'It's falling!' Sure enough it did fall, leaving the ridge with a sort of jump and landing, without loss of brilliance, half way down the roof, then bouncing from there over the eave and disappearing before reaching the ground. Immediately upon the extinction of the first light the second disk started to fall, and then the rest, one after another, in exactly the same way at regular intervals. Abruptly as the last one disappeared the light around the barn vanished and all was again dark. I at once looked at the sky and saw it was exceptionally clear, with no clouds and the stars very brilliant. An investigation in the morning showed that nothing had been disturbed and that there were no signs of anything out of the ordinary having taken place."

GLB-061 GLOBULAR LIGHTNING

Marsh, O. C.; Nature, 53:152, December 1895.

On Tuesday, July 23, 1878, I was on board a large yacht at anchor in the harbour of Southampton, England. About two o'clock in the afternoon, when we were about to sail, a violent thunderstorm came up from the west, and as it passed over Southampton, several bolts descended, one of which, as I afterwards learned, struck a church. As the first drops of rain came down

on the yacht, I was standing in the after-companionway, looking forward, when my attention was attracted by a bright light apparently near the upper part of the foremast. When I first saw it distinctly, it was about half-mast high, and was falling slowly and directly toward the deck. This light was a ball of fire, a delicate rose-pink in colour, pear-shaped in form, with the large end below, and appeared to be four or five inches in diameter and six or eight inches in length.

When it struck the deck, about forty feet from where I was standing, there was a loud explosion, and it was some minutes before it could be ascertained what damage had resulted. The mate, who stood near the mainmast, about twenty-five feet from where I was, was knocked down, but soon recovered. The same bolt, or part of it, also passed in front of the foremast, down a windsail ventilator, into the gallery, where it knocked a large tin pan from the hands of a cook, and upset things generally throughout the culinary department, but injured no one seriously. Of the crew, some were on deck, and others below, but none were really injured, although a few were badly demoralised. A strong ozone-like odour was observed immediately after the explosion, and this remained perceptible for some time.

The officer in charge of the yacht, Captain Matthews, who was forward at the time, and escaped without injury, stated that just after the stroke, he saw "streaks of lightning running around on deck like snakes." I was myself only dazed for a moment by the explosion, and saw distinctly that the deck forward was illuminated with a bright confused light. The owner of the yacht, George Peabody Russell, and his other guests, had gone below when the storm began, and suffered no injury, except possibly from fright, as they were still further away from the stroke.

GLB-062 BALL LIGHTNING

Anonymous; Monthly Weather Review, 33:409, November 1905.

The following letter was from Mrs. A. E. Russell, of Paducah, Kentucky.

My niece and I were sitting in my front hall on July 16, 1905, when suddenly, without warning, what seemed like a big ball of fire passed between our heads. My niece's head was not distant more than six inches from our telephone box. She experienced no shock, while I was blinded by it for half a minute.

The front and back hall doors were screened but they showed no sign of any lightning having touched them. A tree in the back yard about ten yards from the back hall door had a round hole made in the bark with a dent in the wood just as if a cannon ball had been shot against it. The three horses standing near the tree were knocked down; the horse standing in a straight line between the tree and the house seemed dead for a long while.

My niece says that there had been a low rumbling noise of thunder just previous to the lightning, but I did not hear it. A neighbor who had left my house two minutes before and was on the road says she heard no thunder and saw no lightning until suddenly a terrific explosion seemed to occur just over her head; she was blinded and saw nothing more.

I have witnessed the lightning strike trees three times on our front lawn, but I never before saw a ball of fire.

GLB-063 AN INSTANCE OF BALL LIGHTNING AT SEA

Seyhoth, Robert; Monthly Weather Review, 29:249-250, June 1901.

The summer of 1867 found me, then a mere boy, aboard the New Bedford whaling bark Orray Taft, outbound from the desolate harbor of Marble Island, in the northwestern corner of Hudson Bay, where the vessel had wintered in the ice from September until June, and whence she had resumed her cruise in Arctic waters after "blubber and bone." On the night of June 30 to July 1 the bark encountered a genuine hurricane, with the (for the latitude) unusual phenomenon of a violent thunderstorm. A rock-bound lee shore and the presence of floe ice in large quantities, with an occasional berg, necessitated the carrying of all the sail possible, in order to "claw off" from the rocks on the one hand, and steer clear of the madly heaving and tumbling ice masses on the other. At about 2 a.m. wind and rain ceased with startling suddenness, and the sky showed signs of clearing, though a portentous cumulus cloud or "thunderhead" still hung low over the troubled waters.

The sudden cessation of the uproar, together with the violent pitching and rolling of the ship, brought the captain to the companion hatch, whence he shouted the emphatic order "Stand by to wear ship," adding, somewhat profanely, "We'll catch h-- presently from the opposite quarter." Inured as the crew of a whaler is sure to become to unusual and critical situations, and apathetic as the writer felt to the peril of the present one, he nevertheless had a distinctly uncanny sensation at this sudden transition from howling hurricane to dead calm, associated with a large degree of skepticism at the captain's assurance in predicting and preparing for a still more violent change to come; for he had never before passed through the center of a cyclone, and his theoretical knowledge of the laws of storms was decidedly limited. But the man or boy who, aboard a whaler, would let skepticism stand in the way of his prompt compliance with an order from the captain would find his berth an exceedingly unhealthy one, and would most likely have cause to regret the day of his birth; so all hands rushed to their proper stations, to "stand by and haul," as and when directed. Happening to secure the upper hold on the fore-topsail brace, the writer facing sternward, again noticed the evil-looking thunderhead apparently but a few yards above the mizzen truck, and, while waiting in silent expectancy for the things to come, saw a ball of fire, the size of a man's head, detach itself from the cloud and sail quite leisurely to the mizzen truck, striking which it exploded with a deafening crash and sent a shower of hissing sparks over rigging and deck.

Of the immediate consequences, save one, the writer can only speak from hearsay. When he regained consciousness he found himself sitting, propped up against the weather side of the mainmast, paralyzed in the right half of his body, and his shipmates busily engaged, some in clearing away the wreckage of the shattered mizzenmast, others in sounding the pump to discover whether or not the bolt had knocked a hole in the vessel's bottom. The latter calamity was probably averted by the fact that the lightning had found an easier escape to the water by way of the anchor chains through the hawsepipes, as both anchors had been made ready to let drop in case of the vessel's inability to weather the rocks. The one exception above noted, and which he has accepted as a proof that the velocity of thought is greater than that of lightning, was his distinct realization, at the critical moment, that he had been struck by lightning and was being hurled to the deck, though consciousness failed him before he struck it. He also had time to formulate the thought, "Well, it is all over with you this time," and feel rather gratified at the

supposed fact. There was absolutely no pain felt, not even an unpleasant sensation; on the contrary, he seemed to sink into an agreeably restful position though, according to his shipmates' statements, he was hurled with great violence into the lee scuppers. Of the other men on deck, especially those having hold of the brace, everyone was more or less shocked, but none were rendered insensible. The writer's uppermost hold on the rope had evidently deflected the greater part of the charge through his body. The paralysis of his right side was gradually succeeded by a prickling, tingling sensation, and the movement of his limbs had again become possible by the time the watch was told to go below. His former skepticism of the captain's prognostication had to be atoned for by a mental apology, for the hurricane began with increased fury, and from the opposite quarter, almost immediately after the lightning had struck the mast.

One rather amusing story was told of the third mate, whose station in wearing ship was forward of the windlass. Standing inside of a big coil of the anchor chain, along which the lightning flew so that it looked like a huge fiery serpent, the mate was said to have been swiftly turned around his own axis a number of times, looking more like a dancing dervish than a grim old tar, while the lightning followed the convolutions of the coil. When he had regained his breath, the profanity of the veteran whaleman was said to have bordered on the sublime.

For other appearances of ball lightning during calm interludes, see GLB-003, GLB-028, and GLB-056.

GLB-064 BALL LIGHTNING AT ALPENA, MICHIGAN

Anonymous; Nature, 126:153, July 26, 1930.

August 1, 1907. Ball Lightning at Alpena, Michigan.---On August 1, 1907, during a heavy shower with thunder and lightning, a ball of lightning about six to eight inches in diameter entered a house. It dropped lightly on to the floor, moved round the room in circles, then entering the wall, moved up inside it and came out a few feet above the window. A four-inch brace was splintered and much plaster was forced into the room. The ball then travelled across the room again and out of the other wall, making a ragged hole. It struck into the earth about 30 feet from the house, leaving a hole about 6 inches wide and a few inches deep.

GLB-065 [DESCENT OF BALL LIGHTNING]

Anonymous; Nature, 24:476, September 15, 1881.

At a recent meeting of the Banburyshire Natural History Society Mr. E. A. Walford read a note "On the Occurrence of a Fire-ball at Watergall" on August 23. In answer to Mr. Walford's queries, Mr. Fessey, jun., had sent an account as follows, dated "Watergall, Leamington, August 30:---As regards the fire-ball, I was about 200 yards from it, in a waggon hovel. I saw it directly it left the sky, as I was looking in that direction at the time. When I first saw it, it looked like a ball of fire, about as large as a dinner-plate. It slowly descend-

ed, and I have no doubt I could have run twenty yards from the time I first saw it until it struck the ground; but when about fifteen to eighteen feet from the ground, it exploded with a loud crash, quite as loud as a cannon, distinctly before the thunder, which was very loud also. The explosion shook the whole building. I certainly thought the slates were falling in, but when it exploded one part struck the hedge, making a hole in the ground about a foot deep, and laying all the roots bare, but not damaging them. For some time the place looked all on fire, and there was a considerable quantity of smoke when it hit the ground, lasting for a second or two. It was seen by myself and four men. They also agree with me that this is as near as possible a correct explanation of it. We dug the hole out yesterday, but found nothing. The soil was blackened for several inches deep."

GLB-066 A FIREBALL

Tennant, John; Nature, 24:285, July 28, 1881.

On Wednesday the 20th ult., about midnight, a house at Mont Dore, in the Auvergne, was destroyed by a fireball during a severe thunderstorm. My brother, who has lately arrived from thence, did not see the ball himself, but his valet, an intelligent Italian, saw it distinctly. He describes it as a globe of fire about half a metre in diameter, which approached the house obliquely, seeming to pass over a distance of 200 metres in about half a minute. It entered the door of the house and there burst. My brother heard the explosion as well as his valet, and describes it as a dull thud like that of a smothered blast. The house, which was a wooden one, was set on fire, a child burnt to death, and another inmate seriously, if not mortally, injured. Several inhabitants of Mont Dore are said by the valet to have seen the ball, one of whom lived in the adjacent house.

GLB-067 BALL LIGHTNING

Botley, Cicely M.; Nature, 126: 919, December 13, 1930.

The following case history was quoted from Flammarion, probably his book Thunder and Lightning.

During a storm at Beugnon (Departement Deux-Sevres, France) about the year 1904, a globe approached the door of a cattle-shed where were sheltering two children. "One of the children had the courage to touch it with his foot; immediately a frightful detonation shook the walls of the farm, the two children were thrown to the ground, without any wound, but eleven head of cattle were killed in the stable.

This case supports the old tale that ball lightning, indeed, all lightning, is more dangerous to animals than to humans.

GLB-068 FIREBALL

Cocking, Annie; Nature, 30:269, July 17, 1884.

[Autumn, 1881; Chiswick, England] The storm had lasted some time, and I sat reading a little back from an open window but facing it. Suddenly it became so dark that I could no longer see. I dropped my book and looked out. A ball of fire was passing through the window into the room. It moved very slowly onwards and downwards towards me, and became almost stationary over my book. At first I thought it rested upon it, but I soon saw it was moving slowly across. Having passed over the book, it turned in the direction of my hand, paused just beneath it, and then sank towards the carpet. At this instant a peal of thunder crashed over the house--it was the very loudest I have ever heard.

GLB-069 BALL LIGHTNING

Talman, Charles F.; American Mercury, 26:69-72, May 1932.

This article in American Mercury reviews the general aspects of ball lightning and goes on to recount some interesting case histories, four of which are reproduced below.

Dr. L. B. Tuckerman, of the United States Bureau of Standards, reports a case that occurred many years ago in Ohio. Some men who had taken shelter in a barn during a thundershower were looking across the barnyard toward an orchard where pigs were allowed to run, when they saw a ball of fire fall from aloft and roll slowly over the ground. One of the pigs trotted up to the ball and began to nose it. A moment later the ball exploded and the inquisitive porker fell over as if dead. The men walked across the yard to examine the supposedly lifeless animal, but before they reached him he staggered up and ran off full tilt, squealing at the top of his lungs.

Miss Sara E. Branham, a senior bacteriologist in the Public Health Service, reports a personal experience of her childhood days in Georgia. She was one of a group of children assembled during a thunderstorm in the long hall running through the center of a country house. Miss Branham's aunt was reading a story to the youngsters, when a sharp click attracted their attention and they saw a small glowing ball enter the front door. It floated through the entire length of the hall, moving in jerks and so slowly that one of the little boys rose from his seat and snatched at it, but missed it. A strong smell, probably of ozone, attended its passage. Leaving by the back door, it apparently struck a tree a few yards away and disappeared. The tree was not injured.

The records indicate that ball lightning may strike an animate or inanimate object without leaving the slightest trace, or, on the other hand, may cause great mischief. In a case reported to Dr. Humphreys from Kentucky a boy was standing in a doorway watching a thunderstorm, when a small ball of fire suddenly darted at him. He turned to run, but the ball lighted on one of his fingers and then vanished. It left no mark, but his finger remained numb for some time.

A case in which several balls were observed at one time is reported by Dr. C. G. R. Jennings, of Glenora, New York. He writes: Fifty years ago, when I was a medical student, I was walking home just at dusk during an evening of

thunderstormy weather. The air was sultry and there were flashes of heat lightning on the horizon. When I came to what we called in New England the village green, I saw a remarkable exhibition of what I assumed to be static electricity. There were some twelve or more round balls of luminescence bouncing around in the most undisciplined manner in all directions. They would apparently strike the ground, then bounce up into the air in the lightest and most buoyant fashion. They looked to be about the size of a football.

Similar cases with multiple spheres "bouncing" in the air like toy balloons are reported in section GLD because they resemble some electric discharge phenomena.

GLB-070 FIREBALLS

Millar, W. J.; Nature, 30:312, July 31, 1884.

In reference to the phenomena of fireballs the following notes may be of interest. Last year, in July, I was residing on Naphill Common, Buckinghamshire. About midday, during my absence at Oxford, a violent thunderstorm broke over the district, and appeared to extend from Oxford to London. On returning I found that the house had been struck by lightning, apparently in two places. One chimney was knocked in through the roof, the debris partly filling up my room. The kitchen chimney had also been visited, the lightning breaking some of the brickwork of the hearth, and passing a person cooking at the fire; two or three others were in the house at the time, but no one was hurt. On carefully examining the marks left, I found that a door in a room adjoining the one above-mentioned had been split, and some iron knobs knocked off and broken, the screw nails being removed out of the wood, and a large hole several feet square made in the side of the house. From examination of the outside of the wall at the foot of the kitchen chimney, the bricks showed displacement opposite the marks inside at the hearth. I believe a tree was struck, and a water-trap or cesspool shifted out of position. Some men using a reaping machine in a neighbouring field stated that they knew the storm was coming by the fire playing about the blades of the machine. A boy who had been near at the time said that he saw a large ball of fire fall on the house, which it seemed to enter; it then reappeared, and passed into the meadow. I therefore think it likely that the damage done to the rooms and side of house was due to the electric development called a fireball.

GLB-071 BALL LIGHTNING

Anonymous; Literary Digest, 46:177, January 25, 1913.

A singular instance of what seems to have been globular or "ball" lightning is reported in the French scientific papers. According to Ciel et Terre, to which a description of the phenomenon is contributed by witnesses, Messrs. Dember and Meyer, the lightning was seen in a place where there was no storm at the time, altho storm-clouds were visible in the neighborhood. The appearance was that of two luminous, orange-colored globes, one above the other and connected by a slender cord or chain, which emitted a feebler light and seemed

granular in constitution. The two globes moved together horizontally toward the northeast, altho at the place where the observers were, the wind was from the north. The upper globe, which was the larger, kept on its way steadily, while the other dropt slowly toward the ground. The connecting cord then disappeared and the globes moved on slowly, remaining visible for two minutes and finally disappearing silently.

This is obviously not typical of ball lightning because of the long lifetime. The coordinated behavior, too, is unusual and would tend to place the phenomenon in the category of nocturnal lights.

GLB-072 BALL LIGHTNING

Gillmor, Daniel S., ed.; Scientific Study of Unidentified Flying Objects, Bantam Books, Inc., New York, 1969.

The Condon report devotes considerable space to ball lightning because some UFOs are undoubtedly cases of ball lightning. In keeping with the current scientific view, ball lightning is recognized as a very real physical phenomenon, although estimates of ball lightning's energy density is so high that present theories cannot explain it. After reviewing the properties of ball lightning and some of the proposed theories, several interesting case histories are discussed, five of which are reproduced below.

A commercial airliner (LI-2) was struck by ball lightning on 12 August 1956 while flying in the lower Tambosk region of the USSR. Before being struck, the aircraft had been flying at 3.3 km altitude through a slowly moving cold front which contained dense thunderclouds. During a penetration of one thundercloud, where the air temperature was about -3°C, the crew saw a rapidly approaching dark red almost orange fireball 25 to 30 cm in diameter to the front and left of the aircraft. At a distance of not more than 30 to 40 cm in front of the nose, the ball swerved and collided with a blade of the left propeller, exploded in a blinding white flash, and left a flaming tail along the left side of the fuselage. The sound of the explosion was loud enough to be heard over the noise of the engine. No substantial damage could be found. One of the left propeller blades had a small fused area 4 cm along the blade and less than 1 cm in depth. Around the damaged region was a small area of soot, which was easily wiped off.

In 1952, a T-33 jet trainer was flying near Moody AFB in Georgia. Because of a thunderstorm, the pilot was told to proceed to Mobile, Ala. As the T-33 rolled out onto a westerly heading at 4 km altitude, it collided with a "big orange ball of fire" that hit the nose head-on. The jolt was such that the student pilot believed there had been a midair collision with another aircraft. The low frequency radio compass no longer functioned, and they had to receive radio guidance to another base. On examination of the aircraft, they did not find a single mark or hole. The only damage was to the radio compass unit in the nose of the T-33 which was practically melted inside and was rendered useless. After the radio compass was replaced, everything functioned normally.

Another pilot distinguishes ball lightning from balls of St. Elmo's fire, and states that he has only seen "true" ball lightning near severe thunderstorms associated with squall lines, mountainous terrain, and significant cloud-to-cloud lightning. He defines "true" ball lightning as having the following characteristics: (1) diameters between 15 and 30 meters, (2) never originates outside the main thunderstorm cloud, (3) generates from a single point and expands

in exactly the same manner as the fireball of an atomic explosion, but with a longer lifetime, (4) earphones detect soft sibilant hiss, easily distinguishable from crash static, which gradually increases in loudness concurrent with the growth of the ball, then rapidly decreases in loudness after peak brightness, (5) no apparent thunder. He considers smaller luminous balls seen near his aircraft to be St. Elmo's fire. If Kugelblitz within clouds can be as large as is estimated by this pilot, then ground-based observations reflect only weak manifestations of the phenomenon.

The following case is indicative of high-energy ball lightning. At 3:30 p.m. on 26 April 1939, following a moderate rainstorm at Roche-fort-sur-Mer (France), an extremely brilliant flash of lightning branched into three directions. At the first impact point, a witness described a ball 15 to 20 cm in diameter and 2.5 meters above the ground which passed only 4 meters in front of him. He felt a breeze of air at the same time. The globe climbed an iron cable which it melted and pulverized, producing smoke in the process. The electrical conduits of an adjoining house were burned and the meter was damaged. The observer, who was installing a gas pipe, received a shock. At the second impact point several workers saw a globe also 15 to 20 cm in diameter touch the top of a crane. There ensued a great explosive noise accompanied by a blue spark as large as an arm which flew 40 meters and struck the forehead of a dock worker, knocking him to the ground. A dozen shovelers working 10 to 50 meters from the crane received shocks and were knocked over, one being thrown 60 cm into the air. The shovels were torn from their hands and thrown 3 or 4 meters away. No smoke or odor was perceived. At the crane, current flowed along the electric cable, boiled the circuit breaker board and the windings of the crane's electric motor. The chief electrician received a violent shock and was unable to free his hands from the controls. At the third impact point, a ball of fire as large as two fists hit a lightning rod and descended along the conductor to the ground, disappearing behind a building. Two workers saw a ball of fire roll very rapidly along the ground.

In St. Petersburg, Fla., during the summer of 1951 an elderly woman was found burned to death in an armchair near an open window. Above one meter, there were indications of intense heat---melted candles, cracked mirror, etc. A temperature of 1400°C would have been needed to produce such effects. But below one meter there was only one small burned spot on the rug and the melted plastic cover of an electric outlet. A fuse had blown, stopping a clock in the early morning hours. Since lightning is common near St. Petersburg, this case has all the marks of Kugelblitz. (pp. 732-735) (Martin D. Altschuler)

The final case seems to be one of those mysterious occasions of "spontaneous combustion" of a human being.

GLB-073 BALL OF FIRE

Anonymous; Nature, 22:466, September 16, 1880.

During the severe thunderstorm which passed over North London on Monday, a peculiar phenomenon was witnessed in the grounds of the Welsh Harp, Hendon, by some gentlemen boating on the lake. A vivid flash of lightning was succeeded by a tremendous peal of thunder, a great ball of fire at the same time descending from the heavens into the water. When the storm had abated over 100 fish of various kinds, including two fine carp, weighing together 23 lb., were found floating dead on the lake.

GLB-074 BALL LIGHTNING

Smith, W. F.; Nature, 22:267, July 22, 1880.

On Saturday night, the 17th inst., an instance of this form of lightning came under my observation.

The day had been hot, the thermometer registering a temperature of about 71°F. in the shade during the middle of the day, which was bright and clear. In the evening, however, a curious haze or mist spread rapidly over the landscape, while the temperature had fallen to about 68°F. This haze was very much denser and more anlaogous to the smoke-fog of a town than I have ever observed in the country at this time of year, yet the air did not seem particularly damp or chill.

About 9 p. m. frequent flashes of sheet-lightning occurred, with rumblings of distant thunder at intervals, both of which continued more or less up to midnight, about which time, the mist having somewhat cleared off, I saw when returning home, apparently about a quarter of a mile ahead, a ball or globe of fire of considerable size descend slowly from the clouds, and when near to or touching the earth suddenly disappear, its disappearance being accompanied by two slight but quick concussions, which may have been an explosion and its echo. The fire-ball could not have been visible more than five or six seconds. I cannot ascertain that any damage was done by it.

Mists, perhaps of the type above, have been noted in reports of electrical discharge phenomena and earthquakes.

GLB-075 CURIOUS ELECTRICAL PHENOMENON

Mott, F. T.; Nature, 22:193, July 1, 1880.

At about 4.30 p. m. this day a severe thunderstorm with a deluge of rain came up from the north-west and lasted about an hour. At 5.30 my wife was standing at the window watching the receding storm, which still raged in the south, just over Leicester, when she observed, immediately after a double flash of lightning, what seemed like a falling star, or a fireball from a rocket, drop out of the black cloud about 25° above the horizon, and descend perpendicularly till lost behind a belt of trees. The same phenomenon was repeated at least a dozen times in about fifteen minutes, the lightning flashes following each other very rapidly and the thunder consisting of short and sharp reports. After nearly every flash a fireball descended. These balls, appeared to be about one-fifth or one-sixth the diameter of the full moon, blunt and rounded at the bottom, drawn out into a tail above, and leaving a train of light behind them. Their colour was mostly whitish, but one was distinctly pink, and the course of one was sharply zig-zagged. They fell at a rate certainly not greater than that of an ordinary shooting star. I have never witnessed a phenomenon of this kind myself, but my wife is a good observer, and I can vouch for the trustworthiness of her report.

GLD-001 MOUNTAINTOP ELECTRICITY

Gillmor, Daniel S., ed.; Scientific Study of Unidentified Flying Objects, Bantam Books, Inc., New York, 1969.

A graduate student of the University of Colorado was climbing Chimborazo, a high and isolated mountain in Ecuador. The summit is a large flat plateau 400 meters in diameter and 6266 meters above sea level. He and a companion left their camp at 5700 meters on the morning of 1 March 1968. At 10 a.m. clouds started forming at the peak and a small amount of graupel began to fall. When they reached the summit, between 2 and 2:30 p.m., there was considerable cloudiness. Just as they were about to take the traditional photograph of conquest, the graupel began to fall more heavily. Suddenly they felt an odd sensation about their heads described as mild electric shocks and crackling and buzzing sounds. Their aluminum glacier goggles began to vibrate, and their hair stood on end. The climbers dived into the snow and waited. Thunder was heard in the distance. They found that whenever they raised their heads off the ground, the electrical effects recurred. It seemed as if there were an oppressive layer 50 cm above the surface. After waiting half an hour, the climbers crawled off the peak on their bellies. They proceeded in this manner for an hour and a half, 400 meters across the plateau and down the slope. After descending 60 meters, they found they could stand up. By this time the fall of graupel and the sounds of thunder had ceased.

The following observations are quoted from the journal maintained on Pike's Peak by the Harvard College Observatory during the 1870s and 1880s.

"16 July 1874. A very severe thunderstorm passed over the summit between 1 and 3 p.m., accompanied by mixed rain and hail. Sharp flashes and reports came through the lightning arrester, to the terror of several lady visitors; outside the building the electric effects were still more startling. The strange crackling of the hail, mentioned before, was again heard, and at the same time the observer's whiskers became strongly electrified and repellent, and gave quite audible hissing sounds. In spite of the cap worn, the observer's scalp appeared to be pricked with hundreds of red hot needles, and a burning sensation was felt on face and hands. Silent lightning was seen in all directions in the evening, and ground-currents passed incessantly through the arrester."

"21 July 1874. Not only did the constant crackling of the fallen hail indicate the highly electrified state of the summit, but from the very rocks proceeded a peculiar chattering noise, as if they were shaken by subterranean convulsions."

"25 May 1876. At 6 p.m. continued thunder was heard overhead and southeast of the peak. The arrester was continually making the usual crackling noise. About this time, while outdoors, the observer heard a peculiar "singing" at two or three places on the wire very similar to that of crickets. When the observer approached near one of these places the sound would cease, but would recommence as soon as he withdrew two or three feet distant."

"18 August 1876. During the evening the most curiously beautiful phenomenon ever seen by the observer was witnessed, in company with the assistant and four visitors. Mention has been made in journal of 25 May and 13 July of a peculiar "singing" or rather "sizzling" noise on the wire, but on those occasions it occurred in the daytime. Tonight it was heard again, but the line for an eighth of a mile (200 m) was distinctly outlined in brilliant light, which was thrown out from the wire in beautiful scintillations. Near us we could

observe these little jets of flame very plainly. They were invariably in the shape of a quadrant, and the rays concentrated at the surface of the line in a small mass about the size of a currant, which had a bluish tinge. These little quadrants of light were constantly jumping from one point to another of the line, now pointing in one direction, and again in another. There was no heat to the light, and when the wire was touched, only the slightest tingling sensation was felt. Not only was the wire outlined in this manner, but every exposed metallic point and surface was similarly tipped or covered. The anemometer cups appeared as four balls of fire revolving slowly round a common center; the wind vane was outlined with the same phosphorescent light, and one of the visitors was very much alarmed by sparks which were plainly visible in his hair, though none appeared in the others'. At the time of the phenomenon snow was falling, and it has been previously noticed that the "singing" noise is never heard except when the atmosphere is very damp, and rain, hail, or snow is falling."

"10 July 1879. At 5 p.m. the hail turned to snow, and ceased at 5:30 p.m., the wind being gentle throughout. On stepping to the door at 6 p.m., observer states that he felt a peculiar sensation about the whole body, similar to that of an awakening limb after being benumbed; that his hair stood straight out from his head, and seemed to produce a peculiar "singing" noise like that of burning evergreens; the telegraph line and all metallic instruments producing a noise like that of swarming bees. When he put on his hat, the prickly sensation became so intense that he was compelled to remove it, his forehead smarting as though it had been burned for fully three hours later. At 7 p.m. the electric storm had ceased."

With the exception of tornado situations described earlier (where heat is also present), it is not likely that electrical sensations are anywhere more intense than on mountaintops. UFO reports sometimes indicate creepy, crawling sensations, much less pronounced, however, than those experienced by mountaineers. (pp. 741-743) (Martin D. Altschuler)

The humming, bee-like sounds are very similar to those heard at Yellowstone Lake, the vicinity of Kent, England, and when northern lights are seen---at least by some people. All of these sounds may be due to infrasonic sound, physiological reactions to electromagnetic radiation, or some effects we do not yet recognize.

GLD-002 CURIOUS LIGHTNING IN THE ANDES

Anonymous; Scientific American, 106:464, May 18, 1912.

Dr. Walter Knoche, the German director of the Chilean meteorological service, has begun an investigation of the remarkable displays of so-called "heat lightning" which are often observed along the crest of the Andes, and are sometimes visible far out at sea. (In one case Dr. Knoche saw them from Easter Island, 300 miles from the Chilean coast.)

Thunderstorms are rare in Chile, and this fact may possibly be explained on the assumption that the Andes act as a gigantic lightning-rod, between which and the clouds silent discharges take place on a vast scale. The visible discharges occur during the warm season, from late spring to autumn, and appear to come especially from certain fixed points. According to Dr. Knoche they are confined almost exclusively to the Andes proper, or Cordillera Real, as distinguished from the coast cordillera. Viewed from a favorable point near their origin there is seen to be, at times, a constant glow around

the summits of the mountains, with occasional outbursts, which often simulate the beams of a great searchlight, and may be directed westward so as to extend out over the ocean. The color of the light is pale yellow, or rarely reddish.

One striking feature of these discharges is that they are especially magnificent during earthquakes. At the time of the great earthquake of August, 1906, throughout central Chile the whole sky seemed to be on fire; never before or since has the display been so brilliant. The natives regard these lights as the reflection in the sky of the glowing lava in the craters of volcanoes; but there seems to be no doubt that they are electrical discharges.

It is planned to make spectroscopic observations of this singular phenomenon, and also, if possible, measurements of the electrical state of the atmosphere in the high Andes where it appears to have its origin. Possibly the result may be to connect up "Andes lightning" with a peculiar form of aurora which has been observed by Lemstrom over mountain summits.

GLD-003 CAPTAIN WITNESSES THUNDERSTORM IN A CLEAR SKY

Anonymous; Literary Digest, 116:25, July 1, 1933.

In the log of the British steamer Moravian, Capt. A. Simpson described a thunder-storm on December 30, 1902, just within range of Cape Verde lighthouse. At 1:30 a.m. a warm puff of dust-laden wind came off the African shore. Lightning, at first distant on the northeast horizon, became almost continuous, with loud thunder.

All the stars were visible; only upper clouds, no cumulus, in the sky. Captain Simpson had never before experienced a severe thunder-storm without cloud. Charles Fitzhugh Talman, who describes this freak thunder-storm in his Science Service feature Why the Weather?, goes on:

"For fully an hour the sky was one blaze of lightning, and wire ropes, mastheads, yardarms, derrick ends, etc., were lighted up. All the stays seemed to have glowlamps 3 to 4 feet apart, and the mastheads and yardarms a bright light at their extremities. The officers and passengers were roused to witness the weird spectacle.

"The most remarkable part of the phenomenon was the extraordinary sound emitted throughout. It was, says the log, exactly like the noise of the sparks from the carbons of an arc lamp; or as if several thousands of cicadas had taken up their quarters in the rigging; or the crackling of burning grass or twigs.

"This noise was not local near the bridge, but the officers reported it all over the ship, even in the neighborhood of the noisy steering-gear."

Dust storms are often electrified, and dust may have been a factor in establishing high electrical potential differences here.

GLD-004 CORONAL EFFECTS

Gillmor, Daniel S., ed.; Scientific Study of Unidentified Flying Objects, Bantam Books, Inc., New York, 1969.

St. Elmo's fire appears as a glowing luminescence hovering above a pointed object or near a wire conductor. It is usually oval or ball-shaped, between 10 and 40 cm in diameter, and has a glowing blue-white appearance. Its lifetime exceeds that of ball lightning, sometimes lasting several minutes. The decay is silent but may be sudden or slow. Sometimes hissing or buzzing noises can be detected.

The primary difference between ball lightning and St. Elmo's fire is that St. Elmo's fire remains near a conductor. It has been observed to move along wires and aircraft surfaces, sometimes pulsating. Foo-fighters are probably a manifestation of St. Elmo's fire.

. . . . . .

. . . . Here is an account of St. Elmo's fire from the same pilot who gave observation 3 of the previous section.

"The smaller 'ball lightning' I have always associated as being the phenomenon known as St. Elmo's fire; however, St. Elmo's fire generally consists of an infrequent blanket covering the leading edges and trailing edges of an aircraft. It does not blind or brighten but is merely irritating as it prevents clear radio reception. The 'small ball' formation varies in size from two inches (5 cm) to a foot and half (46 cm) in diameter and generally 'rolls around' the aircraft apparently unaffected by the movement of the aircraft. On one occasion a small ball (about six inches (15 cm) in diameter) of yellowish-white lightning formed on my left tiptank in an F-94B then rolled casually across the wing, up over the canopy, across the right wing to the tiptank and thence commenced a return, which I didn't note, but I was advised by my observer that it disappeared as spontaneously as it had arisen. I have seen this form several times but rarely for as long as a period which I would estimate to be about two minutes in duration. Sometimes the balls are blue, blue-green, or white though it appears to favor the blue-green and yellow-white. It might be of interest to you to know that subsequent to the 'small ball' rolling over my aircraft, the aircraft was struck three times by conventional lightning bolts which melted four inches (10 cm) off the trailing edge of each tiptank and fused about a four inch section covering my tail lights." (pp. 735-736) (Martin D. Altschuler)

GLD-005 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Physics, 1:25:363-411, 1834.

The following section of Olmsted's long report on the great meteor display of 1833 deals with concurrent electric and magnetic phenomena which perhaps had some causal relationship to the meteors. Note that auroral activity was also seen (GLA-005).

10. ELECTRICAL AND MAGNETIC OBSERVATIONS.-- Observations made in various places, indicated a highly electrical state of the atmosphere. No very decisive observations with magnetic instruments have come to our knowledge.

. . . . . .

(2.) Dr. Kirtland, at Poland, Ohio, "on retiring to rest, a little after 10 o'clock, discovered brilliant electrical sparks emitted from his clothes on any slight motion." (Letter to Professor Silliman.)

(3.) While riding in the town of Fredonia, (says a correspondent of the New York Daily Advertiser,) in the evening of the 14th inst. between 6 and 7 o'clock, the night after the meteoric display, the tips of the ears of my horse, for a half an inch in length, became luminous, and similar in appearance to phosphorescent

bodies. It remained for some minutes.

. . . . . .

. . . .The fact that such electrical appearances were unusually striking at the time of the occurrence under review, and a few hours after, being granted, we should still have to inquire, whether the electricity were a cause or a consequence of the meteors, or whether it were merely a subordinate effect of the change in weather.

Similar remarks may be made with respect to any magnetic influence which may have been detected. Should a connexion be traced between the apparent motions of the meteors and the laws of terrestrial magnetism, this discovery would throw light on the motions of these bodies, but would still leave the greater part of the difficulties, such as their nature and origin, unsettled.

But the known connection of the aurora borealis with terrestrial magnetism, and the obvious connexion of the phenomenon in question with auroral appearances, afford reasonable grounds for examining the magnetic indications with greatest attention; considerations, which add to the regret already adverted to, that so few magnetic observations have been communicated to the public.

GLD-006 ATMOSPHERIC ELECTRICITY

Bowlker, C. A. C. ; Nature, 40:55, May 16, 1889.

I send you the following account of a curious, and, I believe, rare electrical phenomenon witnessed last week by a friend of mine and myself.

We had, in the course of a long mountain ramble, reached the summit of Elidyr Fawr (3033 feet), a mountain lying to the north-east of Llanberis, and about four miles north of Snowdon. Being a short distance in front of my friend, I sat down and rested with my back to the cairn, sheltering myself from a cold south wind which was blowing with considerable velocity. In about two minutes I heard a curious buzzing sound commence, apparently proceeding from the top of the post set up not long ago by the Ordnance surveyors. I had heard the same noise about three years ago while descending the arete of the Weisshorn, and on that occasion, as on this, there was a south wind blowing, accompanied by snow---on the Weisshorn in large flakes, on Elidyr Fawr in fine powdery flakes. On the Weisshorn, for above an hour every rock seemed to emit the peculiar buzzing noise, and our ice-axes did the same. We were in too great a hurry, however, to pay much attention to the phenomenon. A day or two after, I related my experience to a gentleman, Mr. Powell---who, I trust, will forgive me for mentioning his name---and learned from him that he had had a similar experience on the Unter-Gabelhorn, near Zermatt. The day was on that occasion, if I remember right, clear, when the noise was heard, followed in a short time by a flash, and a shout from two of the party that they were struck. No harm was done by the shock, but the sensation was described as being like that which would be felt if every hair of the head were caught hold of and violently twisted. Having heard the sound before, I readily recognized it on Elidyr Fawr, and resolved if possible to study the phenomenon more closely. I first climbed on to the cairn, and found that the sound proceeded from the whole surface of the wood for about two feet from the top of the post. I then raised my stick, which had an iron point, and found that the sound began to proceed from it directly a height of about six feet from the ground was reached. I then put my hand on the part emitting the sound, but could feel nothing. On putting my stick down, and keeping my hand up, the sound proceeded from my hand---from more or less of it according as I raised

it higher or lower---and I imagined that on the back of my hand the sensation of being very slightly pricked in many places was perceptible. My friend was much impressed by the peculiarity and intensity of the sound, and agreed with me that it would not be wise to stay long. As we proceeded along the ridge, after a slight drop, we rose again, and while standing on some rocks, the noise began in our caps, accompanied by such an agitation of the hair that it quite seemed as if we had literally a "bee in the bonnet." There was no sound of thunder, and in the course of about half an hour the snow-storm passed away, not however before we had descended far below the enchanted summit.

Snow, like sand and other forms of precipitation, can separate electrical charge and establish conditions for such discharge effects.

GLD-007 NOTICES OF EARTHQUAKE SHOCKS FELT IN GREAT BRITAIN .....

Milne, David; Edinburgh New Philosophical Journal, 31:92-122, 1841.

In reading the following account, it should be recalled that earthquakes can produce electrical discharge effects through the piezoelectric effect, at least in principle.

April 2, 1750; Liverpool, England. A person went out into the open air during the shock, and saw multitude of blood red rays converging from all parts of the heavens to one dark point; but saw no luminous body. The phenomenon disappeared in fifteen minutes. (p. 99)

GLD-008 CELESTIAL SIGNS OF EARTHQUAKE

Anonymous; Literary Digest, 115:27, February 4, 1933.

Mysterious lights in the sky during or just before an earthquake have been traced for four additional earthquakes by a Japanese expert, Mr. K. Musya.

That such lights sometimes appear as celestial "warnings" of the approaching catastrophe is an ancient belief which modern science always has rejected. Says Dr. E. E. Free's Week's Science (New York):

"No way is known in which such lights could be created by the shock or by the preliminary earth stresses from which the shock results.

"Two years ago, however, Mr. Musya became interested in reports of such lights seen at the time of the Japanese earthquake of November 26, 1930. Thereafter he took pains to collect all similar reports at times of Japanese earthquakes, especially on the occasion of the severe earthquake of November 2, 1931. At this time no fewer than 355 persons saw luminous appearances in the sky, like the rays of a bluish search-light pointing upward from below the horizon.

"Most of these lights were seen in the direction of the center of the earthquake, as tho something that happened thereabouts caused the sky lights as well as the shock. It seems that the reality of some kind of luminosity in the sky in the neighborhood of earthquakes must be accepted, altho neither Mr. Musya nor any other scientific man has been able to suggest a plausible theory of how these lights are caused. Perhaps some electrical disturbance of the upper air precedes or accompanies the earthquake and causes lights like the Aurora."

GLD-009 [PLAIN COVERED WITH THOUSANDS OF LIGHTS]

Anonymous; Nature, 6:270, August 1, 1872.

A correspondent of the Madras Mail, quoted by the Times of India, says that on the night of June 15 last the plain to the east, north, and north-east of Nandidroog was covered with "many thousands" of lights, which have been observed occasionally in former years. The correspondent compares the appearance to that of a large city brilliantly illuminated, and in one direction the scene, through a binocular glass, "looked like a view of part of the starry heavens, each flame being like a star." As many of the lights were from ten to fifteen miles distant from the reporter's point of view, he conjectures that each flame must have been five to six feet in length. An attempt is being made to find out the cause of the curious phenomenon, the most likely hypothesis being that the lights are "caused by the ignition of some inflammable gas escaping in jets from the surface of the earth."

This account is similar to one from England (GLD-024). It is difficult to tell whether the lights are electrical, optical, or neither.

GLD-010 EARTHQUAKES AND LUMINOUS PHENOMENA

Milne, John; Nature, 87:16, July 6, 1911.

In vol. xiv., No. 6, 7, and 8, of the Bollettina della Societa Sismologica Italiana, we find a very long paper by Dr. Ignazio Galli on the collection and classification of luminous phenomena observed at the time of earthquakes. After an introduction, he considers that which might be excluded and the difficulties first met with in the formation of a catalogue of the phenomena he discusses. The illustrations which he gives of luminosities and other strange phenomena which have appeared at or about the time of earthquakes are 148 in number. The date of the first is 89 B.C., and the last March 30, 1910. These descriptions occupy 184 pages. The various luminosities are classified under more than twelve heads, and to these are added the number of times that earthquakes have been associated with vapours, smoke, and odours of sulphur or bitumen.

Seismologists have known for years past that certain earthquakes are said to have been accompanied by appearances of the Aurora Borealis, glimmering lights in the sky, fire-balls, ignis fatui, lightnings, corrustations, and emanations from the soil, but this is the first time so large a collection of these phenomena have been brought together for their consideration.

When resident in Japan the present writer made many experiments extending over some years on electrical and magnetic phenomena associated with seismic disturbances. He also collected material from all parts of the world which bore upon these associations. One conclusion arrived at is that it is an undoubted fact that at the time of certain large earthquakes, as, for example, the one which in 1906 destroyed Valparaiso, curious lights which, in this instance, were compared to those of chain lightning, have been seen playing across the hills in the epicentral region. Observations of this nature led the writer to make experiments at Shide, in the Isle of Wight, and at the King Edward VII Mine at Camborne, in Cornwall. The object was to determine whether there was or was not at the time of a large earthquake a practically

instantaneous transmission of energy to distant regions other than that recorded by seismographs. It was observed, and still is observed, by many persons that the face of a very large chalk pit at Shide exhibits, after dull damp days, a flaring luminosity. In a chamber at the end of a tunnel is this pit, a cylinder carrying photographic paper was installed. This cylinder was enclosed in a box, one end of which was a metal plate containing three holes. The plate touched a flat chalk surface. The cylinder took one week to turn; therefore parts of the paper before the holes were very slowly exposed to a chalk surface about 3/16th of an inch distant. On certain weeks the results were nil. Other weeks, after the development of the paper, there were three dark bands corresponding to the position of the holes, suggesting that the chalk had acted like an extremely feeble light. Another experiment was to place small pieces of photographic paper in envelopes, a certain number of which had a small glass window; these were placed against the face of the chalk. The image of the windows was frequently obtained, but nothing more than the effects of damp was found upon the others.

The conclusion arrived at was that the photographic effects were in no way connected with radio-activity, but they were probably electrical. The effects obtained in the granite of Cornwall were very marked and, like those observed in the Isle of Wight, varied in their intensity. As to the possibility of these effects being due to micro-organisms, a number of investigations were made, but there were no indications that organisms obtained from the chalk surfaces were connected with luminosity.

Whether these observations throw light upon differences in climate observed at different places, even though they may be near to each other, is a matter for conjecture, but future researches may show that the well-being of living things on the surface of our earth is more dependent upon its radiations than has hitherto been imagined.

The luminescence of the chalk could be biological, chemical, or electrical in origin.

GLD-011 STRANGE EARTHQUAKE LIGHTS

Anonymous; Literary Digest, 47:1060, November 29, 1913.

Says a writer in Cosmos (Paris, October 16):

"What serious, objective truth is there in stories of luminous phenomena---columns of fire and lightning---said to accompany earthquake shocks? Prof. Ignazio Galli has collected 148 observations of such phenomena observed in connection with earthquakes from 89 B. C. up to the month of March, 1910.

"All experts in seismic research are not, like him, convinced of the reality of the phenomena in question. Father Secchi, having gone to study on the spot the effects of the earthquake of August 22, 1859, at Norcia, recognized the inanity of the stories of flames and of fiery columns; besides this, the shock took place in broad daylight. Father Bertelli says that certain wandering lights, noted at the time of the Ligurian earthquake of February 23, 1887, might have been due to the inflammation of sulfureted hydrogen or of hydrocarbons given off from the earth, but he was also inclined to attribute these lights to the entirely subjective impressions of persons frightened by the shock.

"On this same question, Professor G. Agamennone gives, in his turn, this opinion. After the earthquake that devastated Bisignano on December 3, 1887,

he learned at Roggeano that a column of fire had been seen; when he sought eye-witnesses he found that the only one was a peasant who, when interrogated, scarcely seemed to speak seriously. After the Calabrian earthquake of September 8, 1905, questionnaires sent out were returned with numerous notes of luminous phenomena, but after sifting the answers it was impossible to conclude definitely that these were in any direct connection with the earthquake. In the neighborhood of Pizzo, cited as one of the most remarkable for the intensity of the luminous phenomena, Agamennone looked up all the eye-witnesses and found that, of all the persons who were at work on the coast that night, one alone had seen lights with his own eyes; they were a kind of shooting stars seen at first three-quarters of an hour, and again a quarter of an hour, before the shock.

"The opinion of Count Montessus de Ballore, director of the Chilean seismological service, may also be recalled. He concluded that all the luminous appearances noted during the earthquake of 1906 at Valparaiso might easily be explained by lightning, contacts between trolley-wires and those of the telegraph or telephone service, and the search-lights of warships.

"Thus the possibility of luminous appearances in direct connection with earthquake phenomena can not be absolutely denied; but their reality is not yet demonstrated."

The tone of these denials resembles that heard from the debunkers of ball lightning, UFOs, and other strange phenomena; that is, everything can be explained in terms of contemporary physical laws.

GLD–012 LUMINOSITY ACCOMPANYING ST. LOUIS TORNADO– – – FEBRUARY 10, 1959

Vonnegut, Bernard; Monthly Weather Review, 87:64, February 1959.

Ordinary lightning and ball lightning often accompany tornadoes, but many of the luminous phenomena seem to be other kinds of electrical discharges.

Newspaper accounts of the 1959 St. Louis tornado which occurred at about 2:20 a.m. have described various luminous phenomena that accompanied this tornado. For example, one observer was quoted as saying, "I saw a blue flash of light and I heard a terrible roar." Another observer stated, "There was a terrific glow of light as if a cloud was illuminated, and there was a sound like the roar of a tremendous automobile racing its engine."

These accounts appear similar to Montgomery's[1] description of the Blackwell, Okla. tornado of May 25, 1955. He stated, "The fire up near the top of the funnel looked like a child's Fourth of July Pinwheel."

In an effort to learn more about the details of this luminosity, we wrote a letter to the editor of the St. Louis Post Dispatch requesting information from readers who might have witnessed such phenomena. Over a dozen people responded to this request and sent in letters describing their observations. The following accounts were taken verbatim from some of the letters that were sent in describing the February 10 tornado:

[1]Floyd C. Montgomery, Monthly Weather Review, May 1955, vol. 83, No. 5, p. 109.

1. "The approach of the St. Louis 2:20 a.m. tornado was a continuous illumination not streaks or strokes as in an electric storm.

"The continuous sort of flat lightning is always an indication of wind and hail.

"I have observed such performances for a number of years, not to say that just when and where it would strike, but one can tell about that there is something coming. Continuous illuminated cloud is what I saw again from 1:30 a.m. till 2:20 a.m. when soon I heard what had happened, passing overhead, but 1-1/2 miles to the south of where I am located, I heard the roar, a sound as if a 100-car freight train was passing by." (Martin Maurer)

2. "The lightning was not close nor did it occur often. But there were two freak shows which I had never seen before. The first in the southeast as a brilliant pink which lasted a few seconds, followed by a pale green which also lingered. It was not a streak but more like a sunset effect and clouds were outlined against it.

"The second was in the northeast and entirely different being a flame-like flare right up from the horizon just as though it were from a burning building. It was followed by a second one just like it and in the same general direction." (Miss Genevieve Plummer)

3. "The night of the storm I awoke at 2 o'clock. I thought it seemed to me it was raining hard so I arose and looked out. At once I saw a big ball of fire in the sky to the east. It looked different kind of bright yellow and then there was a long flash not like usual but very bright and to me it looked like the shape of a broad sword not slim like the flashes I have seen before." (Mrs. M. Hatch)

4. "On the night of the storm I woke as the result of heavy thunder (apparently about 2 a.m. or shortly after). The thunder stopped and a very heavy rain came against the west windows at about the strength of a strong fire hose. The windows did not break. After only a minute or two the rain stopped suddenly and a peculiar very rapid lightning flashing began flashing through the west window. My windows were covered by a transparent mesh-type curtain (glass fiber) so that I could see the light but their translucency did not allow me to see more and I did not realize there was more to be seen than an ordinary bad thunderstorm.

"This lightning flashing was very rapid---perhaps two or three flashes per second and not as brilliant as the usual big flash preceding a thunderclap. This flashing passed the west windows moving rapidly north and in a few moments was passing the north window going northeasterly (presumably---at least it passed by each window in about the same way. Total time of passage past both windows perhaps 3-4 min.). I don't recall hearing any sound as this rapid flashing was going on, but my windows were closed, and I was probably in a half-sleep condition." (L. G. Spiess)

Ball lightning has been seen to form during sudden lulls in violent storms. (GLB-056 and GLB-063) This "eye" of the storm may be where electrical activity is high, giving rise to luminous phenomena.

GLD-013 [LUMINOUS FOOTPRINTS]

Anonymous; Nature, 12:564, October 28, 1875.

A correspondent of the Aberystwith Observer, the Rev. James Lewis, of Llanilar Vicarage, writes as follows to that journal:---"Whilst returning from

service at the parish church of Rhostie, about 8.15 p.m. on Friday, the 24th ult., in company with two members of the congregation, my attention was called to a remarkably strange phenomenon. In walking across a field on the farm of Cwmclyd, it was noticed that our footsteps were marked by a peculiar light, which could be traced back for several yards, each footprint being as distinctly marked on the ground as when one walks in snow. When we got into the adjoining field the light disappeared until we came near to the end of it, when it was observed that our footsteps were again marked by the same luminous appearance. In colour the light was similar to that of phosphorus rubbed on a wall in a dark room, or a mass of glow-worms, of which insect, however, there was no trace on the surrounding ground."

Since no electrical storm or other atmospheric effects were mentioned, this luminous phenomenon may be chemical or biological in origin. There are, however, cases of terrain made luminous by some sort of electric discharge phenomenon.

GLD-014 [PHOSPHORESCENCE DURING THUNDERSTORM]

Anonymous; Nature, 12:447, September 16, 1875.

Night of July 7–8, 1875; Switzerland. After describing the suffocating calm preceding the storm, the noise of its approach, its violence, and the damage it inflicted, the following curious facts were related:

The smallest of the hailstones were the size of hazel-nuts, many were as large as walnuts and chestnuts, and some even as large as a hen's egg. Some of the hailstones measured four inches in diameter, and six hours after they fell weighed upwards of 300 grammes. For the most part the hailstones were of a flattish or lenticular form, with a central nucleus of 0·16 to 0·40 inch diameter, enveloped in several concentric layers of ice, generally from 6 to 8, alternately transparent and opaque.

.....

The electrical phenomena were very remarkable; the flashes of lightning succeeded each with so great rapidity from midnight till a few minutes after 1 o'clock in the morning, that a mean from 2 to 3 were counted each second, or from 8,000 to 10,000 per hour. Electrical phosphorescence was remarkably intense before and during the hail. The ground, animals, prominent objects, as well as the hailstones, were strongly phosphorescent. Immediately after the hail, ozone was greatly developed, the smell being so pronounced as to be compared by nearly all observers to garlic. The incessant electrical discharges passed from cloud to cloud over a central point from which the hail fell, but thunder was very rarely heard.

GLD-015 LUMINOUS PHENOMENA IN NOCTURNAL TORNADOES

Vonnegut, B., and Weyer, James; Science, 153:1213–1220, September 9, 1966.
(Copyright 1966 by The American Association for the Advancement of Science)

The authors of this paper advocate a strong role for electricity in tornado action, a conclusion based on tornado energetics and the frequent observation of electrical

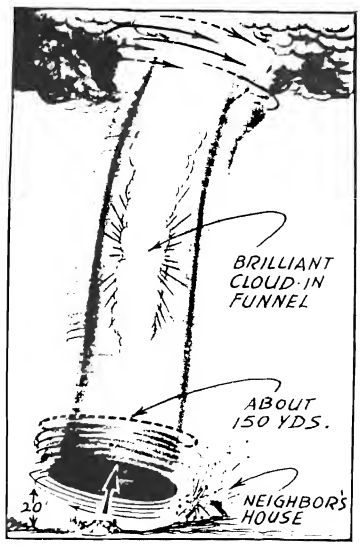
effects in the neighborhood of tornadoes.

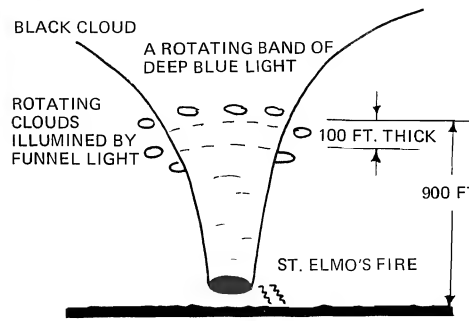
During the Toledo tornadoes of April 11, 1965, Weyer was taking photographs of the storm and was fortunate enough to get a picture of two vertical shafts of light in the region where the tornadoes were active. These rather startling photos were supplemented by the following eye-witness accounts:

> The twister came through here up high. From southwest to northeast.... There was hard wind. I was outside. Suddenly there was no wind. My eardrums felt like they would burst, very intense. I heard a far away roar and at the same time it was all around me.... Then a great wall of white came. There was hard wind and all white. I could not see through the white. There was very little damage here.
>
> Just after the tornado struck, I was inside of the house looking out, I saw something very bright about the size of a basketball about six feet away from me and about five feet off the ground. It was white, blue and yellow in color and coming slowly toward me.... at less than the speed a person would walk.... when it seemed to hit the door, it made the door sound like it was singing.
>
> We were shaken up and our trailer along with others was dented badly from hail the size of baseballs. The beautiful electric blue light that was around the tornado was something to see, and balls of orange and lightning came from the cone point of the tornado. The cone or tail of the tornado reminded me of an elephant trunk. It would dip down as if to get food then rise up again as if the trunk of an elephant would put the food in his mouth. While the trunk was up the tornado was not dangerous, just when the point came down is when the damage started. My son and I watched the orange balls of fire roll down the Race Way Park then it lifted and the roof came off one of the horse barns.
>
> The storm hit unexpected---all sorts of things were falling about. The most interesting thing I remember is a surface glow---some three or four feet deep---rolling noise etc.... there was sort of a general brightness for a few seconds---some static on radio etc.
>
> We thought we saw searchlights all around us, but there were no light beams shooting up to the clouds from the ground. The lights darting around in the clouds were sort of luminous and appeared to be more round in shape than anything else, also they were quite large. The lights were not as bright as a stroke of lightning, but they were above a dense layer of clouds, and bluish white in color....they were shooting around. We could see the lights in the west, northwest, north, and northeast from 8:00 p.m. on.... We did not have much stroke lightning and I do not recall hearing thunder. Our electricity was knocked out at 9:32 p.m., and that is when we saw one black funnel. The reason we could see it is because there was a slight glow coming from the sides of it. It came from due west.
>
> I was standing in my backyard about 9:00 p.m. looking at the sky toward the west to north about 15°. The sky was really black.... All at once a big hole opened up in the sky with a mass of cherry red. The opening looked about 1/4 mile long and about the same height. It had a yellow tinge in the center and the edges were darker cherry red with black spots in the edges. This opening opened up complete in about 6 seconds, stayed open about 10 to 12 seconds then closed in 6 seconds. The sky was completely black again. It was about 30° to 35° up. The black spots that I referred to were small portions of dark clouds like balls, just a few on the right of the sketch and the lower left. They were rolling some, always working toward the outer sides. The cherry red had some vibration to it, very little. The upper center.... had a very fast quiver. Also a motion like hot steel melting in a pot. This motion was very small but fast.

The authors then make the following comments regarding the observations.

> There appear to be several possible explanations for the columns of light shown in [the photo]. They may be two tornado funnels illuminated externally by lightning; they may be some kind of luminous electrical discharge; or they may be tornado funnels illuminated by lightning or some other kind of electrical discharge within the vortex. We doubt the first of these possibilities on the grounds that if there were external lightning capable of illuminating the clouds, we should see evidence of illumination on the ground or objects in the foreground. Thus we are inclined to favor either of the two latter explanations.





Appearance of the Blackwell tornado of May 25, 1955. (Adapted from GLD-015, Fig. 7).

Pertinent observations made during two other tornadoes follow. The first tornado occurred on a summer afternoon in 1942 in Champaign, Illinois; the second, June 17, 1959, at Miami, Florida.

> I was looking....up at the clouds when I saw something that looked like a searchlight beam extend out of the cloud and reach to the skyline. It seemed a bit brighter than the cloud background. Edges were sharp, overall intensity even, sides parallel. Width about a degree of arc. No movement or turbulence evident. The phenomenon was interesting enough so I took out my Polaroid glasses and observed this "ray" through them, twisting the lens to look for polarization. No polarization was noted. This ray was obvious enough so that passerbys on the street were staring at it. All this took, say, 60 to 120 seconds (or more). Then abruptly the ray was instantly replaced by a normal tornado funnel. No transition stage was noted. The funnel did not descend from the cloud layer. It appeared over all, in situ. At this time I was a student at the Army Weather School at Chanute Field.

> [The] lower extremity [of the funnel] was continuously illuminated with a blue-green light flashing like an electric welding torch. A part of this was no doubt produced by the tornado disrupting....power lines.... However, the tornado was associated with a thunderstorm which had an extreme amount of electrical activity with almost continuous cloud to cloud and cloud to ground lightning strokes....

The authors also discuss the possible roles electricity may play in tornado formation and action. They feel that electrical forces can help explain the very high energy density in tornado cores.

GLD-016 ELECTRIC THEORY OF EARTHQUAKES AND VOLCANOES

Anonymous; Living Age, 102:387-398, 1869.

This is an old and rather curious article. There are several stories of lightning's seeming preference for certain localities where other geophysical phenomena seem to be focussed; for example, the Moodus Sounds (GSD-014).

> Any one who has lived much in the country must have heard, or noticed for himself, that there are certain spots in each locality where sheep and cattle are struck during thunderstorms more frequently than elsewhere. It is well known that men and animals are more liable to be struck by lightning when standing under trees than in the open country. But it is not to such cases that we refer. We speak of spots on the hills or on the open moor where there are no trees, and where the herbage or vegetation is of the same character as prevails for miles around, yet where, nevertheless, the lightning-flash descends to earth, or issues from it, more frequently than elsewhere.
>
> There must be a cause for this. And there is but one cause which can be assigned for it. At these spots the earth must in a special manner attract the electric discharge from the air---the earth must in those places give a readier passage, whether upwards or downwards, to the electric fluid than elsewhere. If such spots were examined, we believe it would be found that the subjacent rocks come near to the surface, and also that those rocks are of a kind through which the electric currents pass readily. In some cases, probably, the rocks at such spots are impregnated with iron or other metallic ores; and certainly they will be rocks of higher molecular organization than sandstone---namely, traprocks and others of so-called igneous origin. We believe that certain kinds of rock are the favourite or special media of the magnetic currents, which are in constant action around and beneath us, and which may be regarded as the nerve-force of the earth and of all matter---sandstone probably having the least, and the "igneous," crystalline, and metalliferous rocks the greatest affinity and attraction for those currents. (p. 392)

GLD-017 LUMINOUS PHENOMENA OBSERVED ON MOUNTAINS

Cash, C. G.; Nature, 56:31, May 13, 1897.

> On Easter Monday, 19th ult., I was ascending Braeriach by its well-known northern ridge, and shortly after I had crossed the "snow-line," I witnessed a

phenomenon of great beauty, the explanation of which I cannot give. The edge of my plaid, of my gloved hands, of my knickerbockers, &c., was bordered by a two inch band of brilliant violet light; at the moment of beginning any movement. The light was not visible around anything at rest, nor did it persist; but only showed at the moment when rest was changed for movement.

My attention was directed to this for a very short time only, for heavy snow began to drive in my face, and I had to watch where I was going, as the immediate surrounds included dangerous ground.

After my return, I found an account of a somewhat similar appearance in the Cairngorm Club Journal, vol. i., p.159. I copy the account as there given by Dr. John Gordon, of Aberdeen:---

"Half-way across the snow-slope, while the sun was somewhat obscured, but was still sending a considerable intensity of light, we observed a strange phenomenon. On the side of our body next the snow-slope there was a nimbus of violet light, which clung to clothes, naked fingers, and the shaft of the ice-axe. So plentiful did it appear in the palm of the hand that it looked at times like a pool of violet ink, and one thought it could be pitched away. On shaking the hand, however, the nimbus clung, and was not to be removed. Occasionally the colour varied, taking on shades of brownish-yellow and blue, but violet was the most marked colour. At another time, in much the same condition of light and snow surroundings, one of the party, who was very proud of the beauty of the silver case of his compass, was disgusted to find that it had a distinctly yellow, pinchbeck look. This light refraction or polarisation [?] was not so evident to some of the party, but the writer has observed it before in similar circumstances and atmospheric conditions."

I may add that, in my own case, no direct sunlight reached me, as I was in the lower part of a dense cloud or mist. Some of your readers may offer an explanation of this remarkable and beautiful appearance.

GLD-018 THE ANDES GLOW

Young, J. R. C. ; Weather, 26:39, 1972

I was particularly interested in this article [GLD–019] for two reasons. In the spring of 1944, one dark clear night, I observed the flash type of discharge being made repeatedly at the summit of what I believe is called Mont Leon to the north-west of Bone airport in Algeria. The night in question was clear and starlit and the top of Mont Leon was covered with a little cap of cloud; evidently it coincided with the inversion top, and it was in this cloud the flash occurred. Inquiry seemed to show that this was commonly seen in winter there.

When a major coronal discharge takes place around an aircraft in flight, and may I say I have never seen this on aircraft fitted with the latest type dischargers, what happens is this. Flashes of light appear upon the windscreen and then as discharge increases the nose of the aircraft appears immersed in a purplish haze which is accompanied by a loud hissing noise. This may all die away. If not, as a seeming crescendo is reached, there is a loud bang and a flash of light is seen to emanate from the aircraft, exhibiting the classical zig-zag formation and ending in a point. Then all is darkness and silence apart from the continued aerodynamic and engine noises which by comparison with moments before amount to a strange hush. Perhaps there is some limiting value of the potential gradient beyond which coronal discharge is replaced by a direct discharge of the current to a considerably greater distance.

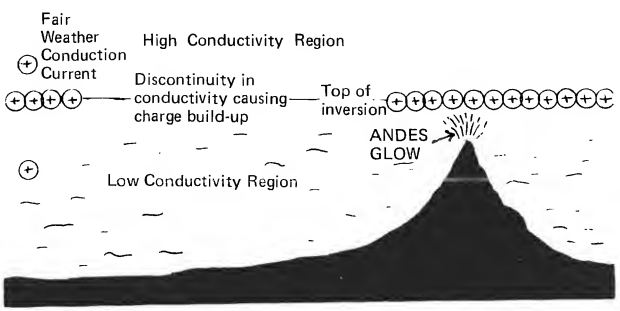
GLD-019 MOUNTAIN-PEAK POTENTIAL-GRADIENT MEASUREMENTS AND THE ANDES GLOW

Markson, Ralph, and Nelson, Richard; Weather, 25:350-360, 1971.

Markson and Nelson begin by reviewing the phenomenon of the "Andes Glow":

> "Andes glow" or"Andes lights" are terms used to describe illumination seen at night in the vicinity of certain mountain peaks. While the majority of reports have come from the Andes mountains of Bolivia, Chile and Peru, this phenomenon has also been reported in the European Alps, Mexico, and Lapland.....and presumably could occur in many mountainous regions under favourable conditions. While sometimes thought to be lightning, for lack of a more obvious explanation, the interesting property of these light displays is that they can occur under cloudless skies. Sometimes they are but one single flash, while at other times they may persist intermittently for hours. On occasion, a periodicity has been noted in the time between flashes.....At their most spectacular they have been described as "....not only clothing the peaks, but producing great beams, which can be seen miles out at sea"..... They seem to favour particular mountain peaks where often they can be seen during the dry season.....Very low humidity is frequently mentioned as the dominating meteorological factor when Andes lights are seen. Rather than lightning, the Andes lights may be a large scale Saint Elmo's Fire with many points across the mountain top going into corona discharge.

Markson and Nelson next review the sparse literature on the subject. Next, they describe measurements they made of electric fields on the summits of some Mexican mountains. The field gradients were found to vary, reaching 3,100 volts/meter---25 times the normal value. No glows were observed during the experiments, but they believe that stronger fields could easily build up and create discharge phenomena. They remark that mountain-top glows in the polar regions might easily be taken for auroras, and that this impression might be more than subjective. Solar flares are not only associated with auroras but they are known to increase the earth's electric field gradient. In other words, mountain-top glows and auroras may both be stimulated by solar activity.



The mechanism by which a haze might initiate point discharge from a mountain peak. (Adapted from GLD-019)

GLD-020 ELECTRIC PHENOMENA IN THE EUPHRATES VALLEY

Huntington, Ellsworth; Monthly Weather Review, 28:286-287, July 1900.

Huntington was well-known at the time for his studies of the effects of climate on man.

> During a recent ten days' geological trip through an almost unvisited part of the Taurus Mountains to the south of Harpoot I heard of a phenomenon which I should be glad to have you explain, either by letter or through the columns of the Review. Before leaving Harpoot I was told by a man from Aivose that Keklujek Mountain, near his village, fought with Ziaret Mountain, on the other side of the Euphrates River. The weapons were balls of light, which the mountains threw at each other. As the region was one of volcanic activity in comparatively recent times, and as hot springs at extinct craters are still to be seen, I thought at first that this must be a traditional account of a volcanic eruption. Subsequent investigation, however, showed that the story had its origin in a meteorological phenomenon. At first I was skeptical as to the truth of what follows. After hearing substantially the same story from ten or twelve men whom I saw in five different places separated by an extreme distance of 40 or more miles, I became thoroughly convinced of its truth. It may be a common occurrence, but I have never heard of it and can find no account of it in the few books at my command.
>
> The facts, upon which all agree, are as follows: A ball of fire is sometimes seen to start from one mountain and to go like a flash to another. At the same time there is a sound like thunder. This occurs by day or by night, although by day no light is seen. It always occurs when the sky is clear and never when it is cloudy. It sometimes happens two or three times in a year, and then again is not seen for several years. For the last two years it has not been seen. It is most common (or possibly never happens except) in the fall at the end of the long, dry season of three months. The mountains show no special features different from other mountains. I visited one of them, Karaoghlon (Black Son) Mountain, and found it to be composed of metamorphic schistose shale of cretaceous age. Its height is 7,350 feet and the top is comparatively flat. One observer said that a glow remained after the flash, but all the rest contradicted this. Another said that the ball of fire was first small, but grew larger as it passed over, and then grew smaller again. He evidently was between the two mountains.

GLD-021 ELECTRIC PHENOMENA IN THE EUPHRATES VALLEY

Anonymous; Monthly Weather Review, 28:290, July 1900.

In attempting an explanation of the phenomenon reported by Huntington (GLD-020), the Editor of the Monthly Weather Review begins thus:

> We need not apologize for refraining from attempting to find the correct explanation of the mysterious lightnings and thunders here recorded. It is well known that lightning passes between cloud and cloud or cloud and earth, but we have not yet any well authenticated case of its passing from peak to peak, although the poets describe it as "leaping from crag to crag." Byron is quite true to nature when he (in Childe Harolde, Canto III, stanza 92), describing a

thunderstorm on Lake Leman, says:

Far along
From peak to peak, the rattling crags among,
Leaps the live thunder

There are peaks in the Rocky Mountains on which almost continuous electric discharges have been observed, but they pass off into the air quietly, like St. Elmo's fire, never in great flashes from peak to peak. During eruptions of Vesuvius, the lightning passes from the mountain to the clouds of steam that have risen from the volcano, but not between neighboring peaks. In general, the air ordinarily offers such a resistance to the passage of electricity, while the earth is such a good conductor of electricity, that it would be easier for two electrified peaks to discharge through the earth than through the air. We cannot, therefore, think of a lightning flash passing between two neighboring peaks. On the other hand, a cloud or a mass of electrified air that has not quite attained the cloudy condition may lie between two peaks, and flashes may proceed from it simultaneously to the two peaks in such a way as to lead a careless observer to say that one peak discharged over to the other.

GLD-022 ST. ELMO'S FIRE ON BEN NEVIS

Rankin, Angus; Nature, 40:439-440, September 5, 1889.

St. Elmo's Fire as seen occasionally at the Ben Nevis Observatory takes the form of jets of light on the tops of all objects that stand any height above the general level of the roof of the Observatory, such as the chimneys, anemometers, lightning-rod, &c. In a very fine display the tops of the objects are quite ablaze with the phenomenon, which then glows and hisses in brilliant tongues of white and blue, from four to six, or even more, inches in length. Nor is the phenomenon confined to these objects alone in the finer displays, but if the observer stands on the roof his hair, hat, pencil, &c., glow with it as well, and when he raises a stick above his head the stick has also a long flame at the top. Further, however, than having a slight tingling in his head and hands he suffers no inconvenience. The hissing is a very marked characteristic of the phenomenon, being always heard during ordinary displays, though in the feebler displays, when the light can barely be seen, it cannot be distinguished from the hissing of the wind and the snow drift. On one occasion the sound was a very highly pitched note. In the finer and even in ordinary displays St. Elmo's Fire is an object of great beauty, and the stormy character of the weather---namely, squally winds with heavy showers of snow and hail, and with clouds of snowdrift flying all around---heightens rather than diminishes the effect, although at the same time it detracts from the convenience of observing with advantage.

GLD-023 A PSEUDO-AURORA

Brunton, Lauder; Nature, 87:278, August 31, 1911.

For some time I have been staying at the Kurhaus, St. Beatenberg,

Switzerland, and my window commands a view of the Bernese Oberland from the Wetterhorn to the Balmhorn. The Eiger Monch, Jungfrau, and Blumlisalp stand out most clearly above the lower mountains in front of them, of which the Faulhorn and Mesen are members. There has been a continuance of hot and dry weather for many weeks, and there have been occasional thunderstorms with both forked and sheet lightning. On the night of August 21, about ten o'clock, semicircular flashes of light shot up apparently behind the Monch, quivered for a few seconds, and then disappeared. I counted twenty-eight in a minute. The light was sometimes intense at a central point, which was steady, and from this a quivering glow proceeded and lighted up from 15° to 20° of the horizon. The outline of the Jungfrau group could occasionally, but not always, be seen.

The appearance seemed to me very like an aurora borealis which I saw in Scotland in the 'fifties, but the centre of the light here was to the southwest of where I stood. I do not know how long the light had appeared before I saw it, but it continued to flash with great brilliancy for about twenty minutes. It then became less bright, and did not shoot so high into the sky, but extended laterally to the south for about 30° behind the Oberland chain. After half an hour more these died away, and on looking out two hours later nothing was to be seen. I am informed that a similar phenomenon was visible on the previous night, but was less brilliant. The resemblance to a true aurora was so great that I have thought it might be worth description.

See GLD–029 for semi-circular flashes of light from volcanoes. Both instances may have an electrical origin.

GLD-024 ATMOSPHERIC PHENOMENON

S., B. W.; Nature, 22:362, August 19, 1880.

A curious phenomenon was observed here after sunset the night before last, and again in a less degree last night. (Dates: August 11 and 12, 1880)

Looking across from this point to the position of the sun at and after setting, the line of sight crosses about three miles of sea, then about the same distance or rather less of projecting high ground, and beyond that many miles of sea again. On Tuesday (10th) the sun set in a hot haze, and half an hour after there appeared on the edge of the projecting land what looked like tongues of flame fifteen to thirty minutes in height, lasting from two to four seconds each, and then disappearing in different places, sometimes half a dozen at a time. At the same time there was more or less of a flickering light along the whole line of projecting land.

My first impression was that it was an optical illusion, and the second that a moor was on fire behind the ridge, and that these were points of flame. The first was negatived by the fact that four others beside myself (two of them with very keen sight) saw the lights independently in the same places; and the second by the gradual fading of the light as the evening became darker, the "tongues" retaining pretty much their relative brightness to the general glow until both faded out.

The day had been extremely hot, and the evening was sultry, with motionless air. I imagine the appearance was due to irregular refraction, arising from heated currents of air from the cooling land, and that the circumstance of the slice of land with its currents occurring between the two stretches of

homogeneous air over the sea allowed the effect to be seen without being masked, as it would have been had there been intervening land. But I never saw it before, and don't remember to have seen it described.

This account is similar to one from India. (GLD-009)

GLD-025 [ELECTRIC FLUID ENVELOPES GIRL]

Anonymous; Nature, 22:204, July 1, 1880.

The Times Geneva correspondent writes under date June 20 that a remarkable electrical phenomenon occurred at Clarens on the afternoon of Thursday last. Heavy masses of rain-cloud hid from view the mountains which separate Fribourg from Montreux, but their summits were from time to time lit up by vivid flashes of lightning, and a heavy thunderstorm seemed to be raging in the valleys of the Avants and the Alliaz. No rain was falling near the lake, and the storm still appeared far off, when a tremendous peal of thunder shook the houses of Clarens and Tavel to their foundations. At the same instant a magnificent cherry tree near the cemetery, measuring a metre in circumference, was struck by lightning. Some people who were working in a vineyard hard by saw the electric "fluid" play about a little girl who had been gathering cherries and was already 30 paces from the tree. She was literally folded in a sheet of fire. The vine-dressers fled in terror from the spot. In the cemetery six persons, separated into three groups, none of them within 250 paces of the cherry tree, were enveloped in a luminous cloud. They felt as if they were being struck in the face with hailstones or fine gravel, and when they touched each other sparks of electricity passed from their finger-ends. At the same time a column of fire was seen to descent in the direction of Chatelard, and it is averred that the electric fluid could be distinctly heard as it ran from point to point of the iron railing of a vault in the cemetery. The strangest part of the story is that neither the little girl, the people in the cemetery, nor the vine-dressers appear to have been hurt; the only inconvenience complained of being an unpleasant sensation in the joints, as if they had been violently twisted, a sensation which was felt with more or less acuteness for a few hours after. The explanation of this phenomenon is probably to be found in Prof. Colladon's theory of the way in which lightning descends, as described in Nature, vol. xxii, p. 65. The Professor contends that it falls in a shower, not in a perpendicular flash, and that it runs along branches of trees until it is all gathered in the trunk, which it bursts or tears open in its effort to reach the ground. In the instance in question the trunk of the cherry tree is as completely shivered as if it had been exploded by a charge of dynamite.

These luminous effects closely resemble those experienced near and in some tornadoes (GLD-015).

GLD-026 [FIREBALLS ON CHURCH TOWER]

Anonymous; Nature, 22:155, June 17, 1880.

Mr. G. Ambrose Pogson, British Vice-Consul at Hamburg, writes to the Times from that place, under date June 12, as to "St. Elmo's Fire":---A series of thunderstorms, he states, has lately passed over Hamburg. During the 11th inst. the air was densely charged with electricity; the storm broke about 10.15 p.m., lasting until 11 p.m., during which time, at very short intervals, from my station, about 1,200 yards distance from the copper-roofed tower of the church known as St. Jacobi, about 300 feet high, I saw this phenomenon apparently resting about 30 feet from the summit of the steeple. The colour was a reddish purple, and reminded one somewhat of burning potassium. From repeated comparisons with other objects during the lightning flashes, I judged these fire-balls (two were several times visible) to be from 4 feet to 6 feet in diameter. The longest duration that I timed was 42 seconds. This passing away of such dense masses of electricity by induction was visible some twenty times, but whether performed silently I had no means of ascertaining. From the apparent size of flame and the non-lightning quality of the colour, I estimated it as equal to 10,000 candles. The colour was doubtless the effect of the glare of the copper roof.

GLD-027 PHOSPHORESCENCE OF THE SEA

Groves, Thos. B.; Nature, 23:411, March 3, 1881.

You will perhaps permit me to record the occurrence of a phenomenon very rarely witnessed on this coast---I mean the general and quasi-spontaneous luminosity of the sea.

It is of course common enough to observe sparkles of light more or less abundant when sea-water is briskly disturbed by contact with an oar or the bow of an advancing vessel; but it has only once before been my fortune, and that was twenty years ago, to witness the crest of each wavelet illuminated by the pale silvery light proceeding from countless phosphorescent organisms present in the water.

The night, being cloudy, favoured observation, but there was considerable haze. The wind was south-east or thereabouts, the temperature of the air being 52^{O}F., that of the sea close by the shore 47^{O} 5F.

The phenomenon was visible on the night of Thursday, February 17 only. The following night was equally favourable for observation, and the temperatures were the same within a degree, but the cause or causes no longer operated. On casting into the sea a shower of pebbles, which the night before produced brilliant flashes of light, or larger stones, which then developed concentric luminous wavelets, only a doubtful effect was observed. The organisms had, it seemed, already expended their force---probably had actually died---and I thought I perceived an unusual frothiness in the water.

Is it not uncommon for this to occur so early in the year? It is in summer, when the temperature of the sea is high, that we expect to see the water "fiery." Was the phenomenon observed on other parts of the coast?

The author presumes this is a bioluminescent phenomenon, perhaps like the famous "light wheels" of the Indian Ocean. (GLW section) Nevertheless, electrical discharge is a possible stimulus and the observation is presented here.

GLD-028 A STRANGE LIGHT ON THE ANDES

Anonymous; Literary Digest, 45:840-841, November 9, 1912.

Translated from a Havana paper.

Ordinarily the light has a glistening appearance, and commonly its boundary has the shape of a bold curve; not seldom it is seen only on one side of the Cordilleran group. The most vivid, the most powerful flashing occurs at a definite point, and it sometimes rises several degrees above the main Cordilleran crest. Often the discharges seem to reach beyond the zenith and consequently over the so-called Artists' Cordillera, and far way to sea. When the sky is clear the phenomenon can be perceived with ease; and during long intervals after darkness it can be observed day by day. Of course, it may be present also during daylight, but it is not then observable.

It begins in late spring and lasts till the approach of winter; and toward the south this phenomenal light becomes gradually less or ceases altogether. In northern and central Chile, in Bolivia, and probably, too, in Peru, this flashing is seen, altho on occasional long intervals of their joint area it apparently fails to appear.

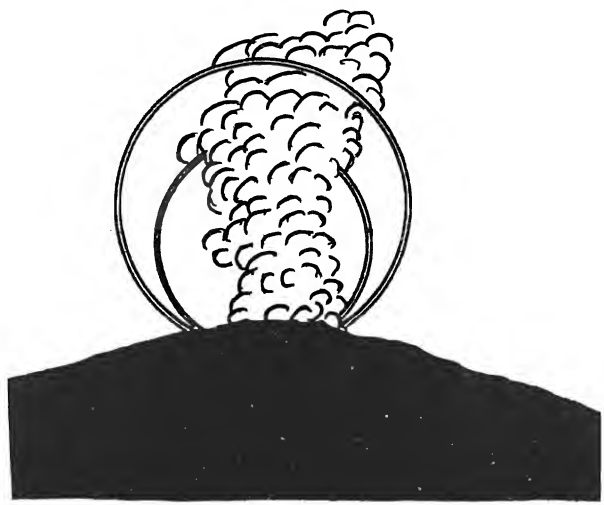
Quite recently a naturalist, during a journey through a valley of the main Cordillera, observed this phenomenon with exactness. One evening about nine o'clock, while studying an unusual and frequent discharge, he was able to ascertain that its point of issue was an elevation of the Cordillera along which he was roaming. Moving constantly around this peak was a band shaped like a segment of one or two degrees in height and somewhat similar to the zodiacal light in brightness. During the present season the light has glistened as usual, but with much greater strength, and especially above the discharge, into which the glistening has disappeared after a moderate interval. The naturalist believes that this flashing of the Andes is due to profuse electric discharges in certain districts of their Chilean section, and particularly among the greater peaks. The predominating popular view is that this light is a reflection of the molten lava in volcanic craters. Such a view is erroneous, however. It is not improbable that the number of the points at which these discharges occur changes; and it is possible, too, that during the great earthquake of August, 1906, discharges occurred along the whole crest, for, if we may accept authoritative statement, the sky everywhere in central Chile then flashed with a quivering "fire," such as was never seen either previously or thereafter.

Observation leads to the conclusion that this seeming radiance of the Andes is the result of a copious issue of electricity, which is visible only from certain favorable points of view, and perhaps is not always occurring. How these discharges, which are noiseless and produce no sparks, may be designated at this day, is not quite clear. Probably, if we may follow further eminent opinion, the great infrequency of thunderstorms in Chile is related to the apparently compensating action of the lightning crest of the Cordilleras. And whether the flashing of the Andes is not related, too, to that form of the aurora borealis which is sometimes observable above mountain peaks in Norway must be answered by further investigation.

GLD-029 THE FLASHING ARCS: A VOLCANIC PHENOMENON

Perret, Frank A.; American Journal of Science, 4:34:329-335, 1912.

On the afternoon of April 7, 1906, the present writer, in company with Professor Mattenucci, was skirting the southern flank of Vesuvius on a trip to the main source of the lava at the Bosco Cognoli. The volcano at this time was entering one of those paroxysmal phases by which the eruption---already three days old---worked progressively up to its great culmination, which occurred, it will be remembered, between this and the following day. The ejected detritus was of a mixed nature, viz., the fresh lava, clear red in full daylight, being mingled with old material from the upper portions of the cone, then in process of rapid demolition. The frequency of the explosions varied from approximately one every three or four seconds to at least three per second. Although powerful, they were very sharp and sudden in their nature, and at the instant of each---but before it could be sensed by the eye or ear---a thin, luminous arc flashed upward and outward from the crater and disappeared in space. Then came the sound of the explosion and the projection of gas and detritus above the lip of the crater. The motion of translation of the arcs, while very rapid in comparison with that of the detritus, was not above the limits of easy observation and there could be no doubt as to the reality of the phenomenon, which was repeated some hundreds of times.



The flashing arcs from the Vesuvius eruption. (Adapted from a photograph, Fig. 1, in GLD-029).

Later, during the 1910 eruption of Etna, the writer again observed these strange arcs.

On the morning of March 30 [1910] bombs as large as a meter in diameter were ejected and these explosions produced the flashing arcs which were in all respects identical with those at Vesuvius. Until they were pointed out to him my guide did not observe them, and it is quite possible that I myself might not have seen them had I not known what to look for, as the absence of

a darker setting and the lesser distance of the viewpoint rendered them more difficult of observation than at Vesuvius. Some fifteen were clearly seen by both of us, all the stronger explosions producing them.

What is the nature of this phenomenon? The only hypothesis which seems in accord with the observed characteristics sets forth a proposition which, at first thought, may seem almost startling, viz, that we have to do with visible sound waves. According to some far from accurate measurements made on the spot the velocity of propagation of the arcs seemed to correspond with that of sound. We may certainly assume the outburst to be spherical or at all events globular, as though a huge soap bubble were rapidly blown from the crater and that the edge alone is visible and therefore appears from any point of view as an arc. The movement of this visible portion will therefore be at right angles to the line of sight and the arrival of the sound---from the crater radially to the observer---must be compared with the arrival of the arc at some point equidistant from the crater but at right angles to this radius. As the arcs rapidly fade into invisibility with increasing distance from their source the difficulty of accurate measurement will seem to be very great.

The possibility exists, of course, that the arcs are electric in nature, for volcanoes are known to stimulate lightning discharges.

GLD-030 WHAT WAS IT?

Dunn, Mrs. James; Fate, 14:116-117, February 1961.

My husband and I live on a farm outside of the town of Marion, Mich. On one side of our house is a hayfield. Early one morning in June, 1960, as I was doing my housework, my husband came into the room where I was working and gazed out of the window. He said to me, "Come here a minute. What is that red object?"

I looked out of the window and saw what appeared to be flames leaping up in the uncut hay.

My husband said, "I'll go out there and see what it is."

We both went outside and he walked ahead to investigate. He called out, "I don't see anything here."

I said, "It is all around you."

We both went into the house and gazed out again. There it was. It lasted for half an hour. We both watched until it gradually disappeared. What was it?

Unfortunately, no weather information is given here. Shimmering of the atmosphere is sometimes reported prior to the formation of ball lightning. Of course, electrical discharge phenomena are often flame-like in appearance.

GLD-031 ON THE FACTS OF EARTHQUAKE PHENOMENA

Mallet, Robert; Report of the British Association, 303, 1854.

This and the following item (GLD–032) are from the 1854 section of Mallet's catalog of earthquakes.

March 22, 1841; Coblentz. A shock of a second's duration, from N. E. to S. W. Accompanied by a very loud noise. The steersman of one of the steamers declared that he saw a blue flame rise from a hill in the distance, which remained suspended in the air for a time, and then sank and disappeared upon the spot it rose from.....

GLD-032 ON THE FACTS OF EARTHQUAKE PHENOMENA

Mallet, Robert; Report of the British Association, 259, 1854.

February 9, 1836; Hungary. A very severe shock. Preceded by terrible noise, and extraordinary disturbances in the atmosphere. At Zalles-Gyorok the ruins were numerous. In some places flames issued from the ground....

GLD-033 CURIOUS PHENOMENON

Markwick, E. E.; English Mechanic, 75:417, June 27, 1902.

A friend informs me that, on looking at the sunset sky on May 10 last from about 6.50 p.m. to 7.5 p.m., or perhaps a little later, he saw numberless "suns" in various parts of the sky, coloured "magenta to violet" principally, although they also changed to yellow and green. He called his sister out of the house; after that, his farm manager; and then again referred to the local postman; all of whom verified the curious sight, the lady remarked they (the "suns") looked "like toy air balloons." The locality is near Ivybridge, South Devon. Weather was clear at the time. I understand the "suns" were visible at a moderate altitude, and in the direction of the sunset.

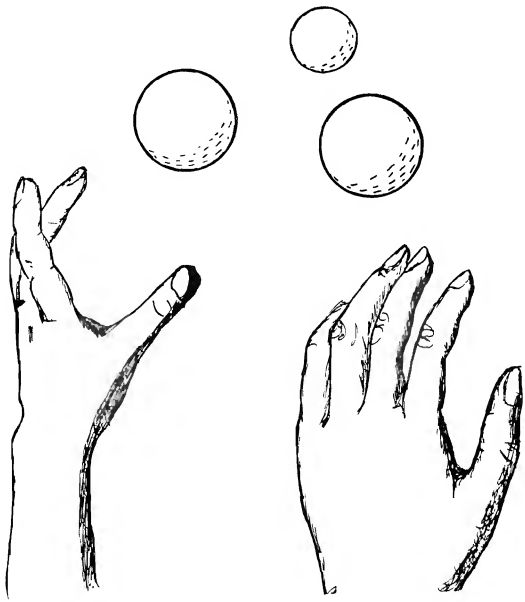
I have questioned my friend personally on the subject, with a view to ascertaining whether or not he was the victim of some complementary effect, after looking at, or towards, the bright image of the sun. He is a man of the world, has travelled largely, is a good sportsman, in excellent health, and is the last person, one would consider, to make such a report, unless something unusual had really been seen. Moreover, he was thoroughly corroborated by the individuals to whose attention he directed the phenomenon, and who saw the "suns" quite plainly. The local press did not at the time contain any reference to the matter. The time of year negatives, I think, the idea of the phenomenon being due to floating pieces of gossamer or thistledown. Can any of your correspondents suggest what it was my friend saw?---for it altogether beats me, who have been an observer of the sky for a considerable number of years, during which I never remember anything of the sort.

GLD-034 ELECTRICAL PHENOMENA NEAR WEYMOUTH

Anonymous; Nature, 126:262, August 16, 1930.

Aug. 17, 1876. Electrical Phenomena near Weymouth.--At Ringstead Bay, near Weymouth, Dorset, during a sultry afternoon, on ground above the cliffs, a number of globes of light were seen of the size of billiard balls, extending from a few inches above the surface to a height of 7-8 ft. They slowly rose and fell vertically, sometimes within a few inches of the observers but always eluding the grasp. The number of these objects varied from twenty to "thousands". No sound accompanied the display, but at 10 P. M. there was a thunderstorm.

Quite possibly, the globes reported above might be ball lightning, but the very large number of them militates against this.



Elusive spheres described in GLD-034

GLD-035 [MYRIADS OF LUMINOUS BODIES CROSS SKY]

Anonymous; Nature, 22:64, May 20, 1880.

A remarkable phenomenon was observed at Kattenau, near Trakehnen, Germany, and in the surrounding district, on March 22. About half an hour before sunrise an enormous number of luminous bodies rose from the horizon and passed in a horizontal direction from east to west. Some of them seemed of the size of a walnut, others resembled the sparks flying from a chimney. They moved through space like a string of beads, and shone with a remarkably brilliant light. The belt containing them appeared about 3 metres in length and 2/3 metre in breadth.

GLD-036 BOUNCING BALL

Hazeltine, Kate R.; Fate, 17:117-118, October 1964.

I was intrigued by the article A Bounce of Foam in Mexico as it brought to mind a tale my late father, Lewis M. Hazeltine, told of a similar object or "thing" he saw on the Kiatone Road in Warren County, Pa., in the early 1870's when he was a young man.

Father was driving a team of horses out of Jamestown, N. Y., over the Kiatone Road south towards Warren, Pa. The dirt road had been cut through tall trees, mostly pines, and a space or burn of 25 feet had been left on each side to let in light.

Suddenly there appeared on the right hand side of the road a sort of spongy looking white ball about five feet in diameter. It bounced along, changing shape somewhat as it touched the ground and keeping pace with the horses and buggy.

Father was both surprised and frightened---in fact, he said, his hair literally stood up on his head. He might have thought it an apparition had not the horses also become frightened and so unmanageable that they literally ran away, leaving the woods and the bouncing ball behind.

Father often wondered what the strange object might have been and from whence it came. He had, of course, no opportunity to examine it at close range, but he recalled that although it changed shape as it bounded, it appeared not to tear as it hit the tree stumps. It seemed to be intact as it faded from view.

GLD–037 A DESTRUCTIVE "DUST DEVIL"

Anonymous; Fate, 25:47, February 1972.

A white ball of smoke blew through the home of Mrs. Willine Hamilton of McClain, Miss., in April 1971, rattling pots and pans, blowing out a wall and damaging the roof---then spinning off with several articles of clothing. Mrs. Hamilton thought it was a twister---but the sun was shining.

A Weather Bureau representative said he first thought the white ball was a sonic boom but changed his mind because booms don't blow things away.

Lamar Woodward of the Weather Service said his office couldn't identify the white ball positively as a "dust devil" but he went on, "I have seen dust devils that were pretty destructive."

GLD-038 [ROUND OBJECTS PARADE OVER NEW YORK CITY]

Fort, Charles: The Books of Charles Fort, Henry Holt and Company, New York, 1941.

Upon the 21st of September [1910] (New York Tribune, September 22) a great number of round objects were seen passing from west to east over the lower part of New York City. Crowds stood in the streets, watching them. They were thought to be little balloons. I have records of similar objects, in large numbers, that could not be considered little balloons. For several hours this procession continued. (p. 640)

GLD-039 ELECTRICAL ACITIVITY ASSOCIATED WITH THE BLACKWELL-UDALL TORNADO

Vonnegut, B., and Moore, C. B.; Journal of Meteorology, 14:284-285, June 1957.

Referring to the experiments of R. Gunn, which seemed to indicate that the electrical effects of a tornado are no stronger than those of an ordinary thunderstorm, Vonnegut and Moore point out that, in the Blackwell-Udall tornado, lightning strokes were occurring at rates between 2 and 25 per second. This is 4-40 times faster than those described by Gunn. Further, the authors claim that Gunn's instrumentation had too long a response time to measure the very rapid changes in electrical activity. The authors then reaffirm their belief that tornadoes are extremely active electrically and add the following eye-witness accounts in support of their thesis.

> Eyewitnesses to the tornado in Blackwell also have reported evidence of intense electrical activity. Montgomery, who viewed the tornado from a distance of about 3000 ft., reports: 'As the storm was directly east of me, the fire up near the top of the funnel looked like a child's Fourth of July pin wheel. There were rapidly rotating clouds passing in front of the top of the funnel. These clouds were illuminated only by the luminous band of light. The light would grow dim when these clouds were in front, and then it would grow bright again as I could see between the clouds. As near as I can explain, I would say that the light was the same color as an electric arc welder but very much brighter. The light was so intense that I had to look away when there were no clouds in front of it. The light and the clouds seemed to be turning to the right like a beacon in a lighthouse.'
>
> Montgomery also tells of other eyewitnesses who had different views of the phenomenon, such as Mrs. Carl Sjoberg whose house in the direct path was completely demolished: 'She saw lightning coming up from the ground two or three feet high and about half as wide as adding machine tape. It was a deep blue and forked on the end like a 'Y' or like a snake's tongue.'
>
> According to Montgomery, Lee Hunter, who was 4 mi. north of Blackwell, described the tornado as follows: 'The funnel from the cloud to the ground was lit up. It was a steady, deep blue light---very bright. It had an orange color fire in the center from the cloud to the ground. As it came along my field, it took a swath about 100 yards wide. As it swung from left to right, it looked like a giant neon tube in the air, or a flagman at a railroad crossing. As it swung along the ground level, the orange fire or electricity would gush out from the bottom of the funnel, and the updraft would take it up in the air causing a terrific light---and it was gone! As it swung to the other side, the orange fire would flare up and do the same.'

GLD-040 THE NOTES OF CHARLES FORT

Fort, Charles; The Fortean Society Magazine, 1:12, Spring 1944.

> August 26, 1826. Fiery whirl. Carcassone (Aude), great heat in the morning. At noon massing clouds in the west. Then a thick black cloud suspended over a field. Crackling and hissing and air rushing toward the cloud. A loud detonation and an enormous column of fire hovered the field--throwing down walls and picking up and killing sheep. A strong sulfurous odor. Nobody said it burned anything.

GLD-041 ATMOSPHERIC ELECTRICITY

Omond, R. T.; Nature, 40:102, May 30, 1889.

In Nature of May 16 (p. 55), Mr. Bowlker describes some 'curious' and, as he believes, 'rare electrical phenomena' which occurred to him and a friend on the Welsh mountains. Such phenomena are rare only because competent observers are so. The effects described are by no means uncommon, and they may be classed under the brush discharge and the glow, the one being an interrupted, and the other a continuous, discharge to the air.

H. de Saussure gives the results of his observations in America, Switzerland, and other places. He remarks that the lighting-up of the rocks at night is analogous to the curious fact of electricity moving over the prairies. It is compared to a kind of miniature lightning discharge, resulting from the electrified cloud brushing over the earth, and discharging itself in thousands of sparks coursing over the meadows. In Mexico he noticed the crepitation of the stones due to electrical discharges, and in Switzerland he describes certain pricking and burning sensations, and sounds like that of simmering water, emitted from sticks laid against the rocks, and from the tops of the alpenstocks. This humming of the mountains is by no means rare, and it seems to indicate a flow of electricity from the ground into the air.

When Prof. James Forbes was at work on the glaciers of Switzerland, he noticed on one occasion, near Mont Cervin a curious sound proceeding from his alpenstock. The guide referred it to a worm eating the wood; he reversed the stick, and the worm was already at the other end. He raised his hand above his head, and the fingers yielded a fizzing sound while the angular stones all round were hissing like points near an electrical machine. There was hail at the time, and a thunderstorm soon set in.

M. Trecul relates in the Comptes rendus the following curious case:--- While writing at an open window in August 1876, between 7 and 8 a.m., he noticed a number of small luminous columns descend obliquely on his paper, each about 2 metres long, and half a decimetre broad at the widest part, obtuse at the farther end, but gradually thinning towards the table. They had mostly a reddish-yellow tint, but near the paper the tints were more intense and varied. In disappearing they left the paper with a slight noise, like that produced by pouring a little water on a hot plate. Loud thunder was heard at the time of the observation.

GLD-042 MOUNTAIN PEAK POTENTIAL GRADIENTS

Latham, J.; Weather, 26:80, 1971.

After commenting on the potential gradient measurements of Markson and Nelson (GLD-019), Latham makes this comment as to the source of the potential gradient:

.....A possible reason for the occurence of "Andes Glow" is that immense electric fields can be generated by the blowing of snow over the mountain peaks (Latham and Stow, 1967 Quart. J. R. Met. Soc., 93, pp. 55-68) thereby producing a visible discharge.

GLD-043 AN ELECTRICAL EFFECT ON CRIB GOCH, SNOWDONIA

Satow, R. F. W.; Weather, 26:79-80, 1971.

On 14 November 1970, I was climbing Snowdon with three companions. We were going from Pen-y-pass (summit of Llanberis Pass) via the steep-sided ridge of Crib Goch. About 1200 GMT at the eastern end of this ridge, all members of my party, and most of those in another we had joined, experienced a curious sensation. For about five minutes, an easily audible hissing sound could be heard, apparently originating from the backs or shoulders of our Bri-Nylon anoraks. This sound was not caused by the moderate snow and snow pellets being blown against our anoraks, as it maintained a steady intensity when the wind and precipitation temporarily abated.

I later discovered we were at the time close to the centre of a small 'Polar Low.' Fairly strong convective activity would probably have been present over the mountains, and I have surmised that we may have experienced an electrical discharge on the sharp ridge.

GLD-044 THUNDERSTORM PHENOMENA ON THE MATTERHORN

Larden, Walter; Nature, 48:316-317, August 3, 1893.

On July 10 I was on the Matterhorn in very doubtful weather. It appeared as though the Fohn (or southerly wind) were struggling with a northerly wind, and as though the former conquered. Clouds or mist pressed up from Italy, and rose higher and higher, covering the other mountains before the Matterhorn. We had some snow at intervals even before midday, and by the time that we had, on return from the summit, descended as far as the upper hut, it was snowing steadily. I think that, as regards the Matterhorn, the electrical hissing of ice-axes, rocks, etc., began about 3.30 p.m. or 4 p.m., and lightning began rather later.

At last came one flash, apparently very near to us, the thunder following close with a crash. Before the thunder, however, and apparently with the flash, came a curious splitting, cracking and shivering sound, with a kind of 'splash' from the rocks---as it seemed. I give many adjectives for want of one good expressive word. This sound preceded the thunder, and was both sharp and faint; I felt that I only heard it because I was on the spot.

.....

It was dark when we reached the lower hut; and all down the arete the brushes of purple light that streamed from our fingers (when held up) and from our axes, hats, hair, etc., were very beautiful. The fingers gave better brushes when wetted. There were numerous brushes streaming from the rocks, these being wet with water melted from the snow.

Some other people who were on the Gorner Grat the same day told me, before I mentioned my experiences, that the lightning seemed to give a splashing sound on the rocks. They also told me that those who wore felt hats, felt return shocks, while those with straw hats did not. All the hats were wet.

GLL-001 VOLCANO LIGHTNING

Gillmor, Daniel S., ed.; Scientific Study of Unidentified Flying Objects, Bantam Books, Inc., New York, 1969.

The charged material ejected by active volcanoes often sets the stage for spectacular lightning discharges, as described below.

> Undersea volcanic eruptions began on the morning of 14 November 1963, only 23 km from the southern coast of Iceland, where the water depth was 130 m. Within 10 days an island was created which was nearly 1 km long and 100 m above sea-level. Motion pictures showed clouds rising vertically at 12 m/sec to an altitude of 9 km. The cloud of 1 December contained intense, almost continuous light, presumably the result of large dust particles and perhaps electric effects of sulfur.
>
> Aircraft flights through the volcanic cloud were made during period of no lightning. Large electric fields were measured, sometimes exceeding 11,000 volt/m.
>
> The production of lightning by volcanoes is of considerable interest for atmospheric electricity. Nevertheless there is no evident relation between volcano lightning and UFO reports. (pp. 739-740) (Martin D. Altschuler)

GLL-002 [EARTHQUAKE LIGHTNING]

Anonymous; Nature, 21:19, November 6, 1879.

> A violent shock of earthquake is reported to have occurred in West Cumberland at 5:30 A. M. on Saturday week. A vivid flash of lightning was seen at the same time.....

GLL-003 "INFERNITO"

Anonymous; Nature, 40:429, August 29, 1889.

Following a description of the violent eruptions of hot water and petroleum at a spot in Venezuela bounded by the rivers Zulia and Catatumbo and the Cordillera, this description of an unusual electrical (?) phenomenon is appended:

> .....Considering the immense amount of inflammable gases which must be given out by the flows and deposits of petroleum as described above, it may be easily believed that this has a direct bearing upon the phenomenon known since the conquest as the Faro of Maracaibo. This, consisting of constant lightning without explosion, may be observed towards the south from the bar at the entrance to the lake, and Coddazzi in his geography explains it as being caused by the vapors arising from the hot water swamp situated about one league to the east of the mouth of the Escalante, at the southern extremity of the lake.....

GLL-004 THE FREAKS OF LIGHTNING

Abbott, J.; Harper's New Monthly Magazine, 38:577-588, April 1869.

In this fascinating old account, the author is just as certain that electricity is important in waterspout formation as many modern scientists are sure it is not.

> One of the most singular and least understood of the phenomena connected with the agency of electricity is the formation of Waterspouts. The evidence is complete that the influence of electricity is very largely concerned in these wonderful gyrations, but whether as cause or effect is not so clear. They are most frequently observed at sea, though sometimes they appear in an imperfect form in lakes or upon other small bodies of water. And even on land, especially in mountainous regions, a commotion in the clouds, attended by an immense fall of rain, has often occurred, presenting appearances closely analogous in their nature to those of the regular water-spout as observed at sea.
>
> .....
>
> The connection of electricity with the phenomenon is indicated by the fact that at the moment when the upper and lower formations meet a flash of lightning is often seen to dart from one to the other, showing that the water and the cloud are in opposite electrical conditions at the moment before they unite. Besides this there are some experiments which may be made with electricity artificially excited, in which effects are produced which seem in a considerable degree analogous to those witnessed in this phenomenon--- sufficiently so to increase the probability that the agency of electricity is in some way involved, though it is not known in precisely what manner or to what extent.

Abbot also presents one of the classic "pranks" of lightning.

> A great many curious tales are related of extraordinary interpositions of the electric force in some of the most striking dramas of human life. Arago gives an account of the chief of a band of brigands being struck down in the court-yard of a prison in Bavaria, in the midst of his comrades. He was seated on the pavement, or on a stone, being fastened by an iron chain to a fixed ring or staple, his companions, bound in a similar manner, around him. The electric charge, controlled probably in some degree by the chain and the iron fixture to which it was attached, passed through the body of the chief and instantly killed him. His comrades, knowing nothing of the natural laws by which this terrible agency is controlled, were struck with consternation, believing that the lightning had intelligently selected their ringleader, by the special judgment of Heaven, in retribution for his crimes.

Lastly, this old tale from Egypt may be one of the sources of assertions by Pyramidologists that the pyramids exert or focus some strange forces that affect people in mysterious ways.

> There is an account of a German philosopher who was visiting the pyramids of Egypt, and having ascended to the summit of the Pyramid of Gizeh, he was astonished to observe that the ends of his fingers, when he raised them into the air, became invested with a luminous halo. He also observed that a gourd mounted in metal, which one of his Arab guides carried, gave out from a metallic button which was attached to the cover scintillations of light, and even sparks, whenever he approached his finger toward it. The guides were

thrown into consternation at observing these, to them, supernatural appearances, and they insisted on returning at once to the ground.

GLL-005 LIGHTNING INDUCED BY THERMONUCLEAR DETONATIONS

Uman, M. A., et al; Journal of Geophysical Research, 77:1591-1596, March 20, 1972.

The lightning flashes induced by a thermonuclear detonation at Eniwetok Atoll in the Pacific in [October 31] 1952 are described. The five discharges were upward-propagating and were apparently initiated from instrumentation stations slightly above sea level. The likely mechanism for the necessary charge and electric-field generation (Compton electrons produced by gamma rays from the detonation) is explored quantitatively. The electric-field intensity calculated 3×10^4 v/m is near the value needed to initiate lightning from surface projections. The charge estimated to be available, however, appears to be insufficient to account for the observed lightning. Scattered trade-wind cumulus clouds and spray electrification from the salt water are considered and rejected as charge sources. (Abstract)

GLL-006 [VAGARIES OF LIGHTNING]

Anonymous; Nature, 37:64, November 17, 1887.

During a hailstorm at Mors, in Denmark, a few days ago, a flash of forked lightning---the only one occurring---struck a farm, and, having demolished the chimney-stack and made a wreck of the loft, descended into the living-rooms on the ground-floor below. Here its career appears to have been most extraordinary; all the plaster around doors and windows having been torn down, and the bed-curtains in the bed-rooms rent to pieces. An old Dutch clock was smashed into atoms, but a canary and cage hanging a few inches from it were quite uninjured. The lightning also broke sixty windows and all the mirrors in the house. On leaving the rooms it passed clean through the door into the yard, where it killed a cat, two fowls, and a pig, and then buried itself in the earth. In one of the rooms were two women, both of whom were struck to the ground, but neither was injured.

GLL-007 STRANGE PRANKS OF LIGHTNING

Lane, Frank A.; Science Digest, 27:63-67, June 1950.

This article first reviews the properties of both ordinary and ball lightning. The emphasis is on some of the strange things that lightning does. To this end, a score or so case histories are presented, from which the following are selected.

On another occasion lightning struck a carpenter's shop. When the men had left it they had placed their tools in two lines down a bench with a coat laid be-

tween the lines, but with none of the tools touching it. The lightning struck the bench and then the flash apparently divided. It burnt all the handles of the tools and seared a broad patch under them on the bench. The coat in the middle was undamaged. The lightning left the shop by tearing a hole through a wall.

. . . . . .

An amusing instance of the effect of the heat occurred when a field of potatoes was struck. Some of the stalks were burnt to cinders, but the potatoes underneath were cooked to a turn, just as if they had been cooked beneath hot ashes.

. . . . . .

Birds have been seen to fall from the sky and when examined, found to be partly roasted.

Fish, too, are occasionally killed when lightning strikes their waters. When a lake was hit 18 cart-loads of dead fish were carried away.

. . . . . .

Lightning struck a room where a girl sat at her sewing machine with a pair of scissors in her hand. There was a brilliant flash of light, the scissors were spirited away and the girl found herself sitting on the sewing machine.

. . . . . .

Two girls were standing by a reaping machine when lightning struck. The girls were stripped to the skin and their boots were torn from their feet. Otherwise they were unharmed.

GLL-008 ON LIGHTNING FIGURES

Tomlinson, C.; Nature, 12: 9-11, May 6, 1875.

The letter headed "Struck by Lightning," and signed "D. Pidgeon," contained in Nature, vol. xi, p. 405, is valuable, and the more so because it is unaccompanied by any theory. Formerly, when ramified marks appeared on the persons of men or animals, they were always referred to some near or distant tree, of which the marks formed "an exact portrait." Thus, in the Times of September 10, 1866, is an account of a boy who had taken refuge under a tree during a thunderstorm, having been struck by lightning, and on his body was found "a perfect image of the tree, the fibres, leaves, and branches being represented with photographic accuracy."

In a paper read by me before the British Association at Manchester in 1861, I attempted to show that such ramified figures are not derived from any tree whatever, but represent the fiery hand of the lightning itself.

The author next describes his experiments demonstrating how electrical discharges in glass create good representations of trees; i.e., dendritic structures. However, the three cases below can hardly be explained as natural dendritic lightning figures.

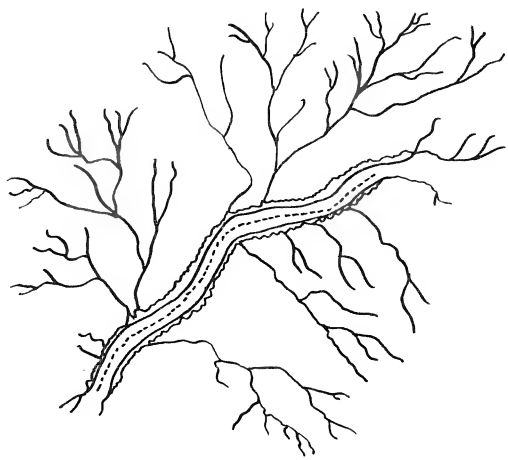
1. In September 1825, the brig Il Buon Servo, anchored in the Bay of Armiro, was struck by lightning, and a sailor who was sitting at the foot of the mizenmast was killed. Marks were found on his back, extending from the neck to the loins, including the impression of a horse-shoe, perfectly distinct, and of the same size as the one that was fixed to the mast.

2. In another case that occurred at Zante, the number 44 in metal was attached to the fixed rigging between the mast and the cot of one of the sailors.

The mast was struck and the sailor killed. On his left breast was found the number 44, well formed and perfectly identical with that on the rigging. The sailors agreed that the number did not exist on the body before the man was struck.

3. M. Jose Maria Dau, of Havannah, states that in 1828, in the province of Candelaria, in the island of Cuba, a young man was struck by lightning, and on his neck was found the image "d'un fer a cheval qui avait ete cloue a peu de distance contre une fenetre."

Tomlinson claims that these obviously artificial figures are essentially shadows cast by the electric current when the artificial object is struck.



Dendritic "breath figure" of an electric discharge. (Adapted from GLL-008, Fig. 1)

GLL-009 DEATH FROM THE SKY

Fuller, Curtis; Fate, 11:12, December 1958.

Late in July, 15-year-old Kenneth Luker of La Marque, Tex. was walking toward the coop where he was raising chickens and had nearly 100 laying hens. Suddenly a lightning bolt came out of the sky and struck him. He was just slightly shocked, however, and only one arm was affected.

But that night Kenneth's mother, Mrs. Allen Luker, had a dream. A voice came to her in the dream and said: "The boy is dead."

Three weeks later, on August 21, Mrs. Luker's dream came true. Kenneth was riding a bicycle with a younger brother and a friend, George Allen. There was no thunder, no rain, not even any heavy black clouds. But just as a truck was passing the little cavalcade, another lightning bolt struck Kenneth. This time it killed him.

GLL-010 LIGHTNING PLAYS QUEER PRANKS

Hicks, Clifford B.; Popular Mechanics, 105:65-69, June 1956.

Here are some old and often-repeated "pranks" of lightning. No sources are given and they may be just "tall tales."

> There's a horse in northern New York State that must be one of the most surprised animals of all time. A bolt struck Old Dobbin and knocked off his shoes but otherwise left him unharmed. And it's hard to beat the true story of the woman who was lying in bed, her hair in bobby pins, when lightning struck the house. The bolt turned the bobby pins into curling irons and gave the woman a permanent wave, but didn't harm so much as a hair of her head. Still another bolt executed a cow in New Hampshire without even touching the farmer who was milking her. Over in France, lightning once killed all the black sheep in a flock without touching a single white mutton chop.
>
> About a year ago a bolt struck a church belfry in Maryland. It surged through the automatic chime system, short-circuited key wires and touched off a long program of church hymns.

GLL-011 LIGHTNING STRIKES TWICE

Anonymous; Fate, 23:106, December 1970.

> Harry Bowden of Durham, England, has British doctors bewildered. Two lightning bolts have struck him, burned off his shoes, reduced his clothing to shreds and left him alive and well.
>
> A doctor at Shorley Ridge Hospital said, "We never have seen anything like this. We plan to submit a special report to the British Medical Journal."
>
> The first time Harry was struck, early in 1968, the lightning tore a rake out of his hand.
>
> Early in June, 1969, a bolt ripped his trousers to shreds, tore off his jacket, burned the bottoms out of his socks and split the elastic sides off his shoes. He escaped with minor burns.

GLL-012 ATMOSPHERIC ELECTRICITY

Tomlinson, C.; Nature, 40:102, May 30, 1889.

Here, Tomlinson merely repeats a portion of a report given in an earlier issue of Nature and described here under GLD-025.

GLL-013 TORNADO LIGHTNING

Gillmor, Daniel S., ed.; Scientific Study of Unidentified Flying Objects, Bantam Books, Inc., New York, 1969.

Although many convective events, such as isolated thunderstorms, dust devils, hurricanes, etc., occur in the atmosphere, these have energy concentrations much smaller than that of a tornado. Consequently, several researchers believe that a tornado can be maintained only by an intense and continuous lightning discharge along its axis. Such a discharge heats the air within the funnel, thereby causing violent updrafts and vortex motions. Whether or not this theory is correct, there is little doubt that the electrical power generated during a single tornado event is at least 2×10^{10} watts, or about 1/10 of the combined power output of all the electrical generators in the United States.

Such estimates may be too conservative. Tornado lightning is reported to be brighter, bluer, and more intense than its thunderstorm counterpart. Long before a tornado is observed, lightning interlaces the clouds. About 15 minutes prior to the appearance of the funnel, the lightning becomes intense and continuous. After the funnel descends, the sky is reported to be in a blaze of light with never ceasing sheet lightning.

Large hailstones are commonly produced both by tornadoes and by severe isolated thunderstorms. Hail is closely correlated with intense electrical activity. Observations of burned, wilted, and dehydrated vegetation, and odors of brimstone (burning sulfur) provide further evidence of electrical action. The tornado funnel is usually preceded by a peculiar-whining sound, a noise indicative of coronal discharge.

After this general introduction, the following eye-witness accounts of tornado lightning were added.

.....

"After a tornado passed over Norman, Oklahoma and headed north, personnel at Tinker Field heard a sharp hissing sound overhead combined with a lowpitched continuous roar. We were conscious of an unusual and oppressive sensation. The noise source was definitely above us. When it was nearest us, I saw the sky above gradually grow lighter, then fade to black. The light was greenish in color. Associated with the light was a strong sensation of heat radiating downward. The noise increased in volume and then faded out as though it came from the south and passed us going north. The rain had stopped while this phenomenon was overhead."

This same uneasy feeling and impression of downward heat is noted in GSH-008.

"The funnel from the cloud to the ground was lit up. It was a steady deep blue light---very bright. It had an orange-color fire in the center from the cloud to the ground. As it came along my field, it took a swath about 100 yards wide. As it swung from left to right, it looked like a giant neon tube in the air, or a flagman at a railroad crossing. As it swung along the ground level, the orange fire or electricity would gush out from the bottom of the funnel and the updraft would take it up in the air causing a terrific light---and it was gone! As it swung to the other side, the orange fire would flare up and do the same."

"There was a screaming, hissing sound coming directly from the end of the funnel. I looked up, and to my astonishment I saw right into the heart of the tornado. There was a circular opening in the center of the funnel, about fifty to one hundred ft. (15 to 30 m) in diameter and extending straight upward for a distance of at least half a mile (800 m), as best I could judge under the circumstances. The walls of this opening were rotating clouds and the whole was brilliantly lighted with constant flashes of lightning, which zig-zagged from side to side."

"We looked up into what appeared to be an enormous hollow cylinder bright inside with lightning flashes, but black as blackest night all round. The noise was like ten million bees plus a roar that beggars all descriptions."

"A few minutes after the storm passed, there was a taste and smell in the air like that of burnt sulfur. The air was clammy, and it was hard for me to breathe. The sensation was like being smothered."

"...burned up the trees that lay within its circumference, and uprooted those which were upon its line of passage. The former, in fact, were found with the side which was exposed to the storm completely scorched and burned, whereas the opposite side remained green and fresh."

"...suddenly it turned white outside. This whiteness definitely was not fog. I would say it appeared to be giving off a light of its own."

"The beautiful electric blue light that was around the tornado was something to see, and balls of orange and lightning came from the cone point of the tornado."

"The most interesting thing I remember is a surface glow---some three or four feet deep---rolling noise, etc."

If a researcher had never heard of a tornado, and were asked to compare the eyewitness accounts of tornadoes (such as these) with those concerning UFOs, he would probably find the tornado reports to be more fantastic and incredible. Luminous tornado clouds with no funnels to the ground are possible causes of several UFO reports. (737-739) (Martin D Altschuler)

GLL-014 ON THUNDER AND LIGHTNING

Arago, M.; Edinburgh New Philosophical Journal, 26:81-144, 1838.

Without having the slightest wish to revive antiquated ideas regarding thunder-stones,* I shall simply remark here, that it is not proved that we should absolutely regard as false the whole of the narratives, in which a fall of various matters is related to have accompanied thunder storms. What pretext, for example, is there for considering as untrue the following fact, which I extract from the works of Boyle. "In July 1681, a thunder storm produced a great deal of damage near to Cape Cod, upon the English ship the Albemarle. A flash of lightning was followed by the fall of a burning bituminous matter into the boat hanging at the stern, which gave out an odour similar to that of gunpowder. This substance was consumed on the spot, and it was in vain that they attempted to extinguish it with water, and to sweep it overboard with a broom."

Concerning the odours developed by the thunderbolt. Some philosophers have supposed that there was no necessity for inquiring into the particular causes of the perceived odour in each flash of lightning. They have insinuated that the fulminating matter in its more or less abundant passage through the nervous papillae of our organs, may itself excite a movement analogous to that which results from any given odour. This opinion might to a certain degree be admissible if the subject related only to smells which were experienced at the moment. But the thunderbolt, wherever it passes, occasions, even in the open air, odours which are perceptible for a long time. Again, when lightning forces its way into a confined situation, its passage is followed by sulphurous vapours, through which the eye cannot penetrate. There is evidently, therefore, some substance disseminated through the air. Are we to suppose that these substances are carried along with the lightning in its course, as were those powdery deposits examined by M. Fusinieri, and which have contributed to supply a commencement to our explanation of fire-balls;

or rather, do they proceed from the sudden evaporation of the different substances which are contained in the new or old wood, varnished or unvarnished, in the walls, stones, soils, &c. &c. through which the lightning has passed? These are points which in our present state of information cannot be determined and whatever may be the fate of these proposed explanations, we must not be too confident concerning the alleged uniformity of the nature of the developed odour. I have found, in truth, that if, in most instances, it has been stated to resemble the smell of sulphur; on other occasions it has been compared to that of phosphorous, and not unfrequently to nitrous vapour. The odour of nitrous gas, as will afterwards be pointed out, could more easily be accounted for.

* The pretended thunder-stones which some nations venerated, had generally the form of a wedge, an axe, or of the iron point of an arrow or lance. The origin of these stones is not at all doubtful, since precisely similar ones have been found among the tools and arms of the natives of America, and since we have learned how they are made. The ancient Continent, also, was originally inhabited by savage nations; and similar requirements, and a similar scarcity of iron, would produce in it the same kind of industry. But when the improvement in metallurgy produced stronger instruments, more cutting and more convenient, stones were abandoned, and have since been preserved uninjured below the surface of the ground. These stones have often been found in the trunks of trees, and hence it has been contended that they owed their position there to a thunder storm---every other explanation was held to be an impossibility. But, at this rate, it must have been thunder which introduced toads into the trunks of those trees where they are concealed, and the several pieces of ancient money which the hatchet is frequently revealing. (pp. 85-86)

GLL-015 LIGHTNING FROM A CLEAR SKY, JANUARY 20, 1931

Myers, Fred; Monthly Weather Review, 59:39-40, January 1931.

At 4:17 a. m. a flash of lightning was observed overhead and slightly toward the north. The sky was clear with about 2 strato-cumulus clouds along the horizon from the southwest to the northwest. There were six or eight flashes from 4:17 a. m. to 4:32 a. m., no more being observed until 5:15 a. m. when a single flash occurred in about the same location as the others.

Light rain had been falling during the night, ending about 2:45 a. m., the sky clearing by 4 a. m., the stars were shining brightly and the clouds could be seen distinctly in the west. The lightning appeared to flash across the sky and not to the ground. No thunder followed the flashes. This is the first time lightning has occurred from a clear sky at this station as far as can be determined. (Location: Tatoosh Island.)

GLL-016 NOISE ASSOCIATED WITH LIGHTNING

Cave, C. J. P.; Nature, 126:401, September 13, 1930.

Some years ago I directed attention in Nature to the swishing sound that is sometimes heard when a flash of lightning is very close to the observer. I had at that time never heard the sound myself. I heard it, however, very distinctly on

the night of Aug. 29 30. I had been expecting a flash to come close, as a very active storm centre had been moving directly towards this spot, with steadily decreasing intervals between the cloud to earth flashes and the thunder. I did not see the actual flash, only the illumination of the garden through the open window; it was very brilliant and was followed instantly by a noise as though a shower of large water drops had been thrown onto a hot metal plate; this was followed almost instantly by the thunder. I think there was a slight interval between the swish and the thunder, but it must have been only a fraction of a second; I had been counting seconds after previous flashes, but with this one I had not time to begin to count before the thunder came. The flash must have struck a point well within a hundred yards of my room, and I suspect that it struck the lightning conductor on the house. The noise was heard by my daughter and by two other people in the house. It was also heard by two people in a cottage about 50 yards from the house; one of them likened it to a red-hot poker being plunged into cold water, the other to the sound of the arc when two electric cables are short circuited.

The origin of the noise is obscure. I feel inclined to think that it is caused by some of the branches into which the main discharge often divides before reaching the ground; it may well happen that a number of these may be nearer to the observer than the main discharge and so be heard first. The noise was not like the crackle of a brush discharge on a large scale. The chief argument against this explanation is that a correspondent in Nature described the sound as occurring not after but before the flash. But it seems possible that on some occasions brush discharges may occur just before a flash. At any rate, this sometimes occurs with a highly charged Wimshurst machine.

GLL-017 STRANGE KINDS OF LIGHTNING

Anonymous; Literary Digest, 111:22, October 10, 1931.

Mr. Talman begins with an account of an exceptionally weird electrical display reported by Dr. Walter Knoche, for many years director of the weather service of Chile. We read:

"He was traveling by steamboat down the Rio Paraguay in South America, on October 3, 1927. A severe drought had prevailed in the surrounding country for months. At 7 o'clock in the evening---tho no rain fell---a tremendous electrical storm began.

" 'It did not approach,' writes Dr. Knoche in the Meteorologische Zeitschrift, 'but was instantly there---and it was there as far as the eye could reach, to north, south, west, and east, and overhead. It would have been impossible to count even approximately the number of the lightning flashes. Many of these were in the form of streak lightning, but were reddish or yellowish. Almost equally numerous were the flashes of dazzling white 'beaded' lightning---a phenomenon resembling a string of glowing pearls in the sky. Such lightning is, so far as anybody knows, extremely rare, and the occurrence of more than one or two examples of it in a single storm is almost unheard of.

"Dr. Knoche tells also of gorgeous glows of sheet lightning along the borders of the clouds and of various phenomena that cannot readily be classified, including curious, rapidly moving, orange-colored discharges, which he says resembled cylindrical masses of glowing gas, flashes that revolved like pinwheels; and, at one period of the storm, hundreds of luminous arcs crowded together near the zenith, so dazzling that he had to close his eyes.

"Perhaps the strangest feature of this exhibition was that it went on for hours without thunder. Thunder began abruptly in the early morning, and then became a continuous roll. The storm ended---or the steamer passed out of it---about 8 o'clock, having lasted thirteen hours.

"The same meteorologist has published accounts of equally marvellous electrical exhibitions in another part of South America---the spectacular glows and beams seen on summer evenings along the crest of the Andes as viewed from Santiago and places along the west coast, as well as from vessels on the Pacific.

"The mountains seem to act as gigantic lightning-rods, giving rise to more or less continuous diffused discharges between themselves and the clouds, with intermittent outbursts simulating the beams of a great search-light.

"Displays of similar character have been reported from mountainous regions in other parts of the world, including the Alps. Science has, as yet, little to say about this phenomenon, which is still ignored in most books on meteorology."

.....

"Lightning that shoots up from the horizon at the apparent speed of a sky-rocket, or occasionally travels horizontally from the edge of a cloud at the same deliberate pace, has been reported several times during the last two centuries, but it remains one of the great rarities. A case was observed on August 18, 1927, from the British steamship Inkum, in the Bahamas. Similar lightning was seen near Calcutta one evening in July, 1903.

"Some of the most bizarre manifestations of lightning are those that flash in the column of smoke and vapor from the crater of an active volcano. The marvelous electrical displays that attended the eruption of Pelee, in 1902, are described in George Kennan's dramatic story of that outbreak. The streaks of lightning terminated in starlike outbursts, and each flash was accompanied by a booming detonation. Probably the true explanation is that the discharges passed through and volatilized flying chunks of rock in the midst of the smoke cloud."

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In a considerable number of reported cases of ball lightning, Mr. Talman thinks that the object described as a fiery ball was actually a brush discharge of electricity from some particle of matter falling or floating in the air or from the fixt surface on which the supposed ball was seen. He explains:

"The natural brush discharge is best known as a small tuft of light issuing from the tip of some elevated object, such as a ship's mast, a church spire, or a lightning-rod. In its simpler manifestations, the phenomenon is usually called St. Elmo's fire, or corposants, and has been familiar to mankind from antiquity.

"During dust-storms and sand-storms in the western United States it is not uncommon for insulated metal objects to become so strongly charged with electricity that they give off brush discharges, which are visible at night. Observers report herds of cattle with 'balls of fire' on their horns, and the barbs of wire fences ablaze with electric discharges. During one of these storms, in western Kansas, sparks two or three inches long were drawn from a wire running to a windmill, and a prairie fire, it was thought, was started by sparks at the break of a fence wire."

GLL-018 LIGHTNING FROM A CLEAR SKY

Gisborne, H. F.; Monthly Weather Review, 56:108, March 1928.

On July 2, 1927, Stanley Lukens, a forest ranger, was supervising the opening of the Gold Peak lookout on the Missoula National Forest. While Lukens and his assistant were setting up the fire finder they aimed the alidade at various prominent topographic features to check the orientation of the map. As they were making one of these test observations toward a point southeast of Gold Peak both men saw a flash of lightning strike the ground almost on their line of alidade sight, and about 15 miles from them. This flash was followed by four others within the next few minutes. The first strike started a forest fire, the others did not. The phenomenon was most peculiar because all of these strikes descended almost vertically, apparently out of a blue sky, the nearest clouds being about 15 and 25 miles, respectively, from the area struck.

Both Lukens and the lookout, a Mr. Wertz, were greatly impressed by this condition because their general impression was that at that time, 2:30 p.m., the sky was practically clear. A small thunderstorm had passed over Gold Peak between 7:50 and 8:15 a.m. that day, then the sky had cleared. Mr. Lukens remembers, however, that at the time of these "bolts from the blue," there were two small cumulo-nimbus clouds south and southwest, 30 to 40 miles from Gold Peak. These lightning bolts, all of which struck within a small area not over half a mile in diameter, appeared to descend almost vertically, and they were not between the two clouds, but in a northeasterly direction and over 15 miles from them.

No thunder was heard from these flashes, and no further bolts were seen. About half an hour after these strikes the cloud which had been south of Gold Peak passed over the struck area and delivered sufficient rain to extinguish the fire, which had been smoking appreciably. This cloud is reported by Mr. Lukens to have been about 1 to 1-1/2 miles long by one-half to three-quarters of a mile wide, and was of the cumulus type.

GLL-019 LIGHTNING WITHOUT CLOUDS

Baskin, Donald; American Meteorological Society, Bulletin, 33:348, 1952.

On July 21, 1952, at 2:15 p.m. local time, the plane I was flying was struck by lightning.

At the time of this incident I was flying a mission that kept me in the same geographical area for more than one hour. I was at 5,000 feet altitude and had 5,000 feet of very small steel cable trailing behind the aircraft with a cloth sleeve attached. I was flying on a heading of 270 degrees magnetic, and off in the distance (about 50 miles) I noticed a flash of lightning. About two minutes later the plane I was flying was struck by lightning. The plane lurched and I was blinded momentarily. The lightning struck the plane on the left side of the nose and traveled down the side to the rear. It passed on to the small cable at the rear of the plane and completely demolished it by burning it to a crisp. My ordnance man reported that we had lost all the cable. I looked back and there was a trail of smoke to the rear about 2,000 or 3,000 feet caused by the burning cable. This smoke trail was observed by Naval personnel on the ground some seven or eight miles away. It is to be noted that no precipitation was encountered for more than one hour prior to the discharge and there were no clouds of any type present at my location. About ten miles to the east, there was an altocumulus cloud (bases 5,500 feet, tops 7,000 feet), emitting a light drizzle.

GLL-020 LIGHTNING

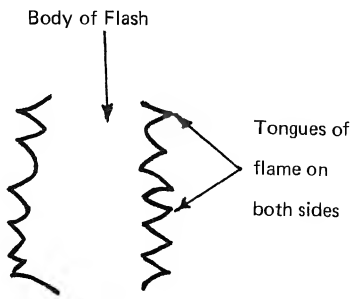
Vonnegut, B.; Weather, 27:213, 1972.

The following observation of unusual lightning is an excerpt from a letter I recently received from Wilson M. Powell, Professor Emeritus of physics at the University of California at Berkeley. It describes a lightning event which occurred while he was doing experiments in cosmic rays on the summit of Mt. Evans in Colorado at an altitude of 14,260 feet.

'I saw lightning strike about 300 feet away and hit a rock so that there was a yellow sodium flame at the point of impact. The lightning seemed to be about 30 to 50 feet in diameter and to have pointed flames on both sides. I missed the first bolt and saw only the later flashes.

My co-worker described the same thing for another stroke of lightning, having seen it out of the back window of a car. He was also wearing glasses, and at the time I wondered if this might have been caused by reflections in his glasses. My observation was made out in the open, and I was wearing no glasses.'

Professor Powell concludes his observation saying, 'I have never found anybody able to corroborate my observation and am hoping that you may be able to do so.'



Sketch of peculiar lightning strike (Adapted from GLL-020)

GLL-021 PHENOMENA PRECEDING LIGHTNING

McAdie, Alexander; Monthly Weather Review, 56:219–220, June 1928.

In the Meteorological Magazine June, 1928, p. 113, Mr. R. S. Breton, writing from Tung Sung, Southern Siam, states that on a number of occasions he has noticed a sharp "vit" or "click" accompanying lightning that has struck something in the immediate neighborhood, preceding the thunder by a perceptible fraction of a second.

He adds that he has three times noticed that animals show alarm immediately before a flash and that in one case a dog walking on grass turned and began to bark angrily in the direction of a very strong flash that came one-fourth second after, striking several of a group of trees 200 yards away. He mentions two occasions when fowls rushed for shelter from the open in alarm before a very near discharge actually took place. In each case the discharge was a very powerful one, taking place on dry soil before rain had fallen. He asks "if it may be that the sensitive feet of the dog could detect vibrations before the discharge took place."

The editors of the magazine answer "that the 'vit' or 'click' accompanying lightning which has struck close by appears to be new; no reference to any similar observation can be found in the literature and at present it is not possible to offer any explanation."

Clicks preceding intense lightning flashes are common at Blue Hill Observatory and undoubtedly can be heard elsewhere under certain conditions, when an insulated metallic conductor is exposed, in a strong electric field, and a grounded conductor is close by. At Blue Hill every intense flash within a radius of 1,000 meters gives this click preceding thunder by an interval which is a function of the distance of the flash.

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Regarding the behavior of the dog, it would seem to be not so much a question of sensitive feet as a matter of insulation and increasing electrification to a degree that the hairs, for instance, become discharging points. This bristling can be seen readily on animals caught in thunderstorms near the top of a mountain. I recall being near the summit of Mount Whitney (4,420 meters above sea level, 14,502 feet), during a thunderstorm. The hairs of the burros (pack animals) stood out straight, and a faint hissing could be heard. A metal button on my cap gave a tingling sensation. I kept wondering how long it would be before a flash of lightning would demolish the entire party of astronomers as they proceeded in close formation to the summit. I think we had a narrow escape from disaster. During a week's stay at the summit we had several thunderstorms, when the lightning seemed to be below us.

The feeling of uneasiness preceding lightning flashes may be due, aside from effects of pressure, temperature, and humidity, to the increasing electrical strain, as a charged cloud comes over the position of the observer. We know from our quadrant-electrometer measurements that at such times the potential gradient increases steadily from 50 volts per meter to 10,000 or more. A jet of water from an insulated collector exhibits many interesting changes as the charged cloud approaches. In fact we can tell just about when the flash will occur. We can also detect and record discharges which an observer fails to detect, if dependent on the eye alone. With each flash there is an instantaneous equalization of potential and return of the needle to zero.

GLL-022 DEATH BY LIGHTNING

Anonymous; Monthly Weather Review, 47:729, October 1919.

A. G. Newell describes an interesting phenomenon in connection with the burns received by a man who was killed by a lightning stroke in London. The man and his wife were walking in the open, near a row of elm trees

when he was struck. The wife was momentarily stunned, but upon recovering she saw her husband standing erect with a blazing line up and down the back of his coat. He died immediately, and fell backward against an iron fence. Severe burns on his back indicated that he was struck from the right side of his back.

From the right shoulder and across the chest and down to the lower of the front of the abdomen impressions of branches and leaves were clearly imprinted on the skin, showing like an X-ray plate how certain rays of light were impeded by the branches and foliage, whilst others made the contours of these. There were two distinct branches with leaves, one occupying the space between the right iliac crest to near the ensiform cartilage and the other proceeding down on the left side from the stomach to the left iliac crest. To my mind it would appear as if these were implanted while the man was falling back with a flash coming over the right shoulder.

The pattern of branches and foliage is usually explained in terms of the normal dendritic pattern created by lightning on other electrical discharges in various media. (See GLL-008)

GLL-023 EFFECT OF LIGHTNING ON THE HUMAN BODY

von Szalay-Ujfalussy, Ladislaus; Monthly Weather Review, 47:729, October 1919.

[Abstracted from Meteorologische Zeitschrift, July-August, 1918, vol. 35, pp. 192-194]

Those who are killed by lightning always have marks upon their bodies. A photograph of a dendritic pattern on a woman's back is reproduced. Where marks are lacking, there is some question as to whether they were actually killed by the lightning or by the sudden shock, which would result in heart failure or failure of other organs to continue to function. It is also true that in such cases the victims are generally found lying on their backs. This tends to give weight to the argument that their eyes were directed so as to see the lightning, and thus to cause the falling backward. The author strongly contends that the psychological element has a large influence on the fatality of the stroke, citing the cases where small children were uninjured, although the mother who held them in her arms was killed; and, also, the fact that sleeping or drunken people are less frequently victims of lightning.

GLL-024 LIGHTNING FROM A CLOUDLESS SKY

Ashcraft, Charles E., Jr.; Monthly Weather Review, 28:489, December 1900.

The phenomenon of lightning from a cloudless sky seems to be regarded in the States as one of very rare occurrence, as it very likely is. I cannot remember of ever observing it while in the States, but down here in the West Indies it is of very frequent occurrence, so frequent in fact that it is not regarded as remarkable by the people. When first I saw this phenomenon after arriving in the tropics it caused me considerable wonder, and I was also in doubt as to whether it was real lightning or not. So I made inquiries among the residents and found to my surprise that it occasioned no wonder

to them, and they evidently failed to understand why it should to me. Subsequently I have observed it numerous times till finally the novelty has worn off, and I, like the residents, accept it now as only an ordinary occurrence. However, I believe this letter is justified, inasmuch as the phenomenon is rare in the States and any information related thereto may be welcome.

The appearance of the flash is that of sheet lightning, generally single flashes being seen at intervals of from two to five minutes, and again only two or three occasional flashes will be seen during an evening. They do not seem to be confined to any particular quarter of the sky for local reasons, as I have observed them in all quarters. I do not think flashes are due to falling meteors, but they may be the reflected flashes of distant thunderstorms, although a clear sky certainly does not offer so good a reflecting surface as a clouded one. However, I am inclined to believe that the theory of the exchange of electricities between vertical currents of air is a very plausible explanation for the following reasons: In the first place the phenomenon has always been observed in the evening, usually between 7 and 9 p. m., never before 7, I believe, but several times after 9 o'clock. As this latitude is free from the disturbing effects of ever-passing areas of high and low pressure, the diurnal phases of the weather are therefore very constant and much alike from day to day. So that ordinarily between 7 and 9 p. m. the temperature falls, cool breezes spring up, a rapid clearing condition sets in, the clouds disappearing sometimes like magic, and by 9 p. m. the sky is usually clear. Now, it is always at this time when the colder currents of air are descending, causing the cool breezes and clearing condition and setting up a vertical circulation with steep gradients, that the lightning is seen. Sometimes the sky is not absolutely clear, a few clouds nearly always hanging over the mountains to the east of station, but the lightning will be seen far out to sea, perhaps, to the westward, where not the least vestige of cloud is visible. Then it is about this time in the evening that the maximum electrification of the air occurs, and in view of the fact that the lightning always occurs at the one time, is it not probable that the exchange of electricities between the descending and ascending currents having different temperatures and humidities, and therefore different electrical potentials, is the cause thereof.

I may add that these lightning flashes have been observed more frequently during the hurricane season, but just what weather conditions prevailed on the dates of occurrence I am unable to say, as I failed to make note of the dates. Furthermore, the phenomenon can not be peculiar to the region of Dominica alone, as I have talked to a number of persons who have lived long in tropical parts, and they are all agreed that lightning from a clear sky is no uncommon thing.

GLL-025 LIGHTNING FROM A CLOUDLESS SKY

Pague, B. S.; Monthly Weather Review, 28:429-430, October 1900.

I was much interested in the report of J. N. Weed, of Newburg, N. Y., concerning lightning from a cloudless sky and the comments thereon, as published on Pages 292 and 293 of the Monthly Weather Review for July, 1900. A few hours after reading the report and the comments I had the opportunity to observe lightning from a cloudless sky. The circumstances were as follows: On October 4, 1900, the weather map showed conditions somewhat

favorable for thunderstorms over the greater portion of upper and lower Michigan and over the surrounding region; the local forecast for Detroit was for fair weather; during the afternoon of October 4, owing to dark appearing clouds in the southwest, it looked as though a thundershower might occur in this vicinity before midnight. The clouds kept well to the south and were of the cumulus form. About 5 o'clock rain apparently was falling over in Canada about 10 miles south and southeast of this station. As sunset approached the clouds disappeared from the horizon, except on the south and southeast sides. About 7:45 p. m. (local, sun time) I started on a bicycle, riding out Woodward Avenue, which is in a straight line northwestward from the thunder and lightning then prevailing over in Canada. After riding about thirty minutes, and being then about 15 miles from where the thunderstorm was in progress, I observed flashes of lightning. The evening was nearly calm, the temperature very pleasant, and not a cloud was observed in the sky. After riding about two miles more I dismounted and looked carefully for clouds, but none were visible. Lightning was very distinct in the south and east; with my back to the place whence I knew the lightning came, I could see overhead flashes of lightning, in the form of sheets, which, like Mr. Weed, I would characterize as of rather delicate type. It continued and increased, waxing and waning. The lightning occurred at frequent intervals all along the horizon from the south to the southeast, with flashes overhead. Returning to my residence I was then facing and riding toward the horizon whence came the distant flashes; after riding about four miles I was in a position to see what appeared to be a long streak of clouds extending from the main body northwestward; from this extended cloud the lightning appeared to come.

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The experience of Mr. Weed was the same as mine, with this difference, I knew a thunderstorm was prevailing beyond my night horizon and he did not. It is well known that the night horizon of an observer is much less than it is in day time, and this I think accounts for the lightning from a cloudless sky as well as for rain from a cloudless sky, both phenomena being reported, as a rule, as having been observed at night.

GLL-026 LIGHTNING FROM A CLOUDLESS SKY

Anonymous; Monthly Weather Review, 28:292-293, July 1900.

At 7:30 p. m. [August 3, 1899] there was a light wind in this locality [Newburg, N. Y.] from the northwest, mere breathings. At about 9 p. m. there came a sudden gust of wind, lasting but the fraction part of a minute, and then, some minutes later succeeded by another gust of more force. After this they came more frequently, and soon developed into a cold, gusty, northeast wind, which lasted with variable force until 1 a. m., when I retired. At that hour the wind was strong but more to the north. Our horizon in the northeast quadrant is low. In the southeast, limited by mountain crests from four to seven miles distant, and ranging from one thousand to sixteen hundred feet high. Beyond this horizon are a succession of other mountains hidden from our view, with deep valleys between, including the valley of the Hudson River. The night was cloudless until the wind came.

Soon after this a few cloudlets of stratus formed near the north end of the mountains, say east-northeast, near the horizon, but disappeared before the

appearance of the phenomenon I am about to mention.

At the moment of the rising of Fomalhaut above the mountains southeast, we noticed a gleam of lightning, of rather delicate type, just to the left of the star, and back of the mountains. The conditions were such that we could hardly believe that it was lightning, but it continued and increased, waxing and waning until we discontinued observations at 1 a.m. It seemed to me that it changed intensity with the wind. The lightning occurred at frequent intervals all along the horizon from the point of origin to near the east point, and was undoubtedly true lightning.

This is the first time I ever saw lightning in a cloudless sky, and it occurred to me that it might be of interest to the Weather Bureau to question their observers about it, as such phenomena are rare.

My first impression was that it was the reflection from a distant thunderstorm, as the lightning seemed always beyond the mountains and the place of origin below the crest line. On inquiry of some friends who were at Hemstead, L.I., that evening, they informed me that the night there was cloudless, and that at one time lightning occurred, as they then thought, but later concluded it was produced by a falling meteor of the August stream, many of which were visible that night there as well as here. This information seems to exclude the thunderstorm theory. It seemed to me possible that the cold, gusty wind currents falling at a steep gradient, as shown by the gusty type of the wind, might exchange electricities with the warmer surface air forced upward, and thus explain the phenomenon. The character of the topography would seem favorable, under such conditions, to the formation of convection currents with steep gradients.

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On Tuesday, August 7, about 5 p.m. according to a news dispatch from Richmond, Va., lightning from an apparently clear sky, without warning, struck Mr. W. R. White and a colored farm hand near Coldharbor, Hanover County, while both were working in the open field.

The weather map gives no indication of any thunderstorm or rain in this neighborhood at that time; an area of high pressure prevailed, with very hot atmosphere near the ground. During the subsequent night it was cloudless throughout this region; a cool northwesterly wind sprang up. The circumstances are parallel to those attending the small lightning flashes seen at Newburg, except that the latter occurred at night-time. In both cases a cool breeze succeeded to a hot day, whence we infer that a vertical circulation of air was in progress. Ordinarily we think of the lightning that attends a thunderstorm as being in some way the result of the formation of cloud and rain or hail, but the frequent reports of lightning from a perfectly clear sky seem to suggest that the ascent and descent of the currents of air is the important feature in both cases.

See a reply by B. S. Pague in GLL-025.

GLL-027 LIGHTNING PHENOMENON

Anonymous; Monthly Weather Review, 31:534, November 1903.

The following from the Cleveland Leader is kindly communicated by Father Odenbach of Ignatius College in that city:

Geneva, Ohio, November 19.-- A phenomenon was seen in Unionville between

5 and 6 o'clock yesterday afternoon, during the snowstorm. There was a flash of lightning, seeming to emanate from the snow itself and illuminating surrounding buildings and objects quite brightly. It consisted of two almost simultaneous, flashes, one stronger than the other, and of a purple and milky-white color. They were followed by a faint roll of thunder like the approach of a distant storm. Such a freak of nature was known to occur during a snowstorm twenty years or more ago.

GLL-028 NOTABLE LIGHTNING

Anonymous; Monthly Weather Review, 28: 290–291, July 1900.

In connection with the preceding note Mr. Heiskell, of the Weather Bureau, sends the following description of two interesting cases of lightning:

During the evening of Sunday, August 26, 1900, while near Gapland, Md. on the east slope of the Blue Ridge Mountains (12 miles north of Weverton) I saw a most beautiful display of lightning without thunder. The flashes appeared in the southwest corner of the valley known as Middletown Valley, followed the Potomac River and mountains on the Virginia side, then passed to the Blue Ridge at Weverton and followed the mountain top, making a circuit of at least 60 miles, this appeared to occur twice, when gradually the flashes spread, as it were, to the valley, in appearance resembling the discharge of a roman candle. This most beautiful phenomenon lasted from about 7 to 10:30 p. m., and when near the house the light was so vivid that at times one could easily have read a book. An old resident remarked that whenever they had such "lightning storms" it purified the air, and the next day was always bright and clear.

This display of lightning without thunder recalls a thunderstorm that occurred several years ago in the Blue Ridge Mountains in the month of July. I was on a train going to Emmitsburg, Md.; when we changed cars at Rocky Ridge, the sky was heavily overcast with large cumulo-nimbus clouds. As we moved along by the side of the mountain about a mile distant, a terrible thunderstorm, accompanied by high wind burst before us. The lightning was so vivid as to be nearly blinding, and as the storm or clouds followed the mountains the lightning appeared to those on the train to leap from peak to peak, in fact several persons remarked "that mountain must be full of iron." The storm passed off over Emmitsburg and the sun came out as bright and hot as before.

The occurrence of "thunderless lightning" is so common that only a few cases have been collected for this Sourcebook. The note about lightning leaping from peak to peak recalls the phenomenon reported by Ellsworth Huntington from the Euphrates Valley in GLD-020.

GLL-029 [LIGHTNING MELTS EYEGLASSES]

Anonymous; The Fortean Society Magazine, 1:2, October 1937.

Lightning flashed horizontally across a street in the Bronx (7-10-37) knocking down Albert Kuntz, 22, and continuing--to strike down a man across the street. The man says he is Max Haas, 23, but can remember nothing else about himself. "He was rigid when he was picked up." The lenses of his eyeglasses had melted in their metal frames. His wrist-watch was thrown several feet.

GLL-030 A LIGHTNING STROKE FAR FROM THE THUNDERSTORM CLOUD

V., B. M.; Monthly Weather Review, 54:344, August 1926.

Mr. J.H. Armington sends us from Indianapolis the report printed below, which was sent to him by Prof. Z. A. McCaughan, of Bloomington, Ind. The stroke occurred about 1 p.m. on July 23, 1926, in Monroe County; it killed two children.

"I drove to the place referred to and made personal inquiry of people who were within 100 yards of the place. The sun was shining, the nearest cloud seemed to the witnesses 2 1/2 or 3 miles north (toward Clear Creek and Bloomington). They had heard no thunder previous to this stroke and heard only two or three of distant thunder afterward. Their sky stayed clear for two hours afterwards. At the time of this stroke we were having frequent strokes of lightning and thunder here at Bloomington and we had 0.23 inch of rain. Three miles southeast of Bloomington there was a small tornado that broke limbs of trees and carried away anything small that was loose. The lightning was severe. Witnesses near where the children were killed say the lightning traveled horizontally from north to south. It passed three buildings, missing them by about 100 feet, and struck this little house just above the top of the corner foundation post."

The striking of lightning, through clear sky, at points somewhat distant from the region immediately beneath the storm cloud, while relatively rare, occurs probably more frequently than is realized.

During a three-year residence in east-central Florida I observed the phenomena at least three times. The typical local thunderstorm of the Florida summer grows with great rapidity, and is usually an entity quite unconnected with storms of the same kind that may be developing elsewhere within the observer's field of view. Opportunities for watching the lightning strokes from individual clouds are therefore excellent.

It is my recollection that the distance along the ground between a vertical dropped from the edge of the cloud and the striking point of the bolt was of the order of the height of the cloud base above ground. How foreshortening affected this estimate is of course impossible to say. But it is probably true that the distances were never of the order of 2 to 3 miles, as in the extraordinary case described by Professor McCaughan. In one instance (and I think this was true of all these far flung bolts) the spark seemed to leave the cloud from a point at least halfway up from cloud base to summit, and in this one instance which I recall especially vividly it was about three quarters of the way.

The frequent cases of lightning without clouds raise the possibility that ordinary lightning, like ball lightning, may materialize out of "thin air."

GLM-001 A CATALOGUE OF OBSERVATIONS OF LUMINOUS METEORS

Powell, Baden; Report of the British Association, 239, 1852.

Powell quotes the following from a letter from a Dr. Bruit, residing in India. Modern science would generally call the coincidence of meteors and thunderstorms fortuitous.

> "We have had three instances this season of what seems to have been the fall of an aerolite during thunder-storms. On the 25th of September a violent explosion occurred in the air at Bombay, followed by a wild rushing sound overhead, heard at various points over an area of thirty miles in length and eight in breadth, followed by a severe concussion, as if a heavy body had fallen, just before the occurrence of which a large fire-ball was seen plunging into the sea. On the 18th of March, during a violent thunder-storm near Dhutmah in the north-west provinces, at seven p.m., a thunderbolt, as it was called, was seen to fall and strike the ground, giving out in the course of the concussion a clear ringing sound like the crack of a rifle; there was no echo or reverberation at all like thunder. It appeared 150 yards from Choki, and resembled in its descent a huge ball of red-hot iron with a band of fire estimated at about thirty feet in length. On the 30th of April, about midnight a violent explosion was heard during a storm of wind and rain at Kurrachee, resembling the discharge of a vast artillery battery, and about half a minute afterwards a meteor, partially obscured by the rain, but still distinct and visible, was seen descending into the sea. It is now well-established that in India at all events earthquakes are almost always accompanied by furious storms of thunder, lightning, wind and rain: it is difficult to trace the cause of coincidences so remarkable in the commotions of the earth and air, still more so to imagine any connection whatever betwixt the perturbations within the limits of our atmosphere and the movements of solid bodies entering it from regions beyond its boundaries; yet it is surely possible to suppose a thunderstorm propitious to the precipitation on the surface of the ground of bodies which might otherwise have passed on in their career."

Some of the "meteors" mentioned above might well be ball lightning.

GLM-002 YELLOW GLOWING UFO

Al-An', Mariechen; Fate, 14:109-110, June 1961.

This purported UFO might actually be meteoric in origin. Literally thousands of similar reports exit.

> It appeared first like an enormous star in the east, where no star of such magnitude could be. I saw it first and pointed it out to Danal.
>
> The thing was moving toward us and growing larger by the moment. Danal says we saw it for about five minutes as it moved across the sky. It was lost when it was almost overhead (slightly to the right), as the large building next to ours blocked the view.
>
> The object was a definite yellowish light which did not twinkle or pulse. I did see a whole series of light frames when it was still a little distance from us. Danal says he did not see these light frames until after he had gone into the house and gotten binoculars. During this time the object had come quite close, although

I have no way of determining its distance from us, its altitude, speed or size.

It had no lights like planes have, just a general glow of yellowish light. Danal and I differ concerning the light from the several frames forming a long band like windows in a rail car. I said they emitted a bluish white light, while Danal said it was all yellow. At any rate, it made no sound whatever, although the night was still and cold. Neither did it display a tail of light or smoke.

It was moving in an almost direct east-west direction. We were unable to make out the shape of the bulk. Even after it had passed, there was no backwash of sound from it. In fact, one had a strong sense of the utter stillness of the event. This I have found characteristic of all the sightings to which I have been party.

GLM-003 THAT BLACKOUT

Fuller, Curtis; Fate, 19:18, March 1966.

The following item was reported by Robert Walsh. He describes luminous phenomena he saw at the Syracuse, N.Y., airport on November 9, 1965, just after the beginning of the famous Northeast blackout, which some claim was stimulated by a UFO.

During this time "a strange thing happened," Walsh said later. "I was sitting on the ground with others when we saw a sudden ball of fire south of us---toward Thompson Road and Carrier traffic circle.

"It appeared to be about 100 feet in the air and 50 feet in diameter. All I could think of was a mushroom effect.

About 10 minutes later the group with Walsh saw another ball of fire which resembled the first.

"I have yet to see an explanation," he commented.

After Walsh's story was published in the Syracuse Herald-Journal, new reports began to come in. Weldon Ross, a flight instructor and his student, James Brooking, were aloft when the lights went out. A few minutes later they saw "a ball of orange-reddish fire which flared up bigger than a house fire. We were over the high line which runs from Clay to Niagra Falls when we saw the fire flash. It looked like a barn fire---a barn full of hay---and lasted for perhaps 10 seconds," Ross said.

Tom Doxsee of 27 Marie Dr., Town of Manlius, near Syracuse, an insurance man, reported seeing a ball of fire sometime within an hour of the time the lights went out. A woman neighbor of Doxsee told him she saw a bright yellow object, oval-shaped rather than round, which stood on end. Mrs. Everett B. Jones, of Camillus, N.Y., reported seeing a "huge ball of fire" hanging over Camillus Plaza on Route 5 shortly after the lights went out. She told reporters Richard G. Case and Joseph V. Ganley that she watched the huge orange ball sink below East Hill just outside Camillus.

GLM-004 THOSE FLYING SAUCERS

Wylie, C.C.; Science, 118:125-127, July 31, 1953. (Quotations below with permission of the American Association for the Advancement of Science.)

The two themes of this letter are: (1) all UFOs can be explained as misinterpretations

of common objects, particularly specular reflections of sunlight from aircraft and the light breasts of hawks; and (2) the great meteor procession of 1913 was really only a single, large fireball accompanied by shooting stars.

Wylie, a meteor specialist, claims that the only "saucers" reported by people are simply spots of reflected light. His reasoning goes as follows:

> The fact that I receive scores, even hundreds of reports on a bright meteor, but only one on a saucer, shows in itself that the saucers are not space ships, enemy projectiles, or secret weapons, but only spots of reflected light seen from the critical angle.

Refraction plays a role, too, as in the following instance:

> An interesting report from an aeronautical engineer was that two hazy stars, one above the other, moved across the northern sky from west to east. This was evidently a mirage effect, the reflection in the sky, from a rather sharp temperature inversion layer, of the lights of a car which could not be seen directly. Another report, but from a more imaginative person, was that a brightly lighted ship appeared briefly in the sky. This may have been the inverted reflection of a bus with the interior lights turned on momentarily. Occasionally, on clear moonless nights, when a cold front is moving in, highway patrolmen report seeing what they call "goof lights." These are hazy spots of light that move across the sky with an undulatory motion. The goof lights are presumably mirage reflections from a wavy inversion layer, or layer of light haze.

The "goof lights" are termed "nocturnal lights" in this Sourcebook, Subsection GLN.

The deflation of the February 9, 1913 meteor procession is accomplished as follows:

> To show the exaggeration possible in an apparently well-authenticated story, consider the story of the fireballs which appeared over the Regina area of Saskatchewan, Canada, on the evening of February 9, 1913, and moved southeastward across Canada and the United States passing nearly over Winnipeg, Toronto, and other important cities including New York City, thrilling and startling thousands of persons in the United States and Canada. This story has been featured in several recent magazine articles, for example, giving the number of fireballs passing along that path as 200 to 400 (Coronet, XXXIII, No. 5, 131-132 [1953]) and stating that if the fireballs had come to earth earlier, instead of plunging into the Atlantic Ocean, they would have spread fire and flame over the densely populated area between New York City and Philadelphia.
>
> The original reports are available on this display and they show that only one real fireball appeared along that path over North America at that time. The fireball was not very large, as it disintegrated at a height of twenty-five miles near Hamilton, Ontario. This fireball and associated shooting stars attracted considerable attention in the Toronto area of Canada, but they were not travelling horizontally. They were falling downward at an angle of twenty degrees, and they were not travelling in the direction of New York City. The horizontal motion was in the general direction of Washington, D. C., rather than toward New York City. Obviously what really happened was a shower of shooting stars which was exceptionally good in the Toronto area, but attracted relatively little attention elsewhere. The only report from the densely populated New York City area was from a lady who watched the sky for a while and counted seven shooting stars. The popular story is impossible, of course; and it is evident that an excellent but unpredicted shower of shooting stars has been "blown up" into a marvelous pro-

cession of fireballs.

Other scientists disagree with Wylie on this great phenomenon (GLM-006 and GLM-011). Frank Edwards, a popular writer, adds that strange,dark objects passed over Toronto the next day. (GLM-015)

GLM-005 [BALLOON-SHAPED METEOR]

Anonymous; Nature, 4:169, April 27, 1871.

> On February 4, an extraordinary meteor was seen at Pichieani in Peru. It was balloon-shaped, with the pointed end towards the earth, and red-coloured. It descended rapidly to the earth, and its descent was attended by an explosion, leaving a dense cloud over the place. It injured the roofs of several huts, and knocked down a fence for about 500 yards. On the spot, it is reported several dead fish were found of different species, which are supposed to have been lifted out of the river, and dashed against the stones. Similar events happened near Huanochullo and Atucachi.

The identical note appeared in Nature, 3:512.

GLM-006 THE GREAT FIREBALL PROCESSION OF 1913

Mebane, Alexander D.; Science, 118:725-726, December 11, 1953.

> In C. C. Wylie's account of the "great fireball procession" of 1913 [GLM-004], it is perhaps not made sufficiently clear that this description of the phenomenon differs considerably from that which has previously appeared in the astronomical literature. The version of the event so severely criticized by Professor Wylie is not (as readers of his article might tend to assume) a post-factum "popular" accretion, but is that presented in the original report on the occurrence by C. A. Chant of Toronto, the editor of the Journal of the Royal Astronomical Society of Canada. Subsequent writers on the event saw no grounds for questioning Chant's treatment, and were even able to unearth further data of a strongly confirmatory character. Professor Wylie's statement that closer study reveals the facts to have been entirely different from what these astronomers thought them to be is therefore more novel and surprising than his rather casual reference to the matter might lead the reader to suppose. What Wylie in 1953 confidently identifies as "an excellent shower of shooting stars" was positively stated by Pickering in 1922 to have been "in no sense a meteor shower, but a different kind of event altogether." (GLM-011)
>
> It is to be hoped that Wylie's new interpretation will soon be supported by a more formal publication with citation of evidence, since at present it must be acknowledged that it is difficult to connect the description given by him with the original observations published by Chant. These very numerous reports unanimously described a unique procession, lasting for three minutes, of a great number of bright fireballs in clusters moving slowly and strictly horizontally. Wylie's description of the event as local in character is likewise a revision of the previously accepted version and is not easy to reconcile with the data. An extraordinary

fireball procession moving from northwest to southeast was seen successively in Saskatchewan, in Ontario, over the North Atlantic, in Bermuda, and finally by a ship in mid-Atlantic south of the Equator. These successive appearances defined a trajectory (roughly a great circle) 5200 miles long. "A very few fireballs or shooting stars observed in other places" does not seem to be an adequate summary of this situation. If it is to be argued that these successive appearances of a unique phenomenon were due to mere coincidence, strong evidence will have to be adduced.

A fully satisfactory explanation of this spectacular occurrence of 1913 has never been achieved. Wylie's proposal to explain it as simply an ordinary event which was misinterpreted is, at least, a fresh approach. However, it should be recognized that the recorded evidence is difficult, if not impossible, to reconcile with Professor Wylie's description.

Wylie replied to Mebane in the same issue of Science. Generally, he attacked the original observations as physically impossible because: (1) the fireballs could not survive 5000 miles; (2) none of the fireballs was seen to rise from or drop behind objects on the horizon; (3) such a procession must have been seen by the inhabitants of the big U. S. cities it must have passed over.

GLM-007 CURIOUS PHENOMENON DURING THE LATE GALE

J., A. W. B.; Nature, 17:10-11, November 1, 1877.

Your correspondent, "G. A. M." (vol. xvi. p. 551), may be interested to know that the "ball of fire" he saw descend on the evening of the 14th inst. was seen here by me, and by those who accompanied me, at precisely the same time (6.50 p.m.) that he mentions. We were walking in a south-easterly direction, and it seemed to fall from about half-way between that point of the compass and the moon, which was due south of us, and shining brightly. The ball itself appeared to us luminous white, while the "wake" left in its passage through the air, was bluish green. It was visible, I should say, for twenty seconds. Occurring, as it did, at a time when thousands were wending their way to church, it must have been very generally observed.

GLM-008 [METEOR AND SEVERE STORM]

Anonymous; Nature, 17:475, April 4, 1878.

Mr. A. O. Thorlacius, the observer for the Scottish Meteorological Society at Stykkisholm, in the north-west of Iceland, reports the occurrence, on March 4, of the severest thunderstorm ever experienced in that part of Iceland. Thunder and lightning continued without interruption from 5.30 a.m. to 8 a.m., accompanied at intervals with rain and hail. For the past thirty-three years, during which Mr. Thorlacius has observed, nearly all the thunderstorms have occurred during the winter months. At 7 a.m. a very fine meteor passed over the village of Stykkisholm and exploded into innumerable fragments over the harbour, unaccompanied, however, with any audible report, and shortly after another fine meteor passed over the village and disappeared without being observed to explode. It is added that this is the first time such meteors have

been observed by any one at Stykkisholm.

The coincidence of meteors and a severe storm is the point of interest here, although no connecting physical mechanism is known.

GLM–009 ON THE FACTS OF EARTHQUAKE PHENOMENA

Mallet, Robert; Report of the British Association, 130-131, 1854.

> December 29, 1820; Morea and Ionian Isles. There seemed to be three shocks. The weather had been stormy for some days before. At 4^h 10^m A. M. there was an extraordinary gust of wind, which suddenly ceased, it became calm, and soon after the earthquake occurred. The shocks were preceded by a dreadful subterranean bellowing noise. After the earthquake the clouds grouped themselves into large masses, and discharged torrents of rain, and hail of such a size that some of the stones weighed ten ounces. On the night of the 30th there was another terrible storm of rain. The wind remained in the S. E. for twenty-five days after the earthquake. Three or four minutes before the first shock a very large igneous meteor (apparently 4 to 6 feet in diameter) was observed over the sea off Point Geracas, and remained visible for five or six minutes. On the 30th a luminous meteor described a vast parabola over the town, and fell into the sea.....

True meteors do not remain visible for five or six minutes.

GLM-010 [MASS OF FIRE FALLS INTO SEA]

Anonymous; Science, 5:242, March 20, 1885.

> The following account of unusual phenomena was received March 19, at the Hydrographic office, Washington, from the branch office in San Francisco. The bark Innerwich, Capt. Waters, has just arrived at Victoria from Yokohama. At midnight of Feb. 24, in latitude 37^o north, longitude 170^o 15' east, the captain was aroused by the mate, and went on deck to find the sky changing to a fiery red. All at once a large mass of fire appeared over the vessel, completely blinding the spectators; and, as it fell into the sea some fifty yards to leeward, it caused a hissing sound, which was heard above the blast, and made the vessel quiver from stem to stern. Hardly had this disappeared, when a lowering mass of white foam was seen rapidly approaching the vessel. The noise from the advancing volume of water is described as deafening. The bark was struck flat aback; but, before there was time to touch a brace, the sails had filled again, and the roaring white sea had passed ahead. To increase the horror of the situation, another 'vast sheet of flame' ran down the mizzen-mast, and 'poured in myriads of sparks' from the rigging. The strange redness of the sky remained for twenty minutes. The master, an old and experienced mariner, declares that the awfulness of the sight was beyond description, and considers that the ship had a narrow escape from destruction.

In the above report there is an interesting association between electric discharge phenomena and passage of an admittedly strange meteor.

GLM-011 THE METEORIC PROCESSION OF FEBRUARY 9, 1913

Pickering, William H.; Popular Astronomy, 30:632-637, 1922.

This remarkable phenomenon was in no sense a meteoric shower. It was a different kind of event altogether, and while undoubtedly much less spectacular than a great shower, such as that of Nov. 1833, was in some respects more interesting and instructive. It consisted of a procession of fire balls and meteors all moving very slowly, in practically the same path across the sky, from horizon to horizon. It was first seen near Mortlach, 65 miles west of Regina, Saskatchewan, lat. 50°.5 N., long. 106° W. It traversed successively Manitoba, Minnesota, Michigan, Ontario, New York, Pennsylvania, and New Jersey a few miles to the south of New York City. It then went out to sea, and appeared next in Bermuda, was seen from the steamship Bellusia, lat. 17° 35' N., long. 51° 11' W., and last from the steamer Newlands, lat. 3°20' S., long. 32°30' W. The distance between the first and last stations is 5659 miles. Computation indicates that the meteors traversed several thousand miles more, while still within the limits of the earth's atmosphere, thus forming prior to their final destruction a series of minute temporary terrestrial satellites.

There appear, when first and last seen, to have been some 40 to 60 fire balls, arranged at first in 4 or 5 separate groups. Several of these had long tails. In part of the route they were accompanied by innumerable finer particles that were swept off of them in their rush through our atmosphere. The interval during which the larger fire balls were visible under favorable circumstances seems to have been from 30 to 40 seconds, and the duration of the display about 5 minutes. In Canada their color was usually described as yellow or reddish, but not white. Generally they were compared to bright stars, sometimes to Venus, but in Bermuda the two leaders looked like large arc lights, slightly violet in color and of diameter equal to the moon. Their true angular diameter was of course much less than this. An incandescent steel globule 0.2 inches in diameter, at a distance of one half mile was found by Professor I. L. Smith in 1857 to appear of the moon's diameter (Jour. R. A. S. Canada, 1914, 8, 109). This would correspond to a diameter of 24 feet. It therefore appeared 1400 times its true size. If the meteors were at a distance of 70 miles from Bermuda, this would indicate that the diameter of the two leaders was about 28 inches.

A very full description of them, with a computation of their path, and estimates of their height, speed, and size is given by Professor Chant in the Journ. R. A. S. Canada 1913, 7, 145 (See also 404, 438; 8, 108, 112; 9, 287, and 10, 294). The last two papers are by Mr. Denning, and are particularly valuable as giving the data of the two observations made at sea. These were not available when Professor Chant made his calculations, and they not only permit us to correct them, but they serve to give us much more definite information regarding the height, speed, and size of the meteors, regarding which his paper left us in considerable doubt.

The path of the meteors across the United States was about as long as it was in Canada, and they must have been visible over an area of rather more than a quarter of a million square miles, including all the large cities and observatories of the important states of Michigan, New York, Pennsylvania, New Jersey, Delaware, Maryland, the District of Columbia, and southern New England. In fact if the skies were clear they might have been seen by over 30,000,000 people. It is regrettable that it did not occur to any one in this area that this very unusual phenomenon was worth investigating. A collection of observations might at that time have been made, culled from newspapers and by private correspondence, similar to that secured by Professor Chant.

His collection is most valuable and unique, and it is proper to say that all that we know about the meteors is really due to him, since it was his work which called Mr. Denning's attention to the matter. My own first knowledge of the phenomenon was due to reading his papers. The total number of reports on which our knowledge is based is 141. Of these 135 came from Canada, 1 from southern Michigan, 1 from a lady in New Jersey, 2 from Bermuda, and 2 at sea.

GLM-012 [REMARKABLE METEOR]

Anonymous; English Mechanic, 7:351, July 10, 1868.

A remarkable meteor was seen at the Radcliffe Observatory, Oxford, on the 8th ult., at 9h. 50m. When first seen by Mr. Lucas it had the appearance of a fine white cloud about 5^{o} in length and 1^{o} in breadth, a little to the west of Polaris. As the observer was pointing out its comet-like appearance to some persons who happened to be with him in the lower meadow of the Observatory, it appeared to start into motion, taking a course directly west, and passing just below α and β Ursae Majoris, and leaving a train behind of a greater breadth than itself, which remained visible through its whole course after it had disappeared below the N. W. horizon. When it approached Leo it deviated from the straight line which it had previously taken, and turned somewhat towards the south, passing near Regulus, and then bent northwards again. The time that it was visible must have been nearly four minutes. Its appearance at one time was very like that of the flame and smoke combined which sometimes issue from a railway engine, only very faint on account of the brightness of the still remaining twilight. There was a thick haze all the night. A parselenes, or mock moon, was seen on the same night at 13h. 40m.

The unusual motion of this light would seem to place it in the UFO category, although in appearance, at least, it was meteoric.

GLM-013 [ERRATIC METEOR]

Anonymous; English Mechanic, 55:34, March 4, 1892.

"In the environs of Hochlanda," says the paragraph in the Stockholm journal, "there was seen, between 9 and 10 o'clock at night, in the direction of the North, to the west of the Great Bear, and pretty high up in the sky, a large star, which seemed to be of the first magnitude, and which rendered itself conspicuous by its extraordinary movement. At first it advanced with great rapidity, and in a straight line, towards the East for an estimated distance of 125 yds. (!), appearing then to be oblong, and approximately 12 in. long by about a quarter of that wide, and to be of a fiery-red colour. It then returned to its first position, afterwards to move not less rapidly towards the West to regain, after about an equal interval, its original position; subsequently rising slowly, then descending considerably below it, and finishing by recovering it. It moved principally in straight lines, with a very slight elliptical curvature, but incessantly changing colour. This agitation (or movement) continued for 10 hours, when it ceased. The phenomenon was observed by several people. The sole hypothe-

sis admissible at present," the writer goes on to say, "in the study of these meteors, which are bolides of which the trajectories are often perturbed in their initial direction, is that it may happen that after having encountered atmospheric strata of greater and greater density, the bolides experience a kind of ricochet, which prevents their further approach to the earth, and sends them back towards the upper regions of the atmosphere---circumstances which may occasion changes in the form and curvature of the trajectories of bolides. We must, nevertheless, add that the symmetry of the movement in the present phenomenon is without precedent in the catalogue which treats of these phenomena." I should think so. An elliptical bolide of a fiery red, but continually changing colour, which oscillates like a pendulum and remains visible for 10 hours!!! is not likely to be included in any "catalogue which treats of these phenomena."

Assumed by the writer to be an erratic meteor, this light seems more like a nocturnal light.

GLM-014 ELECTRICAL PHENOMENON

Higgin, Thomas; Nature, 35:173, December 23, 1886.

"Yloilo, October 1, 1886. Last night a most extraordinary phenomenon was visible in the heavens. About 9 o'clock the sky was perfectly clear, all the stars visible, but no moon, when suddenly the whole heavens were lit up as if by electric light, a very large globe of fire became visible (about the size the moon appears when full) and floated slowly northwards. I was in rather a bad position for seeing where it actually went, a house being between me and the horizon. This ball was followed by smaller ones, which were close to the big one, and gradually got smaller, till they appeared like falling stars, only they went much more slowly."

The title implies an electrical phenomenon akin perhaps to reports of floating balloon-like balls of fire in GLB and GLD sections, but a meteor procession could also have been seen.

GLM-015 UFO'S, NATURAL SATELLITES OR METEORS?

Edwards, Frank; Fate, 16:49-54, December 1963.

After reviewing the scientific reports on the meteor procession of 1913, Edwards adds the following:

On the afternoon of the following day, still another chapter was added to this bizarre and baffling report. The Toronto Star says that in broad daylight, many persons watched three groups of solid, dark objects pass high above the city. "They passed from west to east in three groups," says the Star, "and then returned in more scattered formation, seven or eight in all."

Items describing this meteor procession (the main procession, not the one mentioned above by Edwards) are GLM-004, GLM-006, and GLM-011.

GLM-016 A BALL OF FIRE

Thomason, E. M.; Fate, 20:136, March 1967.

In early November, 1951, in Texas City, Tex., one afternoon about five o'clock I looked into the sky to see black storm clouds threatening. I thought it might start raining any minute or even turn into a tornado. While I was looking a large green ball of fire suddenly came out of the north trailing a tail of green fire. It was very low, beneath the clouds, and when it was almost directly over the city it made a right-angle turn and flew out over the Gulf of Mexico. It didn't take more than three or four seconds. I have never seen anything move so fast.

GLM-017 WHAT SHAPE?

Fuller, Curtis; Fate, 20:26, May 1967.

Near San Diego last December 19 [1966] a group of Lemon Grove residents and two Hoover High School students in Allied Gardens described three small orange spheres that came over the horizon from the north. They were on view for about five minutes. Then they climbed to "about the zenith of the sky" and shattered in a shower of sparks. In another report, a bright orange object was seen to move from east to west and back to east. Then it faded and disappeared.

GLM-018 A CATALOGUE OF OBSERVATIONS OF LUMINOUS METEORS

Powell, Baden; Report of the British Association, 235-237, 1852.

I have the honor to transmit an account of a singular phaenomenon witnessed by myself and my family on the morning of the 4th of September 1850.

"I was then residing at the Vicarage, South Mimms, Middlesex, in a situation peculiarly favourable for astronomical observation.

"I had been engaged for several consecutive days in observing the planet Mercury during his approach to the sun; partly to test the accuracy of my power of observation by the calculations of the Nautical Almanack, but chiefly to remark how nearly I could trace the planet in his course to the sun, before he should be wholly lost in his rays.

"For this purpose I used the most careful adjustments my instrument was capable of, and continued my observations without noticing anything peculiar.

"When, however, on the morning of the 4th of September I was preparing my equatoreal before it was fixed on the planet, I observed, passing through the field of view, in a continuous stream, a great number of luminous bodies; and I cannot more correctly describe the whole appearance, than by employing the same language which I used when I communicated the circumstance to the Royal Astronomical Society, in the Monthly Notices of Dec. 13, 1850, and Dec. 12th, 1851.

"When I first saw them I was filled with surprise, and endeavoured to account for the strange appearance by supposing that they were bodies floating in the atmosphere, such as the seeds of plants, as we are accustomed to witness

them in the open country about this season; but nothing was visible to the naked eye.

"The sky was perfectly cloudless; and so serene was the atmosphere, that there was not a breath of wind through the day, even so much as to cause any perceptible tremor of the instrument; and I subjected the luminous bodies to examination by all the eye-pieces and coloured glasses that were needful; but they bore every such examination just as the planets Mercury and Venus did, both of which were frequently looked at by me, for the purpose of comparison, during the day; so that it was impossible I could resist the conclusion (much as I was early disposed to hesitate) that they were real celestial bodies moving in an orbit of their own, and far removed beyond the limits of our atmosphere.

"They continued passing, often in inconceivable numbers, from 1/2 past 9 a.m., when I first saw them, almost without intermission, till about 1/2 past 3 p.m., when they became fewer, passed at longer intervals, and then finally ceased.

"The bodies were all perfectly round, with about the brightness of Venus, as seen in the same field of view with them; and their light was white, or with a slight tinge of blue; and they appeared self-luminous, as though they did not cross the sun's disc; yet when seen near him they did not change their shape, or diminish in brightness.

"They passed with different velocities, some slowly, and others with great rapidity; and they were very various in size, some having a diameter, as nearly as I could estimate, about 2", while others were approaching to 20".

"I tried various powers upon them, and used both direct and diagonal eye-pieces; but with every one I employed they showed the same appearance, being as sharply defined as the planet Jupiter, without haze or spot, or inequality of brightness.

"I naturally anticipated some such appearance at night, but after 1/2 past 3 I saw nothing peculiar, though I waited till 11 p.m.; but have since been informed that at 1/2 past 11 (it is believed on the same night) a meteor of amazing brilliance and size, and passing in the same direction and about the same altitude, was observed by Mr. Ballan of Wrotham Park, in the immediate neighborhood of South Mimms.

"I repeated my observations the following morning, and then saw one such single body pass in the same direction as those of the preceding day.

"They occupied a tolerably well-defined zone of about 18° in breadth; and, though with some exceptions, their direction was due east and west. Their motion was perfectly uniform, so far as I was able to follow them with the instrument at liberty; and they were observed continuously by myself and members of my family, accustomed to the use of instruments, both by day and night.

"The telescope I employed on this occasion is one of 3-1/2 feet focal length, and 2-3/4 inches aperture, by Mr. Dollond, of faultless performance and mounted equatoreally by Mr. Jones of Charing Cross, the circles divided by Mr. Rothwell of London, and reading off to 5".

"I understand that a similar phaenomenon has been witnessed by Mr. Cooper of Markree Castle, County of Sligo, though I have not communicated with that gentleman on the subject; but I take the opportunity of subjoining a portion of the contents of a letter to me from Charles B. Chalmers, Esq., F.R.A.S., now residing at Jugon, Cotes du Nord, France.

"He thus writes:-'About the latter end of the year 1849, I witnessed a phaenomenon similar to that which you saw in September 1850, in every respect, excepting that I thought some of the bodies were elongated, though certainly the majority were globular; and their brightness appeared to me about equal to that of Venus, as seen at the same time.

"'I was then residing at Weston-Super-Mare, in Somersetshire; and the instrument with which I saw them was a 5-feet telescope, equatoreally mounted, in a fixed observatory.

"'I was engaged similarly to yourself in observing the planet Mercury; about 1/2 past 10 a.m. I was at first inclined to believe it must be the seed of some plants of the thistle nature floating in the air, but from my position that could not have been the case.

"'The wind on the day I observed the phaenomenon was very slight; but such as it was it came from the sea. The bodies all appeared sharply defined, no feathery appearances that I could detect; and I did not observe any difference in their brightness during the time I observed them'."

GLM-019 ON THE FACTS OF EARTHQUAKE PHAENOMENA

Mallet, Robert; Report of the British Association, 259, 1854.

April 24, 1836; Italy. A terribly destructive earthquake. In Rossano, an instant after the shock, all the houses were seen either thrown down or crumbling into ruins; and in Croscia not a single house was left standing. Long and deep fissures opened in the earth. An igneous meteor was seen, having the appearance of great beams of fire.....

GLM-020 UFO IN 1800: METEOR?

Powers, William T.; Science, 160:1260, June 14, 1968.

The UFO controversy has focussed attention on unusual atmospheric phenomena. The famous "Condon Report" of the University of Colorado, while ostensibly debunking UFOs, did discuss many unusual, often unexplained phenomena that happen above the earth's surface. In a similar vein, old observations of strange events are once again being scrutinized. Powers quoted the following from the Transactions of the American Philosophical Society, 6:25, 1804.

A phenomenon was seen to pass Baton Rouge on the night of the 5th April 1800, of which the following is the best description I have been able to obtain.

It was first seen in the South West, and moved so rapidly, passing over the heads of the spectators, as to disappear in the North East in about a quarter of a minute.

It appeared to be of a size of a large house, 70 to 80 feet long and of a form nearly resembling Fig. 5 in Plate IV.

It appeared to be about 200 yards above the surface of the earth, wholly luminous, but not emitting sparks; of a colour resembling the sun near the horizon in a cold frosty evening, which may be called a crimson red. When passing right over the heads of the spectators, the light on the surface of the earth, was little short of the effect of sun-beams. though at the same time, looking another way, the stars were visible, which appears to be a confirmation of the opinion formed of its moderate elevation. In passing, a considerable degree of heat was felt but no electric sensation. Immediately after it disappeared in the North East, a violent rushing noise was heard, as if the phenomenon was bearing down the forest before it, and in a few seconds a tremendous crash was heard similar to that

of the largest piece of ordnance, causing a very sensible earthquake.

I have been informed, that search has been made in the place where the burning body fell, and that a considerable portion of the surface of the earth was found broken up, and every vegetable body burned or greatly scorched. I have not yet received answers to a number of queries I have sent on, which may perhaps bring to light more particulars.

GLM-021 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Science, 1:26:132-174, 1834.

The following observation was not connected with the 1833 meteor display, but Olmsted included it because of its peculiarities.

> "In November, 1825, about one hour after sunset, a meteor was seen in the town of Newton, Trumbull Co. Ohio, rapidly crossing the sky in a direction somewhat east of south, in size surpassing the full moon, but somewhat irregular in its form. At a certain point in its course, a portion of the meteor was seen to separate, and descend to the earth in an oblique direction, while the main body passed on, and soon disappeared. At the same time, and at the place where the meteor was seen to fall, two ladies who were walking in the road in the same direction in which the meteor was moving, found themselves suddenly enveloped in a mass of light. A ball of fire or light, several feet in diameter, seeming to come from above and behind fell upon them and the ground, breaking, as it struck into a thousand smaller balls, rolling upon the earth and breaking again into still smaller balls, till it disappeared. Looking up, they saw the other portion of the meteor just as it disappeared in the distance before them. This phenomenon was attended with no noise or heat, and their clothing exhibited no traces of having been in contact with any foreign substance." E. N. Sill, Esq., of Cuyahoga Falls, (communicated to the writer.)

The fragmentation of the fire ball is a property of ball lightning. Possibly there was no meteor at all, or perhaps ball lightning was somehow generated by the meteor.

GLM-022 A CATALOGUE OF LUMINOUS METEORS

Powell, Baden; Report of the British Association, 54-55, 1856.

> August 11, 1853. Tillington, near Petworth, England. A bright light behind the hills preceded the rising of a bright body like the full moon. Gradually diminished to a small star. Rays proceeding from it on all sides, not shooting out by stationary.

GLM–023 [SLOW METEORS OVER AUSTRALIA]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

Fort obtained the following from the Sydney Herald and Melbourne Leader.

There was a meteoric explosion, at Parramatta, November 13th [1902]. A fire ball fell and exploded terrifically, at Carcoar. At Murrumburrah, N. S. W., dust and a large fire ball fell, upon the 18th. A fire ball passed over the town of Nyngan, night of the 22nd, intensely illuminating sky and ground. Upon the night of the 20th, as reported by Sir Charles Todd, of the Adelaide Observatory, a large fire ball was seen, moving so slowly that it was watched four minutes. At 11 o'clock, night of the 21st, a fire ball of the apparent size of the sun was seen at Towitta. An hour later, several towns were illuminated by a great fire ball. Upon the 23rd, a fire ball exploded at Ipswich, Queensland. It is of especial importance to note the record of one of these bombs, or meteors, that moved so slowly that it was watched for four minutes.

GLM-024 [PHENOMENA DURING THE CHARLESTON EARTHQUAKE]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

Aug. 31, 1886---"Just before the sun dropped behind the horizon, it was eclipsed by a mass of inky, black clouds." People noted this appearance. It was like the "dense, mountain-like cloud" that appeared at Callao, Peru, before the earthquake of Sept. 4, 1868. But these people were in a North American city. Meteors were seen. They were like the fire balls that have shot from this earth's volcanoes. Luminous clouds, such as have been seen at times of this earth's eruptions, appeared, and people watched them. There was no thought of danger. There was a glare. More meteors. The city of Charleston, South Carolina was smashed.

People running from their houses---telegraph poles falling around them---they were meshed in coils of wires. Street lamps and lights in houses waved above, like lights of a fishing fleet that had cast out nets. It was a catch of bodies, but that was because minds had been meshed in the net of a cult, woven out of the impudence of the De Ballores and the silences of the Davisons, spread to this day upon every school of this earth.

The ground went on quaking. Down from the unknown came, perhaps, a volcanic discharge upon this quaking ground. Whether it were volcanic dust, or not, it is said, in the New York World, September 4, that "volcanic dust" was falling, at Wilmington, North Carolina.

September 5th---a severe shock, at Charleston, and a few minutes later came a brilliant meteor, which left a long train of fire. At the same time, two brilliant meteors were seen, at Columbia, S. C. See almost any newspaper of the time. I happen to take from the London Times, September 7. (p. 788)

. . . . . .

. . . . . Meteors kept on coming to Charleston. They kept on arriving at this quaking part of the earth's surface, as if a point on a stationary body. The most extraordinary display was upon the night of October 22nd. There was a severe quake, at Charleston, while these meteors were falling. About fifty appeared (New York Sun, November 1). About midnight, October 23-24, a meteor exploded over Atlanta, Georgia, casting a light so intense that small objects on the ground were visible (New York Herald, October 25). A large meteor, at Charleston, night of October 24th (Monthly Weather Review, 1886-296). An extraordinary meteor, at Charleston, night of the 28th, is described, in the News and Courier, of the 29th, as "a strange celestial visitor."

"It was only a coincidence."

There is no conventional seismologist, and there is no orthodox astronomer,

who says otherwise.

In the Friend of India, June 22, 1897, is another record of some of the meteors that were seen over Charleston: that, at the time of the great quake, Prof. Oswald saw meteor after meteor shoot from an apparent radiant near Leo. Carl McKinley, in his Descriptive Narrative of the Earthquake of August 31, 1886, records a report from Cape Romain Light Station, upon "an unusual fall of meteors during the night." (p. 789)

The above item typifies Fort's methodology, although he frequently employed much more humor. He collected data---often incongruous data---from diverse sources and then challenged science to explain the inconsistencies and/or the contradictions with the science of his time.

GLM-025 REMARKABLE METEORS

Schofield, Frank H.; Monthly Weather Review, 32:115, March 1904.

The following report, as kindly communicated by the editor of the Pilot Chart, is dated U. S. S. Supply, at sea, latitude 36° 20' north; longitude 127° 36' west, February 28, 1904:

1. I have the honor to report that three somewhat remarkable meteors were observed from this ship at 6:10 a.m. (Greenwich mean time 3 hours 12 minutes) February 28, 1904, in latitude 35° 58' north, longitude 128° 39' west.

2. The meteors appeared near the horizon and below the clouds, travelling in a group from northwest by north (true) directly toward the ship. At first their angular motion was rapid and color a rather bright red. As they approached the ship they appeared to soar, passing above the clouds at an elevation of about 45°. After rising above the clouds their angular motion became less and less until it ceased, when they appeared to be moving directly away from the earth at an elevation of about 75° and in a direction west-northwest (true). It was noted that the color became less pronounced as the meteors gained in angular elevation.

3. When sighted, the largest meteor was in the lead, followed by the second in size at a distance of less than twice the diameter of the larger, and then by the third in size at a similar distance from the second in size. They appeared to be travelling in echelon, and so continued as long as in sight.

4. The largest meteor had an apparent area of about six suns. It was egg-shaped, the sharp end forward. This end was jagged in outline. The after end was regular and full in outline.

5. The second and third meteors were round and showed no imperfections in shape. The second meteor was estimated to be twice the size of the sun in appearance, and the third meteor about the size of the sun.

6. When the meteors rose there was no change in relative positions; nor was there at any time any evidence of rotation or tumbling of the larger meteor.

7. I estimated the clouds to be not over one mile high.

8. The near approach of these meteors to the surface and the subsequent flight away from the surface appear to be most remarkable, especially so as their actual size could not have been great. That they did come below the clouds and soar instead of continuing their southeasterly course is also equally certain, as the angular motion ceased and the color faded as they rose. The clouds in passing between the meteors and the ship completely obscured the former. Blue sky could be seen in the intervals between the clouds.

9. The meteors were in sight over two minutes and were carefully observed

by three people, whose accounts agree as to details. The officer of the deck, Acting Boatswain Frank Garvey, U.S. Navy, sighted the meteors and watched them until they disappeared. He sent a messenger to me who brought an unintelligible message. When I arrived on the bridge the meteors had been obscured for about one-half of a minute.

In many respects, the above resembles many modern UFO reports.

GLM-026 THE NOTES OF CHARLES FORT

Fort, Charles; The Fortean Society Magazine, 1:15, October 1937.

1812, May 1. Black rain and detonations, meteors or globes of fire and a glow in the sky "resembling the Aurora Borealis," large flock of birds, "sand and ashes." Schornburgh's History of Barbadoes, p. 69.

GLM-027 [DIGRESSING METEOR]

Anonymous; Nature, 27:423, March 1, 1883.

On February 5, at 6.45 p.m., a meteor of unusual size and appearance was observed near Arvika, in Sweden. An observer who happened at the time to be passing a lake---Glasfjorden---states that he first observed the meteor high on the horizon, going from south-east to north-west, when, after about eighteen seconds, it suddenly changed its course to south-east. During its progress to north-west, calculated at eighteen seconds, the meteor made several digressions from its plane, while its size varied from that of an ordinary star to that of the sun, sometimes emitting a white, at others a yellow light, and at times discharging showers of sparks. At the point of changing its direction, when it was so near the surface of the lake that its path was reflected therein, it possessed a distinct tail, and with this adjunct it passed out of the range of sight in a south-easterly direction, after being observed for nearly fifty seconds.

GLM-028 A CATALOGUE OF OBSERVATIONS OF LUMINOUS METEORS

Powell, Baden; Report of the British Association, 188–189, 1852.

"On the evening of Friday, March 19 [1847], A. and I left Albion Road [Holloway] about half-past 8. Not any stars were then visible, but when we were in Highbury Place, A. called my attention to what we thought a fire-balloon ascending slowly. It was in the west, a little inclining to the south. As it passed on slowly to the west its intense brilliance convinced me that it was not an earthly thing. When it appeared to be over Hampstead (but as high in the heavens as the sun is at 6 o'clock in the evening when the days are longest), it shot forth several fiery coruscations, and whilst we were gazing at it, broke into an intensely radiant cloud. This cloud sailed on slowly, and we never took our eyes off it. At this time the stars were shining. When we were

in the gravel path opposite to Highbury Terrace, the cloud was rather higher in the heavens, and more to the W. It cast a most brilliant light on the houses there, brighter than moonlight, and unlike any light I ever saw. It appeared of a blue tint on the bricks, but there was no blue light in the cloud itself. Suddenly over the radiant cloud appeared another cloud still more brilliant, but I now felt so awe-struck that I cannot say precisely how long they hung one over the other, before the most wonderful sight happened. Perhaps they remained so for two or three minutes, when from the upper cloud a small fiery ball (about the size that the largest planets appear to the naked eye) dropped into the lower cloud, and was instantly absorbed. Soon after another similar ball dropped from the upper to the lower cloud; and then a ball apparently four or five times the size of the two preceding fell from one cloud to the other in the same wonderful way. Shortly after this both clouds disappeared, apparently absorbed in the heavens, though I did see a few particles of the brilliant clouds floating about for a minute or so. Presently the moon appeared considerably to the northward of the place where the clouds had hung. We then saw the bright light across the heavens which you told me was zodiacal light, which lasted for more than an hour."

GLM-029 OBSERVATIONS OF THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Science, 1;25:363-411, 1834.

The following observations were made around the time of the famous 1833 meteor display.

At Poland, Trumbull County, Ohio.--- A luminous body was distinctly visible in the north east, for more than an hour. The Hon. Calvin Pease informs me that he discovered it at 4 o'clock, near the star Alioth, in Ursa Major; that it was then very brilliant in the form of a pruning hook, and apparently twenty feet long and eighteen inches broad, and that it gradually settled towards the horizon, until it disappeared. I first saw it at 5 o'clock, when it resembled a new moon, two or three hours high, shining through a cloud, about fifteen minutes afterwards, no vestige of it could be seen. (Dr. Jared P. Kirtland's letter to Prof. Silliman.)

At Niagra Falls.--- They were seen as early as two o'clock, and soon after, a large luminous body, like a square table, was seen nearly in the zenith, remaining for a time nearly stationary; and from this were emitted large streams of light. (Mr. Horatio A. Parson's letter to Prof. Silliman.)

Prof. Silliman was founder of the American Journal of Science.

GLM-030 [EARTHQUAKES AND METEORS]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

In Ponton's Earthquakes, p. 118, it is said that, upon the 8th of October, 1857, there had been, in Illinois, an earthquake, preceded by "a luminous appearance, described by some as a meteor and by others as vivid flashes of lightning." Though felt in Illinois, the center of the disturbance was at St. Louis, Mo. One notes the misleading and obscuring of such wording: in all contemporaneous

accounts there is no such indefiniteness as one description by "some" and another notion by "others." Something exploded terrifically in the sky, at St. Louis, and shook the ground "severely" or "violently," at 4:20 A. M., Oct. 8, 1857. According to Timbs' Year Book of Facts, 1858-271, "a blinding meteoric ball from the heavens" was seen. "A large and brilliant meteor shot across the heavens" (St. Louis Intelligencer, October 8). Of course the supposed earthquake was concussion from an explosion in the sky, but our own interest is in a series that is similar to others that we have recorded. According to the New York Times, October 12, a slight shock was said to have been felt four hours before the great concussion, and another three days before. But see Milne's Catalog of Destructive Earthquakes--- not a mention of anything that would lead one away from safe and standardized suppositions. See Bull. Seis. Soc. Amer., 3-68---here the "meteor" is mentioned, but there is no mention of the preceding concussions. Time after time, in a period of about three days, concussions were felt in and around St. Louis. One of these concussions, with its "sound like thunder or the roar of artillery" (New York Times, October 8) was from an explosion in the sky. If the others were of the same origin---how could detonating meteors so repeat in one small local sky, and nowhere else, if this earth be a moving body?..... (p. 406)

GLM-031 [HAYCOCK REVOLVES THROUGH AIR]

Anonymous; Nature, 7:112, December 12, 1872.

Another phenomenon of a similar kind is recorded as follows by a correspondent of the Birmingham Morning News. The people living near King's Sutton, Banbury, say that about one o'clock on Saturday they saw something like a haycock revolving through the air, accompanied by fire and dense smoke. It made a noise resembling that of a railway train, but very much louder, and travelled with greater rapidity. It was sometimes high in the air, and sometimes near the ground. It passed over the estate of Colonel North, M. P., Sir W. R. Brown, Bart., and Mr. Leslie Melville-Cartwright, whose park wall it threw down to the foundation in several places, and at one place for upwards of sixty yards. A man named Adams was breaking stones, and a minute before he was standing under a tree that was torn up by the roots and the branches scattered in every direction. Two or three trees near him were torn up, and one of them, the largest beech on Sir William Brown's estate, which tore up with it twelve or fifteen tons of earth. For a distance of nearly two miles, hedges, rails, trees, hovels, and ricks have been knocked down or injured. A whirlwind followed the fire-meteor, and carried everything before it. Stones from the walls knocked down were carried forty yards away, and the water in a pond disappeared on the passage of the phenomenon. After travelling about two miles the meteor seemed to expend itself and disappeared all at once. There was a heavy fall of rain at the time, and a vivid flash of lightning just before. The direction taken by the meteor was from south to north, and it travelled almost in a straight line.

The mass of fire described above does not resemble ball lightning and is certainly not a meteor as we understand them. The phenomenon is probably atmospheric in nature and possibly electrical in origin.

GLN-001 [THE PALATINE LIGHT]

Gaddis, Vincent; Invisible Horizons, Chilton Books, Philadelphia, 1965.

Nocturnal lights are luminous phenomena that usually persist in a specific locality---sometimes for centuries. The lights may vary in number, size, and color and seem to be able to elude pursuers by maneuvering or just disappearing. They are not the products of storms, as ball lightning seems to be, although they of course may be atmospheric aberrations of some sort. Nocturnal lights are rarely reported in the scientific literature. Thus, there is in this subsection a heavier dependence upon popular magazines and books. These accounts, however, are certainly no more fantastic than those of ball lightning.

The first nocturnal light, the Palatine Light, is seen off Block Island, RI. In his description, Gaddis quotes Samuel Livermore's A History of Block Island:

> The light is actually seen, sometimes one-half mile from shore, where it lights up the walls of a gentleman's rooms through the windows.....
>
> The people here are so familiarized with the sight they never think of giving notice to those who do not happen to be present, or even mentioning it afterwards, unless they hear some particular inquiries have been made. It beams with various magnitudes. Sometimes it is small, resembling the light through a distant window, at others expanding to the highness of a ship with all her canvas spread. The blaze actually emits luminous rays.....
>
> The cause of this 'roving brightness' is a curious subject for philosophical speculation. Some, perhaps, will suppose it depends upon a peculiar modification of electricity; others upon the inflammation of phlogogistous (sic) gas.(p. 91)

The Palatine Light has been seen by many reliable people through the years. Its name comes from that of a ship that met a fiery doom off Block Island. The tale of the Palatine light apparently has much in common with ghost stories.

GLN-002 PSYCHOLOGICAL ASPECTS OF THE WELSH REVIVAL

Fryer, A. T.; Proceedings of the Society for Psychical Research, 19:80-161, 1905.

During the great Welsh religious revival of 1904-1905, strange lights were seen along with other curious phenomena. A. T. Fryer's classic study of the revival provides many fascinating case histories as well as his own thoughtful comments.

In times of great emotional stress, people sense strange things, and do strange things, too. This psychic dimension is part of the problem---perhaps in some physical phenomena as well as in the psychical realm. Certainly some of the things seen during tornadoes and earthquakes strongly resemble those seen during the Welsh revival, as the following case histories will demonstrate.

It should also be pointed out that the Society for Psychical Research during Fryer's day enjoyed the support of many of England's most prominent men of science.

First, Fryer's general comments on the Welsh "lights":

I now come to that part of the subject which has perhaps caused more excitement in the public mind than any other feature of the Revival. All my readers must have heard of the mysterious lights in Merionethshire associated with the name of Mrs. Jones of Islawrffordd, near Dyffryn. This good lady is, I am told, a very simple, quiet person, whose life until recently has been passed in obscurity. Some time ago she read Sheldon's book, In His Steps, and was much moved by it. She determined to work for the spiritual good of her neighbours, and she began her ministry early in December, 1904. The story is that she is attended by lights of various kinds wherever she goes, and as I shall show presently, there is more in this personal attention than might be supposed. I am spared the necessity of giving minute details, since Mr. Beriah G. Evans, a Carnarvon journalist, has taken care to inform the world as to the lights, and his account of what he and others have seen may be read in The Occult Review for March, April, and June, 1905. The numbers are in the S. P. R. Library. It is important to notice that the coast in the neighbourhood of Dyffryn has been favoured or disfavoured with lights of many shapes and sizes in former times. Pennant in his Tour in Wales gives a full account of the appearances of mischievous blue flames that alarmed people and did material damage near Harlech in 1694. Lights of a blue colour appeared also in the neighbourhood of Pwllheli in 1875, and the publication of Mr. Picton-Jones' account of what he then saw elicited from a correspondent the relation of a similar occurrence in 1869 or 1870. Again in 1877 lights of various colours were seen moving over the estuary of the Dysynni. Through the kindness of the editor of the Oswestry Advertizer I have received the extracts from his "Bye-gones" columns, which give the notes on lights for the three years 1869, 1876, and 1877. These are quoted in my Appendix (16). I am not satisfied with the investigations that have taken place, and I think now as I did at the first, that the Society might well employ a geological expert to go over the district and discover, if possible, what conditions are present favourable to the natural production of incandescent vapours. Mr. Bernard B. Redwood (son of the well-known scientific expert, Sir Boverton Redwood) was sent down by the Daily Mail in February, 1905, but his report,[1] which I give in the Appendix (17) is not to be conclusive. He planned his investigation on the supposition of electrical disturbance, and I am not surprised that he was disappointed at the result. He says, with more approximation to what I think is the cause of some of the lights, that it is just possible that there may have been some lights caused by spontaneous ignition of phosphuretted hydrogen generated in the marsh at Egryn and distorted by mist. He adds that "Methane or marsh gas is never self-ignited, and may be left out of the question." With his personal opinion of Mrs. Jones I am not disposed to agree; but granting its truth, we have still to reckon with the witnesses I shall quote as to the reality of both subjective and objective lights. The evidence received I proceed to give, first, however, stating my conviction that Merionethshire has been the scene of late of a large amount of exaggeration and misconception, and perhaps trickery. But having made all allowance for persons who mistook meteors, brightly-shining planets, farm lanterns, railway signals, and bodies of ignited gases for tokens of heavenly approval of Mrs. Jones and the Revival, there remain sufficient instances of abnormal phenomena to encourage further inquiry. Evidence of misapprehensions I have received.

A vicar in the neighbourhood has sent me the following: "A very reliable man informed me that one morning last week [in February, 1905] on looking out through his bedroom window about 6 a.m. he saw some remarkable lights rising over the marsh indicating a wave, bluish colour, and ascending up into the

[1] This report was not published in the Daily Mail, but Mr. Redwood kindly sent a copy of it to us.--Editor.

heavens and vanishing away, but he did not in any way connect the light with the Revival in any shape or form."

Correspondents from whom I have managed to obtain evidence relate various experiences. Mrs. Jones of Islawrffordd wrote on January 16th, 1905: "I have seen [the light] every night from the beginning of the Revival about six weeks ago. Sometimes it appears like a motor-car lamp flashing and going out, and injures nothing at all; other times like two lamps and tongues of fire all round them, going out in one place and lightning again in another place far off sometimes; other times a quick flash and going out immediately, and when the fire goes out a vapour of smoke comes in its place; also a rainbow of vapour and a very bright star." She said that the lights were always seen out of doors, and at about six o'clock in the evening. I asked if they had been seen by anyone who had not been converted, and the answer was "Yes."

A man at Dolgau says (January 25th, 1905): "We have not seen it now for a fortnight. We saw it for eight nights some time back at about 11 o'clock. We were afterwards a week without seeing it, and then we saw it once more.... It was very like the light of a lamp, but not so bright, and appeared to me to move gradually. Once I saw it move swiftly. It was in a place where there was no light to be. It appeared very low down, along the ground, I should think." In reply to queries he says that the colour was a weak white light, always very much the same; it appeared at first accidentally, it was not expected. There is a ditch running through a ravine near the spot.

Another correspondent says that only once did he see the light, on January 2nd, 1905. "It was hovering above a certain farmhouse, and it appeared to me as three lamps about three yards apart, in the shape of a Prince of Wales's feathers, very brilliant and dazzling, moving and jumping like a sea-wave under the influence of the sun on a very hot day. The light continued so for ten minutes. All my family saw it the same time. It was 10.40 p.m. at the time." My questions were treated by him as evidence of utter unbelief, and repeated requests for further information met with refusals.

A young woman of some education wrote (February 4th, 1905): "I saw the light you refer to one night in the beginning of January [between 10 and 10.30 p.m.]. At first I saw two very bright lights, about half a mile away" [it was between Dyffryn and Llanbedr], "one a big white light, the other smaller and red in colour. The latter flashed backwards and forwards, and finally seemed to become merged in the other. Then all was darkness again. It did not appear in the same place again, but a few minutes after we saw another light which seemed to be a few yards above the ground. It now looked like one big flame, and all around it seemed like one big glare of light. It flamed up and went out alternately for about ten minutes, very much in the same way as some lighthouses."

It is probable that the two persons whose accounts I have just given saw the same light from different points of view.

On December 22nd, 1904, at 5.18 p.m., another deponent saw, in company with two other persons, a large light "about half way from the earth to the sky, on the south side of Capel Egryn, and in the middle of it something like [a] bottle or black person, also some little lights scattering around the large light in many colours. Last of all the whole thing came to a large piece of fog, out of sight."

.....

The lights seen in July were, I believe, not any of them due to extraneous physical causes. If they are called subjective, the term must be held only to be equivalent to an operation within the physical limits of the percipients, and the lights must be considered in relation to the sounds and changes of bodily tem-

perature experienced by several persons elsewhere as related in this paper and Appendix. In the ascending scale of vibrations the order is sound, heat, and light waves. Is it probable that persons affected by such stimuli as the Revival provided heard, felt, or saw accordingly (1) to the intensity of the stimulus in each case, and (2) to the susceptibility of the percipient? If one man's mental organs were excited to a certain degree, he would hear a voice; if to higher degree, he would experience a vision; either operation, however, being entirely within the brain of the subject. I advance the theory of physical vibratory operation with considerable hesitation, and only because I am not satisfied with the proposal to attribute the occurrences either to diseased imagination (if by that term is meant a species of self-deception) or to some mental operation apart or distinct from the organism by which the mind works. If a sharp blow upon a certain portion of the head causes a man to "see stars," may it not be possible for a mental stimulus from without to act in a similar way? When it is known how mind can affect mind at a distance it will be possible, perhaps, to explain the operation within a man's self which interprets stimuli now as sound, now as heat, or again in vision. My chief concern here is to ask that the three kinds of experiences may be examined in correlation and all of them with due regard to the ascertained laws of vibration and modes of energy. The theory may be put thus:

A. Agent, exercising influence and suggesting form.
B. Recipient of mental stimulus whose brain translates the message into sound, heat, or light form according to its own capacity of motion.

In this inquiry the physical and the psychical cannot safely be dissevered, however necessary it may be to specialise for the sake of adequate research.

Fryer's Appendix begins with accounts of lights seen prior to the revival.

The following accounts of previous appearances of lights at various places along the coast of Tremadoc Bay are taken from Bye-Gones (a series of notes on antiquarian subjects which appears weekly in the Border Counties Advertizer, Oswestry, and is reprinted in quarterly parts), the extracts having been kindly furnished to me by the editor:

From "Bye-Gones," March 1875 (p. 198).

Mr. Picton-Jones has been kind enough to address to us the following letter, in response to the request which we made last week for further information:

"Yoke House, Pwllheli, 2nd March, 1875.---The curious lights appeared again on Sunday night. We saw twelve at the same time; two were very bright, the one of a red, the other of a blue colour. They were inland, the same as before, but from what we could observe they did not confine themselves to marshy ground, although at first they seemed to rise from the ground where we knew there were swamps. It was a very dark and foggy night, and my brother, my son Percy, my keeper and I went out about a mile to see if we could get near them. When we had gone about half a mile we observed four or five behind us. We went to the farm adjoining, and called their attention to them. Mrs. Picton-Jones and two servants watched them for an hour and a half, and had, from their description, a better view than we had, as we were occasionally in hollows. On our way home from Bryntani farm we saw a bright light at Yoke House, which we all thought was a lamp put out to direct us home, the night being so dark and our course across country. The other servants by this time, having come home from church and chapel, were watching the curious antics of the lights. I should mention that we came to banks or ditches. Those at Yoke House saw the same light, and thought it was our lamp, but were all mistaken, as, when we got within about 200 yards of our pond, the light turned into a deep blue colour and disappeared. In

front of the other pool there are some sheds, and one light that had appeared before we started seemed to go in and out, round the corner, on to the cart horse stable, round its gable end, then on to the barn, exactly the same as if it were a human being, with the exception of rising to such a height that even 'Tall Agrippa' could not come up to it. Their movements and the distance which they spread were the same as described before. Our house is about three-quarters of a mile from the Cardigan Bay, and the promontory is about seven miles as the crow flies. Last night they did not appear, but we saw several flashes of lightning.---I am, sir, your obedient servant, G. T. Picton-Jones." (Cambrian News).

From "Bye-Gones," March, 1875 (p. 210).

"Having read the account by Mr. Picton-Jones of the strange lights seen by him near Pwllheli, I beg to say that I witnessed a very similar phenomenon on the marshy ground near Borth. Some five or six years ago, owing to an accident on the Cambrian Railway, I had to post from Machynlleth to the neighbourhood of Towyn, where I was then residing. It would then be about 12 o'clock p.m. when I came in sight of the low ground and sandy dunes between Borth and the Dovey, the night being perfectly clear and still and the stars shining, when, to my astonishment, I saw four or five lights moving apparently on the sand hills near the farm of Ynyslas. I called the post-boy's attention to them, and never did I see a man so paralysed with fright: I thought he would have fallen off the box, and the perspiration, as I could see by the light of the lamps, fairly ran down his face. He evidently considered them of supernatural origin, as he told me an incoherent story of a boat's crew of shipwrecked foreigners having been murdered when they came ashore there many years ago (upon further inquiry I found there was some tradition of the sort). However, there the lights were, moving about in a sort of aimless way until, as near as I can remember, we reached within a mile or two of Aberdovey. They were white, and about the size and brilliancy of the lamps carried by railway guards and porters. There is yet another phenomenon of which no satisfactory explanation has ever yet been given. On the 24th of September, 1854 (I refer to my game book of that year), a friend was shooting with me at Herefordshire. The day was perfectly still, the sky cloudless, when sounds like discharges of heavy artillery came from the west, which, striking against a range of wooded hills running north and south under which we were shooting, made most wonderfully distinct echoes. These discharges, or whatever they were, continued for several hours at regular intervals of about two minutes. Since then similar sounds have been heard two or three times (judging from the letters to the papers), and principally by persons living in Cardiganshire, but their origin has never yet, so far as I can see, been discovered."

.....

Psychological Aspects of the Welsh Revival.

The following paragraph is taken from the Western Mail of March 13th, 1905:

"Mysterious lights were seen in Wales before this year of revival. Here is an old extract: 1694. April 22. 'A fiery exhalation rising out of the sea opened itself in Montgomeryshire a furlong broad and many miles in length, burning all straw, hay, thatch, and grass, but doing no harm to trees, timber, or any solid things, only firing barns or thatched houses. It left such a taint on the grasse as to kill all the cattle that eate of it. I saw the attestations in the hands of the sufferers. It lasted many months.' From Memoirs of Evelyn (1819 edition). Also in the Powys-Land Papers for 1883."

Extract from Pennant's Tour in Wales, Vol. II., p. 372, ed. 1810:

"Winter of 1694.---A pestilential vapour resembling a weak blue flame

arose during a fortnight or three weeks out of a sandy, marshy tract called Morfa Byden, and crossed over a channel of 8 miles to Harlech. It set fire on that side to 16 ricks of hay and 2 barns, one filled with hay, the other with corn. It infected the grass in such a manner that cattle, etc., died, yet men eat of it with impunity. It was easily dispelled: any great noise, sounding of horns, discharging of guns, at once repelled it. Moved only by night, and appeared at times, but less frequently; after this it disappeared."

Appendix 17. Investigation of reported phenomenal lights in North Wales.

February 21st, 1905. In accordance with instructions, I proceeded to Barmouth on Monday, February 13th, arriving there at 6.50 a.m. on Tuesday the 14th, with the object of investigating a report that mysterious lights had been seen on the hill sides above Egryn, which is a little village about four miles from Barmouth. I was accompanied by an assistant to help with the installation and working of the electrical apparatus. This apparatus consisted of an electrical collector raised 20 feet above the ground on a pole and supported on an insulator. Attached to this collector was a phosphor-bronze wire about 300 yards in length and carried on porcelain insulators. This wire constituted the positive electric lead, and in the circuit I placed a galvanometer and a telephone receiver, which latter is the most sensitive indicator of abnormal atmospheric electrical conditions. I also placed a delicate compass between the galvanometer and the telephone receiver where it would instantly respond to the slightest electrical influence; the negative poles of these instruments were well "earthed." On testing this line with a single small dry cell, all the instruments responded.

I spent the greater part of the day of the 14th in investigating local reports and in surveying the ground where the lights were reported to have been seen. I visited the local telephone and telegraph stations, and inquired if the instruments there had been interfered with by atmospheric electricity. In no instance was this the case, although the men in charge told me that in consequence of the presence of a large sun spot they had received orders to pay special attention to the working of the instruments. I then inquired if there was a "Marconi Station" in the neighbourhood, but I learnt that the nearest one was at Holyhead. It occurred to me that the lights might have been due to a discharge of what is known as "globular lightning," but this form of electrical disturbance is usually accompanied by an explosion, and much damage is done in the vicinity. A careful examination of the hillside failed to show any signs of this.

I erected my apparatus on the hillside on the spot where the lights were reported to have been seen, and remained by it for many hours of darkness without observing the slightest deflection of the instruments or seeing anything abnormal, with the exception of two brilliant flashes towards the north. These, I afterwards learnt, were due to an attempt on the part of some newspaper correspondents to photograph the chapel by flashlight.

Wednesday, 15th February. On my behalf Mr. Dilnot wired Mr. Jones of Dyffryn to ask for the whereabouts of his wife, who was reported to be the originator of these lights. Mrs. Jones unexpectedly returned to Dyffryn, so I proceeded there and interviewed her. This interview was unsatisfactory; it is obvious to me that the woman is a religious maniac, and that no reliance can be placed on her statements, which were vague and indefinite. Another long night watch resulted in nothing. I certainly saw several lights which might have appeared to be abnormal to the overwrought imagination, but when resolved by a powerful prismatic night fieldglass which I had with me turned out to be farm lanterns.

On Thursday, February 16th, I returned home via Portmadoc, where Mrs. Jones had been preaching, in order to investigate the local reports. Here

again I failed to obtain one single definite statement by an eye-witness.

Conclusion. It is just possible that there may have been some lights caused by spontaneous ignition of phosphuretted hydrogen generated in the marsh at Egryn and distorted by mist, although I never saw any. Methane, or marsh gas, is never self-ignited, and may be left out of the question. The presence of atmospheric electricity I think I have disproved.

In view of the fact that Mrs. Jones solumnly stated to me that Venus, which was particularly brilliant at that period, was a new star, had only appeared since the Revival, and was situated a short distance above her house, I think we may dismiss these lights as phantasies of overwrought brains. Bernard B. Redwood.

Appendix 18.

From Mr. J. J., of D_____, Merionethshire. The original account, which I received in January, 1905, is in Welsh; I give here a translation of it:

In reference to the fire concerning which you wrote to me. There are several here who have seen it in varying forms---sometimes near Chapel Egryn, sometimes on the roof thereof, and sometimes some half mile or more from the place.

When I saw it, it was about half a mile from the chapel and about a mile from where I stood. That was about 5 o'clock in the evening. The first form in which it appeared to me was that of a pillar of clear fire quite perpendicular. It was about 2 feet wide and about 3 yards in height. Suddenly another small fire began by its side some 2 yards distant from the first pillar. It rapidly increased until it assumed the same measurement and form as the first. Then another small fire suddenly arose on the other side of the first pillar, and increased rapidly until it assumed the same size and form as the other two columns. So there were three pillars of the same size and form. And as I gazed upon them I saw two arms of fire extending upwards from the top of each of the pillars.

The three pillars and their arms assumed exactly the same shape and remained so for about a minute or two. As I looked towards the sky I saw smoke ascending from the pillars, and immediately they began to disappear. Their disappearance was equally swift with their growth. It was a gradual disappearance; the fire became small and went out.

I thought they were natural fire, but it was a very wonderful fire. I never saw fire the same as it in my life---three pillars or columns of the same measure and of exactly the same shape and equidistant from each other. I do not propose to offer any kind of explanation. I leave that to you.

Appendix 19.

From Mr. L. M., of H_____. May 30, 1905. With regard to the lights which appear in this neighbourhood, perhaps one instance of my experience will suffice. I have been an eye-witness of them on more than one occasion. I happened to be with Mr. Beriah Evans, Carnarvon, on that night, the report of which has been given to the world by Mr. Evans himself. I can testify to the truth of the report.

The night which I am going to relate you my experience was Saturday evening, March 25, 1905, when Mrs. Jones, the evangelist, of Egryn, was conducting a service in the Calvinistic Methodist Chapel at Llanfair, a place about a mile and half from Harlech on the main road between Harlech and Barmouth.

My wife and myself went down that night specially to see if the light accompanied Mrs. Jones from outside Egryn. We happened to reach Llanfair about 9.15 p.m. It was a rather dark and damp evening. In nearing the chapel, which can be seen from a distance, we saw balls of light, deep red, ascending from one

side of the chapel, the side which is in a field. There was nothing in this field to cause this phenomenon---i.e. no houses, etc. After that we walked to and fro on the main road for nearly two hours without seeing any light except from a distance in the direction of Llanbedr. This time it appeared brilliant, ascending high into the sky from amongst the trees where lives the well-known Rev. C.E. The distance between us and the light which appeared this time was about a mile. Then about eleven o'clock, when the service which Mrs. Jones conducted was brought to a close, two balls of light ascended from the same place and of similar appearance to those we saw first. In a few minutes afterwards Mrs. Jones was passing us home in her carriage, and in a few seconds after she passed, on the main road, and within a yard of us, there appeared a brilliant light twice, tinged with blue. In two or three seconds after this disappeared, on our right hand, within 150 or 200 yards, there appeared twice very huge balls of similar appearance as that which appeared on the road. It was so brilliant and powerful this time that we were dazed for a second or two. Then immediately there appeared a brilliant light ascending from the woods where the Rev. C.E. lives. It appeared twice this time. On the other side of the main road, close by, there appeared, ascending from a field high into the sky, three balls of light, deep red. Two of these appeared to split up, whilst the middle one remained unchanged. Then we left for home, having been watching these last phenomena for a quarter of an hour.

Perhaps I ought to say that I had an intense desire to see the light this night for a special purpose; in fact, I prayed for it, not as a mere curiosity, but for a higher object, which I need not mention. Some will ridicule this idea, but I have a great faith in prayer....

.....

Appendix 21.

From the Rev. E. W. E. June 26, 1905. Mrs. Jones of Egryn's last meeting at _____, being rather late on Wednesday, May 24th, it was therefore after midnight that Mrs. E. and myself retired upstairs to rest. After putting out the light in our bedroom I could not go to bed. Then looked out of the window, but could see nothing. Then I went to the back bedroom, where our two boys sleep; and whilst I was looking out of this window towards the Penrhys hill, my wife came behind and put her hand on my shoulder, then asked me if I were looking for something. I said ye, that I was looking for something strange, because I felt very strange. Mrs. E. had just pushed the curtain on one side when she exclaimed, "There's something!" I said, "Where?" When she told me the direction I then exclaimed, "Yes, really, there is the strange light." It appeared to us in the form of a column of fire about two feet wide and several feet high, quite distinct, and of the tint of a fiery vapour. After looking at the column for a second or two, then some bright balls of fire appeared in the column near its base, then these brilliant balls would burst and disappear upwards. Then the column would disappear, but in a moment would appear again in the same form, in the very same spot, and then the balls would appear in the column, and the balls burst and disappear upwards in the same way. This we distinctly saw six times (6 times).

It was, as nearly as we could judge, about 12.45 on Thursday morn, May 25, and lasted in all about three minutes.

I saw Mr. E. on June 21, 1905, and he pointed out to me the exact spot on the hillside where the light appeared to be. The spot in this case is on the western side of the valley (it was on the eastern in Dr. M.'s case); no houses near. There is a path by a wall, and it was at a slight break on the top line of the wall that the light appeared to be.

I afterwards sent a series of questions to Mr. E., which I print here with his answers, dated June 28th, 1905:

(1) Have you ever seen a corpse-light?---No.

(2) Is your birth-place in South or North Wales?---Dowlais, Glam. Also my father and my mother were born at Dowlais.

(3) Have you seen much of Mrs. Jones before or during her visit?--- Never before her coming here, and only at our meetings, until the Saturday after I saw the strange light. Then I had, with a few others, about two hours' semi-private conversation with Mrs. Jones.

(4) Did you hope or expect to see any lights?---No. Neither Mrs. E. nor myself had any desire or longing to see the light. I feel almost certain that what Mrs. Jones said in the meeting about the lights that appeared to her around Egryn, near Barmouth, could have nothing to do with the form, the time, or the place of the strange light Mrs. E. and myself saw.

Mrs. E. does not understand Welsh, so Mrs. Jones' addresses could have no direct influence upon her. Mrs. E.'s report of what she saw would be similar to mine, and I believe that I sent you as faithful and accurate a report of what we saw, and how and when we saw it, as can be put in a few written words.

.....

Appendix 27.

The following are the accounts of some of the witnesses who saw the light at Ynysybwl on July 23rd, 1905.

(a) From Mr. M.J.P. August 3rd, 1905. Re the lights seen at Ynysybwl on the 23rd of July last, I am sending you my version of the affair, as I had the pleasure of seeing it, which was as follows:

I went on the night of the 23rd, which was Sunday, for a walk after supper; although not in the habit of taking a walk, something compelled me to go, so in company with a few friends we went along the street for a short distance, when we were attracted by a voice raised in prayer on the mountain side, and we at once wended our way thither, where we had the pleasure of joining in with the company already assembled in prayer and praise to God, and our Maker met with us, and we received a great blessing to each of our souls, praise God. Well, after about an hour and a half we drew the meeting to a close, and commenced our way homeward. By now we had got as far as what is called the Robert Town Square, when we again commenced to praise God, when my attention was suddenly drawn to a mysterious light which appeared in the sky, which I had the pleasure of seeing. Firstly, it appeared to my startled gaze to be a ball of light about the size of the moon, with a slight mist over it. I gazed at it for a short time and then the stars began to shoot out around it; then it gradually rose higher in the heavens, and as it rose it grew brighter and smaller and the smaller it got the brighter it seemed to grow, and the last I saw of it, it was a little larger than the evening star, and very bright. I might also say that while the mist covered the light it would open and brighten at intervals, so that [is] all I saw of the Mysterious Light.

.....

(b) From Mr. R. J. August 2nd, 1905. Re the light seen at Ynysybwl on Sunday night, the 23rd of July, I am sending you my version of the matter as seen by myself, which is as follows:

I might say to commence that I as a Sunday School teacher, with the most of my class, eleven in number, went on Sunday evening to a place called Ynysyboeth, a distance of about five miles, to a service conducted by Mrs. Jones, Egryn, the lady that has been seeing all the mysterious lights. So we enjoyed ourselves grand, and after the close of the meeting we went our way back home to Ynysybwl; but we arrived so far as the mountain side that leads down to Ynysybwl, when we felt as if we were compelled to hold a prayer meeting there, which we did, and was in a very short time joined by a godly company, where we met with God in prayer and praise, and God wonderfully blessed us in our souls, and encouraged

us to press on to that mark of our calling, which is in Christ Jesus, and also to show us that He was pleased with us, we had a convert. Praise God for it. Now don't you think God met with us? We closed there in about an hour and a half, and went down homewards; but when we got to a place called Robert Town Square, we again started to praise God, but we had hardly started when the mysterious light already referred to appeared, which as I saw it is as follows:

First of all my attention was drawn to it by a person in the crowd, and I looked and saw a block of fire as it was rising from the mountain side, and it followed along the mountain side for about 200 or 300 yards, before it gradually rose to heaven. Then a star, as it were, shot out to meet it, and they clapped together and formed into a ball of fire. It also grew brighter as it rose higher, and then it seemed to sway about a lot; then it seemed to form into something like the helm of a ship. The size of it at this time would be about the size of the moon, but very much brighter, and lasted about a quarter of an hour. I then went home to call my wife to see it (which is a distance of about 300 yards), and [the] strange [thing] about it was I could not see it from there, although my home faces the mountain side. But when I got back to the square already mentioned it was again quite visible. This, sir, is the manner in which I saw the light; mind, saw it, I mean, not imagined it; not at all.

(c) From Mr. J. J. The account was received on August 6th, 1905.

In accordance with my promise to you I write you a full account of how I saw the "light." Eleven of us from Ynysybwl had gone over one Sunday evening to Ynysyboeth to a meeting at which Mrs. Jones, Egryn, was present. We had a grand meeting, and two sinners gave themselves up. After the meeting was over, we made our way homeward, singing hymns all the way to Abercynon. After starting across the mountain, some of us felt inclined to have a prayer meeting, but the majority were for having it on the Ynysybwl side, and a glorious meeting it was. The heavenly powers descended with force, and another convert was made.

We had now swelled considerably in number, and proceeded to the square opposite the Robert Town Hotel, and while we were singing the star appeared, like a ball of fire in the sky, glittering and sparkling, and as it went up it seemed to be bubbling over. This continued for about 20 minutes....

(d) From Mrs. C. J. The account was received early in August, 1905.

The manner in which the lights appeared to me at the Robert Town Hotel Square was as follows:

Firstly, there appeared in the heavens a very large and bright ball of fire. It was of a much more brilliant lustre than an ordinary star---very much the colour of a piece of iron white-heated. It had two brilliant arms which protruded towards the earth. Between these arms there appeared a further light or lights resembling a cluster of stars, which seemed to be quivering with varying brightness. This was its form when I saw it, but others who had seen it before me had noticed it growing from smaller dimensions. It lasted for ten minutes or more.

Fryer ends his paper with this note quoting William Crookes, an early experimenter with electrical discharges and a strong advocate of psychic research.

Note,---In his Presidential Address (1897), Sir William Crookes gave a table of the velocity of vibrations in 63 steps, and suggested that the "X-rays" would be found to lie between the 58th and 62nd steps, and he added that, "It seems to me that in these rays we may have a possible mode of transmitting intelligence. ..... Let it be conceived that the brain contains a centre which uses these rays as the vocal chords use sound vibrations and sends them out, with the velocity

of light, to impinge on the receiving ganglion of another brain. In this way some of the phenomena of telepathy and the transmission of intelligence from one sensitive to another through long distances, seem to come into the domain of law, and can be grasped.....Is it inconceivable that intense thought concentrated towards a sensitive with whom the thinker is in close sympathy may induce a telepathic chain of brain-waves, along which the message of thought can go straight to its goal without loss of energy due to distance?"

I have suggested in the S. P. R. Journal (April, 1905), that the contents of a telepathic message probably amount in volume to no more than a word or two, as in code telegraphy, and that the enlargement of the message into a scene or lengthy verbal communication is the work of the recipient mind.

Accepting the probability of a brain wave of sufficient intensity to carry a word or sign to a mind in conscious or unconscious sympathy with the agent, it would appear that the operation within the brain of the recipient, if sensitive to the message, is of a totally different character. The mind then is not simply perceptive but constructive, and, needless to say, works by the ordinary machinery and vibratory methods it daily employs. The message is realised in the form of sounds, changes of temperature, or visions, in accordance with the mental potentiality of the percipient. Whether the difference in mode of realisation has any relation or not to the mental capacity and habitual thought methods of the operator in other matters might be worth examination. At any rate, the limitation of the initial message to an agent's word or sign and the attribution of the resultant sounds or sights to the percipient, not only goes far to explain "the clothes of ghosts" and the elaboration of scenic settings, the misunderstandings and erroneous impressions, that are found in our records, but may do a little to remove some of the objections to telepathy felt by many scientific minds even when they are the subjects of its operation.

There are some remarkable similarities between the Welsh lights and the "more conventional" nocturnal lights and ball lightning. Could the same forces---physical and/or psychic---be at work in all such manifestations?

GLN-003 THE NOTES OF CHARLES FORT

Fort, Charles; The Fortean Society Magazine, 1:16, October 1937.

1812-1814, Dec. 2. (A newspaper clipping) MYSTERY WAR OF 1812. The mystery of the "blue lights," which appeared on the shores of New London harbor, Conn., on the night of December 2, when Commodore Decatur planned to run the British blockade, has never been solved. (Aside: The clipping is from an American paper served by the "Premier Syndicate"---1924, T. T.)

T. T. stands for Tiffany Thayer, the Secretary of the Fortean Society.

GLN-004 BACK TO UFO'S

Fuller, Curtis; Fate, 14:26-27, January 1961.

Nanaimo, B. C., Oct. 21, 1959. Five Nanaimo hunters observed a bouncing,

glowing ball over Lone Mound one night this past weekend. After bouncing a while, the object withdrew to a point some eight miles away, later returned and began bouncing up and down near the ground. Then it raced toward the west, stopped for an hour and finally zoomed off at great speed and disappeared. At least 35 other UFO sightings were reported in the area during the preceding week.

GLN-005 BACK TO UFO'S

Fuller, Curtis; Fate, 14:26-27, January 1961.

"A weird-looking light in the sky spoiled a fox-hunting trip near the Lester Connell farm in the Jadwin community last Friday night.

"In the hunting party were Frank Andres and son Richard of St. Louis, who own a place near the Turtle community, and Mr. Connell and son Johnnie. The Andres family had gone over to the Connell place to run the dogs and had gotten about a mile from the house when about 9:35 they saw in the sky the strange formation which appeared to be about 10 to 12 feet from top to bottom and about 25 to 30 feet in length. It was very bright but had an amber-colored glow. It appeared to waver around but seemed to be coming in the general direction of the hunters. The fox hounds quit their chase and came running toward the hunters.

"The four hunters watched the object about 25 minutes and when it got to what was estimated at a quarter of a mile away, Mr. Andres flashed his light toward it but could see nothing because the other lights were so bright. However, as soon as he turned his flashlight on, the strange object quickly vanished over the ridge at a terrific speed. No noise was heard from the unusual phenomena.

GLN-006 DANCING LIGHTS OF ADA, OKLA.

Fuller, Curtis; Fate, 15:16-18, November 1962.

Recently crowds of folks have been lining up at the Busby Ranch near Ada to watch the fox fire dance. Finally John Bennett of the Ada Evening News went out to watch the goings on. Here is part of his report.

"... and there it was. It looked orange, like light filtering through trees from a window of a house. 'That's just a house light,' I scoffed. The boys and girls (watching the nightly show) answered in a chorus that if that was a house light, it was the first one they ever had seen that danced and changed colors. And, by golly, it did.

"It started glowing bigger and bigger and giving off a diffused orange, then red, then yellow light. For a full five minutes the light glowed like a dying ember. Then things started happening.

"The lights began to dance. They flickered eerily up and down like a bouncing luminous ball, then darted sideways. The single ball of light appeared about three feet in diameter.... During its fantastic flight back and forth it changed colors: first orange, then yellow, then red. But it stayed in one general area, behind what looked like a sparse growth of trees....

"In the tree line the light had changed colors again and was beginning to get more active. Suddenly a piece of the glow broke away and started a rapid bouncy course across the field in front of us. It looked like a luminous basketball, and about the same size. It danced before our eyes about 100 yards out front. We traced the glowing trajectory that appeared like a giant lightning bug, until it went out....

"The big show ended there. Shortly after the field orbit by the satellite the glow resumed but it didn't dance around much. In about an hour I left. My suspicion is that it is a hoax but I can't explain the dancing lights. It would take a clever manipulation of light. And it's beyond me how anyone could make the darn things go so fast."

During his visit Bennett talked with one of the boys, Ronnie Black, who said that a week before a piece of a ball of fire had bounded away from the main body and came right up to the fence.

"It just bounced across the field and came right up a few feet from me," Ronnie said. "I didn't move and it was like it was looking right at me. It wasn't any higher than the top strand of the fence here and you could see the tops of the weeds under its glow. Then it darted off fast as lightning."

GLN-007 TEXAS GHOST LIGHT

Fuller, Curtis; Fate, 19:29, January 1966.

Frank X. Tolbert, a columnist for the Dallas Morning News, reports the folks along Bragg Road near Saratoga in East Texas are seeing the "ghost light" again. Bragg Road is a straight red clay trail through a forest of pines and other tall trees, running on a former railroad right-of-way.

Not long ago Henry Kirby Pitts, a young deputy sheriff of Hardin County based at Sour Lake, saw the light. "Some have described it as red," he says. "It looked yellow to me."

Pitts' sighting was under a full moon. A big yellow light appeared far behind his car, moved in swiftly to right in back, then vanished.

Pitts is a young fellow with a master's degree from Sam Houston State who has decided to make law enforcement a career. He takes a scientific attitude toward the mysterious light. "There's a natural cause for this weird light which is scaring folks around here, and I'm going to find out what it is," he asserts.

The same nocturnal lights are described in GLN-010.

GLN-008 MEXICAN MYSTERY LIGHT

Mack, Bill; Fate, 23:63-65, June 1970.

Bahia Kino used to be a sleepy little Mexican fishing village. But progress has changed Kino. Motels, restaurants and beautiful ocean-view homes have made it one of the most popular Gulf of California resorts. Despite this rapid growth of the picturesque little town one thing remains the same---the mystery light of Kino.

This light, generally seen on warm summer nights, has baffled amateur

investigators and qualified scientists alike.

My own introduction to the eerie phenomenon came during a fishing expedition to Kino. I parked my camper truck on the beach and because of the long drive I had made to reach my favorite spot I went to bed quite early in the evening. About 10:00 p.m. I was waked from a deep sleep by a strange bluish light coming through the camper window. It looked electrical in origin and reminded me of a similar light I once witnessed during a severe Japanese earthquake. But the Japanese light had had a simple explanation: it was caused by snapped trolley lines arcing out on the concrete. It had been a true electric blue.

But Kino Bay is a long way from having trolleys---at that time there weren't even telephones---and the light source was approximately 300 yards from my camping spot, originating smack in the middle of the desert growth. It appeared to be about 50 yards long and I estimated its phosphorescence extended about 25 feet into the air. There it sat, just a blob of blue light!

Baffled, I got up and walked somewhat apprehensively toward and into the strange luminosity. But although the light was intense there was nothing there, only the usual cactus. There was no odor, no particular sensation and no apparent source.

. . . . . .

. . .From Juan I learned the light has been seen for years and was greatly feared by the primitive Seri Indians who live in the area.

. . . . . .

This is another perplexing problem posed by the light. It always appears in the same spot. As far as anyone knows its location never has varied an inch.

. . . . . .

. . . on my third trip approximately a month later I hit pay dirt, or more correctly pay light. The light began to glow about 11:00 p.m. on a still, sultry night. Starting slowly it seemed to build in intensity until it reached its peak glow at approximately 11:45. The light remained visible for nearly two hours during which time, armed with a compass and metal detector, I made several tours around it.

I had reasoned that if the ionization theory was correct and if the light appeared only in that spot something large and metallic might be the collecting agent. Secretly I had hoped to find a meteor although the ground surface showed absolutely no indication of ever having been disturbed. But, like everyone else's, my efforts were doomed to failure. Neither the compass nor the metal detector were affected in any way by the ghostly glow.

This light can be photographed. I made several exposures with a twin lens Yashica-Mat camera and was rewarded with a set of pictures of extremely poor quality which could be duplicated by holding a dull orange light bulb in front of the camera. The light showed as a tiny glow in the center of an otherwise intense black.

GLN-009 BALLS OF FIRE

Andre, George, Jr.; Fate, 14:112-113, January 1961.

The author first describes how he was raised in Ineu, a small town in Romania. Then, he relates a story he heard and an actual event he experienced, both of which involved balls of fire---though perhaps of different origins. The story involves a tunnel in a hill in Romania:

According to these persons, every so often someone would almost go berserk because he found himself chased by a red-yellow ball of fire which originated on top of the hill and rolled down into the valley, disappearing as it crossed the river bridge. It always came down the same street and disappeared by the river.

There were no autos and no auto headlights at the time these incidents reportedly took place.

In 1924 my mother, my sister and I were all awake in one bed room when, from the foot of the double bed, a brilliant orange-yellow ball of fire rose and splattered upon the ceiling. We noticed no heat from it and nothing was burned or scorched.

The first ball of fire has the characteristics of a nocturnal light, while the second is similar to ball lightning.

GLN-010 BALL OF FIRE

Fuller, Curtis; Fate, 14:22-23, May 1961.

Hundreds of sightseers have been swarming to the marsh country around Saratoga, Tex., to watch the fireballs. They bounce around the Big Thicket swampland at night and late in the summer. Bragg Road north of Saratoga, where the fireballs were seen most frequently, was crowded with sightseers.

Things got so thick that Sheriff Whit Whitaker had to post an order prohibiting firearms in the area. Some sightseers were attempting to shoot the fireballs out of the air.

In case you wonder what the fireballs are, any scientist can tell you. Dr. Edwin Hays, head of the biology department of Lamar State College of Technology in Beaumont, Tex., explains that they are caused by "swamp gas" ignited by spontaneous combustion. Such balls of fire, says Dr. Hays, are not uncommon in marsh country.

We would like to challenge Dr. Hays and every other proponent to this old chestnut of a theory to prove it.

A common scientific criticism of psychic phenomena is that it is not repeatable under laboratory conditions. Well, we challenge the swamp gas theorists to produce a little swamp gas under laboratory conditions, ignite it spontaneously, and produce their own little fireballs that go bouncing merrily along for minutes at a time.

The same nocturnal lights are described in GLN-007.

GLN-011 A "SPOOK LIGHT" MYSTERY SOLVED?

Anonymous; Fate, 13:85, September 1960.

The famous "spook light" of Hornet, Mo., a phenomenon which for years has baffled investigators, is believed to have been explained by a 17-year-old boy, William E. Underwood, of Carthage, Mo. His report of his investigations placed him among the top 40 winners of 1960's Science Talent Search conducted by Science Service of Washington, D. C.

The "spook light" appears along a lonely gravel road two miles southwest of the village of Hornet. William's description of the phenomenon is typical of

what has been observed for years.

Soon after dusk, he reported, a greenish-yellow ball appeared to descend out of the hills and to advance rapidly toward him along the road. When he moved toward the light, it vanished. The light varied in intensity and in the time of its appearance. It sometimes appeared to be two lights.

William said viewing the light through a spectrotelescope showed it had a continuous spectrum. This led him to deduce that the light had an incandescent source. Infrared films of the phenomenon convinced him it was produced by the double refraction of car headlights.

He believes his theory in further supported by the physical features of the area in which the light appears. U. S. Route 66, east and west, was in a direct line with his observation point and Spring River crossed close by between the gravel road and the highway. For this reason William concluded that the "spook" was nothing more nor less than the light of car headlamps refracted over the range of low-lying hills.

GLN-012 PULSATING BALL

Fuller, Curtis; Fate, 12:12, November 1959.

Mr. and Mrs. Dana Franklin of Melbourne Village had watched the late-late TV show and were getting ready to go to bed early Thursday morning, May 14. Franklin saw a light almost as large as the full moon above the trees from his bedroom window which faces north-east. The light appeared to be moving very slowly from north to south.

At first he thought it might be an airplane but dismissed the notion when he heard no noise.

"It was a huge yellow ball, glowing brilliantly and coming slowly toward the house. In the center was a small fiery red ball. It got very close to the house and then turned at about a 40-degree angle to the left, toward the southeast, and as it turned the brilliant light went out and it went into soft colors, like pastels but with more brilliance," Franklin continued. He estimated the object might be about 600 feet above the ground. He is a former airplane pilot, incidentally.

"I saw reds, green and blues, sort of intermingled, and it was pulsating, like the colors were contracting and expanding and all the time it was moving very slowly, almost at a standstill at times," he went on.

"When it turned it appeared to be a different shape. It was no longer a round ball, but had a cigar or conical shape, tapering off at the tail, and then it put on a little burst of speed."

The object took another slight turn to the east and then rose fast, almost straight up, going away toward the east, getting smaller and smaller, until all they could see was a white light.

"When it got way up it gave out a burst of light and in a couple of seconds disappeared," Frankie said.

About two minutes later Franklin heard a rumbling of some kind but said it could have been thunder. He says he's seen lots of meteors but this wasn't one of those. "It was 10 to 20 times as bright as a missile at this distance from the Cape."

GLN-013 THE NIGHT THE SKY TURNED ON

Keel, John A.; Fate, 20:30-37, September, 1967.

Compiler's Summary: John Keel, a well-known popular writer on unusual subjects gathered many accounts of the strange lights seen over much of the Midwest on the night of August 16, 1966. The more interesting of these are summarized below.

Flandreau, S.D.: Low, bright light hanging over cornfield; looked like the moon.

West Battle Lake, 200 miles north of Flandreau, S. D.: Large ball of light sailed toward fishermen; surrounded by a mist; changed from white to red; joined by second ball; faded away with slight poof.

Cass Lake, Minn.: Pink, horseshoe-shaped light; turned blue; melted away.

Warroad, Minn.: Circular shape encompassed by green haze; changed colors; shrank and faded away.

Walker, Minn.: Disk; two or three feet in diameter; bounced along treetops; discharged bluish flame.

Ranier, near International Falls, Minn.: Reddish object wobbles over town; larger than local water tower.

Duluth, Minn.: Multicolored globe; appeared to rotate; bigger than football field; car windows steamed up.

Cameron, Wis.: Oblong shape passes over car; changed colors; windshield steamed up.

Racine, Wis.: Flat, round object; red light on top, white lights around perimeter.

Minneapolis-St. Paul airport, Minn.: Luminous object passes over city, radio stations receive over 75 calls.

Fort Smith, Ark.: 1500 people stand in streets watching multi-colored lights passing overhead.

Paragould, Ark.: Lights move in circle above town; move up and down; zoom away.

Keel also mentions the UFO "flaps" of March 30, 1966, which covered N. Y., N. J., Minn., Iowa, Ohio, Calif., S. C., and Wisc.; and July 13, 1966, over Neb.

Keel divided the sighting into three categories: (1) small, low-flying objects; (2) color-changing lights which faded away; and (3) high-flying lights.

GLN-014 OZARK SPOOK LIGHT----A SCIENTIFIC REPORT

Bayless, Raymond; Fate, 17:27-33, September 1964.

Compiler's Summary: Bayless describes his visit to the MO-OK area to investi-

gate the Hornet, Mo. spook light, which is actually seen in Oklahoma. His sighting involves: a double light with reflection from the dirt road clearly seen; appearance and disappearance of the light due to the hilly nature of the country; telescopic examination revealing up to 16 separate lights; lights were roughly circular in shape, golden amber, sometimes with a reddish tint.

Observations attributed to George W. Ward indicate the light was from four to six feet in diameter. The light approached Ward and enveloped his car.

Earliest published account of this nocturnal light was in the Kansas City Star in 1936. A number of tales about the light date from the 1800s, however, and there are also Indian legends.

Bayless discusses the possible explanations, dismissing the will-o'-wisp theory as inconsistent with the facts. The various experiments testing the automobile headlight theory are mentioned. These theories indicate that headlights from nearby highways can indeed be seen from the area of the nocturnal light due to atmospheric refraction. The problem with this explanation is that the light was apparently known well before automobiles and highways existed, although there is no supporting literature for this claim.

GLN-015 WILL-O'-THE-WISPS

Fox, Howard; Nature, 7:222, January 23, 1873.

> Prof. Geikie, in his introductory lecture of the Murchison Chair of Geology at Edinburgh, which appeared in Nature, vol. vii, p. 184, mentions that he never had the good fortune to encounter one of these legendary sprites. It may not be uninteresting to some of your readers to know that they are still extant. On October 5 last I was walking to the "Lizard" with a friend, and near Ruan Major we saw a light travelling fast over the country, which my friend took to be the light of a dog-cart. As there was no road in the neighbourhood we watched, and soon saw two others rising from the same place and bounding over the country till they seemed to be about thirty feet from the ground in a swampy field opposite us, when they disappeared. Another rose from the other side of the field, and after reaching the middle of the field, it also disappeared. In about ten minutes we saw five or six, but none afterwards.
>
> I have asked several farmers of the district and many of my friends if they had ever seen any, but have only met with one farmer who said that when a boy he used to see them on Goonhilly Downs adjoining. The geological formation of this district is serpentine.

GLN-016 MARYLAND'S GHOST LIGHT ROAD

Robertson, H. Charles; Fate, 11:92-96, July 1958.

Compiler's Summary: On the clear, sultry night of July 16, 1952, on a mile-long stretch of sandy road outside Hebron, Md., two state troopers observed a shimmering orb coming toward their car. The police chased the light. When their car reached 40 mph, the light disappeared. On the following night, six men tried to

surround the light, but as the men neared it it went out and reappeared in a nearby field.

After these sightings, hundreds of people drove to Hebron to get a look at the light. Older residents said that the light had been seen for years. Local legends tie the light to an old murder.

GLN-017 CHEAPER BY THE DOZEN

Fuller, Curtis; Fate, 12:16, July 1959.

The same kind of thing [See GLN-018] is going on in the Molloy Community, about 10 miles west of Vernon, Ala. A light appears nightly along a rural gravel road south of Highway 18 near an old well.

Gardner Lampkin, 74, says the light has been around since he was 10 and he's seen it many times. Back in those days men shot at the light, but they never killed it. Lampkin said that before the shots the light would be small and bright, suspended in mid-air. After the shots it would seem to spread out, but it always stayed there.

GLN-018 CHEAPER BY THE DOZEN

Fuller, Curtis; Fate, 12:16, July, 1959.

"Spook lights" too are among the things that seem to be coming in bunches these days.

A light was reported flickering along the Sac River near El Dorado Springs, Mo., late in March. Some people reported the light was red, changing to white and green.

A man by the name of Duane Witt, who works in a print shop in El Dorado Springs, says he saw the light four times during March. He said it was near Blackjack, 10 miles east of El Dorado Springs. Witt and some of his friends chased it around a field. They said it looked to be about the size of a football, but they couldn't get closer than a block. "It just seems to bob and drift away," Witt said. "Somebody is out chasing it almost every night. One night we counted 40 cars lined up along the road leading by that field."

GLN-019 AN ATMOSPHERIC PHENOMENON IN THE NORTH CHINA SEA

Norcock, Chas. J.; Nature, 48:76-77, May 25, 1893.

During a recent wintry cruise in H. M. S. Caroline in the North China Sea, a curious phenomenon was seen which may be of interest to your readers. The ship was on passage between Shanghai and the western entrance of the famous inland sea of Japan. On 24th February, at 10 p. m., when in latitude 32° 58' N., longitude 126° 33' E., which, on reference to the map, will be seen to be sixteen to seventeen miles south of Quelpart Island (south of the Korean peninsula) some unusual lights were reported by the officer of the watch between the ship

and Mount Auckland, a mountain 6,000 feet high. It was a windy, cold, moonlight night. My first impression was that they were either some fires on shore, apparently higher from the horizon than a ship's masthead, or some junk's "flare up" lights raised by mirage. To the naked eye they appeared sometimes as a mass; at others, spread out in an irregular line, and, being globular in form, they resembled Chinese lanterns festooned between the masts of a lofty vessel. They bore north (magnetic), and remained on that bearing until lost sight of about midnight. As the ship was passing the land to the eastward at the rate of seven knots an hour, it soon became obvious that the lights were not on the land, though observed with the mountain behind them.

On the following night, February 25th, about the same time, 10 p.m., the ship having cleared Port Hamilton, was steering east, on the parallel of 34°. when these curious lights were again observed on the same bearing, at an altitude of 3° or 4°. above the horizon. It was a clear, still, moonlight night, and cold. On this occasion there was no land in sight on a north bearing when the lights were first observed, but soon afterwards a small islet was passed, which for the time eclipsed the lights. As the ship steamed on at a rate of seven knots an hour, the lights maintained a constant bearing (magnetic) of N.2°W., as if carried by some vessel travelling in the same direction and at the same speed. The globes of fire altered in their formation as on the previous night, now in a massed group, with an outlying light away to the right, then the isolated one would disappear, and the others would take the form of a crescent or diamond, or hang festoon-fashion in a curved line. A clear reflection or glare could be seen on the horizon beneath the lights. Through a telescope the globes appeared to be of a reddish colour, and to emit a thin smoke.

I watched them for several hours, and could distinguish no perceptible alteration in their bearing or altitude, the changes occurring only in their relative formation, but each light maintained its oval, globular form.

They remained in sight from 10 p.m. until daylight (about 5.30 a.m.). When lost sight of the bearing was one or two points to the westward of north. At daylight land 1300 feet high was seen to the north and north-north-west, distant fifty miles, the mirage being extraordinary.

Thus, these lights were seen first in longitude 126° 33' E., and last in longitude 128° 29' E. At first the land was behind them, but during the greater part of the distance run it was forty-five or fifty miles away to the north; and the bearing of the lights for at least three-fourths of the distance did not change.

On arrival at Kobe I read in a daily paper that the "Unknown light of Japan" had, as was customary at this season of the year when the weather is very cold, stormy, and clear, been observed by fishermen in the Shimbara Gulf and Japanese waters. The article went on to say that these lights were referred to in native school-books, and attributed to electrical phenomena. On mentioning the matter, however, to the leading Europeans in Yokohama and Tokio, they appeared to have no knowledge of the matter.

Captain Castle, of H. M. S. Leander, informed me that, not long ago, the officers of his ship saw lights in the same locality which they thought at first were caused by a ship on fire. The course of the vessel was altered at once with a view of rendering assistance, but finding that the lights increased their altitude as he approached, he attributed them to some volcanic disturbance, and being pressed for time, resumed his course.

The background of high land seen on the first night dispels all idea of these extraordinary lights being due to a distant volcano. The uniformity of the bearing renders the theory of their being fires on the shore most improbable. I am inclined to the belief that they were something in the nature of St. Elmo's

fires. It is probable that there are travellers among the readers of your interesting journal who have seen or heard of this phenomenon, and will be able to describe its origin and the atmospheric conditions necessary for its appearance.

GLN-020 THE QUEER LIGHTS ON BROWN MOUNTAIN

Anonymous; Literary Digest, 87:48-49, November 7, 1925.

The following is attributed to Robert Sparks Walker, writing in the publication, Light:

"What would you think or say, if you were standing on Rattlesnake Knob, on the Morganton, North Carolina, road about 7:30 p.m. and saw in a southeasterly direction a curious light, about the size of a toy balloon, smaller than the full moon, and very red, rise mysteriously over Brown Mountain, proceed into the air a short distance, waver as if it were palsied, and then in less than a minute disappear?

"The lights, however, do not appear regularly at the same spot. Brown Mountain has a table-shaped top at 2,600 feet elevation. Small tributaries of the John River flowing south make many indentations in its surface. Geologists say that there is nothing unusual in the formation of Brown Mountain---that it is simply a pile of Cranberry granite.

"In 1913, at the request of one of North Carolina's representatives in Congress, the United States Geological Survey sent a man down there to study the origin of the strange lights. He did not tarry long before he branded them as coming from the headlights of locomotives flashing up over the mountain. The people laughed at his simple explanation. They continued to let the strange lights amuse and entertain them, and work upon their imaginations.

"The descriptions of the strange light made by various observers do not agree. One person says that it is pale white, as is ordinarily observed through a ground-glass globe, with a faint, irregular halo encircling it. He claims that it is restricted to a prescribed circle, and appears from three to four times in rapid succession, then conceals itself for twenty minutes, when it reappears within the same circle. Another observer, who was standing about eight miles from Brown Mountain, says that suddenly after sunset there blazed into the sky above the mountain a steady glowing ball of light. To him, the light appeared yellowish, and it lasted about half a minute, when it disappeared rather abruptly. It appeared to him like a star from a bursting skyrocket, but much brighter.

"To some people it appears stationary; to others, it moves sometimes upward, downward, or horizontally. A minister says that it appeared like a ball of incandescent light in which he could observe a seething motion.

"Some persons have suggested the will-o'-the-wisp as an explanation, but since Brown Mountain bears the reputation of owning no marshy ground, it could hardly be such a phenomenon. Then some one said it might be phosphorus, but phosphorus is oxidized so readily that it is never found in a free state. Of course a number of people thought it might be fox-fire, but fox-fire makes such a very weak, pale light that their guesses were obviously erroneous.

. . . . . .

"And of course, some person mentioned 'St. Elmo's fire'---an electrical discharge from sharp objects during a thunder-storm. St. Elmo's fire is

brushlike in appearance, and since the strange lights could not be it, the amateur scientist's next assertion was that probably the phenomenon known as 'Andes light' was the guilty chap! The Weather Bureau says that the Andes light is a striking luminous discharge of electricity observed over the crest of the Andes in Chile, where thunder-storms are almost unknown. Silent discharges of electricity take place between the peaks and the clouds. The Andes light is said often to produce glimmering lights with circular borders, sometimes observed for more than 300 miles.

"The citizens of the mountainous part of southwestern Virginia, where the ridges run parallel with each other, separated by deep, narrow valleys, report that they sometimes observe a noiseless electrical discharge from one summit to the air. However, the contour of Brown Mountain is said to be unfavorable for any phenomenon like Andes light.

.....

The first geologist who visited Brown Mountain in 1913, after checking up the train schedule, and watching the lights, let the schedule and lights convince him, Mr. Walker tells us, that the headlights from locomotives were responsible for it all, and in short order left the mountain. Objections followed, for the simple reason that headlights make a beam in the air like a search-light. the suggestion of automobile lights was objected to for the same reason. In 1922, when the lights of Brown Mountain had persisted in arousing the curiosity of the people, another representative of the people asked the Department to send a second geologist to make a more complete investigation. This was made in the same year. Says the writer:

.....

With maps spread out on the table, and directions properly noted and landmarks sighted and marked, the investigator proceeded to make observations. When the observation of the lights was made, the time of arrival and disappearance of the strange lights was checked with the train schedule, and after remaining there a fortnight, the investigator came to the conclusion that he had observed a fair representation of the 'strange lights' of Brown Mountain, and that 47 per cent of them originated from automobile headlights; 33 per cent from locomotive headlights; 10 per cent from fixt lights, and 10 per cent brush fires.

"It was agreed that while the queer lights appeared above Brown Mountain, none of them originated there, but in a broad valley several miles beyond.

"The atmospheric conditions in the valley beyond are said to be ideal for juggling distant lights that penetrate the atmosphere. The air varies in density, which makes it very refractive. The dust and mist are credited with giving the lights the various colors and tints.

"So much for the conclusion of the geological investigator. Last year when I heard that intelligent people living in that part of North Carolina refused to accept the report of the investigator, I sent a letter of inquiry to a few prominent business men there, those who had been observing the lights for many years. One of these men exprest the opinion that the geologist had tried hard to find out the source of the strange lights, but had failed. That the lights had been observed for the last sixty years, and long before railroads were constructed in that part of the country, and before the advent of the automobile; that the flood of 1916 put the railroads out of business for a solid week, as well as the automobiles, yet the strange lights continued to put in their regular appearance. As conclusive proof that the lights do not originate from headlights, he states that the mysterious lights fail to appear following a long drouth; that after the report was made, he went to a certain site, turned his back to the railroad and highway, and witnessed the strange light suddenly come up from the mountain-top, and keep moving until it was lost in the sky."

GLN-021 LIGHTS IN THE OUTBACK

Fuller, Curtis; Fate, 13:23-24, August 1960.

This note in Fuller's column describes repeated sightings of nocturnal lights in Australia by William E. Young, Alexandria Station.

> Late at night when he's driving through the moonlight, between the clumps of tall grass and the high red anthills, he sees what seem to be car headlamps on the road ahead.
>
> The lights glow brightly as his car approaches them. Then they suddenly vanish. He never finds car tracks ahead, or embers of a campfire.
>
> "The aborigines call them the 'Min Min' lights," Young recently told Richard C Trimble of the Chicago Daily News. "Nobody has ever explained them."

GLN–022 SPOOKLIGHT EXPLAINED?

Fuller, Curtis; Fate, 18:12, December 1965.

> Popular Mechanics Magazine recently sent writer Robert Gannon down into the Ozark foothills in an attempt to solve the mysterious "Ozark Spooklight" seen for many years in the vicinity of Hornet, Mo.
>
> With the aid of Geological Survey topographic maps, aerial photographs, a compass and an odometer, Gannon believes he has solved the problem. The "Spooklight" is nothing more or less than headlamps from automobiles on U. S. Route 66 10 to 15 miles away. Those automobiles drive in a direct line with "Spooklight Road" for a distance of 15 miles, Gannon says.
>
> With Gannon using colored cellophane over his headlamps, and blinking his lights according to a fixed timetable, Gannon's associate was able to spot every blink of his colored lights.

However, old-timers say the light was seen long before there were cars or a Route 66.

GLN-023 WHAT SHAPE?

Fuller, Curtis; Fate, 20:26-27, May 1967.

> From Melbourne, Australia, last April 11, 1966, we have a report of a mysterious column of light witnessed by an R. Sullivan, a steel contractor. Near Wycheproof, about 100 miles from Melbourne, Sullivan was driving down a straight, tree-lined highway when his car suddenly swung to the right. He braked and found himself facing a column of "light" about 25 feet high and shaped like an ice cream cone. It was about three feet wide at the bottom and 10 feet wide at the top. The bottom was brilliant white and seemed to rest on the ground. The rest was rainbow-hued. The column rose silently from the ground "at tremendous speed."

This tale is no stranger than many in the scientific literature describing ball lightning or tornado luminous phenomena.

GLN-024 SWAMP GAS, WILL-O'-THE-WISP OR UFO'S?

Utke, Allen R.; Fate, 20:32-40, October 1967.

Descriptions of luminous swamp gas by those claiming to have seen it usually agree quite closely. They will tell you they saw flame-like, torch-like, balloon-shaped or mushroom-shaped lights on a windless summer or warm autumn evening. The lights were either on the ground or just above it; they were pale blue with an occasional tinge of some other color but they are never described as white. The lights are usually only a few inches in size and seldom larger than four or five feet long or in diameter. They may appear to be steady or they may flicker on and off as if extinguished and re-ignited. If they do not actually move they give the impression of moving if several of them flicker on and off in close proximity. Or they may actually rise into the air. But they rarely rise more than five to 10 feet off the ground before they are extinguished. No single flame or ball of swamp gas ever is described as lasting more than a minute before it is extinguished. The only sound ever described in connection with these lights is an occasional popping sound.

GLN-025 THE ROCKIES' POT OF GOLD, COLORADO

Linehan, Edward J.; National Geographic Magazine, 136:157-201, August 1969. (Quotation with the permission of the National Geographic Society.)

I recall quite vividly the last such town I visited before leaving Colorado---a place called Silver Cliff in the Wet Mountain Valley west of Pueblo. Today it counts about 110 year-round residents, where once 5,000 lived.

"Be sure to get there after dark," a fellow camper from Kansas had told me, "and drive out to the old cemetery. You'll see something mighty strange."

We had bounced about a mile out of Silver Cliff across pitch-black prairie when Bill Kleine, who runs the local campground, told me to pull up and switch my headlights off.

"Do you believe it?" I asked him. "About the lights in the graveyard?"

"I've seen them plenty of times. This is a good night for them---overcast, no moon."

We climbed out beside the old burying ground, and for long minutes I strained to see something, anything. Slowly, vague outlines of grave markers emerged, in ragged rows.

"There." Bill's voice was quiet, almost a whisper. "And over there!"

I saw them too. Dim, round spots of blue-white light glowed ethereally among the graves. I found another, and stepped forward for a better look. They vanished.

For 15 minutes we walked about the place, pursuing one will-o'-the-wisp, then another. I aimed my flashlight at one eerie glow and switched it on. It revealed only a tombstone.

"Some people think it's phosphorescence," said Bill. "You know, from decaying wood in the crosses or something. Others say it's just reflections from the lights of Silver Cliff, or Westcliffe down there."

I looked back at the two towns. Those small clusters of lights seemed far too faint to reflect way out here. Still, it was possible.

"Only trouble is," said Bill, "my wife and I have both seen these lights

when the fog was so thick you couldn't see the towns at all."

No doubt someone, someday, will prove there's nothing at all supernatural in the luminous manifestations of Silver Cliff's cemetery. And I will feel a tinge of disappointment. (p. 201)

GLN-026 SPOOKLIGHTS AND FIRE DEVILS

Norman, Eric; Weird Unsolved Mysteries, Award Books, New York, 1969, pp. 116-129.

Compiler's Summary: The first portion of this chapter deals with fires of mysterious origin, which are not pertinent to this section. The bulk of the chapter, however, describes peculiar lights and fireballs very much in order here. The more interesting of these are summarized below.

March 21, 1916; Joliet, Ill: During a peculiar thunderstorm, blue fireballs were seen. Over 20 windows were broken. The windows later turned a strange burned color.

Summer 1923: Two beams of light were seen swishing across a yard in a scissors movement. No place given. Original source was March 1968 issue of Search.

July 1966; Llano, N. M.: Bouncing lights accompanied by flying rocks. Balls were bluish or grayish.

The ghost light of Silver Cliff, Colo. and the Hornet, Mo. light are discussed in some detail, with the accounts based on previously published accounts.

April 15. 1918; Atlanta, Ga.: Yard is lit up, object resembling a "statue" flies overhead, sky glow remains 10 minutes. Afterwards, a fireball emerged from bedroom. This account is similar to some in the GLB section describing large luminous aerial objects splitting or engendering ball lightning.

Most of the above incidents are undocumented and rather sensational in nature.

GLN-027 GHOST LIGHTS

Edwards, Frank; Strange World, Lyle Stuart, New York, 1964, pp. 35-39.

Compiler's Summary: Chapter 6 of Frank Edward's book is a short one which touches briefly on the Brown Mountain, N.C. lights, the Hornet, Mo. spooklight, and the Silver Cliff, Colo. ghost lights. In the latter two instances, Edwards claims that pursuit of the lights results in elusive action and sometimes disappearance and reappearance nearby.

Other ghost lights mentioned even more briefly are those of Gonzales, La., Suffolk County, Va., and the one between Alpine and Marfa, Texas. The latter is called the Chinati Light and has been seen for 80 years. The Indians attribute it to the spirit of a dead chief. At times it is a double ball, which often blinks out but sometimes just fades away.

GLN-028 [FORT'S NOCTURNAL LIGHTS]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

Shining things, flying like birds, in the fields of North Norfolk continued to be reported. [circa 1908] The brilliant things looked electric. When they rested on trees, everything around them was illuminated. Purdy's descriptions are very different from "a pale, yellow glow." Upon the night of December 1st, he saw something that he thought was the lamp of a motor cycle, moving rapidly toward him, in a field, stopping, then rising several yards, moving higher, and then retreating. It moved in various directions. See the Field, Jan. 11, 1908. (p. 626)

.....

Something else was reported, in this region. In the Eastern Daily Press, Jan. 28, 1908, it is said that, at night---moon bright---"a dark, globular object, with a structure of some kind upon the side of it, traveling at a great pace," had been seen in the sky, by employees of the Norwich Transportation Company, at Mousehead. "It seemed too large for a kite, and, besides, its movements seemed under control, for it was traveling against the wind." (p. 627)

.....

London Daily Express, February 15, and following issues, 1923---brilliant, luminous things moving across fields, sometimes high in the air, at Fenny Compton, Warwickshire. They were "intense lights," like automobile headlights. Sometimes these luminous things, or beings, hovered over a farmhouse. It was a deserted farmhouse, according to the London Daily News, February 13. About a year later, one of these objects, or whatever they were, returned, and was reported as "a swiftly moving light," by several persons, one of them Miss Olive Knight, a school teacher, of Fenny Compton (London Sunday News, Jan. 27, 1924).

The Earl of Erne tells, in the London Daily Mail, Dec. 24, 1912, of brilliant luminosities that, from time to time, in a period of seven or eight years, had been appearing near Lough Erne, Londonderry, Ireland, "in size and shape very much like a motor car lamp." In later issues of the Daily Mail, the Countess of Erne tells of these things, or creatures, "like motor car lamps, large and round." (p. 627)

GLW-001 A STRANGE PHENOMENON

Anonymous; Nature, 21:409-410, February 26, 1880.

The following letter from R. E. Harris, Commander A. S. N. Co.'s s.s. Shahihehan, dated Calcutta, January 19, appears in the Calcutta Englishman of January 21:

The most remarkable phenomenon that I have ever seen at sea was seen by myself and officers on the 5th instant between Oyster Reef and Pigeon Island (Malabar coast). At 10 p.m. we were steaming along very comfortably; there was a perfect calm, the water was without a ripple upon it, the sky was cloudless, and, there being no moon, the stars shone brightly. The atmosphere was beautifully clear, and the night was one of great quietude. At the above-named hour I went on deck, and at once observed a streak of white matter on the horizon bearing south-south-west. I then went on the bridge and drew the third officer's attention to it. In a few minutes it had assumed the shape of a segment of a circle measuring about 45^{0} in length and several degrees in altitude about its centre. At this time it shone with a peculiar but beautiful milky whiteness, and resembled (only in a huge mass, and greater luminous intensity) the nebulae sometimes seen in the heavens. We were steaming to the southward, and as the bank of light extended, one of its arms crossed our path. The whole thing appeared so foreign to anything I had ever seen, and so wonderful, that I stopped the ship just on its outskirts, so that I might try to form a true and just conception of what it really was. By this time all the officers and engineers had assembled on deck to witness the scene, and were all equally astonished and interested. Some little time before the first body of light reached the ship I was enabled, with my night glasses, to resolve in a measure what appeared, to the unassisted eye, a huge mass of nebulous matter. I distinctly saw spaces between what again appeared to be waves of light of great lustre. These came rolling on with ever-increasing rapidity till they reached the ship, and in a short time the ship was completely surrounded with one great body of undulating light, which soon extended to the horizon on all sides. On looking into the water it was seen to be studded with patches of faint, luminous, inanimate matter, measuring about two feet in diameter. Although these emitted a certain amount of light, it was most insignificant when compared with the great waves of light that were floating on the surface of the water, and which were at this time converging upon the ship. The waves stood many degrees above the water, like a highly luminous mist, and obscured by their intensity the distant horizon; and as wave succeeded wave in rapid succession, one of the most grand and brilliant, yet solemn, spectacles that one could ever think of was here witnessed. In speaking of waves of light I do not wish to convey the idea that they were mere ripplings, which are sometimes caused by fish passing through a phosphorescent sea, but waves of great length and breadth, or in other words, great bodies of light. If the sea could be converted into a huge mirror and thousands of powerful electric lights were made to throw their rays across it, it would convey no adequate idea of this strange yet grand phenomenon.

"As the waves of light converged upon the ship from all sides they appeared higher than her hull, and looked as if they were about to envelope her, and as they impinged upon her, her sides seemed to collapse and expand.

"Whilst this was going on the ship was perfectly at rest, and the water was like a millpond.

"After about half an hour had elapsed the brilliance of the light somewhat abated, and there was a great paucity of the faint lustrous patches which I have before referred to, but still the body of light was great, and, if emanating from

these patches, was out of all proportion to their number.

"This light I do not think could have been produced without the agency of electro-magnetic currents exercising their exciting influence upon some organic animal or vegetable substance; and one thing I wish to point out is, that whilst the ship was stopped and the light yet some distance away, nothing was discernible in the water, but so soon as the light reached the ship a number of luminous patches presented themselves, and as these were equally as motionless as the ship at the time, it is only natural to assume that they existed and were actually in our vicinity before the light reached us, only they were not made visible till they became the transmitting media for the electro-magnetic currents. This hypothesis is borne out by the fact that each wave of light in its passage was distinctly seen to pass over them in succession, and as the light gradually became less brilliant, they also became less distinct, and had actually disappeared so soon as the waves of light ceased to exist."

Most reports of light wheels come from the Indian Ocean. One opinion is that some acoustic or electromagnetic source activates the bioluminescent agents in the sea. There are also, however, instances of luminous mists hugging the ground or sea surface. These mists may be associated with auroral or electrical discharge phenomenon. Several cases of a "white," "milky," or "phosphorescent" sea are recorded elsewhere in the volumes in Series G. (See also GLD–027.)

GLW-002 LUMINOUS FOG

Anonymous; Monthly Weather Review, 36:371, November 1908.

George A. Turner, second officer of the steamer Counsellor, reports that on Friday, July 24, 1908, when in the Gulf of Siam, latitude 30° N., longitude 103° E., "the steamer past thru a small field of remarkable phosphorescent patches in the form of a kind of vapor lying above the surface of the water in lengths of 500 to 1,000 feet and breadths of 100 feet approximately, and about 15 to 20 feet in depth to the surface of the water. At distances of 1 to 2 miles these 'streaks' appeared like shining silver (no moon shining), and at first were taken to be shoals of fish, but on passing directly thru one it had all the effect of a slight luminous fog. No disturbance or presence of any fish appeared in the water, which is only about 25 to 30 fathoms in depth, and no unusual color appeared in the contents of a draw-bucket taken at the time.

The above report refers to a stationary phenomenon similar to the rotating light wheels. The luminous patches appear in several reports of light wheels, being apparently a precursor of the formation of a wheel.

GLW-003 BRILLIANT GULF WATERS

Anonymous; Monthly Weather Review, 36:371, November 1908.

The following extract was taken from the Tampa, Fla., Times, November, 1908:

A remarkable marine phenomenon was observed by the steamship Dover, Capt. Yon A. Carlson, as that vessel steamed to Tampa from Mobile. When at

a point 35 miles from Mobile light, at 7 o'clock in the evening of the 24th, the ship ran suddenly in a streak of light coming from the water which alternated blue and green, the colors being so brilliant that the vessel was lighted up as if she were covered with arc lights with colored globes.

A half mile streak of dark water, and a blackness that settled like a pall over the ship followed, and a second streak of the same brilliant-hued waters was encountered. The second streak was about as wide as the first one, and when the ship ran out of it the same black waters and a night of exceptional blackness were also encountered.

"I have sailed the high seas for twenty years," declared Captain Carlson, "and have seen interesting phenomena, both meteorological and otherwise, in the waters of every known ocean, but I never saw anything that approached this blue and green light from the water phenomena. The night was dark, but clear, and we ran into the streaks without any seeming warning. I was in the pilot house when we struck it, and I ran on deck, thinking that something was on fire.

"The crew tumbled out to witness it also, and it was magnificent. It was so light that it was remarked by the chief engineer that it could be read by, and to make sure I grabbed a paper, and the finest print that I could find was easily discernible. We ran out of the streak into a streak of black water, and the darkness of the night seemed to increase as we did so. From the streak of blackness we ran into the second streak of lighted waters. Each of the streaks and the intermediate streak of black water was about half a mile wide. The wind at the time was a light northwest. The sea was smooth and we were bearing southeast by east half east, 35 miles from Mobile light."

GLW-004 LUMINOUS WHEELS PUZZLE SEAMEN

Anonymous; New Scientist, 33:447-448, March 9, 1967.

In the Gulf of Thailand and waters to the south-east, last March, three merchant ships independently observed the rare and apparently unexplained phenomenon known as the phosphorescent wheel: bands of luminosity skimming across the surface, apparently radiating from a central bright source. One of them saw it twice, a week apart; another had come across such a luminous spiral in the same region in October, bringing the total to five sightings in a few months all along a line running roughly from Bangkok to the north-western tip of Borneo.

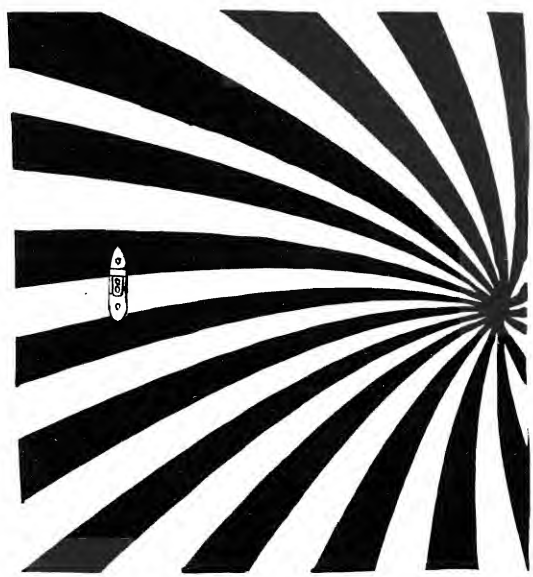
The Marine Observer, which provides a platform for mariners with tales to tell ("Responsibility for each observation rests with the contributor") has published the five accounts, with comments from Professor Kurt Kalle of Hamburg, formerly of the German Hydrographical Institute and now a recognized authority on phosphorescent wheels.

The typical wheel seems to be a mile or more in radius, and to consist of a number of radial or spiral arms, rotating at a surprising rate. The captain of the m.v. Chengtu describes waves of milky-white mist, 30 ft. wide and 30 ft. apart, perhaps 8 ft. deep, passing across the ship at the rate of two a second---implying that the arms were moving at about 100 ft. a second or more. A week later the same observer encountered two such wheel systems, reinforcing to produce five or six bright flashes every second in the region of the ship, and illuminating about 80 per cent of the sea surface---not, however, brightly enough to read by. Another observer (m.v. Glenfalloch) reports something looking like low banks of luminous mist being thrown out from a central patch, 50 or 100 ft. across, which itself pulsed about twice a second.

Professor Kalle, commenting that such wheels are relatively common in the Borneo Sea and the Gulf of Thailand (the last reports from there were in 1957 and 1961), wonders whether the mist is an illusion due to the darkness. Luminous wheels in the water are more reasonable, it seems. And indeed, the officers of the m.v. Beaverbank say that, although the arms looked to be about 2 ft. above the surface, this was probably an illusion. They describe the waves as having brilliant green leading edges, and as passing the ship at between 12 and 15 a minute. They seemed to be emitted from the central source at about 75 a minute.

The wheels can apparently rotate in either direction, or indeed both at once: from the m.v. Glenfalloch comes a second report, this time of two wheels one above the other rotating in opposite directions.

These wheels are put down to bioluminescence; but, while patches of phosphorescent seawater due to marine life are quite credible, structures a few miles across behaving in an organized fashion and with parts moving faster than wind, water or waves are something else again.



Structure of a light wheel, as described in subsection GLW.

GLW-005 REPORT OF AN UNUSUAL PHENOMENON OBSERVED AT SEA

Pringle, J. Eliot; Nature, 20:291, July 24, 1889.

The following report to the Admirality has been communicated to us for publication by Capt. Evans, C.B., F.R.S., the Hydrographer to the Navy:-

H. M. S. Vulture, Bahrein, May 17, 1879. Sir,---I have the honour to inform you that, at about 9.40 p. m. on May 15, when in lat. 26° 26' N. and long. 53° 11' E. [the Persian Gulf], a clear, unclouded, starlight night, Arcturus being within some 7° of zenith, and Venus about to set; wind north-west, force 3, sea smooth, with slight swell from the same direction; ship on starboard tack, heading west-south-west and going three knots, an unusual phenomenon was seen from the vessel.

I noticed luminous waves or pulsations in the water, moving at great speed and passing under the ship from the south-south-west. On looking towards the east, the appearance was that of a revolving wheel with centre on that bearing, and whose spokes were illuminated, and looking towards the west a similar wheel appeared to be revolving, but in the opposite direction. I then went to the mizen top (fifty feet above water) with the first lieutenant, and saw that the luminous waves or pulsations were really travelling parallel to each other, and that their apparently rotatory motion, as seen from the deck, was caused by their high speed and the greater angular motion of the nearer than the more remote part of the waves. The light of these waves looked homogeneous, and lighter, but not so sparkling, as phosphorescent appearances at sea usually are, and extended from the surface well under water; they lit up the white bottoms of the quarter-boats in passing. I judged them to be twenty-five feet broad, with dark intervals of about seventy-five between each, or 100 from crest to crest, and their period was seventy-four to seventy-five per minute, giving a speed roughly of eighty-four English miles an hour.

From this height of fifty feet, looking with or against their direction, I could only distinguish six or seven waves; but, looking along them as they passed under the ship, the luminosity showed much further.

The phenomenon was beautiful and striking, commencing at about 6h. 3m. Greenwich mean time, and lasting some thirty-five minutes. The direction from which the luminous waves travelled changed from south-south-west by degrees to south-east and to east. During the last five minutes concentric waves appeared to emanate from a spot about 200 yards east, and these meeting the parallel waves from south-east did not cross, but appeared to obliterate each other at the moving point of contact, and approached the ship, inclosing an angle about 90°. Soundings were taken in twenty-nine fathoms; Stiffe's Bank, with fifteen to twenty fathoms, being west about one mile. The barometer was already at 29.25 from 8 to 12 p. m.

	At 8 p. m.	10.15 p. m.	Midnight
Temperature of air	84	83	83
Temperature of sea-water	84	82	82

I observed no kind of change in the wind, the swell, or in any part of the heavens, nor were the compasses disturbed. A bucket of water was drawn, but was unfortunately capsized before daylight. The ship passed through oily-looking fish spawn on the evening of the 15th and morning of the 16th inst.

GLW-006 ILLUMINATION OF THE SEA

Anonymous; Nature, 2:165, June 30, 1870.

The following is derived from the Kolnische Zeitung of June 19:---

"Gulf of Siam, April 11. Last night, between two and three o'clock, I had the opportunity of witnessing an illumination of the sea of the most peculiar kind. It had become quite calm, after a sharp breeze which had sprung up from

the N. N. W., caused by a passing storm in the distance. Heat-lightning was still very frequent in the west horizon, and the sky was covered with light clouds, through which the moon shone rather brightly. We took in sail and set the engines going. I then noticed in the water large white flakes which I had at first taken to be reflections of the moon; they were about a fathom in diameter, apparently lustreless, and of no particular shape, like objects seen lying deep in the water. By the rising and falling of the sea's surface these flakes floated off to a short distance from the ship without imparting any noticeable increase of brightness to the water illuminated by the moon's rays. After steaming further forward for six or seven knots, a most wonderful spectacle presented itself. On both sides obliquely in front of us, long white waves of light were seen floating towards the ship, increasing in brightness and rapidity till at last they almost disappeared, and nothing was observed but a white lustreless, whirling (schwirrendes) light upon the water. After gazing for some time it was impossible to distinguish between water, sky, and atmosphere, all which were but just now clearly distinguishable, and a thick fog in long streaks appeared to be driving upon the ship with furious swiftness. The phenomenon of light was somewhat similar to that which would be produced by the whirling round of a ball striped black and white so rapidly that the white stripes seem to be lost and blended with the dark ones. The light was just as if we were enveloped in a thick white fog. The direction of the waves of light upon the ship was always on both sides obliquely from the front. The phenomenon lasted about five minutes, and repeated itself once more afterwards for about two minutes. Without doubt, therefore, shoals of small creatures in the water were the cause of this luminosity, and the waves of light find their cause, according to my conviction, in the white flakes above described. Yet their moderate velocity of 1-1/2 geog. mile per hour, and the weak light at first emitted by each flake, so weak as not to influence the tint of the surface-water, does not seem calculated to call forth a phenomenon of such magical effect as the one described. The luminous appearance commonly seen in the wake of a ship, or in water disturbed by oars or rudder, is not to be compared with such a phenomenon as the above. In the former the light is lustrous, glaring green and blue, like phosphorus, often very splendid in deep clear water, mingled with a reddish white foam. We saw a beautiful instance of this kind one night, in perfectly still and smooth water, in a a lonely bay of Nipon. It was pitch dark and perfectly quiet, when a heavy shower of rain came on, in large but not dense drops. Every drop as it struck the water became illuminated, little drops of fire sprang up in the air, and a little luminous circle formed itself. It seemed as if the bay was suddenly filled with little flowers of fire. This phenomenon was almost immediately dissipated by a puff of wind."

SECTION GQ: CRUSTAL MOVEMENTS

Earthquakes are far from being completely understood. Fairly convincing correlations exist between earthquakes and solar activity and even the position of the moon. Furthermore, earthquakes are often accompanied by bizarre sounds, lights, and magnetic effects. Some seemingly sound reports connect earthquakes to meteors and unusual weather. Such is the stuff of section GQ.

GQE Earthquake phenomena. Earthquake lights, sounds, odors, and physiological effects. Correlations of earthquakes with meteors and such geophysical phenomena as fog, darkness, and precipitation.

*GQF Fault phenomena. Electrical, magnetic, and thermal anomalies along fault lines. Connections between faults and other geophysical phenomena.

*GQG Geographical correlations. Predilection of earthquakes and other crustal motions for certain patterns, such as the Rouse Belts and great circles.

*GQS Solar and lunar effects. Possible connections between solar activity and earthquake activity. Effects of lunar position.

*This subsection not represented in Volume Gl.

This page reserved for the expansion of the preceding categories in future volumes.

GQE-001 THE MESSINA EARTHQUAKE AND THE EVENTS PRECEDING IT

Soley, John C.; Scientific American Supplement, 68:90-91, August 7, 1909.

While there is an apparent correspondence through the whole range of subterranean phenomena and an interdependence between vulcanism and solar disturbances, the manifestations of the giant forces which bring such ruin and devastation in their train are sometimes so complicated that it is difficult to prove that all the seismic phenomena of a period are concurrent. The decade 1900-1910 has been a period of great seismic activity, and a more careful study of the events has been made than was ever possible before. With the opportunities thus afforded to group the occurrences of the great eruptions and sunspots, of solar flames and earthquakes, their correlation becomes plainer, and we begin to realize that none of those wonderful phenomena was an instance of individual action.

During this period the explosions of volcanoes and the grinding roar of earthquakes have been heard all over the globe, reaching a climax in 1907, when the whole world was in a state of unrest. From that time the eruptions have been fewer and fewer, though the impulses which cause the lands to tremble are still sending their waves vibrating through the crust of the earth. Comparing the records of this decade with those of the two previous ones, the same periodic variation appears, the sixth and seventh years being most fruitful in seismic disturbances, while the second year comes next in point of numbers; in each decade the same periodic variations occur, and they always correspond with the sunspot cycles. Nothing in all the realms of nature is more perplexing than these variations, but the periodicity is incontestable; the grouping of these events into a certain period or fixed part of a period seems to prove that there are laws which govern the movements in the complex systems of the earth and of the sun, and that however discordant may be their action, the tone is eventually restored and they become once more parts of a harmonious whole.

Here, Soley recapitulates many earthquakes and volcanic eruptions occurring near the 1907 peak of activity.

This recapitulation may seem tedious, but it is necessary to show that neither this earthquake nor any other of this period was an isolated phenomenon, and that the Messina earthquake was only a more serious manifestation of the movement of the earth waves which have been pulsing through the earth's crust since the sunspot of last September, [1908] and which reached the Straits of Messina when the surface on both sides was in a weakened condition owing to frequent shocks of the last three years. In this earthquake there were no foci, no epicenters; on the contrary, as the earth waves met with interference in the faults of the rock strata and in the alluvium of the coastal plains, their movement became excessively complicated, and it was the complex disturbance rather than any uplifting of the surface that produced the destructive effects.

GQE-002 THE NEW MADRID EARTHQUAKE

Fuller, Myron L.; U. S. G. S. Bulletin 494, 1912.

One of the greatest series of earthquakes to hit North America centered in the Missis-

sippi Valley in the winter of 1811-1812. Thousands of square miles of this relatively unpopulated land was ravaged during the three principal shocks on December 16, 1811; January 23, 1812; and February 7, 1812. New Madrid, Mo., was near the center of the disturbance. From Fuller's classic paper, some of the more bizarre aspects of the quake are reproduced.

Darkness.---As in most of the great earthquakes the atmosphere seems to have become darkened during the more severe shocks in the Mississippi Valley. Eliza Byran notes that total darkness accompanied the first shock, while a similar "awful darkness of the atmosphere" marked the severe shock of 4 p. m. on February 7. Godfrey Le Sieur also says a "dense black cloud of vapor overshadowed the land" after the severe shocks. At Herculaneum the atmosphere according to Col. Samuel Hammond, was filled with smoke or fog so that a boat could not be seen 20 paces, and houses were so shrouded as not be be visible 50 feet. The air did not clear until the middle of the day. A writer from New Madrid states that at the time of the shock the air was clear, but in five minutes it became very dark, and the darkness continued until nearly morning, during which period there were six shocks. At 6.30 the air cleared, but at the severe shock later in the morning the darkness returned.

The darkness was probably due to a number of cooperating causes. In all probability the dust projected into the air by the agitation of the surface, the opening and closing of fissures in dry earth, landslides on dry hillsides, and possibly the falling of chimneys and buildings contributed to supply to the atmosphere the suspended particles which presumably produced the obscurity described. It is likely also that aqueous vapors, rising from fissures connecting with the warm ground waters (temperature 50° to 55°), or from the waters extruded from cracks and craterlets and condensed by the cold December air played a part. The extrusion of such vapors, usually more or less sulphurous, is described by many witnesses. It is not entirely impossible that conditions favoring condensation of atmospheric moisture either accompanied or resulted from the earthquake disturbance.

Besides the darkness observed in the area of principal disturbance similar manifestations were recorded in other localities. For instance, at Columbia, Tenn., a very large volume of something like smoke was declared to have risen in the southwest, from which direction the sound appeared to have come, and, proceeding northeastward, settled as a black cloud in the course of the 10 or 15 minutes the shock lasted.

An unusual darkness during the earthquake was reported at a number of other points, but if it had any relation to the earth disturbances its nature is not known. It seems likely that in the outlying districts the darkness was due to ordinary clouds associated with storms then in progress across the country.

Odors and vapors.---Sulphurous or otherwise obnoxious odors and vapors were an attendant feature of the earthquake at many points, as stated by nearly every writer. Bryan speaks of the complete saturation of the atmosphere with sulphurous vapor a few minutes after the first shock, and of similar vapors after the shock of February 7. Hildreth speaks of the escape of sulphur gas through the cracks tainting the air and impregnating the water for a distance of 150 miles so it was unfit to use. Another observer, writing to Mitchill from New Madrid, states that although the air was clear at the time of the shock, within five minutes a vapor with a disagreeable smell and producing a difficulty of breathing impregnated the atmosphere. At Jeffersonville, Ind., warmth and smokiness were noted for several days after the shock, while at Columbia, S. C., the air during the shock felt impregnated with vapor which lasted for some time.

The source of the odors in the New Madrid region seems to have been the buried organic matter which here, as elsewhere in the Mississippi embayment, occurs in the alluvium and underlying Tertiary deposits, the emanations coming mainly from the carbonaceous material extruded from below through the fissures and craterlets, which were numerous in the region. In the more remote localities the vapors probably represented normal atmospheric condensations which happened to be coincident with the earthquake disturbance.

"Light flashes" and "glows."---The phenomena of what many be termed "light flashes" and "glows" seem so improbable that they would be dismissed from consideration but for the considerable number of localities from which they were reported. Dillard, in speaking of the shocks (not especially the first one), says: "There issued no burning flames, but flashes such as would result from an explosion of gas, or from passing of electricity from cloud to cloud." Lewis F. Linn, United States Senator, in a letter to the chairman of the Committee on Commerce, says the shock was accompanied "ever and anon [by] flashes of electricity, rendered the darkness doubly terrible." Another evidently somewhat excited observer near New Madrid thought he saw "many sparks of fire emitted from the earth." At St. Louis gleams and flashes of light were frequently visible around the horizon in different directions, generally ascending from the earth. In Livingston County, according to Mr. Riddick, the atmosphere previous to the shock of February 8 was remarkably luminous, objects being visible for considerable distances, although there was no moon. "On this occasion the brightness was general, and did not proceed from any point or spot in the heavens. It was broad and expanded, reaching from the zenith on every side toward the horizon. It exhibited no flashes nor coruscations, but, as long as it lasted, was a diffused illumination of the atmosphere on all sides." At Bardstown there are reported to have been "frequent lights during the commotions." At Knoxville, Tenn., at the end of the first shock, "two flashes of light, at intervals of about a minute, very much like distant lightning," were observed. Farther east, in North Carolina, there were reported "three large extraordinary fires in the air; one appeared in an easterly direction, one in the north, and one in the south. Their continuance was several hours; their size as large as a house on fire; the motion of the blaze was quite visible, but no sparks appeared." At Savannah, Ga., the first shock is said to have been preceded by a flash of light.

That the flashes were entirely imaginary is improbable, but it is very doubtful if anything out of the ordinary actually took place. A source of many of the flashes appears to have been the thunder storms which occurred at the time. Such storms, which were very unusual at the season at which the shocks took place and which were unsuspected by the people outside of their immediate path, have been recorded at a number of points, especially in South Carolina. Bearing on the origin of the flashes or glows the observations of several of the captains of ocean liners in the Tropics at the time of the recent severe disturbance in Mexico (1907) are of significance. They reported that on the night on which they afterwards learned that the earthquake had occurred strong glows in the sky, resembling the auroras of northern latitudes, were seen. As these were not reported farther north the view suggests itself that they were due to magnetic disturbances depending upon or related to the severe earth disturbances going on at the time. It is not improbable that similar magnetic manifestations were associated with the New Madrid shock.

It is probable that in the New Madrid region brush or wood fires, made by the Indians or settlers, may have been an additional cause. It should be noted in this connection that in the New Madrid area itself, where the weather was clear at the time, no mention of any such phenomena was made in the more conservative descriptions. (pp. 44-47)

GQE-003 NOTICES OF EARTHQUAKE SHOCKS FELT IN GREAT BRITAIN . . .

Milne, David; Edinburgh New Philosophical Journal, 31:92-122, 1841.

February 20, 1818; Inverness at 1h 20'. Also at Coningby (Lincolnshire) at 3 P. M. (where "accompanied by a noise like firing of cannon"), and east end of Holderness. Felt also at Kirton in Lindsey, where [a] meteor apparently about size of cannon ball with a streamer behind it; seen at same time moving in air with great velocity.--(G. Mag. v. lxxxvi. p. 364.) (p. 118)

April 13, 1822. A shock was felt at Comrie [Scotland] about 9 1/2 A. M. Very awful shock. More so than for twenty years past. The weather very cold that day and previously, but became warm the day after. Accompanied by two loud reports, one apparently above our heard, the other which followed immediately under our feet. The noise lasted 30", and was much louder than any thunder. (p. 119)

August 13, 1816. At Montrose, a vivid flash of lightning was observed to follow after the shock. At Dunkeld, a small meteor was seen to pass from E. to W. just about the time of the earthquake. There houses were much shaken. Immediately after the shock commenced, I felt a kind of faintishness, which did not leave me for two hours. The same felt by others. I know persons who have the same feeling during a thunderstorm. The faintish feeling was in some persons attended by a very slight degree of sickness. (p. 117)

September 24, 1816. Mr Gilfillan of Comrie states that there was an uncommon phenomenon in the air,--a large luminous body, bent like a crescent, which stretched itself over the heavens. (p. 117)

November 13, 1833. [after an earthquake in England] This thick fog said, by an observer in Dorsetshire, to be precisely similar to the fog which accompanied the Lisbon earthquakes in 1807 and 1816. This fog commenced on the 12th, succeeding heavy rain on the 11th November. (p. 120)

GQE-004 NOTICES OF EARTHQUAKE SHOCKS FELT IN GREAT BRITAIN . . . . .

Milne, David; Edinburgh New Philosophical Journal, 32:pages as noted, 1842.

The long series of earthquakes at Comrie, Scotland, were characterized by many meteorological and physiological phenomena. To give the reader a sampling of these unusual aspects, the following accounts are taken from Milne.

[October 12, 1839] The Rev. Mr. Walker of Comrie writes, that "the shocks of 12th at 1 and 4 P. M. (which were very similar and which were attended with a considerable tremor of the earth), were accompanied with a noise resembling a mixture produced by the rush of a strong wind and the peal of distant thunder. It was different from any noise which I ever heard before. The shock at 3 P. M. (which was far more severe than any that had preceded it, and which was attended with greater tremor or heaving of the earth), was accompanied with a noise which at first resembled the murmurings of distant waters. This continued increasing in intensity for about 2", and then followed a very loud and very terrific sound resembling that of a double shot for blasting rock immensely charged.

"The weather has been remarkably wet during the month of October, and indeed for some months previous, and still continues so. No day has brought along with it any other than a moist, and often a very moist atmosphere. This was especially the case on the 10th when the first severe shock was felt. In the morning of that day the clouds were evidently surcharged, while in the evening for some hours the rain fell in torrents, accompanied with a very violent wind from the SW. by W. Again, of the 12th, when three severe shocks, and so many lighter ones, were felt, the atmosphere was very moist. The air was much darkened during the shocks, and occasionally there fell a few drops of rain. After the second severe shock this day. I retired to the garden to note the appearance of the sky. I found that it had assumed an appearance peculiarly strange and alarming. The heavens, more especially towards the N. and NW., appeared as if hung with sackcloth. A dense dark indescribable species of mist enveloped the mountains in that direction. In many parts they were completely concealed; while in others, the broken crags could be seen as if growing through in terrible majesty, giving to the scene an aspect ineffably grand, and in some respects horrific. If I remember right, there was no heavy rains that evening nor the night following; nor was there, as on the 10th, any boisterous wind. Before the shocks on the 12th there was a slight breeze. This continued during the morning. Shortly before the first and third shocks there was a momentary calm. After these shocks, the wind again rose and blew gently, but from what direction I have not noted."

Mr Walker adds, that "during the second severe shock on the 12th, some slates fell from houses and some loose stones from walls. On that occasion also furniture was moved, and bells rung in some houses. Many persons felt as if under the influence of electricity. This was especially the case on the 12th. Some complained of pains in the soles of their feet; others in their ankle and knee-joints, and others in the wrists. As for myself, the effects on my frame and spirits were a slight pain in the back, and subsequently a violent headach. My limbs felt exceedingly weak. A general tremor seized me." (pp. 111-112)

[October 23, 1841] "Towards the termination of the principal shock on the 23rd, there was a strong smell of a combination of sulphureous and metallic air emitted through the floor; and though I felt perfectly convinced this was not the production of fancy, yet it has been satisfactory to me having heard from others since that they experienced the same. In connection with this, it may be noticed, that some linen placed on the ground 1 1/2 miles east from hence, to blanch on the morning of the 23rd, was on the following day discovered entirely covered with small particles of black. The clothes were on the usual spot for dressing the linen, and removed fifty yards at least from a solitary house, and with high trees intervening. I could not learn that the under surface next to the ground was discoloured. (p. 120)

.....almost direct north from the east end of Locherne, lies a small lake of the name of Lochboultachan, in the center of a small circular glen of the same name. Among these hills, and near this lake, general opinion has placed the seat of the earthquakes. (p. 122)

Note that the Moodus sounds, in Connecticut, as well as the "guns" of Lake Seneca and Lough Neagh are connected with lakes.

GQE-005 ON THE FACTS OF EARTHQUAKE PHENOMENA

Mallet, Robert; Report of the British Association, pages as noted, 1854.

July 28, 1804; Spoleto and as far as Nocera. Violent shocks, especially the first ones.....The air was full of thick fog, so that the moon appeared a blood-red colour. (p. 57)

April 24, 1836; District of Rossano, Italy. A terribly destructive earthquake. .....In Rossano, an instant after the shock, all the houses were seen either thrown down or crumbling into ruins; and in Croscia not a single house was left standing. Long and deep fissures opened in the earth. An igneous meteor was seen, having the appearance of great beams of fire. (p. 259)

April 13, 1750; Lancaster to Wrexham, England..... The heavens were obscured by a thick mist, in which red rays were observed converging towards a point near the zenith. The appearance lasted fifteen or twenty minutes (aurora borealis?). (p. 147)

April 15, 1752; Stavanger in Norway. Several violent shocks lasting several minutes. The weather was remarkably fine until 2 o'clock, when a small cloud rising extended itself over the heavens, and the whole evening there was a violent storm of wind, hail, and thunder and lightning; followed during the night by the appearance of a strange star of an octagonal shape, which seemed to throw forth balls of fire from its angles (!). (p. 153)

October 4, 1755; Mora, District of Toledo. A great number of strange meteorological phaenomena are recorded as having been observed during this month in Spain. Indeed, for some time before the great earthquake of Lisbon, the accounts of halos round the sun and moon, igneous meteors, alterations in well and river water, which generally acquired an offensive odour, besides thunder, lightning, and rain, are to be found from almost all parts of Europe. These phaenomena were most remarkable in Spain, where the water in many of the wells was quite troubled, and rats and some species of reptiles came forth as if much terrified. Domestic animals also appeared frightened and uneasy. (p. 162)

November 1, 1755. THE GREAT EARTHQUAKE OF LISBON. This earthquake, one of the most violent and widely extended on record, produced sensible effects over a space of the earth's surface included between Iceland on the north, Mogador in Morocco on the South, Toplitz in Bohemia on the east, and the West India islands on the west. Actual shocks however were not felt over the whole of this surface; in some places agitation of the water in lakes, canals, &c. being the only sensible effect produced. The centre of disturbance seems to have been situated beneath the Atlantic Ocean a little west of the coast of Portugal.....At Madrid the water in the wells rose several fathoms a little after the shocks. The houses there were much shaken, but nothing fell but two crosses from the summits of the churches. A cleft opened in one place in a mountain, from which an exhalation destructive to cattle issued. Rota, Malaga, Chiclana, Medina, &c. &c. were more or less injured. Birds and quadrupeds exhibited decided symptoms of fear. Numerous meteors and other unusual atmospheric phaenomena are stated to have been observed about this time in Spain and Portugal.....At Augsburg [Germany] magnets let weights suspended to them fall, and there, as at many other places, the magnetic needle was disturbed. (pp. 163-166)

February 2, 1816; Lisbon. A severe shock. At Lisbon the people quitted their houses. There had been a storm the day before, after which the weather was remarkably calm and sultry until the shock, which was succeeded by heavy

rain. A meteor appeared immediately after the first shock. Flocks of birds filled the air, uttering the most discordant cries. (p. 106)

GQE-006 THE NOTES OF CHARLES FORT

Fort, Charles; The Fortean Society Magazine, 1:14, June 1943.

The following note was taken from the London Times, October 21, 1823, p. 2.

1823, Aug. 20. At Ragusa. Quake, phenomena dark. "On the 20th the air became (reverse) suddenly dark. A fiery meteor appeared over the city, and fell into the sea, followed by an earthquake that overthrew many houses. The sea retired nearly a mile from the shore (reverse) 3 felt sharply in Turkish Bosnia. There it was reported that a volcano had broken loose.

Fort's original notes are nearly illegible. This one was translated by Tiffany Thayer, the secretary of the Fortean Society.

GQE-007 THE NOTES OF CHARLES FORT

Fort, Charles; The Fortean Society Magazine, 1:15, October 1941.

1819, June 16. Cutch, India/quake preceded by a violent wind and a noise like that of a large flight of birds (reverse) B. Assoc 1854/122

1819, June 16. Quake of Cutch 1150 persons buried in the ruins of Bhooj. Said that from a hill was thrown (reverse) a ball of fire that then fell to the ground scorching vegetation. Rain fell in torrents. Trans. Lit. Soc. Bombay, 3/90.

The above are verbatim transcriptions of two of Fort's notes, which were originally written on scraps of butcher paper.

GQE-008 EARTHQUAKES AND METEORS

Packer, David E.; English Mechanic, 74:155, September 27, 1901.

On the night of the recent earthquake in Scotland (Sept. 17) several remarkable meteoric appearances were seen here an hour before the shock. The night was generally cloudy, but during intervals of clearness several meteors were visible. The most remarkable of these resembled ribbon-like flashes of lightning seen through a dense mist, although no ordinary lightning was visible at the time. Two of these, radiating from Cassiopeiae at 12.20 to Pegasi and the southern horizon respectively, appeared almost simultaneously, while a third at 12.25 rose up from the south towards Perseus. Their appearance was quite unique, nothing like them having been seen during 19 years of observation. The scintillation of the stars on this night presented a peculiarly spasmodic character.

During the celebrated earthquake that visited the Midlands on December 16, 1896, a strange meteoric light was visible at the time of the shock, and in many places quite distant from the area of the disturbance. Dr. Mallet, many years ago, cited many instances of connection between earthquakes and meteors (Brit, Assoc. Reports, 1850, p. 74) and remarks that the meteoric phenomena have always on these occasions exhibited peculiar characteristics. Humboldt has remarked that during the celebrated earthquake at Riobamba in 1790, Feb. 4, an extraordinary shower was seen over the wide area of the disturbance, particularly at Quito, that just before the disastrous earthquake at Cumano, 1766, Oct. 13, a similar display was seen, while another series of seismic disturbances that also afflicted Cumana so disastrously in 1799, Nov. 13, was immediately followed by the historic "Leonid" display of that year, 1799, Nov. 13, of which both he and Bonpland were eye-witnesses. There seems something very remarkable in the fact that these South American earthquakes should be accompanied by conspicuous celestial phenomena. That a relation between earthquakes exists, there can be no doubt, although the law governing the relation remains to be discovered.

GQE-009 [EARTHQUAKE AND LIGHTNING]

Anonymous; Nature, 23:564, April 14, 1881.

The destruction caused by the Chios earthquake has been even greater than we stated last week. The Constantinople Correspondent of the Daily News sends some interesting particulars: The temperature on the 3rd was heavy and oppressive and the horizon was broken by broad flashes of light that seemed to denote a coming storm. In all this atmospheric disturbance however the inhabitants saw nothing extraordinary, and were far from being alarmed by what they fancied would result in a thunderstorm. At ten minutes to two in the afternoon a terrific shock was felt, bringing three-fourths of the houses in the town to the ground like so many packs of cards, and burying a thousand persons under the falling ruins.

A recapitulation of damage suffered completed the note.

GQE-010 FIRST REPORT ON THE FACTS OF EARTHQUAKE PHENOMENA

Mallet, Robert; Report of the British Association, pages as noted, 1850.

In various volumes of the Report of the British Association, Robert Mallet published the accounts of many thousands of earthquakes. He summarized his immense catalog of observations as follows: (Of course, only the descriptions of the more unusual aspects are reproduced below.)

1st. The Weather generally. Although in numberless accounts we read of peculiar appearances before the earthquake, as red lurid skies, red and blue suns, &c., and during the continuance of earthquakes, of strange appearances and threatening portents in the sky, yet, judging from all the narratives of the best observers, there seems to be no ground for supposing that there is any connexion between the state of weather or appearance of air and sky immedi-

ately before earthquakes.

In the south of Europe a general belief prevailed that calms, oppressive heats and a misty atmosphere, were the usual preludes of earthquake. Hamilton says he found it a general observation in Calabria, "that before a shock the clouds seemed to be fixed and motionless, and that immediately after a heavy shower of rain (during the earthquake), a shock quickly followed." And in the Philippine Islands, De Guignes informs us that "a calm, the sky gray and cloudy, the atmosphere heated and heavy, occasional gusts of wind, and at intervals gentle showers of rain, are the prognostics by which earthquakes are anticipated there." After recording a number of vague opinions held by the South Americans, as to the weather prognostics of earthquakes, Humboldt says, "These are however very uncertain, and when the whole of the meteorological variations at the times when the globe has been most agitated are called to mind, it is found that violent shocks take place equally in dry and in wet weather, when the coolest winds blow, or during a dead and suffocating calm." (Humboldt, Per. Nar. vol. ii. p. 223.) Again, the veteran philosopher says that "even in Italy this belief is dying away;" and expresses his own conviction, strengthened by that of those who have lived long in the great shaken countries of South America, that earthquakes are independent of the weather or appearance of the heavens immediately before the shock. He says he has felt earthquakes when the air was clear and fresh east wind blowing, and also when there was rain and thunder-storms; and this has been very recently confirmed by the continuous observations made at New Zealand during the earthquake of 1848, which began in a gale of wind.

On the relation of earthquakes and volcanic eruptions generally to the condition and phenomena of the atmosphere, Von Hoff remarks; "The question, whether any relation or casual connexion exists between the various movements of the earth and those occurring in the atmosphere, has for a long time remained unanswered. The intimate connexion which subsists between the earth and its atmosphere, and which manifests itself in so many phenomena, has always induced people to presuppose a similar connexion between earthquakes and volcanic eruptions, and the condition of the atmosphere. They believed that the influence of the latter might be engaged in the volcanic process, and that, on the other hand, earthquakes and volcanic eruptions might produce some effect on the condition of the atmosphere. The proof of the first of these opinions, it has been thought, was to be found in great falls of the barometer, in remarkable calms, in dry mists, and unusual gray or red coloring of the sky, and especially in great heat.

"Amongst the effects supposed to be produced by the earthquake on the atmosphere, were reckoned tempestuous winds, thunder-storms, meteors, coldness of the air, severe winters, heavy rain, miasmata, producing diseases and affecting vegetation. A very remarkable instance of the latter is quoted, namely, that in Peru; after the earthquake of 1687, wheat and barley would not thrive at all, though formerly the country was remarkably favourable for them.

"There can be no doubt that an answer to the question, whether a connexion exists between these phenomena of fixed terrestrial bodies and the condition of the atmosphere, is of the greatest importance to a thorough knowledge of both. But from the multifarious conditions which have here to be taken into consideration, from their complication, and from the difficulty of distinguishing, amongst many recurring at the same time, between the indifferent and those which are really important, an extended series of successive observations, made with the utmost care and circumspection, will be required, in order even to approach the object which is aimed at in researches of this sort." (pp. 66-68)

On the Influence of the Season of the Year and Time of Day upon Earthquakes.---Von Hoff remarks, "As we have already noticed, a dependence of the earthquake upon the time of year has occasionally been supposed to have been remarked. In the equinoctial regions earthquakes have been thought to occur more frequently during the rainy season than at any other time of year. Sometimes they have been supposed to be peculiar rather to the period of the equinoxes, sometimes to the winter months; with many other similar opinions. Indeed examples are not wanting which appear to favour such views; as for instance, the observation, that of all the earthquakes which occurred in Sicily from 1792 to 1831 (Hoffman in Poggendorff's Annalen, b. xxiv. s. 52), double as many took place in March as in any of the other months. Still however an almost more profound obscurity hangs over the question, whether earthquakes and volcanic eruptions are more peculiar to one time of the year or day than to another, than over the consideration of the other connections of these phenomena with those of the atmosphere. This subject has also been treated of in an elaborate manner in another paper on the causes of earthquakes (Memoire couronnee, Utrecht, 1820-28, and enlarged, Leipzig, 1827-28) by Herr Kries, who has brought forward instances in no small number, which prove that earthquakes, even of the most violent kind, have occurred at every time of day and in every season of the year."

"I myself (says Von Hoff) have in another place (Poggendorff's Annalen, b. xxxiv. (110) s. 99f.) made the experiment of collecting and arranging all the instances of earthquakes which occurred during ten years, in order to find whether any one time of the day or year presented a greater number of these phenomena than the others. The result of these researches however seems to be, that with respect to this relation of earthquakes also, no law can be laid down. We must consider it as an established fact, that both earthquakes and volcanic eruptions may occur at any time of the day or year, since experience has shown this with respect to almost every time. The only question which remains on the subject is, whether we can ascribe to any one or other season or time, a greater tendency to produce or favour the production of such phenomena. A mere collection of facts, even though embracing a long period of time, would of itself hardly supply an answer to this question; since, in order to draw tolerably accurate conclusions from such a collection, many other circumstances would have to be taken into consideration. We ought not to content ourselves with collecting and arranging a mere successive list of these phenomena, but on the contrary, we should compare with one another only the most considerable, and those which occurred in the same climate, with other precautions of a similar nature.

.....

This branch of the subject however cannot be deemed complete until from the largest possible catalogue of earthquakes, extending over the whole historical period, a similar deduction with suitable precautions shall have been made.

A singular work, now very scarce, was published in 1729, by a professor at Lima, entitled 'L'Horloge Astronomique des Tremblemens de Terre,' in which he undertakes, from a discussion of 108 earthquakes occurring in his own time, to predict that of their recurrence; the period of tide and state of the moon are the immediately influencing causes, according to him, as well as the moon's place in the zodiac; the critical time is confined to six hours and some minutes of the horary circle, within which the moon is on the meridian of the place; and he says he has confirmed his results by 143 observations in 1729, and 70 in the subsequent year, which proved correct.

Mr. Edmonds, in the Cornwall Polytechnic Journal, has also endeavoured to connect the occurrence of earthquakes with the period of the moon; he shows

that several of the most disastrous have occurred the day after the first quarter.

I mention these latter authors, not as attaching any importance to their conclusions, but as showing to those who will consult the originals, the wrong direction in which such researches have been made. (pp. 64–66)

5th. At the moment the fissures open in the earth, fire and smoke (apparently) have been observed to issue.

On this matter much new and exact observation would be most desirable. The narratives generally affirm that flame made its appearance momentarily at the mouth of the fissure, and that a volume of smoke, or some say dust, was vomited forth and hung for some time above the mouth.

That some earthquakes have been observed from points situated so directly above and so close to the focus of volcanic action beneath, as to make all this quite possible in its most literal sense, cannot be doubted, when we call to mind the Volage's chain cable having been made incandescent, and even partly melted, as she swung by it at anchor on the coast of South America; or Captain Tilland's narrative in the Philosophical Transactions for 1811, of the submarine volcano, which he actually saw rise, upon the surface of the sea, near the island of St. Michael's when laying to, within a few cables' length of the spot. Within four hours after the first visible commotion, the summit of the crater was 20 feet high above water, and 400 or 500 diameter; and before he left, it had raised itself to 80 yards in height. Volumes of steam were discharged, the sea was violently agitated as though boiling, lightning-flashes were emitted from the clouds above, and water-spouts formed in various places around showed the violent disturbance of electric equilibrium. A continuous noise like musketry mingled with discharges of cannon stunned the ear, and the shocks of earthquake felt were sufficient to shake down part of a cliff upon which some observers stood. Many such records show how closely men may sometimes approach the "Atri Janua Ditis," and live in the midst, as it were, of the smoke and fervent heat of the unknown regions within; but when the occurrence of flame and smoke is recorded of fissures in non-volcanic lands, and in territories suffering from earthquakes whose origin is manifestly far away, as in the Lisbon one for example, some different solution must be sought for.

The following suggests itself as at least worthy of future investigation.

The experiments of Becquerel and other electricians have shown, that when fracture in a solid takes place, a powerful electrical disturbance is the consequence. This will be great in proportion as the surface and mass fractured are themselves large. When therefore a fracture of a mile long and of many feet in depth is formed, whether by subsidation and slipping, or in any other way in soft material, and yet far more when one of those greater fractures in hard rock takes place, such as have been described when a whole mountain mass has been rent in two at a blow, the disturbance of electric equilibrium may be expected to exceed that of a heavy thunder-storm, and may, quoad this particular part of earthquake phenomena, realize the dreams of the older philosophers, who thought an earthquake was a thunder-storm under ground.

In this then I believe is to be found the usual source of the flame or flash, seen suddenly to appear and vanish at the mouth of the rent, and the identification of the supposed flame or flash with electricity in an analogous case, was made by Sir W. Hamilton, who alludes to its violent disturbance always in the cloud above the crater of a volcano in eruption, though he suggests no origin for such disturbance in the case of fissures opening, from which he had satisfied himself by subsequent examination, that there was no evidence of flame or volcanic exhalations of any sort having issued from their mouths. And as to the smoke which has even been described by some authors as dust, I fancy it has been none other in almost all cases, if not in all. (pp. 55–56)

2nd. Effects on Animals. Hamilton says that during shocks, horses and oxen extended their legs widely to avoid being thrown down (an evidence of the velocity of the shock), and that hogs, oxen, horses and mules, as also geese, appeared to be painfully aware of the approach of the earthquake of Calabria; and the neighing of a horse, the braying of an ass, or the cackling of a goose, even when he was making his survey, drove the people out of their temporary sheds in expectation of a shock.

All birds appear sensible of its approach, but geese, swine, and dogs more remarkably than any other animals; the geese quit the waters before the earthquake and will not return to it. Can it be that with their heads immersed they are able to hear the first distant mutterings, while these are yet inaudible to those who hear through the air, and not as in their case through a liquid?

Von Hoff notices "a presentiment (vorgefuhl) which it was thought had been remarked in particular species of animals shortly before an earthquake. Even men have sometimes, a short time before such occurrences, felt a tendency to headache, giddiness (vertigo), and an inclination to vomit.

"It has been remarked, that at such times domestic animals showed a decided uneasiness, dogs howled mournfully, horses neighed in an unusual manner, and poultry flew restlessly about. These latter phenomena might easily be produced by mephitic vapours, which often ascent to the surface of the earth before the breaking forth of the earthquake."

The Cirricelli, (possibly our Sand-eels,) a little deep-water fish, like our white bait, which usually lies buried in the sand, Hamilton says, "came up to the surface with many others, and were caught in multitudes;" this might arise either from actual heat of the sea-bottom and water close to it, or from its being fouled by the commotion or by exhalations into it; or they may have been startled by the vibrations, as trout are when one stamps violently on a river bank.

There is unquestionable evidence of earthquake shocks (and not of great intensity) producing nausea and vomiting in men and women; sometimes, as in a school at Philadelphia, numbers were so affected, at the same instant awakened from sleep by the shock; whether this arise from sudden dread produced by the unusual and fearful visitation, or be analogous to sea sickness, has not yet been determined.

These few particulars constitute nearly all that has been observed of this point of our subject. (p. 68)

5th. The Rain-gauge. Torrents of rain have often been noticed as falling during earthquakes, and they have also often begun in heavy rain, and sometime, have been concluded with rain, and this has in each case often been accompanied with thunder, lightning and wind; but, on the other hand, so many earthquakes have occurred with serene skies, before, during, and after the shocks, that we must conclude there is no necessary connexion established between them. I can find no numerical observation as to rain, in relation to our subject, recorded.

As secondary effects after earthquakes, disturbances in the usual fall of rain may be almost certainly anticipated in a degree greater as we approach the volcanic centre; but this branch of seismo-meteorology is as yet untouched. (p. 72)

.....

7th. The Magnetometer. Humboldt found, in the great earthquake of Cumana (4th Nov. 1799), the declination and magnetic intensity unaffected, but to his surprise the dip was diminished by 48 minutes. He had no ground to suppose an error.

With this solitary exception, in all the other earthquakes he experienced on the high lands of Quito and Lima, all the magnetic elements remained unaffected. (Relat. Hist., t.i. pp. 515, 517.)

These movements are of course totally different to those which have been observed by Arago, Biot, and repeatedly at Dublin by Dr. Lloyd, in their magnetic observatories, viz. oscillations suddenly affecting the magnetometers, and most probably due to the transmission of very small impulses from a distance through the earth, and having their origin in very distant earthquakes. Such must have been the cause of the simultaneous movements of the magnetometers of Arago at the Observatoire, and of Biot at the College de France some years since. Indeed it was found that at the moment a slight shock had been felt in Switzerland and southern France. Capocci, Director of the Observatory at Naples, relates that at the eruption of Vesuvius of Jan. 1st, 1839, the declination-needle was moved. (Poggend. Annal., b.l. p. 192; Comptes Rendus, t. ix. p. 735.) It is questionable, however, in all such cases, whether the motion be due to magnetism or to pulses communicated to the needle through the shaken ground; and hence special instruments would be desirable, formed to make the distinction.

"In many instances," says Von Hoff, "in which an opportunity of observing the magnetic needle during an earthquake has presented itself, an alteration in its direction for the time has been observed. The usual periodical oscillations (Abweichungs-Schwingungen) are quicker, or take place in a different direction, or are altogether interrupted. It is only in very modern times that great and regular attention has been devoted to the observation of the magnetic needle; consequently good observations of it made during earthquakes are as yet but few in number. The suddenness and unexpectedness of earthquake phenomena certainly render it difficult to obtain accurate observations made at the place where the earthquake occurs, if even the necessary preparations for such observations should be ready, which is to be expected from very few places. The greatest care and the most perfect and accurate instruments also are required for magnetical observations made at the place of the earthquake; the more especially since the shock itself, in proportion to its violence, may mechanically put the needle in motion, which motion is quite independent of that produced by magnetism.

"More remarkable however are the changes in the direction of the dip- and variation-needles, which take place at a distance from the place where the earthquake was observed, and at a place where the shock itself is not perceptible; as, for instance, in Paris, on the 19th of February and 31st of May 1822, simultaneously with an earthquake which occurred in Savoy and some of the southern parts of France. If this observation should be established by others carefully made, the existence could not be denied of a connexion between terrestrial vulcanism (Erd-vulcanismus) and terrestrial magnetism." (Gesch. Veran. Erdober, Th. iv.) It may be here remarked, that without self-registering seismometers and magnetometers, any correct or sustained observation of a connexion between these forces is impracticable. (pp. 72-73)

. . ..

9th. Meteors. "A somewhat nearer connexion may be supposed to exist between earthquakes and phenomena of this kind. These meteors belong to a class of phenomena proportionally seldom displayed by the atmosphere; yet they have been tolerably frequently observed to occur at the same time with

earthquakes. To this class belong the so-called globes of fire, and other extraordinary lights and illuminations (Entzundungen) in the regions of the air, which cannot be considered as belonging to the ordinary methods of electrical discharge."

Such meteors have been observed to occur contemporaneously with earthquakes in the years 95 B. C., and A. D. 893, 1001, 1325, 1640, 1674, 1683, 1703, 1737, 1752, 1756, 1810, 1820, 1821, 1822, 1824, 1828, 1829, 1831, 1833 and 1835.

Humboldt states, that just before the great earthquake of Riobamba, a great shower of meteors was seen at Quito (4th of Feb. 1797); that he was informed at Cumana, that just before the earthquake of 1766 a similar display had been seen; and on the 11th of November 1799; he and Bonpland witnessed such a phenomenon in close connexion as to time with the earthquake which then afflicted Cumana. (Per. Nar., vol. iii. p. 331; Cosmos, notes 44, 45.)

10th. The Aurora. This phenomenon, now so well ascertained to be in direct sympathy with terrestrial magnetism, has been often observed before and after earthquakes. I have found no instance in which it was remarked during an earthquake-shock, but it might then easily escape observation.

On the 19th and 20th of October 1848, during the New Zealand earthquake, the aurora was very bright in the south-east (the direction nearly towards which the shock travelled); but there was nothing to show any connexion, in this or in any other case, with the forces concerned directly in the shock.

If there be any real reaction upon the magnetometer for declination hereafter discovered, as due to volcanic action, and not traceable to secondary, electrical or other disturbance close to active vents (and nothing can be more possible than that the sudden movement beneath of great masses of fluid igneous rock, usually rich in iron, shall be found to have such reaction), then it may also be found that the aurora, that most airy and evanescent of all visible meteors, may have some direct, though probably slight relation to the most tremendous agency that the mechanism of our planet possesses.

11th. Other Atmospheric Phenomena. Under this head Von Hoff has placed together some curious facts. "I have already mentioned," says he, "that it seems to me more probable, that the changes going on in the interior of the earth exercise some influence on the atmosphere, than that the latter should in any way influence that process which seems to have its seat deep in the inner portions of the earth. As the globes of fire before spoken of may have their origin in peculiar gaseous exhalations, so it seems probable that other changes in the condition of the atmosphere may be produced by these terrestrial forces. Indeed, alterations in the ordinary state of the atmosphere have not unfrequently been remarked, which ought not too boldly to be ascribed to the influence of the earthquake. We have already noticed the observation, that the earthquake in Peru, in the year 1687, for a long time prevented the success of certain crops. There have also been strange colourings of the heavens and unusual fogs noticed as occurring at the same time with earthquakes; such as the unusual colour of the sky at Lisbon on the 1st of November 1755, and the dry fog (Nebel), which was so thick as to produce darkness, during the earthquake in Calabria in 1783. Since observations upon phenomena of this kind, made in modern times, deserve more confidence than those which are preserved in the older accounts, I do not consider it altogether superfluous to quote some instances in modern times of remarkable conditions of the atmosphere existing during earthquakes:---

"1824, 12th August.---In Tuscany. The sun appeared as it were veiled, and was more like the moon.

"1824, 30th November.---In Martinique. After the earthquake, the temperature of the air (which before had been very high) fell very considerably.

"1825, 19th January.---At St. Maura. Extremely heavy showers succeeded the earthquake, and lasted for several days.

"1826, 23rd November.---In the Ryrol. The violent wind which had existed before the earthquake, ceased during its continuance, and rose again after its termination.

"1827, 1st February.---In Naples. On the day of the earthquake, the air, which before had been very cold, suddenly became pleasantly warm.

"1827, 3rd June.---In Martinique. Rain immediately succeeded the earthquake, although none had fallen for sixty-six days before.

"1828.---In Peru. The most unusual and extremely violent rain, lasting four days, succeeded the earthquake in the district which had been most severely visited by it, namely at Truxillo, Lambeyeque, Chiclaya, Puira, and in the desert of Sechua.

"1830, 8th February.---At Agram. A fog, having a very bad smell, spread itself abroad, and lasted for three hours.

"1831, 3rd December.---At Martinique. Heavy showers of rain fell after the earthquake.

"1832, 18th October.---In Saxony. After the earthquake, the thick yellow fog, which had existed there for several days, suddenly dissipated itself, and the air, which before had been harsh, became mild.

"1834, 4th October.---At Bologna. After the earthquake, the air became suddenly cold.

"1835, 27th October.---In the Pyrenees. During the earthquake there rose clouds of hot air, which gave out a distinct smell of sulphur." (Von Hoff, Gesch, Veran. Erdober, Th. iv.) (pp. 74–75)

.....

23rd. Earthquakes occur which are accompanied by various sounds, having a subterraneous origin, and which may either precede, or accompany, or succeed, the occurrence of shocks, or precede, accompany, and succeed, the shocks of some of them; and again, earthquakes occur, even of the greatest violence, unaccompanied by any sound whatever.

The intensity of the sound is by no means in proportion to the violence of the earthquake. One of the most tremendous earthquakes on record, that of Riobamba, occurred, according to Humboldt, unaccompanied with any noise whatever.

The kind of sound has been very variously described, so variously as to induce the belief that there are different sounds on different occasions. Humboldt says ('Cosmos'), "It is either rolling, or rustling, or clanking, like chains being moved, or like near thunder, or clear and ringing as if obsidian or some other vitrified masses were struck in subterraneous cavities." One cannot but imagine that in the latter similitude the ear has borrowed its impression from the preconceived view of the author's mind.

Professor Krashenikoff, of St. Petersburg, in his description of Kamschatka, as translated by Dumaresque (1760), says, "Earthquakes happen here several times in the year. The most violent that was observed, was in the beginning of February 1759, which, during a westerly wind, lasted exactly six minutes; and before it a noise was heard and a strong wind underground, with a hissing which went from north to south." By some the sound has been directly compared to that of quenching a mass of red-hot iron in water. There was a shock of earthquake at Coningsby in Lincolnshire, in

England, on the 6th of February 1817, and also at Holderness near it, when it was heard "like waggons running away upon a road; and so forcible was the illusion, that waggoners on the roads actually drew up their teams to let the supposed runaway waggon pass them safely. While this was heard at Conings-by, they heard also at intervals of about a second of time, sharp and loud noises like the discharges of gunshots; and all gradually died away to a grumbling noise, which shifted from the east to the south." (Quart. Journal, vol. xviii.)

Hollow bellowings is a common expression with narrators. The describer of the New Zealand earthquake of 1848 (West. Rev., p. 397, for July 1849) says, "The earth is in a continual state of tremulousness, and the dull sound of the earthquake is continually heard. This sound has been much exaggerated; it is something like the sound of a railway train rumbling through a tunnel, I mean as heard by a person outside and near the mouth. I have also heard nearly a similar sound made by a very large steam ship chimney, except that the earthquake sound is less sonorous. It has been compared with distant thunder and with distant guns, but it is more rumbling in its nature; in short, it admits of no exact comparison. I have noted that when the shocks occur during a heavy gale, this dull rumbling sound is not perceptible: it is overcome by the nearer noise of the wind." (pp. 41-42)

GQE-011 [EARTHQUAKE LIGHTS AND ELECTRIC EFFECTS]

Anonymous; Nature, 6:89-90, May 30, 1872.

With reference to the connection between electricity and earthquakes, the Pall Mall Gazette quotes from a Californian paper, the Inyo Independent, the following curious statements respecting the prevalence of electrical phenomena at the time of the recent earthquake in that State:---"A few days after the big shock, so called, at Cerro Gardo, very loud thunder was heard during a violent snowstorm. With the exception of the snow, the same thing occurred here, and perhaps at other places in the valley. This is remarkable, because almost unprecedented. Immediately following the great shock, men whose judgment and veracity are beyond question, while sitting on the ground near the Eclipse Mines, saw sheets of flame on the rocky sides of the Inyo Mountains, but half a mile distant. These flames, observed in several places, waved to and fro, apparently clear of the ground, like vast torches. They continued for only a few minutes. In this office, one day last week, while one of the proprietors was running a large number of sheets of flat-cap paper through a job press, these sheets, after leaving the press, were affected by the movements of the operator's hand, as a strong magnet would affect iron filings. When his hand was near them, the whole pile, or at least a hundred of them from the top, seemed to float in the air, like tissue paper in a slight breeze. The top sheet would rise at each end up to the hand when held four inches above it, and thus by attraction be moved entirely away from the others. At times during the night sparks of fire were repeatedly emitted from a woollen shawl on being touched by the hand. At the Kearsarge Mill, located at an altitude of nearly 80,000 feet above the sea, the following occurrence was noted by Harry Clawson and P. J. Joslyn:---The former, while sitting with his knees within three inches of a castiron stove, felt a peculiar numbing sensation, and supposing his limbs were 'asleep,' essayed to rub them with his hand. As soon as his hand touched his knee he felt a shock, and immediately after, and for a couple of seconds, a stream of fire ran between both knees and the stove.

Obviously, it cannot be 80,000 feet, probably 8,000 is meant.

GQE-012 EARTHQUAKES AND THEIR CAUSES

Lake, John J.; English Mechanic, 21:51-52, April 2, 1875.

Only the summaries of the more unusual earthquake phenomena are presented below.

4. It has been observed that clouds have become fixed or suspended over particular spots affected, or about to be affected, by earthquake, as in London, in 1749, in Calabria, in 1783; and it is more than probable that the fog that enveloped Euphemia, in Sicily, in 1638, Millitello in 1693, and other places when they were destroyed arose from the operation of one cause.

5. Explosions of great violence frequently attend these convulsions, often with disastrous results. When Millitello was destroyed, there was a great explosion heard in the fog that enveloped it; traces were noticed afterwards as of the presence of fire on the rocks in the neighbourhood, and the vines in the country surrounding it appeared as though they had been seared by fire. A similar explosion was heard in 1783 at Castel Nuovo, in Calabria, when that place was overwhelmed.

7. Earthquakes are very frequently attended by thunder and lightning. At Munster, in 1612, thunder and lightning were heavy during an earthquake; and in Sicily, in 1693, it caused very great mischief. This conjunction of lightning with earthquake was noticed by Luke Howard, and constitutes what he designates "spurious earthquake." One of the cases he mentions occurred in Radnorshire: "At Knill Court the oscillation of the house was plainly perceptible, and felt by all the family, and that, too, in several apartments, and was accompanied by a peculiar rumbling noise. At Harpton, a severe storm of thunder and lightning was experienced the same night and at the same time."

8. Peculiar rushing noises have also at times been perceived, as in Staffordshire, in 1692, and London in 1749.

9. These convulsions are attended by the disturbance of the magnetic needle, and compasses on board ship are frequently for a time useless. On the 19th January, 1845, on the Thames steamer, during an earthquake in the West Indies, they revolved on their pivots with great rapidity; and on the 29th October, 1867, during a hurricane, there were shocks of earthquake at St. Thomas's, and the electrical disturbance was so great as temporarily to render the compasses unavailable.

.....

But by far the most prominent agent [in causing earthquakes] seems to be electricity, and the Italians, who suffer so much from these calamities, consider it to be the only cause. The evidences of the activity of the electric fluid in this respect are so palpable that they cannot be controverted. As some may be sceptical on this point, it will not be amiss to examine a few cases in which the operation of this agent is quite apparent.

When considering this part of the subject, we must not omit to notice the frequency with which the greatest weight of these calamities falls upon towns and the neighbourhoods of mountains. This is to be accounted for on the electric theory, from these places offering points for the escape of the fluid which naturally flies there to seek a thoroughfare, so to speak. From this cause we have St. Elmo's fire on the masts and yards of ships at sea, and De Saussure's experiences of the escape of the fluid from an Alpine peak. Hence we may infer that towns and mountains create centres of force in these convulsions.

.....

The earthquakes of 1692, in Jamaica, and 1693, in Sicily, present very strong evidences of general electric disturbance in the globe at those times. One evening in February, 1692, at Alari, in Sicily, the village seemed to the country people to be in flames. The fire, as they imagined, began by little and increased for about a quarter of an hour, when all the houses in the place appeared to be enveloped in one flame which lasted about six minutes and then began to decay, as from want of more fuel. Many who ran to render assistance, observed this increase as they passed along the road, but on entering the village found all to be a delusion. Such appearances of fire and light occur in other localities subject to earthquake, e.g., at Cowrie, Perthshire, one morning before daybreak, in 1842, the light is stated to have been so brilliant that birds were distinguished on the trees. Again in Sicily, about the 15th of May, following the incident at Alari, two hours before sunset, the atmosphere being very clear, the heavens appeared on a sudden all on fire, without any flashes of lightning or the least noise of thunder. This lasted at Syracuse about a quarter of an hour, when there appeared in the air over the city two bows, the colours extremely bright, after the usual manner, and a third with the extremities inverted, and, as not a single cloud was visible in any part of the sky, the abnormal state of the atmosphere is clear.

.....

The earthquake of London, 1749, also exhibited strong symptoms of electric action. The year abounded with thunder and lightning, coruscations frequently appeared in the air, and the aurora removed to the south, showing upon two occasions unusual colors. Dr. Stephen Hales heard a rushing in his house which ended in an explosion in the air as from a small cannon, and attributed it to the escape of the fluid by the steeple of the church of St. Martin's-in-the-Fields, adjoining. The Rev. J. H. Murray refers to the electrical disturbances on the east coast of South America, contemporaneous with the great earthquakes on the west coast in 1868, and considers them related. He describes one storm, just at the time of the earthquake, as giving "an idea of what the bombardment of Sebastopol must have been like."

The phenomena of seaquake are of a similar character. We have ourselves seen electric clouds thrown into auroral forms contemporaneously with the disturbance of the sea at another locality.

Examples might be extensively multiplied, but the above would seem sufficient to show that a leading cause of earthquake is electric action, and that volcanoes sometimes produce the same by direct convulsion, and at others by disturbing the electric equilibrium of a locality.

GQE-013 ACOUSTIC EMISSION PRIOR TO ROCKBURSTS AND EARTHQUAKES

Armstrong, Baxter H.; Seismological Society of America, Bulletin, 59:1259-1280, 1969.

Armstrong begins by noting that prior to many major earthquakes, animals have appeared highly disturbed.

For example, there are stories that dogs in Talcahuano, Chile, ran howling out of that city before the big Concepcion shock of 1835, that dogs in San Francisco whined during the night preceding the 1906 quake, and that the cries of dogs, cats, and cows awakened residents of Taal, Phillipines, shortly before an earthquake occurred there.

Although such stories are generally dismissed as folklore, Armstrong's paper investigates the possibility that vibrations prior to the quake may generate sound at frequencies that animals can hear but men cannot. His conclusion follows:

> We have explored the hypothesis that popular reports of animal agitation prior to earthquakes might result from their detecting high-frequency sound emission from preliminary fracturing. Since such preliminary emission has been observed in the laboratory up to a megacycle or more and in nature up to a few kilocycles, it is very likely that high frequency sound may be emitted from highly strained regions prior to earthquakes. However, estimates of its range using laboratory Q-values show this to be so short that it is not likely to be detected by animals or instruments, but it cannot be ruled out for earthquakes involving surface rupture, or earthquakes with rupture occurring into a body of water. ..... In particular, sound channels might be formed along foci of high stress.

GQE-014 THE NEW MADRID EARTHQUAKE

Shepard, E. M. ; Journal of Geology, 13:45-62, February 1905.

The New Madrid earthquake of December 16, 1811, severely ravaged an area of the Midwest some 200 miles long by 30 miles wide. Evidently powerful compressive forces were created.

> There seemed to be a blowing out of the earth, bringing up coal, wood, sand, etc., accompanied with a roaring and whistling produced by the impetuosity of the air escaping from its confinement.

GQE-015 REPORT ON THE FACTS OF EARTHQUAKE PHENOMENA

Mallet, Robert; Report of the British Association, pages as noted, 1852.

> November 4, 1704; at Zurich and the country round. Two violent shocks. Preceeded by a brilliant meteor in the air. At the same time there was a violent storm of thunder, lightning and wind at Bale, where however no shock was felt. (p. 110)

> December 21, 1731; at Naples and in La Duglia. Shorter and less violent than the last [earthquake]. The heavens were clear, but the sun appeared pale as if obscured by a thin vapor. Before this earthquake the inhabitants of the Terra-di-Bari perceived around Monte Gargano a sort of flame like sudden lightning, which vanished in smoke..... (p. 128)

> October 21, 1731; [various towns in England]. Another shock, ... The windows were shaken violently. Followed, one minute after, by brilliant lightning at Aynho. The day after, the sky appeared the colour of earth. (p. 129)

> December 9, 1731; Florence. A slight shock. The same day a luminous cloud was seen, driven with some violence from E. to W., where it disappeared below the horizon. This phenomenon is said to have been quite different from

an aurora borealis. (p. 129)

March 19, 1750; London [and environs]. Three or four consecutive shocks in the space of 10 or 12 secs..... Preceded by a loud noise compared by some to thunder, by others to the roaring of the wind, and moving in the direction, according to some, of S. E. to N. W. or W.; according to others, of W. to E., N. W. to S. E. or vice versa. This noise (compared to that of a carriage in motion) was heard at one or two places where no shock was felt. A black cloud with continual and confused flashes of lightning had been visible, the latter ceasing a minute or two before the earthquake..... Dogs howled dismally, fishes threw themselves out of the water, and a horse that was brought to the watering-place refused to drink. One person felt himself turned on his feet by the shock. (p. 146)

Mallet's catalog, which is published in several volumes of the Report of the British Association, lists many other concurrent atmospheric phenomena. The earthquake sounds are, of course, easy to understand, but the mechanisms behind earthquake lights and the apparent physiological effects are unknown---if they truly exist at all.

GQE-016 EARTHQUAKE-ASSOCIATED SKY LUMINESCENCE

Gillmor, Daniel S., ed.; Scientific Study of Unidentified Flying Objects, Bantam Books, Inc., New York, 1969.

Intense electrical activity has often been reported prior to, during, and after earthquakes. Unusual luminescent phenomena seen in the sky have been classified into categories: (1) indefinite instantaneous illumination: (a) lightning (and brightnings), (b) sparks or sprinkles of light, (c) thin luminous stripes or streamers; (2) well-defined and mobile luminous masses: (a) fireballs (ball lightning), (b) columns of fire (vertical), (c) beams of fire (presumably horizontal or oblique), (d) luminous funnels; (3) bright flames and emanations: (a) flames, (b) little flames, (c) many sparks, (d) luminous vapor; (4) phosphorescence of sky and clouds. The classification is somewhat ambiguous, but is rather descriptive of luminous events associated with earthquakes.

The earliest description of such phenomena was given by Tacitus, who describes the earthquake of the Achaian cities in 373 B. C. E. Japanese records describe luminous effects during many severe earthquakes. In the Kamakura Earthquake of 1257, bluish flames were seen to emerge from fissures opened in the ground.

Flying luminous objects are mentioned in connection with the earthquake at Yedo (Tokyo) during the winter of 1672. A fireball resembling a paper-lantern was seen flying through the sky toward the east. During the Tosa earthquake of 1698, a number of fireballs shaped like wheels were seen flying in different directions. In the case of the Great Genroku Earthquake of 31 December 1730 in Tokaido, luminous "bodies" and luminous "air" were reported during the nights preceding the day of the severest shock. Afterwards a kind of luminosity resembling sheet lightning was observed for about 20 days, even when there were clouds in the sky. One record of the Shinano Earthquake of 1847 states: "Under the dark sky, a fiery cloud appeared in the direction of Mt. Izuna. It was seen to make a whirling motion and then disappeared. Immediately afterward, a roaring sound was heard, followed by severe earthquakes." In Kyoto in August, 1830, it is reported that during the night preceding the earthquake luminous phenomena were seen in the whole sky; at times, illumination emitted from the ground was com-

parable in brightness to daylight. In the Kwanto Earthquake of 1 September 1923, a staff member of the Central Meteorological Observatory saw a kind of stationary fireball in the sky of Tokyo.

The earthquake at Izu, 26 November 1930, was studied in detail for associated atmospheric luminescence. Many reports of sightings were obtained. The day prior to the quake, at 4 p.m., a number of fishermen observed a spherical luminous body to the west of Mt. Amagi, which moved northwest at considerable speed. Fireballs (ball lightning) and luminous clouds were repeatedly observed. A funnel-shaped light resembling a searchlight was also seen. Most witnesses reported pale blue or white illumination, but others reported reddish or orange colors.

That large electrical potentials can be created by the slippage or shearing of rocks is not surprising. Nevertheless, associated ball lightning and luminous clouds are of significance to this study. Of possible importance is the use of electrical measurements to provide some advance warning of an impending earthquake. (pp. 740–741) (Martin D. Altschuler)

GQE-017 NOTE ON EARTHQUAKES IN CHINA

Macgowan, D. J.; Nature, 34:17–19, May 6, 1886.

The tremors that are experienced in Chehkiang, Kiangsu, and coterminus regions to the west, are sometimes followed by the appearance on the ground of substances that in Chinese books are styled "white hairs." When I first called attention to records of that kind that are found in local gazetteers, I suggested that they might be crystals precipitated by gaseous emissions, such as were once reported as occurring after an earthquake in the south-west of the United States; from later descriptions of these "horsetail-like" substances I incline to the opinion that they are organic, perhaps mycillium.

In the summer of 1878 the vernacular press gave an account of the occurrence of the phenomenon at Wusoh, a city on the grand canal, thirty miles north of Suchau. "At noon, June 12th of that year, shocks of an earthquake were experienced, which lasted several minutes (Sin. 'the space of time taken in swallowing half a bowl of rice'); the motion was so great that sitting or standing was difficult but no harm was done. Two days later at night there was a severer shock, after which, within and without the walls of the city, white hairs resembling a silvery beard, about three inches in length, were found, which boys pulled out of the ground, gathering handfulls in a short space of time " My list of Chinese earthquakes for the past two thousand years having been destroyed by fire I am unable to indicate the regions in which earthquakes were followed by the emission of "hairs," but my impression is that all, or nearly all, are alluvial valleys.

GQE–018 COLLECTION OF HAIRS AFTER EARTHQUAKES IN CHINA

Dyer, W. T. Thiselton; Nature, 34:56–57, May 20, 1886.

Dyer begins by quoting most of Macgowan's discussion on "earthquake hairs" as presented in GQE-017. Then, he gives his views:

I think there can be little doubt that Dr. Macgowan's conclusion is well founded,

and that the "white hairs" have no real connection with the earthquake.

In 1852, during one of the late Mr. Fortune's visits to China, he experienced the shock of an earthquake at Shanghai. He gives the following curious account in "A Residence among the Chinese" (pp. 4, 5), of the subsequent search for the hairs:--

"Groups of Chinese were seen in the gardens, roadsides, and fields engaged in gathering hairs which are said to make their appearance on the surface of the ground after an earthquake takes place. The proceedings attracted a great deal of attention from some of the foreign residents in Shanghai, and the Chinese were closely examined upon the subject. Most of them fully believed that these hairs made their appearance only after an earthquake had occurred, but could give no satisfactory explanation of the phenomenon, while some, more wise than their neighbors, did not hesitate to affirm that they belonged to some huge subterraneous animal whose slightest shake was sufficient to move the world.

"I must confess, at the risk of being laughed at, that I was one of those who took an interest in this curious subject, and that I joined several groups who were searching for these hairs. In the course of my travels I have ever found it unwise to laugh at what I conceived to be the prejudices of a people simply because I could not understand them. In this instance, however, I must confess the results were not worth the trouble I took. The hairs, such as I picked up, and such as were shown to me by the Chinese, had certainly been produced above the earth and not below it. In some instances they might readily be traced to horses, dogs, and cats, while in others they were evidently of vegetable origin. The northeastern part of China produces a very valuable tree known by the name of the hemp-palm [Chamaerops Fortunei, see Kew Report, 1880, p. 31], from the quantity of fibrous bracts it produces just under its blossoms. Many of these fibres were shown to me by the Chinese as a portion of the hairs in question; and when I pointed out the source from which they had come, and which it was impossible to dispute, my friends laughed, and, with true Chinese politeness, acknowledged I was right, and yet I have no doubt they still held their former opinions concerning the origin of such hairs. The whole matter simply resolves itself into this: if the hairs pointed out to me were the true ones, then such things may be gathered not only after earthquakes, but at any other time. But if, after all, these were not the real things, and if some vegetable (I shall not say animal) production was formed, owing to the peculiar condition of the atmosphere and from other causes, I can only say that such production did not come under my observation."

GQE-019 [QUAKE AND THUNDERSTORM]

Anonymous; Nature, 33:18, November 5, 1885.

On October 9, between 9 and 10 a.m., two severe shocks of earthquake were felt on the Lis Island, in the parish of Sorunda, in Sweden. In the school-house, while teaching was going on, two severe shocks were felt like two blows from an enormous hammer in the northwestern corner of the building. In this corner the windows rattled, the floor swayed, and rumbling like that of distant thunder was heard. Simultaneously a great thunderstorm passed over the district, accompanied by heavy rain. It has, however, been ascertained beyond doubt that the shocks were not due to the former, as the shocks were felt by many persons out of doors. The earthquake went from west to east.

SECTION GS: SOUND PHENOMENA

With so many jets aloft and the other sounds of modern technology, man can conveniently ascribe anything he hears to one machine or another. Nevertheless, concealed in the noisy background there are many detonations, hums, swishes, and even musical sounds that are not man-made. These are divided into the following categories.

GSD Strange detonations. Explosive sounds, apparently from nowhere, often localized with long histories. Examples: the Barisal Guns, the Seneca Guns, water guns of Lough Neagh, etc. Correlation of some with earthquakes, meteors, and whirlwinds.

GSG Infrasonic sound. Association with storms and auroras. Physiological effects.

GSH Hums, hisses, etc. Unexplained hums heard in many localities. Yellowstone Lake "whispers," brontophonic sounds. Correlation with meteors and auroras. Possible effects of electromagnetic waves on human perception.

GSM Music, bells, etc. Odd oceanic sounds. Bell of Nakous. Cry of Memnon.

This page reserved for the expansion of the preceding categories in future volumes.

GSD-001 "BARISAL GUNS" AND "MIST POUFFERS"

Darwin, G. H.; Nature; 52:650, October 31, 1895.

Much of the information on mysterious detonations was published in Nature in response to the following letter from George H. Darwin, the son of Charles. Although Darwin associates the Barisal Guns and mistpouffers, they may, of course, have entirely different origins.

In the delta of the Ganges, dull sounds, more or less resembling distant artillery, are often heard. These are called "Barisal guns"; but I do not know the meaning of the term. The object of this note is to draw the attention of the readers of Nature to this mysterious phenomenon, and to the similar "mist pouffers" of the Belgian coast.

My attention was for the first time drawn to the subject some days ago by a letter from M. van der Broeck, Conservator of the Museum of Natural History of Belgium. He writes of certain "curious aerial or subterranean detonations, which are pretty commonly heard, at least, in Belgium and in the north of France, and which are doubtless a general phenomenon, although little known, because most people wrongly imagine it to be the sound of distant artillery.

"I have constantly noticed these sounds in the plain of Limburg since 1880, and my colleague of the Geological Survey, M. Rutot, has heard them very frequently along the Belgian coast, where our sailors call them 'mist pouffers' or fog dissipators.

"The keeper of the lighthouse at Ostend has heard these noises for several years past; they are known near Boulogne, and the late M. Houzeau spoke of them to my friend M. Lancaster. More than ten of my personal acquaintances have observed the fact.

"The detonations are dull and distant, and are repeated a dozen times or more at irregular intervals. They are usually heard in the day-time when the sky is clear, and especially towards evening after a very hot day. The noise does not at all resemble artillery, blasting in mines, or the growling of distant thunder."

M. van der Broeck, after referring to the "Barisal guns," says that he was disposed to regard the noises as due to some peculiar kind of discharge of atmospheric electricity. "But my colleague M. Rutot believes the origin to be internal to the earth. He compares the noise to the shock which the internal fluid mass might give to the earth's crust."

Mr. Clement Reed has informed M. van der Broeck that he believes similar noises are heard on Dartmoor, and in some parts of Scotland. I was not previously aware of anything of the kind in these islands.

Before any systematic observations are undertaken, it will be useful to form some general idea of the frequency of these sounds and of their geographical distribution.

Will any of the numerous readers of Nature in various parts of the world give us an account of their experiences in this matter?

GSD-002 "BARISAL GUNS" IN WESTERN AUSTRALIA

Cleland, J. Burton; Nature, 78:101-102, June 4, 1908.

Responding to Sir George Darwin's request for further reports of Barisal Guns and mistpouffers, Cleland related in this letter to Nature how he and his companions were dispatched by the government of Western Australia on an expedition to the area of the Strelley River. The time was August 9, 1907, 8:35 P. M.

> .....I was lying in the tent when, in the words of my diary, we suddenly heard a dull roar lasting several seconds, increasing in loudness and then decreasing. Everyone heard it and looked around. The sky was quite clear, and there were no signs of thunder clouds. There was no apparent tremor. I thought the noise came from the S. E., others from the N. E. Some suggested it was the rumble of a herd of cattle galloping over a clay pan with hollow ground beneath, as they hear similar noises in the Kimberley District (W. Australia)..... Next day "some men camped twenty miles west from here inquired if we had heard the rumble last night; it appears their Afghans jumped up and said "buggy coming." .....
>
> The sound resembled a distant, prolonged peal of thunder or the discharge of a far-away piece of ordnance or mine explosion. The nearest working mines would be about sixty miles away, the sea about fifty miles, and it is needless to say there is no artillery within hundreds of miles. No noticable meteor was seen by anyone, and had the noise been due to this, would it have been heard at places twenty miles apart? It might have been due to an earthquake,but no tremor was noticed.
>
> I have heard from eye-witnesses of dull sounds resembling this being heard in the Kimberley district of this State. At the time, a black fellow said, "Hill tumble down," and next day they found that great masses of rock had fallen.

As subsequent entries in this section will show, the prolonged rumbling described in this report is more akin to seismic or meteoric sounds than Barisal Guns or mistpouffers. The rising and falling of the sound and its seeming elusiveness reminds one of the Yellowstone Lake sounds and the Haitian gouffre.

GSD-003 BARISAL GUNS

Schurr, Henry S.; Nature, 61:127-128, December 7, 1899.

During most of 1890 and 1891, Schurr was a District Superintendent of Police in the Bengal area of what is now Bangladesh. In his official capacity he travelled widely throughout the Ganges Delta. Excerpts from his report to the Geological Surveyor-General follow.

> Barisal Guns are heard over a wide range extending from Twenty-four Pergunnahs through Khulna, Backergunge and Noakhali, and along the banks of the Megna to Naraingunge and Dacca. They are heard most clearly and frequently in the Backergunge district, from whose headquarters they take their name.
>
> These Guns are heard most frequently from February to October, and seldom in November, December or January. One very noticable feature is their absence during fine weather, and they are only heard just before, during, or immediately after heavy rain.
>
> The direction from which they are heard is constant, and that is the south or south east. I have heard them west of me when down in the extreme south of the district, but never north of me. I have been told by captains of river-going

steamers that they have heard these reports to their north. These gentlemen, however, ply along waters outside the range of my observations, which lie on the mainland and its adjacent waters.

These Guns are always heard in triplets, i.e. three guns are always heard, one after the other, at regular intervals, and though several guns may be heard the number is always three or a multiple of three. Then the interval between the three is always constant, i.e. the interval between the first and the second is the same as the interval between the second and the third, and this interval is usually three seconds, though I have timed it up to ten seconds. The interval, however, between the triplets varies largely, from a few seconds up to hours and days. Sometimes only one series of triplets is heard in a day; at others, the triplets follow with great regularity, and I have counted as many as forty-five of them, one after the other, without pause.

The report is exactly like the firing of big guns heard from a distance with this peculiar difference, the report is always double, i.e. the report has (as it were) an echo.....

The report varies little in intensity, and I cannot recollect that there was much difference in the sound, whether heard at Barisal itself or some 70 or 80 miles to the south at the extreme end of the district. The state of the atmosphere may affect it, but to no appreciable extent.

The following two paragraphs are from Schurr's letter of transmittal to Nature.

It is well known to all navigators of these waters there is a peculiarly deep depression to the south of the delta, which either has never been sounded, or, if sounded, has shown a most unaccountable depth, and it is assumed that these reports emanate from this depression. But I am not inclined to accept this as a sufficient explanation, as the sounds are so very irregular in their frequency....

There are two special occasions to which I would draw attention: the first in February, 1891, when from the southernmost outpost, Chaltabuni, I followed the reports for some forty miles out to sea; the second, mentioned in my letter to the Surveyor-General of Bengal, when, in August, 1894, for more than six hours, I followed the reports without getting any appreciably nearer, and also never hearing them to the north of me.

The triplet feature of the Barisal Guns reported by Schurr is most intriguing, but it is not confirmed in Scott's account (GSD–011). Nevertheless, triplets of strange detonations seem rather common all over the globe, as reports in this section will confirm. This regularity and the echo structure noted by Schurr seem to preclude a seismic origin.

The apparent seasonal nature and correlation of the Barisal Guns with storms are also curious. The latter observation would seem to separate the Guns from the mistpouffers, which are primarily fair-weather phenomena. Wave action seems ruled out as a source, too, because Schurr followed the Guns forty miles out into the Bay of Bengal.

GSD-004 THE BARISAL GUNS AND SIMILAR SOUNDS

Godwin-Austen, H. H.; Nature, 53:247-248, January 16, 1896.

The question, I think, arises, Are we not dealing, in India at least, with

two very different phenomena? Are these sounds like that of heavy ordnance, which are heard occasionally at the base of the Eastern Himalayas and the Garo and Khasi Hill Range, the same as those longer known and more familiar as the "Barisal Guns?" Mr. Scott's description of the sounds he heard when on board the steamer moored in the narrow channels near the sea, are remarkably like wave action. He says: "Sometimes a single report, at others two, three or more in succession, never near, always distant, but not equally distant. Sometimes the reports would resemble cannon from two rather widely separated opposing forces, at others from different directions but apparently always from the southward, that is, seaward." This is precisely what one would hear on a still night, when an ocean swell was coming up the Bay of Bengal and breaking all along a low shore with an undulating outline stretching many miles east and west.

Regarding the distant booming reports, that are heard further inland, I was, I think, one of the first to notice and put them on record. In the Proceedings of of the Asiatic Society of Bengal, March 1869, vide "Notes from Asaloo, North Cachar, on the Great Earthquake of January 10, 1869," after giving some details of the daily shocks that were recorded up to the 17th of that month, I find the following on p. 98. "Very noteworthy is the distant report of a heavy gun on January 19, heard towards the west at 1h. 49m. 19s. p.m. (I was sitting at work at a table outside the office tent); the time I took immediately by chronometer, as I fully expected a shock to follow. Another very loud explosion was heard from Mahadeo Peak at midnight of the 29th, and again from the same peak at 7 a.m. the next morning, the 30th; but no shock came after, on either occasion.

.....

"These subterranean explosions must be heard over large areas, and it would be interesting if they could be noticed, or rather if those hearing them would make the matter public; I have no doubt there are many individuals who will remember having heard such sounds." The reports like big guns, "top chalta," as the natives expressed the sound, heard at Asaloo in January, during a period of great seismic activity, were, I consider, intimately connected with it; and that the similar reports, solitary instances not continuous, heard in the previous year at different places in the same range, were also of a subterranean nature. Seismic sounds are not always accompanied by a disturbance of the earth conveyed to the senses. I find in my journal the following:

"Nongtung, in Jaintia Hills, December 21, 1887."

"While seated at dinner, a curious rumbling sound was heard in the west. Mr. Ogle immediately said, 'that is the rumble of an earthquake,' and we waited with intense expectation for several seconds for the shock, I with my watch out ready to take its duration; but it never came. We then thought it might have been a herd of elephants coming up the ridge, and, disturbed by our camp fires, had rushed off through the jungle; but on going into Jawai on Christmas Day, we learnt that a shock had been felt there on the same date and time, and that it apparently came from the west."

The best-defined unaccountable sound occurred when I was surveying the Bhutan Dooars in the spring of 1865. I have some remembrance of putting it on record at the time, perhaps in my annual report. I was standing at the plane-table in the forest twelve miles south-west of Buxa, when the report of a heavy gun was heard in the direction of the mountains, clear and distinct, yet a long way off, followed closely and at irregular intervals by two other discharges.

GSD-005 [UNEXPLAINED DETONATIONS IN ENGLAND]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

In the London Times, Nov. 9, 1858, a correspondent writes that, in Cardiganshire, Wales, he had, in the autumn of 1855, often heard sounds like the discharges of heavy artillery, two or three reports rapidly, and then an interval of perhaps 20 minutes, also with long intervals, sometimes of days and sometimes of weeks, continuing throughout the winter of 1855-56. Upon the 3rd of November, 1858, he had heard the sounds again, repeatedly, and louder than they had been three years before. In the Times, November 12, someone else says that, at Dolgelly, he, too, had heard the "mysterious phenomenon," on the 3rd of November. Someone else--that, upon October 13, he had heard the sounds at Swansea. "The reports, as if of heavy artillery, came from the west, succeeding each other at apparently regular intervals, during the greater part of the afternoon of that day. My impression was that the sounds might have proceeded from practicing at Milford, but I ascertained, the following day, that there had been no firing of any kind there..... (p. 407)

GSD-006 COMMENTS ON ROCK BURSTS, OUTBURSTS, AND EARTHQUAKE PREDICTION

Osterwald, Frank W.; Seismological Society of American, Bulletin, 60:2083-2085, December 1970.

Compiler's Summary: Undoubtedly many mysterious detonations have seismic origins, particularly the Moodus Sounds and the explosions heard so frequently at Comrie, Scotland. This paper gives a physical basis for seismic origins; namely "rockbursts." A rock burst is defined as "a sudden and often violent failure of masses of rock in quarries, tunnels, and mines." Powerful internal stresses cause the explosive failure of the rock, which may be accompanied by "shocks, rock falls, and air concussions." The likelihood of explosive failure is, of course, increased when mining operations remove rock that was previously helping to contain the stresses. In mining areas, rock bursts are also called outbursts, bumps, pillar bursts, pounces, and other such descriptive names.

GSD-007 ON EARTHQUAKE-SOUNDS

Davison, Charles; Philosophical Magazine, 5:49:31-70, 1900.

In this classic paper, Davison, a noted English seismologist, described the detonations and rumblings heard by Humboldt in Mexico. See also GSD-032.

Lastly, a very remarkable serious of earth-sounds is that described by Humboldt as the subterranean thunder of Guanexuato, a city on the Mexican plateau far removed from any active volcano. "The noise," he says, "began about midnight on the 9th of January, 1784, and continued for a month..... From the 13th to the 16th of January, it seemed to the inhabitants as if heavy clouds lay beneath their feet, from which issued alternate slow rolling sounds and short quick claps

of thunder. The noise abated as gradually as it had begun. It was limited to a small space and was not heard in a basaltic district at a distance of a few miles." "Neither the surface of the earth, nor in mines 1600 feet in depth was the slightest shock to be experienced. No similar noise had ever before been heard on the elevated table-land of Mexico, nor has this terrific phenomenon since occurred there.

The quotations above were probably extracted from Humboldt's treatise Cosmos.

GSD-008 NOTES ON REMARKABLE EARTHQUAKE SOUNDS IN HAITI

Scherer, J.; Seismological Society of America, Bulletin, 2:230-232, 1912.

The sounds are described variously as resembling the noise of a "heavy wagon passing over pavement, of thunder rolling in the distance, of dynamite exploding or of cannon being fired off, of water falling on dry leaves, of the wind blowing through high forest trees in a tempest. Yet all these different sounds may be heard without any appearance of storm."

The region where the gouffre appears to be most commonly heard is the range of La Selle, which is of Tertiary limestone, lies in an east to west direction, and has a mean altitude of 2200 meters. The region is very unstable, and the mountains give much evidence of past volcanic activity..... On the north the range is bordered by a steep cliff along the line of dislocation caused by the subsidence of the northern plain. This displacement is believed to be constant though slow and imperceptible, and the noises may be caused by these adjustments or brady-seisms. The sounds are apparently the same as those accompanying noticable earthquakes, and the people of Haiti apply the name gouffre to both.....

.....

The vicar at Croix-des-Bouquets, ten to fifteen miles north of the range of La Selle, gives a very interesting account: "From November 7 to 13, 1911, the sound of the gouffre was heard every day, but it was very different at night from what it was in the daytime. During the day the sound was heard from the southeast, and seemed to come from a great depth. It was like a deep roaring, and then at times like the howling of a dog. From time to time it stopped with a hollow boom, which might be taken for a distant cannon-shot. According to the inhabitants the noises were simply warnings of earthquakes or of some other disaster; sometimes they were thought to be connected with the weather. It was frequently said that the gouffre had not been heard so distinctly for a long time, nor in a manner so prolonged and persistent, as during the three weeks that had just passed. During the night it was different, although the sound came from the same direction: there was a perfect tumult; rumbling of thunder, howling, and a sound like the rushing of a strong wind. There was no wind, however. Sometimes one heard all the noises at once. Generally, and above all from seven to ten o'clock at night, the sound ended with a loud detonation much stronger than in the day, followed by a long echo. Then again would be heard an outburst that can not be imagined. It was as if a mountain of glass were shattered, and the noise seemed echoed in all directions. At times it seemed as if one could hear the roar of surf or even the dead thud of objects falling, such as blocks of stones rolling down precipices. During the night there was something very sinister in these phenomena. The same things were observed at Grand-Bois and Post-Gobert in the district of Mirebalais."

It also appears from this correspondence that the gouffre is heard in the northwestern part of the island at Port-de-Paix and at Limonade, for instance. At

Port-de-Paix the sounds seem to come from some place in the St. Nicolas mountains, and at Limonade they come from Monte Christi, to the east. At the latter places, however, the phenomena of the gouffre seem much less considerable than in the range of La Selle.

GSD-009 [THE MELIDA DETONATIONS]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941, p. 394.

Melida (sometimes spelled Meleda), like Comrie, Scotland, has been a focal point for long outbreaks of cannonading, all seemingly of a seismic origin. Fort picked up the following description from the Quarterly Journal of the Royal Institute, 20:417.

> That, early in the morning of March 20, 1822, detonations were heard at Melida, an island in the Adriatic. All day, at intervals, the sounds were heard They were like cannonading, and it was supposed that they came from a vessel, or from Turkish artillery, practicing in some frontier village. For thirty days the detonations continued, sometimes thirty or forty, sometimes several hundred, a day.

GSD-010 SUBTERRANEAN SOUNDS HEARD IN THE WEST INDIES

Templeton, E. C.; Seismological Society of America, Bulletin, 5:171-173, 1915.

> In the Bulletin Semestriel de L'Observatoire Meteorologique Seminaire-college St. Martial, Port-au-Prince, Haiti, January-June 1914, are some interesting notes concerning the rumbling sound, popularly known as the "gouffre," which is heard frequently in the West Indies. There appears to be a difference of opinion as to its cause, some claiming that the sound is related to seismic disturbances.
>
> Mr. Maxwell Hall, British government meteorologist at Jamaica is authority for the following:
>
> In 1835, at the time of the eruption of Coseguina (a volcano on the west coast of Nicaragua), noises like those of a cannonade were heard at Jamaica, 700 English miles away.
>
> At the beginning of January 1907, before the great earthquake of January 14th of that year, similar noises were heard at Mandeville and in other parts of the parish of Manchester, and at certain places in the parish of St. Elizabeth. They were heard several times at the same places, and were mistaken for noises of distant thundering or of the firing of large caliber cannon.
>
> At 8:30 a.m., December 3, 1907, distinct rumblings were heard at Kings-Valley, Westmoreland. They seemed to come from a chain of high mountains to the north. No shock was felt.
>
> Noises like the sound of enormous waves on the shore were heard at Kings-Valley, Westmoreland, at 10 p.m., January 15, 1908. They came from the north, and lasted thirty or forty minutes.

.....

Father J. B. Julio, curate at Pilate, states that:

A hollow sound as of distant thunder was heard from time to time on the heights of Pilate between 4:00 and 9:00 a.m. on July 15th. The weather was calm and favorable to the distinct perception of this noise. To the observant this is merely the sound of waves which, rushing into the caverns of the sea of Borgne, produce the "gouffre" a noise which is echoed from mountain to mountain. But the people of Borgne maintain that it is produced in the sea by millions of little fishes.

.....

Notes from Canon L. M. Caze at Ganthier, Fonds-Verrette, describe:

Certain gaping pits of great depth near Fonds-Verrette, Bois Tombe and Ravine Contree from which strange sounds, as though produced by explosions, escape periodically at the approach of the rainy season of the year, and sometimes also during the dry season when strong winds are blowing. The explosions are said to be followed by the escape of great jets of white vapor from the pits and to be accompanied by a violent trembling of the ground within a radius of 500 or 600 meters. There is evidently some superstition connected with these pits, since it is claimed that objects cast into the pit one day have been found on the following day lying on the ground near the pit's mouth.

GSD—011 BARISAL GUNS

Scott, G. B.; Nature, 53:197, January 2, 1896.

I first heard the Barisal Guns in December 1871, on my way to Assam from Calcutta through the Sunderbans. The weather was clear and calm, no sign of any storms. All day the noises on board the steamer prevented other sounds from being heard; but when all was silent at night, and we were moored in one or the other of the narrow channels in the neighborhood of Barisal, Morelgunge and upwards, far from any villages or other habitations, with miles and miles of long grass jungle on every side, the only sounds the lap of water or the splash of earth, falling into the water along the banks, then at intervals, irregularly, would be heard the dull muffled boom as of distant cannon. Sometimes a single report, at others two, three, or more in succession; never near, always distant, but not always equally distant. Sometimes the reports would resemble cannon from two rather widely separated opposing forces, at others from different directions but apparently always from the southward, that is seaward. We were not very far from the sea when I first heard them, and on mentioning to an old lady on board that I heard distant cannon, she first told me of the mysterious sounds known as the "Barisal Guns."....

I specially remember spending a quiet Sunday, in the month of May, with a friend at Chilmari, near the river-bank. We had both remarked the reports the night before and when near the hills previously. About 10 a.m. in the day, weather clear and calm, we were walking quietly up and down near the river-bank, discussing the sounds, when we heard the booming distinctly, about as loud as heavy cannon would sound on a quiet day about ten miles off, down the river. Shortly after we heard a heavy boom very much nearer, still south. Suddenly we heard two quick successive reports, more like horse-pistol or musket (not rifle) shots close by. I thought they sounded in the air about 150 yards due west of us over the water. My friend thought they sounded north of us. We ran to the bank, and asked our boatmen, moored below, if they heard them, and if so in what direction. They pointed south!

.....

The year previous I had discussed the sounds with Captain Stewart, of the Survey of India Department, who had some years previously been employed on the Survey of the Sunderbans tracts. He said the reports were heard all over the Sunderbans; that several experts had failed to account for them. He once had a theory that they were caused by submarine eruptions in the Bay of Bengal; but this would hardly account for them 300 miles distant, and I believe they are never heard out at sea in the bay.

Scott made the above observations while serving on the Indian Survey. He contradicts Schurr (GSD–003) on three accounts: (1) he claims the Guns are heard in clear, calm weather (like the mistpouffers); (2) he states that the Guns are not always triplets; and (3) he had never heard of them being heard out on the Bay of Bengal.

GSD-012 CURIOUS AERIAL OR SUBTERRANEAN SOUNDS

Van den Broeck, Ernest; Nature, 53:30, November 14, 1895.

Van den Broeck notes below that the mistpouffers must not be considered merely a local phenomenon. Strange detonations are heard worldwide, and many of them appear to be associated with water.

This year the mysterious detonations were heard up to the end of September, and even up to the beginning of October, not only by me but by several of my friends and correspondents; this is much later in the year than usual. Now great and unusual heat prevailed this year during the whole autumn, and this coincidence affords a strong support to the theory of an origin arising from certain conditions of rise of temperature.

Sailors of the port of Ostend assert that "Mistpouffers" prevail over the whole of the North Sea as far as Iceland, and they consider them to be a sign of fine weather, with calms and heat.

GSD-013 [RETURN OF THE MOODUS SOUNDS]

Anonymous; The Fortean Society Magazine, 1:7, October 1941.

The following was ascribed to the Buffalo Evening News of March 2, 1940.

The mysterious "Moodus noises" have returned. At irregular intervals since colonial days, this region [Connecticut] has been shaken by sharp earth shocks and dull booming sounds have echoed throughout the countryside. No one has been able to explain them and even the Indians were mystified.

They thought the place so peculiar, they gave it its name meaning "the place of strange noises." Shortly before midnight the noises came back. Loud rumblings were heard and houses trembled. Townspeople were awakened. There was no damage. Scientists for years have been endeavoring to explain the cause of the noises which last were heard eight years ago.....

GSD-014 EARTHQUAKE IN CONNECTICUT

Anonymous; American Journal Of Science, 1:39:335-342, 1840.

The famous Moodus Sounds seem to have occurred as long as white men have lived in Connecticut--perhaps much longer. Their nature points to a seismic origin; but the historical trappings are curious.

What we have at our disposition shall be devoted to a scene of local disturbance in Connecticut which has been observed ever since the settlement of the country. The region is around East Haddam, on the Connecticut river, a few miles below Middletown. The following memorandum was by request communicated to the senior editor of this Journal twenty five years ago, by the late Rev. Henry Chapman, and it has been kept on file with the expectation of making an investigation on the spot; but, as that which has been so long delayed may never be done, we are induced to give the fragment on the present occasion.

"In attempting to give an account of the circumstances attendant on subterranean noises, so frequently heard at East Haddam, perhaps it may be proper to mention the common opinion respecting them.

"East Haddam was called by the natives Morehemoodus, or place of noises, and a numerous tribe of cannibals resided there. They were famous for worshipping the evil spirit, to appease his wrath. Their account of the occasion of the noises is, 'that the Indian god was angry because the English god intruded upon him, and those were the expressions of his displeasure,' Hence it has been imagined that they originated after the arrival of the English in this country.

"About fifty years ago, a European by the name of Steele came into the place and boarded in the family of a Mr. Knowlton for a short period. He was a man of intelligence, and supposed to be in disguise. He told Mr. Knowlton in confidence, that he had discovered the place of a fossil which he called a carbuncle, and that he should be able to procure it in a few days. Accordingly, he soon after brought home a white round substance resembling a stone in the light, but became remarkably luminous in the dark. It was his practice to labor after his mineral in the night season. The night on which he procured it he secreted it in Mr. K.'s cellar, which was without windows, yet its illuminating power was so great that the house appeared to be on fire, and was seen at a great distance. The next morning he enclosed it in sheet lead, and departed for Europe, and has never since been heard of. It is rumored that he was murdered on his way by the ship's crew. He said that this substance was the cause of the noises---that a change of temperature collects the moistness of the atmosphere, which causes an explosion.

"These shocks are generally perceived in the neighboring towns, and sometimes at a great distance. They begin with a trembling of the earth, and a rumbling noise nearly resembling the discharge of very heavy cannon at a distance. Sometimes three or four follow each other in quick succession, and in this case the first is generally the most powerful.

"The particular place where these explosions originate, has not been ascertained. It appears to be near the northwest corner of the town. It was near this place that Steele found his fossil. The place where the ground was broken when the first one occurred which I mentioned above, was about three and a half miles from this place. There was no appearance of a deposit near where the ground was broken, but it has been observed that this place has been repeatedly struck with lightning.

.....

"The awful noises, of which Mr. Hosmer gave an account, in his historical minutes, and concerning which you desire further information, continue to the present time [1729]. The effects they produce, are various as the intermediate degrees between the roar of a cannon and the noise of a pistol. The concussions of the earth, made at the same time, are as much diversified as the sounds in the air. The shock they give to a dwelling house, is the same as the falling of logs on the floor. The smaller shocks produced no emotions of terror or fear in the minds of the inhabitants. They are spoken of as usual occurrences, and are called Moodus noises. But when they are so violent as to be heard in the adjacent towns, they are called earthquakes.

For other legends involving strange sounds, see GSD-019

GSD-015 [MORE MYSTERIOUS DETONATIONS]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

In the Times, Mrs. Lane, of Petersfield, 20 miles from Portsmouth, writes that, at 11:30 a. m., and at 3:30 p. m., several days before the 17th, she had heard the detonations, then hearing them again, upon the 17th. (p. 500)

Fort included this observation because it concurred with those reported in GSD-016 and GSD-035; both from November 1905.

GSD-016 [TRIPLET OF DETONATIONS]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

In the English Mechanic, 82:433, Joseph Clark writes that a few minutes past 3 P. M., upon the 18th a triplet of detonations was heard at Somerset--- "as loud as thunder, but not exactly like thunder." (p. 500)

Compare this report to those of GSD-015 and GSD-035.

GSD-017 THE "GUNS" OF LAKE SENECA, N. Y.

Anonymous; Monthly Weather Review, 31:336, July 1903.

Around Lake Seneca, one of the Finger Lakes of New York State, one often hears the dull boom of the Seneca guns. These lake guns or water guns are like those of Lough Neagh, Ireland. The editor of Monthly Weather Review perhaps embraced too quickly the gas-bubble theory because the Lough Neagh water guns are heard when the lake is frozen over. (GSD-029)

In the Monthly Weather Review for September, 1897, page 393, we have given some account of the "barisal guns," the "mistpouffers," and similar phenomena whose origin is as yet not certainly understood. The following letter describes an analogous phenomenon in Seneca Lake, N. Y., and it may well be that the barisal guns have their origin in the escape of bubbles of gas just as do the "guns" of Seneca Lake.

Mr. Wm. M. Prosser, of Dresden, Yates County, N. Y., writes as follows, under date of August 18, 1903.

So far as I am personally concerned I know of no explosions of inflammable gas, and the newspaper stories are fabrications in this respect.

The "lake guns" are evidently caused by gas escaping from the sand at the bottom.

Long Point is situated about 15 miles south of Geneva, N. Y., and about 25 miles north of Watkins, N. Y., on the west side of Seneca Lake. Directly off the Point the water is very deep. Heavy currents pass either north or south at regular intervals. A heavy wind for a few hours will change the position of the extreme end of land (which extends 1-1/2 miles eastward) several rods. When the swell is not too heavy you can always see the gas rising in bubble form, which, as a rule, makes very little noise, but larger eructations evidently produce these "lake guns." The sand would not stay in place were it not for the water holding it there at the extreme point. Large steamers can land there with but the aid of an ordinary gang plank.

I do not know that he gas is inflammable, but I could easily ascertain if it is of any special interest to you. Natural gas is found in considerable quantity within 3 or 4 miles of the point, on the outlet of Keuka Lake, but hardly in paying quantities. However, I am told that a company has been formed that will exploit the gas along the outlet, but not at the Point.

GSD-018 [THE SENECA GUN]

Clise, Eleanore R.; Letter to William R. Corliss, March 27, 1973.

The following excerpt from Clise's letter provides a relatively recent observation of the Seneca Gun. The comment about modern drilling about the lake supports the gas-bubble theory of the Gun's origin. Clise is the City Historian of Geneva, N.Y.

One night in August 1940 when I was at a cottage near Dresden (twelve miles south of Geneva), I heard the sounds about midnight. The air was clear and still. It was just as I had always heard the noise described---dull, far-away, muffled, repeated booming for a few seconds.

The present infrequency of reports of hearing the lake guns is said to be due to the drillings in the area around the southern part of Seneca Lake. Perhaps such work permits the accumulated gas to escape in other ways.

GSD-019 THE ECHO OF THE SENECA

Johnston, M. S.; Geneva Gazette, circa 1940.

The following excerpts from the above article were contributed by Eleanore R. Clise, City Historian, Geneva, N. Y.

The "Lake Gun"..... [is an] uncanny, mysterious sound, like the report of a far-away cannon, softened by coming over the water.....

.....

There has been a tendency to treat the whole subject in a skeptical manner. But scientists do not treat it so. They have regarded the lake gun of Seneca Lake as a perfectly respectable fact....., that it was not a product of imagination..... Dr. Hamilton L. Smith, for many years professor of science in Hobart College at Geneva, ... is remembered to have stated his opinion that the sound came from the explosion of gas collected in the bottom of the lake or in fissures of the underlying rock. This theory was practically demonstrated by the experience of a reliable neighbor who was startled and his canoe nearly overturned by a great bubble which came to the surface in the middle of the lake and burst with a loud noise.

Dr. John M. Clarke, the present State Geologist..... may be quoted as follows: "I have always thought that the common explanation of the 'lake guns' of Seneca Lake was a fairly competent one. I have no personal knowledge of the phenomena, but it is reasonable to think that the emanation of gas bubbles from the lake might produce such reverberating explosions, especially during the winter when there may be ice over the point of emission and which could crack under the added pressure. The gas storage in the shales is common throughout the Finger Lakes region, though seldom productive commercially. It is stored in little cavities which appear to be replenished and which may form either a constant or a spasmodic supply..... I am rather inclined to think that spasmodic discharges from these gas accumulations might account for these so-called guns...."

The sound is usually heard on hot, sultry days, though one has heard the ice crack as Dr. Clarke suggests. More often than not they are heard on afternoons by the lake or on it, when the south wind was dying down or had ceased to blow, and the surface of the water had become glassy, or 'oily' ..... and the sky has gradually become overcast with the haze of a gathering thunderstorm. Again out of the stillness one can hear coming from the south or southeast the solemn, lazy, deep-toned, muffled, unexpected, "Boom!"

Much has been said, much has been written about the mysterious "Echo of the Seneca." We have heard that it is the voice of Agayenteh who was slain by the Great Spirit for an attempted wrong on the part of the young Indian. History says that at the time he was swallowed up by the angry waters, a noise as of the roaring of a thousand pieces of artillery suddenly burst upon the ears of the afrighted witnesses, which echoed and re-echoed along the shores of the Kanadasaga for several minutes. Amidst this, with the red lightning playing about his head, the forward end of Agayenteh's light canoe was lifted far out of the water; himself standing erect, with arms outstretched and hair streaming in the blast--another crash of heaven's artillery, another vivid streak of lightning, and the boat and form of Agayenteh disappeared altogether. A few moments after the moon shone out clear and bright--the bosom of the lake was without a ripple.

GSD-020 CURIOUS AERIAL OR SUBTERRANEAN SOUNDS

Davison, C.; Nature, 53:4, November 7, 1895.

It is not possible that the "Barisal Guns" and "mist pouffers," referred to by Prof. Darwin are merely earthquake sounds, the attendant shock being too slight to be otherwise perceptible? Nearly all earthquakes are accompanied by a rumbling sound, due, I believe, to the small and rapid vibrations proceed-

ing chiefly from the margins of the area over which the fault-slip producing the earthquake takes place (Geol. Mag., vol. ix., 1892, pp. 208-218). In some districts (Comrie in Perthshire, East Haddan, in Connecticut, Pignerol in Piedmont, Meleda in the Adriatic, &c.), sounds without shocks are common during intervals which may last for several years, but slight shocks with sound occasionally intervene, as if the sounds and shocks were manifestations, differing only in degree and the method in which we perceive them, of one and the same phenomenon.

Davison's suggestion that Barisal Guns are seismic would seem to be contradicted by their doublet and triplet nature. (Davison means "East Haddam," the site of the Moodus Sounds in Connecticut)

GSD-021 BARISAL GUNS AND SIMILAR SOUNDS

Harries, H.; Nature, 53:295-296, January 30, 1896.

The following observation was presented in a letter to Nature. In keeping with the custom of the times, the unidentified detonations were ascribed to "electricity."

S.s. Resolute, Captain W. Deuchars; 8 p.m., July 30, 1883, in 71°9' N., 12°28' W.---"Six reports like those of guns heard to the westward, supposed to be caused by electricity, as no ships are thought to be in the vicinity." Wind during the day calm to very light easterly airs; weather foggy; sea smooth, with a very slight south-easterly swell.

GSD-022 BARISAL GUNS IN WESTERN AUSTRALIA

Cooke, W. E.; Nature, 78:390, August 27, 1908.

I have just received the following note from Mr. H. L. Richardson, Hillspring Station, 100 miles north-east of Carnarvon, on our west coast:---"A peculiar incident happened here last evening (June 26) about an hour after sunset. In a south-easterly direction from here three reports took place high up in the air, and then a rushing noise like steam escaping, lasting for a few seconds, and gradually dying away. Mr. Loeffler, one of the owners of the station, was standing outside with me at the time. It was a beautifully clear evening, and there was nothing visible at all in that direction. The reports sounded like explosions of some combustible to which there was no resistance.

Again a triplet of detonations from high in the atmosphere. Possibly a group of meteors, possibly a seismic sound, but see GSD-023.

GSD-023 ON THE OCCURRENCE OF EXPLOSIVE OR BOOMING NOISES IN CENTRAL AUSTRALIA

Cleland, J. Burton; Royal Society of New South Wales, Journal and Proceedings, 187-203, 1911. Based on a review by J.C. Branner; Seismological Society of America,

Bulletin, 2:261, 1912.

The author of this paper calls attention to, and asks for explanations for, the occasional booming noises heard by himself and others in various parts of central and northwestern Australia. He quotes from his own notes and from the observations of others, and adds many references to similar phenomena reported from other parts of the world. These sounds are variously described as resembling the distant firing of cannon, rumbling like the blowing off of steam from a large boiler, galloping of a herd of cattle, rumbling of thunder, blasting in mines, and gunshots. The explanations suggested and rejected are earthquakes, caving of river banks, electric discharges, displacements of rocks by frost, breaking of surf rollers, firing of bombs, subaqueous volcanic disturbances, falling meteors.

The explanation for these phenomena in Australia that appears to be regarded with most favor by the author is that in the dry interior the hot days and cold nights cause expansion and contraction of the rocks which result in their buckling and cracking. Movements along faults and the cracking of ground in dry weather are also appealed to.

GSD-024 BARISAL GUNS

Robinson, Charles H.; Nature, 53:487, March 26, 1896.

In 1810 a party, outfitted by John Jacob Astor, made an overland trip from the Missouri to the mouth of the Columbia. They tried to go through the Black Hills, but were obliged to withdraw and flank them. In these hills they note as follows: "In the most calm and serene weather, and at all times of the day or night, successive reports are now and then heard among these mountains, resembling the discharge of several pieces of artillery. Similar reports were heard by Messrs. Lewis and Clark in the Rocky Mountains.

Such explosions are also said to occur frequently in Brazil. "Vasconcellis, a Jesuit father, describes one which he heard in the Sierra, or mountain region of Peratininga, and which he compares to a park of artillery."

The key features here are (1) the repetitions of the "discharges;" and (2) their occurrence during "calm and serene weather." These sounds cannot be oceanic, nor would one expect frequent repetition from meteors.

GSD-025 BARISAL GUNS

Cooper, W. S.; Scientific American, 75:123, August 1, 1896.

Mist pouffers seem to be heard along the Florida coast too. Once more, calm weather seems a prerequisite.

On the evening of December 28, 1885, I was with a companion in a sailboat on the Gulf of Mexico about 20 miles S. E. of Cedar Keys, Florida. We were becalmed. The next morning the sky was cloudless. There was a light fog and no breeze. The atmosphere was bracing but not frosty. We were about ten miles out but in shallow water. Shortly after sunrise we heard reports as of a gun or distant cannon. They came at intervals of about five minutes. We were not certain as to the direction. My companion, who lived several miles further down the coast, said he had often heard the reports on still mornings.

GSD-026 OCEANIC AND SEISMIC NOISES

Anonymous; Monthly Weather Review, 26:216, May 1898.

Elusiveness of the source, an important feature of our mysterious detonations, is discussed here. The detonations sometimes seem in the air, sometimes they are subterranean. They seem near, then far away. The source is never found.

> The mysterious phenomenon known as "Barisal guns," or "Mist poeffers," forms the subject of a useful paper by Dr. A. Cancani, in the last Bollettino, Vol. III, No. 9, of the Italian Seismological Society. The observations on which his discussion is founded are collected from places in or near the inland province of Umbria, where the noises are known as "marina," it being the popular belief that they come from the sea. The sound is quite distinct and easily recognized; it is longer than that of a cannon shot, and though more prolonged and dull, it is not unlike distant thunder. It invariably seems to come from a distance, and from the neighborhood of the horizon, sometimes apparently from the ground, but generally through the air. The weather, when the "marina" is heard, is calm as a rule, but that it often precedes bad weather is shown by the common saying, "Cuando tuona la marina o acqualo vento o strina" (when the ocean thunders, expect rain or wind or heat). The interval between successive detonations is very variable, sometimes being only a few minutes or even seconds. They appear to be heard at all times of the day and year, the experience of observers differing widely as to the epochs when they are heard most frequently. With regard to the origin of the "marina," Dr. Cancani concludes that they can not be due to a stormy sea, because "mist-poeffers" are frequently observed when the sea is calm; not to gusts of wind in mountain gorges, for they are heard on mountain summits and in open plains. If their origin were atmospheric they would not be confined to special regions. Nor can they be connected with artificial noises, for they are heard by night as well as by day, and in countries where the use of explosives are unknown. There remains thus the hypothesis which Dr. Cancani considers the most probable, that of an endogenous origin. To the obvious objections that there should always be a center of maximum intensity, which is never to be found, and that they are so rarely accompanied by any perceptible tremor, he replies that, in a seismic series, noises are frequently heard without any shock being felt, and of which we are unable to determine the center.

GSD-027 [THE JEBEL MUSA SOUNDS]

Anonymous; Scientific American, 74:402, June 27, 1896.

> Since the publication of Prof. Darwin's letter in Nature last October, there has been a considerable amount of correspondence relative to this unexplained phenomenon, one of the later letters drawing attention to a reference by the late Dean Stanley in his "Sinai and Palestine" to "the mysterious noises which have from time to time been heard on the summit of Jebel Musa, in the neighborhood of Um Shaumer, and in the mountain of Nakus or the Bell, so called from the legend that the sounds proceed from the bells of a convent inclosed within the mountain. In this last instance the sound is supposed to originate in the rush of sound down the mountain side. . . . In the case of Jebel Musa, where it is said that the monks had originally settled on the highest peak, but were by these

strange noises driven down to their present seat in the valley, and in the case of Um Shaumer, where it was described to Burckhardt as like the sound of artillery, the precise cause has never been ascertained." The same correspondent, Mr. Edw. Fry, mentions that Burckhardt ("Travels in Syria and the Holy Land," 1822, p. 591) refers to these noises and says "the wind and weather are not believed to have any effect upon the sound."

The Jebel Musa sounds are evidently the same as the "bell" of Nakous mentioned by Ponton in GSM-004.

GSD-028 LAKE BOSUMTWI, ASHANTI

Rohleder, Herbert P. J.; Geographical Journal, 87:51-65, January 1936.

This extensive article on Lake Bosumtwi contains the following fascinating account of supposed periodic gas detonations. The inference is that lake guns may have a similar origin. The sulphurous odor reported below is also a common feature of earthquakes, ball lightning, and many other geophysical phenomena.

> ..... An old saying among the inhabitants around the lake is "Bosumtwi has fired or exploded gunpowder" (Bosumtwi oto atuduru). At irregular intervals once or twice a year, but apparently not within recent years, the lake becomes rough for one or two days, the colour of the water changes to almost black, the surface is covered with dead and dying fish, and the atmosphere becomes full of a choking small of "gunpowder." The phenomenon is accompanied by a loud detonation. No rumblings or earth tremors are noted. Although never observed by any European and never mentioned by the natives, this phenomenon is well known to every lake dweller. The recent volcanic origin of Lake Bosumtwi immediately suggests exhalations of gases, in particular hydrogen sulphide. According to T. Robertson such upheavals are due to gases from decomposed organic matter at the bottom of a lake without any outlet, in particular to marsh gas. This explanation would also account for another phenomenon, mentioned by Sir Albert Kitson, i.e. "flashing lights, making noises like the discharge of artillery." The Chief of Abonu however gave Rattray the equally mater-of-fact and convincing explanation that these mysterious lights were deliberately caused by thieves robbing other people's nets at night and taking fire in a bowl to scare away the highly superstitious and easily frightened lake dwellers. Chemical analyses of the waters of Lake Bosumtwi showed them to be of the alkaline-carbonate type according to information received from Dr. Junner.
>
> Although these periodic upheavals of the lake bottom might give rise to minor local explosions, it is impossible that these small detonations should be heard far away from the lake as has been reported frequently.

The above detonations should be compared to the Lough Neagh water guns and the Seneca Guns.

GSD-029 REMARKABLE SOUNDS

Smith, W. S.; Nature, 53:197-198, January 2, 1896.

The best description of the famous Lough Neagh water guns was relayed to Nature

by Rev. W. S. Smith, the Congregational minister at Atrim, Ireland.

Lough Neagh is a sheet of water covering an area of upwards of 150 square miles, with very gradually receding shores, excepting at one or two spots. For many years after my settlement as minister here from England, I heard at intervals, when near the lake, cannon-like sounds; but not being acquainted with the geography of the distant shores, or the location of towns, or possible employments carried on, I passively concluded that the reports proceeded from quarrying operations, or, on fine summer days, from festive gatherings in Co. Derry, or Co. Tyrone. In time I came to understand that it was not from the opposite shores, but from the lake itself that the sounds proceeded. After questioning many of the local residents, I extended my inquiries to the fishermen, but they could assign no cause. A strange thing about the matter is that the people generally knew nothing of the phenomenon, and that it is shrouded in mystery. I have heard the reports probably twenty times during the present year, the last being on a Sunday afternoon a month since, when I heard two explosions; but with two exceptions they have all seemed to come from many miles away, from different directions at different times. They have come apparently from Toome Bay, from the middle of the lake, and from Langford Lodge Point, about nine miles distant. A fisherman thought they must be the result of confined air that reached the lake by means of springs that are believed to rise here and there in the bottom. But the lake is shallow, seldom more than 45 feet deep. The depression now covered by the lake having been caused, it is believed, by volcanic action when the trap-rock of Co. Antrim was erupted, there may possibly be subterranean passages, though I confess their occurrence does not seem very probable; while the sounds emanate, as stated, from various parts of the lake. I have as yet spoken to no one who observed any movement of the waters when explosions took place, nor have I spoken to any one who was close to the spot at the time. Rather every one seems to have heard them only in the distance, which is strange, as fishermen are on the lake during many months in the year, at all hours of the day and night.

Last winter the whole of the lake was frozen over, for the first time since 1814. One fine afternoon, when the air was still, I was skating in the neighborhood of Shande's Castle, when these mystical guns boomed forth their reports every five or six minutes. On the last day of the skating, when thousands of people from Belfast and elsewhere were assembled in Antrim Bay, there were two fearful boomings, that startled every one near me. They seemed to think some dreadful catastrophe had occurred, as the sounds appeared to proceed from not more than half a mile away. I never before heard them so near. The ice in Antrim Bay remained as it was, but I afterwards learned that it was then breaking up six miles away, but with no alarming sounds.

GSD-030 BARISAL GUNS AND SIMILAR SOUNDS

Praeger, R. Lloyd; Nature, 53:296, January 30, 1896.

August 27, 1886.--While standing with Mr. S. A. Stewart in a recently-mown meadow, near Portmore Lough, on the eastern side of Lough Neagh, our attention was attracted by a rumbling noise. The day was very fine and warm, and dead calm, not a leaf stirring, and a very few light clouds were in the sky. The noise was like a short distant peal of thunder, but sounded faint rather than distant. While we watched a whirlwind suddenly appeared in the direction whence the

sounds had come [the north], and at a distance of about a hundred yards from us. A quantity of loose hay was instantly whirled upward to a height of about 100feet, and, after floating about in circles, slowly settled down. A haycock at the spot was much disturbed, and presented the appearance of having endured a gale of wind. The time between the rumbling sound (which closely resembled the distant report of a cannon) and the appearance of the whirlwind was about half a minute, and the whirlwind lasted somewhat over a minute.

In W. H. Patterson's "Glossary of Words of Antrim and Down," we find the following: "Water Guns.--Sounds as of gunshots, said to be heard around the shores of Lough Neagh by persons sailing on the lake. The cause of the sounds, which are generally heard in fine weather, has not been explained." There is no doubt that the sound we heard was the mysterious "water guns," and there is also little doubt that the noise and the appearance of the whirlwind were closely connected.

Foremost in the preceding account is the association of the Lough Neagh water guns with an atmospheric phenomenon; namely the genesis of a whirlwind. As the GWW section of this sourcebook demonstrate, whirlwinds and especially tornadoes may be electrical in nature and, therefore, natural emitters of sounds resembling thunder.

GSD-031 [SOUNDS FROM THE MOUNT PELEE ERUPTION]

Anonymous; Monthly Weather Review, 30:209, 1902.

The eruption of Mount Pelee on Martinique, latitude 14°45' north, longitude 61° 10' west, appears to have been heard as far away as Maracaibo, Venezuela, latitude 10° 45' north, longitude, 71° 45' west, a distance of about 12° of a great circle, or 830 English miles. In a report from E. H. Plummer, United States Consul at Maracaibo, after some remarks on the weather that have, of course, no relation to the earthquake, he says:

On the morning of the great calamity that has fallen upon the island Martinique, strong rumbling sounds were heard here, as well as in the other parts of this state. At many places during the day before the catastrophe noises of heavy cannonading were heard at La Ceiba, Cabimas, Perija, and Quisiro. At Sinamaica the people thought that a great battle with heavy artillery was in progress near Maracaibo. This is very natural when we keep in view our revolutionary tendencies.

Early in the morning of the catastrophe I found that my servant had saddled my horse; when I asked him if somebody was sick and needed a doctor, he answered that he thought I needed my horse to go to the city, as a big battle must be going on judging from the sounds of the heavy firing of guns. Observing the same sounds, I knew at once that it could not be heavy artillery, for if all of the cannons of Venezuela were fired together they could not produce such sounds.

It was not like cannonading with heavy siege guns; it was neither thunder nor the strange unpleasant subterranean sounds of convulsions of the earth; it was as if immense explosives were fired high up in the clouds.

GSD-032 [MEXICAN SUBTERRANEAN SOUNDS]

Ponton, Mungo; Earthquakes, Their History, Phenomena and Probable Causes, T. Nelson & Sons, Edinburgh, 1888.

Ponton's classic text on earthquakes refers to many unusual sounds, among them the following account of Humboldt's observation in Mexico, already mentioned in GSD-007, and the Melida detonations (GSD-009).

> It has occasionally happened that loud and long-continued subterranean noises have been heard, without their having been accompanied either by earthquake shocks or any other outward indications of internal disturbance. One of the most remarkable examples of this kind occurred at Guanaxuato, in Mexico, and is described by Humboldt in his "Cosmos." This city is situated in a mountainous district, but far from any active volcano. The sounds were first heard at midnight, on the 9th of January 1784, and they continued more than a month. The loudest reports occurred from the 13th to the 16th of January, when they seemed like slow rolling thunder, with intervening short thunderclaps. Both before and after this period the sounds were neither so loud nor so frequent, and after the 16th they gradually died away. The phenomenon was confined to a limited space under the city and its immediate neighborhood. Great alarm was excited among the inhabitants; but no shocks of earthquake were felt, nor did any other consequences follow. What is still more remarkable, in the neighboring mines, which are 1598 feet deep, not the slightest trembling of the ground was perceived.
>
> Something similar happened in the island of Meleda, off the Dalmatian Coast, where subterranean noises were heard from March 1822 to September 1824; but these were attended by slight shocks. (p. 215)

GSD-033 CURIOUS AERIAL OR SUBTERRANEAN SOUNDS

Hughes, T. McKenny; Nature, 53:30-31, November 14, 1895.

> I have sometimes heard on the mountains north of the great Craven Faults, from which I looked over low ground towards Morecambe Bay, what I always took to be the sound of heavy guns somewhere out seaward. They were not, however, repeated at such intervals, nor for so long a time as to support the view that it was the sound of artillery practice; and, when I made inquiries from friends who resided in the district, I never learned that there was anything of the sort going on. The sound struck me as peculiar, but I could not find any satisfactory explanation of it.

GSD-034 [MISTPOUFFERS IN NORTH AMERICA]

Anonymous; Scientific American, 74:402, June 27, 1896.

Mistpouffers seem to be a world-wide phenomenon as evidenced by the following reports from the Canadian east coast. These detonations are also heard best in calm, summer weather. There is also an interesting correlation between the sounds heard on the very deep Kennebecasis and the Barisal Guns, which were related by Schurr

(GSD-003) to the deep depression in the Ganges delta.

Everybody who has been much upon our Charlotte County coast must remember that upon the still summer days, when the heat hovers upon the ocean, what seem to be gun or even cannon reports are heard at intervals coming from seaward. The residents always say in answer to one's question: "Indians shooting porpoise off Grand Manan." This explanation I never believed; the sound of a gun report could not come so far, and, besides, the noise is of too deep and booming a character.

Mr. Samuel W. Kain, secretary of the Natural History Society, of St. John, N.B., has written us that these local noises, and the "Barisal guns" and "mist pouffers," were discussed at a meeting of the society, when "some additional information of interest was elicited. A letter was read from Edward Jack, C.E., stating that he had heard these peculiar sounds on Passamaquoddy Bay years ago. It was also announced that a similar phenomenon occurs in the warm days of summer on the Kennebecasis, a lake-like affuent of the St. John River, of great depth and about seven miles from the city of St. John. This has been observed by several competent observers.

The secretary also read a letter from Captain Bishop, of the schooner Susie Prescott, stating that similar sounds were heard on warm summer days between Grand Manan and Mount Desert Rock.

GSD-035 [TRIPLETS OF DETONATIONS]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

In the London Times, Nov. 23, 1905, a correspondent writes that, at East Liss, Hants, which is about 40 miles from Reading, he and his gamekeeper had, about 3:30 p.m., Nov. 17th, heard a loud, distant rumbling. According to this hearer, the rumbling seemed to be a composition of triplets of sounds. (p. 499)

Compare this report to those of GSD-015 and GSD-016.

GSD-036 BARISAL GUNS

Robinson, Charles H.; Nature, 53:487, March 26, 1896.

On July 4, 1808, the expedition of Captains Lewis and Clark was at this place. Under that date we find the following entry in their journal: "Since our arrival at the Falls we have repeatedly heard a strange noise coming from the mountains in a direction a little to the north of west. It is heard at different periods of the day and night, sometimes when the air is perfectly still and without a cloud, and consists of one stroke only, or five or six discharges in quick succession. It is loud, and resembles precisely the sound of a six pound piece of ordnance at the distance of three miles. The Minnatarees frequently mentioned this noise like thunder, which they said the mountains made, but we paid no attention to it, believing it to be some superstition or falsehood perhaps. The watermen also of the party say that the Pawnees and Recaras give the same account of a noise heard in the Black Mountains [Black Hills] to the west of them"

The mountains towards which these noises were heard were the main range of the Rockies, and distant about eighty miles. In 1854, Mr. Doty, of Governor Stevens's party, heard similar noises. He was near enough to the mountains to be certain that the noises came from them. The locality where Mr. Doty heard them was where the direction observed by Lewis and Clark would strike the mountains.

Plenty of white men have been in this country for the last thirty years, or since 1866. I have made careful inquiry among pioneers, but cannot learn that the noises have been heard since Mr. Doty's report.

GSD-037 [DOUBLETS AND TRIPLETS]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

In the London Times, Nov. 9, 1858, a correspondent writes that in Cardiganshire, Wales, he had, in the autumn of 1855, often heard sounds like the discharges of heavy artillery, two or three reports rapidly, and then an interval of perhaps 20 minutes, also with long intervals, sometimes of days and sometimes of weeks, continuing throughout the winter of 1855-56. Upon the 3rd of November, 1858, he had heard the sounds again, repeatedly, and louder than they had been three years before. (p. 407)

Those doublets and triplets again.

GSD-038 ON THE FACTS OF EARTHQUAKE PHENOMENA

Mallet, Robert; Report of the British Association, 146, 1852.

Mallet's "catalog" is a goldmine of strange phenomena associated with earthquakes. Here is an entry describing typical earthquake sounds:

March 19, 1750; London. Preceded by a loud noise compared by some to thunder, by others to the roaring of the wind, and moving in the direction, according to some, of S. E. to N. W. or W., according to others, of W. to E., N. W. to S. E., or vice versa. This noise (compared to that of a carriage in motion) was heard at one or two places where no shock was felt.

GSD-039 NOTICES OF EARTHQUAKE SHOCKS FELT IN GREAT BRITAIN .....

Milne, David; Edinburgh New Philosophical Journal, 31:92-122, 1841.

Milne's catalog, like that of Mallet, is full of detonations attributable to earthquakes. Here are two:

August 1, 1755; England. Great noise preceded shock, like the report of several cannon.

November 5, 1789; Scotland. Violent shock accompanied by noise like the discharge of distant artillery, extended for more than 20 miles in direction of NW. and SE.

GSD-040 THE EARTHQUAKE

Fisher, O.; Nature, 30:19, May 1, 1884.

O. Fisher, presumably the Osmond Fisher who first proposed that the moon was torn from the earth early in geological history, filed the following report from Bury St. Edmunds:

> While there I was told that an earthquake had been felt that day at Thurston, Elmswell, and Haughley, places between Ipswich and Bury. It was reported that a workman, sitting eating his luncheon on the bank, saw the rails move. Mention-this when I returned home, I was told that the policeman in this village had felt a shock. I therefore interviewed him and made the following note:--"January 15, 1869; P. C. Redhouse, when near the 'Hare and Hounds'" (which is a few hundred yards south of my house)"on Sunday morning the 3rd, about 2 a.m., heard a sound like heavy distant guns, which seemed to shake him and to make him reel. He was walking fast, and stopped. There was no shake after the sound. He thought there were six or seven reports in a couple of seconds. The movement was from north to south. There were three sounds before he stopped, and three afterwards. He did not regain his steadiness for two or three chains' distance.

Of significance are the two triplets and the evidence of disorientation. Such physiological effects are common in the cases of lightning, earthquakes, and some other geophysical phenomena.

GSD-041 VIRGINIA'S TWO LARGEST EARTHQUAKES . . . . .

Bollinger, G. A.; Seismological Society of America, Bulletin, 61:1033-1039, August 1971.

The two earthquakes referred to in the title transpired on December 22, 1875, and May 31, 1897.

> Earthquake sounds are reported to have begun 4 weeks earlier, on May 3, 1897, when another earthquake, this one of intensity VI, was felt in southwest Virginia (Richmond Dispatch, June 3, 1897). That shock was centered some 30 km to the south of Pearisburg near Pulaski, Virginia and was generally felt in Giles Country, where it "loosened some bricks from old chimneys and was accompanied by considerable noise." Between May 3 and May 31, many similar noises were heard in Giles County, but no other shocks strong enough to attract individual attention were felt. The Richmond Dispatch reports that for a week or more before the earthquake of Monday, May 31, "people throughout Giles County were much disturbed by subterranean noises, and all day Monday detonations like the explosion of distant artillery were heard throughout the county." Also, Campbell (1898) states "the noise did not stop with the main shock, but tremores

and rumblings or sharp reports" are described as "occurring during the entire night following the shock." Campbell also noted that these noises and tremors were repeated regularly in the Pearisburg area for some time afterward, growing fewer and slighter until they were no longer noticable.

Bollinger noted further that these sounds were not always associated with specific shocks. He ascribes these noises to the transfer of high-frequency, elastic-wave energy from the ground to the air during foreshock and aftershock events.

GSD-042 NOTICES OF EARTHQUAKE SHOCKS FELT IN GREAT BRITAIN .....

Milne, David; Edinburgh New Philosophical Journal, 31:119, 1841.

The following descriptions of earthquake sounds display the great variety, from explosion to jingle, possible with a single geophysical phenomenon. The earthquakes occurred at Comrie, Scotland, which, like Moodus, Connecticut, has been famous for its supposedly seismic noises.

> About 3 p.m., I was walking, when I heard a sound somewhat resembling the peal of thunder at a great distance,---or rather the echo which succeeds a louder thunder peal passing along through the clouds. I would have believed it was from thunder, had I not felt the motion of the ground under me, as if a heavy carriage had passed over it rapidly at a short distance from me. The sound preceded the movement of the ground about 3" or 4".
>
> .....
>
> There was a very loud noise, like the emptying of a cart of stones.
>
> .....
>
> At Ardvoirlich, the first of these shocks is stated by those who heard it, "as particularly severe, and the noise was described as having a sort of hissing sound, and was compared to a large steam-vessel letting off steam.
>
> .....
>
> In the great shock of the 23rd there were two reports, with an interval of 4" or 5" between the first report and the commencement of the second, before any sensible vibration or concussion ensued. The nature of the noise usually resembles the report of a gun discharged among rocks, when the sound produced is deep and hollow. This marks the first explosion. Then follows the sharp rumble, as if through a cavity in the earth, and in the sharper shocks produces a jingle like the jarring of some metallic body in the earth.

GSD-043 NOTICES OF EARTHQUAKE SHOCKS FELT IN GREAT BRITAIN .....

Milne, David; Edinburgh New Philosophical Journal, 32:106-127, 1842.

> October 23, 1841; Comrie, Scotland. The shock of the 23rd, at half past 10 P.M., which was by far the most severe of any remembered in this neighborhood, and which was attended with greater tremor or heaving of the earth, was accompanied with a noise in nature and intensity indescribably terrific,---that of water, wind, thunder, discharge of cannon, and the blasting of rocks, appeared combined. Giving a short warning by a distant murmur, it gradually increased in intensity for some seconds, when at length becoming louder than

thunder, and somewhat similar to the rush of the hurricane, it suddenly changed and a noise resembling that of a blasting rock thrice repeated followed, which again died away like distant thunder. (p. 122)

The great variety of earthquake sounds is evident in this report. Of particular interest is the triplet of detonations so common in the descriptions of the Barisal Guns.

GSD-044 OCEANIC NOISES; UMINARI

Terada, T.; Monthly Weather Review, 43:315, July, 1915.

Wave action is often proposed as the likely source of the Barisal Guns, mist pouffers and other explosive sounds. In this paper, Terada indicates that the sounds created by a line source of breakers would not be attenuated as rapidly as sound from a point source.

Oceanic noises, called "uminari" in Japanese, are common phenomena among the littoral of Japan.

On account of their intimate connection with the cyclonic centers, the sounds are observed and recorded at the meteorological stations and are reported to the central observatory in the daily weather telegrams. The oceanic noises resemble the rumbling of a heavy wagon passing over an uneven road or crossing a bridge. They are more distinctly audible at a distance of a few miles from the coast, rather than on the coast itself.

Undoubtedly the oceanic noises are produced by the breakers dashing on the coast, but how the breaking waves produce them is not fully understood. When waves break upon the shore they produce not only aerial vibrations, but also tremors in the ground, which are propagated to some distance; it seems uncertain, however, that these sounds, which are of such relatively short periods, are propagated through the porous ground to considerable distances. The aerial vibrations produced by the tremors of the ground are very small; the noises produced by the air escaping from the breaking waves would have a pretty large amplitude, although they would be somewhat irregular in period. On the shore these noises are confounded with a great variety of other noises, such as the rustling of beach pebbles, the dashing sounds of the water, etc. At a distance from the coast these other noises, having high frequencies, die out, and the oceanic noises, having comparatively long periods, survive.

. . . . . .

It is a noteworthy fact that in the case of oceanic noises the source of the sounds is not a single point, but is a line source distributed along the long shore line. In the case of a point source the intensity of the sound decreases in an inverse proportion to the square of the distance from the source. But in the case of multiple sources located along a straight line the case is somewhat different. When the sources produce sound waves of like phase, the resultant wave is cylindrical, and the intensity of the sounds is in simple inverse proportion to the distance. In the case of oceanic noises the sources may be supposed to lie in a straight line, but the waves from the different sources are in differing phases. In this case the intensity of the sound is decreased inversely proportional to the distance. If this simple consideration is approximately correct, the difference between the propagations of the sounds of cannonading and of oceanic noises would be readily explained. The intensity of the sounds from cannonading is reduced to one-hundredth at a distance of 10 fold, but that of the oceanic noises is reduced to only one-tenth at the same distance.

GSD-045 THE NOISE MADE BY A METEOR

Anonymous; Monthly Weather Review, 23:57, February 1895.

The attention of the Editor having been specially called by a correspondent to certain mysterious noises heard at stations in Florida on February 7 or 8, at the time of the remarkable cold weather, it seemed best to investigate this subject, at least far enough to justify one in deciding for or against the various suggestions as to its being an earthquake, or an electrical phenomenon, or a discharge of artillery, or the noise of distant blasting. In reply to a circular sent out by Mr. E. R. Demain, Director of the State Weather Service, about twenty-five reports were received.

Kissimmee, --- About 5 a.m. of February 8 very loud sounds, resembling reports of artillery, were heard in the air. The sound is said to have been heard at a distance of 8 miles. The cause is not known. It is supposed to have originated in the northern part of this town, about 15 feet north of the Florida Midland Railroad, where the ground was slightly torn up.

Orlando, --- The detonations were heard in Orlando on the 7th (Thursday), not on the 8th. On Thursday, just before noon, many residents living east and southeast of Orlando saw a bright meteor pass over toward the north, and its disappearance was followed by a noise as of a loud explosion. Later reports state that a double explosion occurred about 11 a.m., and several report that it shook their homes as would an earthquake; one, who was in bed at the time, felt the house shake and heard the loud report. These persons state that the noise appeared to come from some point southeast of them.

. . . . . .

Green Cove Springs, --- Heard some peculiar sounds during the storm (7th or 8th?); the first were the louder and like thunder and from the southwest; the last reminded one of the booming of distant sunset guns at sea, and apparently came from the northeast.

Plant City, --- No noises on the 8th, but on the 7th, about noon, heard what I supposed was distant, heavy thunder in the southeast, that reminded me of heavy siege guns a long way off. I did not note it as thunder, as I supposed that it was a blasting at the phosphate mines, as it was in that direction and I was told so by a citizen.

The four most interesting reports are reproduced above. They confirm the possibility of a meteor on the 7th, but the detonations on the 8th are unexplained.

GSG-001 INFRASONICS

Stephens, R. W. B.; Ultrasonics, 7:30-35, January 1969.

> Physiological effects [of infrasonic waves] include nausea, disequilibrium, disorientation, blurring of vision, lassitude. Internal damage may occur due to fact that infrasonic waves easily penetrate deeply and may induce resonant effects on organs.
>
> .....
>
> Accidents, absenteeism, and other factors indicating degradation of human performance can be correlated with infrasonic waves arriving from storms 2000 miles away.

Could the disorientation occurring during and after earthquakes, sightings of ball lightning, and other geophysical events have infrasonic origins?

GSG-002 [AN ACOUSTIC ANOMALY]

Gould, Rupert T.; Enigmas, University Books, New Hyde Park, 1965.

In 1822, Captain W. E. Parry was in the Arctic measuring the velocity of sound by timing the lag between the observation of a cannon's discharge and the arrival of the sound. A most peculiar event transpired, as quoted from the Appendix to Captain Parry's Journal of a Second Voyage.

> The experiments on the 9th February, 1822, were attended with a singular circumstance, which was---the officer's word of command "Fire" was several times distinctly heard both by Captain Parry and myself about one beat of the chronometer after the report of the gun; from which it would appear, that the velocity of sound depends in some measure upon its intensity. The word "fire" was never heard in any of the other experiments; upon this occasion the night was calm and clear, the thermometer 25^{O} below zero, the barometer 28.84 inches, which was lower than it had ever been observed before at Winter Island. (pp. 37-38)

GSG-003 STRANGE SOUNDS FROM THE SKY

Romig, Mary F., and Lamar, Donald L.; Sky and Telescope, 28:214-215, October 1964. (Quotation with permission of Sky and Telescope)

In discussing meteoric sounds Romig and Lamar suggest that a meteor's electrostatic and electromagnetic effects are insufficient to create brontophonic sounds and that direct electromagnetic radiation is the only possibility left. This idea, proposed by H. H. Nininger in the 1930s, is quite reasonable because meteors obviously convert some of their kinetic energy into visible light and very likely into other portions of the electromagnetic spectrum. The high velocity of electromagnetic waves would explain how some meteor sounds are heard before or during the actual visual sighting of the meteor which, as sound travels, is many seconds away. (See GSH-001) Romig and Lamar next relay the results of some experiments by A. H. Frey.

He found that some human subjects exposed to beams of low-power radar sets perceived sensations of sound described as buzzing, clicking, hissing, or knocking, depending on the transmitter characteristics. Care was taken to exclude possible rectification (by loose tooth fillings and the like) of the pulse-modulated signal. A peak electromagnetic power density of as low as 400 microwatts per square centimeter at the observer could be perceived as sound.

The effects occurred only in those subjects whose audible hearing by air or bone conduction was good above 5,000 cycles per second. If the background noise level was higher than 90 decibels, the radio-frequency sound was somewhat masked (wearing earplugs improved the reception). We shall not discuss here the possible mechanisms for electrophonic hearing, but perhaps the electromagnetic waves act directly on the brain. It is apparent that there are similarities between these sounds and the anomalous sounds associated with fireballs, and the power levels are not prohibitively large.

Possibly many of the mysterious sounds reported in the section have an electromagnetic origin far from the observer. Indeed, many other strange sights and sounds may come through channels now unknown to science. For specific sounds reported by Romig and Lamar, see GSH-011.

GSG-004 AURORAL INFRASONIC WAVES

Wilson, Charles R.; Journal of Geophysical Research, 74:1812-1836, April 1969.

Compiler's Summary: Observations of infrasonic waves at College, Alaska, indicate that their structure is related to the time and space distribution of the supersonic auroral motions during polar magnetic substorms. The infrasonic waves are observed during the breakup phase of the substorm when there are rapid auroral motions. Observations verify that auroral electrojets generate the infrasonic shock waves.

GSH-001 METEOR IONIZATION AND METEOR SOUNDS

Gillmor, Daniel S., ed.; Scientific Study of Unidentified Flying Objects, Bantam Books, Inc., New York, 1969.

> There are also a significant number of reports concerning sounds heard while the bolide was still descending from the sky, perhaps a hundred kilometers above the ground. These sounds are described as hissing, swishing, whizzing, whirring, buzzing, and crackling, and are attributed to bolides with an average apparent magnitude of -13 (about the brightness of the full moon). Such noises could not have propagated all the way from the meteorite, since sound travels too slowly.
>
> At one time it was believed that people who observed bolides imagined the sounds, as a psychological association with noise from sparklers and other fireworks. Meteor sounds are now regarded as physical effects. On several occasions the observer first heard the noise and then looked upward to seek the cause. (Similar noise has also been reported during times of auroral activity.) (p. 745) (Martin D. Altschuler)

The experiments of Frey (GSG-003) are mentioned next. Several items on auroral sounds, which may be related, are in Subsections GLA and GSH. See Index.

GSH-002 [SOUNDS AT YELLOWSTONE LAKE]

Sellers, Robert E.; Letter to William R. Corliss dated April 12, 1973.

At the time this letter was written, Sellers was Acting Chief Park Ranger.

> The following quotation, concerning strange noises over Yellowstone Lake, is taken from "Haynes Guide", by Jack Ellis Haynes.
>
> "Strange overhead noises at Yellowstone Lake have been reported many times from the earliest days of exploration to the present. These occur when the sky is cloudless, the air perfectly still and usually in the early morning. This strange noise, heard only occasionally, is not like the sound of a distant flight of birds nor any shore noise, but is weird and startling. A description of this unusual phenomenon reported by the author in 1924 follows:
>
> "Our small boat was approaching Pelican Roost island. The surface of the lake was mirror-like in the stillness of early morning. A sound rose overhead apparently from the west beginning with a low roar which gradually became louder and rose in pitch, then gradually faded away as the pitch lowered again, while the sound seemed to soar rapidly to the southward as it faded into silence. Then from another direction a similar sound was heard, and again from still another direction, the whole phenomenon lasting only half a minute. Although I am familiar with most of the sounds common to wilderness areas, this was unlike anything I had ever heard before. It was a mystifying sound which none of us in the boat was able to explain. If sound ever accompanied such a display, it is easy to imagine that we had heard the sound effect that would have been used in a stage production of the spectacle of an aurora borealis."
>
> To our knowledge, there is no modern day scientific explanation for this phenomenon, but Rangers who have heard the noise recently say it sounds like

the rumblings caused by an earthquake. Quakes are very common here, with slight ones occurring almost daily, and the noises are heard only when the lake is quiet and the weather clear and calm.

The Yellowstone Lake sounds bear a strange resemblance to auroral and meteoric sounds. (See GSH-003) As with many of the mysterious detonations, clear weather seems a prerequisite. No reference was given for the quotation of 1924.

GSH-003 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Science, 1:25:363-411, 1834.

During the great meteor spectacle of 1833, several observers heard anomalous sounds.

6. SOUND.--According to the observations of by far the greater number of spectators, the meteors were unaccompanied by any peculiar sound; but on the other hand, such a sound, supposed to proceed from the meteors, was distinctly heard by a few observers in various places.

.....

(2.) Dr. Lee, of New Britain, a few miles northeast of New Haven, saw the meteor which is described p. 366, as falling near Capella, and thinks it was accompanied by a noise like the rushing of a skyrocket.

(3.) One in the northeast was heard to explode with a sound like that of a rush of a distant sky rocket. The time from the explosion to the hearing, was about 20 seconds. (N. York Commercial Advertiser.)

.....

(8.) A crackling sound attended them both. (Richmond Enquirer.)

GSH-004 REMARKABLE SOUNDS

Tomlinson, C.; Nature, 53:78, November 28, 1895.

In a book that was popular about fifty years ago, entitled "Journal of a Naturalist," the author says that the purely rural, little noticed, and, indeed, local occurrence, called by the country people "hummings in the air," was annually to be heard in fields near his dwelling. "About the middle of the day, perhaps from twelve o'clock till two, on a few calm sultry days in July, we occasionally hear, when in particular places, the humming of apparently a large swarm of bees. It is generally in some spacious open spot that this murmuring first attracts our attention. As we move onwards the sound becomes fainter, and by degrees is no longer audible." The sound is attributed to insects, although they are invisible.

A writer in the Edinburgh Philosophical Journal objects to this sound being attributed to insects, first because the fact is stated as being local and partial, heard only in one or two fields, at particular times of the year when the air is calm and sultry. He has often heard a similar humming in a thick wood, when the air is calm, and has diligently searched for insects, but in no case was able to detect them in numbers sufficient to account for the sound.

The same writer refers to remarkable sounds heard in a range of hills in Cheshire. When the wind is easterly, and nearly calm on the flats, a hollow moaning sound is heard, popularly termed the "soughing of the wind," which Sir Walter Scott, in his glossary to "Guy Mannering," interprets as a hollow blast or whisper. The explanation seems to be that a breeze, not perceptible in the flat country, sweeps from the summit of the hills, and acts the part of a blower on the sinuosities or hollows, which thus respond to the draught of air like enormous organpipes, and becomes for the time wind instruments on a gigantic scale.

Once again, we find that hums and whispers---like detonations---seem to require calm weather. The fact that the humming is heard in the summer around the middle of the day suggests insects, and possibly they may have been high in the sky and out of sight, but this does not relate well to the extremely local character of the hum. Local microseisms are another possibility---the Moodus Sounds in miniature.

GSH-005 FAR, FAR WORSE

Fuller, Curtis: Fate, 13:10–11, November 1960.

The following note in the column of Curtis Fuller, Publisher of Fate, describes the strange humming sounds heard in the vicinity of Kent, England.

The Big Hum is an elusive, deep-throated humming noise that only persons sensitive to the lower sound registers can hear.

Nobody knows what causes it; nobody knows where it comes from. It has been discussed in Parliament and in military circles. The Ministries of Science, Supply and Aviation; the General Post Office, the Electricity Boards and Lord knows who all else disclaim any responsibility for the noise.

Complaints have come in from all over England but most of them seem to center in Kent.

Tom A. Cullen of NEA Service interviewed Novelist Edward Hyams and his wife, who started the furor over the Big Hum. Hyams hears the noise only occasionally but his wife hears it often.

"It's low-pitched and intermittent," she explains. "It is stronger inside the house than outside, louder at night than during the daytime; and on weekdays it's worse."

The Kent humming seems related to the hums reported by others living near the ocean. (GSH-007 and GSH-008) Infrasonic waves should be considered as possible sources.

GSH-006 SOUND OF THE AURORA

Paukhurst, Edward A., and Shaw, J.; Nature, 23:484, March 24, 1881. (two letters)

With reference to the question mooted in last week's NATURE (p. 459) by M. L. Rouse as to the sounds emitted by aurorae, perhaps the accompanying extracts may be of interest.

"Record of a Girlhood," F. A. Kemble, Vol. I

"Standing on that balcony [at Edinburgh] late one cold clear night, I saw for the first time the sky illumined with the aurora borealis. It was a magnificent display of the phenomenon, and I feel certain that my attention was first attracted to it by the crackling sound which appeared to accompany the motion of the pale flames as they streamed across the sky; indeed crackling is not the word that properly describes the sound I heard, which was precisely that made by the flickering of blazing fire; as I have often since read and heard discussions upon the question whether the motion of the aurora is or is not accompanied by an audible sound, I can only say that on this occasion it was the sound that first induced me to observe the sheets of white light that were leaping up in the sky. At this time I knew nothing of such phenomena or the debates among scientific men to which they had given rise, and can therefore trust the impression made on my senses."

Shaw's letter follows:

I beg to assure Mr. Rouse that about fifteen years ago, early in the evening, in this very quiet locality, I listened, along with my father, to the sound of the aurora, pulsing above us, across the zenith, and appearing nearer to us, or lower, than most auroras I had seen. The sound was somewhat like the rustling or switching of silk, and we listened to it for some time with great curiosity. The aurora was not coloured, as more imposing ones have sometimes appeared, but white. It recalled to me the lines of Burns in a fragment entitled "A Vision."

"The cauld blue north was streaming forth
Her lights, wi' hissing eerie din;
Athort the lift they start and shift
Like fortune's favors tint as won."

GSH-007 HUMMING IN ARLINGTON, VA.

Hieber, Lucille C.; Fate, 14:122, March 1961.

This letter refers to two possible sources for the localized hums heard by certain people: (1) internal physiological noises; and (2) an unusual sensitivity to man-made electromagnetic radiation.

Referring to the item "Far, Far Worse" in the November issue, regarding the "Big Hum of East Kent (GSH-005), I wish to state that I have read an article about the same subject in a recent copy of The Star, published in Washington, D. C.

This article stated that only certain persons along the low coastal areas have heard the hum and that authorities of Kent are wondering if persons in other parts of the world are hearing it too. It also stated that the hum does not seem to be so much something heard as something felt, possibly a form of radar; for one woman stated she hears it even when she closes her ears.

For about a year and a half I have been hearing a humming of this same nature. While there is a low humming sound connected with it, there also seems to be a more pronounced overtone in the middle range. It is continuous now, sometimes loud and sometimes faint, but always there. It is stronger indoors than outdoors, due, no doubt, to the absence of street noises.

After having examined everything in my apartment building that may have been

responsible for this sound, such as the refrigerator, laundry dryer in the basement, etc., and after having heard the hum even with my hand over my ears, I came to the conclusion that it is caused by high blood pressure, or something internal. Now I am not so sure.

I have waited for some person here in America to come forward in response to the article, but so far no one has.

Arlington, Va., also is located near sea level as is the coast of Kent.

GSH-008 HUMMING IN BELLMORE, N.Y.

Floyd, C. W.; Fate, 14:120, July 1961.

This is in reply to the letter regarding the "Big Hum" in the March, 1961, issue. It may help to explain such incidents for other Fate readers.

The writer of the letter is correct as to the sound of the "Big Hum." For several years I have heard this humming which is in the air and can be heard outside at times, but is more noticable indoors. As if penetrating down from the sky, it does have the sound of a motor, or even may be likened to the buzzing of bees, or the noise of escaping gas or air. In daytime or at night, the hum can linger for hours, at a very low pitch, as if in the distance. At times it becomes very clear as if nearby in the neighborhood. It also seems to reach a high pitch as if directly overhead, yet making a room or porch feel as if thousands of bees were gathered together, producing a sensation of vibration in the air. It stops and starts abruptly.

At times when the hum is quite clear I have been aware of a hot prickly feeling down my spine or between my shoulder blades. It may last for only several minutes, but I have felt as if a heat ray were focused on me. At other times the feel of the downward heat will cause me to have an itching sensation. If I scratch a red swollen mark will instantly appear on the part of the skin irritated. Yet in half an hour the itch and the red scratch marks disappear. Ordinarily a scratch mark will be noticable for a few days.

Also, at times of the humming, an odor of gas or of fetid green plants is very strong. This odor can make one feel faint and sick until it suddenly goes. In summer I thought that the green trees and shrubs might be the cause of the odor, but it is present in the winter also.

I live on the south side of Long Island where waterways lead out into the ocean. I am about a mile or two from it, but I doubt that my location has any connection with the "Big Hum."

Many of the physiological effects mentioned by Floyd resemble those reported in conjunction with earthquakes, infrasonic waves, and other geophysical phenomena. Note also the similarity of the "Big Hum" to the Yellowstone Lake "whispers."

GSH-009 YELLOWSTONE LAKE WHISPERS

Fuller, Curtis; Fate, 19:31, March 1966.

For more than a century visitors have reported hearing strange sounds floating across the biggest lake in Yellowstone Park.

Clyde May Bauer, geologist and former chief naturalist at Yellowstone,

describes the noises as resembling "the ringing of telegraph wires or the hum of bees, beginning softly in the distance, growing rapidly plainer until directly overhead and then fading rapidly in the opposite direction."

The sound has also been compared with the dirge of a giant pipe organ and the echoing of distant bells. The sounds are heard most distinctly in the early morning of cloudless, windless days. One ranger says he heard them nearly every morning for a month.

There are many theories but John M. Good, the park's current naturalist, says "so far no one has the faintest proof of what causes them."

GSH-010 BARISAL GUNS AND SIMILAR SOUNDS

Scourfield, D. J.; Nature, 53:296, January 30, 1896.

In connection with the recent correspondence upon "Remarkable Sounds," the following quotation may be interesting. It occurs as a footnote in a paper by Prof. S. A. Forbes, of Illinois, upon the "Aquatic Invertebrate Fauna of the Yellowstone National Park, &c.," published in the Bulletin of the U. S. Fish Commission for 1891 (Washington, 1893), p. 215.

"Here we first heard, while out on the lake [Shoshone Lake, Yellowstone National Park] in the bright still morning, the mysterious aerial sound for which this region is noted. It put me in mind of the vibrating clang of a harp, lightly and rapidly touched, high up above the tree-tops, or the sound of many telegraph wires swinging regularly and rapidly in the wind, or, more rarely, of faintly-heard voices answering each other overhead. It begins softly in the remote distance, draws rapidly near with louder and louder throbs of sound, and dies away in the opposite distance; or it may seem to wander irregularly about, the whole passage lasting from a few seconds to half a minute or more. We heard it repeatedly and very distinctly here and at Yellowstone Lake, most frequently at the latter place. It is usually noticed on still, bright mornings not long after sunrise, and it is always louder at this time of day; but I heard it clearly, though faintly, once at noon, when a stiff breeze was blowing. No scientific explanation of this really bewitching phenomenon has ever been published, although it has been several times referred to by travellers, who have ventured various crude guesses at its cause, varying from that commonest catch-all of the ignorant, electricity, to the whistling of the wings of ducks and the noise of the 'steamboat geyser.' It seems to me to belong to the class of aerial echoes, but even on that supposition I cannot account for the origin of the sound."

The Yellowstone Lake sounds are highly intriguing due to their apparent motion across the sky. The only conventional sound source that moves across the sky with such speed would be a meteor. Another possibility is a pulse of infrasonic waves with audible components brushing the Yellowstone area from a distant source. However, the apparent concentration of observation on clear, calm mornings does not correlate with known potential sources. (See also GSM-001.)

GSH-011 STRANGE SOUNDS FROM THE SKY

Romig, Mary F., and Lamar, Donald L.; Sky and Telescope, 28:214-215, October, 1964. (Quotations by permission of Sky and Telescope.)

> It should be mentioned that two other natural phenomena cause sounds of a hissing nature. Lightning leader stroke produce brontophonic sounds, heard just before the thunderclap from the return stroke; and auroras have sometimes been reported to produce hissing sounds. The brontophonic noise is due to tiny corona discharges from the vegetation near the observer.....

May not other unexplained hisses and hums be due to unrecognized electrical processes high in the atmosphere?

Romig and Lamar introduce the subject of anomalous meteoric sounds by noting that such reports have decreased in recent years due to reasons such as these:

1. People are better educated and "know" that the sounds they perceive are physically impossible.
2. Unusual natural sounds tend to be masked by jets, reentering spacecraft, and other modern man-made noise.
3. People nowadays tend to spend the night hours inside watching TV.

> One of the few recent meteors that engendered anomalous sound reports was the "Mad Ann" fireball of September 1, 1962, seen in West Virginia, Virginia, and Ohio. The locations of observers of anomalous sounds are shown by number in Frank Drake's chart, along with the fireball trajectory. The observer near Covington stated in an interview that a hissing noise made him look up and see the fireball.
>
> The writers' recent survey of the astronomical literature of the 19th and 20th centuries indicates that this particular effect--hearing the sound before seeing the light--has occurred several times, often in connection with daylight fireballs; the Texas meteor of June 23, 1928, is an example. The survey also indicates that fireballs resulting in anomalous sound reports may have cosmic velocity, but must be rather bright (the average magnitude is -13). Neither the flight path nor the location of the observer relative to it is oriented in any particular way with the earth's magnetic field.
>
> Aside from the persistence of reports, and the remarkable similarity of anomalous noises in all languages, there is little evidence to indicate that these sounds are physically real, they must certainly be the result of an electromagnetic process. But only a few electromagnetic disturbances, which may have been coincidental, have occurred during fireball passages. Obviously, an observer of such a rare event is not prepared to make measurements.

See GSG-003 for the authors' discussion of possible physiological reactions to meteor-generated electromagnetic radiation.

GSH-012 SOUND OF THE AURORA

Burder, George F.; Nature, 23:529, April 7, 1881.

> Upon this subject it may not be out of place to recall the fact that the passage of large meteors is not uncommonly described as accompanied

by a hissing sound. I have met with statements of this kind in the case of meteors which were proved to have been twenty, thirty, or forty miles distant from the observer, and the sound of which, therefore, if it had reached him at all, must have reached him after such an interval of time that he would have been very unlikely to connect the two phenomena. Moreover the sound described in these cases is of a totally different character from the true sound of meteors, which is spoken of by those who have heard it as a heavy roaring or rumbling sound.

The explanation of the alleged "hissing" is not difficult when we remember that the untrained observer of a bright meteor (although it may be distant fifty or a hundred miles from him) invariably regards it as a near object, falling, it may be, into the next field, or behind a neighbouring hill. Regarding it in this light, he attributes to it, by a well-known mental process, a sound such as a firework at the same distance might be expected to produce.

May not the "rustling" of the aurora be equally a subjective phenomenon?

GSH-013 IS THERE AN AURORAL SOUND?

Oxaal, John; Monthly Weather Review, 42:27-29, January 1914.

After discussing the skeptical view of science on the subject of auroral sounds, Oxaal reviews his own experience on October 10, 1911 in northern Finland. First, he describes the aurora itself; then,

Little by little the aurora lost its strength and I sat down to supper. Some time after---unfortunately I can not tell the exact instant---I heard in the north a peculiar, even insistent, rumbling noise not unlike distant thunder. It was so characteristic that I jumped up to see what was going on. The aurora appeared like a bow in the north. It struck me at once that this must be the much-talked-of mysterious auroral sound, and in order to make sure of it I asked my two attendants if it proceeded from the aurora. They replied in the affirmative and continued their work as if it were a well-known and common occurrence.

We may attribute the sound to other causes, but it will be difficult to find a satisfactory one. The air was calm; so it could not have been the soughing of wind in the forest nor the sound of falling trees. It was 5 miles to the nearest inhabited place toward the north and south, 2 toward the northeast, and several to the post road. It is not likely that any travelers were abroad at this time of night in the winter's cold. A river flowed past our camp on the south. Its noise could be heard constantly, but it was even, continuous, and of a different character.

I wrote Mr. Waenerberg, superintendent of mines in Thule, west of Lake Enare, to ascertain whether or not the sound had been heard there. He has a long record of meteorological observations, at least 30 years in length, made for the Finnish Meteorological Institute, and is a very careful observer. He replied as follows:

"On October 10, 1911, we had a very beautiful, flaming aurora over the whole dome of the sky, but no sound was heard here. It is when the aurora sinks down low over field and forest that it is accompanied by a noise similar to that of a roaring and rushing stream. Four times in 34 years have I observed this sound and reported it to various observatories, of which Mr. Tromholt's is one."

It is 60 to 65 kilometers from my camp to Thule; so it is not at all unlikely that

the sound might be heard at one place and not at the other. Again, it is specially noteworthy that this reliable observer also states he has heard auroral sound, but according to his experience it is seldom so pronounced as to be heard generally.

I might again remark that while the aurora flamed and played in the most brilliant hues no sound was heard.

Another phenomenon which I observed at the same time ought to be mentioned as it probably has some connection with the sound heard. As remarked above, the display gradually decreased in strength. The wave motion became weaker, the definite boundaries disappeared, and the illumination became more general. The sky was quite clear before the appearance of the aurora. After a little, light clouds began to form near the zenith where the aurora had been. The transition, which seemed quite uniform, was peculiar to observe and at a certain point it seemed difficult to determine whether the faint light proceeded from the last rays of the dying aurora or from the fine, light, newly formed cirrus clouds.

. . . . . .

Tromholt's large catalogue of auroral observations in Norway up to 1878, published by Schroeter, has numerous discussions of this subject. The earliest, and in some respects rather unreliable, account is that of Absalon Pedersson, dated December, 1563. This recital is so amusing that I will repeat it here:

"One evening a little before Christmas I witnessed the following occurrence which began about 7:30 and continued until fully 9 p. m. Christern Ulff and a goldsmith and both their wives and servants saw it also. At first the moon shone clear in the east. Then a dark cloud which reached high up into the sky came over it. Presently a bright cloud, which shone like a white flame, formed and both remained stationary for some time. After they disappeared an unusually black cloud with scattered cloud wisps all about it approached from the south and overshadowed the moon so that it lost its light. After it had passed the sky grew red in the west and fire and flame darted back and forth so that a great noise was given off. I asked Christern Ulff what caused the sound, as I thought perhaps it came from the Alreichstadselff. He replied, 'Don't you see it is in the sky? It was the clouds that ran rapidly back and forth.' Afterwards other clouds, some black and some white, overcast the moon and then disappeared."

The darting clouds mentioned above should be compared with the curious spindle-shaped display of November 17, 1882. (GLA-011 and GLA-012)

Oxaal continues with the following observations of auroral sound recorded by other scientists.

Sophus Tromholt, who devoted almost his entire life to the study of the northern lights and who has written much in regard to them, has published in the Proceedings of the Videnskapsselskapet for 1880 a paper on the auroral sound which contains many interesting recitals. One of the most interesting of these is perhaps one from Dr. Follum, of Alten, who writes:

"Once in November, 1856, on Beskades, a mountain ridge between Alten and Kautokeino nearly 1,500 feet above sea level, on the occasion of an exceptionally brilliant aurora with gleaming rays of light shooting out from the crown I heard a peculiar, faint, crackling noise in the sky. My companion heard it also and I remember distinctly having stopped and remarked on the sound"

. . . . . .

The following contribution from Pilot O. J. Dahle (pilot on the Haakon Adelsten) dated March 30, 1910, was furnished me through the courtesy of Prof. Stormer:

"Eight or nine years ago I witnessed from the steamship Erling Jarl an extra-

ordinarily interesting aurora. While our ship was crossing Vaags Bay, a little north of Harstad, a brilliant aurora in rapid motion was seen so low down in the air that it barely cleared the tops of the masts. It flamed forth in all the colors of the rainbow and was followed by a peculiar sound, precisely such a sound as would be produced by rubbing together a well-dried skin in the hands. It was neither imagination nor the mistaking of any sound on board, but undoubtedly the result of the movement of the aurora. I have noticed also on other occasions that auroras in rapid motion hanging low in the atmosphere have emitted sounds similar to those mentioned above.

"In the above-named display it seemed that the auroral rays had a horizontal position and appeared as separate layers, one above the other. But the probability is that it was a vertical ray that, by reason of its nearness and its position directly over the ship, appeared to us to be horizontal and that the higher layers were the movements of the same ray seen through this identical ray from below."

A most significant point in Dahle's account is the very low altitude of the aurora, if it truly was an aurora and not some other atmospheric electrical phenomenon. Possibly low auroras are akin to the mountain-top glows mentioned in Subsection GLD.

The sulfurous odor noted is strange, although rather common in cases of ball lightning, earthquakes, and some other geophysical phenomena. There may have been enough electrical activity at low altitudes to create ozone.

. . . . . .

The well-known French balloonist, Rollier, who with an attendant ascended from Paris in 1870 during the siege and came down in Lifjeld, Telemarken, reports that he observed polar light rays through the light fog and, 'presently a peculiar rushing sound was heard. A short time after, strong, almost suffocating fumes of sulphur were encloutered.'"

. . . . . .

"The polar lights have grown more taciturn," says Humboldt, "since we have learned to observe them more closely," and that is quite possible, for there are probably numerous false reports of the auroral sound, especially those that report it as audible at the time the lights are most active and vivid, for it requires a certain time in which to traverse the distance to the observer.

On the other hand it is not always when the aurora drops down moderately near the earth that it can be heard. There are numerous accounts of the polar lights which, judging from the observers' descriptions, have been very near the surface of the earth and which according to these descriptions have not been accompanied by any sound.

In a work on the height of the aurora by Cleveland Abbe in Terrestrial Magnetism, 1898, are cited a great number of reports of such displays which have been seen against the mountains and hence very near the earth, as, for instance, that of the well-known polar explorer, Parry. Sir William Hooker saw the same phenomenon at Ben Nevis, Scotland. General Sabine observed an aurora that was so low that it lay like fog over the ground, through which he walked. Galle, the famous astronomer, saw a cloud growth following an aurora and also a display very similar to that which I observed in Finland, and I cite Galle's observations here because the account of such a man surely ought to be given great weight. It seems therefore incontrovertible that the aurora, under certain conditions, may reach down into the atmosphere at least to the altitude of the cirrus level, approximately 6,000 meters.

GSM-001 STRANGE NOISES HEARD AT SEA OFF GREY TOWN

Dennehy, Charles; Nature, 2:25-26, May 12, 1870.

A brief flurry of letters to Nature was stimulated by the following letter covering strange noises in the sea. The Grey Town "music" is certainly not the only oceanic music recorded in an around the ocean as other entries in this section will demonstrate.

In submitting the following to the notice of your readers, I am guided only by the desire of seeking a solution of what to me and to many others appears a very curious phenomenon. The facts related can be vouched for by numbers of the officers and crews of any of the R. M. Company's ships.

I must premise that this phenomenon only takes place with iron vessels, and then only when at anchor off the port of Grey Town. At least, I have never heard of its occurring elsewhere, and I have made many inquiries.

Grey Town is a small place, containing but few inhabitants, situated at the mouth of the river St. Juan, which separates Nicaragua from Costa Rica, and empties itself into the Atlantic, lat. 10^{o} 54' N., and long. 83^{o} 41' W. In this town there are no belfries or factories of any kind.

Owing to a shallow bar, vessels cannot enter the harbour or river, and are therefore obliged to anchor in from seven to eight fathoms of water, about two miles from the beach, the bottom consisting of a heavy dark sand and mud containing much vegetable matter brought down by the river. Now while at anchor in this situation, we hear, commencing with a marvelous punctuality at about midnight a peculiar metallic vibratory sound, of sufficient loudness to awaken a great majority of the ship's crew, however tired they may be after a hard day's work. This sound continues for about two hours with but one or two very short intervals. It was first noticed some few years ago in the iron-built vessels Wye, Tyne, Eider, and Danube. It has never been heard on board the coppered-wooden vessels Trent, Thames, Tamar, or Solent. These were steamers formerly employed on the branch of the Company's Intercolonial service, and when any of their officers or crew told of the wonderful music heard on board at Grey Town, it was generally treated as "a yarn" or hoax. Well, for the last two years the company's large Transatlantic ships have called at Grey Town, and remained there on such occasions for from five to six days. We have thus all had ample opportunity of hearing for ourselves. When first heard by the negro sailors they were more frightened than astonished, and they at once gave way to superstitious fears of ghosts and Obeihism. By English sailors it was considered to be caused by the trumpet fish, or what they called such (certainly not the Centriscus scolopax, which does not even exist here). They invented a fish to account for it. But if caused by any kind of fish, why only at one place, and why only at certain hours of the night? Everything on board is as still from two to four, as from twelve to two o'clock, yet the sound is heard between twelve and two, but not between two and four. The ship is undoubtedly one of the principal instruments in its production. She is in fact for the time being converted into a great musical sounding board.

It is by no means easy to describe this sound, and each listener gives a somewhat different account of it.

It is musical, metallic, with a certain cadence, and a one-two-three time tendency of beat. It is heard most distinctly over open hatchways, over the engine-room, through the coal-shoots, and close round the outside of

the ship. It cannot be fixed at any one place, always appearing to recede from the observer. On applying the ear to the side of an open bunker, one fancies that it is proceeding from the very bottom of the hold.

Very different were the comparisons made by the different listeners. The blowing of a conch shell by fishermen at a distance, a shell held to the ear, an aeolian harp, the whirr or buzzing sound of wheel machinery in rapid motion, the vibration of a large bell when the first and louder part of the sound has ceased, the echo of chimes in the belfry, the ricocheting of a stone on ice, the wind blowing over telegraph wires, have all been assigned as bearing a more or less close resemblance; it is louder on the second than the first, and reaches its acme on the third night; calm weather and smooth water favour its development. The rippling of the water alongside and the breaking of the surf on the shore are heard quite distinct from it.

What is, then, this nocturnal music? Is it the result of a molecular change or vibration in the iron acted on by some galvanic agent peculiar to Grey Town? for bear in mind that it is heard nowhere else, not at Colon, some 250 miles distant on the same coast, not at Porto Bello, Carthagena, or St. Marta. The inhabitants on shore know nothing of it. If any of your numerous readers can assign a likely cause, will they be pleased to state by what means, if any, its accuracy may be tested? If required, I can forward a specimen of the mud and sand taken from the anchor.

GSM-002 STRANGE NOISES HEARD AT SEA OFF GREY TOWN

Evans, F. J.; Nature, 2:46-47, May 19, 1870.

With reference to the communication published in last week's Nature, on "Strange Noises heard at Sea off Grey Town," (GSM-001) it does not appear necessary to refer these noises to any occult galvanic agency, or magnetic influence in connection with iron ships, although at first sight, and more especially as there is much ferruginous sand in the vicinity, and as the sounds are heard only in iron ships, and not in wood-built, copper-bottomed vessels, there seems ground for such an idea. The solution I would venture to offer is that these noises proceed from "musical fish" or shells.

Musical sounds proceeding from under water, agreeing in character with those described by Mr. Dennehy, appear to be known on the western coast of India and on the coast of Chili. A very interesting account of these musical sounds will be found in Sir Emerson Tennent's work on Ceylon, from the author's own experiences at Batticaloa in that island. His impressions as to the gentleness and harmony of the sounds are as vividly described as those of your correspondent from the Royal Mail Ship Shannon: and although Sir E. Tennent throws no light on the remarkable periodicity of the phenomenon, yet he gleaned by his inquiries that the sounds were heard at night, and most distinctly when the moon was nearest the full. Your readers will find the details at p. 468 et seq., 2nd vol., Edition of 1859.

GSM-003 STRANGE NOISES HEARD AT SEA OFF GREY TOWN

Kingsley, C.; Nature, 2:46, May 19, 1870.

I am glad to see that the vexed question of the noise heard from under the sea in various parts of the Atlantic and Pacific has been re-opened by a gentleman so accurate and so little disposed to credulity as Mr. Dennehy. The fact that this noise has been heard at Grey Town only on board the iron steamers, not on board the wooden ones, is striking. Doubtless if any musical vibration was communicated to the water from below, such vibration would be passed on more freely to an iron ship than to a wooden one. But I can bring instances of a noise which seems identical with that heard at Grey Town being heard not only on board wooden ships, but from the shore.

I myself heard it from the shore, in the island of Monos, in the Northern Bocas of Trinidad. I heard it first about midnight, and then again in the morning about sunrise. In both cases the sea was calm. It was not to be explained by wind, surf, or caves. The different descriptions of the Grey Town noise which Mr. Dennehy gives, will each and all of them suit it tolerably. I likened it to a locomotive in the distance rattling as it blows off its steam. The natives told me that the noise was made by a fish, and a specimen of the fish was given me, which is not Centriscus scolopax, the snipe-fish, but the trumpet-fish or Fistularia. I no more believe that it can make the noise than Mr. Dennehy believes (and he is quite right) that the Centriscus can make it.

This noise is said to be frequently heard at the Bocas, and at Point a Pierre, some twenty-five miles south; also outside the Gulf along the Spanish main as far as Barcelona. It was heard at Chagreasancas (just inside the Bocas) by M. Joseph, author of a clever little account of Trinidad, on board a schooner which was, of course, a wooden one, at anchor. "Immediately under the vessel," he says, "I heard a deep and not unpleasing sound, similar to those one might imagine to proceed from a thousand AEolian harps; this ceased, and deep and varying notes succeeded; these gradually swelled into an uninterrupted stream of singular sounds, like the booming of a number of Chinese gongs under water; to these sounds succeeded notes that had a faint resemblance to a wild chorus of a hundred human voices singing out of time in deep bass."

He had, he says, three specimens of the trumpet-fish, said to make the noise, either by "fastening the trumpet to the bottom of a vessel or a rock," or without adhering to any object. The whip-like appendage to the tail, which he describes, marks his specimens at once as Fistularias.

. . . . . .

Another instance of this sound being heard on board a wooden ship (and this time again in the Pacific) is given (in p. 304 of Mr. Griffith and Colonel Hamilton Smith's edition of Cuvier's Fishes, on no less an authority than that of Humboldt who (say the editors and authors of the Appendix) did not suspect the cause. "On the 20th of February, 1803, toward seven in the evening, the whole crew were astounded by an extraordinary noise, which resembled that of drums beating in the air. It was at first attributed to the breakers. Speedily it was heard in the vessel, and especially toward the poop. It was like a boiling, the noise of the air which escapes from fluid in a state of ebullition. They then began to fear that there was some leak in the vessel. It was heard unceasingly in all parts of the vessel, and finally, about nine o'clock, it ceased altogether. From the narration (says Cuvier) which we

have extracted, and from what so many observers have reported touching various Sciaenoids, we may believe that it was a troop of some of these species which occasioned the noise in question."

For there is, without doubt, a great deal of evidence to show that certain Sciaenoids make some noise of this kind. The Umbrinas, or "maigres" of the Mediterranean and Atlantic are said to be audible at a depth of twenty fathoms, and to guide the fishermen to their whereabouts by their drumming. The fishermen of Rochelle are said to give the noise a peculiar term, "seiller," to hiss; and say that the males alone make it in spawning time; and that it is possible, by imitating it, to take them without bait. The "weak-fish" of New York (Labrus squetaquee of Dr. Mitchell) is said to make a drumming noise. But the best known "drum-fishes" are of the genus Pogonias, distinguished from Umbrina by numerous barbules under the lower jaw, instead of a single one at the symphysis. M. Cuvier names them Pogonias fusca, and mentions that "it emits a sound still more remarkable than that of the other Sciaenoids, and has been compared to the noise of several drums." The author of the Appendix states that these "drum-fish" swim in troops in the shallow bays of Long Island; and according to Schoepf (who calls them Labrus chromis) assemble around the keels of ships at anchor, and then their noise is most sensible and continuous. Dr. Mitchell, however, only speaks of their drumming when taken out of the water. Species of the same genus, if not identical, are found as far south as the coast of Brazil; and it is to them, probably, that that noise is to be attributed which made the old Spanish discoverers report that at certain seasons the nymphs and Tritons assembled in the Gulf of Paria, and made the "Golfo Triste glad with nightly music."

Kingsley's letter enlarges the geographical scope of this phenomenon a great deal and also extends it to wooden ships.

It is curious that the descriptions of the Grey Town noises are very similar to those of the Yellowstone Lake "whispers"---harp-like, resembling voices. (GSH-010)

GSM-004 [THE BELL OF NAKOUS]

Ponton, Mungo; Earthquakes, Their History, Phenomena and Probable Causes, T. Nelson & Sons, Edinburgh, 1888.

> At Nakous, near the shore of the Red Sea, there are heard at intervals, underground sounds resembling the tinkling of a bell. This phenomenon is probably due to some sort of suppressed volcanic agency. (p. 215)

GSM-005 [ORGAN NOTES ON THE ORINOCO]

Gould, Rupert T.; Enigmas, University Books, New Hyde Park, 1965.

Gould reports that Humboldt mentioned "certain sounds, like the note of an organ, sometimes heard near sunrise at various points on the Orinoco." (p. 35)

SECTION GW: WEATHER PHENOMENA

Weather is so incredibly varied and possesses so many facets that the following list must be considered to be preliminary only.

*GWC Strange clouds. Noisy clouds. Clouds pulsing with light. Luminous and noctilucent clouds. Correlations with earthquakes, meteors, and other geophysical phenomena.

*GWD Dark days. Such as New England's famous dark day. Some seem related to forest fires, but they have also been associated with earthquakes and other events.

*GWF Peculiar fogs. Fogs and mists correlated with auroras, earthquakes, and light wheels. "Blasting" fogs.

GWP Precipitation oddities. Colored rain, snow, and hail. "Blood" rain. Unusual hailstones. Cloudbursts. Giant snowflakes.

*GWR Temperature anomalies. Sudden, drastic changes in temperature.

*GWS Solar and lunar effects. Influence of solar activity and lunar position on the weather.

*GWT Tornadoes and waterspouts. Correlated with ball lightning, luminous columns, unusual sounds, burning effects, and physiological effects.

GWW Whirlwinds and dust devils. "Pranks" of whirlwinds. Possible electric and magnetic effects.

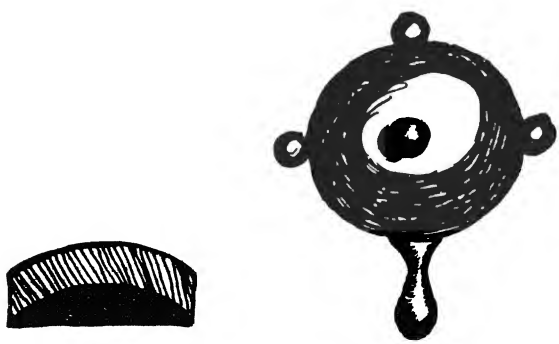
*This subsection not represented in Volume G1.

This page reserved for the expansion of the preceding categories in future volumes.

GWP-001 [STRANGELY SHAPED HAILSTONES]

Anonymous; Nature, 23:233, January 6, 1881.

To the October number of Symons's Monthly Meteorological Magazine Col. Foster Ward writes describing some remarkable hailstones that fell during a slight thunderstorm at Partenkirchen, Bavaria, at 6 p.m. on August 21. He was on a mountain about 3000 feet above the village, and saw the cloud (a small one) pass over the valley below. There were several peals of thunder, but there was no visible lightning, owing, he concludes, to the sun's brightness. "On arriving near home, I met a friend who told me it had been hailing 'tadpoles' and 'acidulated drops.' There had been little or no rain and no visible lightning, and the hailstones fell at intervals and about six feet apart. There were very few of them, my family only picking up twenty in a space occupied by a full-sized lawn tennis court. My son made a sketch of their shape and size, which I inclose. The greater part were of the 'tadpole' shape and were clear as glass, perfectly round, the five knobs being at equal distance from one another. The flat stones had more or less a slight nucleus of snow in the convex portion of the stone. My wife and three daughters, and two ladies staying with us, say that the stones looked just like a lady's hand looking-glass, with a knob at the top and on either side for ornament. More than twenty, perhaps thirty, were picked up of this shape. Of these about two-thirds were studded, the rest plain, with only the tail or handle, the thinnest part of it being near the body of the stone, as in sketch. The studs were all symmetrically placed. There were from three to five in each stone besides the handle. When there were less than five they occupied the same positions as if the five had been complete. In some cases the handle appeared to have been knocked off. The drops were more numerous, were all of same shape, convex at the top, the bottom being concave (like a small china painting palette)."



On the left, section of the convex, disk-like hailstones that fell in Bavaria. On the right, sketch of the tadpole-shaped variety. (Adapted from GWP-001)

GWP-002 A FALL OF YELLOW RAIN

Anonymous; Nature, 2:166, June 30, 1870.

On the 14th of February a remarkable yellow rain fell at Genes. The following details respecting it are given in a letter addressed to M. Ad. Quetelet by M. G. Boccardo, director of the Technical Institute of Genes, who examined it in concert with Dr. Castellani, professor of chemistry. The quantitative analysis gave the following results:-

Water	6.490 per cent
Nitrogenous organic abstances	6.611 "
Sand and clay	65.618 "
Oxide of iron	14.692 "
Carbonate of lime	8.589 "

Observed narrowly under the microscope, the presence was revealed of a number of spherical or irregular ovoid substances of a cobalt blue colour; corpuscles similar to the spores of Peziza or Permospora; spores of Demaziacece or Spheriacece; a fragment of a Torulacea (?); corpuscles of a pearly colour, concentrically zoned, probably small grains of fecula; gonidia of lichens; very scarce fragments of Diatomacece; spores of an olive brown colour; a few fragments of filaments of Oscillaria, Ulothrix, and Melosira varians; a fragment of Synedra; a peltate hair from an olive leaf. If, instead of collecting the earth on the morning of the 11th, when it had already been subjected to the action of rain falling for several hours, I had been able (writes M. Boccardo) to observe the phenomenon during the night, at the moment when it was produced, it is very probable that the microscope would have shown the existence of several kinds of Infusoria, as has been the case in several similar instances.

The author notes that the direction of the wind at Genes during the night of the 13th and 14th was from the south-east, and without being exactly a hurricane as on the preceding few days, was still very strong.

Yellow rainfall is usually associated with pollen falls such as those described in GFL-002.

GWP-003 MORE ABOUT THE HAILSTONES OF REMIREMONT

Anonymous; English Mechanic, 87:436, June 12, 1908.

Under this title, the Semaine Religieuse de Saint-Die has published the following letter from the Cure of Saint-Etienne-les-Remiremont:

"Sir,---Up to now I have kept absolutely silent on the events which took place on Trinity Sunday at Saint-Etienne and Remiremont.

"As I am the only ecclesiastic who saw these now historic hailstones, I believe it is my duty to say a word.

"If I give some particulars of the manner in which I employed my time during the evening of Trinity Sunday it is to show that I was as sceptical as any Thomas.

"I was alone in my presbytery; my curate had been called away on family affairs. Suffering from rheumatism of the knee, I had installed myself comfortably in order to read a large and heavy treatise on geology.

"I had only turned over a few pages on the formation of ice when I heard the door quickly opened. Mlle. Marie Andre, not seeing anyone, called out to me from the passage: 'Monsieur le Cure!' As I was not able to move easily, I replied from where I was: 'Is the house on fire?' But she called out louder, 'Monsieur le Cure, come quickly---they are melting!'

"Mlle. Andre was so persistent that I decided to get up and see what was the matter. 'Look,' she said to me, 'here is the image of our Lady of the Treasure printed on the hailstones.' 'Come, come,' I said; 'do not tell me these silly tales.'

"In order to satisfy her, I glanced carelessly at two hailstones which she held in her hand. But, since I did not want to see anything, and, moreover, could not do so without spectacles, I turned away to go back to my book. She urged, 'I beg of you to put on your glasses.' I did so, and saw very distinctly on the front of the hailstones, which were slightly convex in the centre, although the edges were somewhat worn, the bust of a woman, with a robe turned up at the bottom like a priest's cope. I should, perhaps, describe it still more exactly by saying that it was like the Virgin of the Hermits. The outlines of the image were slightly hollow, as though they had been formed with a punch, but were very boldly drawn.

"Mlle. Andre asked me to notice certain details of the costume, but I refused to look at it any longer. I was ashamed of my credulity, feeling sure that the Blessed Virgin would hardly concern herself with instantaneous photographs on hailstones. I said: 'But do you not see that these hailstones must have fallen on vegetables, and thus received these impressions? Take them away; they are no good to me.' I returned to my book, without giving any further attention to what had happened.

"But my mind was disturbed by the singular formation of these hailstones. I picked up three, in order to weigh them, without looking at them closely. They weighed between six and seven ounces. One of them was perfectly round, like balls with which children play, and had a seam around it as though it had been cast in a mould.

"During my supper (I was alone) I said to myself: 'All the same, these hailstones are of unusual shape, and the imprint on the two I examined was so regular that it can hardly have been due to chance.'

"But I quickly stiffened myself against all thought of the supernatural, and was ashamed of having entertained it for a moment. The storm passed, and I left the table to see what damage had been done to the kitchen garden. I did not hurry, for I supposed that all the vegetables were cut to pieces.

"Nothing of the sort. On going through the paths I only noticed one little branch of a tree broken. But, on the other hand, the ground was riddled with holes from one to two inches deep, like the footprints of a large dog. These holes remained visible for more than two months in places where the earth had not been stirred, particularly under the trees.

"The hailstones were not everywhere harmless, for 1,400 large panes in the roofs of workshops were broken, and the pieces lodged on the work, causing considerable damage, except to the pockets of the glaziers.

"According to information which I believe to be true, the strip of country visited by the large hailstones was not more than three-quarters of a mile wide, extending from Saint-Mont to the fort at Remiremont, and passing through the manufactories at Saint-Etienne. Some few straggled as far as Moulins (Saint-Nabord); but none were seen either at Saint-Ame or at Dommartin, nor in the village nearest to the church of Saint-Etienne, a little over half a mile away.

"What appeared most worthy of notice was that the hailstones, which ought

to have been violently precipitated to the ground in accordance with the laws of acceleration of the speed of falling bodies, appeared to have fallen from the height of but a few yards, and to have only acquired the initial velocity of a falling body.

"Towards half-past seven the news was spread about in the vicinity of the presbytery that many persons had observed the image of Our Lady of the Treasure on the hailstones, and that a number of them were in the form of medallions. Children had collected them in their aprons, and shown them to their parents, who had verified the presence of the same image. Some even saw small details, such as the Virgin's crown, the Child Jesus, the fringes of the robe. Was this the result of imagination?

"But, apart from these details, there is no doubt that the greater part of the hailstones which were examined bore distinctly the image of Our Lady of the Treasure.

"The following morning the milkmen, on returning from Remiremont, reported that many persons in the town had observed the same thing.

"The evidence as to fact is, therefore, indisputable. On the following Sunday, after mass, I asked some young women who had been singing whether any of them had seen the hailstones with the imprint of the Virgin. Out of sixty-five, ten assured me that they had. After vespers I collected fifty more signatures of persons who were thoroughly convinced of the truth of their observations. I do not attach importance to these signatures, which I might be suspected of having influenced, but they were spontaneously given.

"Savants, though you may try your hardest to explain these facts by natural causes, you will not succeed. In the end, the town council of Remiremont, for profound reasons which I need not discuss, forbade the magnificent procession which was in preparation; but on the following Sunday at the same hour the artillery of heaven caused a vertical procession which no one could forbid.

"(Signed) L'Abbe Gueniot,

"Cure de Saint-Etienne-les-Remiremont."

[The last paragraph settles it, of course! Mr. Tweedale could not have uttered a more clinching ipse dixit!---Ed.]

GWP-004 OBSERVATIONS ON THE METEORS OF NOVEMBER 13TH, 1833

Olmsted, Denison; American Journal of Science, 1:25:363-411, 1834.

12. CONCURRENT PHENOMENA.--Near the time of the meteors, there were several remarkable events, which it may be well to record, although they may not have the least connexion with the phenomenon under review.

. . . . . .

(2.) Soon after 10 o'clock, I felt a slight repetition of the tremulous motion of the earth, which has repeatedly been observed in this vicinity of late. (W. F. G. Smith, Lynchburg, see p. 376.)

(3.) At Harvard, in this state, at about 8 o'clock on the morning of the 13th [Nov.] there was a slight shower of rain, when not a cloud was to be seen, the weather being what is called perfectly fair. (Boston Mer. Journal.)

(4.) The writer of this article observed an appearance resembling zodiacal light, between the hours of 7 and 8 on the evenings of Dec. 1st and 3d. That of Dec. 3d. was observed by Messrs. Forrest Shepard, and J. N. Palmer, of New Haven. It consisted of an auroral appearance in the west following the twilight, being an apparent prolongation of the latter. It reached to a length of about 25°,

towards the head of Aquarius. We imagined the galaxy, in that part of the heavens, appeared more luminous than usual. (p. 398)

Ice falls are also associated with meteors on occasion. See GSH-001.

GWP-005 SUNSPOTS AND RAINFALL

Anonymous; Nature, 17:443-445, April 4, 1878.

A great many papers have been published which try to prove or disprove the influence of solar activity upon terrestrial weather. Only the most interesting and significant will be quoted to any extent.

In this present anonymous article, the writer refers first to a debate underway in the House of Commons regarding expenditures for alleviating the Indian Famine. It is described how Dr. Lyon Playfair corrected some misconceptions that arose:

> Dr. Lyon Playfair, as was to be expected, put this matter right before the house. He stated that "it was established that the famines in India came at periods when sun-spots were not visible. Out of twenty-two great observatories of the world it has been shown in eighteen that the minimum rainfall was at times when there were no spots on the sun. That was as true in Edinburgh as in Madras, in St. Petersburg as in Australia. It was therefore essential for the Government of India to take that into consideration in calculating as to when famines were likely to occur. The Secretary of State for India had acted wisely in sending out photographers to the Himalayas to take photographs of the sun, and having seen some of those, he was sorry to say that on none which he had seen were spots to be detected." .....

Next, this article mentions a paper to be published by Mr. Meldrum:

> In this important paper, Mr. Meldrum, than whom there exists no higher authority, states that the result of his seven years' work has been to convince him that the connection between sun-spots and rainfall is as intimate as that between sun-spots and terrestrial magnetism; and that having regard to the number of cycles at our disposal we should be as justified in rejecting the diurnal oscillation of the barometer as the curve along the hills and hollows of which the maximum and minimum rainfalls of the world lie.
>
> The result of course will be received with incredulity by many--and for many reasons. In the first place the enormous variation in the solar activity is a fact only fully realised by very few. Men grown old in the service of science are as a rule as little anxious to receive new ideas as men grown old in any other of the world's activities, and further and more than this, in the case of many there is what has recently been happily termed "a paralysis of the imagination"--a thing far removed from scientific caution--which may and indeed certainly would do much harm to scientific progress if those afflicted with it had any chance of having the exclusive say in the matter.

Finally, extracts are presented from several papers of Sir William Herschel which describe the variability of solar activity and how this variability might be magnified in terms of terrestrial weather and, in turn, agriculture.

The tone of this paper is fascinating, for it takes as proved the dominance of solar activity on our weather. Nearly a century later, this is still a controversial question.

GWP-006 THE RELATION BETWEEN RAINFALL AND METEOR SHOWERS

Bowen, E. G.; Journal of Meteorology, 13:142-151, April 1956.

Examination of rainfall figures for a large number of stations shows that there is a tendency for more rain to fall on certain calendar dates than on others. There is a close correspondence between the dates of the rainfall maxima in both the northern and southern hemispheres, and this is difficult to explain on a climatological basis. The effect might, however, be due to an extraterrestrial influence.

The rainfall peaks occur approximately 30 days after prominent meteor showers, and it is suggested that they are due to the nucleating effect of meteoritic dust falling into cloud systems in the lower atmosphere, the time difference being accounted for by the rate of fall of the material through the atmosphere.

The hypothesis is tested for a particular meteor stream, the Bielids, which is known to have a 6.5-year period. The rainfall 30 days after the meteor shower is found to have a similar period. Furthermore, the phase of the rainfall periodicity is almost identical with that of the meteor shower.

The data examined are confined to the month of January, and it is proposed to extend the investigation to other months in future papers.

The above quotation is from Bowen's abstract. Since meteor influx may be related to the position of the moon, rainfall may be, too.

GWP-007 AN EIGHTY POUND HAILSTONE

Anonymous; Scientific American, 47:119, August 19, 1882.

Considerable excitement was caused in our city last Tuesday evening by the announcement that a hailstone weighing eighty pounds had fallen six miles west of Salina, near the railroad track. An inquiry into the matter revealed the following facts: A party of railroad section men were at work Tuesday afternoon, several miles west of town, when the hailstorm came upon them. Mr. Martin Ellwood, the foreman of the party, relates that near where they were at work hailstones of the weight of four or five pounds were falling, and that returning toward Salina the stones increased in size, until his party discovered a huge mass of ice weighing, as near as he could judge, in the neighborhood of eighty pounds. At this place the party found the ground covered with hail as if a wintry storm had passed over the land. Besides securing the mammoth chunk of ice, Mr. Ellwood secured a hailstone something over a foot long, three or four inches in diameter, and shaped like a cigar. These "specimens" were placed upon a handcar and brought to Salina. Mr. W.J. Hagler, the North Santa Fe merchant, became the possessor of the larger piece, and saved it from dissolving by placing it in sawdust at his store. Crowds of people went down to see it Tuesday afternoon, and many were the theories concerning the mysterious visitor. At evening its dimensions were 29 x 16 x 2 inches.---Salina (Kansas) Journal.

GWW-001 A CURIOUS PHENOMENON

F., T.; Nature, 6:435, September 26, 1872.

A very curious phenomenon was witnessed here on Wednesday afternoon last, September 4, about three o'clock, in a westerly direction. A somewhat heavy thunderstorm, originating towards the south, had divided its fury before reaching this immediate neighbourhood, one branch passing N. E. towards the Pennine Hills, the other taking the N. W. coarse, that to the N. E., however, being more violent. As the storm was passing, a stream---apparently of water, and fully six inches in breadth---shot with considerable speed from the vicinity of a dark, fiery cumulus across a rain cloud of a very deep blue, murky tinge. Its passage, as witnessed by my boy from its commencement, was similar to that of a rocket, at first assuming a quivering motion, then darting suddenly forward, for some distance horizontally, afterwards obliquely. Its apparent length would be fully twenty yards, being of a very light slate colour. After I saw it the phenomenon remained about two minutes; but its total duration would be not less than five, vanishing gradually during its whole length.

Whatever the phenomenon itself---or its cause, its upward course was certainly very striking, and to me unprecedented---the impression on some people's minds being that it was water drawn up from Lake Ullswater into the clouds by the lightning!! A terrific storm of thunder and lightning occurred on the previous evening at 9 p. m., when several fatal accidents were reported.

Note: misspellings in the original text are copied faithfully.

GWW-002 EXTRAORDINARY WHIRLWIND IN IRELAND

Anonymous; Nature, 6:541, October 31, 1872.

In a letter to the Belfast News-Letter, Mr. C. J. Webb describes an extraordinary whirlwind which occurred in the district around Randalstown, about six miles N. W. of Antrim, near the shores of Lough Neagh, on the 25th of August last. The same phenomenon was witnessed about an hour and a half earlier the same evening at Banbridge, about seven miles S. W. of Dromore. It was first seen near Randalstown about 5 p. m., between that place and Toome, moving rapidly up Lough Neagh from the south, and presenting the appearance of a defined column of spray and clouds, whirling round and round, and not many yards in breadth, while at its base the water was lashed into a circle of white foam. It was next heard of in the neighbourhood of Staffordstown, about a mile from the lake, where it partially unroofed two houses, and damaged any trees or crops which happened to be in its course. From this point it travelled in a straight line for Randalstown, about three miles distant. It passed across a field close to Mr. Webb's house, levelling eight haystacks, and carried a considerable part of the hay up into the air out of sight. The breadth of the storm could be accurately ascertained at this point, and must have extended about thirty yards, as stacks remained unruffled at either side, while those between were thrown down and carried away or scattered about. Everything it lapped up was whirled round and round, and carried upwards in the centre, while dense clouds seemed to be sucked down on the outside, and came close to the earth. Both before and after there was lightning and incessant peals of thunder; but there was no rain till some time afterwards.

The rest of the note describes the damage to a forest and railway station.

GWW-003 [DETONATIONS AND WHIRLWIND ACTION]

Fort, Charles; The Books of Charles Fort, Henry Holt and Company, New York, 1941.

In one of the descriptions of the Lough Neagh water guns (GSD-030) a whirlwind was observed immediately after the detonation. The observer felt certain that the two events were connected. Charles Fort found the following two reports of explosions followed by typical whirlwind action.

> London Times, July 5, 1842---a bright, clear day, at Cupar, Scotland, June 30th---women hanging out clothes on a common. There was a sharp detonation and clothes on lines shot upward. Some fell to the ground, but others went on and vanished. (p. 569)

> There was in June, 1919, at Islip, Northampton, England, an occurrence like the occurrence at Liverpool and Cupar. London Daily Express, June 12, 1919---a loud detonation---basketfull of clothes shooting into the air. Then the clothes came down. There may be ineffective teleportative seizures. (p. 570)

The final sentence is a typical Fortean remark.

GWW-004 A CURIOUS PHENOMENON

Anonymous; Scientific American, 43:25, July 10, 1880.

> The Plaindealer, of East Kent, Ontario, states that a curious and inexplicable phenomenon was witnessed recently by Mr. David Muckle and Mr. W. R. McKay, two citizens of that town. The gentlemen were in a field on a farm of the former, when they heard a sudden loud report, like that of a cannon. They turned just in time to see a cloud of stones flying upward from a spot in the field. Surprised beyond measure they examined the spot, which was circular and about 16 feet across, but there was no sign of an eruption nor anything to indicate the fall of a heavy body there. the ground was simply swept clean. They are quite certain that it was not caused by a meteorite, an eruption of the earth, or a whirlwind.

This phenomenon is difficult to classify. It is reminiscent of the whirlwind/detonation phenomenon viewed near Lough Neagh (GSD-030) as well as the preceding entry.

SUBJECT INDEX

Proper names are so profuse in the quoted sources that a thorough index of them would overwhelm the book; therefore, only important proper names, such as Barisal Guns, are indexed here. To give the index user a better grasp of the item at hand, highly distilled descriptions are frequently used rather than, say, lumping scores of entry references under the too-broad term "ball lightning." No attempt has been made to alphabetize these descriptions. However, entries have been collected under single descriptive phrases where possible. This type of index is experimental and may be changed in future volumes if it does not meet with user satisfaction.

DATE-OF-EVENT INDEX

If an article mentions a specific date or season for a phenomenon, it is indexed here. The distribution of dates is, of course, determined to some extent by the choice of literature. The heavy use of Nature before 1900 accounts for the large number of entries in this period.

1955: Feb 7, GLB-001; May 25, GLD-012, GLD-039
1956: Aug 12, GLB-072
1957: GLW-004
1958: Aug 21, GLL-009
1959: Feb 10, GLD-012; May 14, GLN-012; Jun 17, GLD-015; Oct 21, GLN-004
1960: Jun, GLD-030
1961: GLW-004
1962: Sep 1, GSH-011
1963: Mar 19, GLB-030; Dec 1, GLL-001
1965: Aug 25, GLB-027; Nov 9, GLM-003
1966: Mar, GLW-004; Mar 30, GLN-013; Jul, GLN-026; Jul 13, GLN-013; Aug 16, GLN-013; Dec 19, GLM-017
1968: Mar 1, GLD-001
1969: Jun, GLL-011
1970: May 15, GLB-028; Aug 12, GLB-020; Nov 14, GLD-043
1971: Apr, GLD-037; Aug, GLB-015

PLACE-OF-EVENT INDEX

If an article mentions the specific place where a phenomenon occurred, it is indexed here. Many of the place-names are obscure, particularly in the reports of a century ago. Therefore, entries are arranged, first, by major geographical area, such as the continents and oceans, and, second, by country or some readily recognized regional name. Because only the English literature was examined in preparing this volume, the British Isles and North America are represented heavily. The general content of the entry can be gleaned from the three-letter prefix.

AUTHOR INDEX

AUTHOR INDEX

SOURCE INDEX

The sources actually consulted are indexed below. Probably the most elusive publication listed is The Fortean Society Magazine issued by the now defunct Fortean Society. The great value of this journal, such as it was, resided in the verbatim transcription of a large number of Charles Fort's notes. Many of these have been checked out, found to be accurate, and included in this sourcebook.