DOUBLE MAP SUPPLEMENT: CANADA AND ITS VACATIONLANDS

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Holographic image of Africa's Taung child, one to two million years old

THE SEARCH FOR EARLY MAN

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I SUSPECT that not long after the first human stood up and looked around, he asked himself, "Where did I come from?" Several million years later we are still asking. There is no society that does not have a legend to deal with this mystery.

The Jewish, Muslim, and Christian faiths share the story of creation recorded in the Old Testament Book of Genesis some 2,500 years ago. If you grew up with the same King James edition of the Bible that I did, you learned that the world was created in 4004 B.C., making it now 5,989 years old. My Bible also revealed that Noah came ashore on Mount Ararat on the 17th day of the seventh month, 2348 B.C.

For a few years I accepted these dates on faith without knowing their source. I later learned they were from a timetable developed by Archbishop James Ussher of Dublin, Ireland, in the 1650s. He could not have imagined the number and intensity of the arguments his dates would generate between those fundamentalists who accept the story of Genesis literally and equally devout people who regard it as figurative. Ironically, the Bible gets lost in these debates, since nowhere does it attempt to date the universe.

I like to think the bishop did the best he could with the facts at hand. I also like to think that if he were to come back today, he would be fascinated by the tremendous advances in scholarship in just three centuries, and not too offended that his dates were a bit conservative. The universe we know today—billions of years old, populated with almost incomprehensibly complex life-forms programmed with astonishingly clever plans for heredity, change, and survival—might inspire in him, as it does in so many other people of faith today, even greater respect and devotion for the Creator.

We approach the age-old question of our roots in the lead story in this issue. As exciting and well researched, written, and photographed as it is, 300 years from now it may well seem as naive as the bishop's timetable does to us. And even though it leaves far more questions than answers, Mr. Weaver, Mr. Brill, and all the others who contributed to the presentation—drawing upon virtually all the sciences—have done a magnificent job of making a most complex subject readable and understandable. I'd like to think Bishop Ussher would approve.

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

November 1985

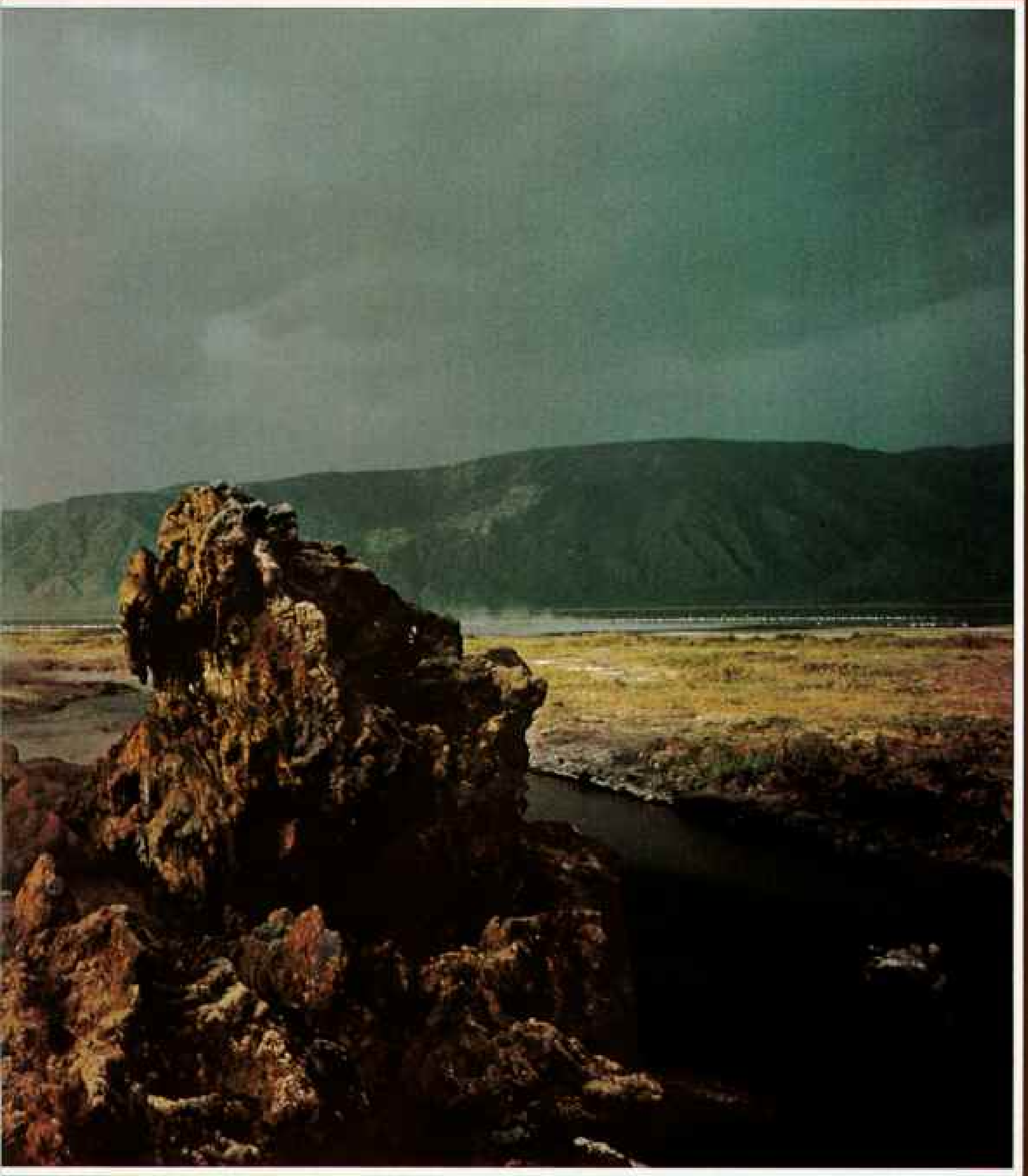
COVER: *Fossil skull of a five-year-old child, preserved for more than a million years in a South African cave, appears actual size in three dimensions in a hologram, best viewed under a single lamp or in direct sunlight. Produced by the American Bank Note Company, a wholly owned subsidiary of International Banknote Company, Inc.*

THE NATIONAL GEOGRAPHIC MAGAZINE
IS THE JOURNAL OF
THE NATIONAL GEOGRAPHIC SOCIETY
FOUNDED 1888

RESTLESS GRAVE, *East Africa's Rift System – here erupting in hot springs at Lake Bogoria, Kenya – has for millions of years preserved remains of*

STONES, BONES, AND EARLY MAN The Search

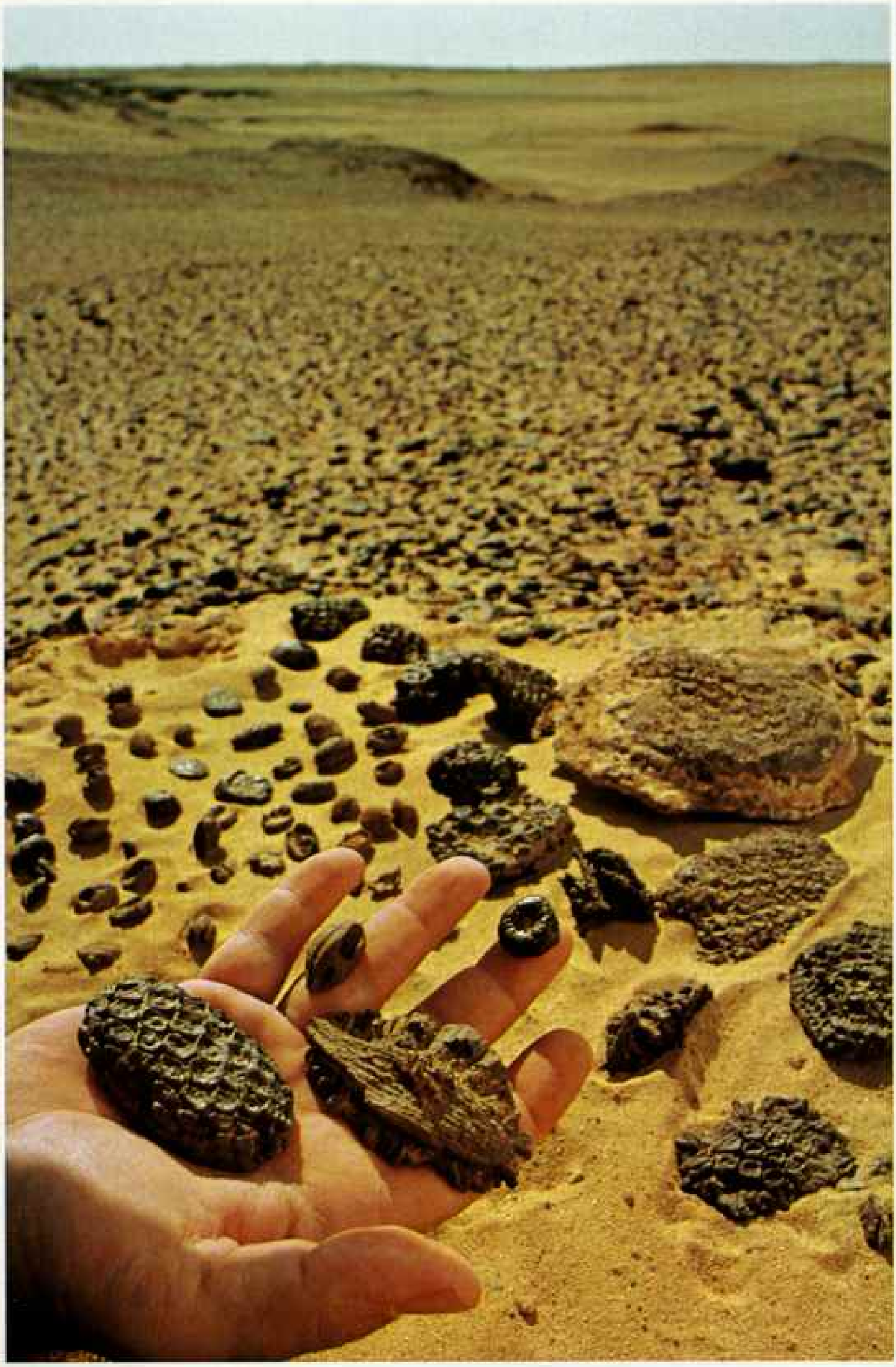
By KENNETH F. WEAVER SENIOR ASSISTANT EDITOR



the earliest bipeds yet found. As the vast region fractures, uplifts, and erodes, the fossils surface, yielding tantalizing clues to the story of man.

for Our Ancestors

Photographs by DAVID L. BRILL Paintings by JAY H. MATTERNES

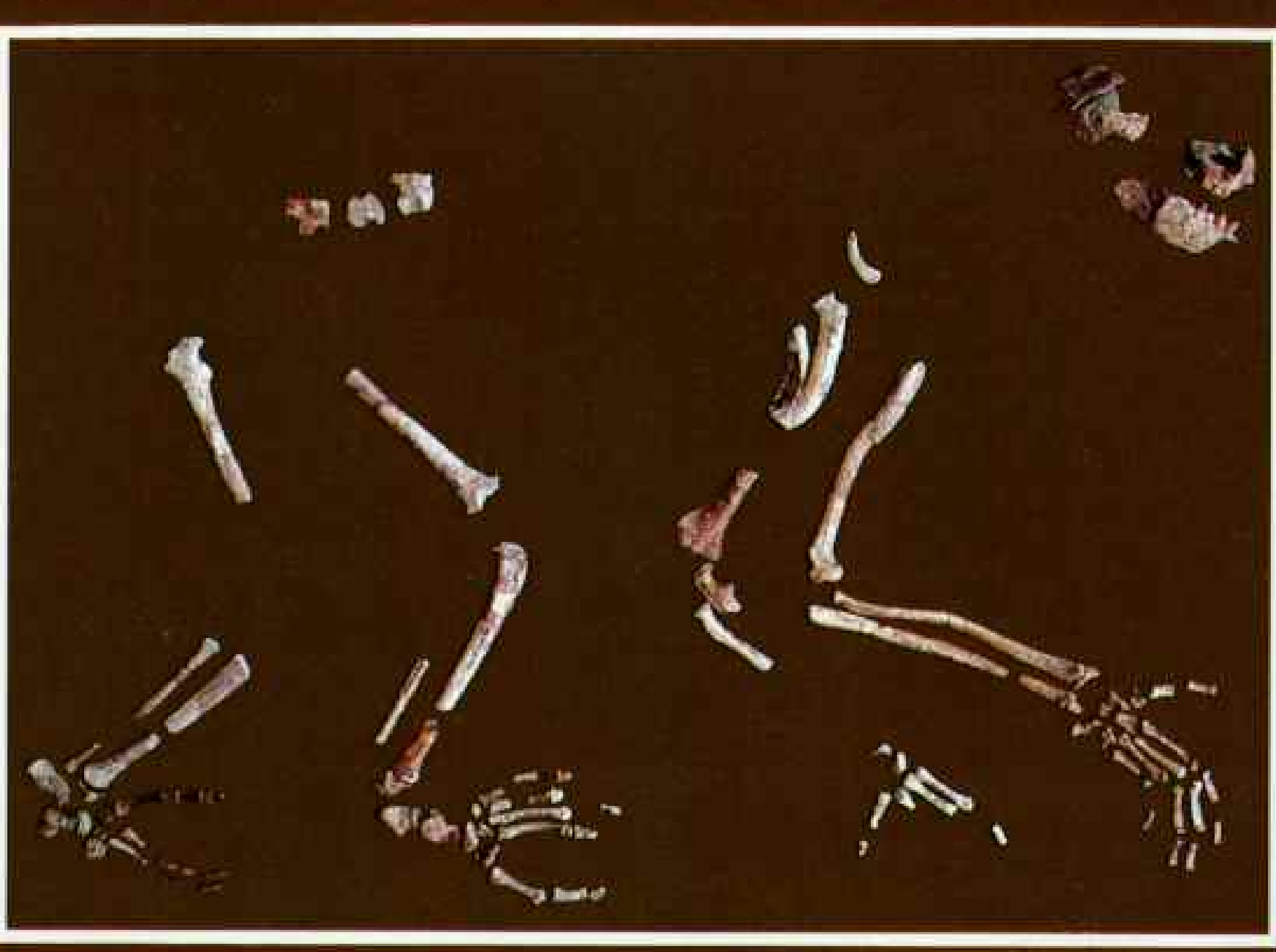


ON A MARTIAN LANDSCAPE in Egypt's Fayum Depression, excavators are finding fossils of the earliest higher primates—precursors of the great apes and man. Winds and flash floods have scoured 33-million-year-old sediments, exposing remains of a tropical rain forest. Fruit of Epipremnum *(the pinecone-like fossils at left)—a climbing vine still found in Southeast Asia—and small nuts probably fed the small arboreal* Aegyptopithecus *(right), dubbed the "dawn ape." Its snout is lemur-like, but the enclosed eye sockets and certain dental features, including 32 teeth—typical of apes and man—make it a likely link with Miocene apes such as* Proconsul.

This unusually complete specimen of Proconsul *(below), a tailless branch walker with an abducted grasping toe, was extracted from sandstone blocks excavated over the years at Rusinga Island in Lake Victoria, Kenya. Its short canine teeth help identify it as a female.*

During the Miocene epoch, from 24 to 5 million years ago, an array of early ape species spread throughout the Old World. Sometime during the last half of the epoch the ancestral line of pongid (ape) and hominid (man and his ancestors) split.

"The wonder of paleontology," says Duke University's Dr. Elwyn Simons, now digging in the Fayum, "is to take these bare damaged evidences and try to put them together to glimpse what the world was like many years ago."



UNASSOCIATED SKULL AND MANDIBLE OF *AEGYPTOPITHECUS ZEUXIS*, ABOUT 2/3 LIFE-SIZE (TOP); *PROCONSUL AFRICANUS*, 1/3 LIFE-SIZE, NATIONAL MUSEUMS OF KENYA (ABOVE)

Stepping out on the road to humanity

SUDDENLY A PRIMATE that stands, walks, and runs on two legs is discovered in a three-million-year-old stratum—with a skeleton so strikingly like our own that it is classified in our unique bipedal primate family, the Hominidae. Identified as an adult female of about 25 years and nicknamed Lucy, the partial skeleton was found by Dr. Donald C. Johanson and an international team at Hadar, Ethiopia, in 1974. Lucy, along with subsequent finds of bits of more than 60 other individuals there and at Laetoli, Tanzania, led to the naming of a new species: Australopithecus afarensis.

Lucy was a diminutive 1.1 meters (three feet eight inches) tall, although other A. afarensis fragments suggest heights up to 1.7 meters. She probably weighed some 30 kilograms (about 65 pounds). Her dense limb bones attest to great muscular strength. Lucy's face and apelike jutting jaws were large, but her brain was probably only one-third the size of a modern human's. Endocasts, plaster impressions made from partial A. afarensis braincases, suggest to some that reorganization toward the humanlike condition was already occurring.

This dental-plaster re-creation was articulated by Dr. Owen Lovejoy of Kent State University and his students. Starting with casts of the original fossils (page 592), here painted brown, they mirror-imaged the bones to supply some missing parts. Sections still absent were filled in, based on other skeletons.

Lucy and her kind adapted to the dry open uplands of Laetoli and the wooded lakeshores of Hadar and survived for about one million years before disappearing from the fossil record. Yet her skeletal traits suggest that she was on the line that eventually led to the human genus, Homo.

Faces from the past . . . lining up the fossil evidence

***THE SKULL** speaks volumes about each of nine generally recognized fossil hominids, which anthropologists classify in two genera.*

The genus Australopithecus possessed a small brain and large face. In the genus Homo a larger brain accompanied a decrease in facial size. The three-quarter drawings (bottom row), showing each skull restored and undamaged, illustrate this changing relationship. Colors call attention to shifts in the bony indicators of major chewing muscles and in tooth proportions.

The jaws, which in A. afarensis jut forward to anchor large incisors and canines (yellow), become less pronounced. In A. robustus and A. boisei, the molars (orange) increase dramatically (some to 2.1 centimeters—almost one inch—across), possibly an adaptation for crushing and grinding nuts, hard-skinned fruits, and tubers. Such teeth were powered by strong chewing muscles, including the temporalis, which helps control the lower jaw. As the temporalis increased in size, its area of attachment (pink) grew accordingly and, particularly in the male, often rose into a dramatic crest.

Another major chewing muscle, the masseter, anchors along the lower edge of the cheekbone (blue), whose forward position in the robust australopithecines produces the flat face.

In Homo species the back teeth became relatively smaller. As the brain enlarged, the skull expanded above the face.

DRAWINGS BY LUBA DMYTRYK GUDZ; PHOTOGRAPHS OF THESE AND OTHER FOSSILS AND ARTIFACTS THROUGHOUT THE ARTICLE BY DAVID L. BRILL WITH THE ASSISTANCE OF JOHN NIENHUIS

Scale:
Front view: 60% actual size
Side view: 30%
Diagram: 20%

Left side shown; image reversed for comparison

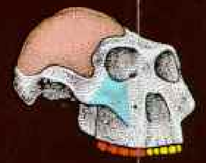
Image reversed

Designation: Composite
Geologic age: 3 to 3.6 million years
Sex: Adult male
Discovery: M. Bush, 1975
Site: Hadar, Ethiopia
Housed: National Museum of Ethiopia, Addis Ababa

A. afarensis

Designation: Sts 71
Geologic age: 2.5 to 3 million years
Sex: Adult male
Discovery: R. Broom and J. T. Robinson, 1947
Site: Sterkfontein, South Africa
Housed: Transvaal Museum, Pretoria

A. africanus

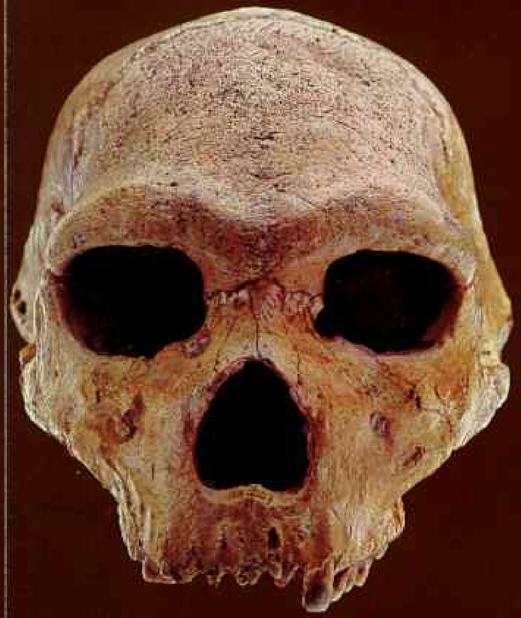


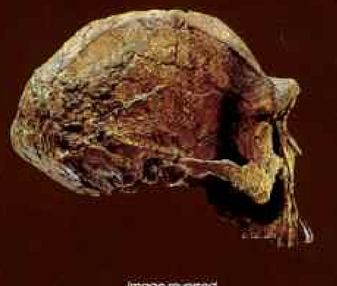
Designation: SK 48
Geologic age: 1.5 to 2 million years
Sex: Adult female
Discovery: Quarryman Fourie, 1950
Site: Swartkrans, South Africa
Housed: Transvaal Museum, Pretoria

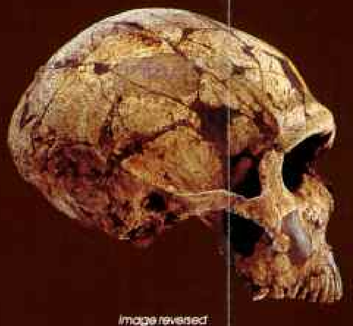
A. robustus

Designation: OH 5 ("Zinj")
Geologic age: ca 1.8 million years
Sex: Adult male
Discovery: M. D. Leakey, 1959
Site: Olduvai Gorge, Tanzania
Housed: National Museum of Tanzania, Dar es Salaam

A. boisei







Designation: KNM-ER 1470
Geologic age: ca 2 million years
Sex: Adult male
Discovery: B. Ngeneo, 1972
Site: Koobi Fora, Kenya
Housed: National Museums of Kenya, Nairobi

H. habilis

Image reversed

Designation: KNM-ER 3733
Geologic age: ca 1.5 million years
Sex: Undetermined
Discovery: B. Ngeneo, 1975
Site: Koobi Fora, Kenya
Housed: National Museums of Kenya, Nairobi

H. erectus

Image reversed

Designation: Petralona 1
Geologic age: Various estimates, 250,000 to 500,000 years
Sex: Adult male
Discovery: Greek villagers, 1960
Site: Petralona, Greece
Housed: Paleontological Museum, University of Thessaloniki

H. sapiens (archaic)

Image reversed

Designation: Ferrassie 1
Geologic age: ca 40,000 to 50,000 years
Sex: Adult male
Discovery: D. Peyrony and L. Capitan, 1909
Site: La Ferrassie, France
Housed: Musée de l'Homme, Paris

H. sapiens (Neandertal)

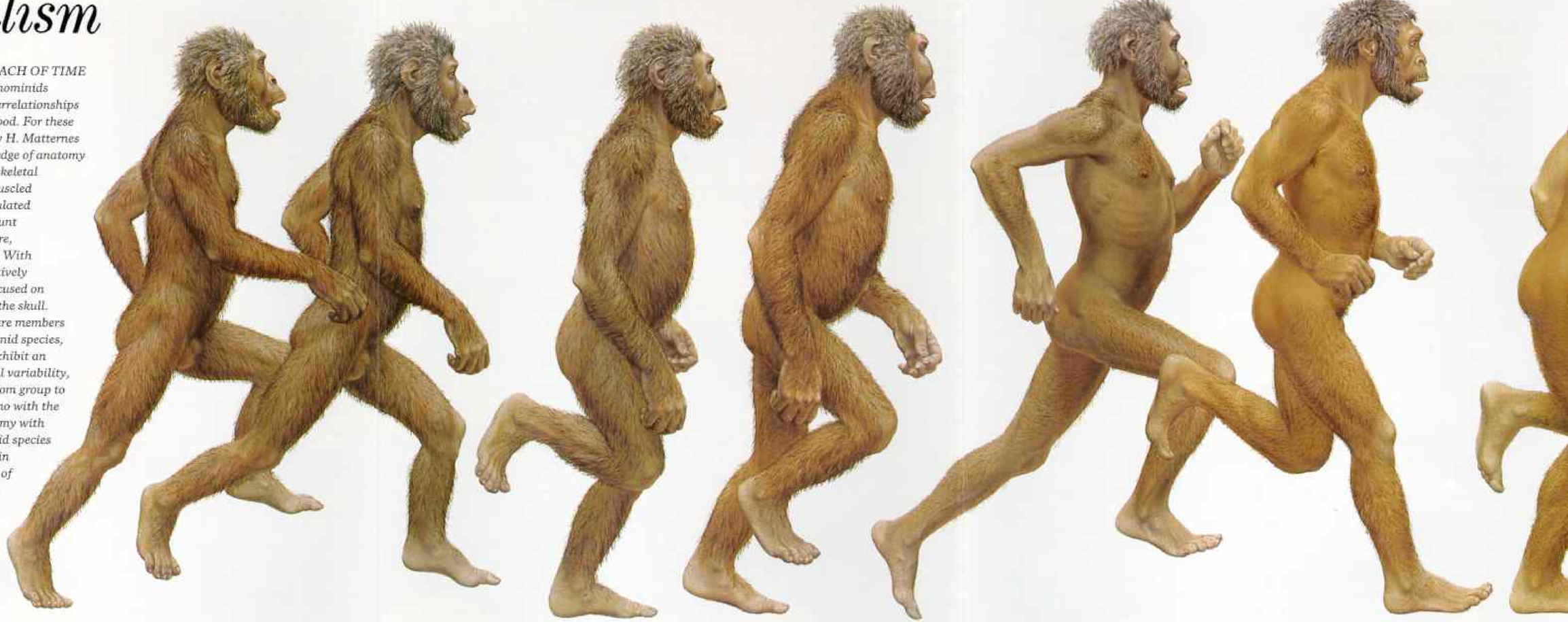
Designation: Cro-Magnon 1
Geologic age: ca 28,000 years
Sex: Adult male
Discovery: French workmen (L. Lartet), 1868
Site: Cro-Magnon, France
Housed: Musée de l'Homme, Paris

H. sapiens (modern)

4,000,000 years of bipedalism

OVER THE VAST REACH OF TIME a diverse group of hominids developed; their interrelationships are still not fully understood. For these reconstructions, artist Jay H. Matternes used his extensive knowledge of anatomy to flesh out fragmentary skeletal remains, creating fully muscled adult males. He has speculated on skin tone and the amount of body hair and its texture, since fossils give no clues. With these characteristics relatively uniform, the artist has focused on the main area of change, the skull.

All populations today are members of the sole surviving hominid species, Homo sapiens, yet they exhibit an immense range of physical variability, both within groups and from group to group; compare the Eskimo with the Brazilian Indian, the Pygmy with the Masai. Earlier hominid species undoubtedly also existed in variable forms as a result of their adaptations to local environments.



A. afarensis *A. africanus*

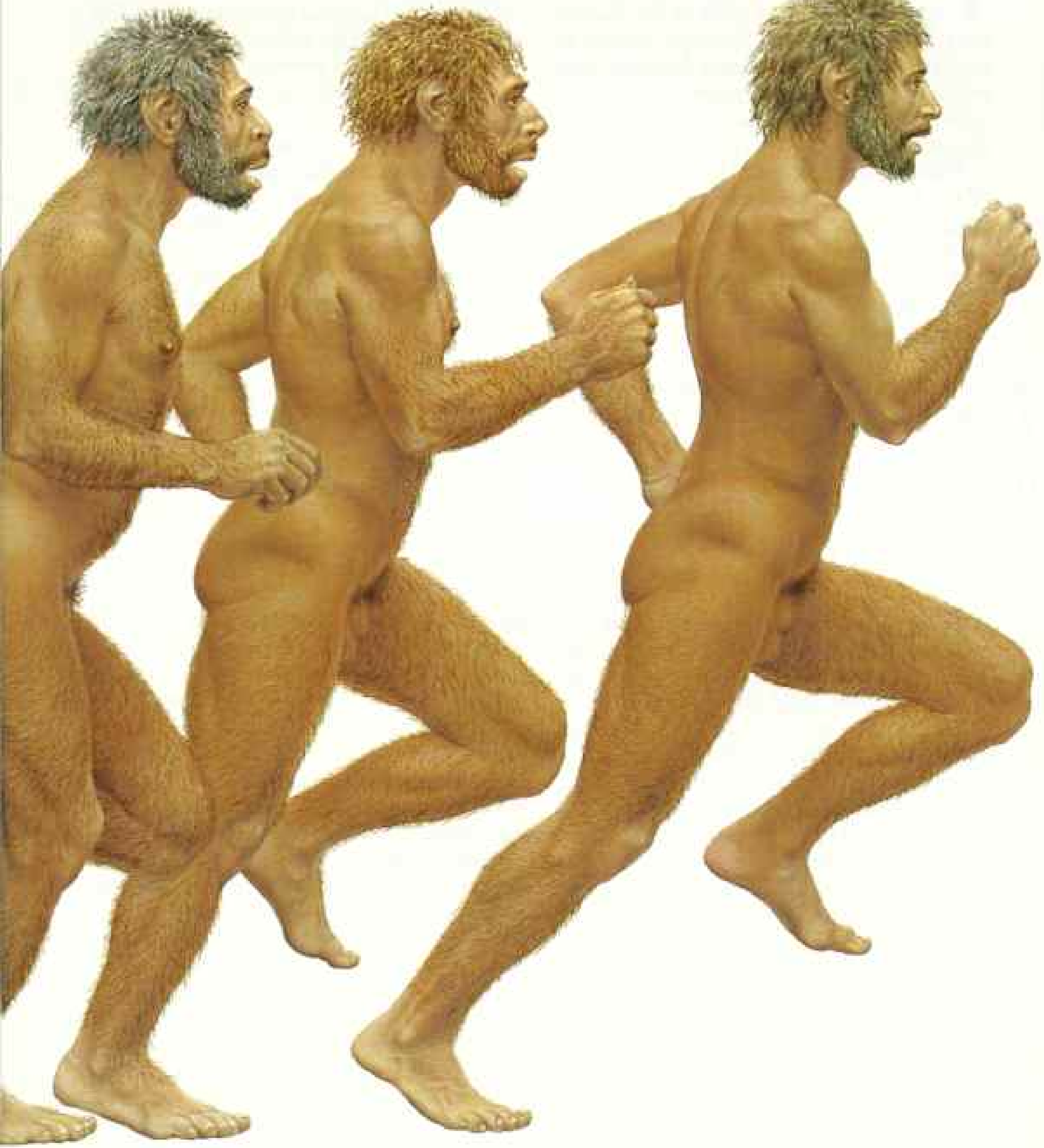
*Known from fossils in eastern Africa, including Lucy, Australopithecus afarensis is the oldest hominid species yet found and may be ancestral to all later forms. Most fossils of africanus, including the Taung child (**cover**), have come from South African caves. Anthropologists disagree over whether africanus was ancestral to all later hominids or only to robustus and boisei.*

A. robustus *A. boisei*

On the basis of several craniums, more than a dozen jaws, and hundreds of teeth in two South African caves, robustus is considered a ruggedly built, massive-jawed hominid. A similar robust form from East Africa is designated Australopithecus boisei. Both may represent a single variable wide-ranging species. These two forms disappear from the fossil record, apparently as evolutionary dead ends.

H. habilis *H. erectus*

The first of his genus, Homo habilis has been found in East Africa, where his span overlaps that of A. boisei and coincides with the appearance of simple stone tools. Habilis gave rise to the larger brained Homo erectus, first identified as Java man in 1893, and later as Peking man, discovered in the 1920s. Erectus fashioned more advanced tools and controlled fire. Enough specimens exist to show physical variability through his 1.3-million-year history.



H. sapiens (archaic) *H. sapiens* (Neandertal) *H. sapiens* (modern)

Homo sapiens specimens begin appearing in increasing number and variation at the time erectus disappears from the fossil record, about 300,000 years ago. The archaic type seems transitional between erectus and later forms. Neandertals, named for the German site of discovery in 1856, were rugged Europeans and Middle Easterners who survived during the Ice Age. But by 30,000 years ago they had died out or been assimilated by anatomically modern humans.

The Search for Our Ancestors

THE MISTS that shroud the corridors of time seemed to part slightly as I turned the ancient skull in my hands. Like Hamlet with his Yorick, I sought to read the story this messenger from the past might tell. What lay beyond the tiny face with protruding jaws and empty eye sockets that stare with a perpetual grin?

This was the Taung child, treasured prize of the University of the Witwatersrand in Johannesburg, South Africa. Born on the highveld in the south of Africa one to two million years ago, the child died at the age of five or six, and the bones ended up in a cave. Accumulating debris gave the skull protection against the usual destruction by animals, insects, and soil acids. Gradually waterborne carbonates percolating into the cave replaced the organic portions of the bones, turning them to stony fossils.

Millennia passed. Climates changed. Animals became extinct; new species appeared. But the child slept on in its rocky tomb. Finally, in 1924, workmen excavating for lime blasted open the Taung cave. A stony cast of the inside of a skull caught the eye of a miner. This endocranial cast, which reproduced many of the convolutions of the brain, was partially encased in breccia (sand, rocks, and lime cemented together). The miner rescued the fossil and took it to the mine office.

Meanwhile, Professor Raymond Dart, head of the Anatomy Department at Witwatersrand, had asked to see any fossils found at Taung. And so, a few days later, two cases of breccia blocks were delivered to Professor Dart at home, just as he was putting on a morning suit for a wedding at which he was to be best man.

With mounting excitement Professor Dart examined his trove, despite the pleas of the groom and his wife's admonitions that he would be late for the nuptials. Nothing showed in the first box. But in the second lay the brain cast, and close by was a block into which the cast fit perfectly. Then, in his mind's eye, Dart saw it—the face of the Taung child itself, in fact hidden by its hard, rocky matrix.

"I stood . . . holding the brain as greedily as any miser hugs his gold . . . ," Dart wrote later. "Here, I was certain, was one of the most significant finds ever made in the history of anthropology."

The wedding reception over, Dart immediately began the tedious and delicate task of freeing the face and lower jaw of his fossil. Lacking the tiny vibrating drills available today, he used his wife's knitting needles.

Baboon skulls had occasionally been found at Taung, but this was no baboon, Dart was sure. The brain cast was too large for a baboon. The canine teeth were not fanglike. The skull would have been balanced on the spinal column in such a way that posture was upright, quite unlike the four-footed posture of a baboon or chimpanzee.

This, Dart believed, was an early ancestor who had been bipedal—had walked on two legs. Dart named it *Australopithecus africanus*, or "southern ape of Africa," and announced his discovery in the British journal *Nature*. Overnight the 32-year-old Dart was a celebrity. But from the scientific establishment came ridicule and stony resistance. Anthropologists dismissed the Taung child as "just a somewhat beat-up chimpanzee."

In truth, Dart's missing link was anatomically inconvenient, with its small brain, low forehead, and small humanlike lower jaw. According to the prevailing idea of the day, primitive man should have had a big brain and an apelike jaw with big front teeth. And to prove it, Britain had its famous Piltdown skull, discovered in 1911, with a high forehead, big brain, and large canine tooth. Dart's detractors could not know that within 30 years Piltdown man would be proved a fake. To this day no one is sure who perpetrated this gigantic hoax by salting a modern human skull with a doctored-up orangutan jaw in deposits in southeastern England.

Twelve years after Dart's discovery a Scottish physician and paleontologist, Robert Broom, found an adult skull of the same kind as the Taung child. Again the specimen was encased in mineral, in a lime quarry at Sterkfontein, some 50 kilometers (30 miles) west of Johannesburg. Still later, at the same site, Broom found postcranial remains (parts of the skeleton below the skull). These

left no doubt that *Australopithecus africanus* was indeed bipedal, and not an ape. At last Dart was vindicated.

It may not be natural
for man to walk on two legs,
but it was a noble invention.

—GEORG CHRISTOPH LICHTENBERG

THE TAUNG CHILD was not the first fossil evidence of human ancestry. A few famous remains had surfaced in the latter half of the 19th and the early years of the 20th century: Neandertal man in Germany and France, Cro-Magnon in France, Java man in the Dutch East Indies. All were relatively big-brained, all were well up on the ladder of human evolution, and all belonged to the genus *Homo*.*

RAYMOND DART HOLDS A CAST OF THE TAUNG CHILD, THE FIRST AUSTRALOPITHECINE FOUND.

But the small-brained *Australopithecus* was something much more primitive. The earliest example of primordial, bipedal man yet discovered, it pushed human ancestry far back into the shadowy past. Further, it offered the first evidence in Africa of early hominids ("hominid" refers to the family of man, Hominidae, including his immediate forebears). Today Africa is recognized as the very cradle of the human race.

*Biologists classify all living things with scientific names to show evolutionary relationships. Closely related creatures belong to a single species; closely related species belong to a single genus. For the Taung child *Australopithecus* is the genus and *africanus* the species. Similarly, modern man is *Homo sapiens*.

In the wake of the Taung announcement, new finds came slowly at first. But the keen interest human beings have in understanding their roots spurred a number of pioneering scientists and explorers. Discoveries in recent years have produced thousands of fossils and an explosion of knowledge.

"Most of what we know about early hominid ancestors has been learned in the past 25 years," says F. Clark Howell of the University of California at Berkeley, who has carried out major excavations in Tanzania, Ethiopia, and Spain.

To discover just how much has been learned, I have traveled the globe, visiting museums and fossil sites in a dozen countries, watching excavations, and talking to anthropologists, archaeologists, geologists, paleontologists, and other specialists. In their laboratories I have observed an array of scientific wizardry with which scientists are wresting unexpected secrets from teeth, scraps of bone, and flakes of stone.

And from this flood of new knowledge comes a far-reaching result: With considerable confidence, scientists are now tracing our lineage as bipedal creatures back at least four million years. And if certain fossil fragments from Kenya are hominid, the lineage may go back to five million or more.

The players in this long drama of human evolution include (by some reckoning) three australopithecine "cousins" of the Taung child (*afarensis*, *robustus*, and *boisei*) and three species of our own genus, *Homo* (*habilis*, *erectus*, and *sapiens*). We shall meet these characters as our story unfolds.

Two obvious questions: Who were the ancestors before four million years ago? And what was it that induced the first hominids to forsake an arboreal existence and become terrestrial? The answers are eagerly sought, but they are still clouded by sketchy evidence and controversy.

I can trace my ancestry back to a
protoplasmal primordial
atomic globule. —"THE MIKADO"

SOME 33 MILLION YEARS AGO, in the geologic epoch known as the Oligocene, a small fruit-eating animal called *Aegyptopithecus* climbed through the

trees of a tropical forest in northern Africa. This creature weighed about four kilograms (eight or nine pounds) and had monkey-like limbs and apelike teeth.

Today only petrified logs and plants remain of the vegetation, for what was once a forest is now one of the driest regions on earth: the Faiyum Depression in Egypt's Sahara. Howling windstorms scour the barren landscape each winter, stripping away the sand and occasionally uncovering fossil remains of *Aegyptopithecus*.

Through the persistent efforts of Elwyn Simons of Duke University, enough of these bones have been found to permit reconstruction of the "dawn ape" (page 563). Though superficially resembling a cat, the dawn ape was a primate—that is, it belonged to the biological order of mammals that includes all prosimians, monkeys, apes, and

humans. *Aegyptopithecus* is, in fact, according to Simons, "the oldest creature we know that is in the direct ancestry of man."

A gulf of mystery separates *Aegyptopithecus* at 33 million years and *Australopithecus* at four million. Candidates for intermediate ancestors that have been proposed at one time or another include two from Kenya known as *Proconsul* and *Kenyapithecus;* two from India, Pakistan, China, and

In the forsaken badlands *of Kenya's Samburu Hills, where Miocene strata lie exposed, a joint Japanese-Kenyan expedition seeks fossils that might shed light on the diverging lines of apes and hominids. Here in 1982 the team found a large upper jaw, or maxilla, about nine million years old, the most complete African specimen of a higher primate from that time.*

Kenya called *Ramapithecus* and *Sivapithecus;* and two from Europe called *Rudapithecus* and *Dryopithecus*. These apelike creatures lived at various times between about 8 and 20 million years ago.

Despite much debate and speculation, none of these primates has been finally accepted as a human progenitor. Until more fossils—and more complete specimens—are found, the long geologic epoch known as the Miocene (24 million to 5 million years ago) will remain a largely veiled chapter in hominid evolution.

Certain events near the end of the Miocene and the beginning of the next epoch, the Pliocene, may help answer the second question: What was the driving force that made these shadowy figures of the remote past give up an arboreal life and become upright, two-legged terrestrial hominids?

C. K. (Bob) Brain, director of the Transvaal Museum in Pretoria, South Africa, believes that radically changing environment forced these forest primates to adapt. Brain developed his hypothesis through a study of what is called the Terminal Miocene Event. He finds a remarkable record of catastrophic environmental change, a profound cooling between five and six million years ago, following millions of years of mostly warm climate. This sharp climatic change is documented by analysis of deep-sea cores and terrestrial deposits, by fossil pollen and land snails, and by dramatic changes in mammalian life.

The drastic plunge in temperatures produced a rapid buildup of ice in Antarctica. The enormous ice sheets took up so much water that sea levels worldwide dropped 50 to 60 meters (165 to 195 feet). Rainfall in many places was strongly affected.

Across wide regions of tropical Africa, warm turned cool and wet became arid. The heavily wooded areas of the past retreated steadily, giving way to advancing grasslands and scattered clumps of low trees—much like the savannas of East Africa today. The habitats of ancestral apes shrank alarmingly.

At about the same time, according to fossil records gathered by Elisabeth S. Vrba at the Transvaal Museum, evolutionary changes seem to have taken place in African fauna. Unable to cope with the hostile open

A fossil's long journey

CHANCES FOR SURVIVAL of a hominid bone, perhaps one in a billion, depend on particular sets of geologic circumstances, one of which is demonstrated by these drawings. An early man collapses ***(above)*** *beside a river fringed by lush gallery forest. Hyenas and other scavengers close in and pull the carcass apart. The large, hard skull, in this instance, tumbles downstream in a flash flood and is*

blanketed by successive layers of silt, pebbles, and the ash from an erupting volcano. Gradually, water-soluble minerals turn bone to stone.

Hundreds of thousands of years later the area has become a badlands, and uplift has brought the fossil near the surface (**right**). *Eventually erosion exposes the skull, and it rolls downslope to lie, by chance, in the path of a paleoanthropologist drawn by fossil-bearing deposits* (**below**). *Her team will match bits of matrix clinging to the fossil to the precise level where it eroded out. There they will excavate, seeking more of this skeleton, fossils of the flora and fauna of its time, and possibly stone tools.*

A. afarensis

A. africanus

4 million

A. robustus

A. boisei

3 million

2 million

H. habilis

1 million

H. erectus

500,000

H. sapiens (archaic)

H. sapiens (Neandertal)

100,000 years ago

H. sapiens (modern)

10,000

OLDOWAN TOOL TECHNOLOGY

ACHEULEAN TOOL CULTURE

MOUSTERIAN

PALEOLITHIC

"A pedigree of prodigious *length," Charles Darwin called man's past, long before the fossil record established the antiquity and variety of man's immediate ancestors.*

Australopithecus robustus *and* A. boisei *seem to branch off to dead ends. Whether* A. africanus *was ancestral to* Homo habilis *is currently in dispute. Likewise, Neandertal's place is unclear.*

grasslands, some species of forest- or bush-loving antelopes disappeared completely. On the other hand, several whole new groups of open-country, grazing antelopes appeared for the first time ever. The harsh new environment was a stimulus to extinction of some groups and to an explosion of new species. And among these newcomers may well have been the earliest australopithecines—ancestors to the Taung child and, possibly, to you and me.

Recent molecular evidence seems to support this idea. Careful analysis of the DNA—the carrier of heredity in our cells—shows an amazing affinity between man and ape. As far as the genetic material is concerned, man and chimpanzee are 99 percent identical. Gorillas are almost equally close.

Some scientists believe that molecular studies provide a sort of clock to tell when the various apes and the hominids separated. Orangutans, according to one interpretation, diverged about 16 million years ago, gorillas split at about ten million years, and chimpanzees and hominids diverged perhaps six or seven million years ago. It may be no coincidence that this was reasonably close to the time when unprecedented chill was sweeping across the African Continent.

Always something new out of Africa. — PLINY THE ELDER

JUST AS THE FINDING of the Taung child astounded the scientific world six decades ago, so did discovery of an even more ancient African fossil in November 1974. During an international expedition to Hadar, in north-central Ethiopia, anthropologist Donald C. Johanson and his graduate student Tom Gray were exploring the parched gullies of the Afar badlands. They were searching for hominid fossils. The morning—like most days in the field—had not been productive; nothing but animal fossils. Now a brutal noontime sun was sending waves of furnace heat across the gravel-strewn desert.

The men were about to return to camp when Johanson spotted a piece of bone on the eroded slope above them. Long hidden by layers of sediment and volcanic ash, the fossil had been laid bare by flash floods that on rare occasions slice through these gullies.

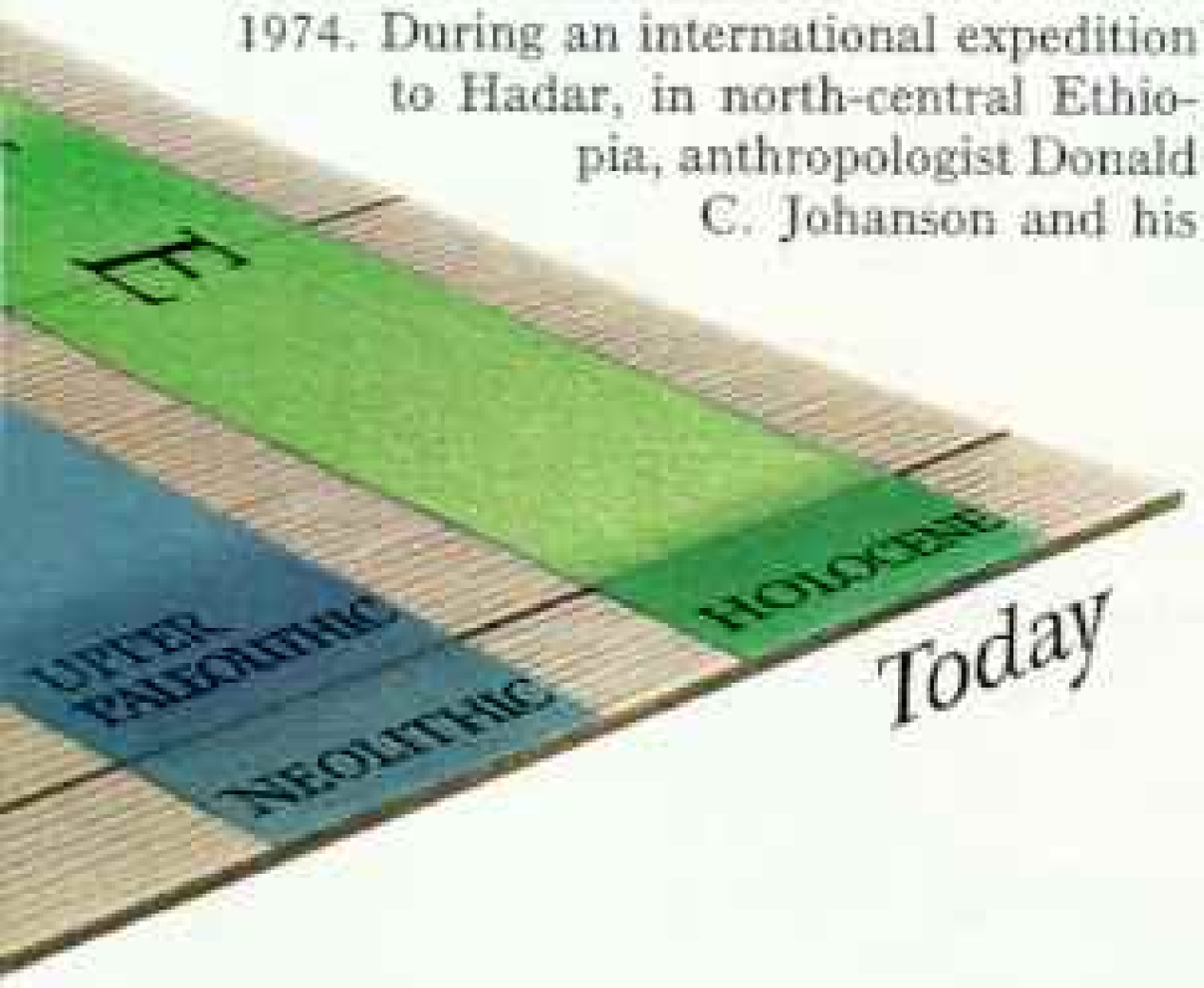
It was hominid, a bit of an arm. Hardly had Johanson made the identification when they spied another bone, part of a skull. Suddenly the slope seemed to sprout fossils—here a bit of thighbone, there a couple of vertebrae and some ribs, farther on a part of a pelvis and a couple pieces of jaw.

But the end was not yet. Three weeks of intensive exploration of the gully uncovered several hundred more pieces of bone. When they were pieced together, they proved to be part of a single individual—an adult female 1.1 meters (three feet eight inches) tall weighing perhaps 30 kilograms (about 65 pounds).

To laymen the individual quickly became known as Lucy, a name taken from a Beatles song popular in the camp. But for scientists, Johanson and his colleagues coined another name: *Australopithecus afarensis.* Thus Lucy was of the same genus as the Taung child, but in the eyes of her discoverers she represented a new species.

Lucy created intense excitement on several counts. She was the most complete and—except for a few questionable fragments found elsewhere—the oldest hominid known up to that time, dated by the radiometric potassium-argon method at about three million years ago. Although much of the skull was missing, roughly 40 percent of the skeleton was recovered. Such a find was extraordinarily valuable, since at that point in hominid evolution fossil remains consist largely of teeth and fragments of jaws, the most indestructible parts of the body. Moreover, the pelvis established without question that Lucy walked with an erect bipedal stride a million years or more before the Taung child.

The discoveries of additional specimens




UNITED KINGDOM
London
Swanscombe
Paris
FRANCE
ENLARGED BELOW
ATLANTIC OCEAN
Altamira/ Camargo/ Castillo/ El Juyo
Atapuerca
SPAIN
Cova Negra
Forbes Quarry
Tangier/Dar es Soltan
Sidi Abderrahman
Salé
Thomas Quarry
Temara
Jebel Irhoud
MOROCCO
ALGERIA
Ternifine
LIBYA
EUROPE
Bilzingsleben
Neandertal
Kulna
Steinheim
Heidelberg
Mladeč
Předmostí
Subalyuk
Vértesszőlős
Krapina/Vindija/ Velika Pećina
ITALY
Saccopastore
Monte Circeo
Bacho Kiro
Petralona
GREECE
Moscow
Sungir
U. S. S. R.
Eliseevichi
Chulatovo/ Pushkari
Kostenki
Volga
BLACK SEA
Akhshtyr
Djruchula
CASPIAN SEA
Çandır
Paşalar
TURKEY
Shanidar
IRAQ
MEDITERRANEAN SEA
Ksar Akil
Amud/Zuttiyeh
ISRAEL
Qafzeh/Ubeidiya
Skhul/ Tabun/ Kebara
Haua Fteah
Faiyum
EGYPT
Nile
Ad Dabtiyah
SAUDI ARABIA
AFRICA
SUDAN
RED SEA
GULF OF ADEN
EAST AFRICAN RIFT SYSTEM
Singa
Middle Awash (Bodo/Maka/ Belohdelie)
Hadar
Dire Dawa
Addis Ababa
Melka Kunture
ETHIOPIA
Omo
Nariokotome
Koobi Fora/Ileret
Kanapoi/Lothagam
KENYA
Samburu Hills
Fort Ternan
Baringo/Chesowanja
Ishango
Rusinga Island
Lukeino Hill
Olorgesailie
Laetoli
Olduvai Gorge
Dar es Salaam
TANZANIA
Kalambo Falls
ZAMBIA
Kabwe (Broken Hill)
Mumbwa
Kromdraai/ Swartkrans/ Sterkfontein
Makapansgat
Pretoria
Johannesburg
Taung
Florisbad
Border Cave
Orange
SOUTH AFRICA
Saldanha
Fish Hoek
Klasies River Mouth
Les Roches
100 km
100 mi
Charente River
Loire
St-Césaire
Fontéchevade
La Chaise
La Quina
Chancelade
Lascaux/ Regourdou
Le Moustier
La Ferrassie
Soleilhac
La Chapelle-aux-Saints
Dordogne
Cougnac
Monsempron
Pech Merle
Cro-Magnon/ Abri Pataud
BAY OF BISCAY
FRANCE
Hortus
Montmaurin
Enlène
Isturitz
Urtiaga
Lezetxiki
Mas d'Azil
Gargas
Niaux
Arago
SPAIN
Bañolas
1000 km
1000 mi
SCALE AT 45° N
NGS CARTOGRAPHIC DIVISION


S I B E R I A
A S I A
Novoselovo
Malta
Lake Baykal
Amur
SELECT SITES BEFORE 10,000 YEARS AGO
Homo sapiens (modern) 10,000-35,000
Homo sapiens (Neandertal) 32,000-125,000
Homo sapiens (archaic) 35,000-300,000
Homo erectus 300,000-1.6 million
Homo habilis 1.5-2 million
Australopithecus 1.2-4 million
Higher primate 8-33 million
Xujiayao
Yingkou
Beijing
Zhoukoudian
Ordos
Garna-i-kur
Teshik-Tash
CHINA
AFGHANISTAN
Shiwalik Hills
PAKISTAN
Indus
Dingcun
Dali
Lantian
Nanzhao
Yunxi/Yunxian
Hexian
Ziyang
Yangtze
Changyang
Tongzi
Mahadaha
Sarai Nahar Rai
Yuanmou
Lufeng
Liujiang
Maba
Minatogawa
Narmada
Luc Yen
JAPAN
INDIA
PACIFIC OCEAN
PHILIPPINES
VIETNAM
Attirampakkam
Tabon Cave
SRI LANKA
Batadomba-lena
MALAYSIA
Niah Cave
EQUATOR
INDIAN OCEAN
I N D O N E S I A
Sangiran
Java
Trinil
Ngandong
Wadjak
Cossack
AUSTRALIA
Talgai
Mungo
Willandra Lakes
Devils Lair
Cohuna
Kow Swamp
Keilor

Traces of early man

AFRICA, the birthplace of the earliest biped, has also been a home to all subsequent hominid species. Four australopithecines have been found only here, as was Homo habilis*. Equipped with a larger brain and specialized stone tools, his sole successor,* Homo erectus*, moved beyond Africa, reaching Java, China, and probably southern Europe. Only* Homo sapiens *spread farther – peopling northern Europe and Siberia and, perhaps by 50,000 years ago, moving on to Australia by sea and later walking across the Bering Strait to the Western Hemisphere.*

in Ethiopia and elsewhere permit anthropologists to sketch a rough description of *afarensis*. Females were substantially smaller than males, a condition known as sexual dimorphism. Females, in fact, were probably about the size of today's Pygmies. Skin color was probably dark, an evolutionary adaptation to the tropical sun. Adults would seem hairier than people today, although—like chimpanzees—they probably had no more hair follicles than we have.

Because of their small heads and large teeth, these early hominids have been aptly called "microcephalic megadonts." Massive back teeth with thick enamel filled the heavily protruding jaws. A rather apelike face was marked by a low forehead, a bony ridge over the eyes, a flat nose, and no chin. Cranial capacity is estimated at 375 to 500 milliliters (about a pint), compared with an average of about 1,350 for modern man. The brain is assumed to have lacked the areas necessary for articulate speech.

Afarensis died close by rivers or lakes. If he made stone tools or weapons, they were exceedingly primitive. Possibly he scavenged meat from carnivores and caught small prey to supplement a diet of fruits, nuts, roots, tubers, and other vegetation.

Whether this archaic creature took to the trees for food or protection is an unanswered question. Some scientists in Europe and the United States see bipedal locomotion in the early australopithecines as being less efficient than in modern humans. They believe that the earliest hominids continued to be partly arboreal. They note that *afarensis* phalanges (finger and toe bones) are slightly curved, which they regard as an adaptation for grasping tree limbs.

Other scientists argue that the curved phalanges have no significance for locomotion, that Lucy's skeletal anatomy was completely suitable for bipedality, and that daily life was on the ground, not in the trees.

Doing the groundwork *for dating fossils, geologist Dr. Francis Brown of the University of Utah collects volcanic ash along the western shore of Kenya's Lake Turkana. Chemical analysis of the sample enables him to correlate it with identical layers at Koobi Fora on the lake's eastern shore, already dated by the potassium-argon method. Thus he estimates an age of 1.6 million years for the* Homo erectus *skeleton found here in 1984 (see the article on pages 624-29).*

THE OLDEST FOSSILS that clearly bespeak a bipedal hominid were found in 1981 at Maka and Belohdelie in the Middle Awash Valley in Ethiopia, some 70 kilometers (45 miles) south of Hadar. There an expedition headed by Desmond Clark and Tim White of the University of California at Berkeley found several fragments of a skull and the upper portion of a femur, or thighbone. These have been dated at close to four million years.

"But how do we know they're really hominid?" I asked Tim White. "How can anyone tell from such limited fragments?"

The answer helps demonstrate the surprising amount of information that modern techniques can extract from a very small amount of material.

"We know partly from X rays," Tim told

me, showing me images made by CAT scan. "See how in the femur neck the bone is thick in the lower portion and gets thin farther up? That's exactly what we find in bipeds, and we don't find it in apes.

"Also, notice this mark." I ran my fingernail across the bone and felt a slight depression. "That's where one of the hip muscles, the obturator externus, left a groove. If this had been an ape, the attachment would have been completely different. And that's only one of the features of this bone that say unmistakably that this individual habitually walked upright."

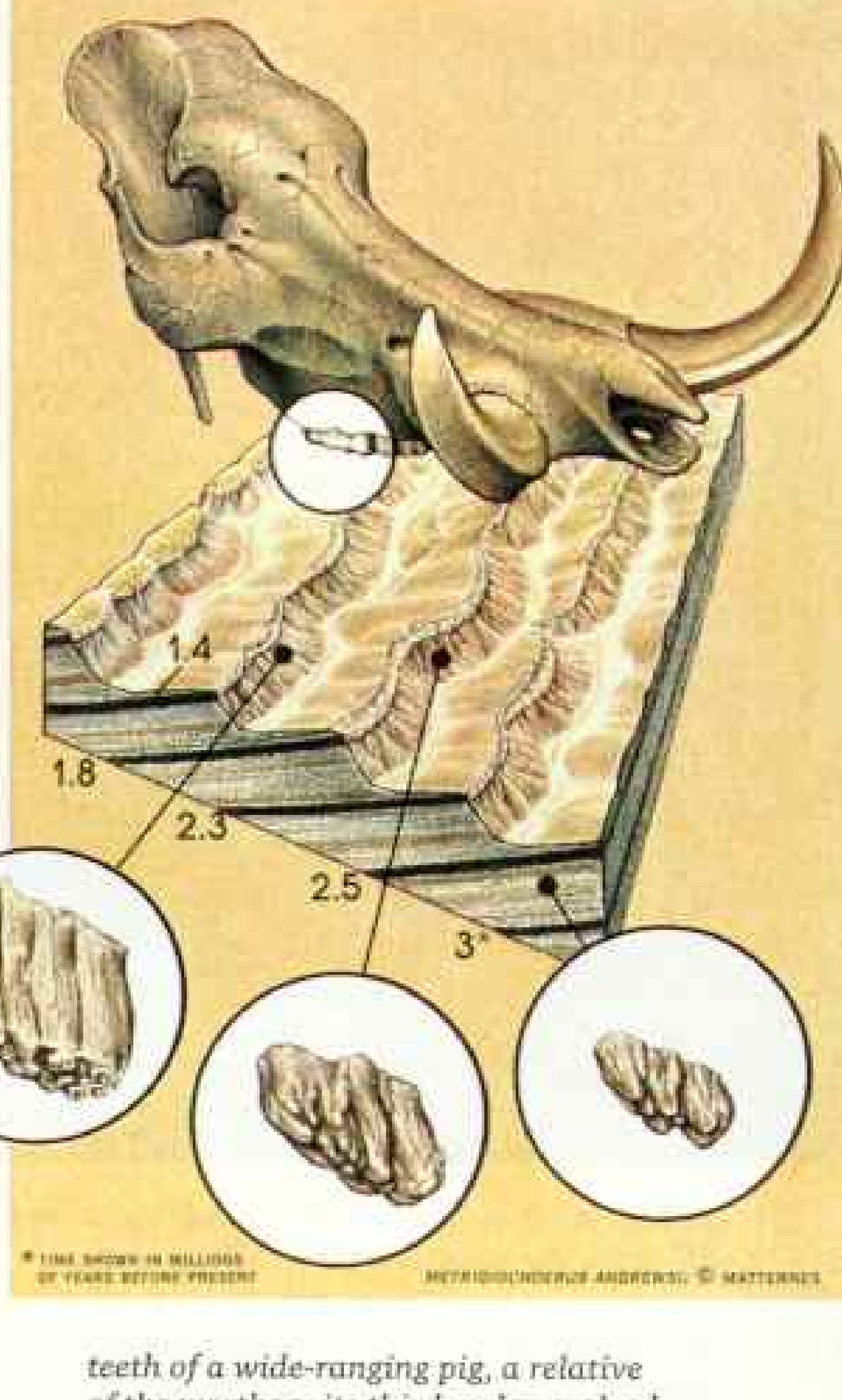
Maka illustrates not only how modern methods can identify a hominid fossil but also how they can fix its age. Maka lies in the East African Rift System, a gigantic rupture in the earth's surface that runs all the way from the Gulf of Aden through eastern Africa and on into southern Africa. Faulting, uplift, and erosion have exposed hundreds of meters of lake and river sediments and a wealth of fossils at various depths, laid down over millions of years. And interlayered with those sediments are numerous beds of volcanic ash from many eruptions over those same millions of years.

Fortunately the chemical makeups of these volcanic strata are highly individual. Each layer has its own chemical fingerprint. At Maka the hominid fossils lie close to an ash layer known as the Cindery Tuff, a marker bed that has been dated by radiometric argon-40/argon-39 analysis.

A similar method measuring the decay of radioactive potassium to argon gives excellent results. In fact, it was the early use of the potassium-argon technique in 1961 to date the lowest level at Olduvai Gorge in Tanzania that radically lengthened the known time span of hominid evolution and ignited the explosion of knowledge about early man.

Some of the best known tuffs, or volcanic ash layers, have been borne by air and water for substantial distances. Some are found at Hadar as well as at the Omo site in southern Ethiopia and around adjacent Lake Turkana in northern Kenya. The same chemical signature identifies a tuff in each place. Once the layer has been identified and dated

Improbable partnership *linking pigs and volcanoes provides another time clock for early fossils. In the orderly Shungura formation along Ethiopia's Omo River, lake and river sediments interbedded with volcanic ash have tilted, exposing a sequence spanning more than a million years. Ash layers dated by the potassium-argon technique form a time frame for fossils found in between. Commonplace finds are the teeth of a wide-ranging pig, a relative of the warthog; its third molar evolved rapidly, becoming taller and longer (**insets**). Once a molar is dated, it becomes a standard time marker for teeth of the same form found elsewhere. Faunal chronology provides correlations for South African caves where radiometric dating has not succeeded. Other mammals, including elephants, are also useful in correlating African sites.*



at one location, the date is immediately useful in every other place the tuff appears.

An indirect method of dating called biochronology depends on the assemblages of animal fossils found in particular strata. Tim White describes the Middle Awash, for example, as being "littered with fossils, from the jaw of a shrew to fossilized crocodile eggs." Among sedimentary layers there he and his colleagues have found an almost continuous fossil record, covering six million years, of extinct pigs, horses, baboons, hippos, and elephants. Since the Awash strata can be dated radiometrically, the evolving species of these animals can also be fixed in time. Thus a well-dated species of an extinct pig, for example, can give a rough idea of the age of a stratum for which geologic dating may be difficult or impossible.

We have found a strange footprint on the shores of the unknown.

—SIR ARTHUR EDDINGTON

ONE AFTERNOON IN 1976 a group of scientists visiting Mary D. Leakey's excavations at Laetoli in northern

Broad ribbon of volcanic ash, *called the Tulu Bor Tuff, was deposited by a large river at Koobi Fora 3.3 million years ago* ***(left)****. A younger layer, containing accretions of glass fragments* ***(below)****, probably rained down from the air.*

Chemical analysis of the Tulu Bor material yielded a unique fingerprint that appears to correlate with an identical tuff at Hadar, Ethiopia, where Lucy was found, and with deep-

sea cores from the Gulf of Aden. Apparently an enormous volcano in the Ethiopian Highlands spewed ash over at least a million square kilometers (385,000 square miles). All hominid fossils found at Hadar, and most of those at Koobi Fora, lay above this level.

Tanzania were amusing themselves by hurling dried elephant dung at each other. One man dodged a well-aimed missile, lost his footing, and found himself lying on a hard surface with strange indentations. These markings proved to be ancient animal footprints impressed in the rock. Exploration turned up thousands of other prints—probably more fossil animal tracks than have ever been found anywhere else in the world—including those of extinct species of rhinoceros, giraffe, hyena, and other animals.

The trails had been made in damp volcanic ash; the rainy season apparently was just beginning. The ash quickly hardened in the tropical heat. Further eruptions of the nearby volcano Sadiman buried the footprints under additional ash layers and preserved the record for the ages.

Valuable as was this finding, it was nothing compared with discovery in 1978 of long trails frozen in the ash, side by side, that appeared to be human. At first Mary Leakey could not bring herself to believe it was so. But careful examination by specialists confirmed that the arch, big toe, and heel marks were truly those of very early hominids.

What can we tell about them from their

footprints? Stride length gives a clue to the height; so does the size of the prints, since the length of the human foot usually is about 15 percent of the individual's height. So we believe that one of these travelers was about 1.4 meters (four feet eight inches) tall, another about 1.2 meters. And they were walking as only upright, bipedal creatures can walk, as analysis by Michael Day of St. Thomas's Hospital in London clearly shows.

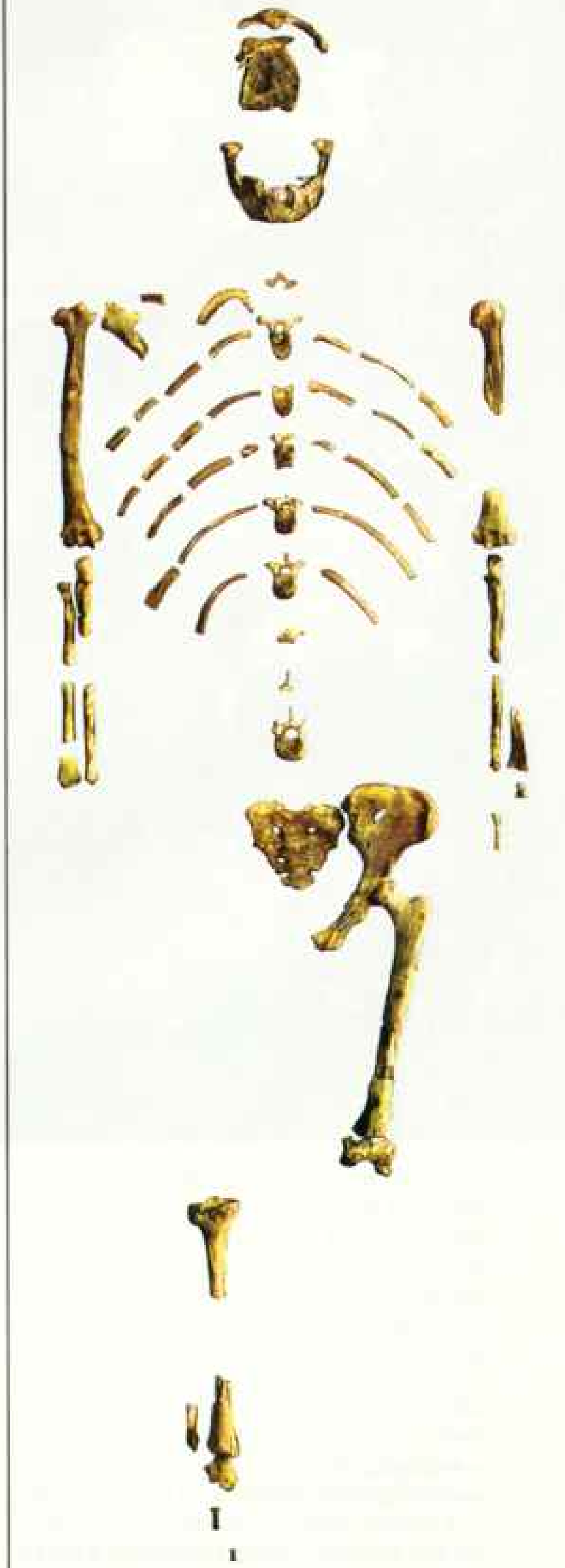
Mary Leakey has described her emotions as she studied one of the trails: "Following the path produces, at least for me, a kind of poignant time wrench. At one point, and you need not be an expert tracker to discern this, the traveler stops, pauses, turns to the left to glance at some possible threat or irregularity, then continues to the north. This motion, so intensely human, transcends time. Three million seven hundred thousand years ago, a remote ancestor—just as you or I—experienced a moment of doubt."

Fossil bones found in the same ash layers as the footprints show resemblances to the *Australopithecus afarensis* hominids of Hadar, in Ethiopia. But the Laetoli individuals have been dated at about 3.7 million years, more than half a million years older than Lucy. Are they the same species?

This question provokes one of the more spirited controversies in paleoanthropology today. Don Johanson and his colleagues consider both the Hadar and Laetoli specimens to be *afarensis*. Moreover, they say, *afarensis* is the ancestral stock leading to *Homo;* other australopithecines were dead ends, in this view.

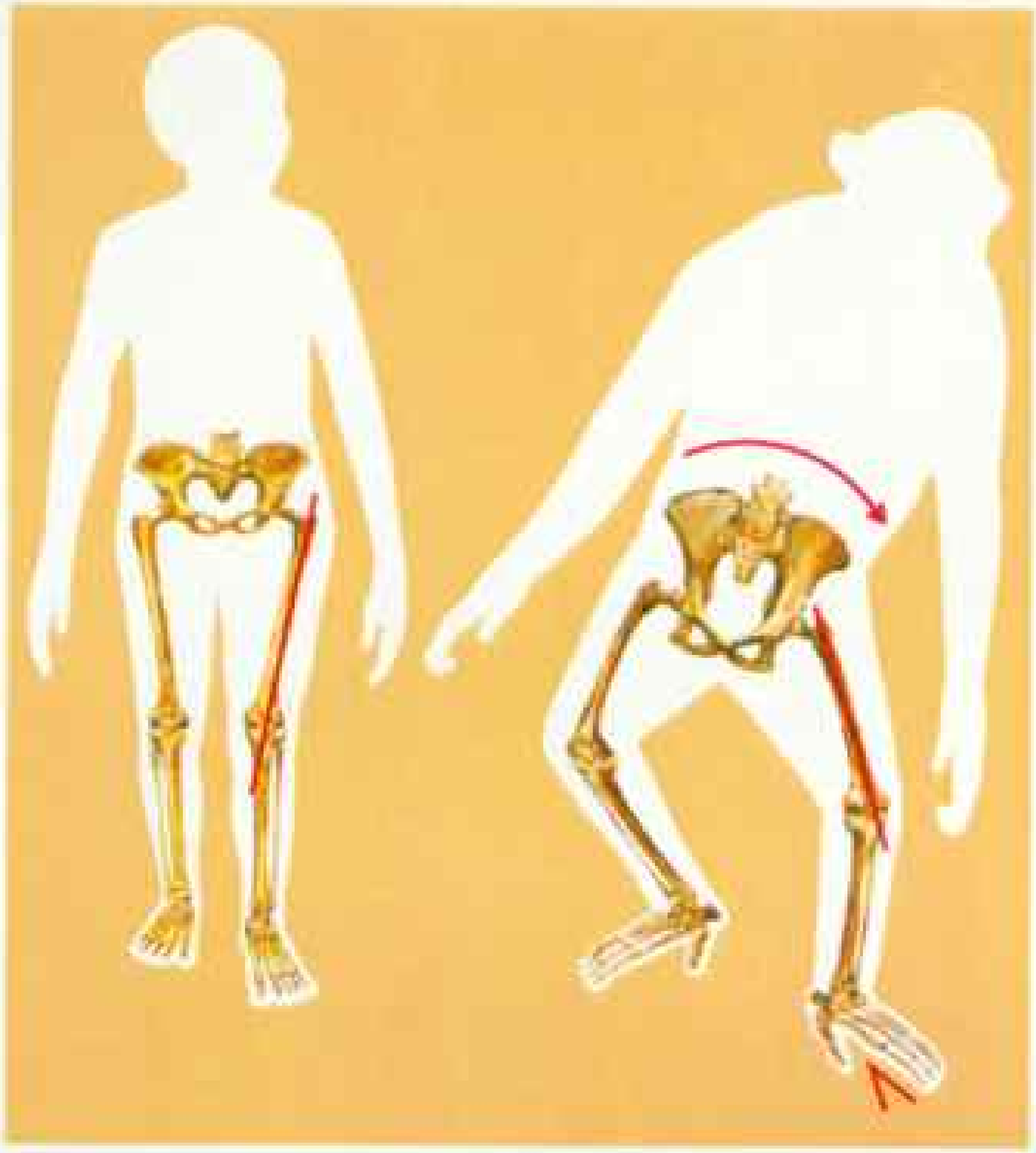
Phillip V. Tobias, successor to Raymond Dart as head of the Anatomy Department at Witwatersrand University, believes that what has been called *afarensis* at Hadar is the same species as a variety of *africanus* found at Makapansgat in South Africa. In his view the fossils at Laetoli link back to the earlier specimens at Maka and Belohdelie, and *they* form the ancestral stock, leading to *africanus* and then *Homo*.

Yves Coppens of the Collège de France, who was involved in the Afar discoveries, now believes that the Afar specimens represent two species, of which *Australopithecus afarensis* is only one. He further believes that the *Homo* line developed independently of *afarensis* and evolved alongside the



The primate that walks...

*MOST COMPLETE fossil skeleton found of Australopithecus afarensis, three-million-year-old Lucy (**left**)—with major portions of her long bones preserved—demonstrates virtually complete adaptation to upright walking. As shown in the silhouettes (**below**), the interrelated adaptations in Lucy's pelvis, femur, knee, and foot permitted body weight to be moved forward smoothly and with minimal muscle fatigue. Lucy's flaring pelvis, for instance, carried gluteal muscles to the side of the thigh for stability. The ape's long pelvis has gluteal muscles in the rear for effective quadrupedal motion, and when the animal walks upright its body tilts from side to side (red arrow) to keep the center of gravity over the stepping foot. In addition, the angle of Lucy's femur, or thighbone, unlike the ape's (vertical red lines), brought her legs under the body.*



LUCY CHIMPANZEE

*Lucy's femoral condyle, the bottom of the femur (**left center**), like that of a modern human, provided a large flat surface to transmit weight through the extended leg, reducing pressure in the knee. A chimpanzee's round condyle is not specially adapted to any single leg position.*

In the hominid foot the big toe aligns with the other metatarsals, which act as a lever to drive the body forward. This repositioning led to the development of an arch to serve as shock absorber. By contrast the ape foot, with its large abducted toe, is adapted to grasping.

CHIMPANZEE LUCY MODERN HUMAN

*The remarkable footprints made in soft damp volcanic ash 3.7 million years ago (**bottom**) at Laetoli, Tanzania, clearly show the toe and arch of an early biped.*

Recently discovered fossils have revolutionized our concept of the human past. Our earliest, most distinguishing characteristic was not a large brain, language, or toolmaking, but the ability habitually to walk upright.

PHOTOGRAPHED AT THE NATIONAL MUSEUM OF ETHIOPIA (OPPOSITE); RICHARD L. RAY (LEFT); DIAGRAM BY JON JICHA

australopithecines over a very long period.

Perhaps all these ideas will be superseded because of future discoveries. Fossils, after all, do not come with labels. Many a proposed classification has later been dropped. A number of fossils once thought to represent different genera or species have been regrouped into a single classification. In truth, the more specimens we find and the more gaps we fill, the more we discover that much of human evolution is a complex and gradually changing continuum. Thus it becomes increasingly difficult to draw lines that say, "Here one species ends and another begins."

And cruel death is always near,
So frail a thing is man.

—"NEW ENGLAND PRIMER"

AFARENSIS seems to disappear from the fossil record about 2.8 million years ago. Meanwhile, in South Africa, *africanus* dominated the scene from perhaps three million to two million years ago, although the Taung child may be younger. In addition to the Taung site, *africanus* has been found at two other cave sites—Sterkfontein and Makapansgat.

Scientific fossil hunting at Sterkfontein began in 1936 and has continued uninterrupted for the past 20 years under the direction of Phillip Tobias and the supervision of Alun Hughes. Erosion has long since destroyed almost all of the roof of the cave, and blasting and excavating have left a large expanse of open pits. Steel catwalks surmount the pits and give an excellent view.

I found Alun Hughes cataloging the finds of the previous week before transport to Witwatersrand. From his pocket he pulled out a beautifully preserved hominid tooth, which he had recovered only the day before.

An enormous pile of rough breccia blocks rose outside the storage shed, concealing who knows what fossil treasures. Hughes demonstrated how hydraulic presses with heavy chisels crack open the blocks. When bone or teeth are exposed, workmen attack with hammers and small tools to chip away the rocky encrustations.

Africanus probably did not live in the caves, which may have been reached by sinkholes or open shafts from above. More

© MAITERNES (FACING PAGE)

Collaborating for science *at the new laboratory of the National Museum of Ethiopia in Addis Ababa, visiting and local researchers catalog the massive collection of fossil vertebrates found at some 400 Hadar locales between 1972 and 1977. Professor Tim White, right, of the University of California at Berkeley, and graduate student Berhane Asfaw examine an elephant tusk. Don Johanson, in the light shirt, confers with Woldesenbet Abomssa, museum storekeeper. Fossils of flora and fauna, including plant pollen and small rodents, help reconstruct Lucy's environment.*

*In an artist's conception (**facing page**), members of an afarensis group forage for figs in a mountain forest above a highland lake and adjacent grasslands. In speculating about their life ways, anthropologists use clues from the complex variable social behavior of chimpanzees and gorillas.*

likely, skeletal remains washed into the pits or were dropped in by carnivores.

Elisabeth Vrba offers an imaginative description of one South African cave, whose steep shaft descended to subterranean chambers partly flooded with pools of rainwater: "Surrounded by darkness, dampness, and the stench of carrion were the carnivores, wading through rotting carcasses and skeletons half-submerged in water and mud: a place part shelter to some, like the baboons and perhaps the apeman, part deathtrap, and part feeding place of opportunist carnivores."

Compared with *afarensis*, *africanus* shows only slight morphological differences. Body size was not much greater. Cranial capacity, averaging about 440 milliliters, was perhaps slightly larger—but the brain was probably still not advanced in the areas necessary for articulate speech. Back teeth were a little bigger, front teeth a bit smaller.

Cruel death indeed haunted the life of *africanus*. This is confirmed by an exhaustive investigation by Alan Mann of the University of Pennsylvania. He studied nearly 400 australopithecine teeth from South Africa. Knowing the ages at which various teeth erupt in modern man, and noting the degree of wear of each tooth, he was able to calculate the probable age of each individual. The average member of the *africanus* sample died at 22 years.

Exact dates for the fossils at Sterkfontein and most other South African cave sites are difficult to determine. Unlike the open sites in East Africa, the caves lack volcanic ash layers that can be identified and dated. Moreover, erosion of cave deposits by underground water and collapse of material within the caves sometimes create a chronological jumble that can be sorted out only with the most meticulous care. Faunal assemblages become especially important for dating under these circumstances.

Another technique—paleomagnetic dating—supports an age of some three million years for the *africanus* site of Makapansgat, about 300 kilometers (185 miles) north of Sterkfontein. This kind of dating is based on the fact that the earth's magnetic field reverses at irregular intervals. Then the north-pointing compass switches to south, or vice versa, and iron-bearing rocks record the change.

And a Branch shall grow out of his roots. —ISAIAH 11:1

FOUR TEETH from the pocket of a South African schoolboy led to the finding of a third species of *Australopithecus*. The site this time was Kromdraai, an eroded limestone cave on a low hill near Sterkfontein.

Robert Broom, whose discovery of the first adult *africanus* skull in 1936 had brought him a measure of fame, was determined to find further hominid remains. He was troubled by the thought that untold treasures of fossil bones were being destroyed by the blasting of the miners and the flames of the limekilns.

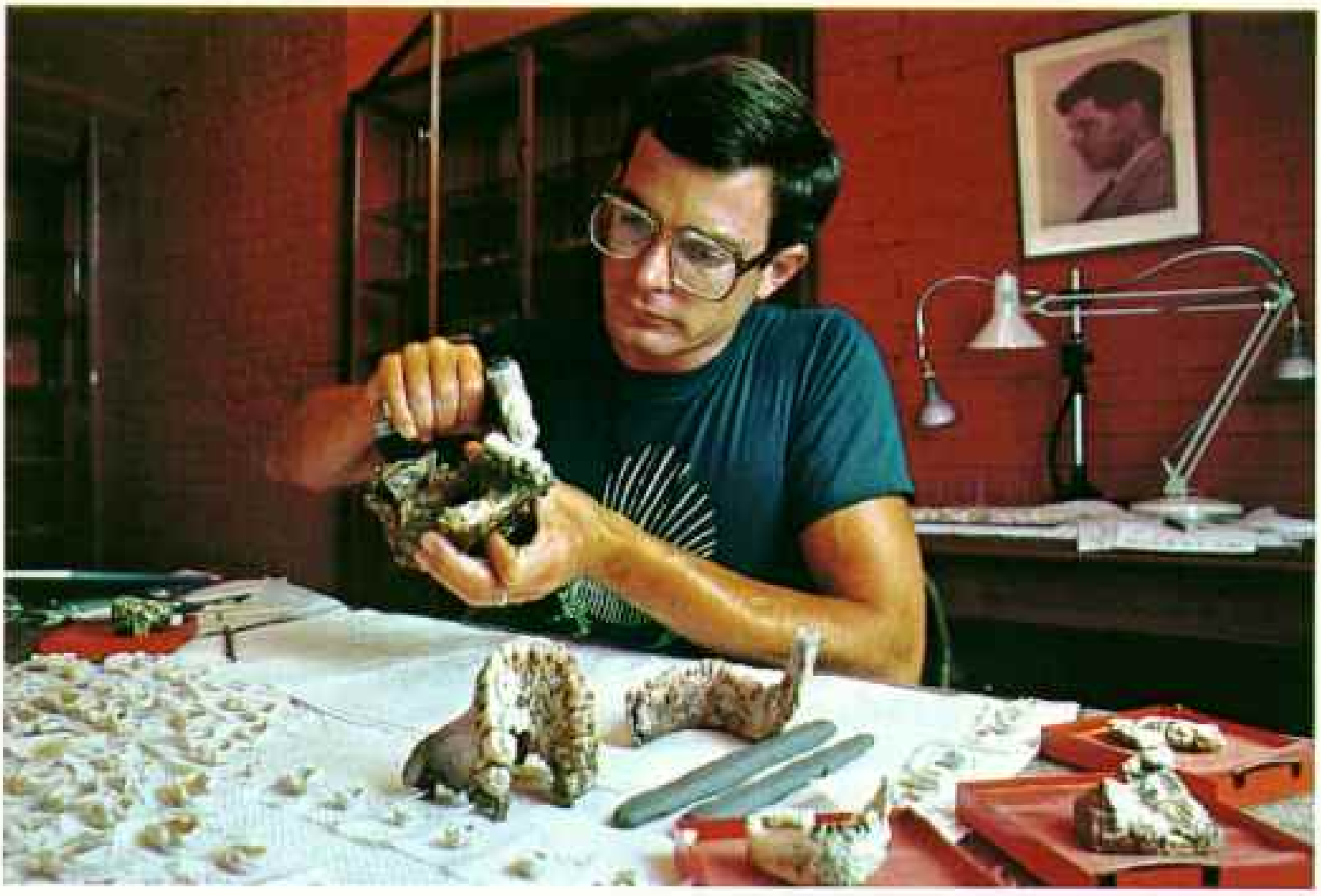
Now and again Broom would purchase specimens from a Mr. Barlow, manager of the lime quarry at Sterkfontein. On one such occasion in 1938, Barlow accepted £2 for a part of an upper jaw with one molar tooth but declined to reveal its origin. Broom persisted; the fossils were of utmost importance to science, he argued. Eventually Barlow relented and said that the jaw came from Gert Terblanche, a schoolboy who lived nearby.

Broom rushed to the school and found the boy. Did he have any other specimens?

"Gert . . . drew from the pocket of his trousers four of the most wonderful teeth ever seen in the world's history," Broom wrote later. He recalled that when they went to Kromdraai, Gert "took us up to the hill, and brought out from his hiding place a beautiful lower jaw with two teeth in position." With additional fragments picked up at the site, Broom was able to piece together much of a skull.

The face and teeth of the Kromdraai specimen were sufficiently different from Sterkfontein's *africanus* that Broom coined a new name—*Paranthropus robustus*, or "robust near man." The scientific world did not take kindly to his creating a new genus, and, although the name is still sometimes used, most anthropologists now consider *robustus* part of the genus *Australopithecus*.

Robustus, as its name implies, is a heavier bodied and more powerfully built creature



What was on the menu *of early man? Teeth may tell, according to some paleontologists, such as Dr. Fred Grine of the State University of New York at Stony Brook. Working at the Transvaal Museum in Pretoria, South Africa (***above***), he makes a mold of* Australopithecus robustus *teeth found at Kromdraai before turning to the africanus palate and mandible from Sterkfontein. From molds he prepared casts to study wear patterns and chewing stroke under a scanning electron microscope. Heavy scratches and pitting on robustus teeth suggest to him that its diet included hard fruits, nuts, legumes, and seeds.*

*For comparison, other researchers study living species. Dr. Mark F. Teaford of the Johns Hopkins University takes molds of monkey teeth (***upper right***), comparing wear of animals on soft and hard diets.*

*Dr. Margaret Schoeninger of Harvard University seeks trace elements such as strontium in the eroded teeth of a dead zebra (***right***) at Koobi Fora. After learning the varying levels of the elements absorbed from their food in the bones of known omnivores, frugivores, and carnivores at a site, she will apply the information to fossil hominids.*

than *africanus*. The massive face is flat or dished, with no forehead and with a supraorbital ridge, a protruding bulge over the eye sockets. Most specimens have sagittal crests—bony ridges running back atop the skull where powerful chewing muscles attached. Relatively small front teeth but massive grinding teeth fit into a thick and heavily buttressed lower jaw.

Because of this heavy-duty equipment, *robustus* has been called "the ultimate chewing machine." The name suggests that this species ate mostly coarse, tough food that needed much chewing—nuts, hard-shelled fruits, fibrous roots, and tubers. Life must have been far from easy. Alan Mann's survey of *robustus* teeth shows average age at death to be about 17 years.

Swartkrans, a large cave excavation just across a low valley from Kromdraai and Sterkfontein, has produced some 130 individuals of *robustus*. Bob Brain, who has carried on the excavations for more than 20 years, has also found beautiful pieces of bone that appear to have been used as digging tools.

Brain showed me some of these fossil bones with polished ends and patterns of scratches on their surfaces. These we compared under the microscope with modern bones that he had used experimentally to dig roots and tubers, just as a hungry *robustus* might have done. The marks are so similar that Brain has little doubt that bone tools (and probably wooden as well) were in use long before the advent of stone tools.

Exact dates are impossible, but *robustus* appears on the scene at some time around

Foraging for tubers, *an Australopithecus africanus female digs with a stick, while a male harvests a whistling thorn for edible ant galls. If the child possesses new genetic traits, such as larger molars, that increase longevity and hence the chance to parent more offspring, these features may be passed on to the next generation and eventually become common. Such adaptations over millennia so change the descendants that science labels a new species.*

two million years ago and dies out sometime after a million and a half years ago. Cranial capacity of about 530 milliliters is larger than that of the gracile, or more lightly built, *africanus*.

Although *robustus*' brain size might suggest that it was more advanced than *africanus*, this powerful creature is believed to be a dead end, an offshoot from the direct line of hominid ancestry. It seems to share this fate with an even more robust australopithecine known as *boisei*, which faded out perhaps a little later than *robustus*.

In archaeology you almost never find what you set out to find. —MARY D. LEAKEY

IN 1931 Louis S. B. Leakey, the anthropologist son of British missionaries in Kenya, began searching for fossils in Olduvai Gorge in northern Tanzania. He believed that true human beings began in Africa far back in antiquity, and had nothing to do with australopithecines.

Olduvai Gorge was a likely setting for the search. A 40-kilometer-long (25-mile), river-carved canyon, dropping abruptly in the Serengeti Plain, it offers well-exposed strata going back nearly two million years.

Season after season, Louis and his archaeologist wife, Mary, explored the 100-meter-deep gorge. The trip down from their home in Nairobi was arduous, and they had little free time and even less money for the work. The frustrating years turned into decades, with scant results for their persistent efforts.

One reward was a collection of extremely primitive stone tools, rudely flaked from pebbles. Called Oldowan tools in honor of the gorge, they were the oldest stone implements known up to that time. (Since then, stone tools some 2.5 million years old have been found in Ethiopia.)

A major break came in 1959, which, coincidentally, was exactly a century after publication of Darwin's *On the Origin of Species*. One July morning, while Louis lay in his tent ill with a fever, Mary slowly explored one of the gullies tributary to the main gorge. Constantly she searched for telltale pieces of bone. The two huge teeth and piece of skull she spotted on that morning sent her racing back to camp shouting, "I've got him! I've got him!"

With dental tools and fine brushes the Leakeys worked over the site, sieving all material. The more than 400 fragments of bone they uncovered permitted reconstruction of an adult skull.

What they had found, Louis believed at the time, was the maker of the Oldowan tools. Like other anthropologists before and since, he coined a new name: *Zinjanthropus boisei*. The genus name meant "East African man," and the species name honored Charles Boise, who had given financial support for the research. But Dear Boy was the affectionate name the Leakeys used for their new skull.

"Zinj" possessed a brain of 530 milliliters, about the same as *robustus*. But in other respects he was hyper-robust. So massive were his face and cheek teeth that he became known as Nutcracker man.

Radiometric dating of Bed I, at the bottom of Olduvai Gorge where the discovery was made, gives an age of 1.8 million years. Thus Zinj was probably a contemporary of *robustus*—and in the view of today's anthropologists was a close relative. He now bears the name *Australopithecus boisei*. Like *robustus*, *boisei* is believed to be a dead-end branch of the hominid line.

Dead end though it may have been, *boisei* led to substantial support for the Leakeys' work, in large part from the National Geographic Society. There followed a flood of fruitful activity at Olduvai, including at last the important discovery of the earliest known member of our own genus, *Homo*.

Man is a tool-using animal . . . without tools he is nothing. —THOMAS CARLYLE

WHY THE GENUS HOMO split away from the more primitive australopithecine line is an open question. One of the more plausible ideas, first suggested by Elisabeth Vrba's studies of fossil antelopes and more recently developed by Bob Brain, is that environmental change precipitated the evolutionary stimulus, just as they believe it did with the appearance of the first hominids.

Brain's analysis of climatic change in Africa shows that sometime after the big temperature crunch five or six million years ago the climate warmed up again. Then another sharp temperature plunge about two and a half million years ago caused a re-expansion of the Antarctic ice sheets. The great Northern Hemisphere ice sheets also built up at this time.

As in the previous cooling, Africa experienced a drying up, a reduction of wooded areas, and a return of widespread open grasslands with low shrubs and trees.

Also, as before, great faunal changes show in Vrba's fossil record in South Africa, with a peak in extinctions and new species close to 2.5 million years ago. For example, the musk-ox group disappeared, and the modern waterbuck, kudu, blue gnu, and oryx suddenly appeared, together with some 20 other antelope species.

And at some point this period saw a watershed in hominid evolution: The hominid lineage split, one branch leading to the robusts and the other to modern humans.

JUST HOW evolution works is the subject of much discussion among today's biologists. One idea is that evolution is gradually taking place all the time because of mutations and changing environmental influences. Another proposal is that long periods of relative evolutionary stability are punctuated by sudden appearances of new species. This hypothesis is called punctuated equilibrium. It may well be, many scientists say, that both kinds of evolution are in operation.

Whether the appearance of the new genus *Homo* is an example of punctuation is subject to debate. In any event, the remains of early *Homo*, 1.8 million years old, do show up in the lowest level of that fossil gold mine, Olduvai Gorge.

These fossils, found at Olduvai from 1959 on, were fragmentary, but they were sufficient to convince Louis Leakey and his collaborators Phillip Tobias and John Napier that they had something different and that *this* was the real founder of the Oldowan tool industry.

At the suggestion of Raymond Dart, the new hominid was named *Homo habilis*, "handy man." But as with Zinj, the Leakeys devised their own whimsical names for the individual fossils, such as Cinderella and George. Another, whose skull was squashed flat, was named after the English model Twiggy, "because she was the only person in the world as flat as this skull."

Scientists believe that evolution takes place in a mosaic fashion—some parts of an organism change more rapidly than others. *Habilis* is a good example. Its face is still primitive, but the back teeth are narrower and the brain shows especially significant change. At 680 milliliters it is half again larger than in *africanus* (although still only half as large as the average brain today).

Not only is it larger, it is also more sophisticated and more in the modern human pattern. Brain specialists such as Ralph Holloway of Columbia University see for the first time in the cast of the *habilis* brain the bulge of Broca's area. This region is essential to speech. Thus, in the experts' view, *habilis* probably had the neurological equipment for at least rudimentary speech.

Could *habilis* make all the sounds human beings make today? Jeffrey Laitman, anatomist at the Mount Sinai School of Medicine, is not so sure. He points out that human infants cannot articulate most sounds until after they are a year old, when the larynx, or voice box, drops down in the throat. With apes the larynx never drops, and, of course, they cannot speak as we do.

Dr. Laitman's studies show that the degree to which the base of the skull is flexed, or bent, is indicative of whether the larynx can move down. And since the bases of the early *Homo* skulls are only slightly flexed, Dr. Laitman believes that the full range of sounds was not possible. Indeed, he suggests, full command of articulate speech did not likely develop until perhaps 300,000 to 400,000 years ago.

Two million years ago *Australopithecus robustus* and *boisei* were living an exceedingly primitive life, without articulate speech, with poor tools and weapons, and probably without much protein from meat.

Their contemporary, *Homo habilis*, on the other hand, experienced a quantum leap forward. Greatly increased brain power could have meant not only the beginnings of speech but also the all-important advantage of stone tools. With *habilis* and his tools the

Compare the evidence

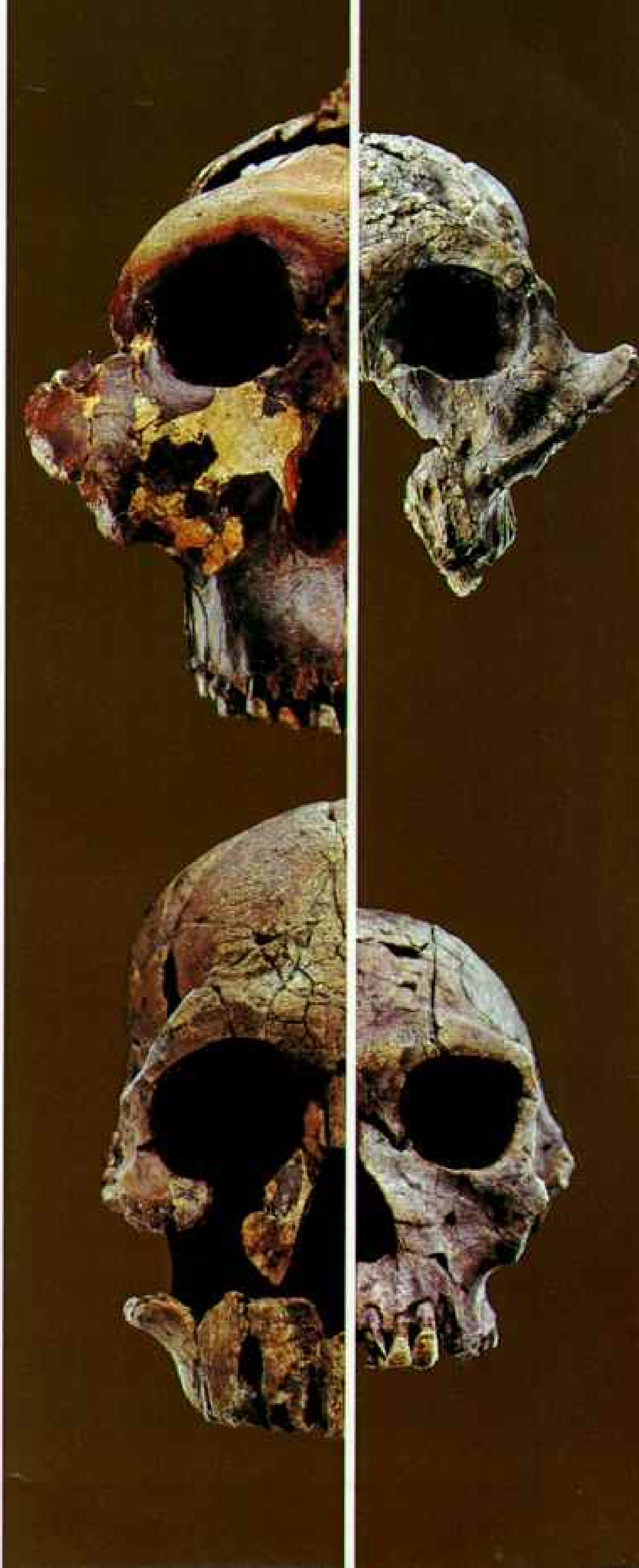
AFTER FOSSILS surface, the work of labeling them begins. Living species are defined by their appearance and behavior; by definition members of a species do not mate with outsiders. But with much of the behavior of early man a mystery, clues from bones alone must serve to differentiate species.

*When archaeologist Mary D. Leakey found the startling skull (OH 5) at upper left in Tanzania's Olduvai Gorge in 1959, a new genus—*Zinjanthropus *("East African man")—and species—*boisei *(after a benefactor)—was named. Later it was redesignated* Australopithecus boisei.

In 1972 a team led by Dr. Leakey's son Richard found the skull (KNM-ER 732) at upper right near Lake Turkana. Was it a new species? Or a variation of boisei? *It looked like Zinj and had a brain size close to Zinj's 530 milliliters. Most experts now agree that the skulls exhibit sexual dimorphism—the male of the species is much larger than the female, a trait common in great apes.*

A problem arose over two other skulls from Lake Turkana. The larger (KNM-ER 1470), at lower left, was labeled Homo habilis *("handy man"). Is the smaller skull (KNM-ER 1813), lower right, its female counterpart, as some argue? No, say others, including Columbia University's Dr. Ralph Holloway, whose endocasts reveal a difference in brain architecture and size from 750 milliliters in the larger to 510 in the smaller. More specimens may solve such controversies.*

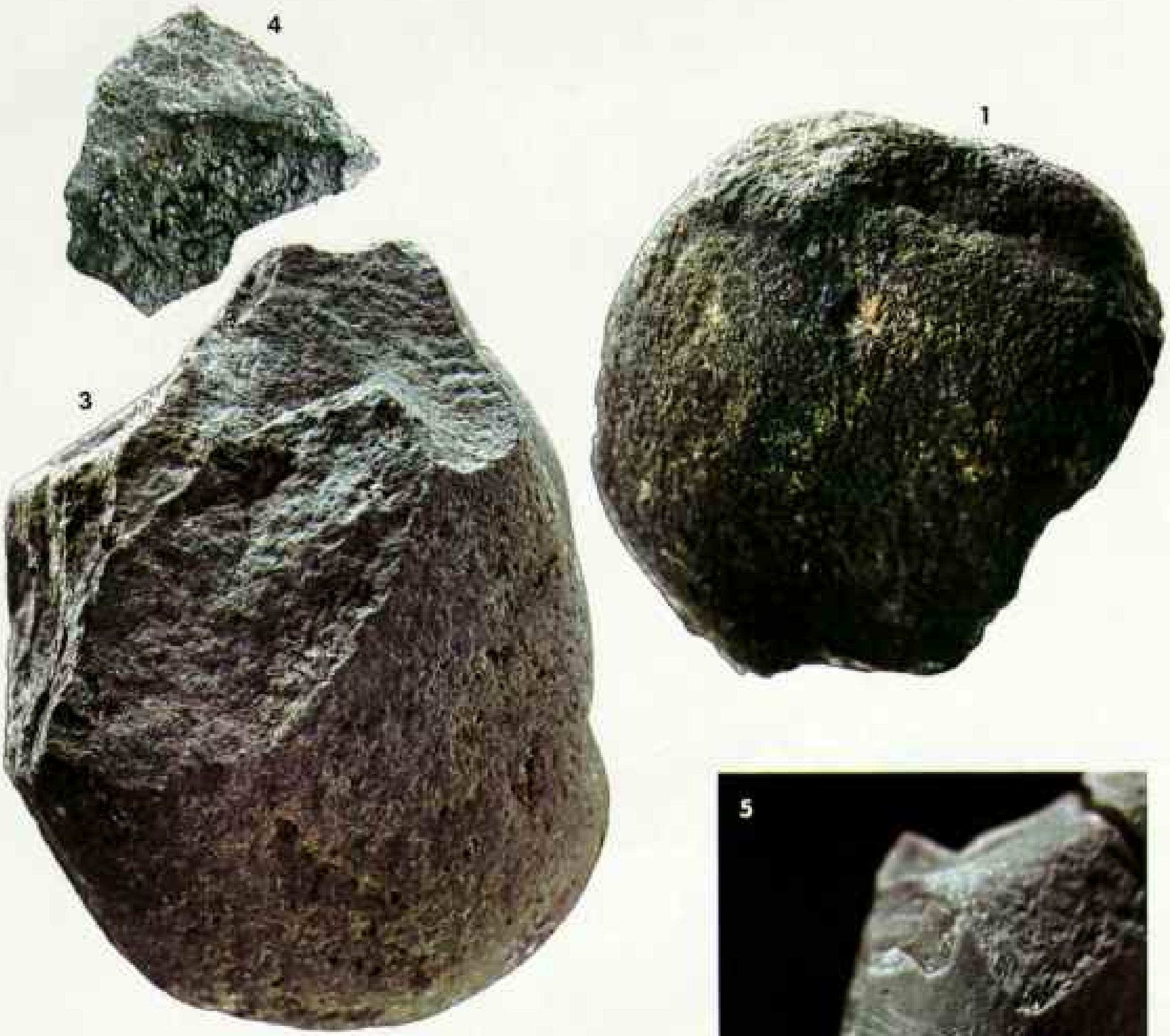
PHOTOGRAPHED AT THE NATIONAL MUSEUM OF TANZANIA (UPPER LEFT); OTHERS AT THE NATIONAL MUSEUMS OF KENYA



Galaxy of stone tools, at top, and antelope bones, many probably shattered by humans,

TWO EXPOSURES ON A SINGLE FILM SHEET. TOP IMAGE TURNED UPSIDE DOWN

is part of the collection of thousands excavated by Mary Leakey at Olduvai Gorge.



ANCIENT TOOL KIT *at Olduvai might have included a lava cobble* (1) *picked from a streambed to batter open an antelope humerus* (2), *exposing the marrow. Or the cobble might have been used as a hammerstone to turn another piece of lava into a chopper* (3) *by knocking flakes from one side. A sharp-edged flake* (4) *could deflesh a bone, leaving telltale parallel cut marks* (5).

The story tools tell

EXTRAORDINARY ASSEMBLAGE of bones and worked stones came to light at Olduvai Gorge's 1.8-million-year-old Bed I after Mary Leakey found Zinj there. It was the first important early man site dated by potassium-argon and the earliest instance of stone tools found with a hominid skull. Meticulous excavation of a 100-square-meter plot with dental tools and sieves yielded 3,510 fragmented bones, most of them from bovids, and 2,275 stone artifacts, largely flakes and broken flakes (seen in part on pages 602-603 and at left). Called Oldowan, the first tool industry has since been recognized in deposits some 2.5 million years old in Ethiopia.

In recent years specialists have investigated possible meanings of the Bed I accumulation. They have shown that stones would not fracture or accumulate naturally at this site. They found that the closest sources of lava and quartzite were several kilometers from the lakeside locale. And while modern apes pick up and use rocks as hammers, they do not try to carry them great distances or to sharpen them.

*Some of the animal bones bore marks of carnivore teeth, others the fractures only a stone would make (**left, 2**); hyenas usually gnaw long bones from each end. Natural processes rarely leave parallel cut marks (**5**).*

Here, then, is the first evidence of hominids who were eating raw meat and marrow. But how did they obtain the animals? Over what period of time? Was this a base camp with hunters dragging back parts of their kill to share? Or were people bringing in bones scavenged from carnivore kills to mine the marrow? Were animals dying in nearby swampy areas and being preyed upon? The last surviving hunter-gatherer groups, such as the Australian Aboriginals and the Kung San of southern Africa, are being studied for parallels.

And finally, who were the early meat eaters? Fragments of Homo habilis *were sieved out near where Zinj was found, raising the startling possibility of the two as neighbors. Were they competitors? Did one imitate the other, or did they fill different niches? Scientists may never find enough evidence to answer all these questions, but they know that hominids were now gaining access to a major food source by creating varied stone tools, a skill that was to be the prerogative of mankind.*

scientist can study not just bones but also the beginnings of culture. Now he can begin to say something about behavior, about how our forebears lived.

Accumulations of tools may suggest a temporary living site or a butchering site. If the stone of which the tools are made comes only from a distant place, it says something about early man's ability to travel and carry quantities of heavy material. Such bits of evidence confirm group activity, which in turn implies complex social organization.

For these reasons some scientists believe that *habilis* saw the beginnings of ritual and folklore. Clearly, the period from two million to 1.5 million years ago was a fascinating and critical one in the history of hominid development.

Although the original *habilis* material was found at Olduvai, the best of the specimens come from Koobi Fora, on the east side of Lake Turkana in northern Kenya. There Richard Leakey, son of Louis and Mary Leakey, has been excavating since 1968. At the National Museums of Kenya in Nairobi, where Leakey is director, I saw a rich collection of thousands of mammalian fossils, stone tools, and early hominid fossils from Koobi Fora. One of the prize specimens is the most complete *habilis* skull ever found, known simply as KNM-ER 1470.

Base camp at Koobi Fora lies on a sandy point projecting into the crocodile-infested waters of Lake Turkana. To my surprise the camp crew and visitors alike swim with impunity in the lake's alkaline waters, although at night scores of pairs of crocodilian eyes glow red in the light of a powerful torch.

At Koobi Fora I had the special pleasure of meeting Kamoya Kimeu, Leakey's deputy and perhaps the most successful finder of hominid fossils in the history of anthropology. With Kimeu I made a foray by Land-Rover into the Koobi Fora hinterland, while Leakey and his wife, Meave, flew in. When we joined forces, Leakey, all smiles, was unwrapping an object: the skullcap of an *Australopithecus boisei*.

Earlier, a member of the permanent crew at Koobi Fora had spotted what appeared to be primate remains. Leakey had gone to check on the find and discovered that it was not merely primate, but hominid. Close by the skullcap were additional fragments.

Seeking answers to an old riddle

*CAVE EXCAVATIONS at Swartkrans, South Africa (**left**), may show whether early man was the hunter or the hunted. During the Pleistocene epoch, beginning two million years ago, an underground cave complex acted as a catch basin for dead creatures whose remains washed or fell in—antelopes, baboons, saber-toothed cats, leopards, and some 130 Australopithecus robustus individuals. A partial juvenile cranium fossil found in 1949 had two holes about six millimeters in diameter, 33 millimeters apart. Some theorized they were caused by*

AFTER C. K. BRAIN, © MAITLAND

*the flesh, and the skull dropped into the cave shaft (**below**), where it was eventually covered by debris.*

Excavators use plumb bobs suspended from grids to plot the exact location of each find. Positive dating by radiometric methods has so far proved impossible, since the region is not volcanic. But faunal chronology has placed early man here at least 1.5 million years ago.

*blows from a pointed weapon. But similar holes occur in skulls of baboons killed by leopards, chief excavator Bob Brain pointed out. He matched the lower canines of a leopard jaw found in the deposit to the holes in the juvenile's skull (**above**), demonstrating that this hominid was more prey than predator.*

Apparently in dragging its kill out of reach of hyenas, the leopard penetrated the skull with its canines. High in a tree, the leopard consumed

Back at camp Meave immediately set to work gluing fragments together. When I tried matching broken pieces, I discovered that a true fit joins tightly and unmistakably. Within an hour the skullcap had been enlarged by at least two dozen pieces. The work of the anthropologist is not only discovery but also reconstruction.

In a light plane Leakey and I surveyed the desert badlands surrounding Koobi Fora, 1,300 square kilometers (500 square miles) of ancient lake sediments and volcanic deposits traversed by eroded gullies. From the air the sparsely vegetated hummocks resembled nothing so much as the backs of kneeling elephants.

As we flew low, Leakey pointed out where many a now famous fossil had been found. Their numbers—1470, 1813, 406, 3733—are as familiar to paleoanthropologists as if they were names. They represent a gamut of hominid species, including australopithecines as well as *Homo habilis* and his world-traveling descendant, *Homo erectus*.

Looking into living quarters *300,000 years old, Professor Henry de Lumley* ***(above,*** *right) has co-directed cave excavation in Arago, France, for 20 years. His belief that a cranium found in one of the 20 occupation levels is Homo erectus is challenged by colleagues.*

He delighted to wander in unknown lands. —OVID

IN THE LATE 1880s, when science knew of only a half dozen discoveries of fossil man, a Dutch doctor, Eugene Dubois, burned with a desire to find the missing link. He sought a colonial post in the Dutch East Indies and began history's first deliberate, systematic search for early man.

With 50 convict laborers Dubois excavated along the Solo River in Java. In 1891, near the village of Trinil, he uncovered a flat skullcap. The next year a modern-looking thighbone turned up that clearly was not from an ape. He called the creature *Pithecanthropus erectus*, "upright ape-man." To the public it would be known as Java man. Other specimens were discovered later, especially at nearby Sangiran.

In China, in 1929, a young paleontologist named W. C. Pei found a similar skullcap embedded in deposits in a limestone cave in a large hill near the village of Zhoukoudian, near Beijing.

For centuries peasants had mined the hill for "dragon bones"—actually the fossil bones and teeth of extinct animals and hominids. Treasured for miraculous healing properties, the fossils were ground up and sold in medicinal preparations.

As one author has put it, we will never know how many powdered bones of early man "have passed harmlessly through the alimentary canals of dyspeptic Chinese."

For a few yen I was able to buy a packet of dragon-bone powder in Beijing's largest apothecary shop. However, regulations

today forbid sale of fossil material unless approved by the authorities.

Pei's skull had escaped the searches of the cave robbers, and it was taken to the laboratory of Davidson Black, anatomist at the nearby Peking Union Medical College. Black had coined the name *Sinanthropus pekinensis*, "Chinese man of Peking," for teeth found earlier in the Zhoukoudian cave, and he believed the skull belonged to the same species. The public chose its own name, Peking man. Other important specimens have been found over the years at Zhoukoudian and at Lantian and Hexian.

The original Peking man bones, representing more than 40 individuals, mysteriously disappeared during World War II. As the Japanese marched on the Chinese capital in 1941, the bones were crated for shipping to safety in the United States. En route to the seaport they vanished. Countless clues have been followed up, but in vain. Fortunately we have excellent casts and meticulous descriptions by a German anatomist, Franz Weidenreich, who had succeeded Davidson Black. Casts, however, can never substitute for the real thing.

As we have seen, biological names have a way of being changed. Today we include both Java man and Peking man in the category *Homo erectus*, "upright man." They are the most famous representatives of the first hominid group believed to have left the African cradle.

No one knows just when *erectus* began to move out of his ancestral homelands. The oldest (and most complete) example of *erectus* in the fossil record is dated at about 1.6 million years ago. It comes from Nariokotome, on the west bank of Lake Turkana. Kamoya Kimeu added this spectacular find to his record list in August 1984 on an expedition headed by Richard Leakey and Alan Walker of the Johns Hopkins University (see the article beginning on page 624).

Erectus seems to give way to his successor, *Homo sapiens*, at perhaps 300,000 years ago. Sometime during the preceding million years the expansion began, moving along the tropical and subtropical fringes of the Old World.

Why did hominids attempt to leave after existing across much of Africa for perhaps three million years?

Milford Wolpoff of the University of Michigan answers that question succinctly: "They left when they did because they wanted to, because they had to, and especially because they could."

Intimately bound up in this explanation is the significant change in *erectus* as compared with his forebears. His face, it is true, is not all that different—still protruding jaws, no chin, thick browridges, and a long low skull resembling a partially deflated football. Teeth are somewhat smaller than in *habilis*.

But the brain—that's the difference. Average size is now close to 1,000 milliliters (about two pints), as compared with the 1,350 average for modern humans. With a larger brain *erectus* may have had more advanced speech. According to evidence of charcoal at Zhoukoudian and elsewhere, he now learns to control fire and cook food. And he makes far better stone tools and weapons, great quantities of large, double-edged, teardrop-shaped "hand axes" (at least we call them that, although no one knows just how they were used).

The early ape-men probably did not venture far afield. But *erectus*, with his enlarged, more complicated brain, inevitably developed intellectual curiosity. Like humans today, he must have *wanted* to see what was on the other side of the mountain.

Beyond that, he may have *had* to leave Africa because of population pressure. *Erectus* had substantially improved capability of exploiting the environment: better hunting and foraging skills, greater ability to move into more marginal ecological niches. On the one hand all this strongly encouraged population increase. On the other hand it meant that when growing population threatened to exhaust the resources in one area, part of the population *could* move on to unexplored areas, just as did the American pioneers.

Evidence of *erectus* is found in East, South, and North Africa, but most specimens come from Asia, possibly including a recently discovered skull from the Narmada Valley in India. The Asian specimens, especially, have thick skulls, the thickest of all hominids. Mysteriously, most of these show multiple healed fractures, as many as seven or eight to a skull. Did *erectus* engage in

wholesale skull bashing in warfare or ritual activity? Or are the wounds evidence that *erectus*, with his much improved weapons, was now hunting dangerous big game?

Another mystery concerns a partial *erectus* skeleton from Koobi Fora known as KNM-ER 1808. Each long bone in this skeleton appears diseased; it has a thick extra layer of spongy bone.

Alan Walker, an anatomist on the expedition that found the skeleton, consulted a number of other anatomists and pathologists about the possible cause of this disease. Their investigations ran into a number of blind alleys until someone recalled the case of the explorer Sir Douglas Mawson.

In 1912 Mawson and two companions, using dog sledges, undertook a long trek across unexplored Antarctic ice. Food and other critical supplies were lost down a crevasse, along with one of the men. Mawson and his companion were forced to begin eating their dogs. They both weakened steadily; only Mawson survived. It is believed that they suffered from vitamin-A poisoning because of eating the livers of the dogs.

Carnivores that eat livers of other carnivores accumulate vitamin A in their own livers to levels that are poisonous to human beings. The excess vitamin can cause bone disease and the growth of a protective layer. Could this explain the mystery of skeleton 1808?

PHOTOGRAPHED AT MUSEO ARQUEOLÓGICO NACIONAL, MADRID (BELOW)

Like a 3-D jigsaw puzzle with no picture on the box and half the pieces missing. —ALAN WALKER

WE KNOW THAT Homo erectus reached India, China, and Southeast Asia. It seems reasonable to believe that he also went into Europe during warm periods when the Pleistocene glaciers were at an ebb. His characteristic tools, known as Acheulean, are common enough there.

Yet, strangely, no unequivocal skeletal remains of *erectus* have been found in Europe. A handful of specimens, such as the Arago remains excavated by Henry and Marie-Antoinette de Lumley in the Pyrenees foothills of France, the huge Heidelberg jaw from Germany, and the back of a skull from Vértesszöllös, Hungary, are sometimes

Experimenting on an elephant *that died of natural causes, archaeologists Dr. Nicholas Toth and Dr. Kathy Schick try to duplicate the skills of early hunters working with stone tools. Their simple unmodified flint flake easily slices two-centimeter-thick hide* (**right**). *With hand axes, colleagues sever the animal's large muscles* (**above**). *Two men were able to butcher 100 pounds of meat each in an hour. By then the tools were so dull that they had to be sharpened by knocking off more flakes to obtain a jagged edge. Later the researchers examined the tools under a microscope to correlate their wear patterns with those on ancient tools to deduce the latter's use.*

Such experiments aid in interpreting finds at an excavation in Ambrona, Spain, where Dr. F. Clark Howell has found elephant bones and tusks (**upper left**) *with an array of stone tools, such as this hand ax* (**opposite**). *Although no hominid bones have been found, the evidence indicates that large numbers of animals were being butchered here more than 400,000 years ago.*

Deliberate burial *enters the record with the Neandertals. A stocky young man lay for perhaps 50,000 years in a pit grave* ***(above)*** *at Kebara Cave on Israel's Mount Carmel before an Israeli-French team excavated in 1983. After death the flesh decayed, and the cranium was removed before the bones were covered with dirt. Ash and charcoal layers suggest the cave was lived in.*

From the world's oldest known cemetery at La Ferrassie, France, Neandertal teeth ***(below)*** *show gum disease, as well as wear suggesting their use as a vise.*

called *erectus*. A number of authorities, however, regard them as early, or archaic, forms of *Homo sapiens*.

The description of paleoanthropology as a tricky jigsaw puzzle is particularly apt during this transition between *erectus* and *sapiens*. The fossil materials are scarce and fragmentary. Moreover, the datings are uncertain and often controversial.

In Europe the oldest unquestionable site of hominid occupation is Soleilhac, in the Massif Central of France, said to be more than 800,000 years old. It offers faunal remains and tools, but no hominid bones.

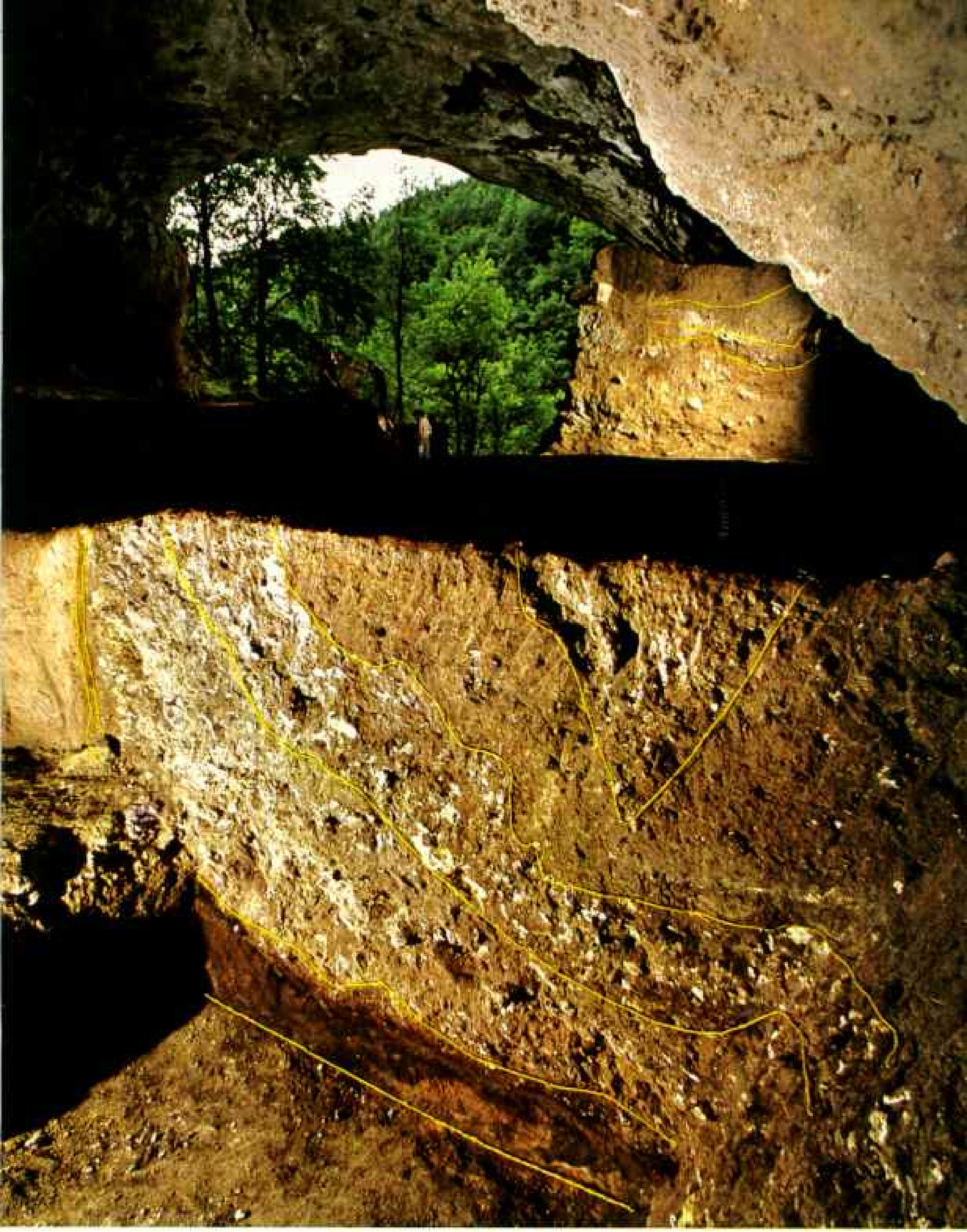
Similarly, Ambrona and Torralba on the Spanish plain, 150 kilometers (95 miles) northeast of Madrid, served as butchering sites perhaps close to half a million years ago. Over a large area thousands of stone tools, traces of fire, well-preserved elephant bones and tusks, and many remains of other animal species have been unearthed by anthropologists Clark Howell and the University of Chicago's Leslie Freeman, but again not a single hominid bone or tooth.

Virtually all the early *sapiens* remains are believed to be less than half a million years old. Important European specimens include the unusually complete Petralona skull, found in 1960 after shepherds fell into a hidden cavern near Thessaloniki, Greece; the distorted Steinheim cranium found in Germany in 1933; and the Swanscombe skull fragments, Britain's oldest known human remains, thought to date from 200,000 to 300,000 years ago.

Non-European samples include the Broken Hill, or Kabwe, skull, found in 1921 in Northern Rhodesia (now Zambia), one of the earliest examples of severe dental decay; the Saldanha skull, found in 1953 near the tip of South Africa; and China's Dali cranium, found in Shanxi Province in 1978.

Over a million years *Homo erectus* changed gradually. But as archaic *Homo sapiens* came on the scene, hominids were still big-browed, flat-skulled, generally crude in appearance. Teeth were a little smaller.

By 200,000 years ago, there is strong indication that brain volume was expanding ever more rapidly. With the appearance of the Neandertal variety of *Homo sapiens*, by about 125,000 years ago, brain size and organization were basically modern.



Climatic changes *can be read in 12 meters of sediment excavated in Vindija Cave in Yugoslavia. The strata show periods of warm climate alternating with cold from 75,000 to 18,000 years ago. Fragmentary remains of Neandertals and early modern humans who found shelter here suggest to some that the earlier type evolved into the latter in central Europe.*

What mysteries do lie beyond thy dust . . . —HENRY VAUGHAN

OF ALL the early hominids, none have been so maligned and misunderstood as the Neandertals, the cavemen of the cartoonists. Unfairly, the very name Neandertal has connoted brutish behavior and primitive backwardness.

A Neandertal skeleton was the first fossil hominid discovery to be publicized. He was the first clue to human ancestry, though he was not then recognized as such.

In 1856, near Düsseldorf in the Neander Valley (Tal, or Thal in 19th-century German), limestone miners quarrying into a cave found an unusual human skeleton. A beetle-browed, low-sloping skullcap, part of a pelvis, and some remarkably thick and slightly curved limb bones fell into the hands of the local science teacher.

No one at the time had any idea of the vast age of the earth, or of the long history of hominid evolution. Virtually everyone assumed that mankind had always had the same form as modern humans. No one was prepared for "a primitive skeleton in the human closet."

So it is not surprising that the science teacher did not view the Neander Valley bones in genealogical terms. Rather, he concluded that the remains were those of a refugee from Noah's flood. Others decided that the creature was "some poor idiotic hermit," a sufferer from rickets, or a deserter from the Cossack army that had camped nearby during the Napoleonic Wars.

This false picture was compounded by the unfortunate case of a nearly complete Neandertal skeleton found in 1908 near La Chapelle-aux-Saints, in the Corrèze region of southwestern France. Marcellin Boule, an authority on fossils, undertook to reconstruct the skeleton. He created the image of a hulking, dim-witted brute, who shuffled with the bent-knee gait of an ape.

Today, with specimens from more than a hundred sites, we know that Boule was wrong. The Neandertals were not so different from us, although decidedly more robust. Thick, heavy bones with markings of powerful muscles reveal a people capable of enormous exertion and endurance.

Body proportions, with rather short lower limbs, were like those of today's Lapps, Eskimos, and other cold-adapted people. Europe's Neandertals were the first humans to move into truly cold climates, enduring miserable winters and short summers as they pushed north into tundra country in the wake of the retreating glaciers.

Noticeably large heads and faces retained heavy browridges that tended to curve over the eye sockets. Receding cheekbones, weak chins, large noses, and protruding jaws were characteristic, especially of the "classic" Neandertals of Europe.

But if the Neandertal's face was still somewhat primitive, his brain was not. Despite a sloping forehead, the average brain was even larger than our own and just as well developed.

It was precisely this brain that enabled the Neandertals to adapt to extreme climates. We find their remains chiefly in caves and rock-shelters where they took refuge. We find also large quantities of specialized stone tools and weapons, of a style known as Mousterian. The tools are finer and more carefully shaped than those of *erectus*.

Large numbers of the tools are thought to be scrapers used in dressing hides for clothing. And, curiously, the Neandertals—like living Eskimos—show a high degree of rounding tooth wear, suggesting that they regularly held hides with their front teeth as they worked on them.

FURTHER EVIDENCE of the intelligence of the Neandertals is seen in their burial practices. They were, in fact, the first people known to bury their dead, which helps account for the fact that we have found relatively large quantities of Neandertal remains.

They may have believed in spirits and perhaps in an afterlife, although this idea is by no means commonly accepted. In a number of the more famous burials, stone tools and other objects were associated with the bodies in a manner that might suggest special concern for the departed one, not unlike the placing of treasures in ancient Egyptian tombs: goat horns circling a child's skull at Teshik-Tash, in Soviet Uzbekistan; huge cave-bear skulls with a burial at Regourdou, in France; a circle of stones

around a skull at Monte Circeo, in Italy.

Some Neandertal remains appear to have been decorated with red ocher. David Frayer, University of Kansas anthropologist, suggests that this practice may have been intended to bring back the blush of life to the body.

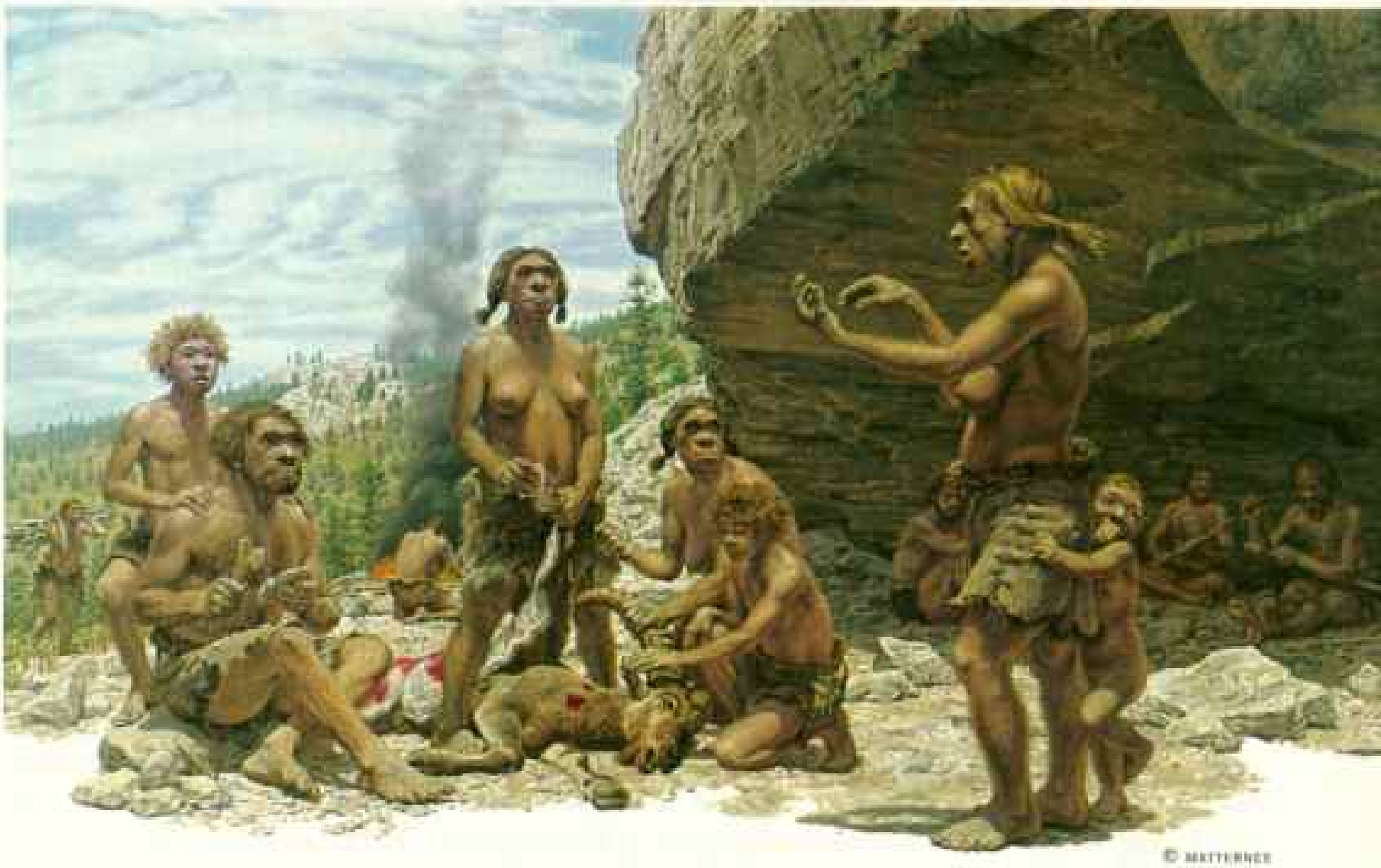
Another conclusion we can draw from remains of the Neandertals is that their social bonds were strong. Consider the case of the Old Man of La Chapelle-aux-Saints. He had a broken rib, severe hip arthritis, and diseased vertebrae; because of gum disease he had lost nearly all his teeth. He couldn't hunt, and he couldn't chew well, yet he survived to the age of perhaps 40. Clearly his fellows were caring for him, or he would have died long before. This case and a number of others like it bespeak altruism and a social conscience that one would hardly have expected from the Neandertal "brutes."

As one anthropologist puts it, "In the light of 20th-century human behavior we should be careful of whom we call brutish."

MYSTERY surrounds the Neandertals. They are somewhat difficult to place in time since the earlier part of their existence is too young for potassium-argon dating, even if suitable volcanic materials were available, and too old for the carbon-14 method. Moreover, many of their remains were discovered decades ago, before today's rigorous excavation techniques, and much important evidence was lost.

Nevertheless, Neandertals seem to appear on the scene in Europe perhaps 125,000 years ago. They disappear—some say quite abruptly—at some time between 30,000 and 40,000 years ago.

One unusually late Neandertal is a skeleton excavated in 1979 at St.-Césaire, in southwestern France, and studied by French anthropologist Bernard Vandermeersch. It is only about 32,000 years old. Oddly, while the remains are Neandertal,



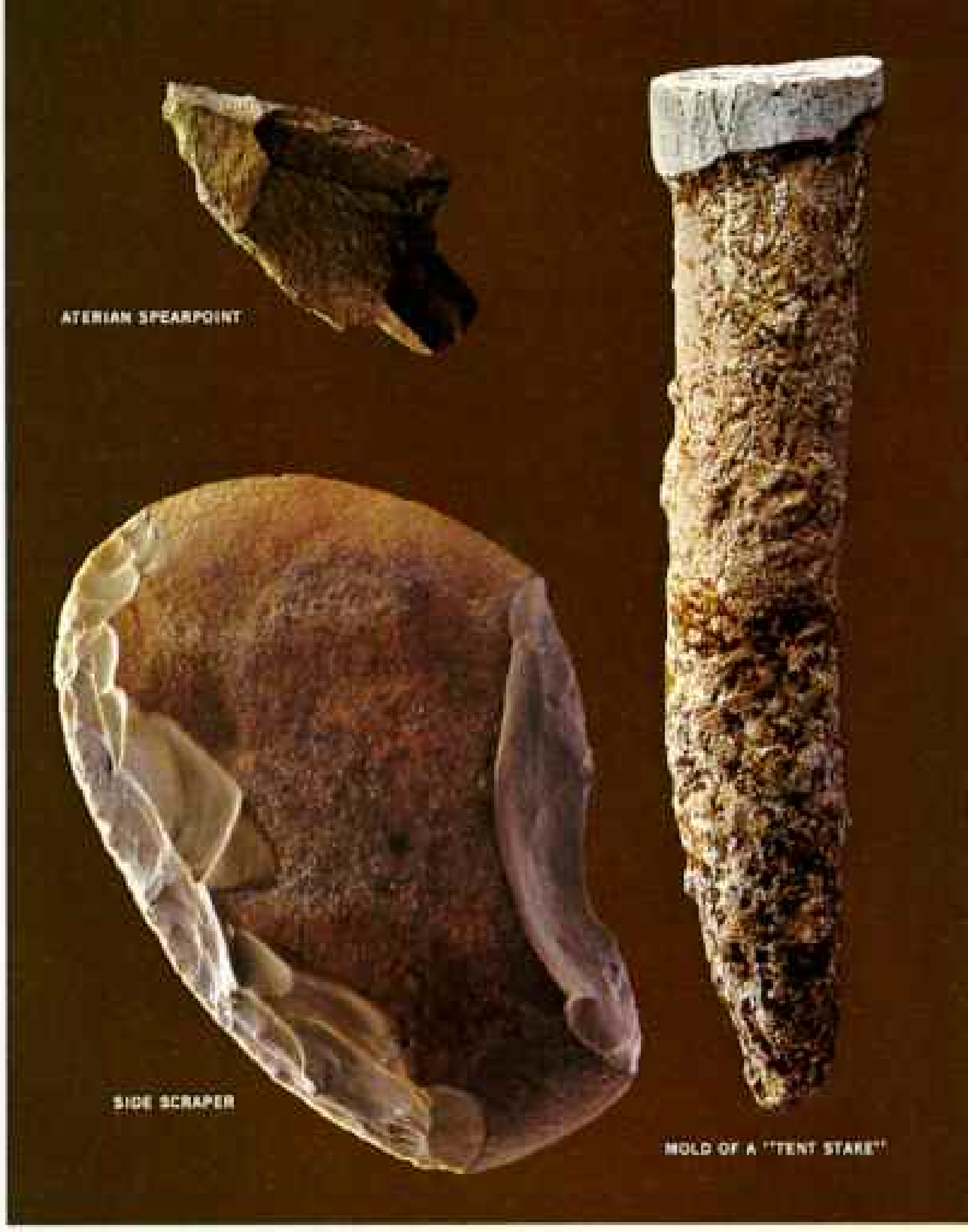
© MATTERNES

After a successful hunt *members of a Neandertal living group prepare their kill at their summer camp in southern France. Some skin the ibex with stone tools, which must be constantly renewed and replaced, while flint spearpoints are prepared, background. Archaeological evidence indicates Neandertals skillfully utilized the abundant natural resources of Europe in both warm and cold periods.*

Specialized artifacts *became increasingly complex over time. Neandertals produced the forms classified as Mousterian. The quartzite spearpoint likely brought down gazelles 40,000 years ago in North Africa. The side scraper represents a tool in use for half a million years. Excavators poured plaster in an unusual depression to obtain the ghost of a wooden peg. The Levallois technique of shaping a core and striking a flake was practiced from southern Africa to western Europe.*

Upper Paleolithic tools are associated with modern man. An engraving tool, called a burin, shaped antler and bone into other tools, such as the needle and the harpoon head. Fine blades and points demonstrate the finesse of gifted craftsmen.

LEVALLOIS CORE, 10 CM; HARPOON HEAD, 18 CM; ALL OTHERS APPROXIMATELY ACTUAL SIZE. BURIN PHOTOGRAPHED AT MUSÉE DES EYZIES, LES EYZIES, FRANCE; NEEDLE AT MUSÉE BÉGOUËN, MONTESQUIEU-AVANTÈS, FRANCE; ALL OTHERS AT INSTITUT DU QUARTERNAIRE, UNIVERSITÉ DE BORDEAUX I, TALENCE, FRANCE



the stone tools associated with them are not Mousterian, but those of Upper Paleolithic man, anatomically modern *Homo sapiens*, who displaced the Neandertals.

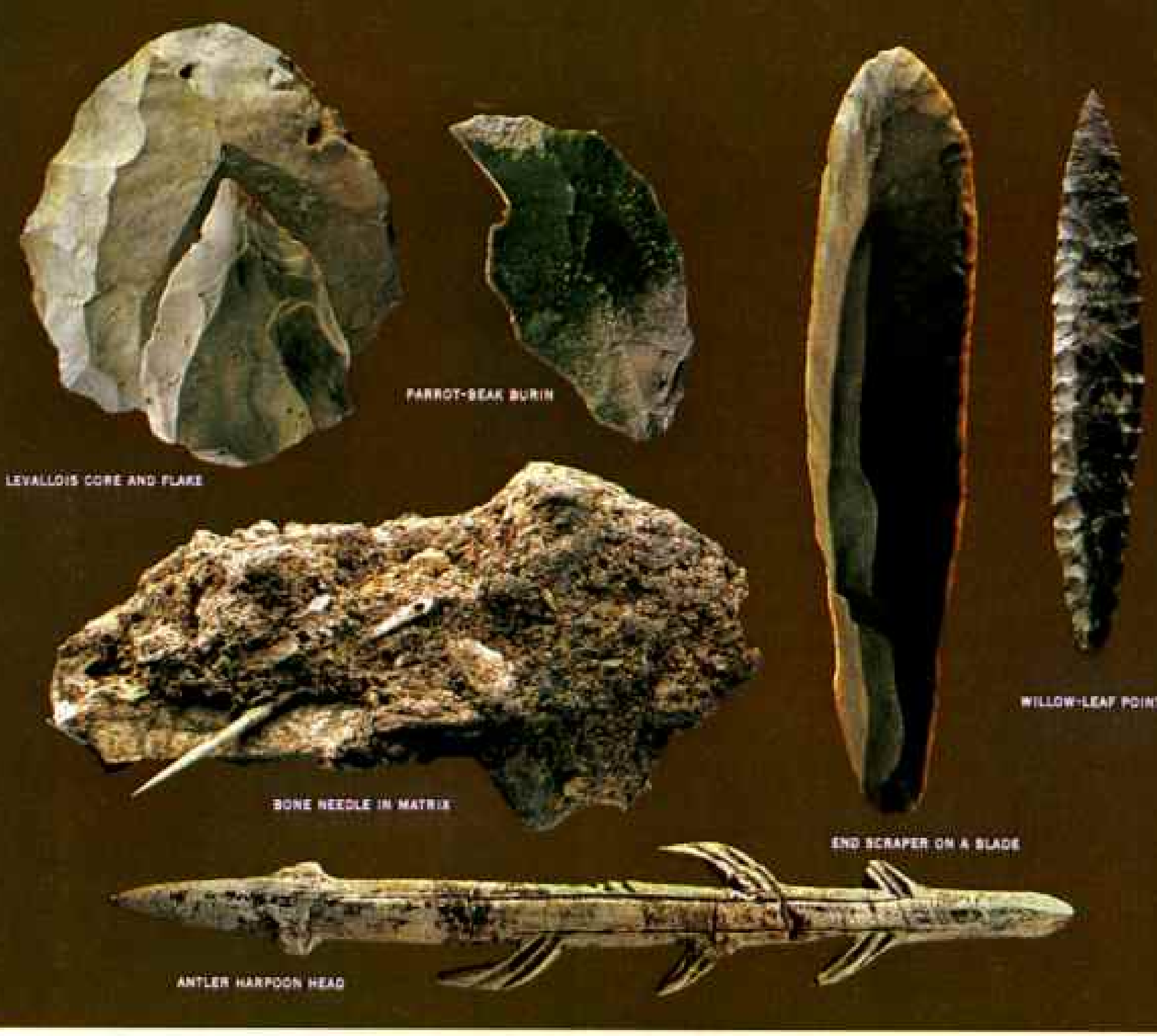
During the relatively short span of about 100,000 years, the Neandertals spread all across Europe, the Middle East, and western and central Asia. They were contemporaries of other forms of archaic *Homo sapiens* found as far away as China and South Africa.

The eastern Neandertal types, such as those from the caves of Tabun and Amud in Israel, not only look somewhat different from the classic European Neandertals, but they also may have evolved more rapidly.

In any event, as Chris Stringer of the British Museum (Natural History) has maintained, the last of the hominid groups seems to appear some thousands of years earlier in the Middle East than in Europe. The Israeli caves of Qafzeh and Skhul have produced remains of people using Mousterian tools, although they are unmistakably modern.

This last group is often referred to as anatomically modern humans, whose physical differences from us are too slight to be of much significance. Where they came from and how they are related to the Neandertals is a matter of much debate.

Did they derive from the Neandertals, in a lineage running back to *erectus*? Or did they evolve from archaic forms by punctuation in the Middle East and replace the Neandertals? Or did they originate in Africa 50,000 to 100,000 years ago, move slowly into southwest Asia, and end up in Europe 30,000 years ago? Fragments of anatomically modern humans found in caves at Klasies River Mouth on South Africa's Indian Ocean coast and dated at more than 50,000 years ago seem to bear out this thesis.



Finally, did the Neandertals lose out in competition with arriving populations who displaced or absorbed them? All we know is that they disappeared, and that by 30,000 years ago a robust version of modern humans had replaced them everywhere.

In Australia Alan G. Thorne of the Australian National University has found anatomically modern remains more than 30,000 years old, possibly much older. By then peoples from both China and Indonesia had found ways to travel considerable distances by water.

Thorne believes that these same peoples could have reached the New World by sea. The conventional view, however, is that early man reached Siberia perhaps 30,000 years ago and crossed much later over the Beringia land bridge into North America. Such a land bridge would have been exposed during periods when the great ice sheets had absorbed enormous amounts of water and lowered sea levels.

What a piece of work is a man!

—"HAMLET"

HARD by the Hotel Cro-Magnon in Les Eyzies, in the Dordogne region of southwestern France, a horse chestnut tree overhangs a shallow rock-shelter. A sign informs the visitor that here, in 1868, railway workers uncovered the first generally recognized example of a fossil of anatomically modern *Homo sapiens*. With the bodies were the fossil bones of reindeer, mammoth, and bison.

In the Musée de l'Homme in Paris, more than a century later, I examined the skull of the Old Man of Cro-Magnon, one of five skeletons buried at that spot. A high

forehead, a chin, and greatly reduced browridges gave the look of totally modern man. He would have passed unnoticed on American city streets, I thought, except for one anomaly: An area of the skull as big as a silver dollar and part of the face were badly eaten away. It has been theorized that the Old Man suffered from actinomycosis, a devastating disease apparently caused by a mysterious species of bacteria.

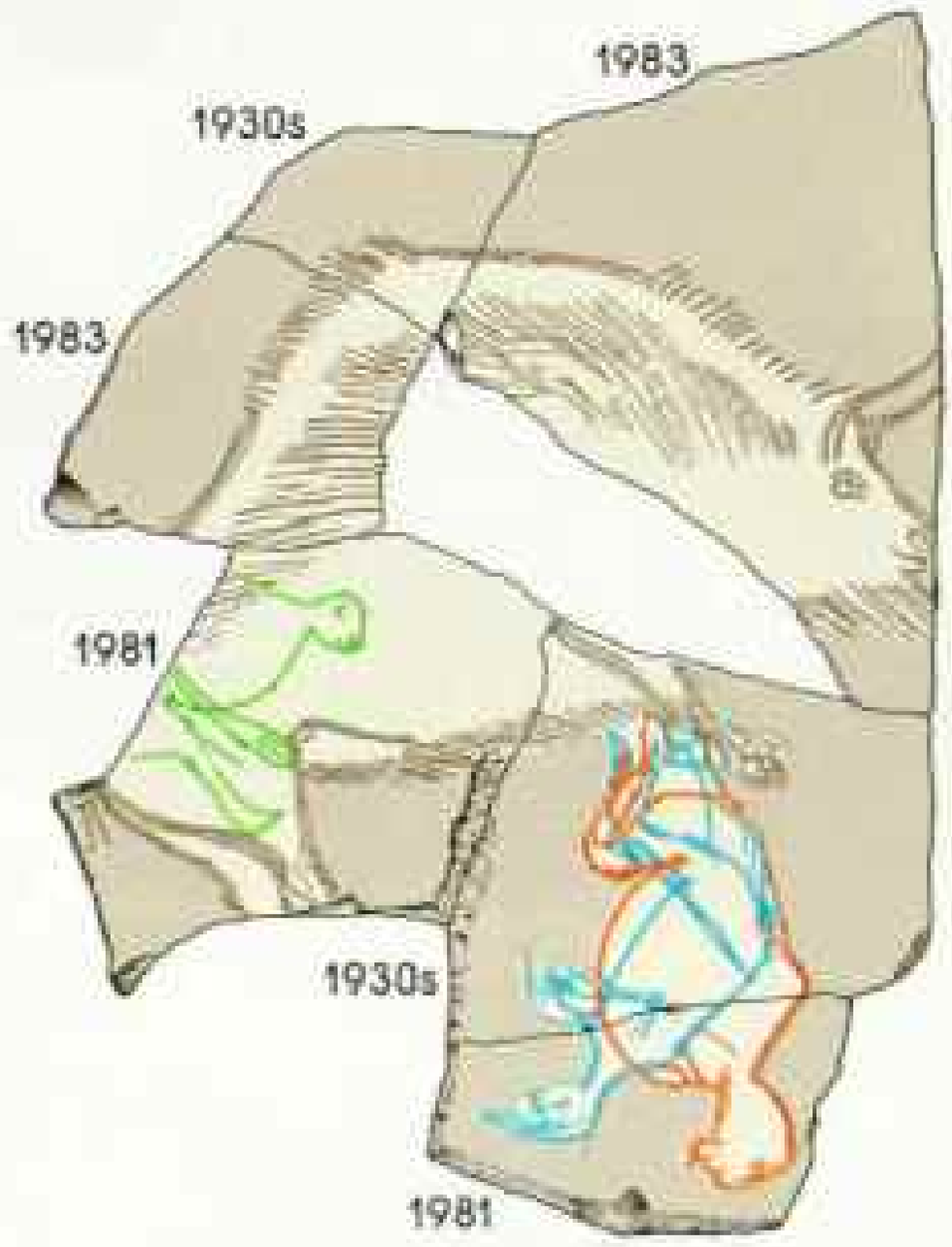
Cro-Magnon man has given his name to the successors of the Neandertals in France, where a century of intensive excavations, especially in the Dordogne, has disclosed much evidence of their life and times. In fact, we know more about their culture than about the people themselves. Their short period, Europe's Upper Paleolithic, from about 35,000 to 10,000 years ago, saw an efflorescence of technology and art that far surpasses anything before.

Upper Paleolithic Europeans were highly skilled nomadic hunters, following the reindeer, their favorite quarry, in its seasonal migrations. They used the atlatl, or spear-thrower, which greatly enhanced their prowess, and perhaps the bow and arrow.

Like their predecessors, they sought refuge in caves and rock-shelters. But with population growing rapidly they formed larger groups—perhaps 50 to 75 persons—that occupied ever larger living sites. They cooked in stone-lined pits.

Upper Paleolithic tools and weapons are things of beauty, finely dressed blades and points. A wide variety of other forms served special purposes, such as engraving bone and ivory for ornamentation, or drilling eyes in bone needles, or carving bone fishhooks. These tools evolved into a variety of styles bearing such names as Perigordian, Aurignacian, and Magdalenian.

In the caves of France and Spain—at Lascaux, Cougnac, Altamira—I have seen evidence of the extraordinary artistic vision of Upper Paleolithic man. Hundreds of figures of animals—deer, bison, horse, mammoth—some engraved in the rock, others painted with the black of manganese oxide or the reds and yellows of iron oxides, move in splendid profusion across the roofs and walls. Hunting and magic appear to intertwine in these exquisite animal forms, for many are pierced by arrows or spears.



The artistic impulse *was expressed in wall art, sculpture, and decorated tools at the close of the Ice Age in many parts of the world. But Europe witnessed the finest flowering yet found. What the images say about their creators remains open to interpretation.*

Consider the fragments of a 13,500-year-old sandstone tablet ***(right)*** *from Enlène cave in the French Pyrenees, excavated by Robert Bégouën and Jean Clottes. Crude lines on one of the first fragments found* ***(above)*** *were interpreted as a single obese human figure by the late Abbé Henri Breuil, pioneering cave-art researcher. A piece found in 1981 showed the one figure was two, possibly a male (red) and a female (blue), with the lower bodies overlapped, leading to the suggestion that they portrayed copulation. Another piece revealed a third figure (green). With even more fragments, a magnificent bison also took shape.*

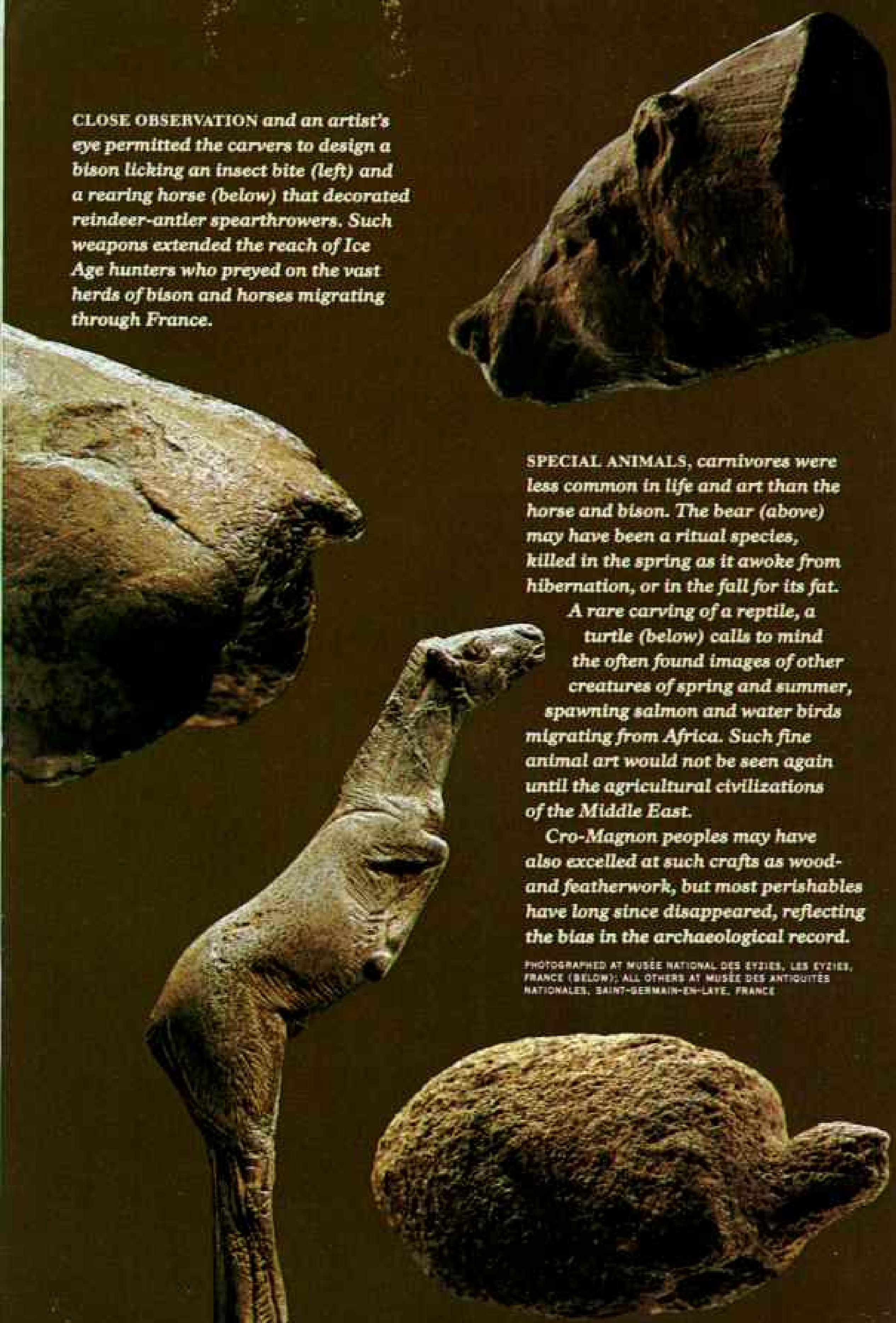
Are the crude human figures related to the animal? Were they added by a different hand, and why? Cave art was often overpainted, renewed, or associated with signs and symbols. Was the tablet broken on purpose, perhaps ritually? Do its burn marks mean it was used in a hearth?

"It's like a Rorschach inkblot test," says Alexander Marshack of Harvard's Peabody Museum. "Anyone can interpret the composition as he wishes."

NGS CARTOGRAPHIC DIVISION (ABOVE);
PHOTOGRAPHER AT MUSÉE BÉGOUËN (RIGHT)

MASTERPIECES OF REALISM, *sculptures of stone, bone, ivory, and clay record the Ice Age animals so familiar to Cro-Magnon peoples, whose artistic expertise peaked in France and Spain between 16,000 and 9,000 years ago. With a flint burin, an artist scribed a pride of lions (below) on an animal rib. He portrayed the carnivores in perspective, a remarkable feat, and in such detail that whiskers and hair in the ear are visible. Triangles have been interpreted as rain clouds or weapons.*

BISON AND BEAR SHOWN TWICE ACTUAL SIZE; OTHERS SLIGHTLY LARGER THAN ACTUAL SIZE



CLOSE OBSERVATION *and an artist's eye permitted the carvers to design a bison licking an insect bite (left) and a rearing horse (below) that decorated reindeer-antler spearthrowers. Such weapons extended the reach of Ice Age hunters who preyed on the vast herds of bison and horses migrating through France.*

SPECIAL ANIMALS, *carnivores were less common in life and art than the horse and bison. The bear (above) may have been a ritual species, killed in the spring as it awoke from hibernation, or in the fall for its fat.*

A rare carving of a reptile, a turtle (below) calls to mind the often found images of other creatures of spring and summer, spawning salmon and water birds migrating from Africa. Such fine animal art would not be seen again until the agricultural civilizations of the Middle East.

Cro-Magnon peoples may have also excelled at such crafts as wood- and featherwork, but most perishables have long since disappeared, reflecting the bias in the archaeological record.

PHOTOGRAPHED AT MUSÉE NATIONAL DES EYZIES, LES EYZIES, FRANCE (BELOW); ALL OTHERS AT MUSÉE DES ANTIQUITÉS NATIONALES, SAINT-GERMAIN-EN-LAYE, FRANCE

In El Juyo cave, in the foothills southwest of Santander, Spain, excavators from the Institute for Prehistoric Investigations, led by anthropologists Les Freeman and Joaquín González Echegaray, have found a 35-centimeter (14-inch) stone head that seems to be half man, half lion or leopard. This artistic expression and the structure containing it suggest to the excavators that the cave held a sanctuary, where religious rituals dedicated to supernatural beings were performed 14,000 years ago.

Why should we grope among the dry bones of the past?

— RALPH WALDO EMERSON

OUR STORY comes to a close at the end of the Paleolithic, about 10,000 years ago. We have traced the rise of humankind from "the first faint whispers of humanity" to the eve of civilization, just before the development of agriculture and the domestication of animals.

It is a marvelous detective story, filled with adventure, heartbreak, intensely hard work, and luck. There are many blank spots yet, many disputed points and controversies. But the general outlines are shaping up; scientists are unraveling the mysteries skein by skein.

Gradually we are satisfying the universal desire to understand our origins, our roots. Slowly we are coming to understand our place in nature, reason enough for an answer to Emerson's poetic plaint.

One final philosophical question is not so easy to answer: What makes a human a human? Perhaps, as Alan Mann suggests, it's the very ability to ask that question—something no other animal can do. □

LEFT TO RIGHT: VICTOR MERINO, DR. JOAQUÍN GONZÁLEZ ECHEGARAY, DR. LESLIE G. FREEMAN, DR. VICTORIA CABRERA, DR. FEDERICO BERNALDO DE QUIRÓS

"They lived well," *remarked Dr. Leslie G. Freeman (**above,** center) of Cro-Magnon peoples at El Juyo cave in Spain. He and colleagues dine on grilled oysters, salmon, mountain goat, and venison, along with wild greens and a fermented honey drink, a menu based on research at the cave. Among the finds were more than 1,000 identifiable seeds of 45 genera, brought from miles around. The plant remains, not fossilized but protected by encapsulating clay for 14,000 years, included (**left,** with pinhead for scale) grasses used for bedding or teas, wild pansy, rosemary, and raspberry.*

A FOSSIL SKELETON 1,600,000 YEARS OLD

Homo Erectus

Scattered by the tides of time, *the most complete early Homo skeleton yet found was discovered last year on the west shore of Kenya's Lake Turkana. A fragment of the skull (***opposite***), unearthed by Kamoya Kimeu, who recognized the species by the bone's curve and thickness, led to a three-week search for the rest of the*

Unearthed

By RICHARD LEAKEY
and ALAN WALKER
Photographs by DAVID L. BRILL

skeleton. White lights show where skull fragments were uncovered, red the limbs, green the remainder.

THE STORY opens 1.6 million years ago, that we know. But did the boy actually perish in the mud and water weeds fringing the prehistoric shore of Kenya's Lake Turkana? Or did he die elsewhere, his body swept down to the shallows in a flash flood?

However he came there, the 12-year-old's body rocked lifelessly for some time in the lake's western backwaters. Later only catfish may have noticed his scattered white bones, trampled into the mud by hippos and elephants visiting the marsh. In time even fish grew indifferent to the fragmented skeleton, until without witness it disappeared beneath layers of lake sediment and river-borne ash from distant volcanoes.

Recently this boy's bones—his skull, his teeth, and most of the rest of his skeleton—came to light in one of the most remarkable finds in human evolutionary studies. This skeleton, the best preserved of an early human ever found, gives us definitive evidence of the size and anatomy of *Homo erectus*, a species intermediate between the first upright-walking hominids and modern man. Moreover, it may help explain whether early humans evolved from apelike ancestors gradually or through abrupt changes in brain size and body shape.

The circumstances of this discovery were extraordinary. Since 1968 the slopes and gullies bordering Lake Turkana have yielded the fossil remains of more than 200 early humans. Until last year all had been found east of the lake by teams from the National Museums of Kenya in Nairobi. In 1971, for example, near Koobi Fora, deputy team leader Kamoya Kimeu recovered *Homo erectus* skull and bone fragments 1.5 million years old. Among these was the partial skeleton of an adult female. In life she had been large, but her disease-distorted bones allowed no firm conclusions about the average size of her kind.

Partners for two decades, *through dozens of digs, Richard Leakey and colleague Kamoya Kimeu (**above**) search under a thorn tree and find facial bones shattered by the roots. In this bleak but spectacular setting the team sieved every inch of dirt, leaving cones of debris (**left**). They washed the concentrate to recover teeth and the smallest bits of bone. The cranium, found in 70 pieces, fit together like a jigsaw puzzle.*

The boy, designated KNM-WT 15000 for Kenya National Museums, West Turkana locale, died of unknown causes; his bones were scattered and trampled in a swamp before sediment covered them. Under him was volcanic tuff dating from 1.65 million years ago, the period when Homo erectus enters the fossil record.

In July 1984 Kamoya, paleontologist John Harris of the Los Angeles County Natural History Museum, and University of Utah geologist Frank Brown pitched tents beside the sandy, sun-dried bed of the Nariokotome River, west of the lake. Scarcely a month later Kamoya radioed us in Nairobi that the field team was ready to move south: Rocky outcrops north of the river were rich in fossils but held nothing exceptional. We told Kamoya to take a day of rest while we flew in. Then we'd strike camp.

That day some expedition members washed clothes or wrote letters. Kamoya's irrepressible energy compelled him to take a walk. Crossing the sand river, he paused occasionally to pry among black lava pebbles strewn across a hillock. Kamoya's diligence is impressive, but it is unlikely that he would have scouted the unprepossessing mound if not for his day of enforced leisure. Nor would he have spotted, in sight of the camp kitchen, a piece of skull. Recognizably human, it was from the frontal section of a cranium, but no bigger than a matchbook.

A research project supported in part by your Society

A skull fragment so small tells you very little. Over the years we had stumbled on countless such fossils that, after tedious excavation, led no further. But as always, Kamoya kept his find to show us.

A few days later great clouds of dust drifted over the hill as we sieved its pebbly soil with mosquito screens. By dusk elated voices spread the word: *"Tumepata kichwa!* —We've found the skull!"

Even by lantern light we could see that we now had additional scraps of a *Homo erectus* skull—and that they would fit back together. A few more days of sieving and a blackened skull began to take shape, painstakingly glued like broken crockery. Yet large sections were still missing, including the face, likely lost forever through erosion, the usual fate of fossil skulls here. We'd give this specimen one more day of investigation.

Impatience never pays. During what we thought would be our last excavation, delicate digging with a dental pick at the foot of a thorn tree suddenly rewarded us. Stones and soil loosened and fell away, revealing

Surveying the harvest *of bones, expedition leaders Alan Walker (***left,** *at left) and Leakey study the maxilla, noting that a permanent canine was just erupting (***bottom***); this fact along with an unerupted wisdom tooth helped place the individual's age at about 12 years. The maxilla fit perfectly with the lower jaw on the table, one of the few sets of jaws found together. The scientists determined the boy's sex by his large size, 1.6 meters (five feet four inches), the shape of the pelvis, and the large canines. A trace of gum disease was his only apparent defect.*

*Cleaned of their calcite crust, the fossils (***above***) were stored at the National Museums of Kenya in Nairobi and reproduced as casts for further examination (***right***). Brown color represents the fossils found, gray what was created by mirror imaging, green the missing pieces, and yellow the parts added for clarity. Further excavations at the site this past August turned up more teeth, along with toe and lower-arm bones. Only extensive study will reveal all the information contained in this unique fossil boy.*

the missing facial bones. Though shattered like the rest of the skull, beside them lay both halves of a tooth-studded upper jaw.

Analysis of the teeth and of pelvic, arm, and leg bones recovered later showed that this fossil skull was that of a boy, no more than 12 years old at death.

During the next three weeks we had the exquisite pleasure of unearthing almost an entire *Homo erectus* skeleton, the first recovered of such antiquity—1.6 million years old—and the earliest set of one individual's bones found in situ. Limb, rib, and collarbones appeared, along with vertebrae and the lower jaw, one of the very few ever to be matched to its skull. To find a more complete skeleton, we must jump forward in time to 100,000 years ago, when Neandertal man began to bury his dead.

This spectacular find dramatically confirms the antiquity of the human form. In its parts and proportion only the skull of the Lake Turkana boy would look odd to someone untrained in anatomy. The rest of his skeleton, essentially human, differs only subtly from that of a modern boy.

And too, because it is a youth's skeleton and so complete, it offers us a unique glimpse of growth and development in early humans. At five feet four inches tall, the boy from Turkana was surprisingly large compared with modern boys his age; he could well have grown to six feet. Suitably clothed and with a cap to obscure his low forehead and beetle brow, he would probably go unnoticed in a crowd today.

This find combines with previous discoveries of *Homo erectus* to contradict a long-held idea that humans have grown larger over the millennia. Our ancestors on the African savanna may have been much taller than we ever imagined. Indeed, we may have reached our present general size more than a million and a half years ago, with some populations in poorer environments becoming smaller fairly recently.

Only luck, the presence of a supply of underground water, and the scanty shade of a few parched thorn trees first drew us to the Nariokotome River and the skeleton of the boy from Lake Turkana. During the 1985 excavation, we began to uncover the last of the missing bones, adding another page to his biography—and to mankind's. □

Canada's Icy
Wilderness Park

KLUANE

Poised for a fall, *ice at the Lowell Glacier's toe menaces kayakers on the Alsek River. Unsurpassed among Canada's national parks for wildness and beauty on a stunning scale, Kluane is a realm of big ice, bigger mountains, large challenges, and great rewards.*

By DOUGLAS LEE

Photographs by
GEORGE F. MOBLEY
BOTH NATIONAL GEOGRAPHIC STAFF

IN THE WARDENS' equipment shed at Kluane National Park Reserve, in a room packed with ready-to-use gear for survival and rescue on mountains, rivers, lakes, and glaciers, is a reminder of the natural laws that govern this vast chunk of subarctic Canada. Two pairs of moose antlers, as broad in span as a man's outstretched arms, are locked in what proved a death embrace to the mighty bulls they once adorned. Tines broken as the moose wrenched and strained against one another's mountainous strength testify to the animals' long and fruitless struggle to pull apart as death came closer. It may have come, finally, in the form of thirst or hunger, exhaustion, cold, or fangs. Their skeletons lay facing together when a warden discovered them.

These dangers—from climate, landform, and live inhabitants—are realities that every human visitor to Kluane must be prepared to meet. As I studied the antlers in a room full of tents, sleeping bags, radios, ice axes, and the many other objects with which human beings improve their odds in an unforgiving wilderness, the inextricably meshed antlers spoke a message to me: Here the strong, too, can perish.

Kluane (Kloo-AHN-ee: the name given by

KLUANE NATIONAL PARK RESERVE

GIGANTIC ICE FIELDS of the Wrangell and St. Elias ranges have been fed over millennia by snows from moisture-laden Pacific winds. Canada's 8,500-square-mile Kluane and the United States' Wrangell-St. Elias National Park and Preserve encompass most of these ranges and are recognized by UNESCO as a joint World Heritage Site. In the 2,800 square miles of Kluane outside the ice fields, a wild menagerie thrives in a rich assortment of habitats created by varied elevations and climatic zones. Most backcountry users hike in to these lakes, forests, river valleys, and alpine meadows.

the native Southern Tutchone to a long, chill lake on the park's border) encompasses some of the continent's least touched and last explored lands, filling the Yukon Territory's southwest corner between British Columbia and Alaska. It is among the youngest, largest, and wildest of siblings in Canada's 100-year-old family of national parks.

Established in 1972, Kluane has not yet graduated from park reserve status to become a full-fledged national park, pending settlement of native land claims. An equal protection level applies, however, and Kluane's 8,500 square miles embrace a wilderness pristine, remote, and guarded as much by its own formidable character as by man.

Here the St. Elias Mountains, the North American Continent's highest range (surpassed only by the single massif of Alaska's Mount McKinley), reach nearly 20,000 feet just miles from the Pacific Ocean, fomenting some of the world's harshest and least predictable weather. Between the snow-crowned heads of the St. Elias lies a glacial sea, the largest subpolar ice-field system outside Greenland.

We live in an interglacial age, and on the half-mile-thick ice of Kluane it is not hard to believe that here the Ice Age retreated and here bides its time. Cold and altitude lock

Traveling with teddy, *Lindsey Bloom and her father* ***(below)*** *enter bear country. Kluane holds 150 miles of trails and old mining roads that lead summer hikers and winter cross-country skiers from the Alaska Highway—the region's only major road—into and beyond the front ranges* ***(right)****. Except for trails, no backcountry development exists. Creature comfort for park interpreter Violet Van Hees means dry socks at camp* ***(bottom)*** *on a canoeing holiday.*

two-thirds of the park in a barren, nearly lifeless regime of wind and snow, ice and rock. Yet in the remaining 2,800 square miles of more hospitable terrain, great braided river valleys, brooding spruce forests, mountain-walled lakes, and high alpine meadows carpeted with tundra support a roll call of northern wildlife unsurpassed in diversity and grandeur.

Dall sheep and mountain goats dot the high rock faces like patches of unmelted snow. Eagles, falcons, and hawks patrol the skies like royalty among the 106 species of birds that nest in the park. Trout, grayling, and kokanee, a landlocked form of salmon, swim in glacier-fed lakes and streams. Perhaps a hundred black bears live in the

forests, giving way in encounters to the more than 250 grizzlies that roam—and rule—the Kluane backcountry.

Kluane offers sanctuary from hunting for timber wolves. About 50 range the park, and one wintry afternoon in a backcountry valley I shared with wilderness guide Doug Thomas the rare experience of watching a pack of wolves while the pack watched me.

IT COULD HAVE BEEN a day in the Pleistocene. On snowy slopes above and below us were moose, huge animals standing, walking, bedding in the snow, or crunching willow buds. They seemed unconcerned by our presence: Mankind was not their worry in this valley.

Three hundred yards away on a rocky knoll commanding the vista was a wolf pack seven strong, assembled to hunt moose but now more interested in two humans dropped by helicopter and abandoned on their hunting ground.

"Ever get the feeling you interrupted something?" Doug asked me. "They don't like us being here. They'll watch us till we leave, then go back to what they were doing—walking among the moose, picking one to take."

Like most Yukoners, Doug is from elsewhere, in his case Vancouver Island, drawn by the beauty, romance, and challenge "north of 60," the magic line of latitude that denotes the high north. Eight years ago,

Flowing some 45 miles *to its end in the Alsek River Valley, the Lowell Glacier—one of the longest among more than 2,000 in Kluane—was recently shattered into a pincushion of ice needles by a surge, here surveyed by a glaciologist studying*

the phenomenon. Several glaciers wind from the interior ice fields of the St. Elias into lower valleys at the mountains' edges. Most of Kluane's large glaciers periodically surge, advancing suddenly as ice pushes out of reservoir areas within them.

with an Indian trapper, he spent his first Yukon winter in the bush. Woods-wise and amiable company around the campfire, he now guides fishermen and photographers in and near the park.

Last year 60,000 visitors stopped at park facilities on the Alaska Highway and the Haines Road. A few thousand used the park's campground or others near the park and fished or made day forays on lakes and trails. Only a few hundred ventured beyond the Kluane Ranges—imposing ramparts reaching 10,000 feet that front the highway, sealing off the interior from view.

No tree grows *today in a valley where a fossil sequoia twig attests to warmer eras in the past. Crustal blocks of varying ages have moved here from great distances, making a geologic jigsaw puzzle of the St. Elias.*

Virtually all hikers come from June to October. A few parties of cross-country skiers enter from December through April, and mountaineers tackle the high peaks in spring and early summer. On this November day, with the temperature 20 below zero Fahrenheit and dropping with the late sun, we had the interior to ourselves—sole representatives of our species in an area larger than Massachusetts.

Ice crystals danced down out of clear air, making a cradle of light beneath the low sun. From far down the valley came a hollow scrape of antlers, but the rut was over and the bulls no longer bellicose, or our presence in their midst would have been as dangerous as crashing a grizzly bears' picnic.

Instead we could admire two bulls with a pair of cows not a hundred yards away: great horn dish antennas, humpbacks like grizzlies, and long, hairy "bells" dangling beneath their chins. We found where they had lain in the snow, and fresh-nipped branches. Doug broke through ice over a hidden stream but kept from getting wet. All the while the wolves watched from their knoll, silhouetted like round rocks with ears.

"The real impact of Kluane is here," Doug said. "There's no human element to it. We look at that moose as beautiful. That wolf is looking at it as a steak. If he doesn't get it, he dies. Out here it's dying or living—there's nothing in between."

CLOUDS ON MOUNTAINS, mountains on clouds: From the road the front ranges rise like waves above Haines Junction, a town of 500 on the Alaska Highway where a spur route links the Yukon interior with the port of Haines, Alaska, and the Pacific. In the park's modern cedar visitor center at the Junction, artifacts and displays outline the human and natural history of Kluane. Past the front desk here in administration headquarters, chief warden Larry Tremblay is "flying the mahogany bomber," his term for the necessary evil of paperwork. Larry would rather be somewhere else, and he is happy to talk from 13 years' experience about the park.

"There were very few hikers when we came. But those words 'national park' draw people. We have older and younger people now. Some are real bushmen—dedicated

hikers—from all over the world. A lot of it's basic wilderness hiking—no trails." In 1979 the United Nations Educational, Scientific and Cultural Organization (UNESCO) proclaimed Kluane and Wrangell-St. Elias National Park and Preserve in Alaska a World Heritage Site. (See **Canada's Vacationlands**, a supplement to this issue.)

Larry arrived in Haines Junction in the summer of 1972 as point man for the park. "First thing I did was get up and down the highway, introduce our presence. We were welcomed; right from the start we felt good here. Next thing, we tried to find out what we had. Very little was known."

At the same time, he curtailed poaching from across the border by Alaskan hunting guides. Close cooperation with Alaskan authorities and canny patrolling have virtually ended problems from either side of the ice-locked boundary line.

In addition to protecting the park from people, much of the wardens' job today involves protecting people from the park. "It's a wilderness country," Larry said, "and to be honest, it's a hostile country. You can't make many mistakes."

Unexpected snowstorms, rising rivers, or sudden squalls on lakes can make the backcountry a trap. "We ask everyone going in to register. Then if you don't show up, we go looking for you. It can be anyone, even our guys. When we go into the backcountry, we go well equipped. We've had guys out there 14 days longer than they expected.

"It's a place that dictates to us more than we can to it. If a glacier decides to move, it's going to move. If we give this park just a little protection, she'll take care of herself."

Larry's broad, weathered face split with a gray mustache and a smile. "She's a tough son of a bitch."

ON A BEAUTIFUL late summer morning on the Cottonwood Trail—the park's longest, a horseshoe-shaped 50-mile route from the highway into the interior—two hikers from Ontario learned how tough Kluane can be.

That same morning I set out with five companions and 11 horses on the first pack trip ever to travel the four-year-old trail.

Warden Ron Chambers at the front of our file reined up when a man with his shirttail out and a pant leg torn flapped hurriedly toward us out of the woods.

"There's a bear up there," said Joe Hosick. His voice was calm, even offhand, but his eyes were wide with shock.

Was he okay? Had anyone been mauled? He wasn't sure; he'd last seen his buddy leaping over bushes. The pair had startled a sow grizzly when Joe took her picture, too late spotting the cub beside her.

In maternal rage the sow had charged, pulling Joe down from a sapling he tried to climb. Roaring over him as he lay on the ground, "she kept coming at me with her teeth and then backing off," he recounted, the sight vivid before him. He paused: "She had bad breath."

Screaming and waving his arms, he expected to die on the forest floor. In full mastery, the bear let him live. Somehow Joe got behind a tree. The sow wheeled and charged after his companion.

My neck prickled as we rode slowly up the trail, Joe walking alongside. Ron and NATIONAL GEOGRAPHIC photographer George Mobley galloped ahead, and it was a relief when we found their tethered horses and heard their voices and that of Joe's friend.

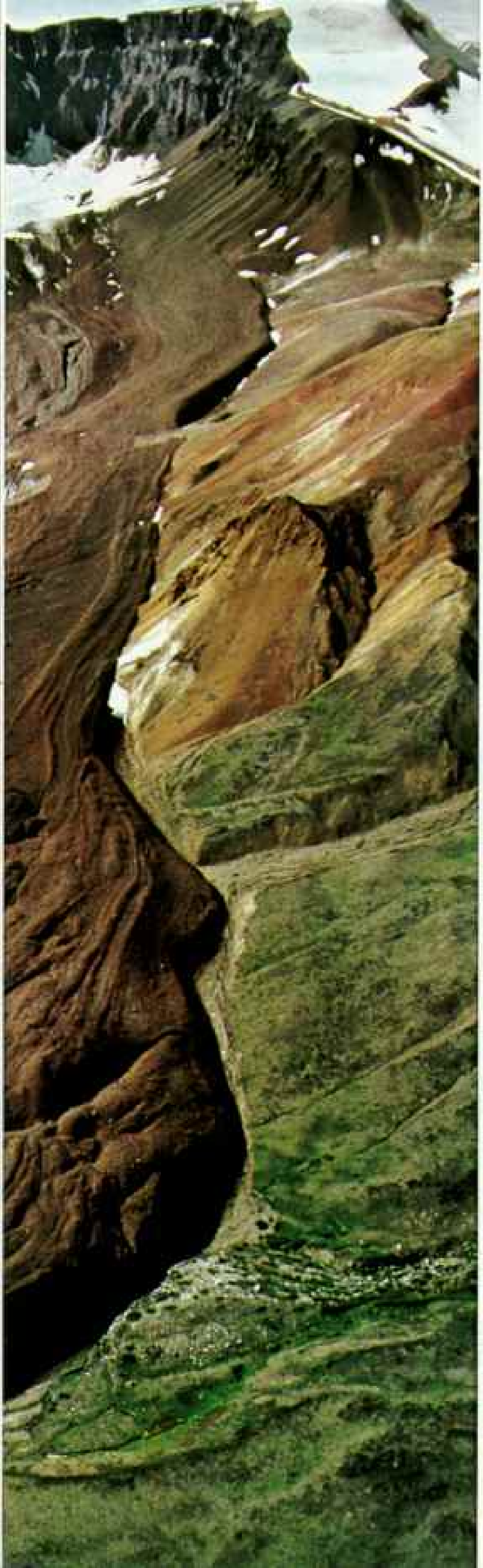
Doug Thomas doctored a claw scratch on Joe's calf, then unlaced a hiking boot where Joe had felt a trickle. A red stain spread around a deep fang hole in his foot. Numbed from shock, Joe had walked more than three miles on the wound without feeling pain (pages 644-5).

I found Ron and George belaying Mike Fisher down from a 30-foot-high tree fork; he leaned against the trunk, limp and round-eyed. "I got halfway up and thought, 'I can't go any higher.' Then I heard a locomotive coming through the woods. She circled and started coming up. If she'd lunged, she could have gotten my foot. So I went on up."

Few adult grizzlies can climb trees, but this mother took a bite at it; deep gouges reached ten feet up the trunk.

When he climbed the tree, Mike told us, "I didn't know what had happened to Joe. I could hear him moaning 'oh no, oh no,' and I thought he was dead."

The two friends reunited on the trail. As they compared experiences, remembering in moments and images, each seemed to come back from someplace far away, as if



Landscapes in motion *are common in Kluane, as seen in a rock glacier—till and scree riding a submerged ice core—that spills* ***(left)*** *from a high cirque once filled with glacial ice. Summer meltwater makes pools like paw prints on a glacier's surface* ***(above)****. Despite surges, glaciers have been in gradual retreat throughout the St. Elias in recent centuries, leaving a legacy of dramatic ice-sculptured valleys. Conditions at the ice fields' edges resemble those that existed at the fronts of the Pleistocene epoch's continental ice sheets. Katabatic winds—superchilled air rolling off the ice's surface—blow frequently. Spring melt often brings violent floods, and autumn's freeze comes early. Highly nutritious quick-frozen fodder is often kept snow free by the winds, providing winter feed for grazers such as sheep—and thus winter feed for wolves and other predators.*

the other's flesh-and-blood presence retrieved something of himself.

"I want to shake the hand of a man who's been bitten by a grizzly bear," Mike said, and as they clasped hands, both smiled for the first time.

RON ESCORTED Mike and Joe back to their car and alerted park headquarters. Wardens immediately closed the valley to public use for several weeks, but we followed the Cottonwood Trail out of the valley into snow-swept high country, then down again into the land beyond the front ranges.

In five days we saw ten bears, including a black bear whose face greeted Mabel Brewster, our hostler, at her tent flap one morning. Mabel yelled and fell back; the bear woofed and bolted. The encounter was a draw, except for tooth holes in a hat and gloves Mabel had left by the campfire.

Through binoculars we watched a mother grizzly and her two cubs forage in scrub and tundra above timberline. Much closer we spied on a boar grizzly as he sat upright like a man at table, eating berries by combing the bushes with his claws. Other bears watched us attentively from a distance when our caravan jingled past. Mabel and Doug were astonished one day to find our horses grazing alongside a grizzly as it cropped grass.

Protected by the size and remoteness of Kluane's backcountry, most of the park's bears avoid humans unless surprised at close range or drawn by food smells. Joe Hosick's was the first injury from bear attack within the park since its founding.

Our packtrain made enough noise to warn the most oblivious beast of our approach. But when we split into two parties, the second group spotted bears, wolves, and moose that had remained hidden when the first riders passed.

"They were sniffing our trail," Ron explained. "They'd probably never smelled horses before."

Ron Chambers views this country from a special perspective: Of equal parts Indian and white heritage, the 42-year-old warden is a true Kluane native, whose earliest memories are of dogsled travel in deep winter while his mother, Grace Chambers, ran traplines in and near what is now parkland.

In Kluane's kingdom *of animals, grizzly bears (**left**) are monarchs of all they survey. Their turf ranges from forested river bottoms to alpine tundra and even the ice fields, where Dall sheep (**below**), wolverines, mountain goats, and at least one cougar have also been sighted far from any habitable terrain. The park's front ranges hold the greatest array of large mammals in North America, as well as a feather duster of 106 bird species. Many of these spend only the summer, while a few such as spruce grouse (**right**) stay year-round. Kluane's wildlife has been protected since a sanctuary encompassed the future parkland in 1943.*

The area was made off-limits to hunting and trapping after the park's forerunner, Kluane Game Sanctuary, was created in 1943. Gold mining within the sanctuary continued until 1972. In the 1950s Grace accompanied geologic expeditions into the area as cook, sometimes taking Ron with her as she had done in earlier years on big-game hunts. Now 73 years old, she traps alone in winter, living in a cabin Ron built for her.

"Before it was a park, I used to go all over it on a snowmobile," Ron recalls, "running over crevasses on the glaciers . . . it was just ignorance that kept me alive, I guess."

Maybe so, but more recently his strength, skill, and nerve have saved his own life and others' in his duties with the park's rescue team. On training exercises near Mount Logan, Canada's highest peak and a focus of Kluane mountaineering, Ron stopped himself and two ropemates from sliding over a cliff by driving an ice ax into a slope with superhuman strength. On other occasions, dangling from a cable beneath a helicopter, he has evacuated stricken climbers from narrow mountain ledges and recovered bodies from furious river rapids.

Ron once spent the better part of an hour on the side of Mount Logan waiting for a helicopter to return, while clouds threatened to strand him: "The most lonesome experience of my life. I've never had so many adventures as since I became a warden. I couldn't imagine what else I'd be doing."

THERE WERE TIMES, as we rode through days of rain and late August snows, when I could well imagine things I would rather be doing. But Kluane rewarded our perseverance with a secret about itself: On the rainiest day of the trip, while we fished a stream for grayling and Dolly Varden trout, George Mobley and Ron wandered up a side creek to discover a previously unknown spawning ground of the park's indigenous kokanee salmon. On a later trip to the foot of Logan, they discovered a colony of pikas pruning mini-patches of tundra: the only animal life known to exist on the Logan massif.

We were rewarded too by moments when the clouds parted to reveal eagle and falcon aeries on cliffs and game trails etched on the black rock above us by the season's first

The wrong place *and the wrong time put hikers Joe Hosick (**right,** at right) and Mike Fisher too close to a mother grizzly bear and cub on Kluane's Cottonwood Trail. A wound on Hosick's foot came in the first actual attack since the park's founding in 1972. The grizzly sow pulled Hosick down from a tree, puncturing his boot with one fang (**below**). Fisher escaped to a treetop (**above**), where horse packers, including the* NATIONAL GEOGRAPHIC *team, found him after meeting Hosick on the trail.*

snows. Fireweed flamed red by the trail, yellowing aspens lit mountainsides as the sun kindled the mixed grays, smoky blues, and somber greens of this northern landscape into bold primary colors.

Then our surroundings seemed as fresh and inviting as a newly minted world. On our last morning, as the sun rose through blue clouds to shine on the marvelous white of snow-dusted mountaintops, I wrote in my journal, "There are times when Kluane has the look of the day of creation."

In fact, these mountains are in ongoing throes of creation: Tectonic plates meet and grind beneath them in this active earthquake region, while ice, wind, and water work and rework their surface.

More than 2,000 glaciers lie within Kluane. About 60 are surging glaciers: In little-understood cycles, these will suddenly advance as much as two miles in a year.

The Lowell Glacier began a surge in spring of 1983. By summer of 1984 it had advanced 1.4 miles, pushing several hundred yards into the Alsek River Valley. Soon after the surge ended, I stood on Goatherd Mountain across from the Lowell and gazed 45 miles up the glacier into the high, frozen fastness from which it flows.

"A couple of years ago we were skiing right up the middle of it," said warden Rick Staley. No one will ski the Lowell for some time to come. Rapid movement shattered the once smooth ice into a hellish discord of pinnacles and crevasses (pages 636-7).

Three thousand feet below us great chunks of ice fell into the river with the sound of monstrous freight cars uncoupling. Between rumbles total silence gripped the enormous spaces around us.

"One day there'll be a lot of hikers up here," Rick said. He and warden Lloyd Freese had come to Goatherd to scout a proposed trail linking the mountain with more accessible valley lakes. Balancing a need for public access to Kluane's interior against a mandate to preserve its wilderness, park planners hope to limit major development.

When a trail reaches Goatherd, hikers could find a lake added to the spectacle of the glacier. At least eight times in the last 3,000 years the Lowell has surged right across the valley to dam the Alsek River. The resulting lakes have reached past present-day Haines Junction, 35 miles away.

"When the ice dams washed out, it was like the Grand Coulee Dam disappearing," glaciology student Jeff Schmok told me as we clambered across towers and chasms of ice near the Lowell's toe. Jeff is serious of purpose and light of heart, and he scrambled about crevasses with the interest of both a scientist and a youthful daredevil.

An Indian name for the Lowell means "fish stop": No seagoing salmon spawn in headwaters of the Alsek, the Yukon's only major Pacific drainage, presumably because the river is often blocked. Kluane's

Dying flutters *of a Wilson's warbler scratched an epitaph on snow at the foot of Mount Logan, Canada's highest peak. Birds are often fatally stranded on the ice fields, many blown off course from migration routes straddling the St. Elias.*

kokanee are descended from sockeye salmon trapped on their spawning grounds by a long-ago surge of the Lowell.

Terraces high on mountainsides mark beaches of ancient lake levels, but no one knows just how many times the lake has filled and drained or when it will grow again. "Large floods wiped out traces of previous smaller floods," Jeff explained.

Legends of the local Southern Tutchone tribe depict floods of biblical dimensions, while Indians downstream tell of a disastrous wall of water in recent tribal memory.

Water trickled everywhere around us and roared in a full-throated river under the ice beneath our feet. With crampons and ice axes we wandered the tortured dreamscape of the glacier. Unearthly shades of blue and green showed above dirty white and patches of rocks and gravel. We entered ice caves surreal with light and color and found pieces of wood carried from somewhere high above, where today no trees grow.

"Now where'd that tree come from?" Jeff demanded. "It looks fresh, but it must be hundreds of years old."

The glacier creaked and groaned, and occasional reports like rifle fire or cannon sounded from the maze around us. Ice toppled into a crevasse and crashed downward into the bowels of the moving glacier. I asked Jeff how often he had poked about the Lowell since its surge.

"This is my first time," he said.

Who else *had* been on it since its surge?

"Nobody that I know of," said Jeff. "We're the first."

SO MUCH remains unknown about Kluane and its past that discovery is an ever present possibility. In an alpine valley in the shadow of the ice fields, I was present when the park's chief interpretive officer, Brent Liddle, made a find that may add whole chapters to our sketchy knowledge of the area's prehistory.

The valley had the feel of another time, a stripped-carcass look of ribbed volcanic mountainsides above rocky tundra and a stream flowing from a lake and a remnant glacier. "It was virtually unexplored until recently," Brent said. "And there are dozens more like it."

Investigating the valley and lake in 1978, Brent noticed tools and flakes of worked obsidian. Parks Canada archaeologists surveyed the site, the largest find of artifacts in the southwestern Yukon, perhaps 5,000 years old.

But Brent's curiosity wasn't satisfied. "There must be a mother lode of obsidian in here somewhere," he said as he hiked the valley with George Mobley and me. We found flakes, crude tools, and unworked nodules of the volcanic glass in streambeds, on slopes, and around what may have been a prehistoric campsite. Brent led us to a trove of petrified wood and a ravine full of fossils. But his mind was on the riddle of the source of the scattered artifacts.

On our last day in the valley he found it. George and I watched through binoculars as Brent climbed a mountain ridge. When he reached the top, an eagle launched from rocks near him and flew barrel rolls over the peak. We saw Brent stop and reach down, then cast about the ridge like a dog on a scent. When he came down the mountain, his face was alight.

"How sweet it is! For a hundred yards it's just black with obsidian chips and tools. They're spilling off both sides of the ridge. This is definitely the biggest find yet."

That night at our campsite high at the head of the valley, the glacier gleamed in starlight like a cloud on the mountainside. We watched the last color fade beyond the mountain wall above us and warmed ourselves with hot toddies.

"It was a weird feeling," Brent said in the dark. "I'm not usually superstitious, but this had all the elements. A cold wind was howling down the valley. Then when I got to the top, a blast of warm air and sand came out of nowhere and blinded me, as if the spirits were trying to turn me back. Then the eagle took off. The hair was standing up on the back of my head. Then I saw the chips.

"I get an eerie feeling, thinking of all the people who climbed up here all those years."

I knew what he meant. In my mind I had named this place the Valley of the Dinosaurs, for a pterodactyl swooping overhead would have been in keeping with the look and feel of this volcanic gash.

The valley, along with vast tracts of the rest of Kluane, enjoys the highest protective status given to parkland: No development is

allowed and even public access is restricted. So the artifacts remain where they have lain since Stone Age hunters sat on the ridgetop and watched for game as they made tools for survival from the bones of the mountains.

SOUTHERN TUTCHONE legends of the glaciers and ice fields tell of fearsome spirits inimical to man: Indians living on the edge of survival had little reason or inclination to visit, and the first footprints in the interior ice fields may well have been those of prospectors and mountaineers less than a century ago.

In 1985 a team attempted the first winter ascent of Logan. Fierce weather turned them back, but three months after their attempt I spotted their footprints, an eerie ant trail leading up Logan's East Ridge, as I swooped around the mountain's flanks beside helicopter pilot Doug Makkonen.

"That's where the guys fell 2,000 feet," Doug said, nodding at an avalanche chute where two wardens survived a plunge in 1980. Doug flew a helicopter used in their rescue, and today he pilots the park's rescue team on training and rescue missions. This afternoon Doug was ready to try something he had never done before: fly his helicopter over the top.

We circled up endless walls of white and more white. Doug breathed through an oxygen mask; I saw spots before my eyes as we neared the thin air of 20,000 feet. But through spots and our clear plastic bubble I gazed down at the deceptively soft-looking surface of the Seward Glacier and over my shoulder at the blue Pacific and the white fan of the Malaspina Glacier beyond Mount Augusta. Large peaks in view—St. Elias, Vancouver, King George, and Queen Mary—took a pink glow above purple ranks of lesser mountains.

We seemed to shrink as the world expanded until, like a gnat circling a giant's brow, we raced over a dome of wind-polished ice that gleamed in the sun.

In a moment it was behind us. We turned and flew out of the park over unnamed peaks that would rule as kings in other ranges. Glaciers wound beneath us; we crossed mountaintops where huge cornices overhung plummeting slopes. Then bushes appeared on mountainsides, then trees, and the monochrome ice fields gave way to forested valleys and the front ranges and finally the thread of the Alaska Highway and beyond it the world. But in my mind's eye I held an image that I will keep of a high, secret place in communion with the sky: the summit not only of a mountain, but also of the lives of those who have stood upon it.

"It's beyond wilderness," Martyn Williams said. "It's the way North America was in the ice ages." Candles lit our faces while a cookstove warmed our tent, our supper, and ourselves high on the South Arm of the Kaskawulsh Glacier. I had camped and

Records in snow *are unlocked by glaciologist Dr. Gerald Holdsworth. He takes cores* ***(above)*** *on the Seward Glacier near Mount Logan to study climate change and long-range spread of industrial pollutants. An ice cave* ***(right)*** *at Logan's foot leads to a frozen underworld.*

Titanic strain *bulges the face of Trapridge Glacier as interior ice presses downhill at the beginning of a surge. Glaciologists monitor the event with electric thermometers set in the ice in a grid seen on the glacier's foot.*

Science and exploration have gone hand in hand since the first Europeans entered the St. Elias late in the 19th century. Although the entire region has been mapped from the air, countless valleys and peaks remain virgin territory.

skied on the glacier for six days in early April with Martyn and Maureen Garrity, Martyn's partner in life and wilderness guiding, and three others who had come to experience the ice fields at surface level.

Kirstie Simpson and Heather Myers work at environmentally oriented jobs in the Northwest Territories. Dick Rice is a medic, fire fighter, and wilderness guide from Juneau, Alaska, and an irrepressible spirit who sometimes broke into laughter from sheer joy in this strange and beautiful place.

Nowhere is Kluane's scale more awesome or deceiving than on the ice; mountains that seem near are far, as we found on day trips out from our snow camp on the glacier.

"The scale is comparable to Antarctica or Greenland," said Martyn, an English-born Yukon convert who has climbed all over the world, recently helping on a quest to scale the highest peak on every continent. "This is just as wild as those places. But in many ways the mountains here are grander. It's the ultimate wilderness experience. It's also the ultimate serenity—you can go into a valley where no one has ever been."

I had come to the ice fields prepared for something of an ordeal, but suffered nothing more than stiff muscles despite temperatures rarely above zero. "This is a skiing and climbing frolic," Martyn had said on the eve of our flight to the glacier, and that is what our days were. Once we heard the brief thunder of an avalanche, and three times small crevasses opened under our skis, but we avoided mishap.

With each day's exploration I became more at ease in the alien landscape. Since my first sight into Kluane's frozen heart from Goatherd Mountain, I had known with mixed anticipation and apprehension that I would come here, but I had never guessed the full beauty of this frozen, wind-sculpted world of white.

ONE AFTERNOON we skied in freezing fog; it was like moving through an endless cottony room without dimensions. Another we spent in sleeping bags watching snow blow against the tent, listening to Martyn's tales of the ice fields. On sunny middays we skied in T-shirts, nightgowns, and long underwear. To move camp, we towed our packs on sledges, tiny figures moving in a line past mountains and valleys that rose up and fell away, each pristine, each a beckoning mystery.

There were evenings when we sat in the close quarters of the tent, contented with dinner, and came to know and truly like one another as we shared thoughts in the candlelight. "This is life boiled down to its basics," Martyn said, "warmth, food, and shelter. The basic pleasures of life are both very simple and easily found."

Once at night I stepped outside and looked back at the tent. It glowed like a living coal of warmth and companionship on the immensity of the glacier, a hearth of human fellowship in a frozen eternity. Beyond the glacier's edge white mountains stood as if awake in the night, gazing upward at green lights that played around their heads.

I had heard a legend in which certain of the northern lights were the souls of children playing on the path to the afterworld. But the lights that swirled above the glacier that night seemed far removed from anything human. They spoke a language no man will ever comprehend, a silent semaphore the gathered mountains understood, of memories from the youth of time and worlds yet to come; a muttered conversation from the stars to the planet; a message from the universe to itself. * * *

Summer snow *blows past camp at a glacier's foot. The ice fields' great size and the height of the St. Elias Mountains create brutal weather conditions all their own—one piece in Kluane's armor of isolation.*

Kluane: A Century of Exploration

By BARRY C. BISHOP

VICE CHAIRMAN, COMMITTEE FOR RESEARCH AND EXPLORATION

THE STORY SWAPPING had begun, and the room was boisterous with tales of mountains and expeditions. "This feels like a fraternity reunion," I commented to my table companions, Dr. Walter Wood and Dr. Bradford Washburn, and then realized that of course it was—the reunion of a fraternity bonded by accomplishment and adventure. With me in Haines Junction's community hall were many leading figures from the last great chapter of North American alpine exploration, gathered to honor anniversaries of two landmark years

GEORGE F. MOBLEY (ABOVE); BARRY KUSHN (FACING PAGE)

in the history of St. Elias mountaineering as part of Parks Canada's centennial celebrations.

Sixty years ago a joint Canadian-U. S. team under the auspices of the Alpine Club of Canada was first to climb 19,524-foot Mount Logan (***above***), Canada's highest peak. Ten years later Brad Washburn, supported by the National Geographic Society, and Walter Wood, of the American Geographical Society, first entered the St. Elias region on separate expeditions that for each began a lifetime of exploration and research in North America's highest mountain range.

Presenting an award to Dr. Wood, Yukon Commissioner Doug Bell (***top left***) told how the high-altitude pioneer "has accepted the challenge of the St. Elias, lived with them, learned from them, and shared that love and knowledge with the Yukon's people."

A literal high point of the reunion came with a helicopter flight that returned Dr. Wood (***bottom left***) to the wilderness he first entered by packhorse in 1935. In the decades that followed, he led more than a dozen expeditions to the Kluane area and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DEE MOLENAAR (FACING PAGE); KAREN KUEHN (ABOVE LEFT); BRADFORD WASHBURN

in 1960 spearheaded founding of an Arctic Institute field station for interdisciplinary scientific study of the St. Elias Mountains.

In the 1960s I was fortunate to work under him building a high-altitude laboratory 17,500 feet up Mount Logan, where major strides were made in understanding the effects of such heights on the human body. I will never forget the uncertainty and exhilaration of landing at that altitude in a light ski-plane. Now as we powered over peaks and glaciers in our chopper, Dr. Wood mused from a lifetime's experience, "The biggest boon to safe, efficient, and enjoyable work in these isolated and inhospitable mountains has been the helicopter."

Fittingly, Brad Washburn flew with us, 50 years after he opened the St. Elias to the air age. On his 1935 aerial survey and mapping expedition, he was first to glimpse huge regions of the mountains' vast heart and to fly men, sleds, and dogs onto the glacial ice for surveying and exploration (***above right***). At the foot of a mountain discovered by Washburn on that first expedition, we stepped from our helicopter to open a bottle of champagne while Brad unfurled a tattered but still whole National Geographic flag (***above***), carried with him in 1935.

The mountain where we stood went unnamed until 1965, when the Canadian government dedicated it to the late President John F. Kennedy. On another Society-sponsored expedition, the President's brother, Senator Robert F. Kennedy, was first to stand on its summit, leaving a memento of his brother and pausing with photographer William Albert Allard to display the Kennedy family coat of arms and an expedition flag stitched together by the team (***facing page***).

Until the ground-breaking work of Washburn, Wood, and the many others who entered this trackless terrain, all but the fringe of the St. Elias had remained a blank on the map. Mount Logan was not discovered until 1890, when it was sighted by I. C. Russell on the first expedition ever sponsored by the National Geographic Society, then two years old. The peak was not identified as Canada's highest until epic journeys were made to survey the Alaskan-Canadian border in this century.

Brad remembered the question that sparked his first foray, asked 50 years ago by Society President Gilbert H. Grosvenor: "What's exciting in North America that still remains unexplored?"

As I flew above the snowy heads of the St. Elias in the company of two men who were first to lay eyes on many of them, I too wondered what frontiers of exploration remain, and what young visionaries stand right now at their doors. □

The Great

By MARK GIROUARD

Photographs by FRED J. MAROON

ENGLISH COUNTRY HOUSES

Good Places

Historic strongholds of the British ruling class, country houses were for centuries not merely elegant homes but also symbols of landed power. They remain treasured showcases of architecture and art. In the 1790s the eccentric Earl of Bristol, Bishop of Derry, raised eyebrows with Ickworth's rotunda.

When I was an undergraduate in the 1950s, I used to stay with my old great-aunt, the Dowager Duchess of Devonshire, at Hardwick Hall in Derbyshire—huge, six-towered, tapestry-hung Hardwick, one of the most romantic houses in the world. Everything was beginning to run down by then. My great-aunt lived mostly in a corner of the house, and the public milled through the rest; only six guest bedrooms were in use, and there were just four live-in servants.

The nurseries up at the top of the house, where I and troops of cousins used to be put up before the war, had been dismantled, and nursery maids no longer carried trays up 103 winding steps. The footmen, whom I could barely remember polishing silver in the pantry, had gone to the war and never been replaced; they no longer stumbled by torchlight across the roofs to their bedrooms in the turrets.

But my great-aunt, though in slightly reduced circumstances (for a duchess), still had the aura of a great lady. One of the ways in which this expressed itself was in the little court that she held each morning in her bedroom, marshaled by her lady's maid. As she lay in her big four-poster bed behind her breakfast tray, in the great high-ceilinged bedroom lined with tapestries, the cook, the housekeeper, and any houseguests assembled in the anteroom outside were admitted to her presence one by one to pay their respects or receive their orders for the day.

Three hundred and fifty years previously, her predecessor the Dowager Countess of Shrewsbury, commonly known as Bess of Hardwick, had lived and died in these same rooms. It was she who had built the house, she who had been played into it by her household orchestra on October 4, 1597. The house was dominated by these two dowagers, one in the present, who was formidable enough, and one in the past, who was a great deal more formidable and had lived with a magnificence surpassing anything my great-aunt had achieved.

In later years I had a lot of fun with old account books, letters, and documents, working out what would have happened at Hardwick if, for instance, Bess of Hardwick's neighbor the Earl of Rutland came to stay in the early 1600s. He would arrive on horseback (roads were still too bad for carriages) with 10 to 15 servants. The gate of the great courtyard would creak open, pushed by the porter from the Porter's Lodge, a crowd of servants would take away the horses, and the party would be greeted by the Usher of the Hall, carrying a staff of office, to be escorted across the courtyard into the Hall.

This was and is a very grand room, where my great-aunt sometimes dispensed afternoon tea. But in Bess's day it was used as a common room and dining room by the 40 servants

EDWARD HALLIDAY PAINTING, NATIONAL TRUST

DINNER FOR SIXTY *or more was a daily affair in 14th-century Haddon Hall when the lord supped with his family, retainers, and servants in the Great Hall* ***(facing page)****. Long in disrepair, the house was meticulously restored by the father of the tenth Duke of Rutland, the present owner.*

Last to preside at Hardwick Hall, Evelyn, Dowager Duchess of Devonshire ***(above)****, was painted in the High Great Chamber for her 80th birthday in 1950. With skills that impressed museum curators, she restored tapestries collected by Bess of Hardwick in the late 16th century.*

of the house staff, by visiting servants, and by all sorts of people who had come on business and stayed the night, so there were likely to be around 100 people in it at times. At Christmas, when the tenants were entertained, the numbers could go up to around 300. The noise must have been considerable until, in honor of an important visitor, the usher banged on the floor with his staff and shouted, "Silence, my masters!"

The visitor, shedding all but a couple of servants, was then handed over to another official, the Gentleman Usher of the Great Chamber, with another staff of office, and escorted up the great stone staircase, winding and turning to the very top of the huge house. Here, walking up and down the 166-foot length of the Long Gallery, Bess of Hardwick, septuagenarian widow—black dress, deep ruff, huge multiple string of pearls, beady eyes, a tough lady if ever there was one—would be waiting.

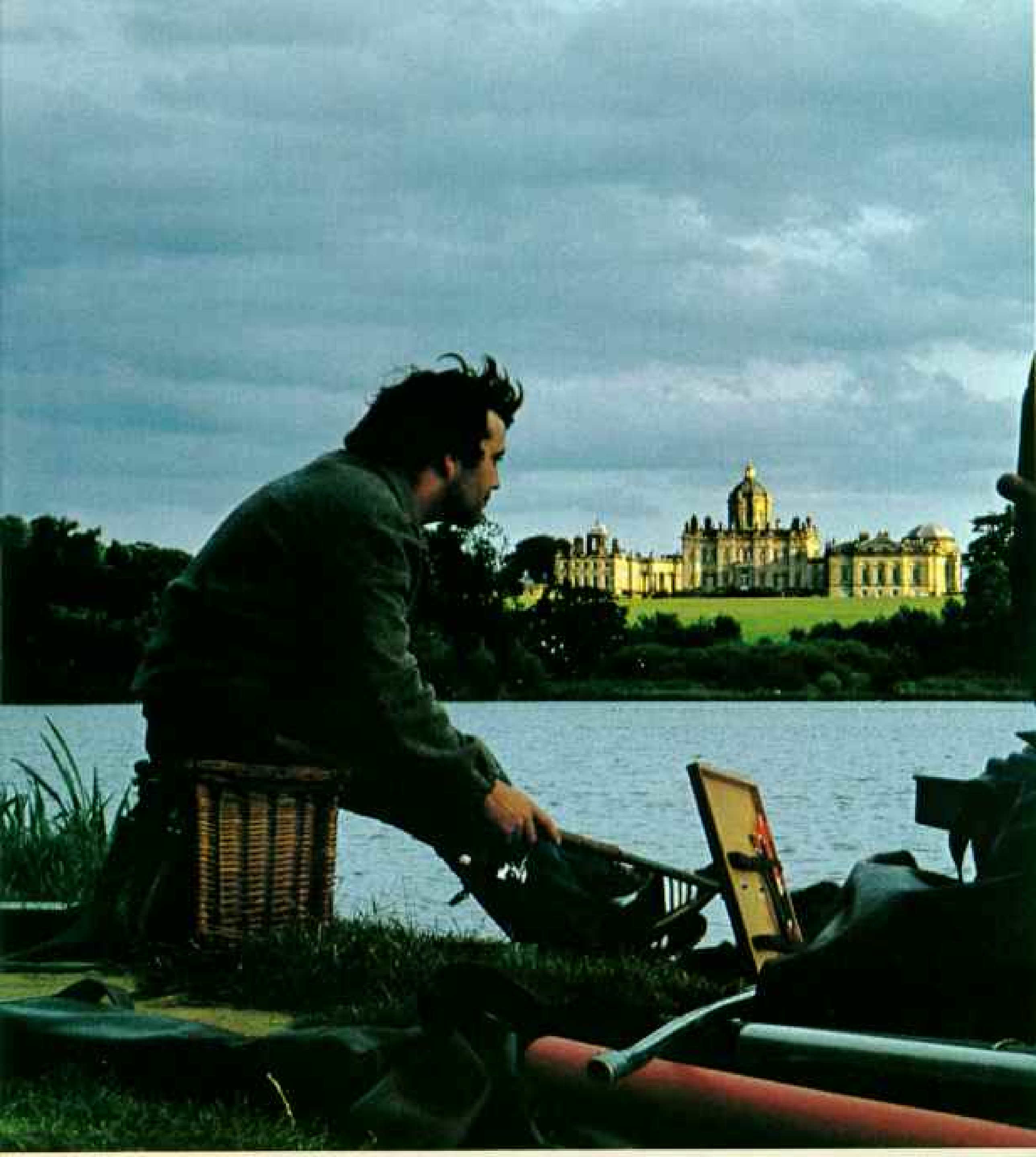
Born in a very modest house at Hardwick, Bess had married and disposed of four husbands, each leaving her richer than the last. She had been a moneylender, property dealer, exploiter of iron works, coal mines, and glassworks, ending up the richest woman in England after the queen.

On grand occasions meals were served next door to the Long Gallery in the High Great Chamber, a room not as large as the gallery but still one in which a two-storied six-room modern house could fit with comfort. The Yeoman of the Ewery was in attendance, holding a gold-and-enamel ewer and basin, in which guests washed their hands before the meal.

A long table to one side of the room was piled high with gold dishes, cups, jugs, bowls, and plates of all kinds, just to make a show: Bess had 251 pieces of gold plate to choose from. The main table was placed along one wall, and Bess sat under a canopy

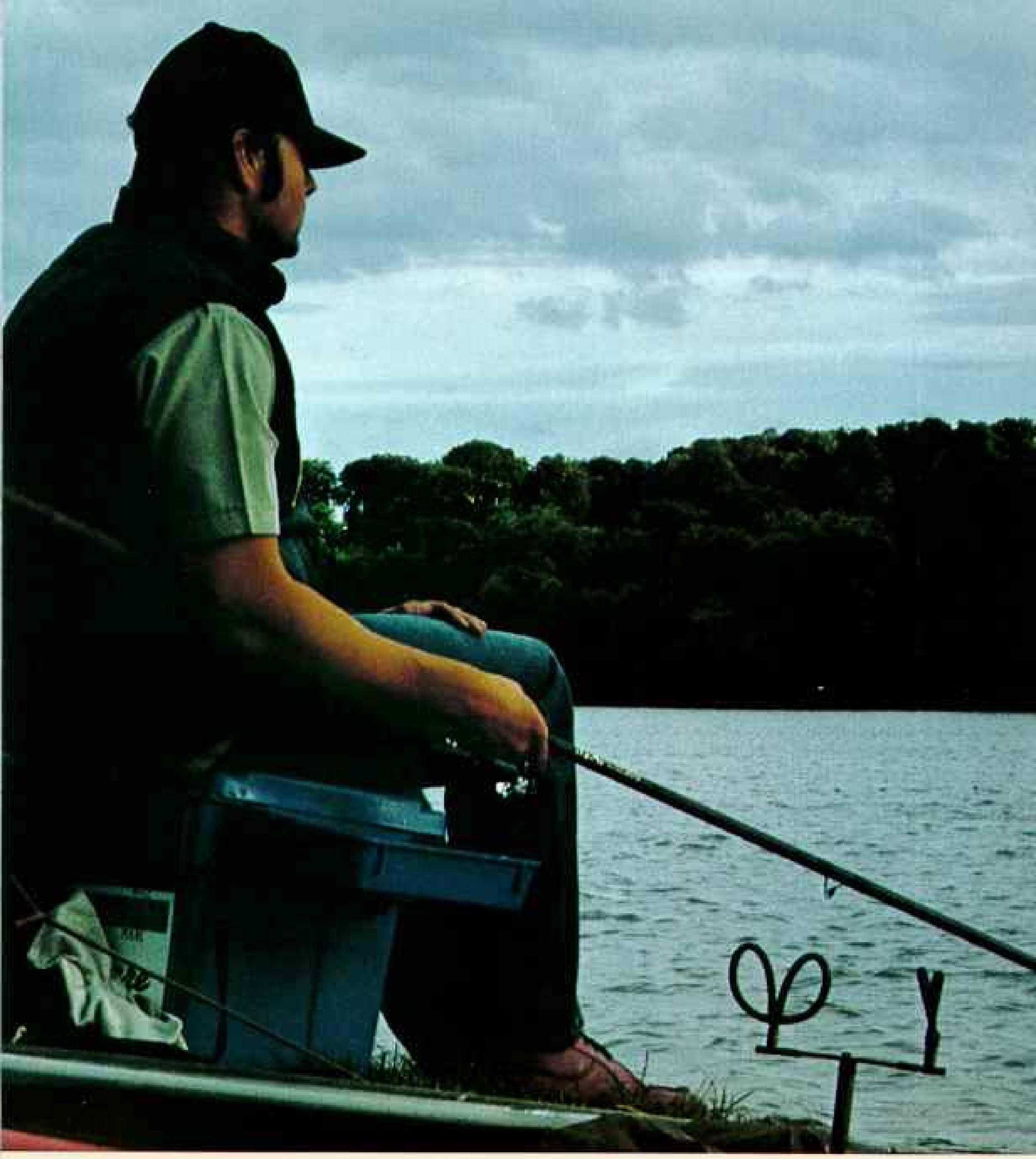
Author Mark Girouard's books, articles, and radio and television programs have earned him renown as a British architectural historian. An architectural degree sharpened the eye of **photographer Fred J. Maroon,** a noted lecturer and author of books on such diverse subjects as Egypt, the U. S. Navy, and his own Georgetown in Washington, D. C.

NGS CARTOGRAPHIC DIVISION, DESIGN: NANCY SCHWENNART, RESEARCH: JAN HAMBLING, PRODUCTION: RAMSEY MURRAY, MAP EDITOR: JOHN T. BLOZIS



behind it, surveying the room. Before her stood a huge gold saltcellar, decorated with her coat of arms and figures of stags and dogs, the crests of her two richest husbands. Her most important visitor would sit on her right, a knight or two might be allowed to sit on her left ("below the salt")—but mere gentry, too grand for the hall but not grand enough for Bess's table, had a second table in another part of the room.

Each course was served on gold plate and carried in procession by a troop of a dozen or so waiters up the great staircase, preceded by the Usher of the Great Chamber with his staff and by servants carrying flaming torches, if it was dark. As it was borne into the High Great Chamber, it was greeted with a fanfare of music. Favorite dishes were hog's head and pig's feet boiled in mutton broth with apples, roasted



blackbirds and sparrows, and salmon cooked in ale. Whatever the food, it must have been cold by the time it got up to the High Great Chamber, but no one seems to have minded.

After supper on fine summer days, guests went up on the roof and were regaled with wine and sweetmeats in one of the turrets. Then, most likely, there was dancing in the High Great *(Continued on page 671)*

FRAMED BY FISHERMEN *on the estate's Great Lake, Castle Howard sits on 10,000 acres in Yorkshire. Designed by Sir John Vanbrugh, the baroque home of the earls of Carlisle was begun in 1700. The lantern dome, first to grace a private residence, was damaged by fire in 1940 and restored 20 years later.*

The fourth earl, who commissioned the great west wing in the 1750s, filled the mansion with two shiploads of Egyptian, Roman, and Greek statuary; a third ship from Italy sank.

LIKE PART OF THE STATUARY, *cleaning women in Castle Howard's hall (**left**) look up from their labors. The home's artworks, including a bust by Bernini and paintings by Holbein, served as backdrops when Castle Howard doubled as Brideshead for the TV production of Evelyn Waugh's* Brideshead Revisited. *Former head of the British Broadcasting Corporation, the late Lord Howard (conferring with his secretary, **above**) welcomed the actors and film crew into his home. Castle Howard's magnificent mausoleum (**below**), designed by Nicholas Hawksmoor, inspired Horace Walpole's remark that it "would tempt one to be buried alive."*

Chamber, followed by bed. The principal guest would retreat to the Best Bed Chamber, install himself in a gilded four-poster bed under a canopy of cloth of gold and silver, and draw the blue-and-red satin curtains, "striped with gold and silver, with gold lace about the edges, and fringed about with gold fringe."

It is arguable, however, that the Best Bed Chamber was never used in Bess of Hardwick's time but was kept waiting for a possible visit from Queen Elizabeth I. She never came. All through the centuries a royal visit was both a culminating moment of glory and a tremendous worry to the owners of a country house. A successful visit could lead to favor at court and immensely valuable jobs or perquisites, but set against this was the appalling expense and the risk that the visit would be a failure.

The monarch came with a retinue of several hundred people. On occasion Elizabeth deliberately parked herself on someone who had displeased her in order to embarrass him; she did this in 1591 to the Earl of Hertford, who had been foolish enough to marry a wife with a rival claim to the throne. The queen stayed for three nights and four days at his house, Elvetham in Hampshire, and nearly bankrupted him.

Bess of Hardwick had children only by her second husband, Sir William Cavendish. She died in 1608, leaving her fortune divided between two of her sons, William and Charles. The Cavendishes, dukes of Devonshire, descend from William. The Cavendishes, dukes of Newcastle-upon-Tyne, and the Cavendish-Bentincks, dukes of Portland, descend from Charles. Once set in orbit by Bess's money, their family fortunes multiplied through marriages to heiresses until in the 19th century the dukes of Devonshire owned seven country houses and almost 200,000 acres, and the dukes of Portland four country houses and some 170,000 acres. They were powerful as well as rich: Bess's great-great-grandson, the fourth Earl of Devonshire, was one of the group of seven who masterminded the replacement of James II by Dutch King William in 1688. The fourth earl was made a duke in reward.

SEE KEY (PAGES 668-9)

CORONETED KEY AND LOCK, *said to have been modeled after a lock on the gates of Warsaw, decorate the door to the Great Hall of Blenheim Palace* ***(above)****, home of the Duke of Marlborough. The duke's crest appears above the eagle door handle. The Red Drawing Room* ***(facing page)*** *displays a John Singer Sargent painting of the ninth duke, his wife Consuelo Vanderbilt, and their family. The drawing room began as a small "withdrawing room" off the bed chamber. In most country houses it became the place where visitors were received, tea was served, and the ladies gathered after dinner while the men lingered over port and cigars.*

BLENHEIM, *a baroque palace in Oxfordshire,* ***(pages 668-9)****, was a reward to John Churchill, first Duke of Marlborough, for his 1704 victory at Blenheim in Bavaria. It was the birthplace of another famous Churchill—Winston.*

Country houses, in fact, were not just big houses in the country in which rich people lived. They were the homes of a ruling class whose right to rule was based on the ownership of land. Large estates produced money; perhaps even more important, they supplied people to fight for their owners in the early days of the country house, and to vote for them in later and more powerful centuries. In the Middle Ages kings were dethroned or set up by quite small armies of two or three thousand people, made up of the war bands of big landowners. The Battle of Hastings was fought by an army of only 7,000 Normans against 7,000 Saxons.

When the lord of Berkeley Castle went clattering through the narrow streets of Gloucester or London, followed by 150 mounted retainers with his lordship's prancing white lion embroidered on their coats, they were demonstrating one kind of power. When in the 18th century tenants and dependents of the Earl of Lonsdale turned out to elect nine members of Parliament on the earl's instructions, they were demonstrating another form: Voting was public up till 1872, so the earl never had any doubt about who voted for whom. The farmer who voted the wrong way could expect immediate eviction.

Bitter feelings could be aroused if one landowner's house outshone his neighbor's. During the 1720s and '30s Sir Robert Walpole, who was prime minister for many years in the early 18th century, built Houghton Hall in Norfolk on a larger scale than the house of his brother-in-law, Lord Townshend, nearby Raynham, which had been the grandest in the county. Lord Townshend, already at odds politically

SPORTING LEGACY *of the country estate, cricket developed in the 18th century as landowners, servants, tenants, and local villagers played bat-and-ball games. A break for tea interrupts a match on the grounds of Penshurst Place, home of Viscount De L'Isle. The British tradition of elaborate afternoon tea grew out of upper-class social life, as late dinner hours became fashionable in the 19th century.*

with Sir Robert, broke off relations and moved out of the county whenever his relative was entertaining.

Almost everyone who made enough money, in whatever way they made it, bought land and a house or houses of suitable importance to go with it. The background of titled country-house owners is extremely varied. The Marquess of Abergavenny descends from the Nevills, who were mighty fighters in the Middle Ages; the Duke of Richmond and Gordon is one of a clutch of dukes descended from randy Charles II's numerous bastards; the Duke of Leeds's ancestor was a 16th-century apprentice who jumped off London Bridge to rescue his employer's infant daughter, later married her, and prospered as a cloth merchant.

Any connection with commerce or banking was looked down on by older families, although they at times swallowed their pride. When Lady Stanley of Alderley's niece married into "trade," her mother-in-law condoled with her that at least "the bitter pill of low connections is well gilded."

It was not until the very end of the 19th century that it became fully acceptable for a country-house owner to keep up links with trade, so that Edward Cecil Guinness, future Earl of Iveagh, could entertain Edward VII and George V for shoots on 23,000 acres of Elveden Hall in Suffolk and still turn out bottles of Guinness stout by the thousands from the family brewery.

From the Middle Ages up till the 17th century, to have a great hall crowded with guests, and still more and grander guests upstairs in the Great Chamber, showed how many fighting men the family could muster and boosted esprit de corps. At the famous Nevill Feast, at Cawood Castle in Yorkshire in 1465, some 2,500 people were entertained, working down from seven bishops, ten abbots, and 28 peers. The guests ate, over several days, 113 oxen, six wild bulls, 1,000 sheep, 2,000 each of geese, pigs, and chickens, 12 porpoises, and 4,000 cold venison pasties.

But in the 17th century, as the rule of law prevailed, actual physical power became less important, the numbers of servants were reduced and were less obviously on view. Guests, even royalty, arrived with smaller numbers of people in attendance. Halls grew less important and smaller. But there were still likely to be a dozen servants hanging around, for the simple reason that before communicating bells were invented the usual way to summon a servant was to shout for him or to send another servant to get him.

The dominating features of 17th-century houses were the pompous protocol that surrounded individual house owners and the punctilious etiquette involved in meetings between members of royalty and the aristocracy, and even of the gentry. Any important person occupied an apartment of three or four rooms set in sequence one after the other. A vista of doors became a prominent feature of big 17th- and early 18th-century houses; in the grander ones their width was carefully calculated so that there was room for an important person to walk through with a gentleman- or lady-in-waiting on either side. Guests could gauge their standing by whether they were received in the first, second, third, or fourth room (the fourth was the best); by how far the person whom they were visiting came along the sequence to meet them; and by whether they were offered a chair with arms, a chair without arms, or worst of all, a stool to sit on.

When the Duke and Duchess of Somerset entertained the King of Spain and Queen Anne of England's husband, Prince George of Denmark, at Petworth in Sussex in 1703, it was only after the prince had paid a formal call on the king's apartment, the king on the prince's, and the two of them on the duchess's, that they were all able to meet in the great central saloon and have supper together; and the prince came through all four rooms of his apartment to escort the king, whereas the king only went as far as the door of the third room

A TREND-SETTING DESIGN *in the early 17th century, the decorated open staircase in Knole has felt the tread of such poets as John Dryden and Matthew Prior, friends of the literary Sackvilles. In the late 18th century John Frederick Sackville, third Duke of Dorset, commissioned the reclining nude sculpture of his mistress, dancer Giannetta Baccelli.*

HERALDING A GLORIOUS ERA *in country-house living, decorative painter Antonio Verrio spread floor-to-ceiling opulence in the Heaven Room of Burghley House in 1694* ***(above)****. Lord Burghley, adviser and lord treasurer to Elizabeth I, spent much of the late 16th century building his Stamford home. The vaulted ceiling in the home's earliest kitchen* ***(left)****—used into this century—helped disperse smoke that must have been blinding when a whole ox roasted on the spit in front of the fireplace. Many wealthy landholding families came to own several homes, including a London residence, and spent only a few months each year at their main country seat.*

in his apartment to meet the prince.

In those days people regularly received visitors in their bedrooms, and important social events such as christenings often took place in them. In royal bedrooms a rail often separated the bed from the rest of the room. Only the most important people were allowed on the inner side of the rail to talk to the king and to dress or undress him. As late as 1761 the Earl of Huntingdon and the Earl of Ashburnham had a violent quarrel by the bedside of George III over who would have the honor of putting on the king's shirt.

This was the most pompous age of the country house, an epoch when walls and ceilings were frescoed with paintings of gods and goddesses or even likenesses of the owner of the house if he was grand or pretentious enough. At Blenheim the first Duke of Marlborough could look up to the painted ceiling and see himself as a godlike figure being carried triumphantly through the clouds in a chariot.

The 16th century had been a succession of religious troubles, revolutions, and beheadings; the 17th had seen a major civil war, the beheading of one king and the deposition of another; but in the 18th the country was relatively peaceful and secure. The German Georges had a somewhat shaky title to the throne and needed the upper classes and votes that the latter controlled in Parliament. Country-house owners had a powerful say in foreign affairs and ran their own neighborhoods more or less as they liked, planting and planning for the future with confidence.

One can get a good feel of the 18th century at Holkham in Norfolk. In the 1730s Thomas Coke, later Earl of Leicester, descendant of a rich and famous lawyer, began to rebuild his family's country house there. Nature was against him, for that part of Norfolk was a poor and windswept land by the sea, described as a place where all one saw was one blade of grass and two rabbits fighting over it. But Lord Leicester spent almost 40 years turning this wasteland into a private paradise. He drained land, planted trees, and for six years traveled around Europe buying books, statues, and pictures, which graced his new house. The big rooms in the main block were as grand as any in the 17th-century house, but they were only for entertaining and putting up important guests. The family normally lived in a wing in quite modest rooms; their living room was the library, a long pleasant book-lined room, looking out across the park.

Outside the park walls were miles of open fields for hunting, and grainfields full of partridges for shooting. Eighteenth-century

country-house owners prided themselves on being educated and cultured, but also on being in touch with country life and country sports. Lord Leicester's great-nephew and eventual heir, Thomas Coke, returned from Rome with a portrait of himself standing against a background of classical statues and columns. But he was also painted shooting with his dogs, and again inspecting his Southdown sheep. He was famous all

ONCE THE PLAYGROUND *of Yorkshire nobility, Gilling Castle now quarters students of the Preparatory School of Ampleforth College, run by Benedictine monks since 1930. Like other estates, it went on the market in the late 19th century, when cheap grain from the U. S. depressed agricultural prices and land values. Some houses have become schools, hotels, and business headquarters. Hundreds were simply destroyed.*

"WRETCHED FRENCH TASTE," *sniffed an 18th-century visitor, surveying the formal garden of Powis Castle in Wales* (**above**). *Thanks to a disinterested owner, the terraced gardens never fell to the English passion for natural landscaping. A century earlier, owners of the 13th-century castle decorated the State Bedroom* (**left**) *in hopes of a visit from Charles II.*

The Rainbow Portrait of Elizabeth I (**below**) *hangs in Hatfield House on the estate where she spent much of her youth.*

The National Gallery of Art in Washington, D. C., presents an exhibit of British country-house treasures November 3, 1985, to March 16, 1986. The exhibit, supported by a grant from Ford Motor Company, will not tour, but a catalog is available. For information write National Gallery of Art, Publications Service, Washington, D. C., 20565.

PORTRAIT ATTRIBUTED TO ISAAC OLIVER, COURTESY MARQUESS OF SALISBURY

over the Western world as a progressive farmer: Owing to his efforts, rabbits in that part of Norfolk gave way to flocks of sheep, and blades of grass to fields of grain.

Coke's only son was born dead in 1776, reputedly because his wife panicked when a mouse got trapped in her immense superstructure of powdered hair while she was asleep. Up to the end of the 18th century, country-house life was a mixture of informality and grandeur, of state rooms and family rooms; the powdered hair went with the gilded silk-hung furniture of the great drawing rooms. But in the course of the 19th century, state rooms of all kinds went out of fashion, and too much gold and silk came to be considered vulgar.

The change was partly due to Queen Victoria, who hated too much show. In 1845, as a young woman of 25, she went with her husband, Prince Albert, to stay with the Duke and Duchess of Buckingham at Stowe, an enormous 18th-century house a few miles outside the town of Buckingham. Victoria and Albert arrived modestly, by royal standards, with an entourage of 27 people. The queen was in a difficult mood, probably because she disapproved of the duke's morals and had been pressured into the visit by her prime minister, Sir Robert Peel. The visit was not a success.

Victoria's technique was quite different from Elizabeth's, but equally annihilating. The Buckinghams had plastered their huge reception rooms with fresh gilding and new furniture and had even provided the queen's bedchamber with silver or gold conveniences. But Victoria merely remarked, "I am sure *I* have no such splendid apartments in either of my palaces." She loudly commented that the carpet in her bedroom was one that she had turned down because it was too expensive and insisted on its being covered with a plain rug because she said she did not dare to step on it. The duchess came down to dinner ablaze with diamonds, but Victoria appeared dressed in plain black velvet with a wreath of heather in her hair.

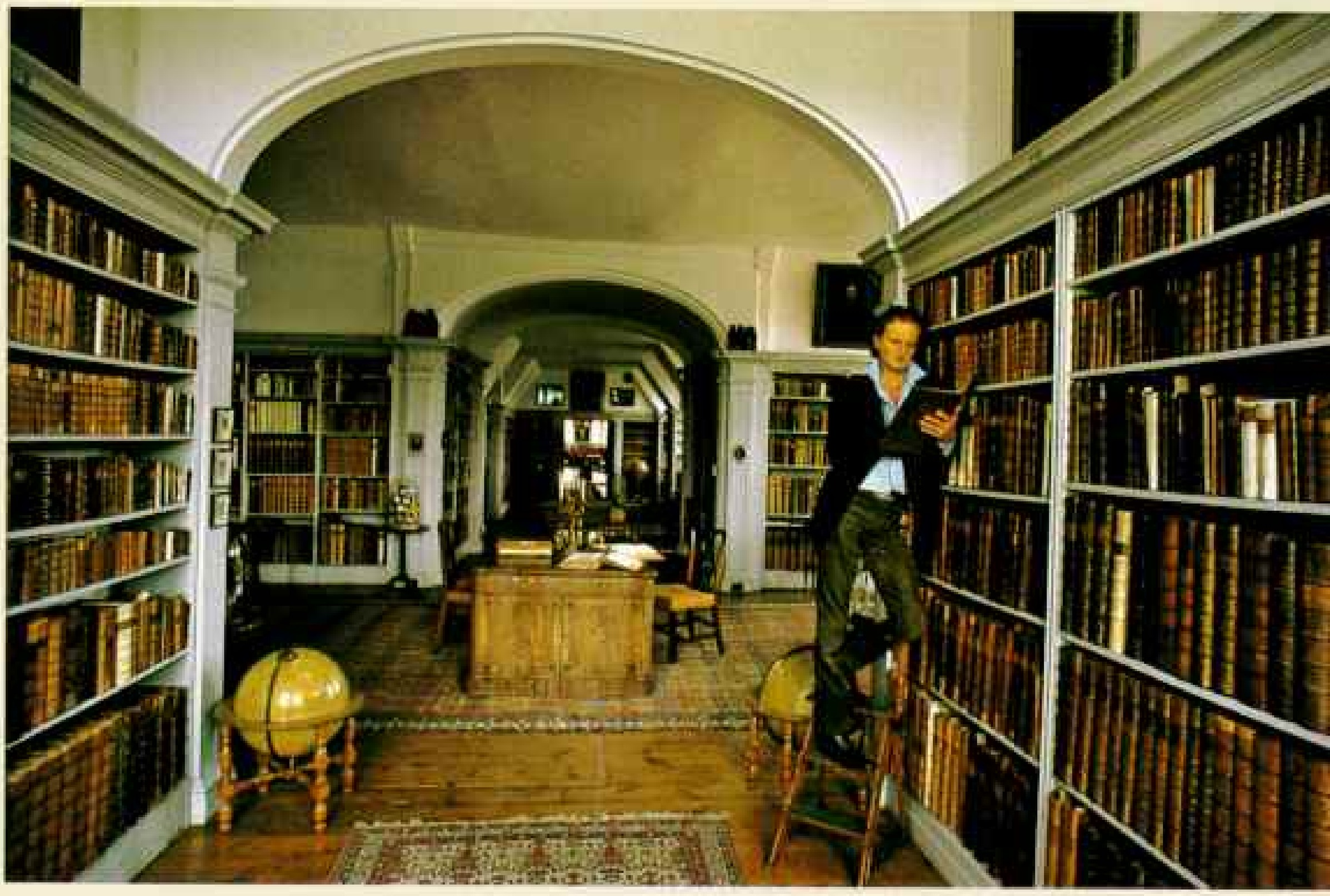
The queen was setting, in deliberately exaggerated form, what was to be the style for her reign. In 1864 Robert Kerr's *The English Gentleman's House* specified "quiet comfort for his family and guests" and "elegance and importance without ostentation" as what the country-house owner should aim to provide. Kerr reads a bit oddly today, for many Victorian and Edwardian country houses were enormous and were run by huge staffs of 40 or more indoor servants. But everything was kept in a low key.

Dashing and glittering lords still existed, like Lord Hardwicke, who perfected the polished silk hat. But a new model became popular: the shabby, comfortable lord who only felt at home in old clothes. In the 1880s the third Marquess of Salisbury was refused admittance to the casino at Monte Carlo. In his shapeless crumpled trousers and stained frock coat he looked so down-at-heel that he was mistaken for a tramp. He was prime minister at the time.

The story of Lord Salisbury's home at Hatfield is a curious one. It had been built between 1607 and 1612 by Robert Cecil, first Earl of Salisbury, who was lord treasurer of England and even more powerful in the political world of James I than the third marquess was in that of Victoria. It was taken for granted that successful politicians of the day would do well out of politics. Both Robert Cecil and his father, Lord Burghley, who was lord treasurer under Elizabeth, made huge fortunes. In return they were expected to entertain the monarch in style.

The house contained a series of grand rooms at one end of the second floor for King James I, and a matching series of equally grand rooms at the other for his queen. Lord and Lady Salisbury normally lived in rather more modest rooms on the first floor beneath the king's but used the upstairs rooms on special occasions. These had two sets of furniture, one for use by the king and queen and one for use by the Salisburys.

After Lord Salisbury's death the family went into a decline. For 150 years it was remarkable only for dimness and financial ineptitude. It was rescued by two generations of successful marriages. A dashing Irish girl injected new vitality; a well-behaved English heiress brought in a great deal of new money. The Cecils rose from earls to marquesses and became the leading political family among

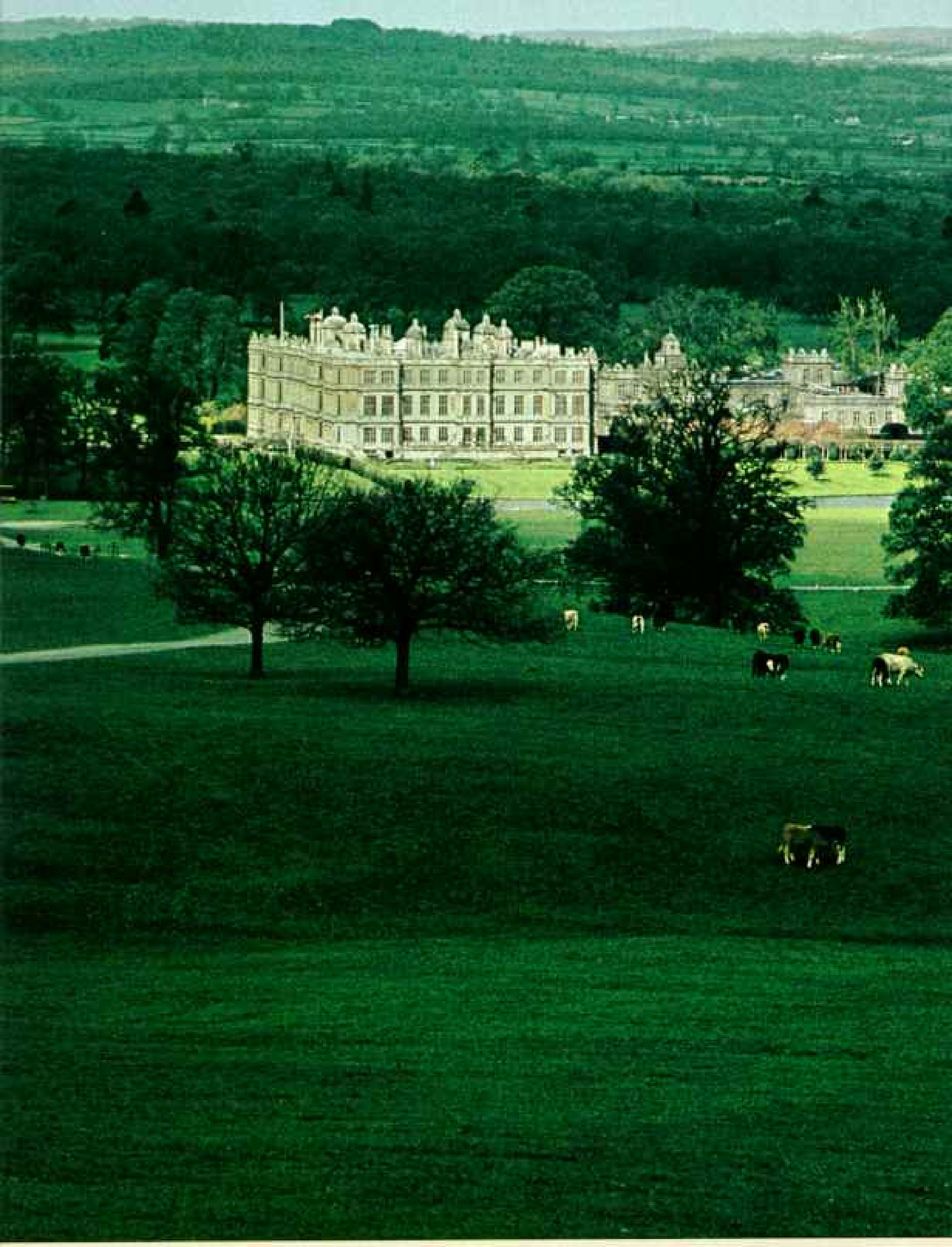


A BIBLE OF HENRY VIII *is among some 40,000 volumes in Longleat House, built by Sir John Thynne, whose uncle first edited Chaucer's collected works. A descendant, Lord Christopher Thynne, reads in Bishop Ken's Library, installed in the 1690s when the bishop lived here.*

British Conservatives. But they used the house quite differently from their equally powerful Jacobean forebears. They sprawled over all of it. The queen's room of state became a book-lined library, the king's withdrawing chamber a billiard room. At big house parties (having only seven guests was described as "having no one in the house"), the guests filled up the sofas and chairs or empty places at table in rooms where the family lived all the time.

The Edwardian period was the heyday of the house party, assembled either for long periods in the summer holidays or at Christmas, or for "Saturdays to Mondays" (the expression "weekend" was considered vulgar). The spread of railways, followed by the advent of motorcars in the late 19th century, made it easier to bring guests together. Parties of 30 to 40 were taken for granted in big houses. There were political house parties, as at Hatfield, where the campaigns for the next Parliament session were planned over the dinner table or over cigars in the smoking room; religious house parties, like those given by Lord and Lady Mount Temple at Broadlands (where Lord Mountbatten was later to live), with hymn sings on the lawn; highbrow house parties, at which intellectual paper games were played after dinner; sporting parties, in houses in which everything seemed to be made out of portions of animals, from inkstands made out of horses' hooves to umbrella stands made of elephants' trunks.

Guests assembled for breakfast at nine o'clock and helped themselves to food from long rows of covered silver dishes on hot plates on the sideboard. Women spent the morning in the morning room, men in the library, but both sexes were often outdoors. At shooting house parties women changed from their morning dresses into tweed coats and skirts and went out to join the men for a picnic lunch. The best shots in England in the late Victorian period were Lord de Grey



CROPPING STATELY LAWNS, *cattle graze in Wiltshire on the Longleat estate now owned by Lord Christopher Thynne's father, the sixth Marquess of Bath. Originally a 13th-century*

Augustinian priory, the Italianate mansion was completed in 1580. About 1760 the grounds were landscaped by premier English garden designer Lancelot "Capability" Brown.

Today they include a safari park to draw visitors. In 1949 Longleat was the first private country house opened as a commercial venture, to help defray enormous costs and taxes.

and Lord Walsingham. Lord de Grey once killed 28 pheasants in 60 seconds with a succession of "left-and-rights" from double-barreled shotguns.

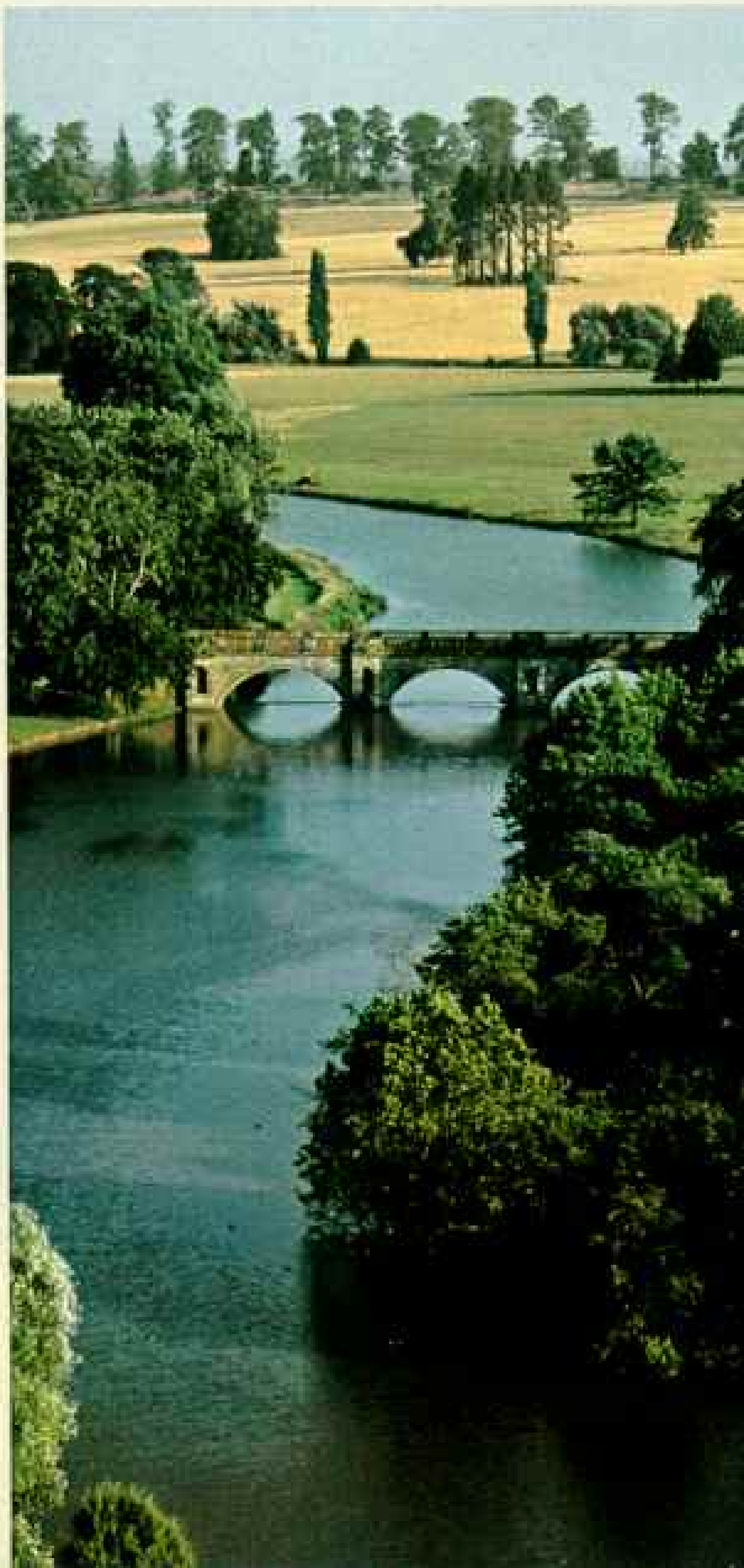
After the day's sport, afternoon tea of cucumber sandwiches, hot buttered scones, and cake was served at five, in the drawing room or hall, or outside in the garden in summer. Dinner, normally served at eight, was the one formal event of the day. Guests were summoned to the drawing room by the booming of a gong and proceeded arm in arm into the candle-lit dining room, according to their social rank.

After dinner, charades or paper games were popular, and after the women had gone to bed the men usually changed into elaborately frogged velvet smoking jackets and stayed up into the small hours in the billiard room or smoking room, drinking brandy, smoking cigars, playing cards or billiards, and swapping stories. Some houses went in for practical jokes. I was told of a guest at Wentworth Woodhouse in Yorkshire who was so infuriated by the booby traps in his bedroom that he left. His host, Earl Fitzwilliam, plaintively remarked, "I don't see what he was making a fuss about. I found a Shetland pony in *my* bed."

During the night there was often activity in the dark bedroom passages. Divorce was not respectable in Victorian or Edwardian society, but in many households discreet adultery was taken for granted. Tactful hostesses arranged bedrooms accordingly. Things could go wrong, however. Lord Charles Beresford (a jolly sailor much in demand at house parties) once slipped into what he thought was the right bedroom door and leapt onto the bed with a loud cry of *"Cock-a-doodle-do!"*—only to find the horrified faces of the Bishop of Chester and his wife gazing at him out of the bedclothes.

The butler, housekeeper, cook, valets, and ladies' maids constituted the upper servants, who were very conscious of their position and bullied the lower servants unmercifully. Meals in the servants' hall were guided by a code of etiquette based on that reigning in the gentry's end of the house.

The servants' hall was the hub of the servants' wing, but all around it was a complex world of huge steaming kitchens, sculleries, laundries, butlers' pantries where



TO CLEAR A GRAND SITE *for Kedleston Hall (**right**), begun in 1759, Sir Nathaniel Curzon moved the entire village of Kedleston, except for the church, half a mile. A fabulous art collection set off by the influential architecture of Robert Adam, Kedleston—like many country houses during that era—attracted sightseers, who were given conducted tours. Current owners Lord and Lady Scarsdale and sons (**top**, at left) take time to describe their home to busloads of paying tourists.*

the silver was polished, stillrooms where the stillroom maid made jams and scones, and a warren of smaller rooms, linen closets, china closets, rooms for cleaning knives, for filling lamps with oil, and for interminably brushing clothes.

Mr. Hughes, of Kinmel Park in north Wales, making one of his rare visits to the servants' wing when showing a visitor round his house, came to a little room, the purpose of which eluded him. He asked the attendant footman, who announced, in pompous tones, "That room, sir, is used only for ironing the newspapers."

Wealth and social prestige produced eccentrics who could indulge their foibles without being restrained. "Mad Windham" of Felbrigg Hall in Norfolk used to dress up as a ticket collector and walk up and down the Norwich-to-London Express punching tickets; his hobby was indulgently tolerated by railway officials. The fifth Duke of Portland so hated being seen by anyone that he communicated with his servants through a letterbox and burrowed like a rabbit, excavating a series of underground rooms at his house, Welbeck Abbey in Nottinghamshire, and a drive that snaked for a mile and a half through a tunnel beneath his park.

The duke's apparent urge to escape from the real world may have derived from his awareness that it was not as friendly to dukes as it used to be. Country-house life in this period exuded an atmosphere of wealth and confidence, but in fact it was already coming under threat. By 1851 more than half the population of Great Britain was living in towns, and country-house owners found it increasingly hard to dominate politics or protect their own positions.

In the 1870s and 1880s cheap grain flooded into England from America to feed the towns. Prices collapsed and landowners' rents slumped disastrously. There is a story that even the sixth Duke of Portland, who inherited from his childless underground cousin, was being forced to economize. He employed a chef whose only job was to make biscuits for consumption with the duke's sherry. "Can't a man have a biscuit with his sherry?" the duke exploded when it was suggested that the chef might be got rid of.

A number of owners recouped their fortunes by marrying new money. American heiresses appeared at the opportune moment to make, in theory at any rate, everyone happy: Their parents liked the idea of a title in the family, and their husbands needed money. These transatlantic matches did not always work. The marriage of Consuelo Vanderbilt, the richest, most characterful of the heiresses, to the Duke of Marlborough was forced by an ambitious mother. Since both bride and bridegroom had wanted to marry other people, it was a disaster. After 11 years of silent dinners at the great dining-room table at Blenheim, she left him.

During World War II many country houses were taken over for use as schools or military headquarters and afterward returned to their owners in a bad state of repair. About 400 country houses were demolished between 1920 and 1955. Many others became schools, hotels, conference centers, or company headquarters. More than 120 country houses now belong to the National Trust, a private charity that takes over houses from their owners, usually with a substantial endowment, and opens them to the public. Whenever possible, the trust acquires the original contents along with the houses, and the families often continue to live in a portion of the house as tenants.

Yet there is still a great deal of money in the country-house world. English agriculture has emerged from a long decline, so that land that was selling at £25 an acre in the 1920s can now be worth £3,000, an increase that outruns inflation. Country-house owners who still owned land in or on the edge of towns often found it increasing

WORKS OF THE MASTERS *fill Norfolk's Holkham Hall, where Viscount and Viscountess Coke enter the sumptuous Marble Hall. Palladian in concept, the room is graced with fluted alabaster columns copied from a Roman temple and a coffered ceiling inspired by architect Inigo Jones. The home was begun in 1734 by Thomas Coke, later Earl of Leicester, who adorned it with classical statuary, Brussels tapestries, and paintings by Rubens, Poussin, and Van Dyck.*

CHARITY BEGINS AT HOME *and rises to a prodigious scale at the Holkham Country Fair, with proceeds aiding worthy causes. Here by the North Sea, the Cokes transformed a nearly*

barren land into a productive estate. In the late 1700s and early 1800s Thomas William Coke, a great agricultural reformer who was later honored as Coke of Norfolk, pioneered farming techniques that increased yields from tenants ninefold in 40 years. He held sheepshearings where thousands of farmers also compared notes on new plows and seed.

A TASTE FOR THE CLASSICAL *gripped 18th-century English society, which bought treasures from financially pressed Italian nobility. At Syon House, a seat of the Duke of Northumberland near London, a bronze copy of "The Dying Gaul" marks the passage from the entrance hall (**facing page**) to the anteroom (**below**), both reflecting Robert Adam's fascination with neoclassical motif.*

in value at an even more sensational rate. And the value of contents of country houses began that soaring spiral epitomized when a portion of the Chatsworth collection of drawings, including some by Raphael and Rembrandt, sold at Christie's in July 1984 for over £21 million.

In 1952 at Knowsley a footman went mad and shot at Lady Derby while she was at dinner; the butler and under-butler were killed in the subsequent struggle, and the chef and valet injured. A wit, hearing of the incident, is said to have remarked, "It's good to hear of a house where you can still get a left-and-right in butlers."

In 1966, however, the Earl of Derby let Knowsley to the police for offices and moved into a smaller house that he had built in the park. Other owners would imitate him, and a minor industry in new country houses started up, most of them carefully designed to look as much like Georgian houses as possible. Rising taxation and costs had made many of the older country houses too big for even the very rich to contemplate living in all of them. Today very few country houses are demolished, but they are coming on the market all the time. Quite a few, especially the smaller ones, are bought for continued use as private houses.

In spite of everything there are still perhaps 1,000 country houses lived in by families who have always lived in them. Life in most of them is not at all grand, however grand the houses may be. But as recently as 1976 the Dowager Lady Rosebery, asked where the kitchen was at Mentmore, the family seat in Buckinghamshire, said she had no idea as she had never been there.

At Doddington Hall in Lincolnshire, Antony and Vicky Jarvis not only know where the kitchen is but live in it. I visited them on a typical English weekend, when their mellow red-brick Elizabethan manor house alternately baked in the hot sun and disappeared into clouds of driving rain. Doddington used to be the home of the Delaval family, one of the liveliest and most raffish of country-house families, who had a fondness for practical jokes such as depositing drunken guests in a room in which all the furniture was screwed upside down to the ceiling. The heiress Delaval left the house and its contents to her close friend, Col. George Jarvis, in 1825. Antony Jarvis, who is now in his 40s, inherited the estate from his father in 1973 and gave up his career as an architect in order to look after the family property.

Vicky Jarvis does the cooking herself, except on special occasions. The family lives in the servants' quarters. The old kitchen, with its huge stone arched fireplace, has become the living room. The buttery and the adjacent pantry, where the silver plate used to be polished, are now a kitchen and dining room; meals are served up on a massive table brought in from the old servants' hall. The Jarvises keep one of the big bedrooms on the first floor, but their three children have moved into former servants' bedrooms—very nice rooms they make too, with low beamed ceilings and latticed windows looking over the gardens.

GENERATIONS OF VOICES *speak in the stones of Haddon Hall's chapel, where a marble effigy honors the son of the eighth Duke and Duchess of Rutland, who died as a child in 1894.*

By the fireplace of the old kitchen, Vicky embroidered a cushion for an 18th-century chair while Antony worked away at a fixture for their new do-it-yourself horse-trailer-cum-camper. "We still own about 1,800 acres," Antony told me. "The house is open to the public two days a week except in the winter. The income from farms and visitors, and a little extra from investments, just about keep things ticking over. In addition, we've had invaluable government grants toward structural repair. Before the war there were ten live-in servants, but now we depend on 'dailies'—three regular ones and six part-timers." Outside help used to run to 15, including gamekeepers, huntsmen, and gardeners. But today there are only two gardeners.

Vicky is a magistrate in a local court and serves on the area board of the National Trust and the Historic Houses Association. "We grow Christmas trees and work flat out before Christmas selling them," she said. "In summer we put on two concerts and an exhibition in the Long Gallery, and from time to time we give a dance for our friends and use the rooms open to the public for ourselves. Volunteers repair books in the library, and I work on the hangings of the four-poster beds. It's a good life, but one never seems to have time to sit and relax."

I thought of similar country houses of England, and of their owners still playing a part in public life as they have always done, of those friendly indispensable daily helpers, and of how Doddington still feels a lived-in house even though the grandest rooms are now seldom used by the family.

The past is alive in every one, not just in rooms like the Long Gallery, where a group portrait by Sir Joshua Reynolds looks down a 100-foot vista. Attic rooms are a jumble of hip baths, horse tackle, hunting boots, stuffed animal heads, old toys, disused furniture, and clothes of all dates. Wander into one little room and you will find three battered hatboxes, two containing ancient top hats, and a third a pith helmet. Folded away in a cupboard are exquisite striped dresses of the 18th and early 19th centuries. Vicky Jarvis pointed out to me the tiny sleeves made for bird-thin arms, cut so the arms could not be lifted above the shoulder. "Their owners never had to do more than raise a cup of tea to their lips," she said.

All over England the country-house weekend still flourishes, even if increasingly informal and reduced to eight or ten people instead of yesteryear's 20 or 30. At Doddington I found high-ceilinged guest bedrooms hung with tapestries, horses to ride or drive, a pond to fish in, croquet lawns and tennis courts, acres of gardens, and miles of bluebell-carpeted woods.

Friends came to lunch, and we savored our drinks in the sun on the terrace before rose-red Elizabethan walls, then moved into the cool Great Hall to eat. We sat in carved wooden chairs over 300 years old, surveyed by family portraits. When Henry James epitomized peace and perfection in his story about "the great good place," he had the country house in mind, and despite changing times it is still a good place today. □

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WASHINGTON, D. C.

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Editor, 1899-1954; President, 1920-1954
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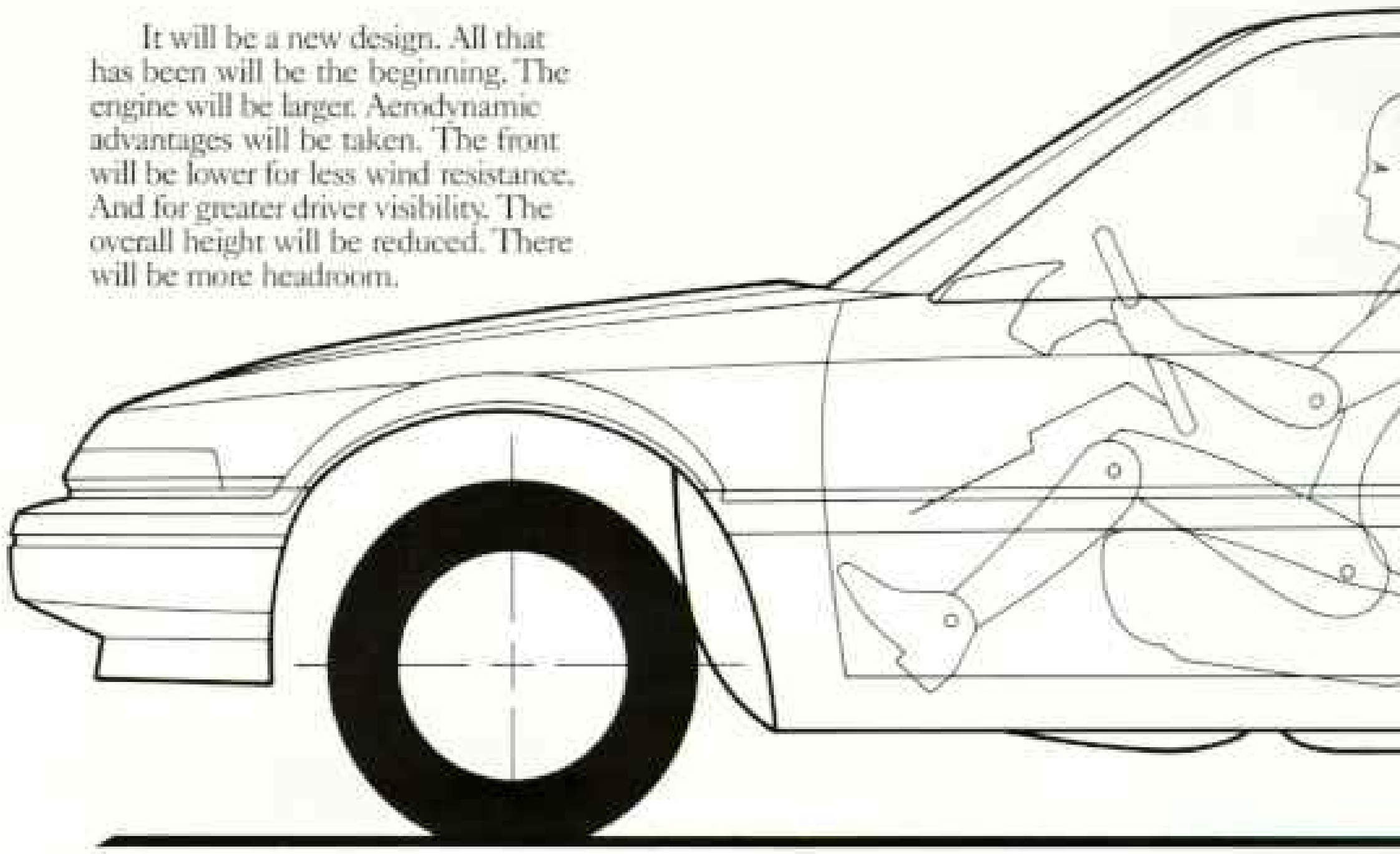
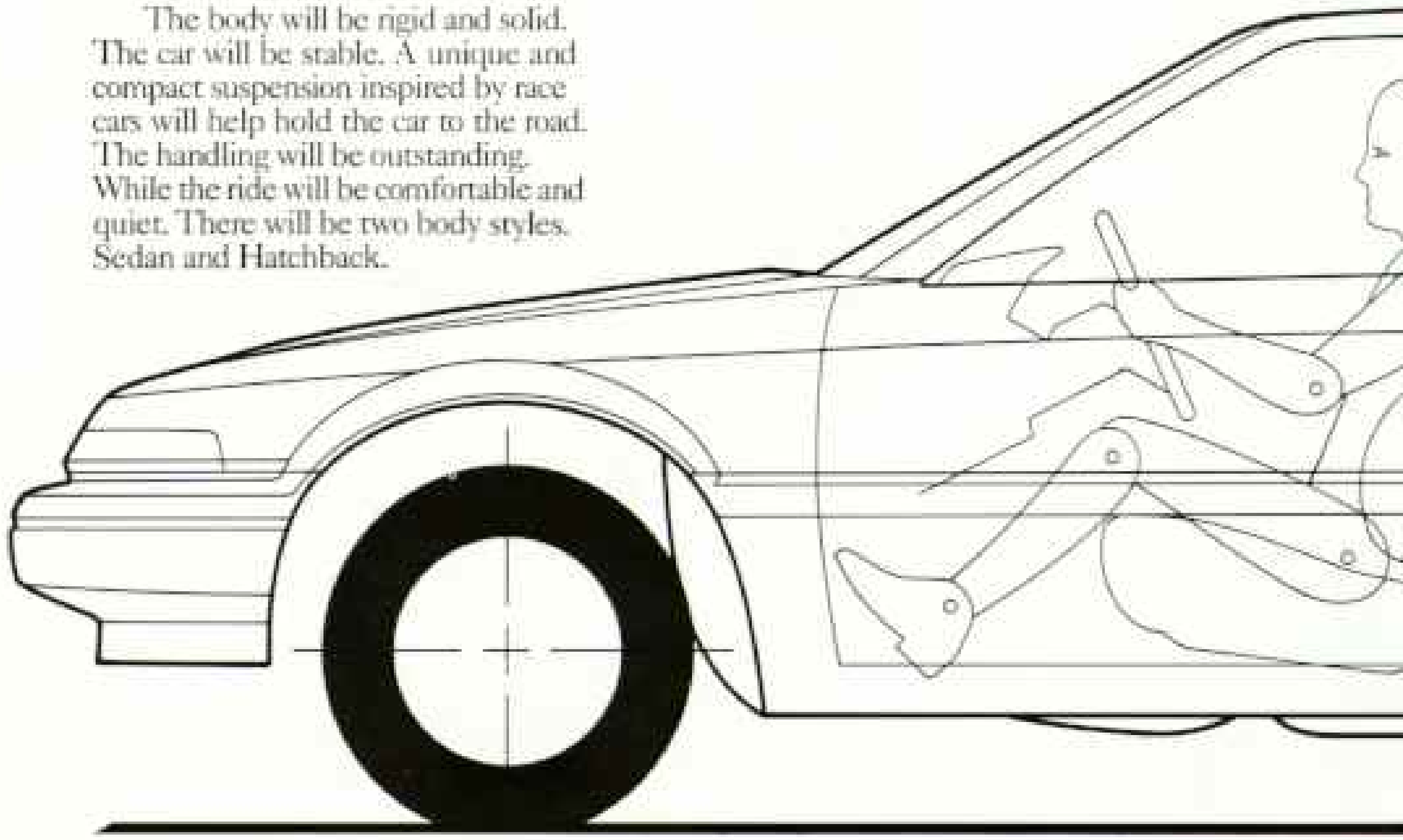
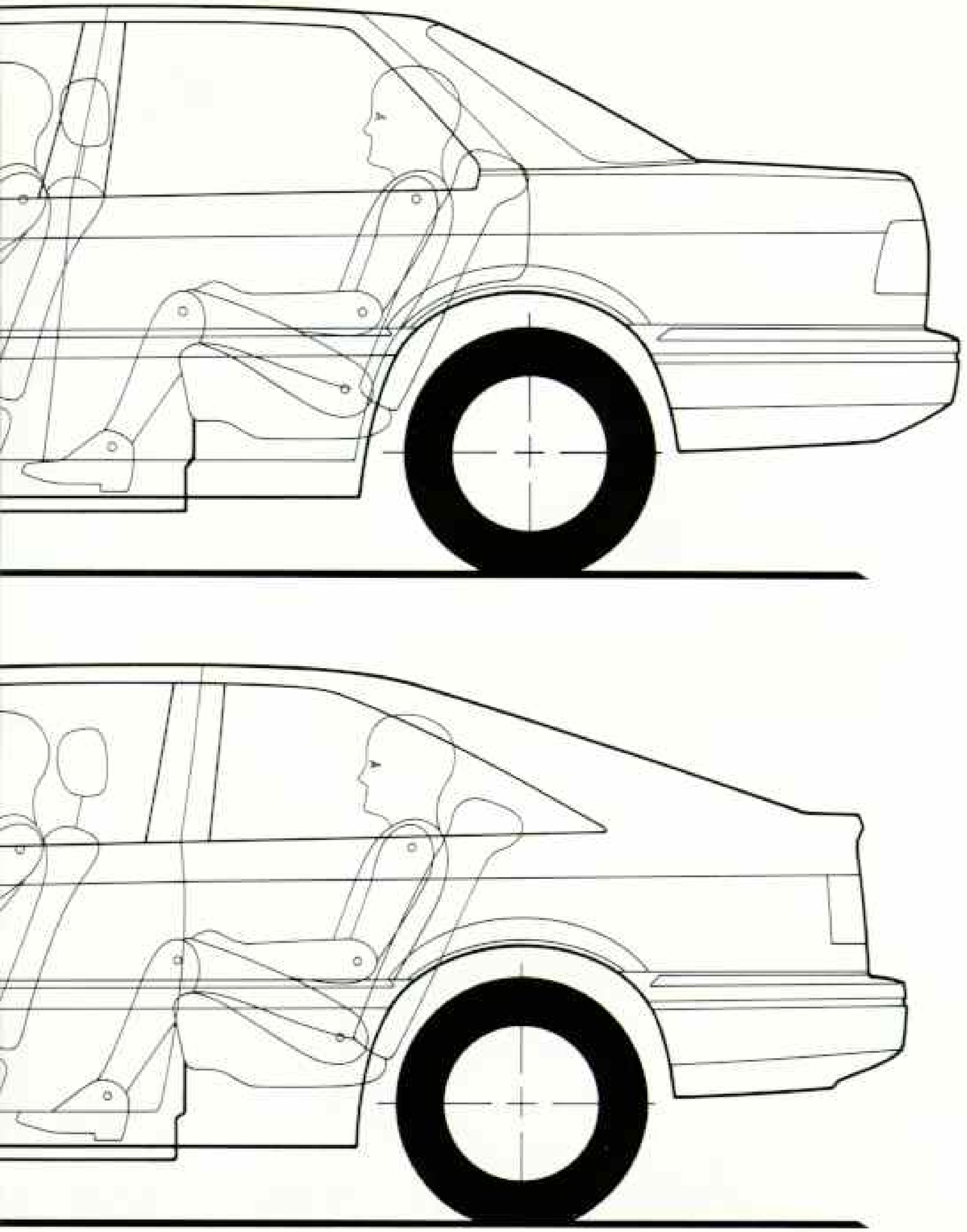


The body will be rigid and solid. The car will be stable. A unique and compact suspension inspired by race cars will help hold the car to the road. The handling will be outstanding. While the ride will be comfortable and quiet. There will be two body styles. Sedan and Hatchback.





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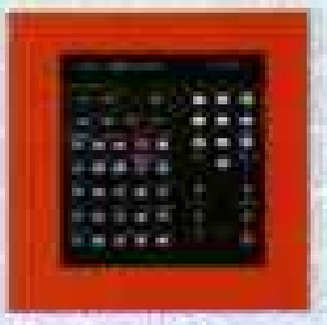

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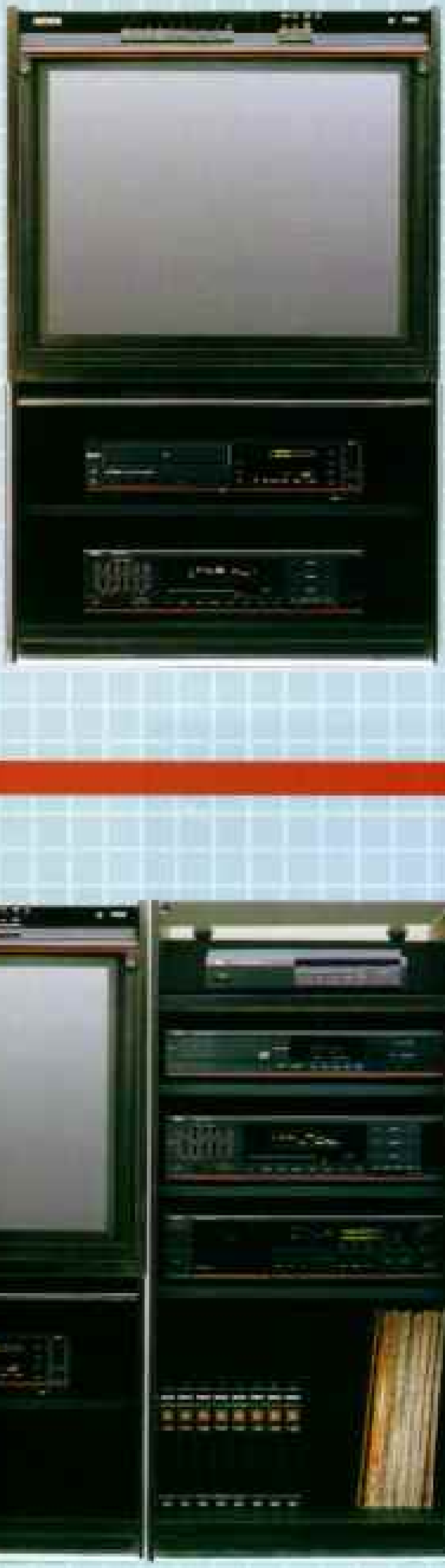

T S Y S T E M S

A Geographic gold medal honors Kenyan fossil finder

FOR A QUARTER OF A CENTURY the fossil remains of early man have been speaking to Kamoya Kimeu. Among his American and British colleagues the 46-year-old Kenyan archaeological excavator jokingly insists the fossils talk with him in an imaginary language, Kikishwa.

I'm inclined to agree with him. I have known Kamoya for nearly 20 years, and with others I constantly marvel at his uncanny instinct for discovering priceless fossils.

On page 624 of this issue anthropologists Richard Leakey and Alan Walker describe Kamoya's latest success—the discovery in 1984 of a hominid skull fragment on the west shore of Kenya's Lake Turkana (**below**). The find led to recovery of the first nearly complete skeleton of *Homo erectus*, a fascinating intermediate stage between the first upright walking man and our own species, *Homo sapiens*.

PHOTOGRAPH BY DAVID L. BRILL

It is hardly the first time that Kamoya's brilliant work has appeared in the pages of NATIONAL GEOGRAPHIC. As assistant to the late Dr. Louis S. B. Leakey, to his wife, Dr. Mary D. Leakey, and later to their son Richard, Kamoya has played an outstanding role in the search for man's origins. His achievements in that field led to his appointment in 1977 as curator of prehistoric sites for the National Museums of Kenya.

This October, in recognition of Kamoya's contributions to the study of early man, the National Geographic Society awarded him its John Oliver La Gorce Medal (**top**). Bestowed only seven times in the Society's history, the award is reserved for "accomplishment in geographic exploration, or in the sciences, or for public service to advance international understanding."

In our judgment Kamoya Kimeu has distinguished himself and his country in all three fields of human endeavor. On November 3 National Geographic EXPLORER, our cable TV program, will carry the award ceremony. Thanks in part to his work, our forerunners of the distant past have begun to speak not only Kikishwa but the language of all mankind.

Gilbert M. Grosvenor

PRESIDENT, NATIONAL GEOGRAPHIC SOCIETY

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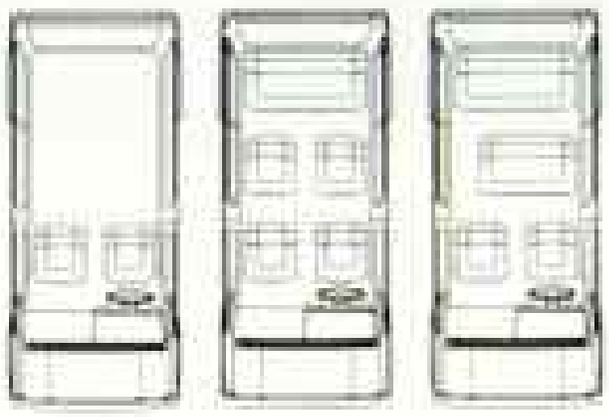

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The Aerostar Wagon offers you a selection of matched seats: buckets, Captain's Chairs and bench. There's room for seven adults.* There's also a path so you can step to the back to reach baggage or children.

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Aerodynamic for lower air drag	.37 Cd	.42 Cd
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Extra driver legroom	41.4 in.	38.3 in.
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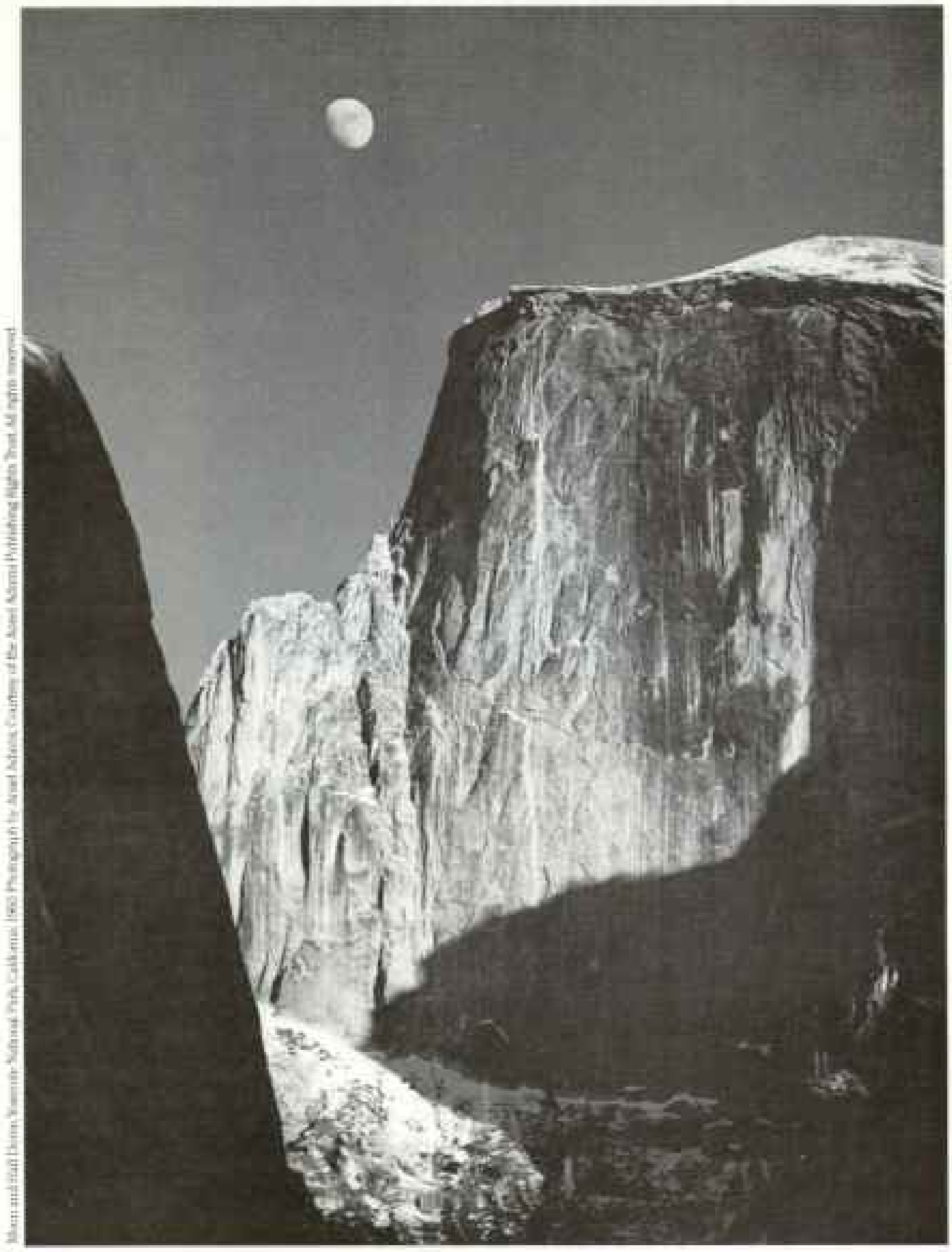

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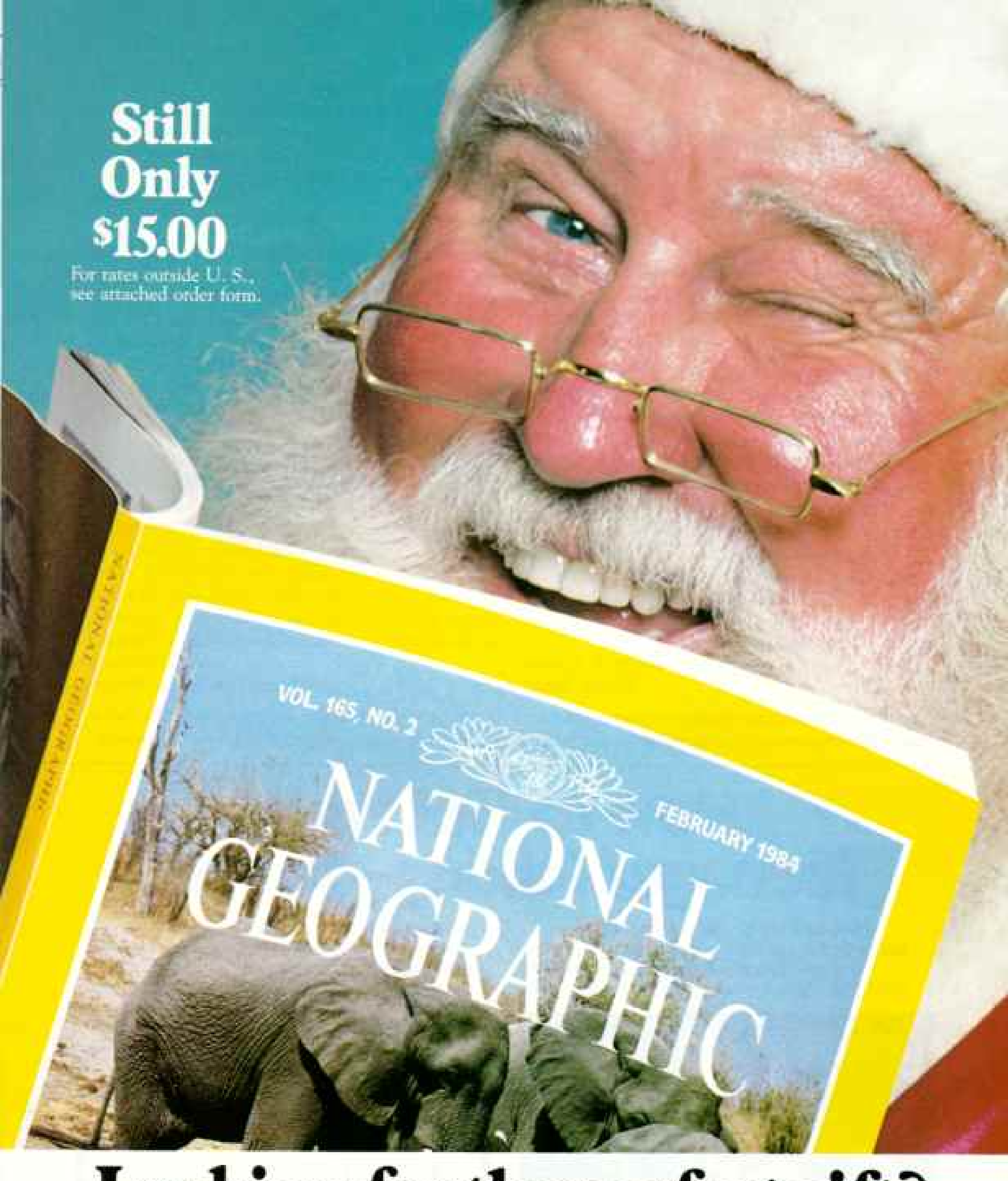

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Members Forum

Iran

The picture of an Iranian father and his blinded son (July 1985, page 119) says it all.

Robert E. Fletcher
Simi Valley, California

I lived and worked in Tehran and Esfahan in the late 1970s. Even as an "infidel," I was welcomed into very humble and very wealthy homes. Muslims, Jews, Christians, Bahais, and Zoroastrians were able to coexist. The shah was no angel, but most of the people enjoyed an amazing degree of freedom, and Iran was making economic, educational, and public welfare progress.

The man who taught me Farsi (who now services appliances in the U. S.) recently told me, "It is so sad. Persians are such fun-loving people. The poetry and the music are gone. Europe had its Dark Ages, now Iran is having hers."

Bryce A. Contor
Howe, Idaho

Too many Americans blindly condemn the Shiites before understanding the religious and political structure that creates a society like Iran. My personal rejection of radical Islam is still strong, but views like the one given by your article have taught me to put aside hate and feel pity for all those being brainwashed and massacred.

Scott Morgensen
Redondo Beach, California

The articles on Iran and Israel were magnificent counterpoints of warring cultures and religions. Can peace ever come when rigid fundamentalism allows no ecumenical compromises? It will take a 21st-century Solomon to overcome and solve the biblical battles of the Middle East.

Dr. Meyer Ashpitz
Kew Gardens Hills, New York

Israel

I just returned from a nine-month stay in Israel. It's been incredibly hard to explain my experience, the politics, the life-style, the people, the kibbutzim, the presence of the army. From now on, every time someone asks me to tell them "all about Israel," I'll whip out NATIONAL GEOGRAPHIC (July 1985). You've included, in a few pages, all that I came to learn in a year. For that, in Israel they say "*kol hakavod*—all the honor."

Suzie Weisman
Albuquerque, New Mexico

I strongly object to the statement that the Palestinians have been subject to a "relatively benign"

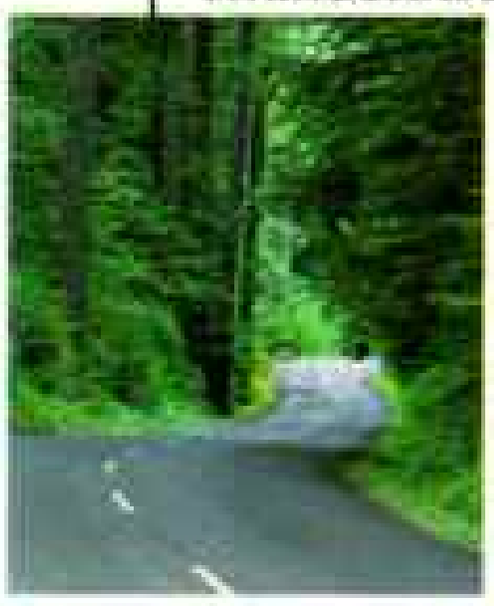
Thunderoads.

Gonzelman Road, California

Get it together — Buckle up.

The engineers who designed these roads knew that they'd present a challenge. But they never expected that some would drive these roads in a Thunderbird for precisely that reason.

On roads with long, smooth straightaways, Thunderbird's sleek lines use the wind to improve the car's stability and road control at highway speeds.



Route 101, Washington

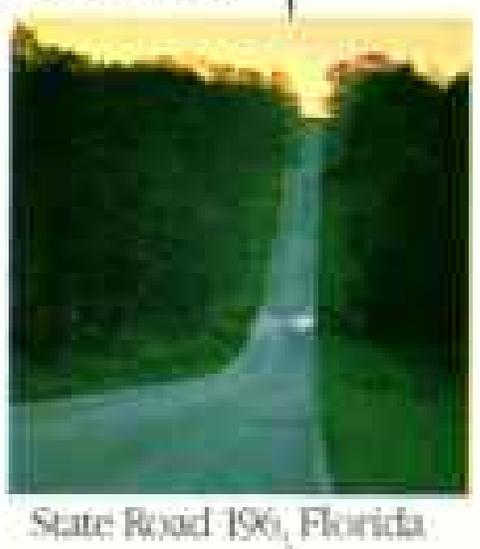
There are also great driving roads with twists and turns that define the term "serpentine." On this kind of road, Thunderbird's precise steering and all-season radials do an excellent job of unwinding the road.

Route 112, New Hampshire

You may even know of a special road that closely resembles an asphalt roller-coaster.

On this kind of pavement, Thunderbird's gas-filled struts and shocks, and modified MacPherson front suspension excel.

On roads like these throughout the country, a very select group of drivers are discovering the meaning of Thunderoads.



State Road 196, Florida

Have you driven a Ford... lately?

Ford

Israeli occupation. I am a member of the National Lawyers Guild, which visited Israel to investigate possible violations of human rights. Voluminous reports issued by numerous human rights, Red Cross, and United Nations organizations document such violations. Palestinian land is constantly being confiscated, their water resources irrigate Israeli farms outside the occupied territories, 10,000 homes on the West Bank alone have been demolished since 1967, thousands are locked up in Israeli prisons, and even the colors of the Palestine flag are outlawed.

John H. Alexander
Chicago, Illinois

"Searching for the Center" is the best piece of journalism I have read about Israel, a brilliant study of that nation's perplexing myriad of problems and challenges.

Kirby Neumann-Rea
Molalla, Oregon

The article is informative and truthful, and it successfully conveys the atmosphere that colors Israel. But in the article most of the Jewish population sees Arabs as inferior and undeserving of a homeland. This opinion is true of some Jews, but others favor coexistence as a necessity. Most Israeli Jews are shocked and angry about Jewish terror and do not justify it in any way.

Rona Melkman
Jerusalem, Israel

Priit Vesilind says Israel has built "a successful democratic society." It is not democratic or successful. If I started a business and could not make ends meet, and if my rich uncle each year paid off my shortages and kept me out of bankruptcy, would I be classed as successful?

Cecil D. Clayton
Slaughters, Kentucky

The author informs us that the Ashkenazim are the Jews of European origin, whereas the Sephardim are the Oriental Jews from Middle Eastern or African backgrounds. One doesn't have to be Jewish to know that the Sephardim are Spanish Jews, Sepharad being the Hebrew for Spain. Sephardic Jews are not Orientals, though the Orientals, by *joining* the Sephardic community, have *become* Sephardim.

Santiago de Churruca
Bordeaux, France

Confusion sometimes occurs because Sephardic is often applied in Israel and elsewhere to all non-Ashkenazim. The name derives from Sepharad, a place in Asia Minor that became home to exiles from Jerusalem after the first destruction of the temple. It later referred to Spain.

Hampton Roads

You did a great job covering Tidewater Virginia (July 1985). A few things you may have missed: most important, one of the largest cities (in area) in this group, Chesapeake. That's kind of like never finding a chip in a chocolate chip cookie—you missed the best part.

Joseph M. Tari
Chesapeake, Virginia

Old Dominion University is the keystone of higher education in southeastern Virginia, with 15,000 students enrolled. We are NASA Langley's largest single contractor for applied research. How could you overlook us?

Robert M. Stanton, Rector
Old Dominion University, Norfolk

I was born and raised in Portsmouth, and Norfolk has always overshadowed each area surrounding Hampton Roads. Your article gave Portsmouth the glowing progress report that she so justly deserves.

Dorothy B. Manheimer
Manasquan, New Jersey

I was very upset with the map on page 77. Poquoson is not listed anywhere.

Donna Smith
Poquoson, Virginia

. . . [nor] our beloved Pungo.

M. Dabney Oakley, Jr.
Free Union, Virginia

. . . [nor] the cross on the beach at Cape Henry. It commemorates the landing on the cape in 1607 of the Jamestown colonists.

W. T. Lay
FPO, New York

Basque Whalers

I'm writing to thank Bill Curtsinger, Richard Schlecht, James A. Tuck, Robert Grenier, and the Society for the magnificent article "Discovery in Labrador: A 16th-century Basque Whaling Port and Its Sunken Fleet" (July 1985). I've never been so captivated by a GEOGRAPHIC story as I was with this one!

Steven J. Borowiec
Raleigh, North Carolina

In regard to your interesting article, I would like to comment on a saying we descendants of Basques have in Mexico. It translates:

Before God was God
and boulders were boulders,
the Basques were already Basques.

Dr. Jesús Maíz
Chihuahua, Mexico

"The Indomitable Basques" states that St. Francis Xavier was a Basque. Portugal has always been small in size, but we have had our giant figures and once ruled a great, far-flung empire. One of our "great" sons was St. Francis Xavier.

Mariette M. Figueiredo
Providence, Rhode Island

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Introducing the Magnavox VHS Movie-Maker.

Home moviemaking has never been so much fun and so little trouble. Thanks to the new Magnavox VHS Movie-Maker.

It lets you record both picture and sound with just the touch of one button. It focuses itself. And because its design is light (7.7 lbs.) and self-contained, it gives you a whole new freedom of movement.

The new Magnavox Movie-Maker is a camera and video recorder/player in one. It tapes up to 2 hours and 40 minutes on full size VHS tape. And its viewfinder doubles as a monitor.

Best of all, you don't even need a VCR to enjoy the movies you make. Just plug it into your TV set. And you're all set.

The new Magnavox VHS Movie-Maker. Your home moviemaking will never be the same. (Thank goodness.)

THIS IS MAGNAVOX

St. Francis was born in Navarre near Pamplona, the ancient Basque capital, and was descended from a noble Basque family. He served in Goa as a missionary for King John III of Portugal in the 1540s, leading to the idea he was Portuguese.

Thank you for an excellent article on excavating a Basque galleon. The gold dredgers in Trinity County, California, have heated their wet suits with hot water from the dredge motors for years.

Marcella Horn
Helena, California

Largest Flower

Your article suggests that the *Rafflesia arnoldii* is the world's largest flower. At least one other contender would be the *Amorphophallus*, of which the flower attains a height of 15 feet and a diameter of 8 feet. *Amorphophallus* also exudes a fetid odor. My wife insists that I move my plant completely out of the house while it is flowering!

Charles A. Smith
Fayetteville, North Carolina

Amorphophallus *plants are indeed spectacular. However, it is the plant and not the flower that attains such garganiuan proportions. What appears to be the flower is technically a spathe, or bract, surrounding the spadix, where the male and female flowers are clustered. The odor draws pollinators—flies, beetles, and other insects normally attracted to carrion.*

Members Forum

In the July 1985 Members Forum you state that King Philip was an Abenaki Indian. King Philip was a Wampanoag, a son of Massasoit, who brought his people to the first Thanksgiving. King Philip disagreed with his father, feeling that the settlers were intruders. Jonathan Tefft, who also disagreed with his father and left home, married a daughter of Massasoit. Tefft was my great- (please add 14 greats) grandfather. I, therefore, had people on both sides of the first Thanksgiving table and King Philip's War.

Shirley Tefft Burris
Asheville, North Carolina

Yes, King Philip was a Wampanoag and a son of Massasoit. Alarmed at the encroachment and evangelism of the colonists, he organized tribes of Massachusetts in a bitter two-year war that resulted in his death. He became a legend to both sides. To descendants such as you, happy Thanksgiving.

Letters should be addressed to **Members Forum**, *National Geographic Magazine, Box 37448, Washington, D.C. 20013, and should include sender's address and telephone number. Not all letters can be used. Those that are will often be edited and excerpted.*

Family room.

Take some of the best things about your family room, put them on four wheels, and you begin to get the idea of what a Dodge wagon is all about.

Because, inside a Dodge you'll find plenty of living room for you and your family. Even our smallest wagon has available seating for 8 people. And our B-350 Maxiwagon can handle a family reunion with optional seating for up to 15 full-size adults.

You'll find a Dodge wagon comfortable. Comfortable to drive. With standard features like power steering and power front disc brakes. And comfortable to ride in. With luxury options like plush command chairs, tilt steering wheel, front and rear air conditioning and heat on most models, and an outstanding AM stereo/FM stereo system with cassette.

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U.S. Postal Service

Photographed by Hans and Judy Beste. *Numbat: Genus: Myrmecobius*
Species: fasciatus **Adult size:** *Length of head and body, 18 – 28cm; tail, 15 – 17cm*
Adult weight: *500 – 700g* **Habitat:** *Eucalypt woodlands in southwest Western Australia*
Surviving number: Estimated at less than 2500

Wildlife as Canon sees it: A photographic heritage for all generations.

Unlike other marsupials, the numbat feeds during the day, foraging among dead tree trunks and limbs for termites, consuming thousands of the insects daily. Besides being a primary food source, termites also create hollow logs which the numbat uses for shelter. Sometimes called the banded anteater because of white bands across its back, the numbat is one of Australia's most endangered animals today.

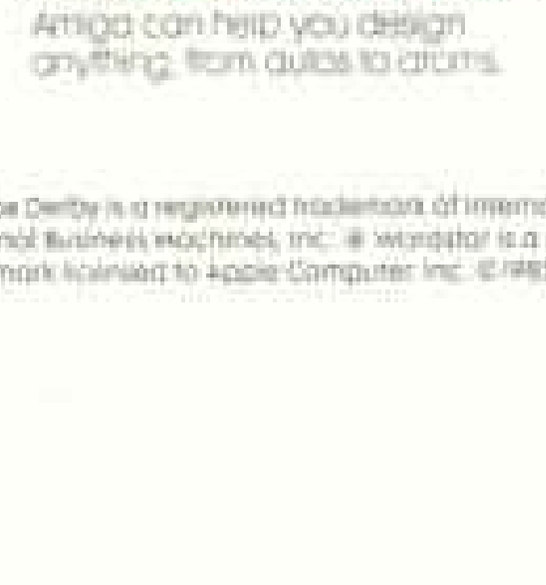
Nothing could bring the numbat back should it vanish completely. And while photography can record it for posterity, more importantly photography can help save it and the rest of wildlife.

The rapidly dwindling number of numbats has prompted an intensive search for ways to ensure the survival of this unusual animal. The first captive breeding colony was started in 1984, offering new hope for establishing future populations. Such efforts, along with photography, also allow more people an opportunity to view an otherwise rarely seen creature, and help provide a better understanding of the numbat's requirements for survival.

And understanding is perhaps the single most important factor in saving the numbat and all of wildlife.

Canon
Images for all time

TODAY IF YOU COME IN



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Amiga's color graphics leave the competition far behind.

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Amiga can not only do many more tasks, it can do more of them at once. And work on all of them simultaneously. While you're preparing the spreadsheet, Amiga will print the memo. And there's probably enough power left over to receive a phone message or a stock quote over a modem at the same time.

Amiga is easier to use and has twice the memory of an IBM® PC. But although it can run rings around IBM, it will also run IBM programs. You have instant access to the largest collection of business software in the industry, including old standbys like Wordstar® and Lotus® 1, 2, 3. Amiga is more powerful than Macintosh,™ too, and more expandable. With an optional expansion module, you can add memory up to 8 megabytes. And while it can do much more than Macintosh or IBM, Amiga costs less than either of them.

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135 hp

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†Calendar year 1986 Wards Automotive Report

GET MORE FROM LIFE–BUCKLE UP!

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"The destruction was unbelievable." "You don't know what to do, who to turn to when you've lost everything."

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And now, in little more than three months, Mary and Marion are back in the home they love.

"You really are in good hands with Allstate."


Tornadoes rip Venic

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VENICE, Florida – A tornado smashed through residential areas of Venice at approximately 4:17 a.m. today. Local authorities estimate property damage at over ten million dollars. Numerous homes were completely destroyed, while many more sustained severe damage. Rescue workers were on the scene in the early morning darkness to provide aid and shelter for the victims of this area's worst natural disaster.
The storm generated winds powerful enough
A boat into a palm

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b. ☐ Hotels & Motels
c. ☐ Camping Facilities
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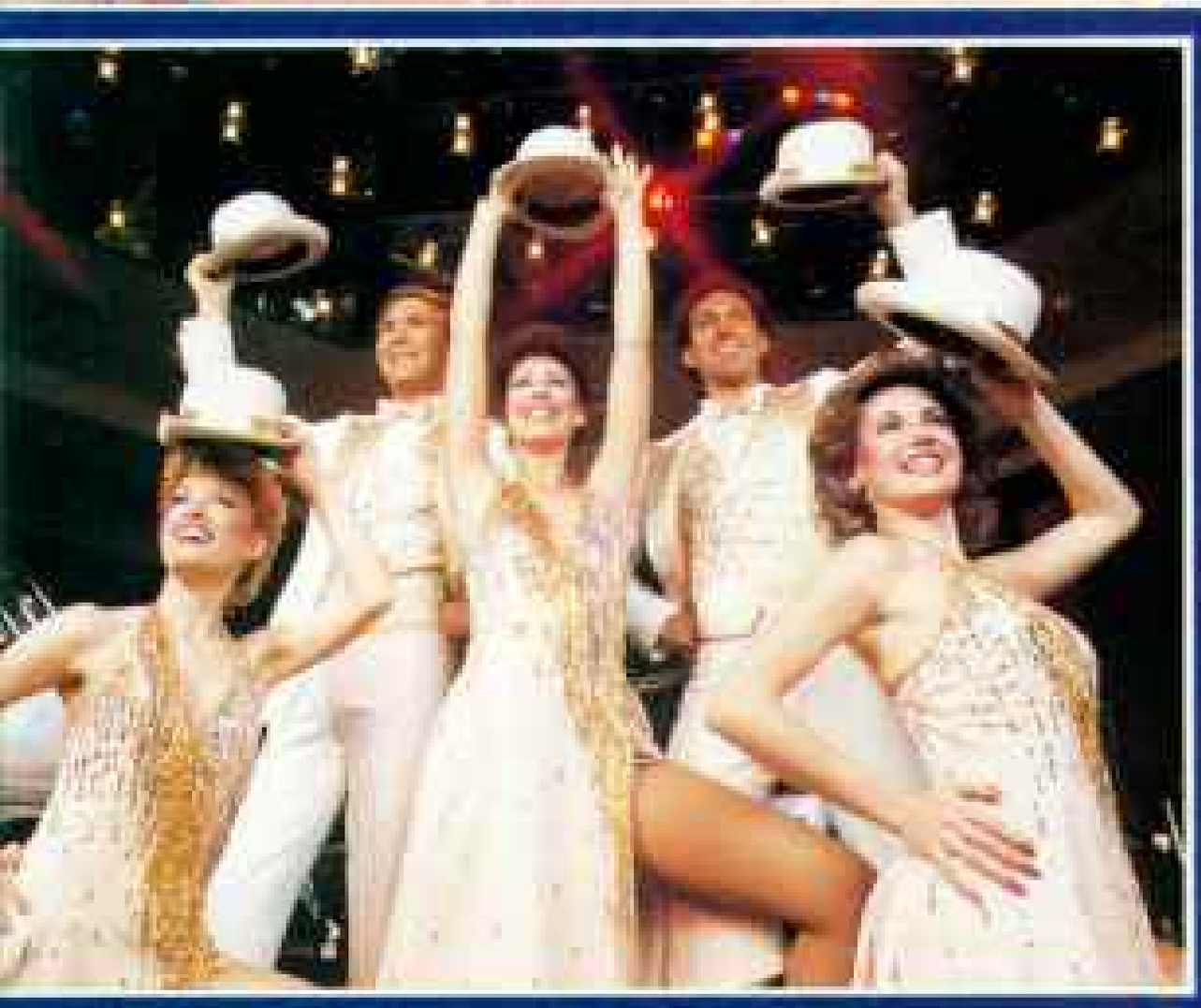

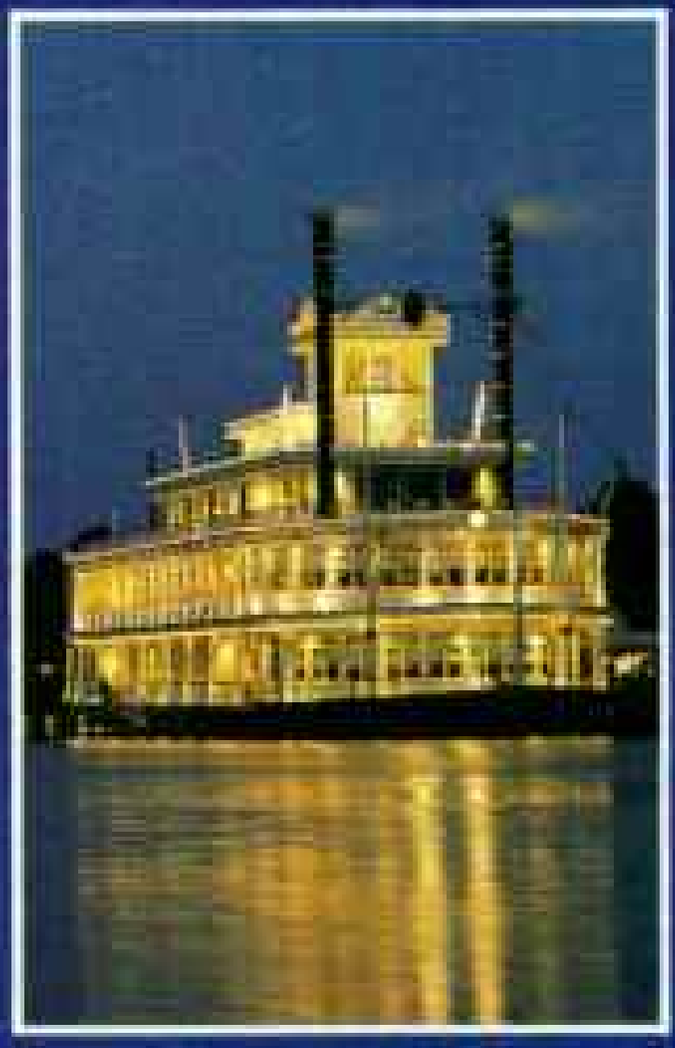

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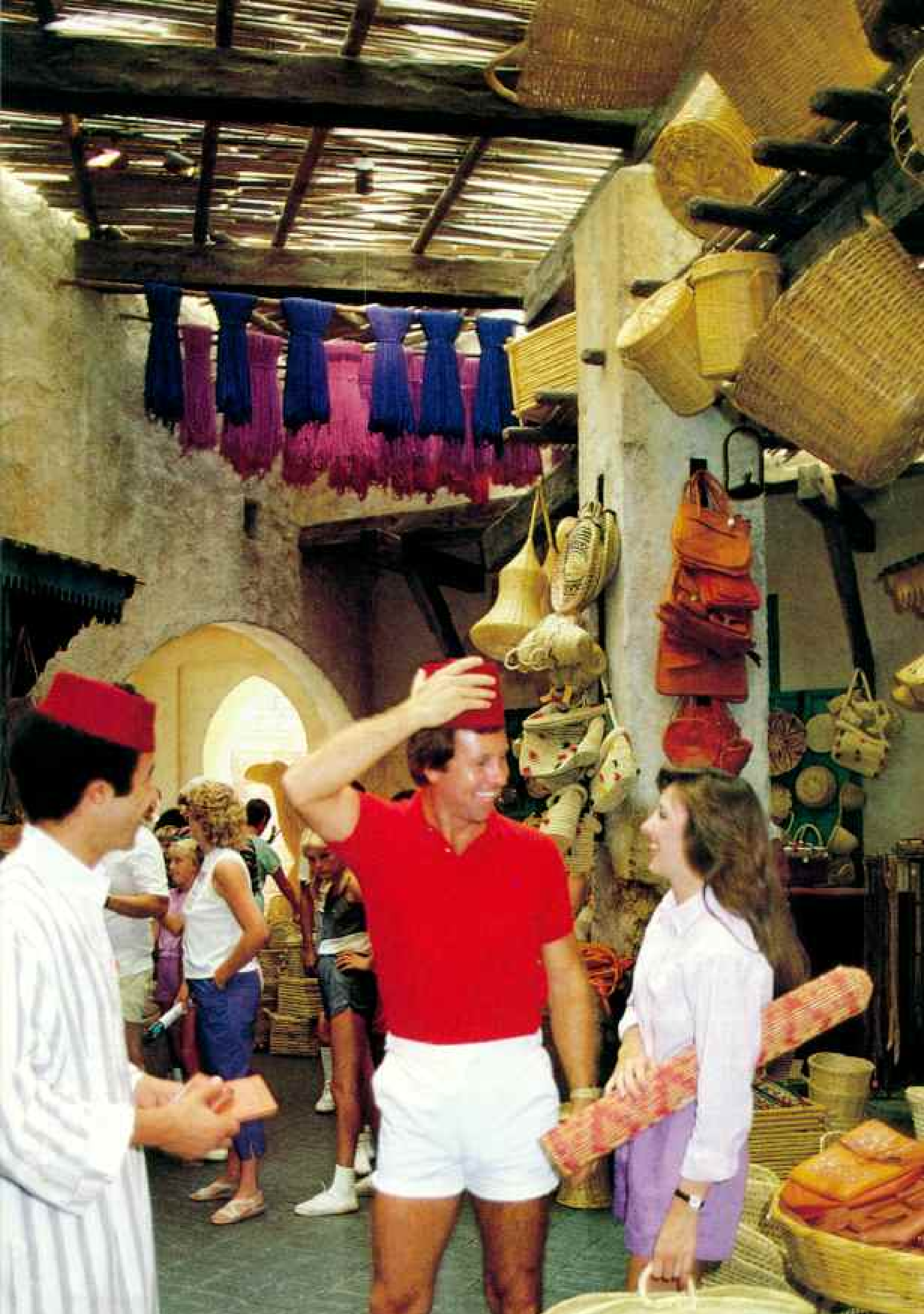

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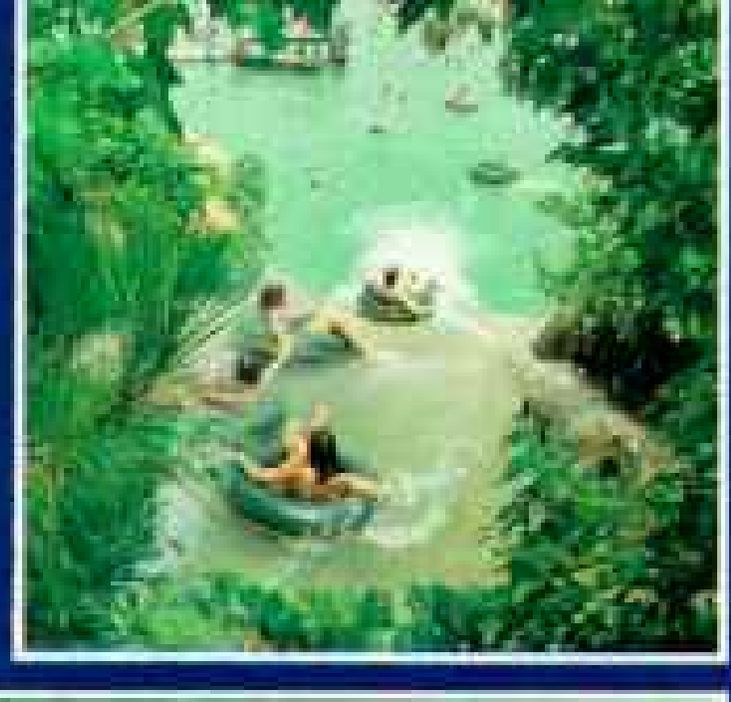

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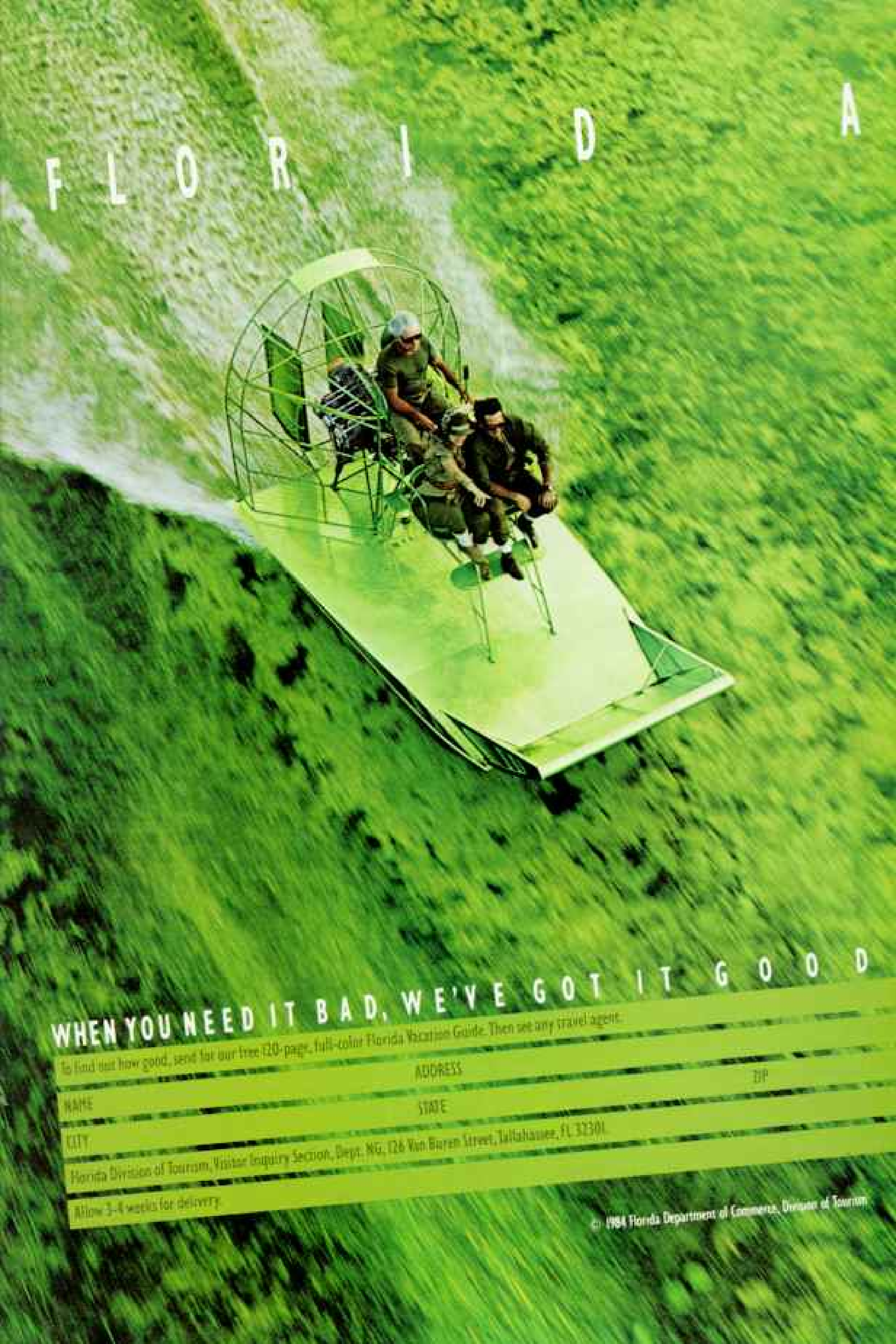
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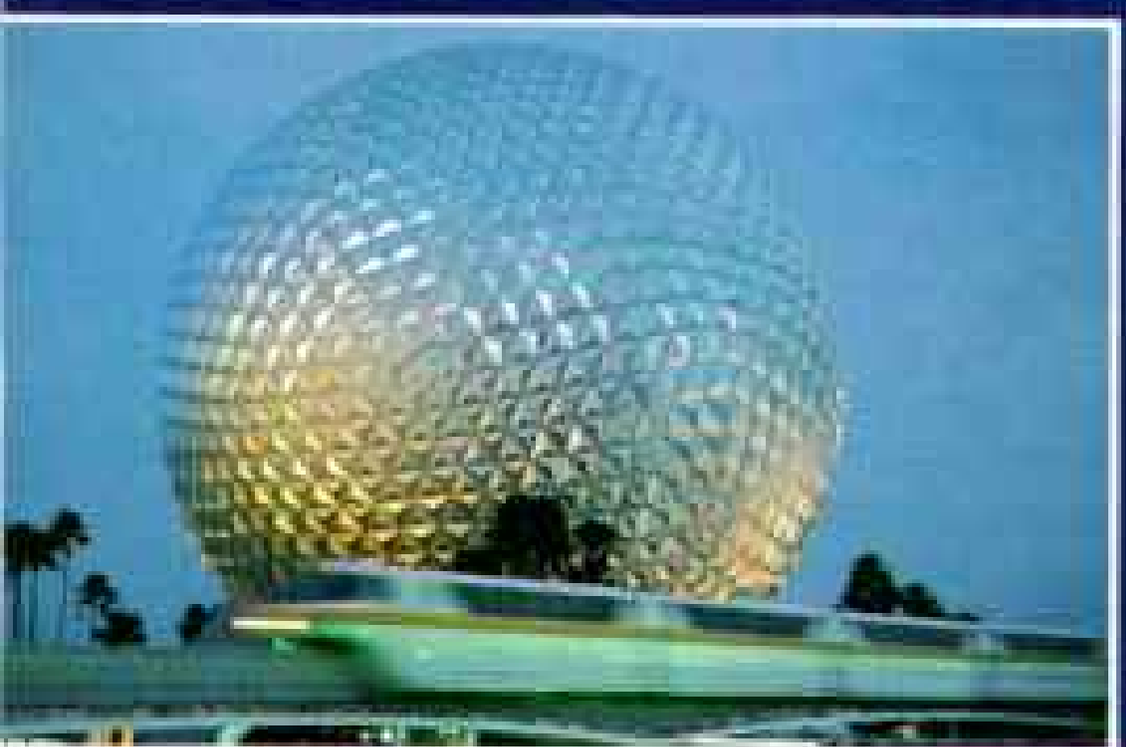
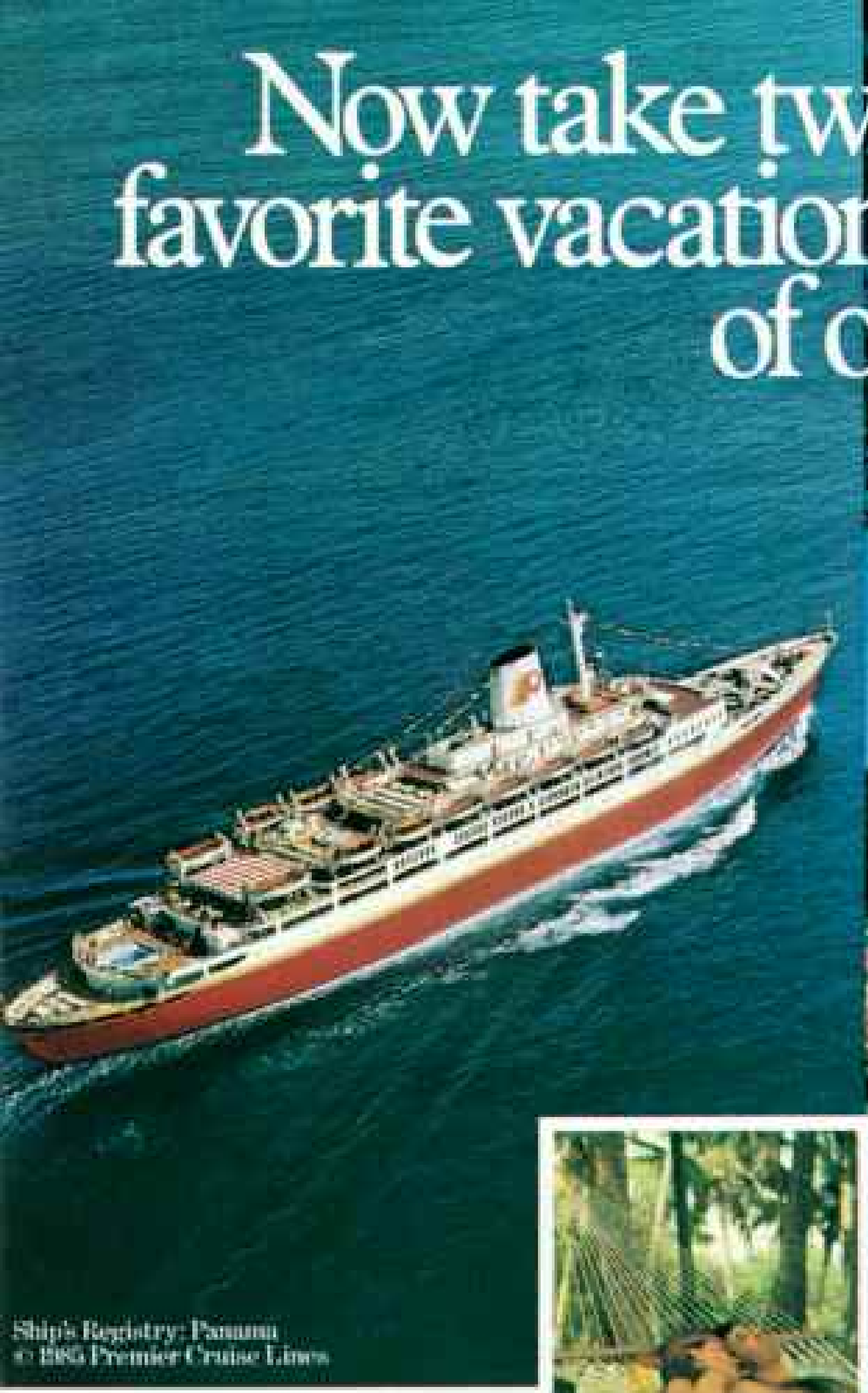


IN EPCOT CENTER, VISIT THE FUTURE AND TRAVEL THE WORLD. Epcot Center is the most wondrous of Disney dreams made real. In its *Future World*, you'll talk to a robot. Ride on sunshine in solar-powered theatre cars. Journey to outer space and back in time. And be among the first to discover Epcot Center's newest world, *The Living Seas*, presented by United Technologies, opening in mid-January, 1986.

In *World Showcase*, the other side of Epcot Center, you'll travel through ten nations re-created in wondrous detail. In a single day you'll shop for bargains in Morocco's Medina, or "old city." View the ancient treasures of a Chinese emperor. Sing and dance with performers from around the world. And dine in a Mexican courtyard, a German biergarten, or even Alfredo's the Original of Rome.

Now take two of Florida's favorite vacations. For the price of one.



It's this year's magic vacation combination. Florida's best 4-night cruise comes with a full 3-day vacation at WALT DISNEY WORLD® Magic Kingdom and EPCOT Center—Free.

Sail 4 nights to the Bahamas. You'll sail from Port Canaveral, the new cruise port to the Vacation Kingdom. Aboard the spectacular Star/Ship Royale, larger than most of today's ships—and the only one with true gourmet cuisine, masterpiece midnight buffets and big-name entertainment on every sailing.

On-board you'll find seven elegant lounges, swimming pool, a complete casino, movie theatre—even a full fitness program and full-time counselors for the kids.

You'll visit charming Nassau for duty-free shopping and nightlife. Then on to Salt Cay in the Out Islands, our private, uninhabited piece of paradise. With 5 glistening beaches, coral cliffs, swaying palms—all yours to explore. And to love.

Full 3-day WALT DISNEY WORLD Vacation—FREE. That's right, it's all free, before or after your cruise: 3 nights at a deluxe Orlando hotel, rental car for 7 days with unlimited mileage, your 3-day unlimited World Passport to all the attractions at the Magic Kingdom and EPCOT Center plus admission and tour of the Air Force Space Museum at the NASA Kennedy Space Center's "Spaceport, USA."

And yes, you can also book your week a different way with our 3-night weekend cruise plus a 4-day Walt Disney World vacation.

Reserve your week now. Premier's Cruise and Walt Disney World Week is available every week. So send in the coupon or call your travel agent now. And ask about our round trip fly/cruise rates from over 100 cities; they're lower than any other cruise lines'. It all works like magic.

I'd like a detailed brochure about Premier's Cruise & Walt Disney World Week, "The Magic Vacation Combination."

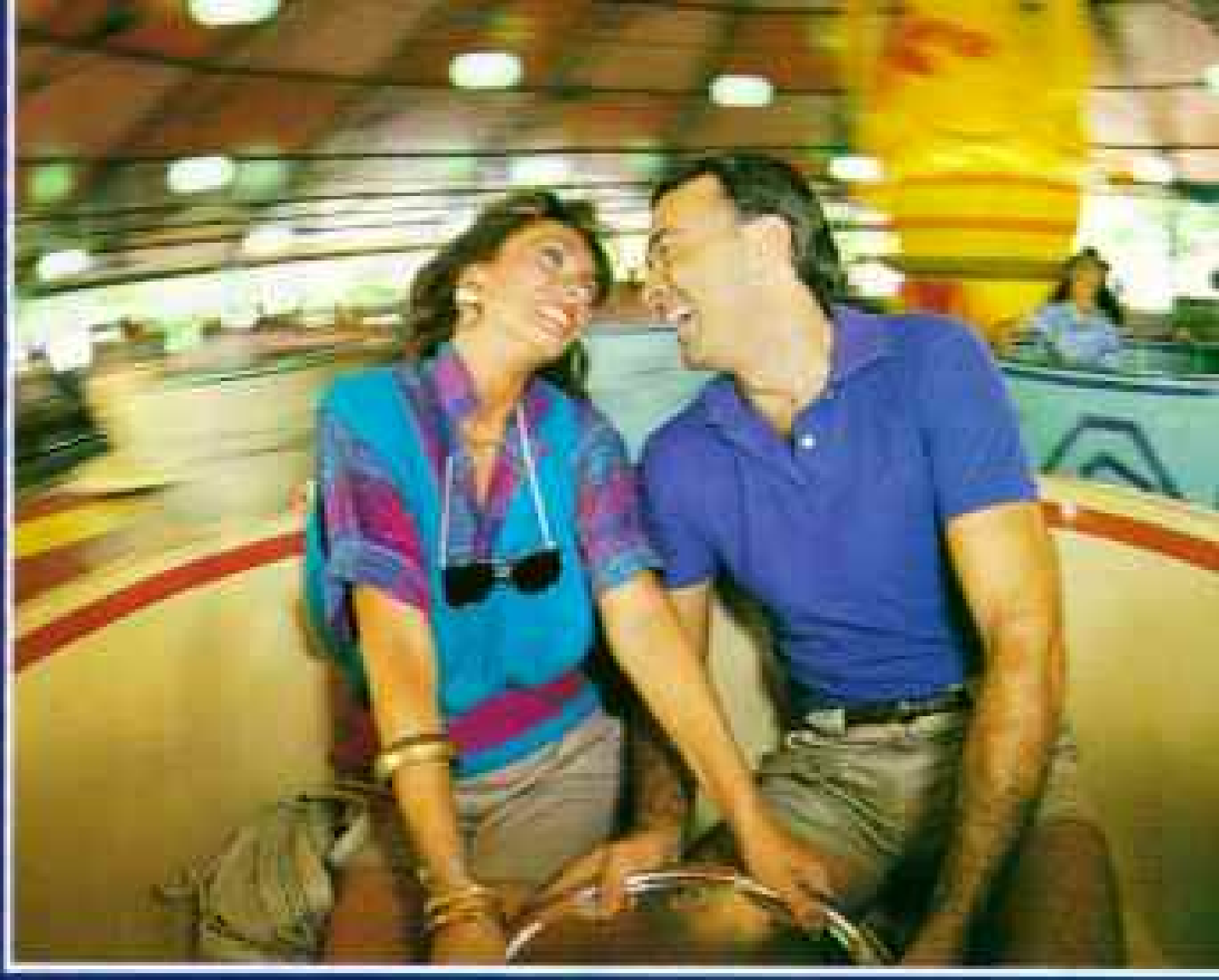
Name:_____

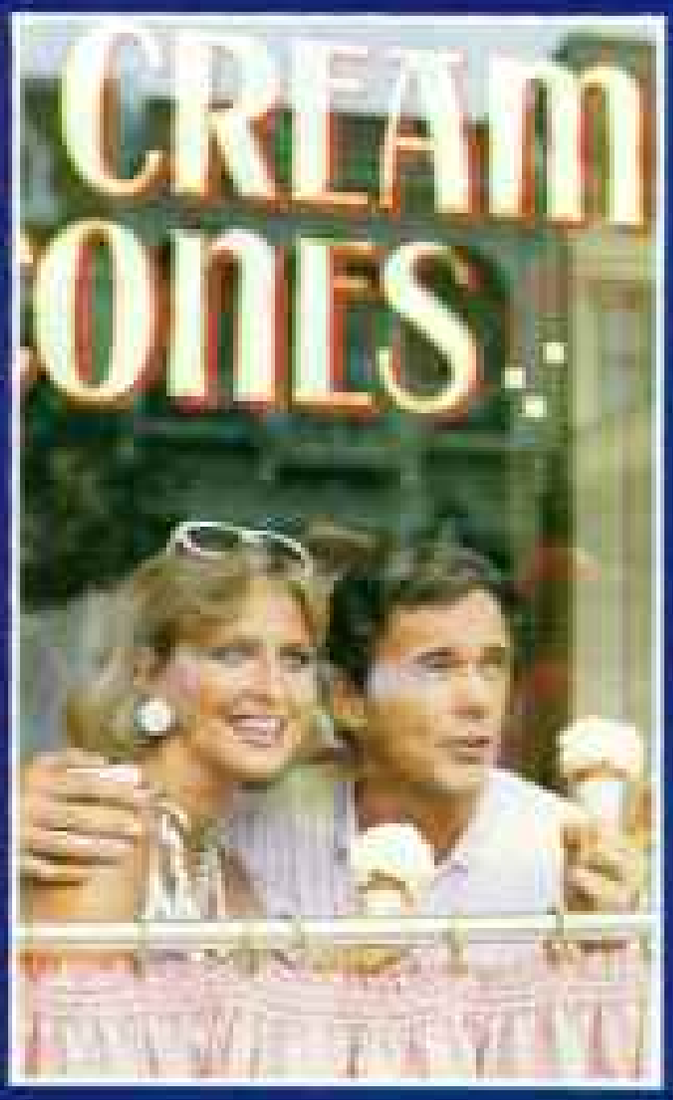
Address:_____

City, State:_____ Zip:_____

Clip and mail to: Premier Cruise Lines, 101 George King Blvd., Port Canaveral, FL 32920
See our 1986 Brochure for details. Certain restrictions apply. NG9

PREMIER CRUISE LINES
The only Cruise and Walt Disney World Week





NOW, IF ONLY THERE WERE SOMETHING FOR THE KIDS TO DO. For the *kids?* The biggest smiles here are often the oldest. And they shine the brightest in a very special place: the Magic Kingdom. In its six themed lands you can do everything from ride a runaway mine train to take a spin in a twirling teacup. Race through the cosmos in Space Mountain. Even sing along with a corner Barbershop Quartet on turn-of-the-century Main Street, U.S.A. It's the most famous kingdom in the world, and it's only one part of the World's Greatest Resort.

THE GREATEST VACATION OF YOUR LIFE CAN BEGIN RIGHT NOW. We'll send you a colorful 26-page brochure, or, if you're ready to go, we'll make your reservations right now. Write Walt Disney World Co., P.O. Box 40RM, Lake Buena Vista, FL 32830

OR CALL TOLL-FREE 1-800-228-3456

For information on holding your meeting or convention at Walt Disney World, please call (305) 828-3200.

Walt Disney World®

SPECIAL ADVERTISING SUPPLEMENT

WITNESS THE RE-CREATION OF THE WORLD.

$233.*

AS LOW AS

4 DAYS, 3 NIGHTS INCLUDING AIRFARE, HOTEL AND CAR.

At the Walt Disney World® Magic Kingdom and Epcot Center, you don't only get Mickey, Minnie, Goofy and the gang for entertainment. You get the world. In loving reproduction. From life-size brontosaurs at the beginning of time to astronauts in space. From a Mayan temple to Morocco's Casbah. And from Main Street, U.S.A. to Peking's Temple of Heaven.

It's a world full of marvels. And here's another phenomenon you'll be amazed at. Our price. For example, an Eastern vacation for 4 days and 3 nights will cost you as little as $233* from Chicago or Columbus, Ohio, $293* from New York or $253* from Kansas City.

And that's for everything. Round-trip discounted airfare in Coach, your hotel, a one-day pass to the Magic Kingdom or Epcot Center and even a car rental†. Our prices for a week are equally out of this world.

So call Eastern Airlines or your Travel Agent. And escape from your workaday world to a world re-created just for the fun of it.

EASTERN

THE OFFICIAL AIRLINE OF WALT DISNEY WORLD®

*Prices require 2 persons traveling together. Effective through 2/6/86. Not valid for travel 11/26–12/2/85 and 12/20/85–1/5/86. Reservations/purchase must be completed by 12/15/85. Prices are per person, double occupancy, subject to availability and may change without notice. Advance purchase, other restrictions apply. Seats are limited. †Rental car is subcompact; meals, taxes, gas, oil, and optional CDW ($7.95 per day) are extra. New York prices range from $293-$368.

GOLD

Gold. The mark of a man. Symbol of his worth. This engraved signet ring of 14 karat gold becomes a prized possession to be handed down from generation to generation. Nothing else feels like real gold.

14 Karat Gold

Krementz

A Jewelry Tradition Since 1866

For the store nearest you write Krementz & Co., 59 Chestnut Street, Newark, N.J. 07101

AT&T's Reach Out℠ America Plan is a lot of talk.

You get an hour of AT&T Long Distance calls for just $9.45.

We can't say enough about our new way to call on AT&T Long Distance Service.

It's different. You pay for your calls by the hour instead of by the mile.

It's economical. You pay just $9.45 for an hour of state-to-state calls.

It's simple. You pay this same rate when you call anywhere in the U.S. served by AT&T Long Distance Service, even Alaska and Hawaii.

And that's a lot of miles for your money. Here's how it works.

The Basic Plan.
A new way to buy long distance.

For just $9.45 a month, you get one hour of AT&T state-to-state, direct-dial long distance calls. Additional hours cost just $8.25.

If you only use part of an additional hour, you'll only be charged for the part you use.

The Basic Plan applies any time Saturday, Sunday till 5pm and every night from 11pm till 8am.

The Bonus Plan.
Get 15% off our already discounted evening rates.

For just $10.85 a month, you can enjoy all the benefits of the Basic Plan plus an additional discount, too.

Enjoy these additional savings Sunday through Friday from 5pm to 11pm when you dial direct, state-to-state, on AT&T.

That means you'll have even more time to take advantage of "Reach Out" America and share all the little things that keep people close.

Select the plan that's right for you. All it takes to enroll is a one-time $10.00 order processing charge.

The "Reach Out" America Plan has a lot to say for it. Sign up and start talking. For more information and to order, call

1 800 551-3131, Ext. 300.

The best service and now an hour of calls for just $9.45. That's AT&T.

Reach out and touch someone.®

Not yet available in all areas.
Certain restrictions apply to residents of Hawaii.

AT&T
The right choice.

Why every kid should have an Apple after school.

Today, there are more Apple® computers in schools than any other computer.

Unfortunately, there are still more kids in schools than Apple computers.

So innocent youngsters (like your own) may have to fend off packs of bully nerds to get some time on a computer.

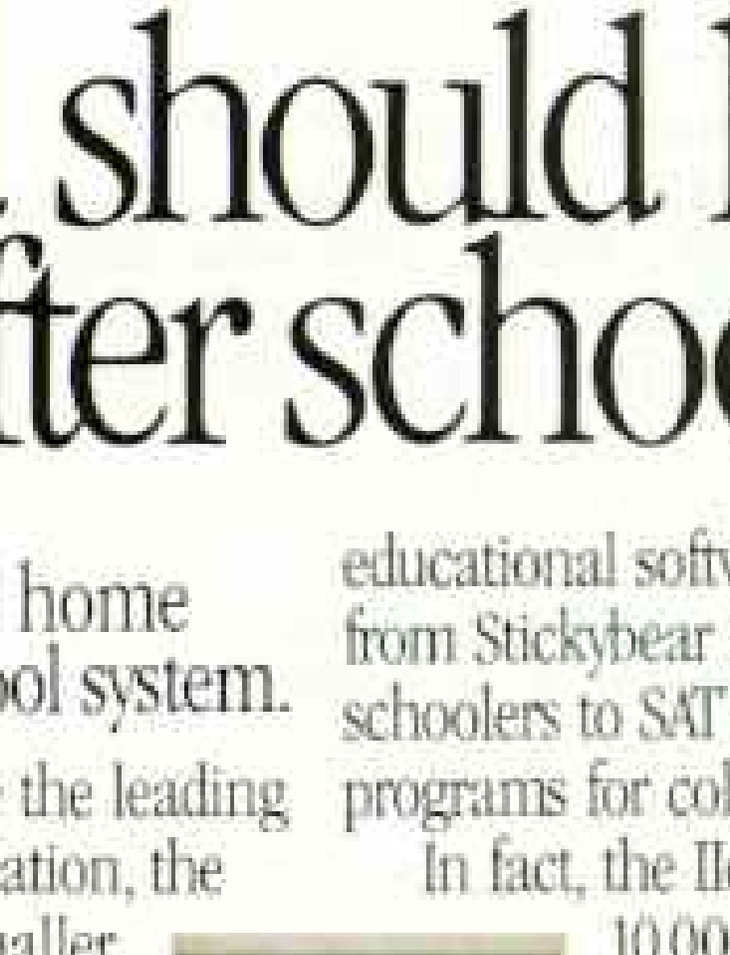
Which is why it makes very good sense to buy them an Apple IIc personal computer of their very own.

Send them home to a good school system.

The IIc is just like the leading computer in education, the Apple IIe. Only smaller. About the size of a three-ring note-book, to be exact.

Of course, since the IIc is the legitimate offspring of the IIe, it can access the world's largest library of educational software. Everything from Stickybear Shapes™ for preschoolers to SAT test preparation programs for college hopefuls.

In fact, the IIc can run over 10,000 programs in all. More than a few of which you might be interested in yourself.



For example, the best-selling, AppleWorks™ 3-in-1 integrated

software package. Personal finance and tax programs. Diet and fitness programs.

Not to mention fun programs for the whole family. Like "Genetic Mapping" and "Enzyme Kinetics."

One Apple that won't leave them hungry.

The Apple IIc is easy to set up and learn. And it comes complete with most everything you need to start computing in one box.

Including a free, easy-to-use 4-diskette course to teach you all about the IIc—when your kids get tired of your questions.

As well as a long list of built-in features that would add about $800 to the cost of a smaller-minded computer. The features include:

128K of internal memory—as powerful as the average

The ImageWriter II prints high quality color graphics.

office computer.

A built-in disk drive that could drive up the price of a less-senior machine considerably.

And built-in adaptors for adding accessories, like our new ColorMonitor IIc, ImageWriter™ II printer and the Apple Personal Modem 300/1200.

A feast for their eyes.

The big 14-inch ColorMonitor IIc displays crisp, color graphics or

The most popular peripherals plug right into the back of the Apple IIc.

a high resolution 80-column monochrome text for word processing.

With our new ImageWriter II, you can take all the color off the screen and put it in print. In

And speaking of high quality color, introducing ColorMonitor IIc.

the form of sharp color graphics. Or near-letter-perfect text, in color or black and white. The ImageWriter II works quickly and quietly. And, with its new SheetFeeder, it will automatically load and unload up to 100 single sheets of paper.*

If local color isn't enough, you can talk to the rest of the world through our new wall-mounted Apple Personal Modem 300/1200. With it, you can do your banking at home, check your stocks, gain access to all kinds of information libraries and much more.

Which would all add up to a very impressive list of expandable accessories if it weren't for all the others. Like an AppleMouse. And an extra disk drive when the time comes.

Avoid growing pains.

So while your children's shoe sizes and appetites continue to grow at an alarming rate, there's one thing you know can keep up with them. Their Apple IIc.

To learn more about it, visit any authorized Apple dealer. Or talk to your own computer experts.

As soon as they get home from school.

OUR NEW 27-INCH TELEVISIONS WON'T CROWD YOU.

Let's face it, a 19-inch picture can be a little cramped. 25-inch screens offer a little more elbow room. But our new 27-inch* stereo color televisions offer more. The big picture. With more picture from corner to corner, side to side and top to bottom. It's incredibly sharp. With rich, vivid colors. And stereo reception built in. So you'll be able to enjoy all the new stereo television broadcasts. Take a look at our new 27-inch stereo color televisions. The big picture.
Zenith. Smarter than ever.

ZENITH
The Smart Sets

The quality goes in before the name goes on.®

*Diagonal Measurement.
Model SB2737Y, black finish with chrome trim. Hinged, detachable speakers. Simulated picture.

In November on Nickelodeon Cable TV: National Geographic EXPLORER

EACH SUNDAY'S PROGRAMMING IS REPEATED THE FOLLOWING SATURDAY FROM 8 TO 11 P.M. (EST)

Sunday, Nov. 3

• 5:00 OLD SKULL, NEW LOOK
To study the ancient Taung skull, top scientists use modern tools.

• 5:15 CRADLE OF MANKIND
Richard Leakey traces the archaeology of Kenya's Rift Valley, where hunter-gatherers struggle to endure.

• 6:10 KAMOYA KIMEU HONORED
Fossil hunter receives National Geographic Society medal.

• 6:20 THE EDGE OF EARTH AND SKY
Watch the perilous launching of hot-air balloons high in the Venezuelan Andes.

• 7:00 CONQUEST
The Soviet Union and the U. S. race to conquer space.

• 7:45 ALASKA'S BIG BEARS
Enjoy a rare, closeup look at Alaska's brown bears as they hunt, fish, and frolic.

Sunday, Nov. 10

• 5:00 THE AMISH
Hear the Amish speak for themselves in this portrait of a gentle people.

• 5:15 OVER SAND
Stunning sand formations in Algeria form the backdrop to breathtaking rock-climbing.

• 5:40 NIAGARA FALLS
Lasting embodiment of power and beauty, the falls have inspired millions.

• 6:15 AMATEUR NATURALIST
Gerald and Lee Durrell meet rhinos in South Africa's Umfolozi Game Reserve.

• 6:45 ALYESKA—ARCTIC WILDERNESS
See the many faces of northern Alaska as caribou, moose, and golden plovers bow to the changing seasons.

• 7:45 BATE'S CAR
Learn from Harold Bate how to run your car . . . on manure!

Sunday, Nov. 17

• 5:00 THE LAST PLACE IN ENGLAND
Isolated Sennan Cove suffers harsh elements and fierce feuds.

• 5:30 MARSUPIALS DOWN UNDER
Meet Australia's tiny honey possum, the termite-hungry numbat, and the amazing, acrobatic pygmy glider.

• 6:00 SHIVA'S DISCIPLES
Flaming torches adorn a young boy as he dances in Kerala, India, where Shiva, the dancing god, is deeply revered.

• 6:45 WATER—A FRESH LOOK
Walter Sigl swims among piranhas and walks under ice, pursuing his hobby of freshwater filming.

• 7:45 THE LADY AND THE OWL
In Ontario, Canada, join Kate and Larry McKeever, who care for injured owls.

Sunday, Nov. 24

• 5:00 BACKSTAGE AT THE BEAVER POND
Share the challenges of a wildlife filmmaker.

• 5:15 AMATEUR NATURALIST
England's hedgerows are home to many creatures, as Gerald and Lee Durrell discover.

• 5:45 MOROCCO'S RIVER ROSE
Lined with pink laurels, the Oum er Rbia has never before been explored by kayak.

• 6:15 TRIUMPH OF THE NOMADS
Before the Europeans came, Australia's Aboriginals flourished in a harsh world.

• 7:10 BIRTH OF A SHIP
French marine carpenter Yvon Clochet creates a replica of a 19th-century sailing vessel.

• 7:45 CUNA INITIATIVE
Cuna Indians along Panama's northeast coast preserve 5,000 acres of tropical rain forest.

SEE EXPLORER on Sundays:

5 p.m. Eastern
4 p.m. Central
3 p.m. Mountain
5 p.m. Pacific

and Saturdays:

8 p.m. Eastern
7 p.m. Central
6 p.m. Mountain
8 p.m. Pacific

***NOTE:** Some Pacific time zone subscribers receive EXPLORER 2 p.m. Sunday and 5 p.m. Saturday. Consult local listings or call your cable operator for confirmation.*

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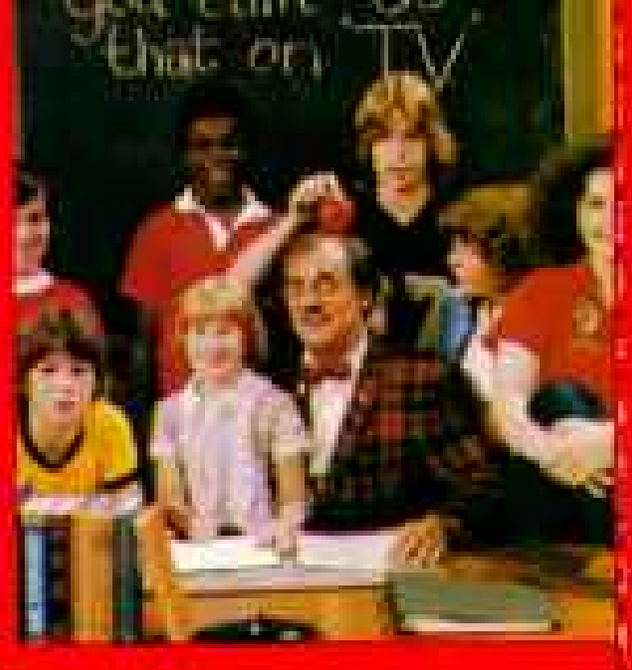


Nickelodeon, America's most respected cable network for children, is now for adults, too! We've enriched our programming with the prestigious National Geographic EXPLORER series. And thanks to the new Nick at Nite, Nickelodeon brings you quality television 24 hours a day.
To get Nickelodeon, call your local cable company.

November on Nickelodeon®!

EASTERN TIME	MONDAY THROUGH FRIDAY
6:00–6:30 AM	Dangermouse/Bananaman ★
6:30–7:00	Nick Rocks
7:00–7:30	Black Beauty ★
7:30–8:00	Lassie
8:00–8:30	The Little Prince/Belle & Sebastian
8:30–9:00	Today's Special
9:00–3:00 PM	Pinwheel ★
2:00–2:30	Today's Special
2:30–3:00	The Little Prince/Belle & Sebastian
3:00–3:30	Black Beauty
3:30–4:00	Lassie
4:00–4:30	You Can't Do That On Television
4:30–5:30	Turkey Television
5:30–6:00	Dennis the Menace
6:00–6:30	Mr. Wizard's World
6:30–7:00	Nick Rocks
7:00–7:30	You Can't Do That On Television
7:30–8:00	Dangermouse/Bananaman

EASTERN TIME	SATURDAY	SUNDAY
6:00–6:30 AM	Dangermouse ★	
6:30–7:00	Nick Rocks	
7:00–7:30	Powerhouse	
7:30–8:00	Kids Writes ★	
8:00–8:30	Out of Control	
8:30–9:00	Belle & Sebastian ★	
9:00–9:30	Star Trek "Animated"	The Little Prince
9:30–10:00	Mr. Wizard's World	
10:00–10:30	Lassie	
10:30–11:00	Dennis the Menace	Turkey Television
11:00–11:30	Nick Rocks	Dangermouse/ Bananaman
11:30–12:00		Star Trek "Animated"
12:00–12:30 PM	You Can't Do That On Television	
12:30–1:00	The Little Prince	Nick Rocks
1:00–1:30	Belle & Sebastian	
1:30–2:00	Lassie	
2:00–4:00	Special Delivery	
4:00–5:00	Standby...Lights! Camera! Action!	
5:00–6:00	Livewire	EXPLORER
6:00–6:30	Out of Control	
6:30–7:00	Star Trek "Animated"	
7:00–7:30	YCDTOTV	
7:30–8:00	Dangermouse/ Bananaman	

Nick at Nite®

	MONDAY THROUGH FRIDAY
8:00–8:30	Dennis the Menace
8:30–9:00	The Donna Reed Show
9:00–11:00	Nick at Nite Movie
11:00–12:00	Turkey Television
12:00–1:00 AM	Route 66
1:00–1:30	Dennis the Menace
1:30–2:00	The Donna Reed Show
2:00–4:00	Nick at Nite Movie
4:00–5:00	Turkey Television
5:00–6:00	Route 66

	SATURDAY	SUNDAY
8:00–8:30	EXPLORER	Dennis the Menace
8:30–9:00		Donna Reed
9:00–11:00		Movie
11:00–12:00	Turkey Television	
12:00–1:00 AM	Route 66	
1:00–1:30	EXPLORER	Dennis the Menace
1:30–2:00		Donna Reed
2:00–4:00		Movie
4:00–5:00	Turkey Television	
5:00–6:00	Route 66	

TORONADO

The category of personal luxury cars is again a category of one. The car that has defined personal luxury for a generation now redefines the category.

The Toronado offers an outstanding ride, with a choice of three suspensions. A revolutionary "body" computer regulates 88 vital functions, from digital instruments to diagnostic checks.

Toronado has been riding the leading edge of automotive technology for 20 years. Inspired aesthetics and engineering is what you have come to expect. This car obeys but one basic rule: never, never be conventional.

There is a special feel in an *Oldsmobile*

GM

Let's get it together... buckle up.

On Assignment

BEING LOCKED IN ROCK for one to two million years might seem the ultimate in stability. Yet now the Taung child could not move so much as 1/1000 of a millimeter—1/25,000 of an inch—if ***Kenneth Haines*** (***right***) was to translate his laser beam into a hologram for this month's cover. Haines, a scientist in optics with the eye of an artist, had made the eagle hologram for our historic March 1984 cover.

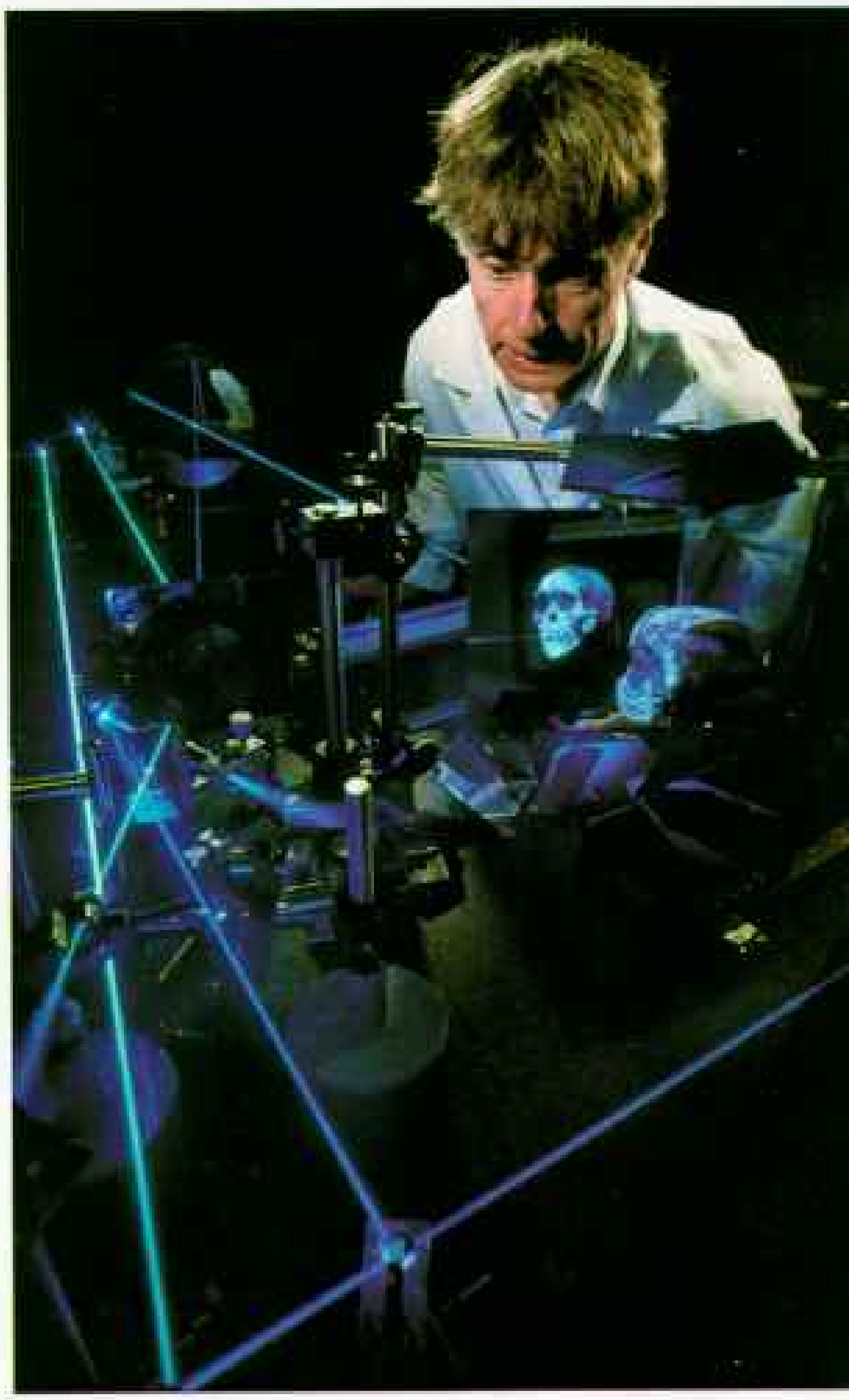
This time, however, Haines was working not in his own American Bank Note Company laboratory in Elmsford, New York, but half a world away at the National Physical Research Laboratory in Pretoria, South Africa. He was there thanks to ***Phillip V. Tobias*** (***below***), distinguished anatomist and paleoanthropologist at the University of the Witwatersrand. Successor to Raymond Dart, who in 1924 had first recognized the importance of Africa's Taung child to the study of human ancestry, Tobias gave enthusiastic and crucial help.

Haines had thought his work would take three weeks, but he found that the South African laboratory, while fine for laser research, was not well suited to making holograms.

Some of the problems: The laser was in a separate room and had to be beamed into a room not itself light-tight or clean enough. The fossil-mounting structure was not stable enough. (That latter problem alone took four weeks to solve.) The fossil had been protected with coatings that reflected too much light. Then Murphy's Law took over. The laser had to be repaired; then it broke; then another had to be flown in from Haines's laboratory. This all compounded the central problem: The priceless skull could not be altered in any way, or even handled, in making the hologram.

Meanwhile, photographer Jonathan Blair was recording the work for the magazine and producing a documentary film of the event.

With the continual all-day and half-the-night help of machinist and laser scientist Cornelis Van der Hoeven, "who was invaluable to me," Haines pressed on for six weeks to make what he considered an acceptable hologram. "Perhaps we were being a little too picky, but I don't think so," he says.



PHOTOGRAPHS BY JONATHAN BLAIR (TOP) AND DAVID BRILL

Whirlpool TimeMaster microwave ovens. Delicious meals made quick and easy.

These days, you're probably finding less and less time to prepare delicious meals. That's why Whirlpool® TimeMaster™ microwave ovens are designed to save you time, and cook beautifully and easily.

Quick Defrost gets meals ready faster than before.

Our Quick Defrost works 40% faster than any other defrost cycle we've ever offered. So a meal that took ten minutes to thaw now takes only six.

A Keep Warm setting that doesn't need a probe.

Our new line of full-sized Whirlpool TimeMaster microwave ovens offers you a Keep Warm setting that keeps your meal ready-to-eat until you're ready to eat it—without a temperature probe. Even dishes cooked in your oven or on your range can be kept warm with this convenient feature.

Cycle changing without starting over.

With these new Whirlpool microwave ovens you can change cooking power, defrosting or cooking time, and even add cooking cycles if you want, without having to start from square one.

Our microwave ovens also have sealed, Spillguard™ interiors for keeping spills inside. They have solid-state touch controls for quick and easy operation. And our Balanced-Wave cooking system helps you cook meals evenly, without having to constantly rotate the food.

The new full-size microwave ovens are an exciting addition to the wide range of Whirlpool TimeMaster microwave ovens that also includes compact and subcompact models.

A promise of quality that we stand behind.

Every Whirlpool appliance is backed by our promise of good, honest quality. It's a promise that we're proud of, and we support it with helpful programs that include our toll-free, 24-hour Cool-Line® service.* To us, it's just another way we can save you some time... and make your world a little easier.

*Call 800-253-1301. In Alaska and Hawaii, 800-253-1121. In Michigan, 800-632-2243.

Whirlpool Home Appliances

Making your world a little easier.