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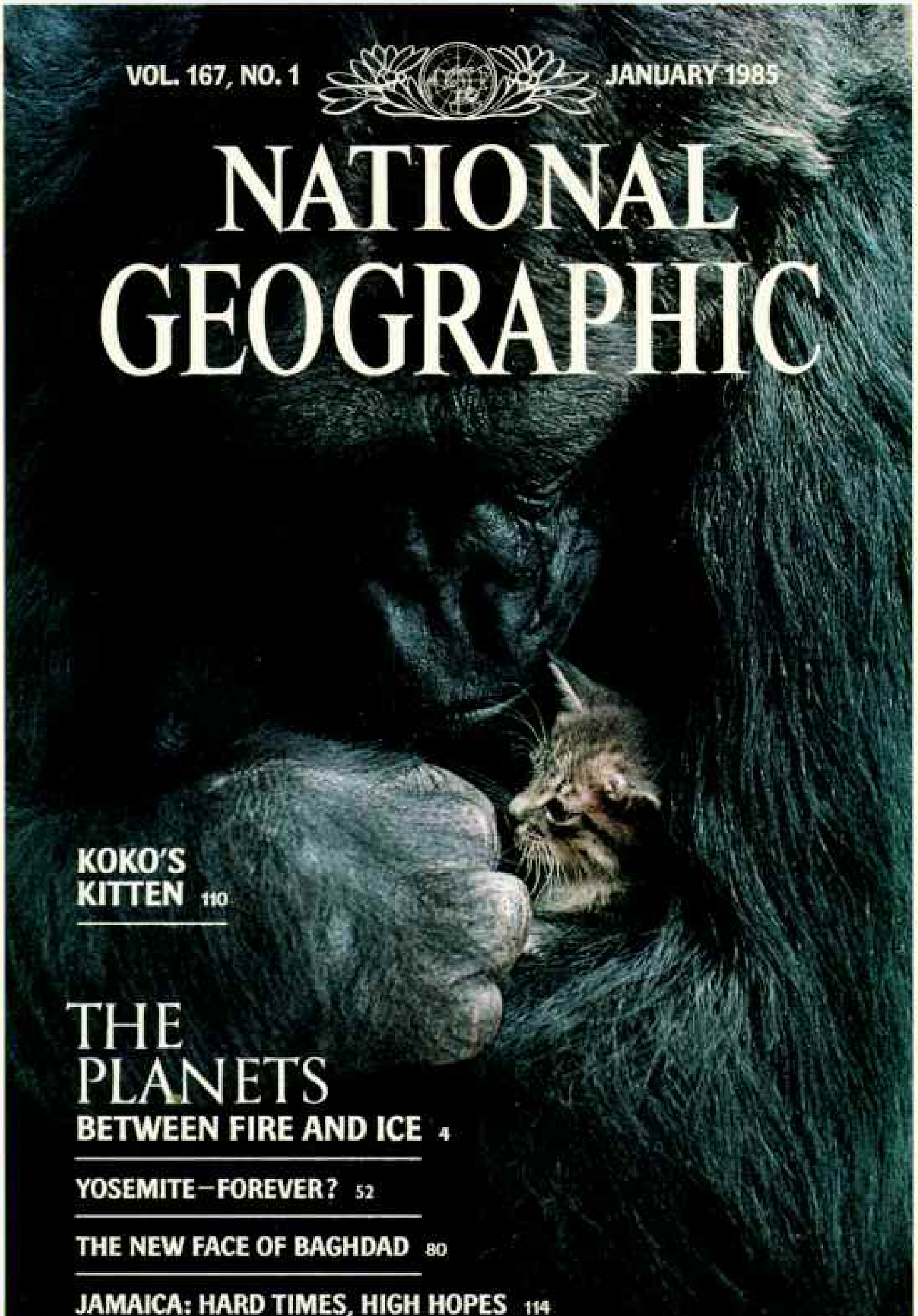

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The Planets: Between Fire and Ice 4

From Mercury to Pluto, planetary exploration is adding new knowledge about the origins and possible future of our solar system. Rick Gore profiles our neighbors in space, marveling that life on Earth thrives in such a narrow niche between unlivable extremes.

Yosemite—Forever? 52

Can being loved too much cause insurmountable problems? David S. Boyer and Jonathan Blair present the wonders and woes of Yosemite, the attempts to preserve its beauty while making the park available to all.

The New Face of Baghdad 80

In Iraq's booming capital William S. Ellis and Steve McCurry discover that the nation's devastating five-year-old war with Iran is out of sight and seemingly out of mind.

Koko's Kitten 110

Using sign language, Koko the gorilla asked for a cat. Jane Vessels and photographer Ronald H. Cohn portray the 230-pound great ape's gentle reactions to her gift.

Jamaica: Hard Times, High Hopes 114

Long plagued by economic woes and political upheaval, the island nation is attempting a comeback, attracting much-needed dollars with programs for new exports and a revitalized tourist industry. Charles E. Cobb, Jr., and David Burnett report.

COVER: *Koko the gorilla snuggles with her new companion, a kitten she calls All Ball. Photograph by Ronald H. Cohn.*

THE NATIONAL GEOGRAPHIC MAGAZINE
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Bronze Age shipwreck ...

LAST SUMMER Dr. George Bass (*below*) telephoned from Turkey to tell me that he had been working on the most fantastic discovery in his 25 years as an underwater archaeologist. As it happened, it was some 150 feet below the surface of the Mediterranean—down in that cold "wine dark sea" where it is hard enough to survive, let alone direct a full-scale scientific study.

WILLIAM R. CURTSINGER

George's report on a 3,400-year-old shipwreck gave me that eerie feeling that comes to all of us occasionally, that I've already lived through this and know what's coming next. But this was no trick of the brain. Exactly 25 years ago the National Geographic Society was considering joint sponsorship with the University of Pennsylvania Museum of an expedition to study a wreck site. I was the picture editor assigned to the project.

On January 7, 1960, Dr. Froelich Rainey, director of the museum, wrote to Dr. Melvin Payne, then vice president of the Society and member of its Committee for Research and Exploration.

"The Bronze Age wreck at Anadolu Burnu is many centuries older than any wreck so far found. It appears to be well preserved, and is of great significance to classical archaeology. But even more important is the organization of systematic undersea archaeology by a team of

... the oldest and most valuable ever excavated

archaeologists and divers which may well open up a whole new field of archaeology. . . . The archaeological work will be under the direction of Mr. Bass of this museum."

Last year George once again went to Turkish waters—with his 16th Society research grant—and, as 25 years ago, was reporting that he had indeed found and studied a Bronze Age wreck and that it was of great significance—even more than that first site a quarter of a century ago. But this time he went not as a student but as the man who had fulfilled Dr. Rainey's prediction by pioneering a new field of archaeology. As founder of the Institute of Nautical Archaeology at Texas A & M University, he is recognized today as a world leader in marine archaeology.

A research project supported in part by your Society

Until that first excavation the seafloor—by far the richest repository of undisturbed historical sites on earth—was mainly the domain of adventurers and treasure seekers. Some 150 nations now have laws protecting such sites in their waters.

As he has done on every one of his major projects in the intervening 25 years, George Bass will bring us the full report of his discoveries when the study is completed. In the accompanying pictures and words he gives us his first impressions, based on last summer's work on perhaps the most important ancient shipwreck ever excavated.

Wilbur E. Garrett

EDITOR

ALL BY WILLIAM R. CURTSINGER

in the Mediterranean

By GEORGE F. BASS

WITH A GLEAM undimmed by some 34 centuries of immersion, a gold goblet (***below left***), part of a spectacular array of artifacts discovered in a Bronze Age shipwreck, comes to light off a cape of southern Turkey near the town of Kaş.

Our Institute of Nautical Archaeology (INA) team can get as excited about gold as anyone—indeed, in this same sandy gully 150 feet underwater we found gold jewelry and pieces of ivory, as well as beads of amber and faience. Yet the piece next to the goblet, a two-handled Mycenaean pottery cup, proved just as valuable, since it helped date our wreck to the 14th century B.C. or possibly even earlier.

In 1982 Dr. Donald A. Frey, INA president, learned of the wreck from the report of a young Turkish sponge diver, who said it contained many objects resembling "biscuits with ears." These were more clues to our ship's age, four-handled copper ingots such as one borne by Tufan Turanli (***below right***), captain of our research vessel, *Virazon*. The ingot is remarkably similar to one depicted in a tomb at Thebes (***below***) dating from about 1350 B.C. So far we have found about 150 copper ingots and some of tin—the raw materials for bronze tools and weapons.

Remarkably, our wreck bears work from three cultures. A colleague, Robin C. M. Piercy, grasps a Canaanite amphora (***left***). Mycenaean Greek ware was found, and other pottery in the foreground, mostly Cypriot, was stacked inside a huge storage jar. Nearby, a tremendous discovery came when we raised a stone anchor and revealed part of the vessel's keel and planking. Although only partially uncovered in 1984, these bones of the wreck push back our knowledge of Mediterranean shipbuilding by nearly a millennium.

Twenty-five years ago, some 45 miles east along this same coast at Cape Gelidonya, I excavated another Bronze Age wreck, an archaeological sensation at the time.* Yet only splinters of its hull remained. It held just 34 copper ingots, and its cargo was pedestrian compared with the rich manifest we are now uncovering.

These things traveled with someone of substance. As we learn more of those ancient sailors whose final voyage ended on the rocks of the Turkish coast, I look forward to sharing our insights with Society members, who have generously helped support our work. □

*In May 1960 and May 1962, Peter Throckmorton described in the GEOGRAPHIC the discovery and exploration of this Bronze Age wreck.

BETWEEN FIRE AND ICE
THE PLANETS

Two decades of planetary exploration have brought stunning surprises – from the discovery of Pluto's moon to huge volcanoes on Venus – that, like Galileo's discovery of Jupiter's moons, fill us with "no small rapture." In a time exposure of the revolving sky, Hawaii's Mauna Kea observatories stand between Mauna Loa's volcanic glow and Jupiter's streaking light, bolder than the star paths.

By RICK GORE
NATIONAL GEOGRAPHIC
SENIOR WRITER

DALE P. CRUIKSHANK

ON JUNE 11, 1983, at 9:53 a.m. a distant siren could be heard in the village of Patuk on Java. Moments later, Asmo Wiyono began to strike the *kentongan*, the hand-carved, wooden chime-like alarm that hangs near his thatch home. Usually the kentongan warns villagers of thieves or erupting volcanoes. This day it signaled the onset of the *gerhana matahari*—Java's first total eclipse of the sun in a century.

This is my first total eclipse as well. I have come to Java for the poetry and symbolism this most basic of solar system phenomena promises. It will also inaugurate a mission.

For years, as a journalist, I have been reporting on our exploration of the planets. Over the past two decades we, the human race, have landed our machines on the moon, Mars, and Venus. We have braved

Image of a heavenly body shrinks in her hands as a Javanese girl

the violent electromagnetic aura around Jupiter and photographed its puzzling moons. We have flown with awesome precision through the rings of Saturn and sent a spacecraft out toward the boundaries of our sun's domain. Our Pioneers and Vikings and Voyagers have probed and sampled and analyzed. Now I am struggling to synthesize what we have learned.

Yet that high-tech universe seems so far away this morning as I sip tea in Asmo Wiyono's home and watch a pinhole in his thatch roof cast a crescent image of the disappearing sun on his granddaughter's face.

"My grandmother and my father have told me this story of eclipses," Wiyono says. "They are caused by Betara Kala, an ugly, giant son of god who was thrown out of heaven. He is trying to eat the sun in his vengeful anger. I know this is not modern thinking. But we think if we make enough noise, we can scare the giant away."

It takes an hour and a half for Betara Kala to eat the sun. As totality approaches, the women in Wiyono's family begin to sing. With broomlike pestles they noisily beat their canoe-size *lesung*, or rice mortar. Torches are lit and the clatter of kentongans resounds across the countryside.

An eerie dusk descends, and for five minutes the moon's disk creates a phantasmagoric black hole in the sky. Radiant silver-white flares shoot out from the darkened sun. Venus and Mars both emerge in this untimely evening. A mild earthquake sets the ground atremble, and I am tempted briefly to believe in giants.

Totality ends and an abrupt sunrise erases the planets. The noisy ritual in the village ceases. Life wins. I return to the world of science. But for a moment the myths that still live on Java have accented just how far we have come, in much less than one generation, in comprehending the solar system.

DAVID MCNEW

obliquely observes a solar eclipse.

EIGHT MONTHS LATER and an ocean away, I am waiting once again for the sun to emerge. I am standing before dawn at the Hale Pohaku midstation on the flank of the volcano Mauna Kea on Hawaii's Big Island. After sunrise I will visit a complex of telescopes on Mauna Kea's summit. Right now, however, I am mesmerized by a splendid naked-eye viewing of the planets.

Over the past month in the predawn sky our eight sibling planets have assembled in their most compact gathering in a hundred years. I have watched them conjoin and glide past each other, and can now understand why the ancients knew these wanderers were different from the constant stars.

One by one I spot the visible planets.

Faint Mercury, *(Continued on page 16)*

CLOUDS OF GAS AND DUST: THE SOLAR SYSTEM'S CRADLE

IMAGINE yourself a time traveler able to turn back the cosmic clock 4.6 billion years to a time when our solar system was still forming. It is about 10 billion years after the big bang that created the whole of the universe, but new stars are still being born—as they always will. We stand at a vantage point above the orbit of Jupiter, itself seen spinning within its own nebula like a small solar system in this artist's conception (***gatefold, far right***). We are witnessing the awesome miracle of our own rapidly evolving planetary system swirling in vast orbits around our infant sun (***near right***). Far more crowded than it would be later, the system teems with millions of moon-size planetesimals competing for safe orbits amid a maelstrom of gas and dust. Stars of other systems in the Milky Way appear as clusters.

Not much earlier in cosmic time, 10 to 20 million years, our solar system was spawned in a cold, diffuse molecular cloud of gas and dust, deep within a spiral arm of the Milky Way (***from left,*** **1**). Triggered by unknown forces, a portion of the giant cloud began to collapse upon itself **2**. As it collapsed, it took on the shape of a disk, rotating inward to an increasingly hot and dense "protosun" at the center **3**.

Over a period as brief as 100,000 years, dust and ice within this stellar embryo, or nebula, accreted into larger and larger particles **4**, until asteroid-size planetesimals formed. They were constantly colliding with one another, shattering, and then reassembling in ever larger bodies. Thus it was, from this violent chaos, that Earth itself acquired its mass.

Temperature would play an important role in the development of the planets **5**. The warmth of the sun probably kept ice from forming on those bodies in the inner solar system. Thus Mercury, Venus, Earth, and Mars would build up their masses mostly from rock and metals. At Jupiter's orbit and beyond, however, the more abundant ices were accreted along with rocky materials.

Suddenly Jupiter and Saturn reached critical masses that caused them to attract enormous mantles of gas. Jupiter, in its pivotal position of being close enough to the system's center to encounter greater densities of gas and far enough away to take on masses of ice, quickly became the giant of planets.

Increasingly, the gravitational fields of the larger bodies imposed structure and order on the system, clearing lanes and setting up wave patterns. Many scientists believe, however, that early periods of order alternated with times of turbulence (***overleaf***), as material from the death throes of dying stars periodically bombarded the evolving system. Food for the growing planets, this star dust continually enriched the system with new material from distant space.

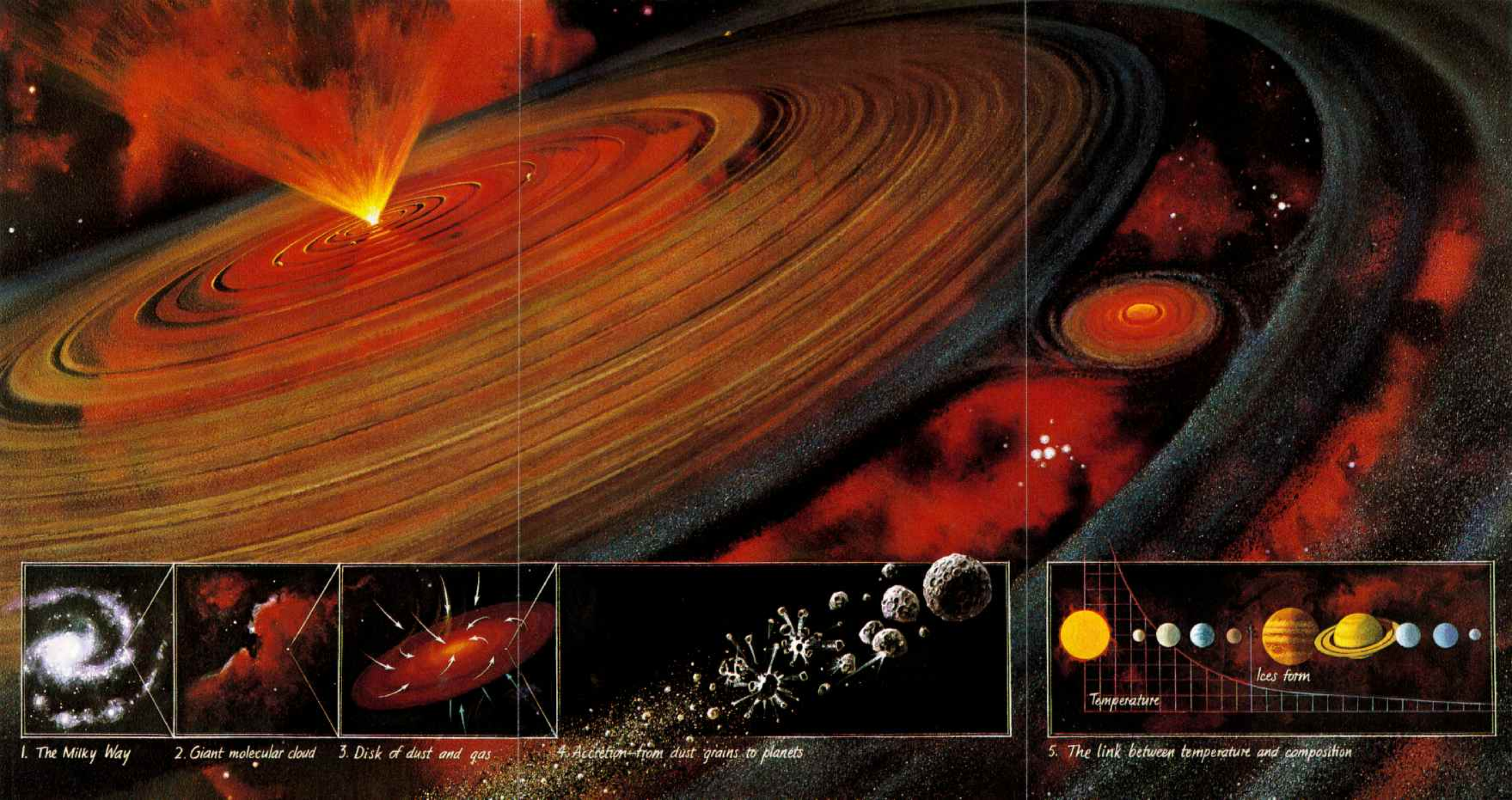
Not all the gas and dust accreted into planets. Most of it swirled inward, where it compacted into the solar core. Eventually, intense pressure raised the core's temperature to a point where it ignited, becoming a vast nuclear furnace—a new star. About the time of ignition, many scientists believe, the sun emitted a tremendous blast of energy, called the T Tauri wind, which blew the solar system's unaccreted gas and dust into interstellar space **6**.

Jupiter's vast size and strong gravitational field caused it to bully the new system in a number of ways and prevented the development of a planet between itself and Mars. Thus the trillions of orbiting chunks of matter that make up the asteroid belt are considered remnants of a "failed planet."

As the solar system began to take on the structure that it retains today, large objects, some even more massive than Earth's moon, were hurled hither and yon in erratic orbits. Slowly, collisions and close encounters cleared the system of such wanderers. Jupiter, again, played an important role. Acting as a gravitational slingshot **7**, it deflected many planetesimals toward the inner solar system, where they had frequent and violent encounters with Earth and its neighbors. This final stage of planetary formation is dramatically recorded in the heavily cratered surfaces of Earth's moon and many other bodies in the mature solar system.

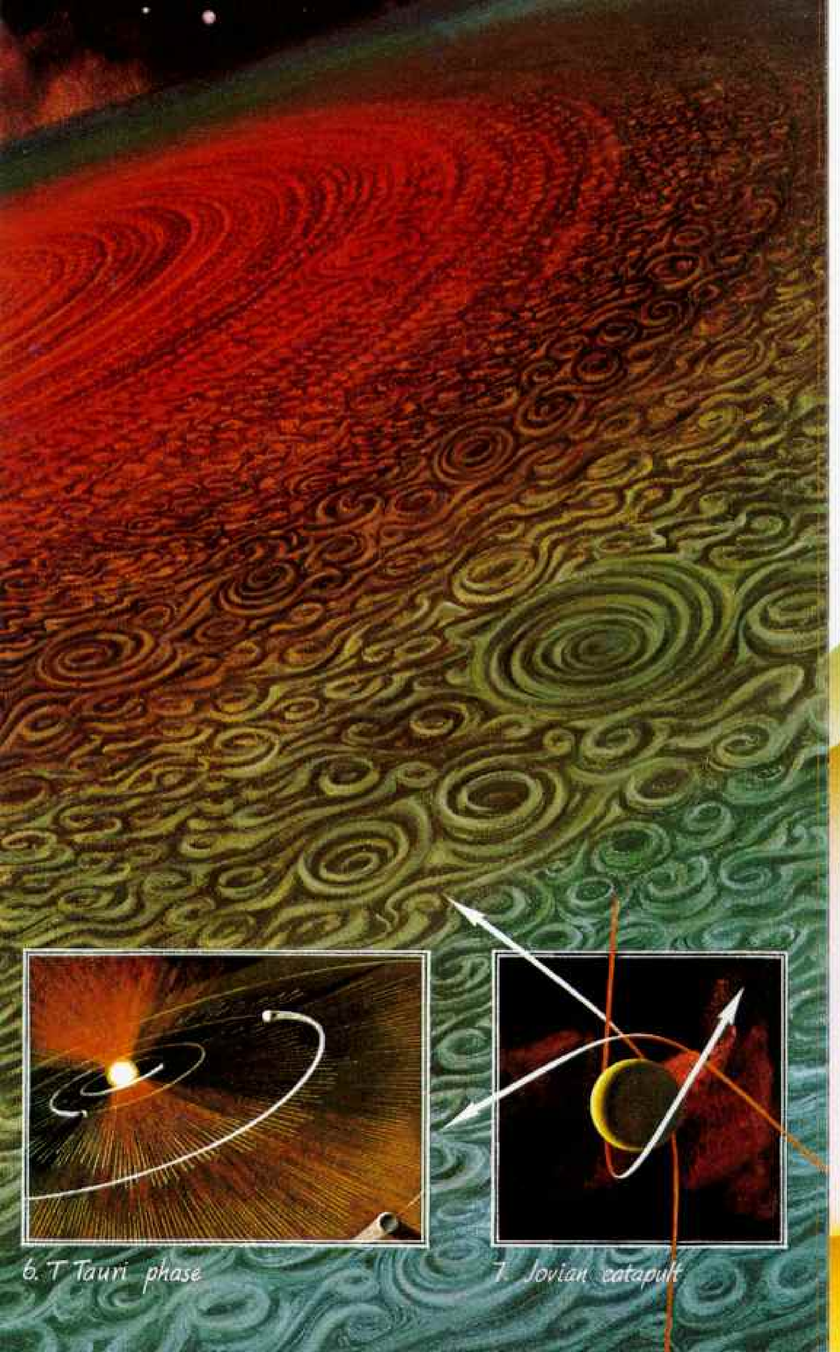
PAINTINGS BY WILLIAM K. BOND, NATIONAL GEOGRAPHIC ARTIST

OPPOSITE PAGES FOLD OUT ▶



1. The Milky Way 2. Giant molecular cloud 3. Disk of dust and gas 4. Accretion—from dust grains to planets

5. The link between temperature and composition



6. T Tauri phase

7. Jovian catapult

THE PLANETS

PLUTO

DISTANCE FROM SUN: 5,900,000,000 km.
REVOLUTION AROUND SUN: 248 years.
ROTATION: 6.4 Earth days. DIAMETER: 3,000 (?) km.
DENSITY: about that of water. MASS: 0.002 x that of Earth. SURFACE TEMP: minus 230°C.

NEPTUNE

DISTANCE FROM SUN: 4,504,000,000 km.
REVOLUTION AROUND SUN: 165 years.
ROTATION: 17.9 hours. DIAMETER: 48,600 km.
DENSITY: 1.6 x that of water. MASS: 17 x that of Earth. TEMP: minus 200°C at cloud tops.

URANUS

DISTANCE FROM SUN: 2,870,000,000 km.
REVOLUTION AROUND SUN: 84 years.
ROTATION: 15.6 (?) hours. DIAMETER: 51,800 km.
DENSITY: 1.2 x that of water. MASS: 15 x that of Earth. TEMP: minus 215°C at cloud tops.

SATURN

DISTANCE FROM SUN: 1,427,000,000 km.
REVOLUTION AROUND SUN: 29.46 years.
ROTATION: 10.7 hours. DIAMETER: 120,600 km.
DENSITY: 0.7 x that of water. MASS: 95 x that of Earth. TEMP: minus 185°C at cloud tops.

JUPITER

DISTANCE FROM SUN: 778,300,000 km.
REVOLUTION AROUND SUN: 11.86 years.
ROTATION: 9.8 hours. DIAMETER: 142,800 km.
DENSITY: 1.3 x that of water. MASS: 318 x that of Earth. TEMP: minus 130°C at cloud tops.

MARS

DISTANCE FROM SUN: 227,900,000 km.
REVOLUTION AROUND SUN: 687 days.
ROTATION: 24.6 hours. DIAMETER: 6,787 km.
DENSITY: 3.9 x that of water. MASS: 0.1 x that of Earth. SURFACE TEMP: variable, averages minus 50°C.

EARTH

DISTANCE FROM SUN: 149,600,000 km.
REVOLUTION AROUND SUN: 365.25 days.
ROTATION: 23.93 hours. DIAMETER: 12,756 km.
DENSITY: 5.5 x that of water. MASS: 6 x 10^{21} metric tons. SURFACE TEMP: variable, averages 15°C.

VENUS

DISTANCE FROM SUN: 108,200,000 km.
REVOLUTION AROUND SUN: 225 days.
ROTATION: 243 days. DIAMETER: 12,100 km.
DENSITY: 5.3 x that of water. MASS: 0.8 x that of Earth. SURFACE TEMP: 470°C.

MERCURY

DISTANCE FROM SUN: 57,900,000 km.
REVOLUTION AROUND SUN: 88 days. ROTATION: 59 days. DIAMETER: 4,878 km. DENSITY: 5.4 x that of water. MASS: 0.055 x that of Earth. SURFACE TEMP: 430°C on day side, minus 170°C on night side.

SUN

PERIOD OF ROTATION: 25 days at equator. MASS: 333,000 x that of Earth. DIAMETER: 1,400,000 km.
TEMP: 15,000,000°C in core, 5500°C at surface.

ICY PLANETS

Far from the heat of the sun, tiny Pluto has temperatures that approach the limits of coldness and may consist entirely of ices. Uranus and Neptune, with cores nearly equal to the closer-in giants, have much smaller accretions of gas. Huge mantles of water, methane, and ammonia probably underlay their dense atmospheres.

GIANT PLANETS

Emitting more energy than they receive from the sun, the gas giants are actually composed of much the same material as the sun. Together they account for more than 90 percent of the solar system's mass not contained by the sun.

ROCKY PLANETS

Enormously diverse atmospheres cover the three large terrestrial planets, while Mercury has virtually none. With widely varying surfaces, shells of silicates overlay inner metallic cores. Alone among the planets, Earth has oceans of liquid water, making 70 percent of its crust inaccessible to view.

THE MOONS

PLUTO

CHARON: *mean distance from Pluto, 19,700 km*

NEPTUNE

TRITON: *left, 355,000 km;* NEREID: *5,562,000 km*

MIRANDA: *130,000 km;* ARIEL: *192,000 km;* UMBRIEL: *267,000 km;* TITANIA: *438,000 km;* OBERON: *587,000 km;*

The seven largest of 17: MIMAS: *185,500 km;* ENCELADUS: *238,000 km;* TETHYS: *294,700 km;* DIONE: *377,400 km;* RHEA: *527,000 km;* TITAN: *1,221,860 km;* IAPETUS: *3,560,800 km*

URANUS

The four largest of 15: IO: *421,600 km;* EUROPA: *670,900 km;* GANYMEDE: *1,070,000 km;* CALLISTO: *1,880,000 km*

PHOBOS: *9,380 km;* DEIMOS: *23,500 km*

EARTH'S MOON: *384,400 km*

SATURN

JUPITER

ASTEROID BELT: *Some as large as small moons, the solar system's asteroids are confined mostly between the orbits of Jupiter and Mars.*

ORBITS OF THE NINE PLANETS *and asteroid belt, at right, represent mean distances from the sun.*

ORBITS

PLUTO
NEPTUNE
URANUS
JUPITER
ASTEROID BELT
MARS
EARTH
VENUS
MERCURY
SUN

THE RINGS

Microcosm of the solar system, Saturn and its rings — here depicted schematically — are yielding a flood of information on celestial dynamics. Though its source is uncertain, the ring material once shrouded the planet as a cloud of wildly orbiting particles. Colliding **1**, *they were all deflected toward Saturn's equatorial plane, forming a disk* **2**. *Beyond a critical point of gravitational force, called the Roche limit, the particles accreted into moons. Within the limit, tidal forces kept the particles from accreting into large objects.*

Other gravitational and collisional interactions shaped and ordered the ring material in exquisite ways. As faster moving inner particles overtook slower outer ones, an exchange of energy, or **angular momentum transfer,** *caused the orbits to widen and the disk to spread* **3**. *Finally, the rings gained structure* **4** *through several mechanisms, all of them subtle consequences of the transfer of angular momentum.*

Alignments between ring particles and outer moons create **resonances.** *If, for example, a particle orbits twice for every orbit of a moon, the two are in a 2:1 resonance (shown schematically as* **A**, **B**, **C**, *and* **D**). *The resultant tugs of gravity, like the well-timed pushes that send a child's swing higher, force the particles into eccentric (noncircular) orbits, where they continue to collide with other particles. These collisions and subsequent gravitational tugs clear out gaps.*

Resonances also trigger two kinds of waves in the rings. **Density waves,** *alternating bands of compressed and expanded ring material, spiral outward from the point of resonance as if along the grooves of a phonograph record.* **Bending waves,** *which intriguingly ripple inward, result when resonant moons pass above and below the ring plane.*

Still other waves detected along the edges of a major gap may be raised by an unseen **moonlet** *orbiting within the gap. Some scientists maintain that such little moons actually clear out multiple gaps in Saturn's rings.*

DIAGRAMS BY ALLEN CARROLL,
NATIONAL GEOGRAPHIC ART DIVISION

1

2

Roche limit

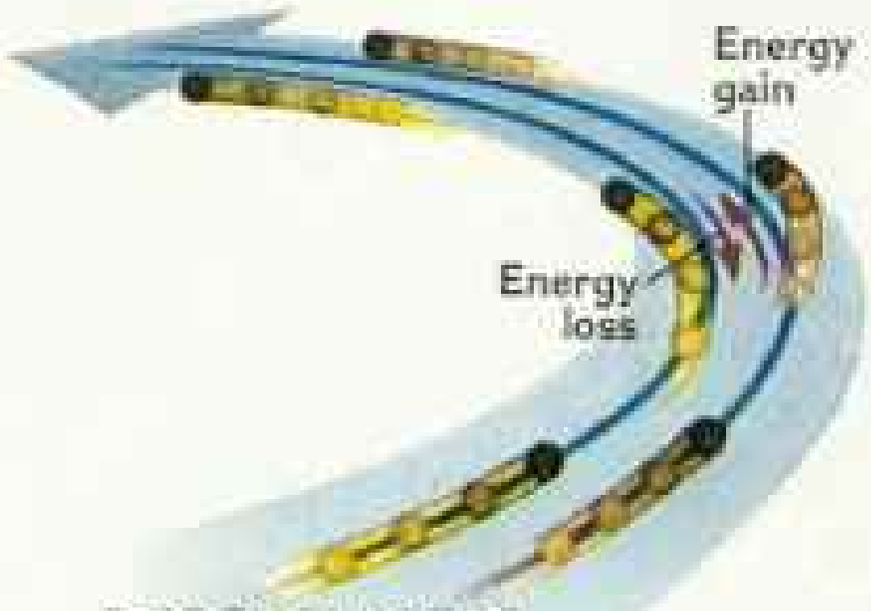
3

Orbiting moon

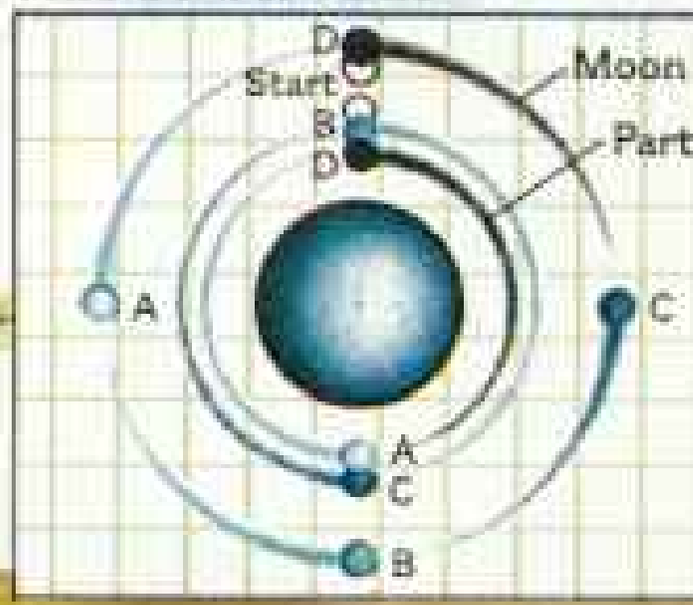
Resonance gap

4

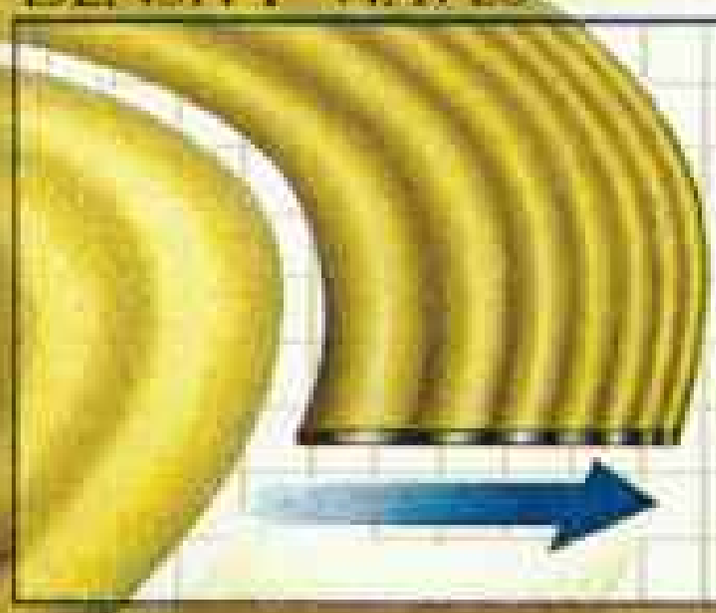
MOMENTUM TRANSFER



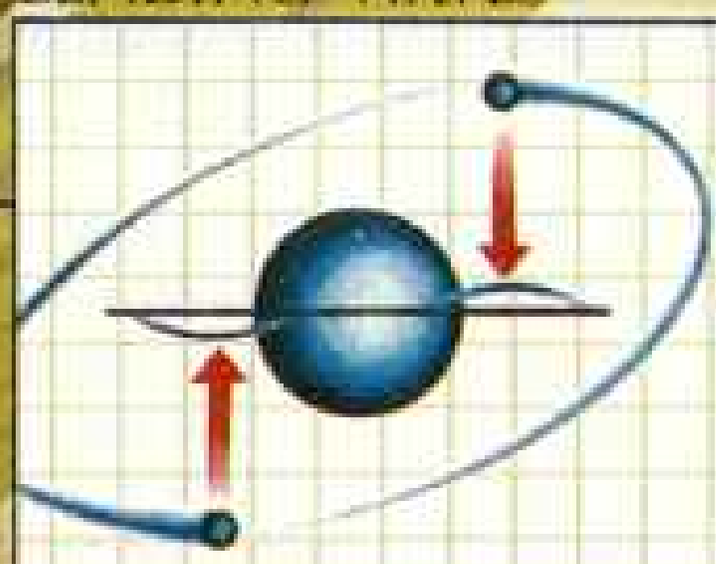
RESONANCES



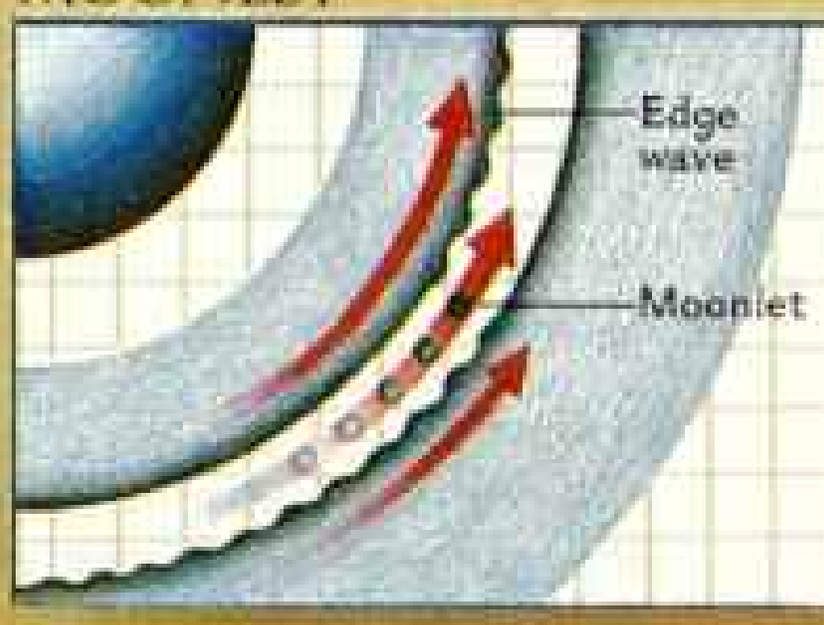
DENSITY WAVES

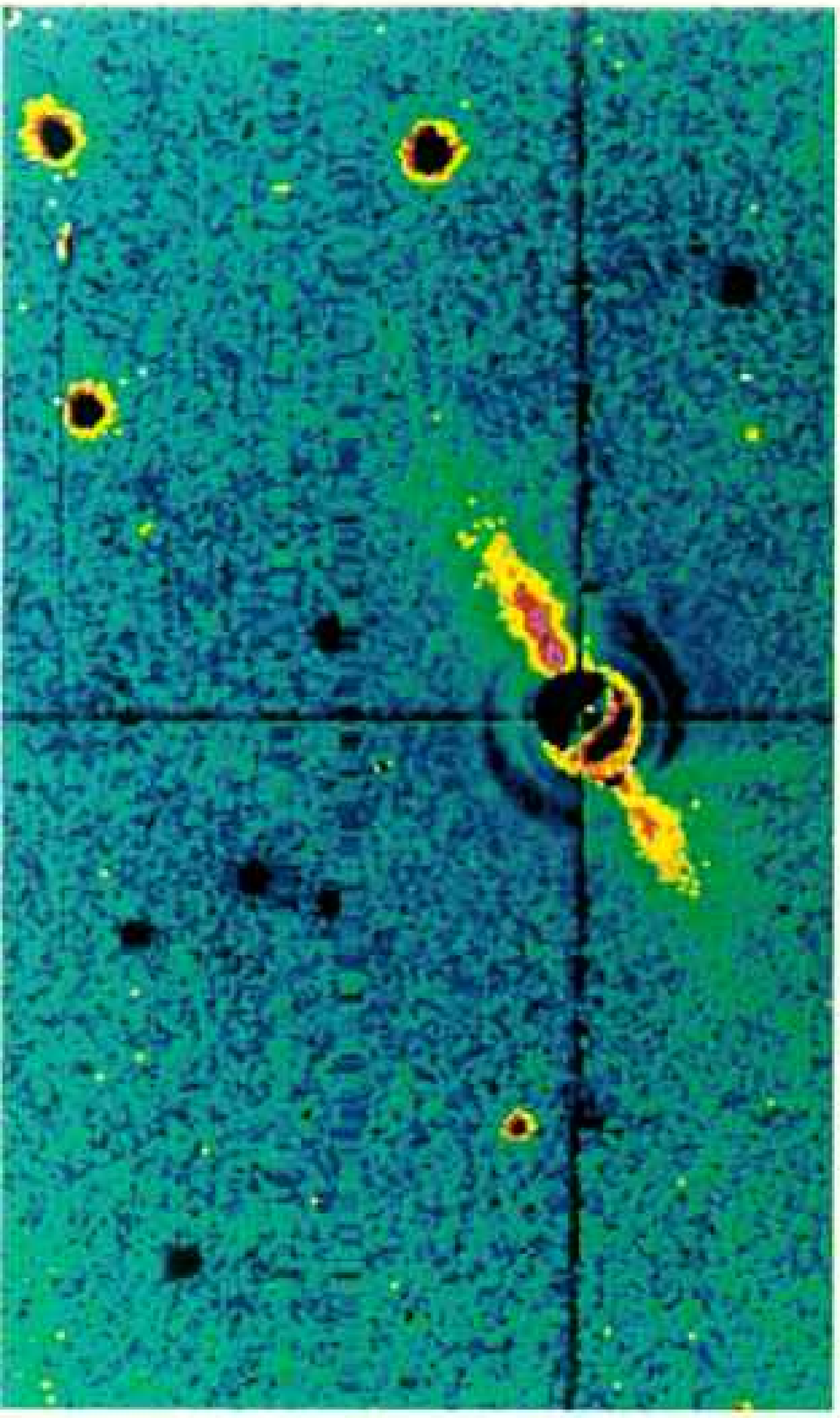


BENDING WAVES



MOONLET





BRADFORD A. SMITH, UNIVERSITY OF ARIZONA, AND RICHARD J. TERRILE, JET PROPULSION LABORATORY

A NEW SOLAR SYSTEM?

FIRST VISUAL EVIDENCE *of a stellar dish outside our own solar system was recorded in April 1984 by astronomers at the Las Campanas Observatory in Chile. Beta Pictoris, a star about twice the size of the sun in the constellation Pictor, is seen within a huge, disk-shaped cloud of matter that may or may not contain planet-size objects. A black dot at the junction of supporting filaments eclipses the star, preventing light from flooding the image and enabling the disk to be seen. Though infrared sensing has detected a cloud of matter around the young star Vega, this may prove to be the first telescope image of an evolving solar system, only 50 light years away.*

(Continued from page 7) we flew but one mission by you. Small, iron-rich, battered by millions of meteorites, you have changed little since the solar system's earliest days. One astronomer has told me you show a face only a confirmed crater counter could love.

How differently scientists regard you, cloud-covered Venus, glimmering above the horizon. We knew you so poorly, sister planet, only a decade ago. Today our knowledge is still rudimentary, but we see you in a new light. We now suspect that oceans, perhaps as extensive as ours, once flowed across your basins. Those oceans have been cooked away by a ferocious heat that makes your surface much hotter than a broiling household oven. What happened, Venus? Why did you turn out so different from us?

And Mars, perpetually frozen, dust-blown, and half Earth's diameter, we know now you were not always so frigid and inhospitable. Rains may have fallen, rivers flowed, and life emerged across your landscapes in your youth. The Viking landers told us you probably no longer harbor life, but we would love to search your rocks for a few diehard lichens or at least their fossils.

Gigantic Jupiter, lord of the planets, we have been rethinking your origin. You were long said to be like a small sun, a great gaseous body, yet without enough mass to ignite as you formed. Certainly hydrogen and helium account for 95 percent of your mass today. But scientists increasingly suspect that you began like Earth, by building a solid core, which then gravitationally grabbed on to gases in the great cloud from which the sun originally formed. Yet, Jupiter, 1,400 Earths could fit within your sphere. Twenty-five Neptunes. More than 100,000 Plutos. Why did you grow so large?

And Saturn, your stunningly complex rings hold clues to the very origin of the planets. For in the solar system's early years, a similar disk orbited the infant sun.

That disk probably evolved from a shell much like the one that has recently been discovered around the young star Vega, also shining brightly in this morning's sky. Vega's shell, found by the Infrared Astronomical Satellite (IRAS), appears to be a cold cloud of dust and probably much larger particles. IRAS could not determine whether planets themselves lurk within the shell.

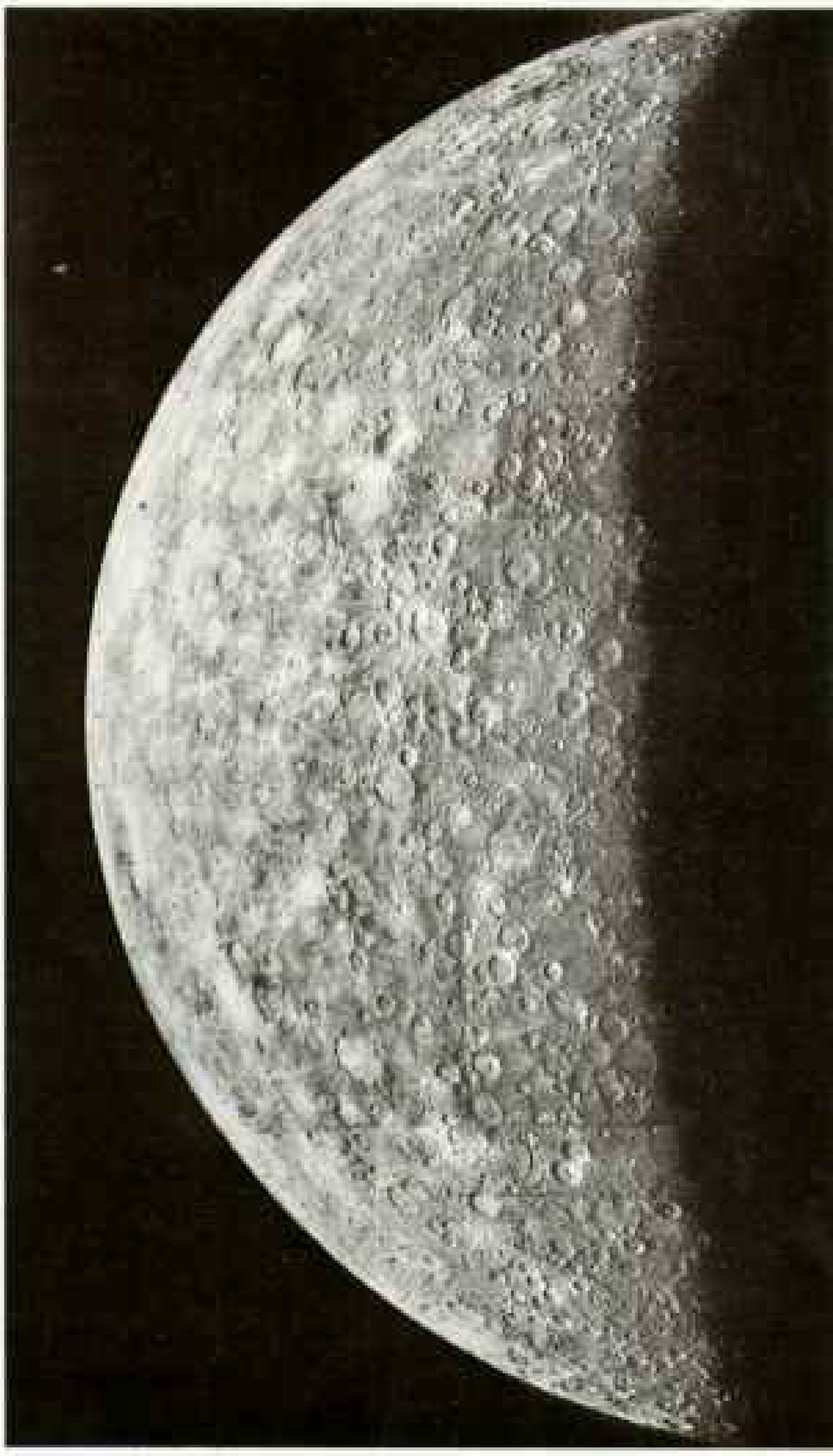
The cloud may simply be a grand-scale asteroid belt of debris left over from Vega's formation. Shells have recently been confirmed around three other young stars. Astronomers Brad Smith of the University of Arizona and Rich Terrile of the Jet Propulsion Laboratory have actually photographed a disk around one of these stars (opposite), a disk they believe contains growing planets.

These evolving stars symbolize fundamental questions for a planet-watcher: How did the solar system begin? What were the steps that then created the hierarchy of worlds around our sun? How did the star dust in the vast dark realm above me evolve into this massive volcano beneath my feet?

AMAZINGLY, we have samples of the original star dust from which our solar system was made. Microscopic packets of it were trapped within meteorites that accreted, or formed, out of the stellar dust shortly after the birth of the solar system some 4.6 billion years ago. Using techniques developed to analyze moon rocks, cosmochemists have examined several of these meteorites that have fallen to earth in recent years. They have found exotic isotopes that may well have been created in a nearby supernova explosion, the violent death throe of another star. These newly forged elements would then have been blasted toward a gathering cosmic cloud that would eventually give birth to our solar system. Planet Earth, suggests cosmochemist Robert Clayton of the University of Chicago, may contain the star dust from ten or twenty vanished solar systems.

As I gaze up at the planets from the flank of Mauna Kea, I find it satisfying to think that this island, this ocean below, even the air I breathe derive from unknown, extinct, and exploded worlds. Perhaps we ourselves are the stuff of future stars.

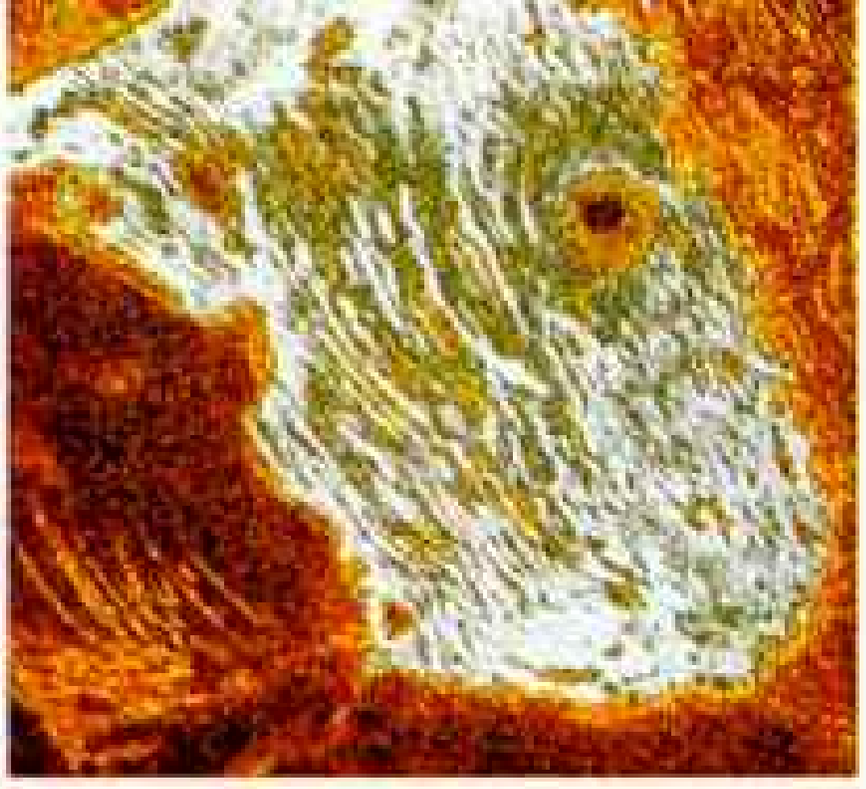
Hawaii's night sky has other reminders of our origins. The belt and the sword of the constellation Orion contain a giant molecular cloud (GMC), a gaseous stellar nursery much like the one that gave birth to us. For unclear reasons, our ancestral GMC fragmented in its youth, as will Orion's, into smaller clouds. Then these stellar embryos gravitationally collapsed into a cluster of infant stars that began moving away from each



NASA

MERCURY

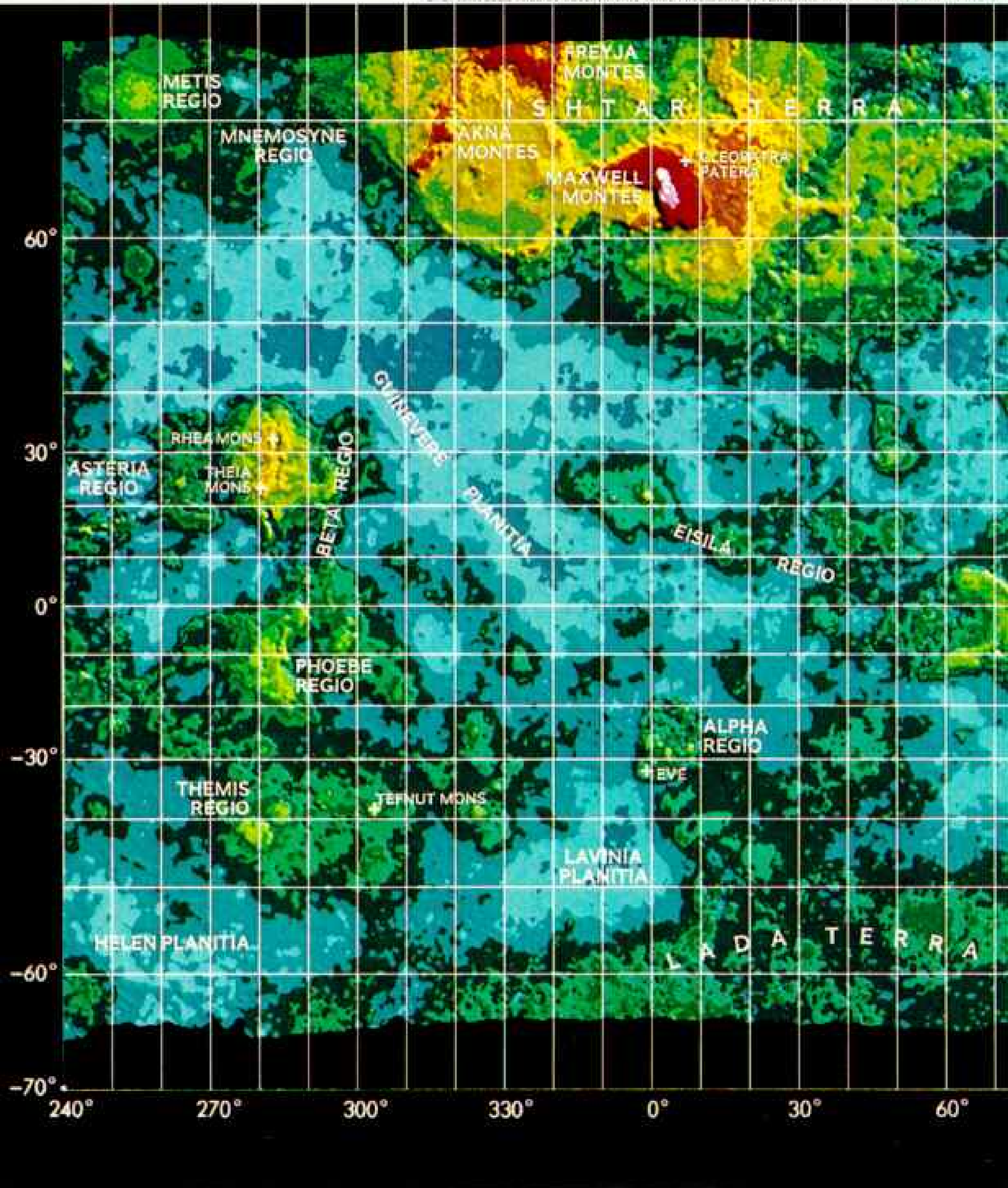
CORPSE OF A PLANET, *small airless Mercury is thought to have once been volcanic, but its millions of impact craters, here seen in a 1974 mosaic of Mariner 10 photographs, betray a geologically moribund state reaching back three billion years or more. The larger craters, which are about 200 kilometers wide, may even date from the very early solar system, when the young planets—Earth included—were still under heavy meteorite bombardment. Geologically active Earth, however, has continued to renew her surface through volcanism and plate tectonics.*



VENUS

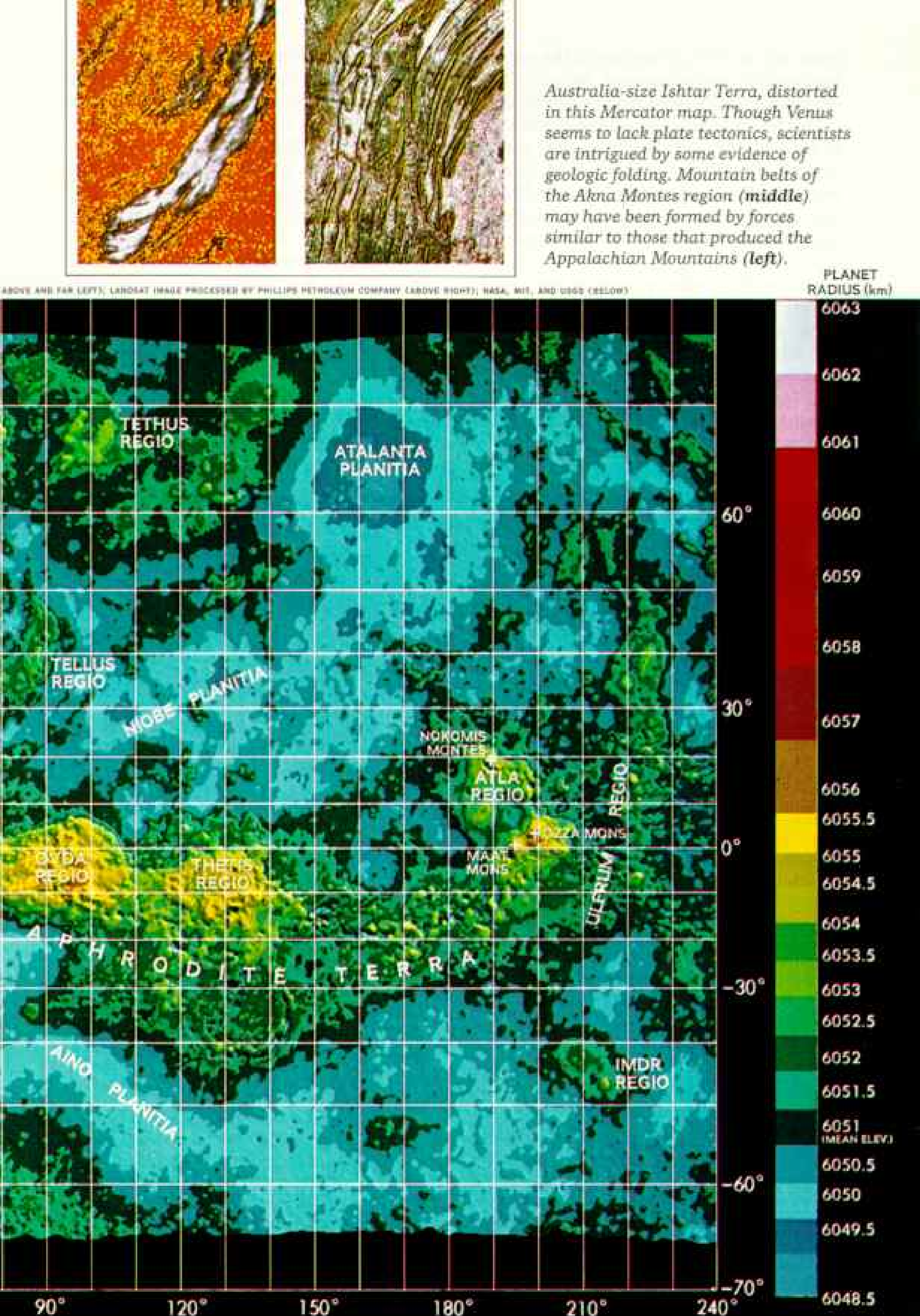
HER VEIL LIFTED *by orbiting radar, Venus bares a face* ***(below)*** *much like, yet unlike, her sister Earth. Perpetually hidden from view by a thick atmosphere, areas of high relief, like equatorial Aphrodite Terra in the east, are surrounded by vast "seas" of remarkably flat, waterless plains. Early detected by Earth-based radar* ***(left)****, the great Maxwell Montes, with a peak higher than Mount Everest, dominate*

D. B. CAMPBELL, ARECIBO OBSERVATORY; IMAGE PROCESSING BY PLANETARY GEOLOGY GROUP, BROWN UNIVERSITY



*Australia-size Ishtar Terra, distorted in this Mercator map. Though Venus seems to lack plate tectonics, scientists are intrigued by some evidence of geologic folding. Mountain belts of the Akna Montes region (**middle**) may have been formed by forces similar to those that produced the Appalachian Mountains (**left**).*

ABOVE AND FAR LEFT: LANDSAT IMAGE PROCESSED BY PHILLIPS PETROLEUM COMPANY (ABOVE RIGHT); NASA, MIT, AND USGS (BELOW)



other and ignited. At one point the sun and our rapidly separating sister stars may have resembled the Pleiades cluster overhead.

Our nebula probably collapsed into a disk of gas and dust spiraling in toward a dense core in the relative eye blink of 100,000 years. As it did, great jets of gas would have shot out. Eddies may have formed throughout the disk; lightning may have sparkled across these stormy regions.

During this collapse most of the cloud's matter swirled in toward the dense core. Some material, however, was left behind and settled into a disk of tiny solid particles orbiting in a hazy veil of gas. They grew like colliding snowballs of stone into trillions of chunks called planetesimals—the building blocks of planets.

As matter continued swirling in, the core grew so dense that gravitational energy heated it to a million degrees and more at the center. At those temperatures the nuclear processes that still fuel our sun could begin. About the time it ignited, it probably ejected a blast of energy called the T Tauri wind, blowing away any gas or star dust that had not yet accreted, or formed planetesimals. For 700,000,000 years planetesimals played gravitational war games, sweeping each other up in an epoch of intense intrasolar-system bombardment and collision.

Earth, like all moons and planets, was struck countless times by other bodies pulled in by its gravitational tugs. When Earth was small, some of these were probably large enough to break our growing planet apart.

V. A. KOTELNIKOV, U.S.S.R. ACADEMY OF SCIENCES

Mettle-testing missions, *several Soviet Venus probes have dropped Venera landers to the surface, where the temperature is hot enough to melt lead and the atmospheric pressure is 100 times that of Earth. The painting* ***(right)*** *depicts Venera 14 in a dense, sulfurous carbon-dioxide atmosphere, which long ago turned Venus into a "greenhouse" gone berserk. Remarkably, the landers functioned long enough to transmit several photographs, like this from Venera 14* ***(above)****. Extending to a camera-distorted horizon are volcanic plates, similar to those on Earth. An enigma hundreds of kilometers across, this corona* ***(left)*** *was detected by Soviet radar and might be the result of large-scale upwelling of magma.*

Each time this happened, Earth reassembled, a bit bigger than before.

Our moon may be a relic of the time when Earth grew big enough to hold its own against the planetesimal assault. Increasingly many scientists suspect that when Earth was only a few tens of millions of years old, an object perhaps as large as Mars struck our accreting planet at more than 35,000 kilometers an hour. The planet survived, although much vapor and molten rock were ejected into space. Some of this ejecta would have coalesced into the moon.

FROM MAUNA KEA my unaided eyes cannot see Uranus, Neptune, or Pluto this morning. They are so far away that even with large telescopes on other mountaintops I have found them unremarkable spots of light. NASA's Infrared Telescope Facility (IRTF) on Mauna Kea has become our primary source of knowledge about these outer bodies, which we are finding riddled with primordial mysteries.

Uranus and Neptune, for instance, have rocky cores about the same size as those in the two gas giants, Jupiter and Saturn. Yet the outer planets are much smaller, only about four times the diameter of Earth. Why did they end up with so much less gas?

Uranus, moreover, is lying on its side, rotating around horizontal rather than vertical poles. Many astronomers suspect that a body the size of Earth once struck the big planet and knocked it askew.

Neptune also shows signs of catastrophe.

COURTESY U.S.S.R. (ABOVE); PAINTING BY JAMES HERVAT (BELOW)

Its moon Triton—about the size of Mercury—is spiraling inward, orbiting in the direction opposite that of our own and most other moons. Eventually Neptune's gravity will tear Triton into a system of ring particles like Saturn's. Did a close encounter with a huge body disturb Triton so? Or was it captured eons ago as it passed too close to Neptune?

And tiny Pluto. It looks more like a moon than a planet. Like Uranus, it is tipped on its side. Some astronomers think it was cast off from Neptune by the same catastrophic encounter that so disturbed Triton. But in 1978 astronomer James Christy of the U. S. Naval Observatory discovered that Pluto itself has a moon, Charon. Astronomers debate whether both could have been cast off together.

Pluto might, suggests Gene Shoemaker of the U. S. Geological Survey (USGS), be a planetesimal that never got incorporated into Neptune. Pluto might have become a comet. But a resonance, or synchronous gravitational relationship, with Neptune keeps Pluto in a highly eccentric orbit far closer to the sun than those of comets. Charon, Shoemaker proposes, is a chunk chipped off by an impact. But the question remains: What is such a little planet doing out there in the domain of giants?

Dale Cruikshank, an astronomer with the University of Hawaii, has spent his career asking such questions. To him the outer solar system is more than a community of oddities. It is a deep freeze where primitive material from the system's early days has been preserved.

After dawn I visit Mauna Kea's telescopes with Cruikshank, who has been finding

EARTH AND MOON

FERTILE CRESCENT *in the lunar sky, the blue planet Earth pulsates with life, while its satellite—unprotected by an atmosphere—is buffeted by solar winds and interplanetary debris. Biologically and geologically alive, Earth is so dynamic a planet that it has taken just 200 million years for its continents to separate from a single landmass and drift to their present positions.*

APOLLO 17 CREW

THE THREE SISTERS

SIMILAR ORIGINS, DIVERGENT HISTORIES...

COMPARABLY ENDOWED with carbon and water, these three terrestrials evolved differently from one another, owing to size and distance from the sun.

Venus, closest to the sun, receives the most solar energy. Early in her history, when the sun shone less brightly than now, she may have had oceans, which would have boiled off as the sun's output increased. Meanwhile, volcanoes were venting carbon dioxide into the atmosphere. Venus lacked the water to return carbon to the crust as carbonate rock, and CO_2 levels rose unchecked. This created a greenhouse, allowing solar energy to penetrate the atmosphere but blocking the escape of heat as infrared radiation. Temperatures on Venus are now too hot to support even primitive life.

Earth is far enough from the sun to retain water, and it recycles its carbon through plate tectonics. The prolonged presence of water enabled marine organisms to evolve, and they now serve as a means of removing CO_2 from the atmosphere. Plate tectonics, with its associated volcanism, continuously returns CO_2 to the atmosphere. Thus in equilibrium, Earth's climate is moderate.

Mars, too, probably once had a moderate climate and liquid surface water, but it is smaller than Earth and tectonically less active. The result: CO_2 was removed from the atmosphere but not returned to it. Thus the greenhouse weakened, water froze, and Mars was left high and dry.

patches of some unknown dark red material on Pluto's frozen methane surface. With colleagues he has proposed that Neptune's huge moon Triton is covered with an ocean of liquid nitrogen, interspersed with continents of methane and possibly water ice.

Cruikshank sees these bizarre realms as the frontier, where spacecraft have yet to spoil things for telescope astronomers: "I can't think of much left to do on Mars with a telescope. Mariner and Viking have given it to the geologists and the meteorologists. We have almost as much weather data now for Mars as we do for Bemidji, Minnesota."

The telescopes Cruikshank uses at Mauna Kea measure infrared radiation (IR)—invisible wavelengths of reflected sunlight or the scant heat that emanates from distant bodies. Astronomers can use IR readings to calculate such things as an object's size, chemical composition, and rotation rate.

"There've been a lot of thrills standing up on this mountaintop," says Cruikshank as we walk around the base of the 14-meter-high (47-foot) IRTF telescope. "There's nothing quite like being up here freezing in the pitch black as your data come in, knowing you are measuring those little chunks out there for the first time. Think of it! We can now measure the heat glow coming off something two billion miles away that is itself colder than liquid nitrogen. That is 320 degrees below zero Fahrenheit!"

What does the discovery that Triton has a nitrogen ocean or that Pluto is mottled with frozen methane and some mysterious red substance tell us about our origins? To Cruikshank each bit of new knowledge helps verify the idea that temperature has shaped the planets since the beginning.

Presumably the nebula around the young sun contained all the chemical elements, from aluminum to zirconium. But near the sun, temperatures were so hot that not even heat-resistant titanium, which becomes a gas only at several thousand degrees, could exist as a solid. Farther out, as temperatures cooled, the heavy metals could begin condensing out of the cloud as solids. Hence, close-in Mercury grew into a high-temperature alloy, rich in iron. Near

...A COMMON FATE?

VAST DUST STORMS occasionally obscure the face of Mars, altering its surface and atmospheric temperatures (**below**). This gave a group of planetary scientists one of their first clues that a "nuclear winter" would likely follow a full-scale nuclear war on Earth. Earth's atmosphere acts not only as a window for sunlight but as a blanket for heat. Unlike carbon dioxide, which thickens the blanket and creates a warming greenhouse, dust and soot thrown into the atmosphere serve to close the window, blocking solar energy from reaching the surface below. According to a study, a 5,000-megaton exchange would send millions of tons of smoke and dust aloft to altitudes where it would last for weeks or months. The results could be worse than the immediate effects of the nuclear blasts, as subfreezing darkness would grip much of the planet, stressing human life to perhaps the brink of extinction.

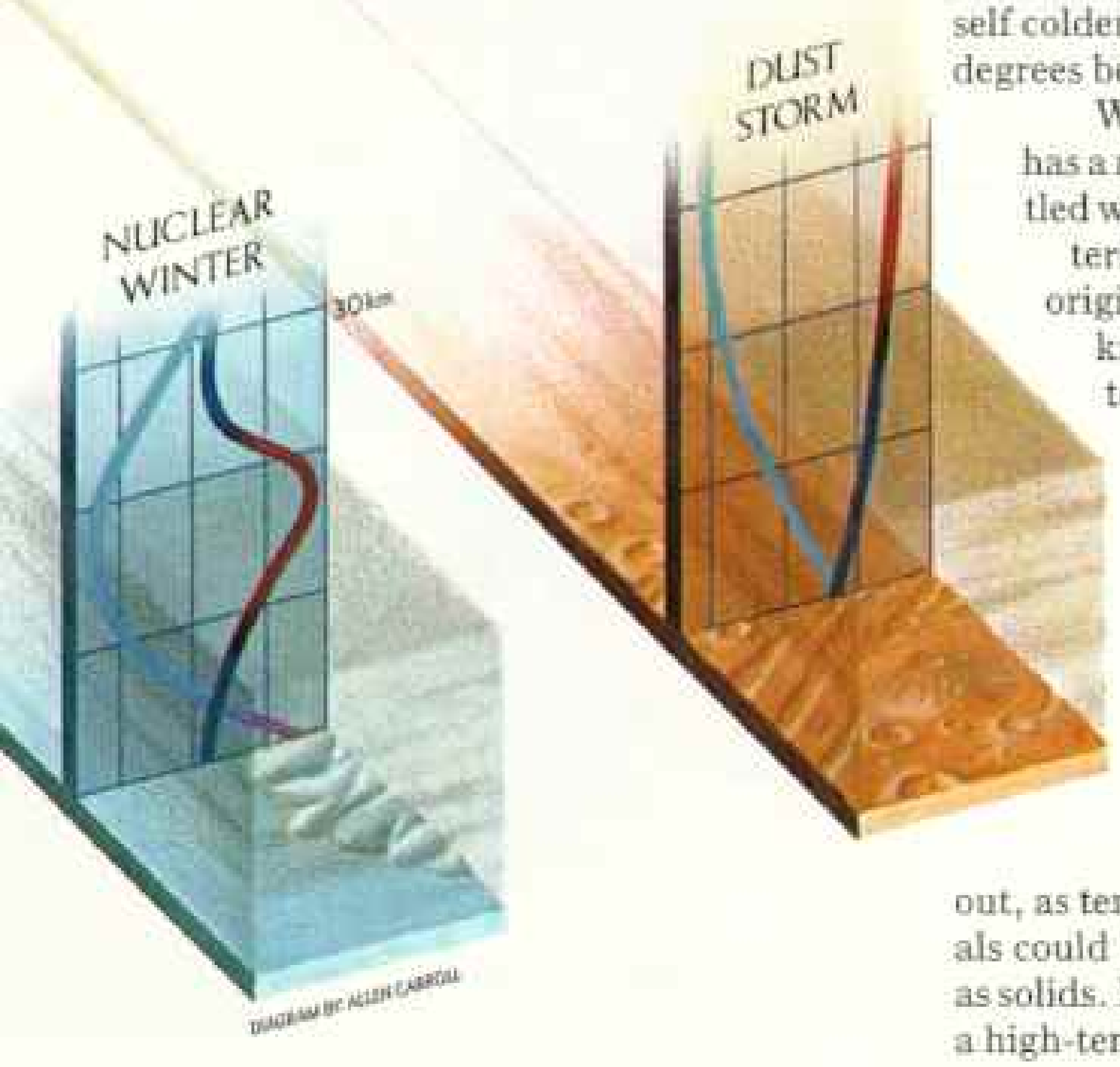
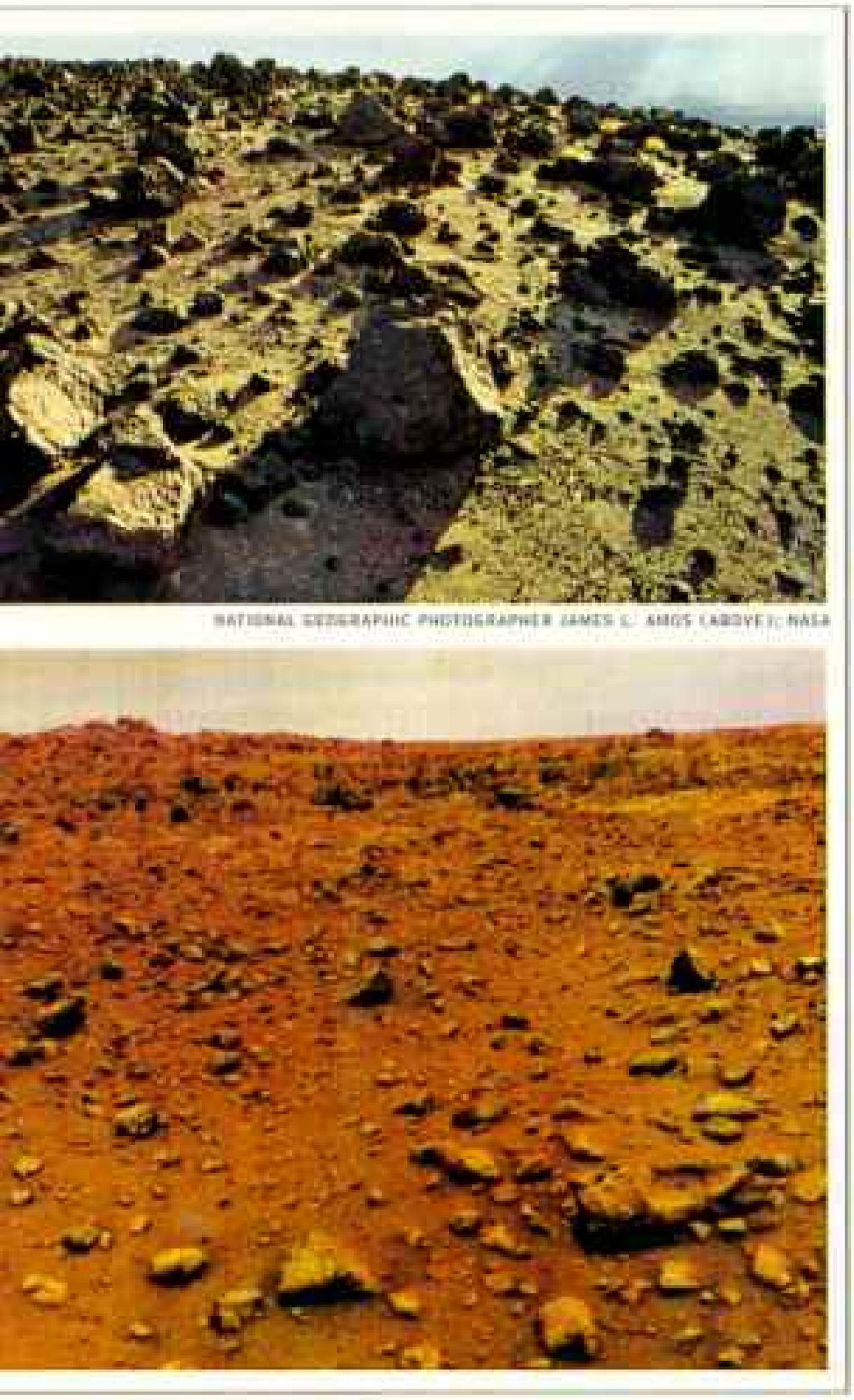


DIAGRAM BY ALAN CARROLL



NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES C. ANOS (ABOVE); NASA

MARS

MORE DEAD THAN RED, *Mars has terrain* (**above**) *that bears resemblance to our own Death Valley, California* (**top**). *But Mars' soil is rich in rust though devoid of life—such was the verdict of the Viking 1 and 2 missions. Though Mars may once have been a wet planet, temperatures and atmospheric pressures are now so low that water can exist only as vapor or ice. Thus, winds alone alter the Martian landscape, roughly equal in area to Earth's continents. Once mistaken for clouds by telescope astronomers, great dust storms rage across the land—like this one 300 kilometers across in the Argyre basin* (**right,** *at upper right). Some grow to such proportions that they blanket the entire planet.*

Venus, Earth, and Mars, great masses of silicates, the chief components of our rocks and soils, could condense out of the nebula.

At the asteroid belt a sharp transition set in. Silicates and heavy metals dominate those asteroids closest to the sun, while the more distant asteroids appear to become richer in carbon compounds that require still colder temperatures to freeze out.

As the temperature continued to fall out beyond the asteroids, water ice emerged from the nebula. So did a suite of reddish compounds that astronomers are now finding across the outer solar system. Cruikshank calls these compounds, which coat many moons and outer asteroids and make the patches on Pluto, the "dark red stuff." This stuff, we suspect, may contain many of the hydrocarbons that on Earth evolved into the agents of life.

Farther out, temperatures grow ever colder. Thus at Neptune, three times as far from the sun as Saturn and almost twice as cold, cosmochemists would expect nitrogen to liquefy, methane to freeze. And that is just what the nitrogen oceans and methane continents that Dale Cruikshank thinks he has found on Neptune's moon Triton prove.

Why should we care about this temperature gradient? For one, it might tell us why Jupiter grew so large. As theorist David Stevenson of the California Institute of Technology explains it, Jupiter formed at the spot in the nebula where water grew cold enough to freeze. Jupiter would thus have had much more solid material to feed upon than the inner planets. It was closer to the sun and had a shorter orbit than the more distant planets. So it could have swept up material in its feeding zone faster, collecting more gas and thus mass.

Eventually the sun ignited, and its adolescent burst of energy blew away most remaining dust and gas in the solar system. No planet would therefore be able to grow larger than Jupiter, and with its tremendous mass Jupiter could gravitationally dominate the further growth of its siblings.

Jupiter, for instance, probably stunted Mars. Acting like a great slingshot, Jupiter's tidal energy threw most of the planetesimals in its vicinity into orbits so eccentric they flew out of the solar system. But many of these errant chunks barraged the inner planets, battering and dispersing other planetesimals that should have been incorporated into Mars. At the asteroid belt this Jupiter effect was so intense that it kept any planets from forming.

Meanwhile, Uranus and Neptune were tossing around the planetesimals in their feeding zones. These remote chunks were rich in ices and carbon compounds. They perhaps contained a lot of the dark red stuff. Many of these planetesimals were sped outward to the edge of the solar system, where they became a huge cloud of comets that still orbits the sun up to several hundred times farther out than Neptune.

Conversely, many of these icy missiles were flung inward. Jupiter incorporated several Earth masses worth of them and shot even more back outward. Countless others of these comets struck Earth and the other inner planets. This great period of bombardment, between 4.5 and 3.8 billion years ago, probably deposited a watery and gaseous veneer on the inner bodies. In fact we may well have gotten most of our present atmosphere and oceans from these objects. Gene Shoemaker argues that comets may have delivered to Earth several times as much water as exists in all of today's oceans.

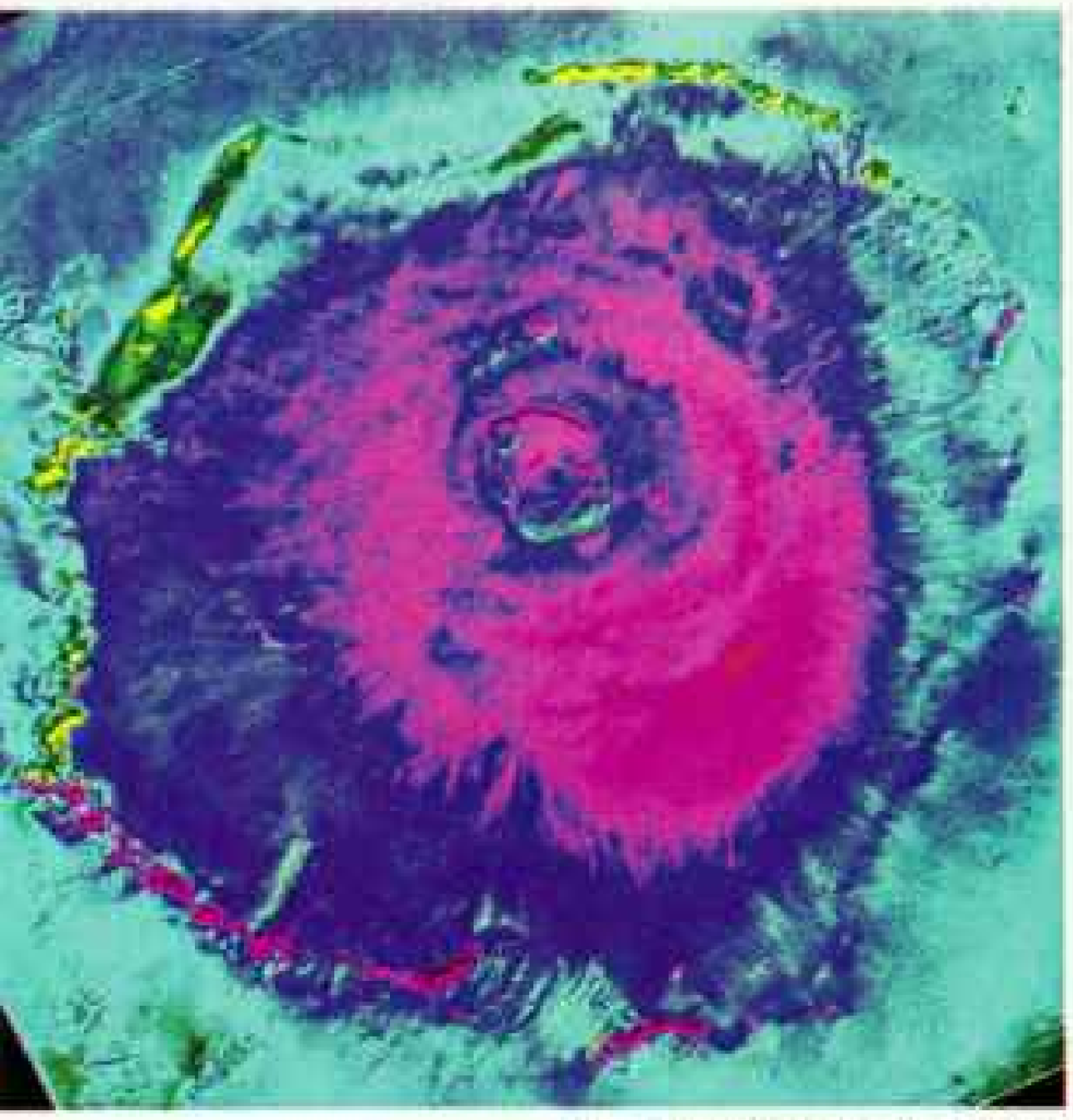
THE VIEW from Mauna Kea is not entirely celestial. Every few weeks since January 1983, Mauna Kea's younger sister Kilauea has been spewing fountains of glowing lava, a sight that Mauna Kea astronomers say draws their attention back to the fundamental process of any planet: getting the heat out.

With pilot Jim Baldwin, I inspect one of Kilauea's outbursts. We fly over an ashen gray cinder cone that spits pulses of incandescent, 1,150-degree lava high into the air.

Giants play *on the dawn side of Mars as the Viking 2 orbiter passes by. Near the top lies Ascreaus Mons, one of Mars' great volcanoes. Close to the south pole is the Argyre basin—scar of an ancient meteorite and origin of great dust storms. In between, spanning 4,500 kilometers, the Valles Marineris cuts deeper and many times wider than the Grand Canyon.*

NASA

Montana-size behemoth, *with a mouth big enough to swallow Rhode Island, Olympus Mons rises above 10-kilometer-high Martian cliffs in a computer-generated, vertically exaggerated image* ***(right).*** *The solar system's largest known volcano, it is similar in origin to Hawaii's Mauna Kea, though three times higher. A computer-colored Viking image* ***(below)*** *highlights surface features, with reds signifying older, smoother lava. Some virtually unpitted flows suggest that the volcano remains active.*



ELLIOT C. MORRIS, USGS, FLAGSTAFF, ARIZONA

The crater glows with a brilliant blast-furnace red, an index of how much heat our 4.6-billion-year-old planet still has to lose.

Some of this heat was buried within Earth during the planetesimal collisions that formed the planet. But most of it probably comes from the gradual decay of radioactive elements trapped beneath the surface.

Planets lose some heat the way a hot potato cools, by conduction and radiation. But over millions of years big planets develop more heat than they can conduct away. They convect the rest, like a boiling kettle. Thus Jupiter's Great Red Spot, a persistent anticyclone as large as the diameter of two Earths, results in part from heated material upwelling from the planet's interior. Rocky planets have analogous heat-releasing hot spots, but these plumes bring up magma rather than gas. Hawaii, for instance, sits atop the most famous of Earth's 30 or more hot spots. This Hawaiian hot spot generates the magma that built Mauna Kea and now is spurting out of Kilauea.

We also suspect that a giant Martian volcano, Olympus Mons, overlies a hot spot. Even though Mauna Kea is Earth's tallest mountain, if measured from its base on the seafloor, it is only a third of the Martian volcano's 27-kilometer (17-mile) height. Most of Mauna Kea would fit in the summit caldera of Olympus Mons.

Why is Olympus Mons so much larger than Mauna Kea? The reasons illustrate the major differences between Mars and Earth.

For one, smaller Mars has greatly cooled down. Its crust has thickened enough to support the weight of such a massive volcano.

RAYMOND M. BATSON AND SHERMAN S. C. WU, USGS, FLAGSTAFF, ARIZONA

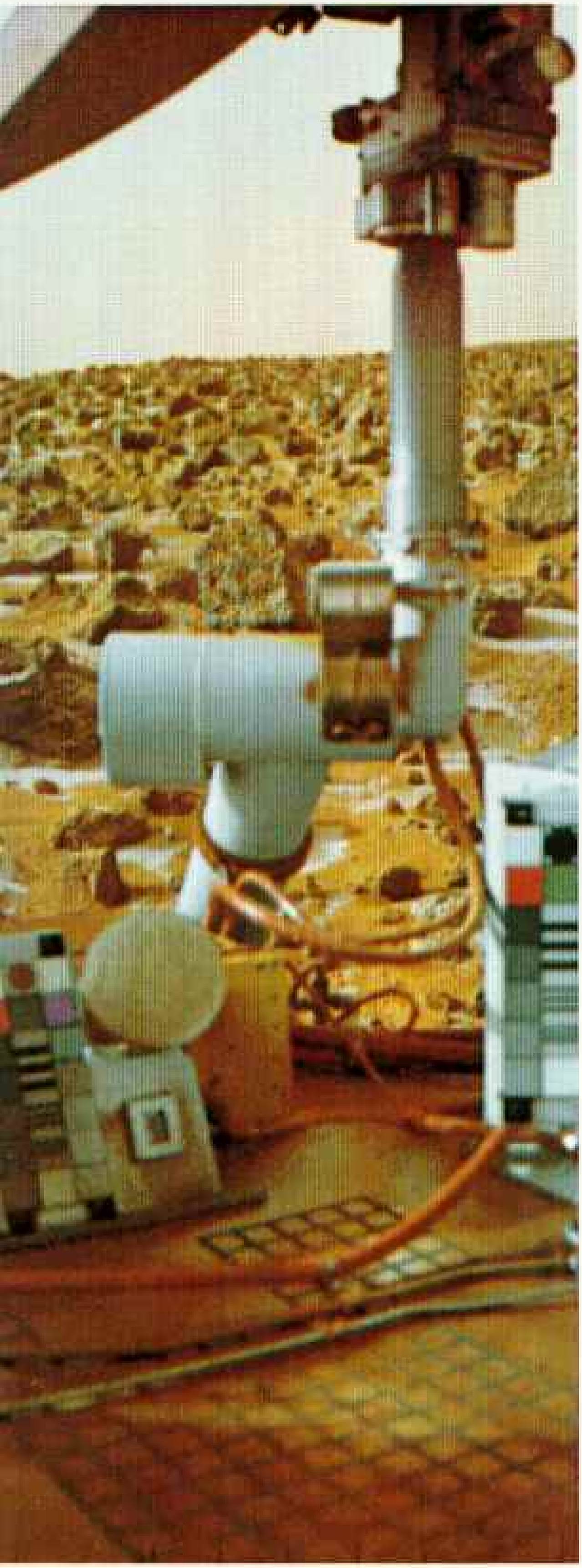
More important, Earth cools off through our distinctive system of plate tectonics, which we began to appreciate only about the time we first set foot on the moon.

Earth's surface is broken into plates, or slabs, bearing two types of crust: continental and oceanic. These plates circulate as the denser oceanic crust continuously dives beneath the edges of the more buoyant continents. The friction caused by the descending oceanic crust melts rock above it. This magma then wells up from volcanoes, especially along deep-sea volcanic ridges. Earth sheds the bulk of its heat through this process of continually recycling its crust.

With less heat to shed, Mars does not need such a dynamic system. Thus the crust atop its Olympus Mons hot spot never moves. The volcano just gets bigger and bigger. On Earth, however, the traveling Pacific plate does not give the Hawaiian hot spot enough time to make an Olympus Mons. Instead it makes a chain of smaller volcanoes, the Hawaiian Islands.

Although Olympus Mons may still erupt every 10,000 years, Mars has essentially frozen to death. Our near-twin Venus presents a vastly different history.

MANY RESIDENTS of Hawaii still suspect that Kilauea's flarings are more the tirades of the avenging goddess Pele than the workings of a deep hot spot. Pele supposedly makes her home in Kilauea, and not even scientists on the Big Island can completely disregard her presence. Each year the Hawaiian Volcano Observatory receives rocks taken as



BOTH BY NASA

souvenirs by visitors who find themselves beleaguered by bad luck, which they attribute to Madame Pele's revenge.

If the Hawaiian lore is right, Madame Pele must also reign on Venus. Evidence is accumulating that our sister planet, whose dense veil of clouds has been hard to penetrate, can be at least as violent a place as Earth. Nowhere do I feel closer to being on Venus than on the fiery, voluptuous flanks of Madame Pele's volcanoes.

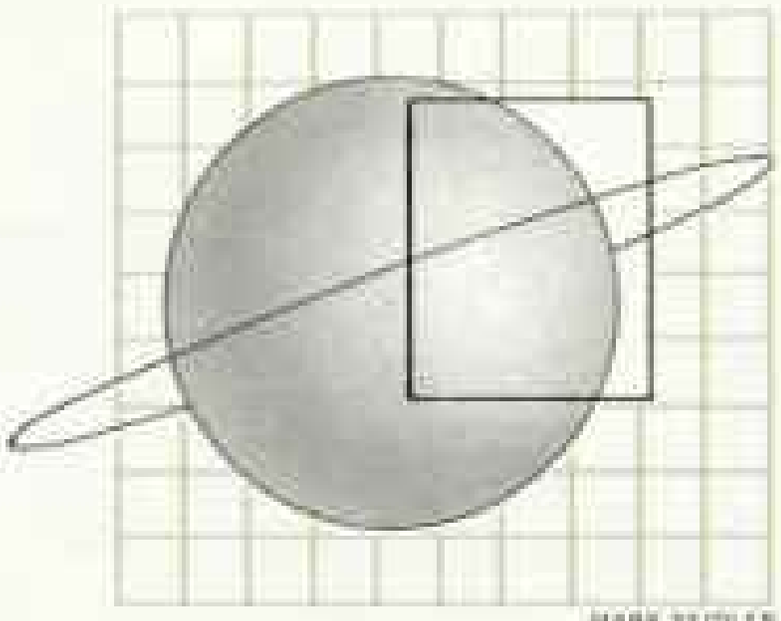
In April 1984 a rare dual eruption of Kilauea and the Big Island's third great volcano, Mauna Loa, draws me back to Hawaii. With a National Park Service team, photographer Jim Sugar and I fly by helicopter to Mauna Loa's fountaining vent. Moments after we land, a wind shift blows over us a cloud laced with sulfurous acids, Madame Pele's astringent breath. Instantly my throat burns. I cannot get my breath or stop coughing. Ranger John Machado urgently waves for us to return to the helicopter, and pilot Paul Morris races us down the mountain. Madame Pele has taken me as close as I ever care to come to breathing the air of Venus.

THE SULFUROUS FUMES in Venus's atmosphere provide one of the new clues that Venus is intensely volcanic. At the University of Colorado, atmospheric specialist Larry Esposito has been analyzing the levels of sulfur dioxide measured by the Pioneer Venus orbiter that has circled Venus for the last six years. Pioneer found unexpectedly high levels of sulfur dioxide, a major product of volcanoes on Earth, in Venus's upper atmosphere. That level has been dropping sharply. Esposito believes that Pioneer arrived just after a mammoth volcanic explosion blew huge volumes of sulfur dioxide into Venusian skies. He calculates that the eruption would

An early morning frost *dusts the Martian landscape around the Viking 2 lander* ***(left)****—fleeting evidence of the scant water vapor in the Martian atmosphere. Frozen carbon dioxide, or dry ice, overlays water ice in the winter pack at the north pole* ***(right)****, where winds have sculptured great terraces of ice and dust.*

JUPITER

SO LIKE THE SUN *in chemical composition, the lord of the planets falls far short of the bulk and heat to blaze as a star itself. Composed 95 percent of hydrogen and helium, it would be pallid to eye and camera were it not for particles in its highly reflective cloud cover (**right**), which accounts for its brightness in the night sky. An anticyclone large enough to swallow two Earths, the Great Red Spot, upper right, is a persistent feature of the Jovian atmosphere. Other turbulences like the huge white eddies, upper left, and maelstroms of currents, lower left, come and go. Undetected from Earth, Jupiter's ring (**above** and **below**) was a surprise discovery of the Voyager 1 mission.*



BOTH BY NASA

have equaled the devastating Krakatoa explosion on Earth in 1883.

Until the orbiter's cloud-penetrating radar began crudely mapping the Venusian surface, we knew relatively nothing about that planet's terrain. Then a surge of new radar imaging began backing up the emerging portrait of Venus as a volcanic caldron. Remarkable computer-enhanced data from radio telescopes at Arecibo, Puerto Rico, and Goldstone, California, began revealing features with shapes suspiciously like lava flows across the planet.

Stunning images from the Soviet Union's Venera 15 and 16 orbiters revealed not only abundant evidence of volcanism but also far fewer ancient meteorite impact craters than on the moon or Mars. Volcanism and perhaps other, unfamiliar, geologic processes clearly have been freshening up the face of Venus. Soviet scientists now estimate the average age of the planet's surface at one billion years, far younger than some large stretches of Earth's continents, but much older than our ocean basins, which are being continuously renewed by plate tectonics.

Does Venus have plate tectonics? The planet does have lowlands resembling desiccated ocean basins, as well as at least three elevated, continent-like regions with mountain ranges (pages 18-19). But unlike Earth, where the land forms only a third of the surface above sea level, 73 percent of Venus's surface is higher than the planet's mean elevation. "Earth is good at making oceans; Venus is good at making continents," suggests USGS expert Hal Masursky.

However, differences between ocean depths and mountain heights on Venus usually seem far less dramatic than on Earth. And because scientists can find no clear-cut evidence that Venus has a global system of dynamic crustal plates, most feel that Venus sheds its heat largely through hot spots. "Imagine 10,000 Kilaueas," says Massachusetts Institute of Technology geophysicist

JAMES L. AMOS (ABOVE AND FAR RIGHT); NASA/ALFRED S. MCEWEN, USGS

MOONS OF JUPITER

*CALLED THE GALILEANS after Galileo, who discovered them in 1610, Jupiter's four large moons are revealing their mysteries to space-age planet watchers at NASA's Ames Research Center in California. Ray Reynolds, at left, was one of a team predicting volcanoes on Io before they were confirmed by Voyager (**pages 38-39**). Says geologist Steve Squyres, right: "Each is a completely different world. They're like a miniature solar system." Looming in the foreground of Jupiter in this montage are Europa and Ganymede. Io orbits in the distance, and Callisto is unseen.*

Sean Solomon. "That's what the surface of Venus may be like."

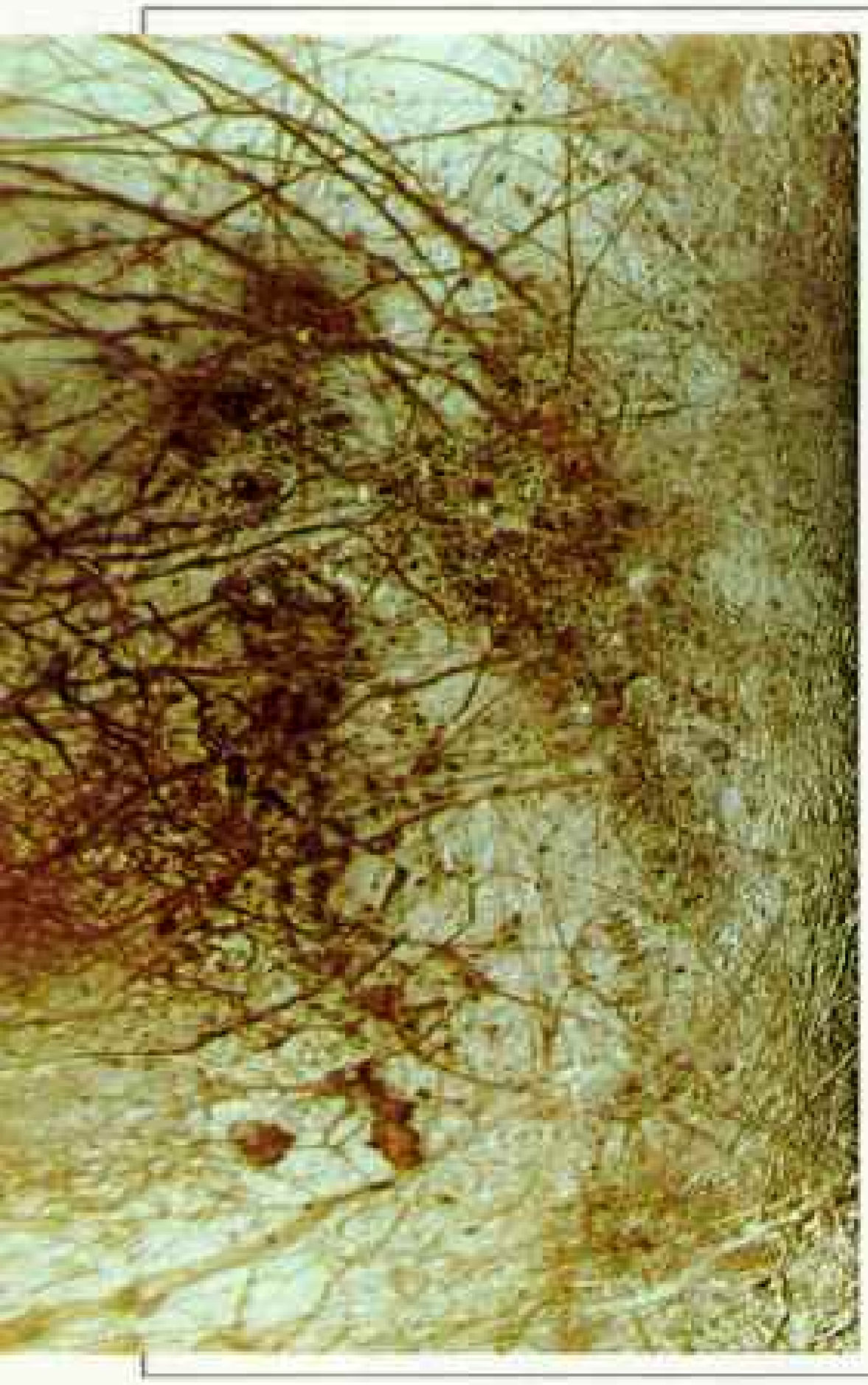
"I'VE BEEN IN ORBIT around Venus many times in my mind," says Brown University geologist Jim Head, a leading synthesizer of the new Venus imagery. Head takes me on a mental tour of the planet. Most Venusian landmarks have now been named, in the tradition of Madame Pele, after famous and often sensual women, from Eve to Cleopatra.

Take Guinevere. Thousands of kilometers across, she is the grandest of several deep lowland plains. Guinevere could be a region where sheets of smooth lava have been flooding the land. The Russians, moreover, found on her face one of what could be a complex of volcanic cinder cones ten kilometers in diameter.

From Guinevere we travel on to the highlands of Aphrodite Terra, easily Venus's largest "continent." More extensive than North America and Africa combined, Aphrodite straddles the equator. She features several huge circular depressions similar to what the Russians call coronas. Hundreds of kilometers across, these coronas don't look like impact craters. They have concentric, ridgelike rings within them. Nothing like them has been seen elsewhere in the solar system, except for eroded but suspiciously similar features that space shuttle astronauts photographed on some of Earth's most ancient terrain in Western Australia.

Soviet scientists propose that these coronas are created by a surge of magma from great depth. Jim Head suggests that they represent a geologic process that no longer occurs on Earth but may still be an important mechanism for Venus to shed its heat.

From Aphrodite we fly on to a second major continent, Beta Regio. Beta is scarred by a trough 100 to 350 kilometers wide and more than 1,500 kilometers long. The trough, with two major volcanoes on its rim,



Smallest and brightest *of the Galileans, Europa has been described as an icy billiard ball, since a smooth crust of frozen water covers its surface (**left**). Bearing resemblance to the Arctic Ocean (**above**), Europa is crosshatched with mysterious lines. Many believe they are refrozen cracks that open occasionally to erupt water from a liquid ocean several kilometers below the surface. "It is possible," says Reynolds, "that the ice at these points is thin enough to allow sunlight through briefly to the water below—thus establishing minimal conditions for life."*

NASA/ALFRED S. MCEWEN, USGS (ABOVE); JAMES L. AMOS (BELOW)

INCREDIBLE IO

WONDROUS STRANGE, *Jupiter's innermost large moon sent minds into orbit when images came back of its geyser Pele. Veiling the surface, an almost transparent cloud of sulfur particles spreads umbrella-like over the 1.3-million-square-kilometer circle that dominates this Voyager mosaic* (**right**). *The most volcanic body yet observed in the solar system, Io is so mottled with hot spots that it resembles a pizza* (**above**). *At the U. S. Geological Survey in Flagstaff, Arizona, Laurence Soderblom* (**below**) *theorizes on how Io's eruptions relate to its molten interior. He and others think tidal pulls from Jupiter and Europa account for the heat that has caused the satellite to "cook out" its water, leaving volatile sulfurous substances.*

NASA/ALFRED S. MCEWEN, LAURENCE A. SODERBLOM, AND TAMMY ROCK, USGS, FLAGSTAFF (RIGHT)

resembles one of Earth's great rifts. On Earth such a rift results when a continent splits apart and a new ocean begins to form.

Venus's third great continent, a bit larger than Europe and named Ishtar Terra, also reminds Head of a classic plate tectonics situation on Earth. A Himalaya-scale mountain belt, called Maxwell Montes, shows repeated, compressed bands of mountain ranges. "It looks like two plates colliding, as North America and Africa once did to form the Appalachians." Such features, says Head, suggest that we should not yet rule out plate tectonics on Venus.

WHY DOES VENUS seem dominated by hot spots versus Earth's drifting plates? For one thing, Earth has oceans. Venus does not. Could water be essential for plate tectonics? Does it react chemically with rocks to make them flow more easily?

Pioneer data indicate that Venus has lost massive amounts of water. It may well have started out with as much as Earth. Yet Venus could not keep its water liquid. As vapor, it rose into the upper atmosphere, where the sun's ultraviolet rays broke its molecules apart. Much of the freed hydrogen escaped into space. Jim Pollack, an atmospheric specialist at NASA's Ames Research Center in California, suggests that Venus had lost almost all its water before it was two billion years old.

Without water Venus was doomed. Water in Earth's atmosphere combines with carbon dioxide to make a mild acid rain. This rain then leaches minerals from the rocks on which it falls and flows to the oceans to form limestone and other carbonate rocks. Thus, over the eons, water has scrubbed out a lot of our primordial CO_2. But on water-poor Venus so much carbon dioxide still fills the air that it creates an intense greenhouse effect. Like a blanket, the CO_2 holds in the solar energy that falls on Venus, making its surface hot enough to melt lead. Earth by contrast maintains just enough carbon dioxide to keep moderately warm in the deep freeze of space.

Temperatures at Venus were only slightly warmer than on Earth during the early years. Can only a few tens of degrees make the difference between a planet

Bound for oblivion, *a payload of scientific instruments descends through Jovian skies in this artist's conception of the Galileo mission to be launched next*

PAINTING BY JAMES HERVEY

year. Passing by the asteroid belt, where it may photograph a large asteroid called 29 Amphitrite, Galileo will begin to orbit Jupiter in late 1988. It will release a probe, designed to help understand Jupiter's atmosphere, that will have one hour to accomplish its mission before communications fail in the crushing gas below the clouds.

becoming a living paradise or a barren hell?

Did life itself play a role in making our planet hospitable? Today life removes large amounts of carbon dioxide. Plants exchange oxygen for CO_2. Oceanic life also takes out CO_2 to make skeletons, which later fall to the seafloor and solidify into rock. We now have strong evidence that sophisticated microorganisms were present on Earth at least 3.5 billion years ago. By 2.5 billion years ago, when Venus probably was locked into its irrevocable greenhouse, photosynthesizing bacteria on Earth had created an atmosphere with abundant oxygen.

Besides sterilizing the planet, Venus's intense heat may be generating an exotic kind of erosion. On Earth rain, wind, and waves erode continents. On Venus "viscous creep" may be the great leveling agent.

"As rocks heat," MIT's Sean Solomon

explains, "they soften and can flow. Mountains may actually creep away, like Silly Putty spreading out. Viscous creep on Venus could be at least as effective as water erosion on Earth in reducing mountainous relief. If so, that further implies that all the high features we see on Venus are young."

If such bizarre processes as viscous creep dominate our closest neighbor, what alien mechanisms have evolved on more distant bodies? Who would have dreamed up the throbbing, spurting moon Io that Voyager 1 discovered on its way past Jupiter?

I remember well the mixture of shell shock and elation among the Voyager team when huge and unmistakable volcanic plumes appeared on images of Io. The rest of the solar system could no longer be regarded as geologically dead.

Io, a moon that is tumultuously hot on the

NASA (LEFT); JAMES L. AMOS

SATURN

SHATTERED SATELLITE *or failed moon? For years, most scientists believed the latter—that Saturn's remarkable rings were unaccreted material from the planet's nebula, held in eternal thrall to Saturn's gravity. But now, with thousands of close-up images from the Voyager flybys, scientists are trying anew to explain the rings' amazing complexity. Peter Goldreich of Caltech (***above***) now thinks they may be of recent vintage. "There's too much going on in there," he says, "for them to have remained stable for 4.6 billion years." Instead, some think the rings are remnants of a collision between a Saturnian moon and an errant comet.*

As little as ten meters thick, the rings probably consist mostly of pieces of water ice from pebble to boulder size. Seen from a distance of 1.5 million kilometers, they cast their shadow across the solar system's least dense planet—only 70 percent the density of water.

inside and frigid on the outside, has spewed its primordial water vapor and indeed all materials lighter than sulfur into space. Sulfur is too heavy to easily escape even the slight atmosphere and gravitational pull of Io. Therefore, sulfur serves as Io's water. In fact, many scientists think that molten sulfur moves through Io's crust much like water through an aquifer.

To get a feel for Io, I leave Hawaii for another of Earth's more remarkable volcanic caldrons, Yellowstone National Park.

THE TEMPERATURE at Old Faithful last night reached minus 39°C (–37°F). The day has warmed to a face-numbing minus 32°C as park geologist Rick Hutchinson and I ski cross-country through Upper Geyser Basin. Like Io, Yellowstone today seems unearthly cold. Like Io as well, this basin has an enormous internal heat load to shed. As we gaze across the snow-mantled vista, geysers—Plume, Vault, Little Cub, and, of course, Old Faithful—are going off in every direction. Ice crystals fall out of geyser clouds, turning the ground white, like the sulfur dioxide snows of Io. Here, where fire and ice merge, I feel for a moment like an alien on my own planet.

Geologist Susan Kieffer of the USGS has been studying Old Faithful for the past few years and has concluded that fluid dynamic mechanisms similar to those that fire its fountaining also drive Io's 100-kilometer-high, umbrella-shaped volcanic plumes.

"If Earth's gravity were the same as Io's," she says, "Old Faithful would erupt 180 meters high instead of 30. If Earth's atmosphere were removed as well, Old Faithful could erupt as high as some of Io's plumes."

Another of Earth's 30-odd hot spots lies beneath Yellowstone's geysers, superheating the groundwater to the explosive point. "Enough heat is released along the Firehole River here," says Rick Hutchinson, "to melt seven tons of ice a second."

Io's geysers also appear to be fueled by hot spots that dominate vast areas of two hemispheres. The geysers range in size from one called Pele, whose plume sprays out across 1,400 kilometers, to Prometheus, whose fountaining spurts over a mere 300 kilometers. Monstrous Pele was erupting when Voyager 1 passed by. Four months later Voyager 2 found it quiet. That, says USGS geologist Laurence Soderblom, means Pele erupts for periods of days to weeks. The smaller geysers were active for both the Voyagers' cameras. Therefore they may erupt for years.

The smaller plumes, says Soderblom, leave white deposits, the sulfur dioxide snowfall. The larger plumes, however, have hotter, deeper sources. They spew out pure molten sulfur. Sulfur's ability to change from red to yellow to orange to black, depending on its temperature, gives Io's surface its mottled appearance.

Why is Io so hot inside? The moon appears caught in a gravitational tug of war between Jupiter and Io's sister moon Europa, 250,000 kilometers farther out. The constant tidal tugging pumps enough energy into Io to overheat its interior.

This same mechanism is at work to a lesser extent on Europa, which would be feeling weaker tugs from Jupiter and the next moon out, Ganymede.

Europa presents one of the most puzzling faces in the solar system. Neither Voyager flew close enough to see many surface details. But scientists did determine that Europa has only a handful of the ancient impact craters that saturate the icy surfaces of Ganymede and Jupiter's fourth major moon, Callisto. Thus Europa, like Io, may still be active and continuously making a new face.

Rather than sulfur or magma, Europa would be covering itself over with water. For Europa's surface may be just an icy veneer, perhaps ten kilometers thick, covering an ocean of liquid water a hundred kilometers deep. Water vapor may thus occasionally geyser out of the long brown cracks that Voyager found across Europa's surface.

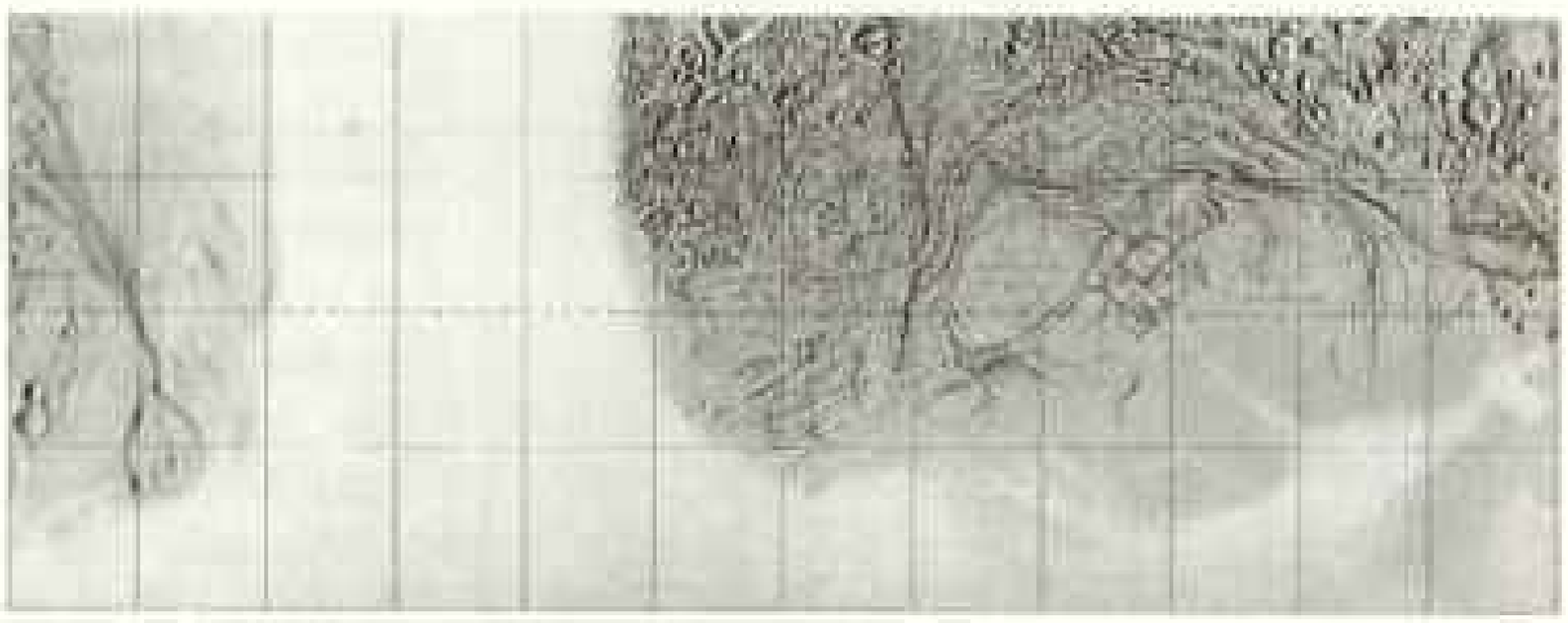
The fractured, frozen faces Voyager saw on the satellites of Jupiter first warned scientists that ice moons were not going to be easy to explain. What the spacecraft saw on Saturn's moons turned out to be even more confusing. Too tiny to have hot rock still within, they nevertheless revealed surfaces that have seen dynamic activity. One of them, Enceladus, appears to have an almost pristine face. Ice volcanism and flash floods of slush thus may be frequent on Enceladus. Moreover, the moon appears to be exploding ice crystals into Saturn's thin, outer

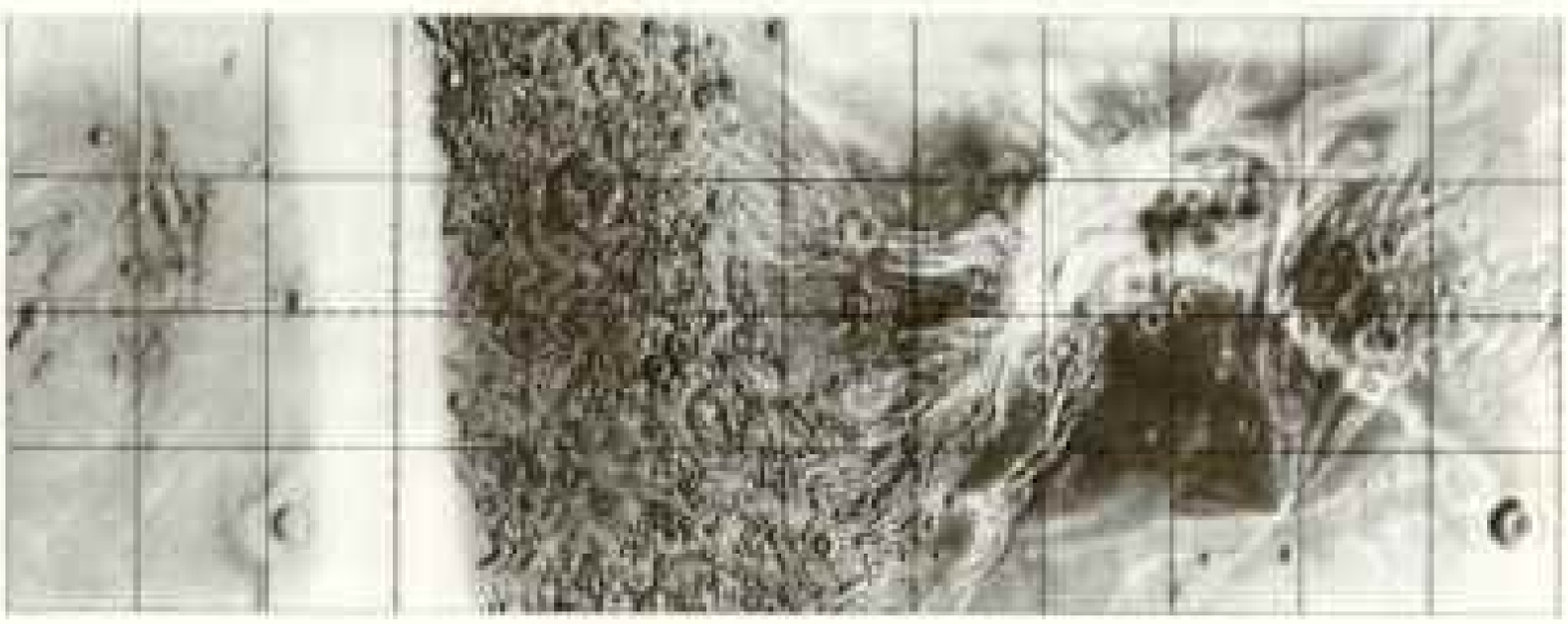
PAINTING BY LUDEK PESEK (ABOVE); NASA

MOONS OF SATURN

COLD CHEMICAL STEW, *the surface of Titan, Saturn's largest satellite, abounds with organic compounds—though with temperatures lower than minus 180°C (-292°F) it is probably too cold for life. Clouds and lakes of ethane surround islands of ice in this artist's conception of a surface shrouded by atmosphere too thick for Voyager cameras.*

Saturn's six other primary moons were open books to Voyager, whose images have produced high-resolution maps. Highly reflective Enceladus (**below**) *seems coated with ice and cracked by long crevasses. The broad white marks on Dione* (**bottom**) *may be frozen outpourings of water from faults.*





PLANETARY PROBES

TWELVE YEARS after the first missions to reach the moon in 1959, when the era of space probes began, U. S. Mariner 9 reached Mars, sending back remarkable pictures of surface features. A surge of missions followed. Viking landed on Mars, and the Soviet Venera probes on Venus. The Voyager spacecraft have taken us still farther, revealing the dazzling domains of Jupiter and Saturn. Dates shown below are arrival dates.

MERCURY

1974: Mariner 10 •

VENUS

*1961 Venera 1 *; 1962 Mariner 2 •; 1964 Zond 1 *; 1966 Venera 2 * and 3 *; 1967 Venera 4 *, Mariner 5 •; 1969 Venera 5 * and 6 *; 1970 Venera 7 *; 1972 Venera 8 *; 1974 Mariner 10 •; 1975 Venera 9 * and 10 *; 1978 Pioneer Venus 1 • and 2 •, Venera 11 * and 12 *; 1982 Venera 13 * and 14 *; 1983 Venera 15 * and 16 *; 1985 Vega 1 * and 2 *; 1988 Venus Radar Mapper •*

MARS

*1963 Mars 1 *; 1965 Mariner 4 •, Zond 2 * and 3 *; 1969 Mariner 6 • and 7 •; 1971 Mars 2 * and 3 *, Mariner 9 •; 1973 Mars 4 *, 5 *, 6 *, and 7 *; 1976 Viking 1 • and 2 •; 1988 Mars Orbiter/Phobos Probe *; 1991 Mars Geoscience Climatology Orbiter •*

JUPITER

1973 Pioneer 10 •; 1974 Pioneer 11 •; 1979 Voyager 1 • and 2 •; 1988 Galileo Probe •

SATURN

1979 Pioneer 11 •; 1980 Voyager 1 •; 1981 Voyager 2 •

URANUS

1986 Voyager 2 •

NEPTUNE

1989 Voyager 2 •

PLUTO

None

THE MOON

Beginning with Luna 1, the U.S.S.R. has launched 22 known missions judged successful. From Pioneer 4 in 1959 to Explorer 49 in 1973, the U. S. has launched 45, including the six manned Apollo landings in 1969-72.

• *U. S. mission* * *Soviet mission*

E ring. The E ring would dissipate in a few thousand years if it were not being resupplied with this fresh ice.

What activates the surface of this little ice moon? Enceladus is so small and so far from Saturn that the tidal heating in it is far weaker than the energy that warms Io and Europa. Therefore planetary geologists would love to do on Enceladus what I find myself doing on the frozen Bering Sea.

A FLAT, eye-achingly white panorama surrounds me as I walk off the U. S. Coast Guard icebreaker *Polar Star*. Never straying from the sight of our two guards armed against polar bears, I wander amid rubble fields where rafts of pack ice have collided, creating patterns more complex than I imagined possible. The silence is profound. World after world out there, I tell myself, looks like this: white monotony in which after a while even a raging polar bear would be welcome relief. Yet to my partner, Richard Voelker, of Arctec, Inc., this world has elusive diversity.

"The Eskimos have 40 or 50 names for different types of ice," he tells me. Voelker's firm is advising major oil companies on the problems ice might present to ships and offshore structures. Slight impurities and tiny differences in the temperature and salinity of pack ice can translate into quite different strengths, resistances, and melting points. The structure of ice also influences its behavior. Ice engineers need to know whether they are dealing with new ice or old, shorefast, close-pack, or rubble-field ice. Voelker talks of multi-year ice that may have drifted in from the Arctic Ocean this year—ice several seasons old. How would he feel, I wonder, to be looking at ice on Callisto, which may be more than four billion seasons old?

We take out long, cylindrical screwlike devices called corers and twist them deep into the ice until seawater gurgles up. We pull up the corer and remove the ice samples. We take the temperature of this ice core at 16-centimeter intervals, then saw it into slices for chemical analysis.

Were this scene on Enceladus, that analysis might well show methane or ammonia or maybe even some of the dark red stuff mixed into the water ice. Such impurities might lower the melting point of ice on

GOSSES BLUFF CRATER (ABOVE)

DANGERS FROM ABOVE

IT'S INEVITABLE, *say scientists: Earth will once again be hit by an asteroid large enough to cause mass extinctions, as probably happened 65 million years ago, when dinosaurs vanished. Meanwhile, impacts with the force of a 50-megaton bomb occur perhaps once every one thousand years on average. About one thousand asteroids large enough to produce impact structures as large as Gosses Bluff in Australia (**above**) or larger now cross Earth's orbit. Some of these are the fragments of collisions between asteroids in the main asteroid belt (**right**) and some probably are extinct comets. Apollo, Icarus, and Adonis are three of the many now identified. With enough warning, say proponents of a "spacewatch," these bodies could be deflected—perhaps with nuclear weapons.*

*Small bodies that breach Earth's atmosphere are often packed with chemical information on the early solar system. Scientists around the world are profiting from a rare carbonaceous meteorite called Allende (**right**) that scattered over northern Mexico in 1969.*

The Planets: Between Fire and Ice

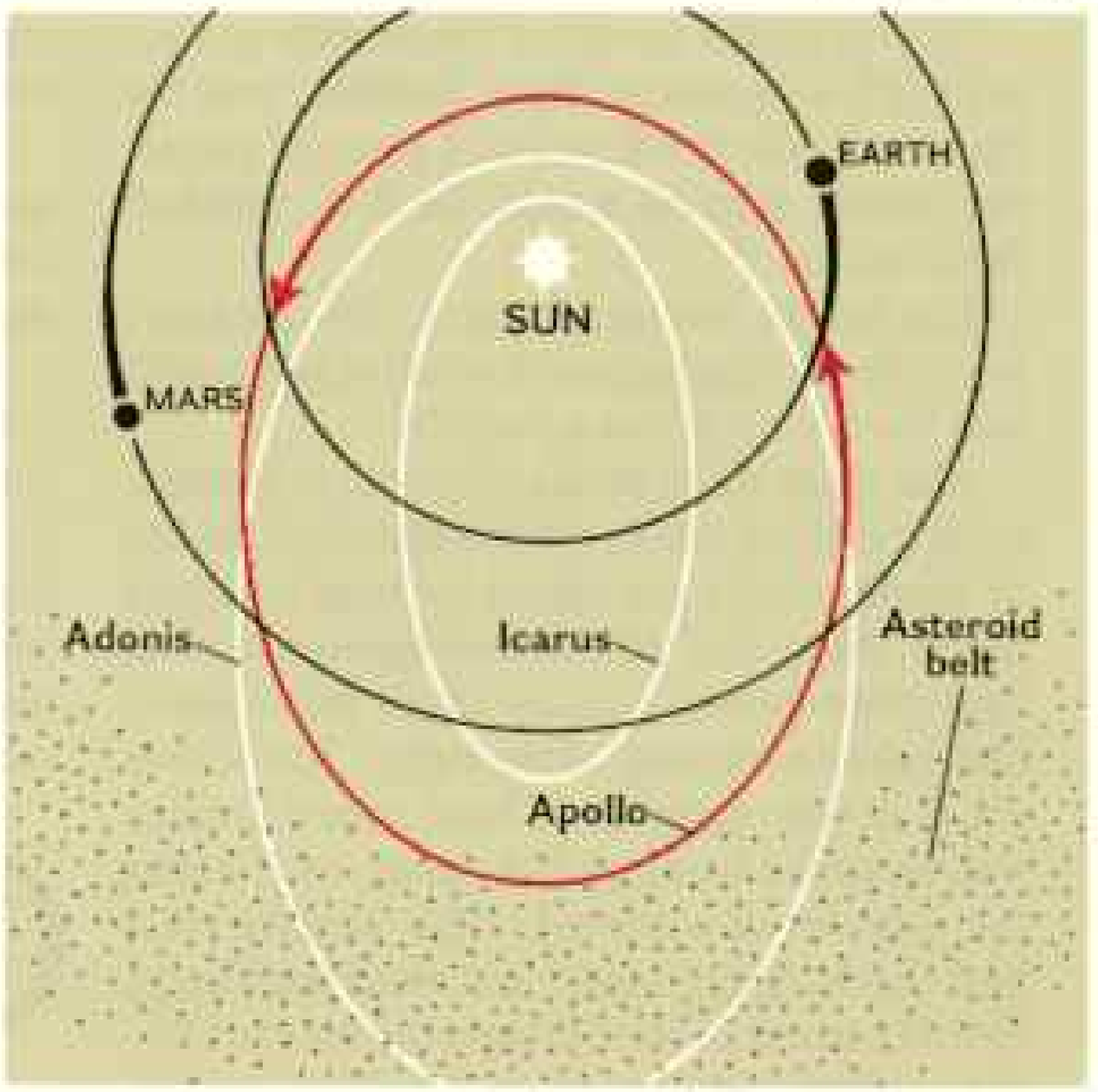


DIAGRAM BY MARK SEIDLER; JAMES L. AMOS (BELOW)

that little body enough so that liquid water could occasionally explode or escape from within. Only by invoking such extraterrestrial chemistry can scientists hope to explain how the moons of Saturn have refreshed their faces.

Astronomers have been faring a bit better with resolving the riddles of Saturn's main rings. When the Voyagers began to photograph those rings, labeled the A, B, C rings from outside in, scientists found far more structure than they imagined. Instead of a few rings separated by the gaps visible by telescope from Earth, Voyager found thousands of grooves, bands, and ringlets within the rings. Moreover, each main ring seems to be ruled by different and distinctive mechanisms. Despite intensive study over the past five years, the rings still confound. But we do know for certain now that the icy particles that compose the rings range in size from pebble to boulder. Also we see that the rings, which extend for hundreds of thousands of kilometers, are extremely thin—in places only ten meters (33 feet).

"If you built a model of the rings to scale," says JPL astronomer Rich Terrile, "and the rings were the thickness of a piece of paper, the whole system would be four football fields across."

But we do not understand, for instance, why the A ring appears relatively smooth and the B ring seems a jumble.

The most stimulating discovery, however, is the great waves within the rings. Much as Earth's tides are raised by tugs from the moon, these ring waves are triggered as tidal tugs from Saturn's many small inner satellites take energy out of the rings. The waves come in two varieties. Those called density waves spiral through the rings, as if along the grooves of a record. Like passing on a bad check, they transfer outward the energy deficit caused by their triggering moon. Others, called corrugated or bending waves, ripple toward the planet as if through a puddle. "They make phenomenal mountains, half a kilometer high, as they move across the thin flat rings," says Terrile.

Although these waves are caused by an energy loss, the disturbances they provoke create countless energy-releasing collisions between ring particles. As a result, the rings are so dynamic that some scientists are now questioning the long-held belief that the rings are almost as old as the solar system itself. Most astronomers assume the rings are made up of leftover debris from the era of accretion, which Saturn's tidal gravity kept from coalescing into a moon.

However, now the rings seem so energized that theorists are asking what "anchors" them. Gravitational theory says the inner ring particles should be losing energy to the outer particles. If so, why have they not all spiraled into Saturn? Conversely, what has kept the more energized outer particles from spreading out into ever more tenuous orbits and vanishing? Voyager did find small shepherding moons that apparently absorb some of this outward thrust, anchoring the outer edges of the rings. But all the energy these shepherd moons would have absorbed over the eons should have pushed the satellites themselves much farther from Saturn than they are.

What anchors these shepherding moons? Astronomers cannot say for sure. But, Caltech theorist Peter Goldreich suggests that since the rings have not dissipated, they may not have been around very long.

"I used to think the rings were ancient," says Goldreich. "But now it appears they could be only a fiftieth to a hundredth as old as the solar system."

If the rings are young, they probably are pieces of a small Saturnian moon that was hit by a big comet. Scientists by nature hate to invoke such catastrophic explanations. However, the more we see of other worlds, and indeed the better we see our own, the more we must admit that catastrophes not only occur but also should be expected.

CATASTROPHE clearly carved the scablands of eastern Washington State, where topsoil has been stripped and deep canyons gouged across a vast area south of Spokane. In a small plane I fly out across this bruised land on a winter day. Great welts of naked brown basalt, what the early settlers called scabs on Earth's wounded skin, are intersected by countless dry channels.

Below Grand Coulee Dam I fly into a chasm some 300 meters deep and in places three kilometers across. I pass over Dry Falls and its jumble of jeep-size boulders

strewn about by some cataclysmic force. What happened here?

"The most spectacular geologic event on the face of Earth in the last three million years," answers Victor Baker, a geologist at the University of Arizona. Some 14,000 years ago, he explains, a glacial ice dam in nearby Idaho failed. More than 2,100 cubic kilometers (500 cubic miles) of water gushed out. A 200-meter-high (655-foot) wave tore and gouged at the land downstream.

As I fly through the canyons, called coulees here, I could be flying across Mars. For this flood was small compared to some that apparently occurred on the red planet. There, through the slopes of the Chryse basin, canyons as long as 1,000 kilometers have been cut, canyons that have revolutionized our theories of Mars' past.

"We all thought Mars was desiccated," explains USGS geologist Michael Carr. "But it's very difficult to make those channels by any process other than running water. That means in the distant past Mars saw catastrophic floods. Like the scablands, only ten times bigger."

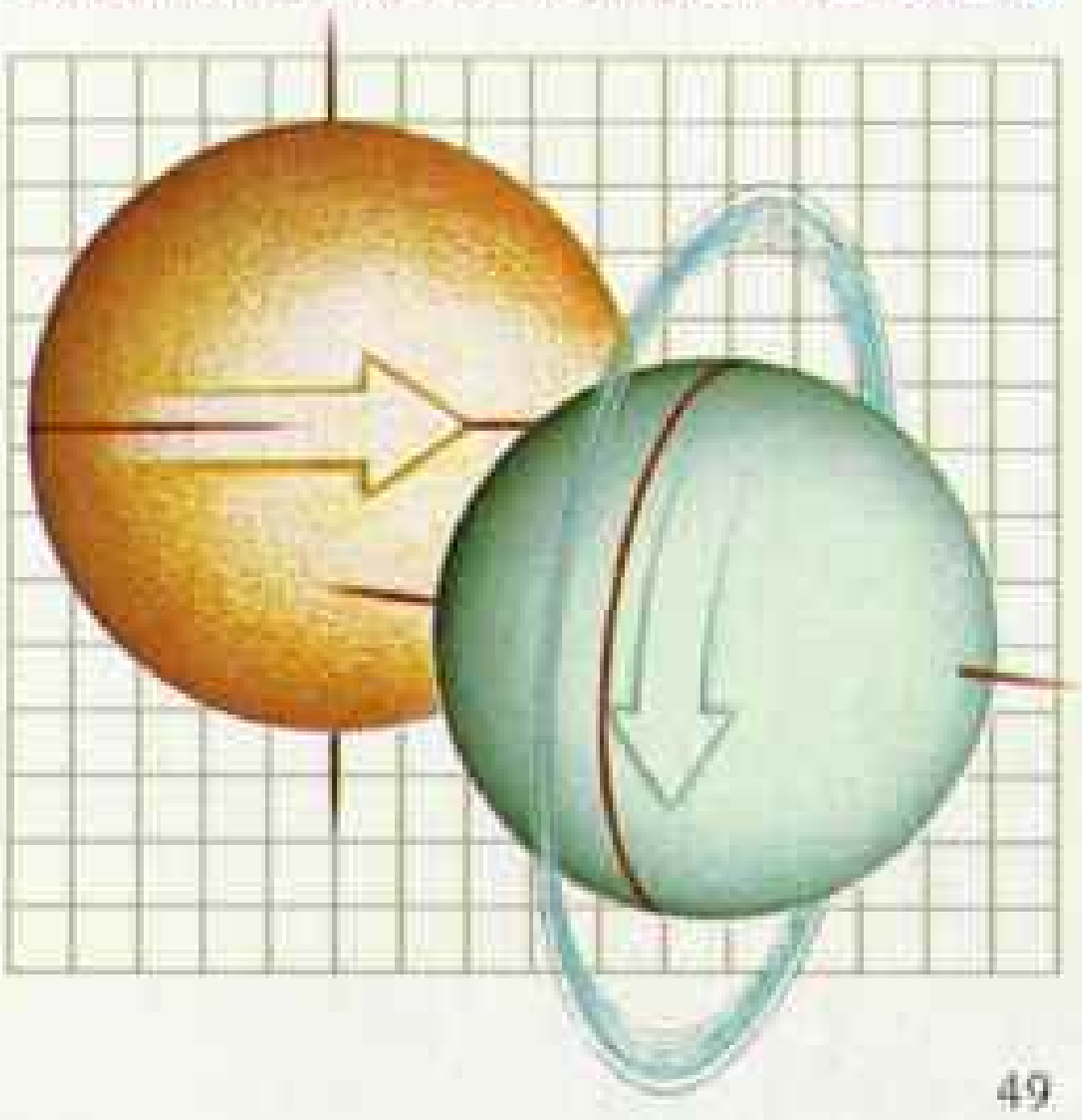
Yet today if all the water in Mars' atmosphere dropped on the surface, it would form a layer only a thousandth of a centimeter deep. How do you get great floods from so little water?

PAINTING BY PAUL HUDSON (ABOVE)

RICHARD J. TERRILE AND BRADFORD A. SMITH (ABOVE); MARK SEIDLER (BELOW)

URANUS

ODDBALL PLANET, *Uranus defies the celestial norm by spinning on an axis nearly level with its orbital plane (**bottom**), a quirk shared with Pluto. Some scientists believe a stupendous collision with an Earth-size body, as depicted by an artist (**top**), literally knocked Uranus on its side. The tilt means that each pole now takes a turn facing the sun during the 84-year-long Uranian "year." Too far from earth's telescopes for detailed images, Uranus holds other mysteries, which scientists are eager to probe when Voyager 2 flies by the planet next January. What, for example, is the nature of Uranus's narrow rings—seen for the first time in a computer-enhanced image from the Las Campanas Observatory (**center**)? And are there atmospheres on any of the five moons—two of which are seen at two and seven o'clock in this image?*



RICHARD J. TERRILE AND BRADFORD A. SMITH

NEPTUNE AND PLUTO

ICEBERGS FLOATING *on a nitrogen sea are features of a recent hypothesis for Neptune's giant moon, Triton, seen in the foreground of this painting* (**left**). *As a cold sun shines 4.5 billion kilometers away, massive Neptune looms ominously close to its largest satellite, which is slowly spiraling inward. One day the satellite may be torn asunder to form a ring.*

The farthest planet, Pluto has a highly elliptical orbit that at times swings inside that of Neptune. In 1978 Pluto was found to have a moon, Charon—seen as a bulge in this telescope image (**below,** *at one o'clock). Pluto will be far afield on its 248-year trip around the sun when NASA's remarkable space probe crosses its orbit. Thus Neptune* (**top**) *will be the final assignation for Voyager 2 when it attains the far reaches of the solar system in 1989.*

PAINTING BY PAUL HUDSON (LEFT);
JAMES W. CHRISTY, U. S. NAVAL OBSERVATORY

Scientists suspect that enough water to make a planetwide ocean a hundred meters (328 feet) deep is locked into polar ice caps, hidden as permafrost, or trapped as groundwater beneath the frozen Martian crust. The floods were probably triggered when occasionally a meteorite impact, an intrusion of magma, or an earthquake suddenly released a thousand Amazon Rivers' worth of water.

As tantalizing as the big channels, however, are smaller streambeds that pattern vast areas of Mars. These, Carr explains, may have been made by rainfall or the melting and runoff of surface ice. Mars thus would have had a dense, warm carbon dioxide atmosphere, like early Earth, for perhaps its first half billion years.

Then gradually most of that atmosphere vanished. As on Earth, Mars' carbon dioxide formed limestone and other carbonate rocks. But without plate tectonics to recycle its rocks, Mars could not reactivate that CO_2 after it was trapped within the crust. Without CO_2's warming effect, Mars froze.

Although Mars is always frigid, it probably has extremely cold periods every 100,000 years or so, much as Earth has ice ages. At the peak of the ice ages, most of Mars' scant CO_2 atmosphere freezes out at the poles as dry-ice caps. Then the climate gradually warms 15 degrees or so, enough to evaporate the polar CO_2 caps. The atmosphere thus thickens enough to generate strong winds. Winds bring great dust storms that may shroud the planet for centuries. Multiple dark layers of dust that Viking found ringing Mars' poles may be a record of these warmer episodes.

Mars is now in between an ice age and one of its milder spells, and its dust storms are only seasonal. Those who study these seasonal storms recently have proposed perhaps the most profound and chilling concept to come out of the space program. They have noted that as dust spreads around the planet, it absorbs and traps the sun's energy in the upper atmosphere. This turns off Mars' slight greenhouse and causes temperatures on its surface to drop.

A similar but far more dramatic effect, they predict, could occur on Earth should a large-scale nuclear war ever erupt. A "nuclear winter" would descend on our planet. Brian Toon of NASA's Ames Research Center estimates that temperatures would plunge 40°C (72°F) across the continents for six months or longer. Plants would be unable to grow. Water supplies would freeze. Global famine would ensue and a large percentage of living creatures would die out. Although scientists now hotly debate how long and cold a nuclear winter would be, most agree that the aftermath of so much dust and soot would be extremely hazardous to life on the planet.

Many scientists now believe that a similar dust cloud, generated when a great asteroid struck Earth some 65 million years ago, brought about the mass extinction of thousands of species, including the dinosaurs.

IT IS THE LAST NIGHT of my fieldwork, and I have returned one final time to Hawaii's Big Island, to a place I love, a lava tidal pool on the Kona Coast. Here at sunset I see Mars emerge above the massive silhouette of Mauna Kea. The fresh balmy air and the resonant rolling ocean speak of what makes Earth so special. So do the darting minnows and sea urchins in this tidal pool.

It was in such pools, perhaps some four billion years ago, that the molecules of life organized themselves. And more than anything else, Earth's claim to uniqueness in the solar system is life. This is indeed the planet where life dominates.

The setting sun colors Mauna Kea's flanks a soft rose, and for a moment the white observatories on its top gleam like beacons. How far we have come from the scuttling crabs here on the lava to the women and men up there who even now are opening the domes and pointing their instruments. We are very smart, we humans, but are we intelligent enough to absorb the lesson our grand glimpses of our sister planets have given us?

We are in a sense like the tiny brine flies I watched hovering above a hot spring in Yellowstone last winter. They spend their entire lives in the thin zone between the instantly lethal water below and the subzero cold just above their wings. How narrow the niche they inhabit! Thank you, Mars. And Venus, Io, Triton, and company. You are helping us see that the distance between fire and ice is not great for us either. □

YOSEMITE—FOREVER?

BRIDALVEIL FALL EXPLODES WITH RECORD SNOWMELT, SPRING 1963

"God himself seems to be always doing his best here," wrote John Muir of the national park high in California's Sierra Nevada. Sometimes abused and overused, Yosemite will survive only if man does his part.

By DAVID S. BOYER
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by
JONATHAN BLAIR

WITH A LITTLE FROWN of pain the old ranger hung up his new hat and put on his old one—a hat made famous by Smokey Bear. Its leather band was cracking with age, and its silver National Park Service insignia, the cone of the giant sequoia, was tarnished. At age 81 Carl Sharsmith doesn't want to retire either himself or his beloved old hat.

He was back at his tent quarters after a long afternoon with tourists. His nose was flaked white and red with sunburn; his eyes were watery, partly from age but also from disappointment at hearing again an old question after a half century of summers in California's Yosemite National Park.

Carl's narrow shoulders and slight figure seemed not much more than a thin, bent sigh. The slump of his body he'd acquired from hunching over the handlebars of his bicycle and the steering wheel of his 1936 Ford. That, plus decades of scrubbing his shirts over a wooden washboard; Carl disdains those automatic washing machines.

A lady tourist had hit him with a question where it hurt: "I've only got an hour to spend at Yosemite," she declared. "What should I do? Where should I go?"

The old naturalist-interpreter-ranger finally found the voice to reply:

"Ah, lady. Only an hour." He repeated it slowly. "I suppose if I had only an hour to spend at Yosemite, I'd just walk over there by the river and sit down and cry."

STANDING OUTSIDE his tent, Carl showed me his ancient green convertible. It has more than 200,000 miles, a rumble seat, and a canvas top "replaced only once." Seasonal ranger Sharsmith has commuted all these years from another job, professor of botany at San Jose State University. He's the most popular naturalist in one of the world's best-loved national parks.

It's a park where snow-fed mountain streams plunge over the brink of some of the world's highest waterfalls and, transforming themselves into diaphanous wedding veils, drift hundreds of feet down near-vertical walls into Yosemite Valley. The valley, sculptured by ancient invasions of ice, is an enormous unroofed cathedral, at its apse a soaring granite altar called Half Dome. Here to worship, with their palettes and cameras, their pens and inspirations, are congregated the painters and photographers and poets; with their coils of rope and visions of ascent, the aspiring climbers; and with their eyes turned upward, the crowds of tourists, stunned and standing in attitudes of awe.

Beyond the valley rim rises the high country, where giant domes of once molten granite bubble up into the blue sky, great white mushroom mountains trying to challenge their counterpart forms, the cumulus clouds. The park is a fantasia of geology and an exhibition in geography—a world of nearly 1,200 square miles carved by rivers, chiseled by glaciers, shrouded by forests, and shaken by storms and earthquakes into a wonderland of dangerous wilderness.

It is also the inspiration for all the national parks in the world. In the midst of the Civil War, before most people even heard of Yellowstone, Abraham Lincoln signed a bill to protect Yosemite Valley and the Mariposa Grove of Big Trees.

Yosemite's closest friend in its early days was pioneer conservationist John Muir. He worked for years to have it protected and ultimately declared a national park; it was, in 1890. On his solitary expeditions, carrying perhaps only a few crusts of bread and a notebook, he explored its every corner. In

Doyen of Tuolumne Meadows, *Dr. Carl Sharsmith, amusing himself with "my old squeeze-box" (**facing page**), has led old and young to experience nature firsthand since becoming a ranger-naturalist here in 1931. The botany professor points out wildflower cycles and, for fun, dons a mustache of ricegrass.*

First view of Yosemite Valley: *A sweeping panorama greets visitors entering the seven-mile-long glacier-carved valley, just as in 1851 when Indian-chasing California volunteers first saw it. Within five years horseback parties were coming*

to marvel at 620-foot Bridalveil Fall and the 3,600-foot face of El Capitan, left, touched here by a westering sun. Towering pines, firs, and incense cedars conceal campgrounds and lodges that accommodate 1.8 million overnight stays a year.

***Passing along a love** for Yosemite, Californians Mary and Leroy Loveall (**right,** seated at center) bring their family every summer. Son Lee and daughter Rosemary, foreground, have hiked most of the backcountry, imbuing Rosemary with such a love of wilderness that she majored in forestry. Lee's wife, Jane, an art teacher, left, travels with her sketch pad. The Lovealls applaud recent park changes, such as reserved campsites limited to six people and a week's stay and shuttle buses to ease traffic. The family gathers deadwood for fires; others buy at a local store (**below**).*

his journals, with insight and passion, he described its every view and vibration, its sounds and smells, its wildlife and its weather, its cathedral walls and temple spires, and all of it, in his mind, part of a cosmic concept related to God.

Yosemite lovers, with Carl Sharsmith among the most faithful, have carried his books ever since—holy writ in a backpack or a glove compartment.

Given Carl's wages of $8.21 an hour, after all these years, his devotion to this land can only be classified as religion. For three generations he has delivered the gospel of John Muir; college kids who held hands on his nature walks have returned with their children and their children's children.

One day I watched Carl fall to his knees in a crowd of all ages, and there in a meadow, within the 12-inch circle where he had thrown his hat, he helped the kids identify three species of grasses and four kinds of wildflowers.

ALTHOUGH it's the size of Rhode Island, Yosemite isn't nearly as big as Yellowstone. Nor as deep as the Grand Canyon. Nor does it shelter as many deer

and bears as the Great Smokies. Still, when you consider the superlatives of the park—those proclaimed by poets and painters and photographers (including the late photographer laureate Ansel Adams), those by Presidents (Theodore and Franklin Roosevelt among many), those by royalty (Queen Elizabeth heading an impressive list), and those by ordinary citizens like me—Yosemite clearly emerges as the "Mona Lisa" of the wilderness. Making the pilgrimage to see her every year are some 2.6 million people, and nearly 15 percent of them come from foreign lands.

The Japanese come in platoons consigned by tourist agencies. One morning I witnessed a congregation of them singing in the high country, conducting, it seemed to me, a religious rite related to nature. They had gathered around a group of wind-twisted little pine trees, trees rooted tenuously in cracks on a forbidding granite slope, trees stunted and crooked and straggly, yet this day touched with a strange new charm. Here was a moment of Far Eastern reverence, set in a fragment of the American West reminiscent of a Japanese bonsai garden.

As the old romantic of the Sierra, John

YOSEMITE
NATIONAL PARK

Timetable of preservation. *1864: Congress gave Yosemite Valley and Mariposa Grove to California for public enjoyment for all time. 1890: Congress made the surrounding high country a national park. 1906: The valley and the grove reverted to the federal government and joined the park.*

VEGETATION

- Alpine
- Subalpine
- Red fir
- Mixed conifer
- Chaparral, oak woodland
- Giant sequoia

Dorothy Lake Pass
Forsyth Peak
Tilden Lake
PACIFIC CREST TRAIL
Matterhorn Peak
Benson Lake
Pate Creek
Wilderness
Yosemite Creek
Wapama Falls
Hetch Hetchy Reservoir
GRANDEUR OF THE YOSEMITE
Muir Gorge
Mt. Conness
GLEN AULIN
Tioga Pass
TUOLUMNE MEADOWS
Tuolumne Falls
WHITE WOLF LODGE
TIOGA ROAD
Mt. Hoffmann
MAY LAKE
Cathedral Peak
Parker Pass
Tenaya Lake
JOHN MUIR TRAIL
HODGDON MEADOW
McGurk Meadow
Tuolumne Grove
CRANE FLAT
Tenaya Creek
SUNRISE
VOGELSANG
Yosemite Valley
ENLARGED BELOW
MERCED LAKE
Merced River
Donohue Pass
Mt. Lyell
Fissure Dome
BADGER PASS SKI AREA
Illilouette Creek
Mt. Clark
WAWONA HOTEL
Chilnualna Creek
Buena Vista Peak
Triple Divide Peak
Mariposa Grove
South Fork Merced
Bridalveil Creek
WINQUAPIN
Sacramento
San Francisco
CALIFORNIA
YOSEMITE
Los Angeles
NEVADA

EL PORTAL
Owned by the National Park Service but outside Yosemite, El Portal will be home to park administration.

Road
Trail
Shuttle bus
High Sierra camp
Campground
Ranger contact station
Accommodations

Yosemite Valley

Upper Yosemite Fall
Forbidden Wall
Lower Yosemite Fall
YOSEMITE VILLAGE
PARK HEADQUARTERS
AHWAHNEE HOTEL
YOSEMITE LODGE
CAMP CURRY
North Dome
CLOUDS REST TRAIL
Half Dome
HALF DOME TRAIL
JOHN MUIR TRAIL
EL CAPITAN TRAIL
Ribbon Fall
El Capitan
Rainbow View
Merced
TUNNEL
Inspiration Pt
Cathedral Rocks
El Capitan Meadow
Bridalveil Fall
Sentinel Fall
Sentinel Dome
Sentinel Creek
Glacier Pt
Vernal Fall
Nevada Fall
Illilouette Creek
Illilouette Fall

Muir could hardly have imagined Yosemite's modern troubles and dangers.

He himself lived with the pulse of wildness—exulting in the crash of earthquakes and avalanches, climbing to the swaying tops of trees during violent windstorms, clinging at the edge of roaring waterfalls, confronting bears or rattlesnakes without flinching. He would be dismayed at what he could encounter here today—an anomaly of unprepared humanity, an assault of city people on his once virgin wilderness, an almost urban scene of congestion, accidents, overcrowding, and, yes, crime.

Superimposed on Yosemite's poetic topography, the turmoil and cacophony can seem like trauma in paradise. I was experiencing it all for the first time. And watching a harassed Park Service trying to protect Yosemite forever.

The trouble began some decades ago, an ongoing struggle to determine whether this park (and others) can be preserved, happily visited by the millions annually who have a right to come, without turning Yosemite into something approaching a Disneyland.

The problem is how to guarantee some sense of solitude for tomorrow, while coping with the crowds of today. Crowds, and commercial operators who provide them with everything: tourmobiles, bicycles, horses, and river rafts; swimming pools, ski lifts, a golf course, and an ice rink; backcountry tent camps, housekeeping cabins, a luxury motel, and $120 hotel rooms; hiking boots, backpacks, and a climbing school; grocery stores, cafeterias, and cocktail lounges with large-screen TV; film processing, Yosemite T-shirts, and souvenirs made in China.

For many years the pattern was for more and more people. More hotels and motels. More fun and games. Entertainment instead of wilderness. Even proposals for an aerial tramway, to scar the cathedral sky with cables to the valley rim. One development plan was scrapped when the public, led by irate conservation groups, rose up in letter-writing wrath. Photographer and conservationist Ansel Adams, whose superb pictures of Yosemite are world renowned, participated in the campaign.

"We won some battles," this patriarch of the park told me just before his death last year at age 82. "But the war isn't over."

Now guiding the park's future is a general management plan, to be implemented over 10 to 15 years. Among its goals: designation of 89 percent of Yosemite's 760,917 acres as protected wilderness, never to be developed; relocation of many Park Service and concessionaire's buildings outside the park boundaries; cutting back cabins and overnight facilities other than campgrounds. The eventual aim is to eliminate private vehicles altogether from congested Yosemite Valley, now beset by an average of 14,000 visitors daily from June through August.

ROBERT O. BINNEWIES is the latest park superintendent appointed to cope with this human tide. A former vice president of the National Audubon Society, he does so with a slight conservationist tilt and an easy, open smile.

"We had to slow down the stampede, even cut some people off at the pass," Bob said. "Our free shuttle buses have reduced the traffic jams. Our advance reservation system works. Even for campsites and permits to hike into the backcountry. Most people now realize they'd rather wait, to enjoy a quality experience, than fight for a campsite or have to line up at an overused toilet."

I knew what Bob was referring to. Not many years ago, as one old hand put it to me, "So many campers arrived every night, lashing onto each other's tent poles in the darkness, that when somebody would strike his tent in the morning, the whole campground would fall down."

"Our new plan at least holds the line," Bob Binnewies continued. "We're reducing some of the pressures and some of the commercialism. We're transferring some staff outside the park. The Curry Company is too. Between us, we've got 3,400 employees and dependents. Part of the overcrowding enemy was us."

The Yosemite Park and Curry Company is today owned by a southern California entertainment and recreation conglomerate, MCA, Inc., and it holds the sole contract for all accommodations and services in the park.

Even in John Muir's day there were cries against "money-changers in the temple." Commercializers operated rival hotels and restaurants, even charged visitors to walk up their private trails, double if they rode

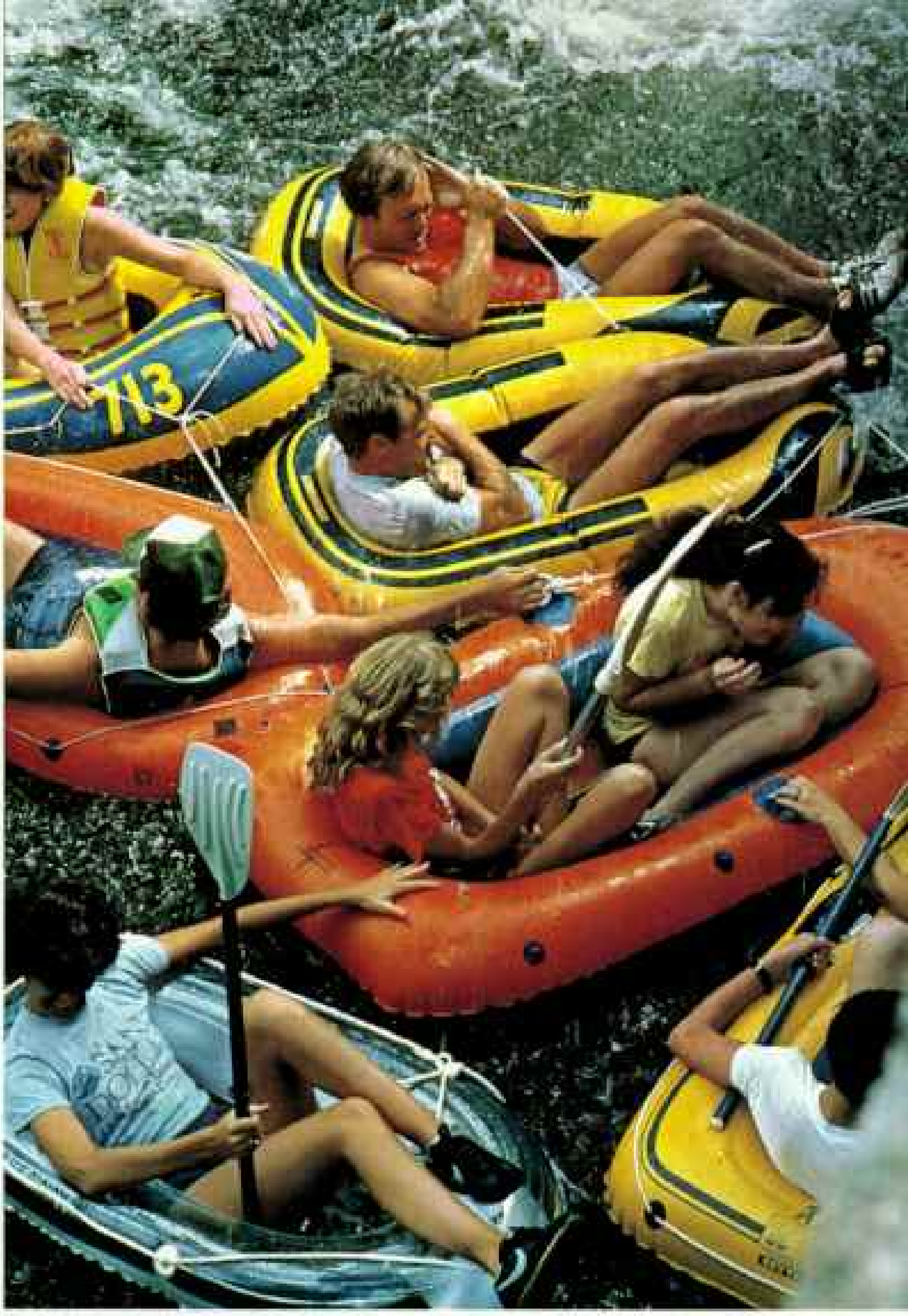
horses. Over the years the Curry family edged out competitors, and for decades the park's commerce thrived under the regime of "Mother Curry." The monopoly was actually encouraged by the Park Service, on the theory that one was easier to deal with than many. It set a pattern for many parks.

"We'll probably have private concessionaires for years to come," Bob admits, "though someday, I hope, we'll graduate to a nonprofit system. The public, after all, owns the parks."

Meanwhile, he said, "Ed Hardy understands our objectives." Ed Hardy manages Curry today. Bob smiled: "We're finding compromises together."

As Hardy himself told me the next day: "If we don't try to be conservationists ourselves, if we ruin Yosemite, we'll cut our own throats. But serving the public is complicated. Some people won't come, particularly older folks, unless it's first class. They'll pay $30 a day for a horse in the backcountry, plus $50 for a bed in a tent and three tablecloth meals. Not everybody wants to stagger in under a 45-pound backpack. Not everybody is physically able to."

However they come, people add to the problems. From Los Angeles to San Francisco and beyond, Californians have turned Yosemite into a backyard playground. On summer weekends they roar up here



Confronting nature *with caution, first-time valley visitors often start with an $8.75 tram tour of the main sights, here Bridalveil Fall to Half Dome (**above**). Others try rafting on the Merced (**upper right**), an activity so popular it can turn five miles of river into a congested expressway. Many seek out wildlife and cause traffic tie-ups when they find it. This mule deer (**right**) roams its meadow unconcerned; pets must be leashed and kept off trails.*

Yosemite—Forever?

Soaring like a hawk, *Eves Tall Chief gets a unique view of Half Dome, right, after leaping from Glacier Point, 3,200 feet above the valley floor. A 20-minute glide carries this veteran of 90 Yosemite flights to a smooth landing and a champagne celebration* ***(above)****. A dozen advanced hang-glider pilots embark each morning, but they fly only by reservation with the Park Service.*

bumper to bumper (too many of them with bottles) to escape oppressive heat or depressing fog. Or just the unmerciful tension of their unrelenting cities; a few simply come to sit on the banks of the "Mercy" for an hour to cry. (The river's real name, Merced, is the Spanish word for mercy.)

Almost every day some get into trouble.

"We have to rescue lots of people," Linda Abbott told me. She's secretary to chief ranger Bill Wendt. "They must think this is television or something. They don't believe us, that accident or death is waiting at every river or waterfall, on every rock or cliff."

Yosemite's glacier-polished granite erodes into coarse sand. It's like buckshot under your shoes, when you're posing near the edge of a cliff or waterfall. As Linda says, "It can shoot you off into eternity before your wife can snap the shutter."

Recovering the bodies is part of Mike Durr's job. He averages 12 a year, and for

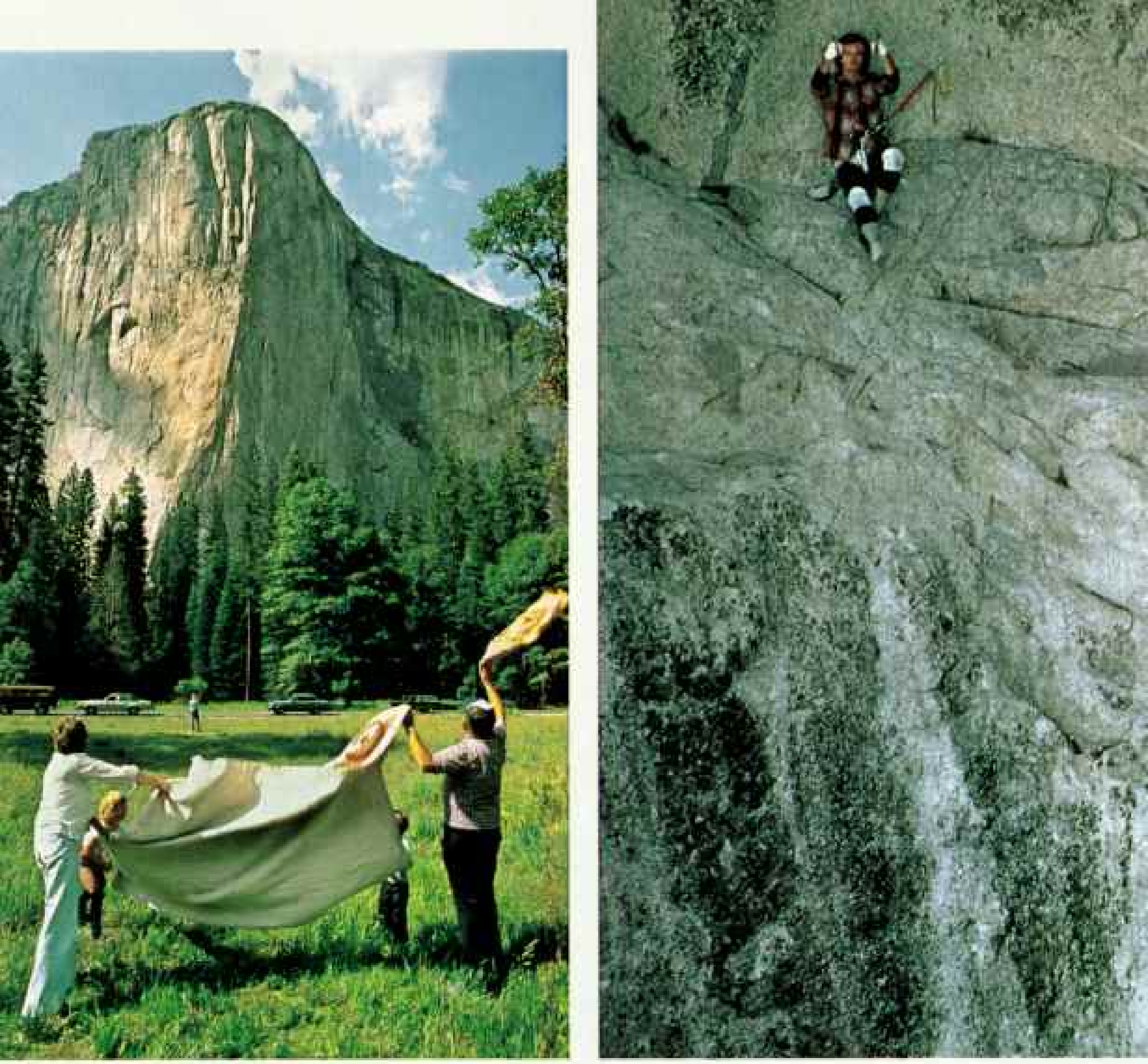
EVES TALL CHIEF AND JONATHAN BLAIR

every body taken to the morgue, he delivers 33 to the hospital.

Often I heard Mike on the park radio or saw him or his crews rappelling out of helicopters, treating medical emergencies, performing rescues. One search involved 110 people; 20 of them were volunteers, who had driven all night from all across California, then had been helicoptered into the backcountry with their German shepherds and bloodhounds.

It took three days to find the lost climber. He had done everything wrong. He'd gone alone. He'd left the marked trail. He'd attempted a new and unestablished route up Half Dome. When he fell, it was 700 feet down a rock chute, and he was dead before he hit bottom.

During those awful days of waiting, I spent time with his parents, his brother, and his girlfriend. For them it was terror and tragedy. For everyone it was sobering;



*"**That's awesome rock,** and I'm coming back," declared Robert Muchnicki, who, despite an injury suffered while climbing Half Dome, reflects the worldwide enthusiasm of rock-climbers for the granite faces of Yosemite. Muchnicki and his partner set out to try Half Dome's northwest face, beginning the climb at 5 a.m., using headlamps. Halfway up, a granite flake about four feet by eight ripped away and glanced off Muchnicki's foot, breaking a bone. For the next eight hours he and his partner rappelled down, aided by other climbers. Here Muchnicki, resting on a ledge (**above**), signals thumbs-up to a rescue helicopter. Racing a setting sun, he hobbles to the craft (**right**), followed by ranger Gary Colliver at right.*

*Climbers on El Capitan are cheered on by waving friends and family (**above left**). "Dangerous as it looks, we lose more scramblers than climbers," chief ranger Bill Wendt reports of the amateurs who climb up on rocks and can't get down, or try shortcuts—and slide into space. Yosemite recorded nine accidental deaths in 1983, six from falls.*

many lives had been risked in the search.

The most difficult rescues are for the climbers, hurt or killed or marooned on vertical canyon walls. The most frequent are for the backpackers, with sprained or broken ankles. Mike gives illustrated lectures on park accidents and urges people to respect this wilderness. "You can park your car anywhere here and be in trouble in five minutes," he says.

THE PARACHUTISTS bother Bill and Mike the most. They jump, illegally, from the tempting heights of Half Dome or El Capitan. They launch before dawn or after sunset, hoping to land undetected; but too many hit the cliffs going down or crash in the rocks at the bottom and then lie there, undetected, with broken bones or concussions.

Fortunately for one of them, my photographer colleague Jonathan Blair spotted a black parachute whooshing down out of the darkness from El Cap. Its daredevil owner, before climbing up, had used rolls of white toilet paper to mark out a safe landing site. In the darkness he missed his target, and began paying a heavy mortgage on a few moments of unlawful flight.

Crash-landing on a giant boulder, he suffered compound fractures and head injuries. His U. S. Navy parachute, worth about $4,000, was seized. The ambulance ride of a hundred miles cost hundreds of dollars. The Annapolis graduate also underwent two hospital months of bone repair and therapy, and wound up with a short leg and washing out of naval flight training.

Returning to Yosemite's federal court, he was sentenced to a year on probation and

given a $500 fine, a record finally cleared. For the Navy the cost included thousands of dollars in hospital care, plus the loss of a pilot. For the Park Service there were the costs of rangers, patrol cars, emergency aid, delivering him to the hospital, arresting him, and processing charges against him.

How much tax money goes directly for people who jump with parachutes, fall while climbing, break their ankles, get lost, or fall into rivers or over waterfalls?

"Well, about $150,000 a year," Bill Wendt says. "That's not counting salaries for search-and-rescue teams. Just medical expense, helicopter time, and replacing equipment.

"Parachutists used to be legal," he told me. "But they blew it. They jumped together, trying to join hands in flight. Or took off from skateboards or pogo sticks. Or walked over the edge on their hands. Free spirits are fine, till they get dangerous or ridiculous."

Eves Tall Chief, an Osage Indian from Oklahoma, is a free spirit. He lives to launch his hang glider, still a legal activity, from Glacier Point, perhaps the most spectacular takeoff site in the country, then drift down 3,200 feet out of the heavens into the valley.

Several times I watched Tall Chief shout out his war whoop as he charged off the cliff, then floated back and forth past Yosemite's ramparts and waterfalls. "It's the ultimate thrill," he told me. "Fifteen minutes of eternity. Like being an eagle."

A professional in laser optics, Tall Chief used to drive race cars. "But these wings give you far better butterflies. The last few seconds before you jump, your heart almost stops. They're an eternity too."

There are those who believe that hang

Watch for falling rock! *Such warnings mean it at Yosemite, where granite domes exfoliate outer layers like an onion shedding skin. With a sound like a rifle shot, this slab 18 feet across broke loose high on Turtleback Dome and crashed onto the highway* ***(above)*** *seconds before the photographer drove up. Every spring crews blast visible hazards along 250 miles of park highway.*

In another assist to nature, the Park Service tries to undo one ironic result of a century of suppressing forest fires. During that time white fir and incense cedar have increased in groves of pine and giant sequoias, interfering with their regeneration. Here in a program of prescribed burning ***(left)****, a technician controls a ground fire set to clear out this understory and give sequoia seedlings a chance.*

Sit *"from morning till night under some willow bush on the river bank where there is a wide view," John Muir advised newcomers wanting to see the valley. Thus they might appreciate sunlight streaming over the walls as here at Cathedral Rocks after an August rain. Created deep in the earth, the monoliths were*

sculptured by the relentless scraping of glaciers. The Hetch Hetchy Valley of the Tuolumne River offered similar vistas until dammed for San Francisco's drinking water. Despite the outcry of John Muir, the Sierra Club, and others, Congress approved the action in 1913, an early example of intrusion within a national park.

gliding, like parachuting, isn't appropriate in a national park. But at least the hang-glider enthusiasts obey the rules, and so far their injuries have been minimal. Park ranger Rich Romero, a hang-glider pilot himself, monitors who launches and when.

"Rich won't let you go in bad wind or weather," Tall Chief says. "Nor until he's checked your flying record and your equipment. As he walks you out there to take off, he looks you right in the eye, making sure you're really ready."

"Sure, it's a thrill," ranger Pete Armington admits. "So is climbing. I'm a climber too. But finally you begin to wonder. I've helped carry down too many bodies."

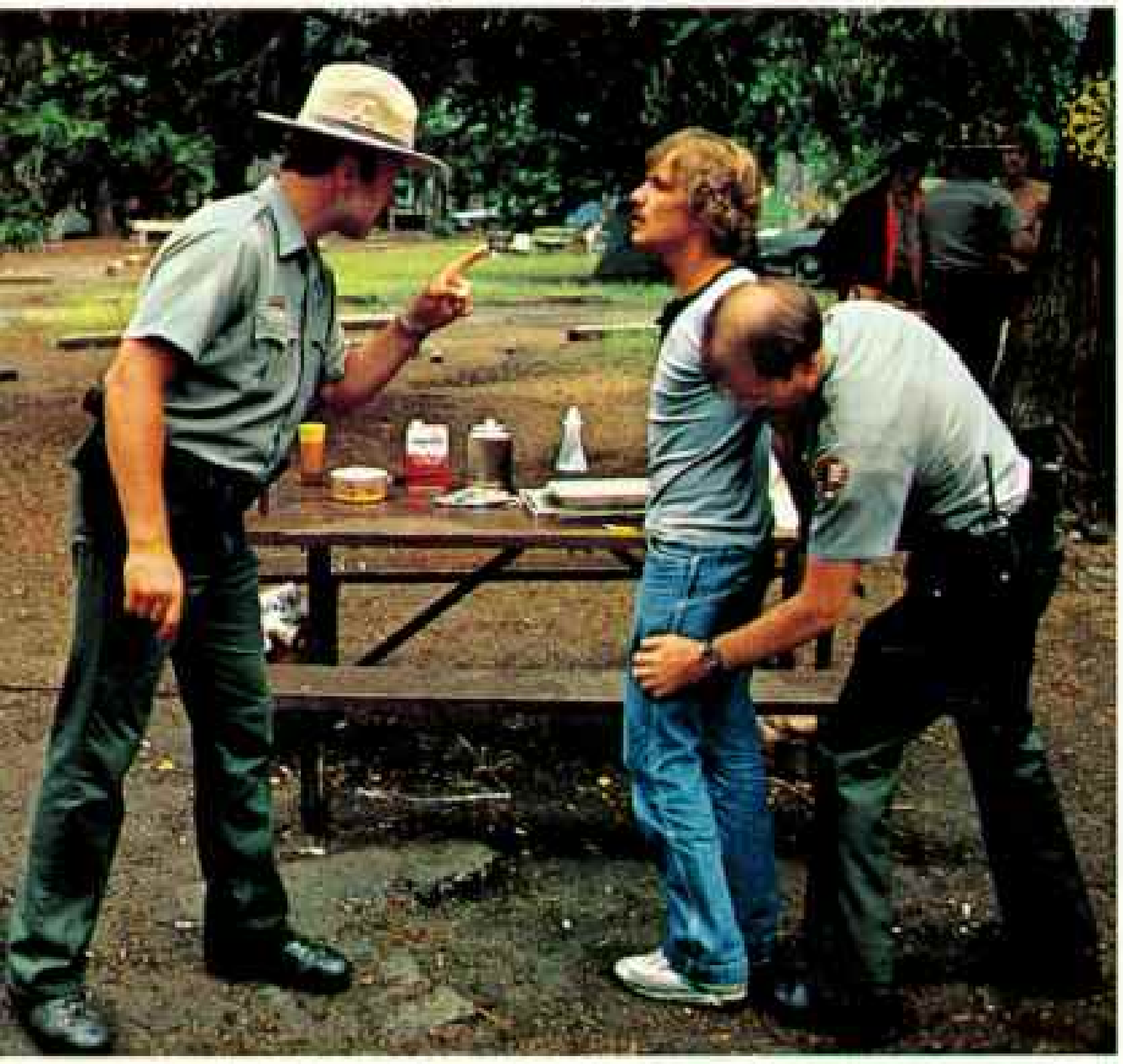
Furthermore, he says, some climbers "are just not the greatest environmentalists. You should see the garbage some of them leave up there on the mountain ledges. Rock-climbing is a traditional Yosemite sport, and I guess it always will be, but I've got reservations about it."

Almost every day in spring and fall, crowds gather like ants at the base of El Cap. Transfixed with admiration or shaking their heads in disbelief, they scan that vast, spectacular wall through binoculars, searching for climbers almost too small for the naked eye. They are roping themselves up, spending as many as five nights tied onto precarious ledges or, slung in hammocks, anchored to the rock face half a mile in the air.

TO TRY TO COMPREHEND their mystique, I read an entire anthology, beautiful poetic phrases written by macho men, commemorating intrepid Yosemite climbs. Strangely, I thought, not one of them mentioned the word "fear." Could climbers be *that* intrepid?

Over the course of five days I checked in apprehensively with Candy Tokheim in the El Cap Meadow. Candy and her three small children occupied an encampment of chairs around a picnic cooler and a telescope. Their husband and father, Joel, was up there, climbing. His parents were in on the vigil too, and his mother, Lorraine, admitted to me, "I pray a lot down here."

Joel did make the top, we all had a celebration dinner, and afterward he answered



***Crime follows** the crowds, and rangers become police, recording 18,000 violations with nearly 600 arrests a year. Since this is federal land, even a parking ticket becomes a federal offense.*

*After a ruckus spread to two campsites, rangers make an arrest (**left**) for disorderly conduct. Those who cannot post bail spend a night in a 16-inmate jail, pending appearance (**right**) at the park's federal magistrate's court.*

Park crime parallels—in number and kind—that of a California community of comparable size. Rangers working undercover for two years recently obtained 80 grand-jury indictments for drug dealing in the park.

my questions: "How could you risk your life and your family's future, while they all watched? And what about fear? Aren't climbers afraid?"

His answers seemed more sincere and human than the cool accounts I'd read by some from Yosemite's climbing hall of fame.

"Well," Joel thoughtfully replied, "before I did it—and I just *had* to do it, you know, I had this awful compulsion in me—I trained for a year. Then I bought enough insurance to support Candy and the kids for three years. In that time, I figured, she could find a better man."

As for fear, well, there in the early hours of the morning, while his family slept, Joel let me read his diary. He'd kept it on El Cap, writing at night or even while belaying his climbing partner. It was full of fear. For three days he wrote about almost nothing but fear; by the fourth day he had gained confidence; on the fifth, as he approached the top, he knew exultation.

"But I'll never do it again," Joel told me. "I don't need to. I'm one of the owners of El Cap now."

AS CLIMBERS attract crowds to El Capitan, Yosemite crowds themselves attract petty thieves and other criminals to the park. Most common targets are the purses, wallets, cameras, and radios left in hundreds of tents and cars.

Today's rangers supplement traditional training with modern police skills and with radios tied to state and federal law-enforcement computer networks. They love this park, furthermore, and they want it seen and not disturbed, by drunks or drugs or robbery, and they sometimes cram Yosemite's 16-prisoner jail beyond its capacity.

I watched rangers at work on horseback and rode at night with one of them in a patrol car. Dan Horner and I started out after dinner, under a full moon that turned Yosemite Falls into luminous gossamer. The spray divided into a glowing spectrum—a lunar rainbow, John Muir called it—but that was our night's only moment of beauty.

Dan ticketed two speeders, then arrested a drunk driver; at midnight we checked out complaints at a Merced River bridge, where teenagers congregate to flirt with

each other and with drugs and liquor.

Throughout the long night he showed little mercy for illegal campers when he caught them sneaking into the park under cover of darkness. Those he found sleeping on the ground or in cars, he made leave the park. The campgrounds were full.

In Yosemite dark-bearded Judge Donald W. Pitts confronts violators in one of the busiest federal magistrate's courts in California. On the day I spent watching him at work, seven of the 21 defendants arrived in orange jail coveralls and handcuffs; two of them, convicts with records of violence, wore leg-irons as well.

The word is getting around that even Yosemite's high country is no place to hide. Backcountry ranger Susan Schulz told me how she and her partner captured a rapist, tied him into a sleeping bag tethered to a post, then slept till they could march him down to jail at daybreak.

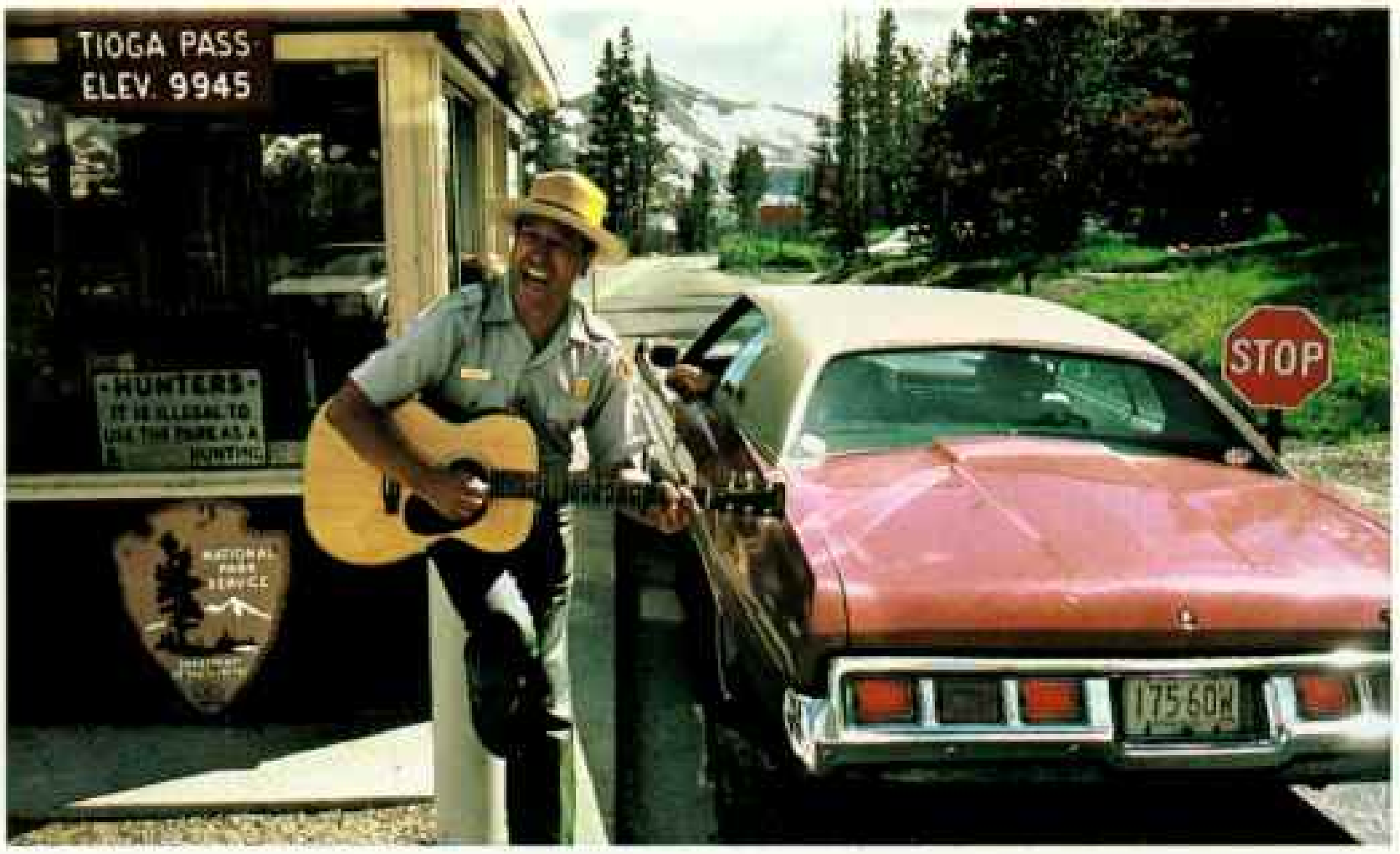
Perhaps the most flagrant burglaries are committed by . . . black bears. Yosemite has possibly 350 of them, many earnestly dedicated to campground thievery.

Climbing the trail toward Clouds Rest, I met two backpackers from Culver City. "We hung our food, even our toothpaste and chewing gum, 20 feet high on a long branch," Charley said. "But a bear brought it all crashing down in the night; he cleaned us out, even the toothpaste."

"And look at this," Laura said. She showed me five foil chewing-gum wrappers, each neatly opened, as if with a fingernail, and empty.

A few miles beyond I met another victim: "This bear stood watching while I packed my food into a sack and roped it far out on a high branch. I figured no way could he get it. But he climbed up, stretched way out, snared the rope with one paw, pulled it down, and ate everything right in front of me. He unscrewed the peanut-butter jar and cleaned it out with his tongue, better than if he'd had a spoon. Don't ask whether he put the lid back on. He didn't."

"No one's ever been killed here by a bear, day or night," ranger-naturalist Jon Kinney told me. "Though all reports indicate the bears are twice as big at night.



Sometimes a serenade, *always a salutation meets up to 2,000 cars a day entering Yosemite at Tioga Pass, highest road across the Sierra. "No entrance is prettier," says Ferdinand Castillo, who has worked as a seasonal ranger for 31 summers. "The key word is enjoy," he says. "And watch out for rocks." The scenic east-west highway is closed in winter, sometimes lying under 20 feet of snow.*

"People sometimes ask what bears do all day in the high country. Mostly, I think they just sleep and dream about all the perspiring backpackers plodding up the trails loaded with prime steaks and ham, pancake mix and strawberry jam, nuts and raisins and chocolate bars.

"When people and bears get to quarreling over the food, we try to determine who started it. If it was the bear, we just tranquilize him and carry him off into the backcountry. But too many campers foolishly keep leaving food in their tents, against park regulations. Sometimes we'd like to ship them off to the backcountry—or wherever they come from."

HIKERS are supposed to stay on the trails, but they too often don't. I saw dozens of their shortcuts on the switchbacks; it means plants and flowers get crushed; it starts erosion, which leads to gullies and washouts.

Ranger Ferdinand Castillo has a particular problem with it. Hundreds of people stop every day at his 9,945-foot-high Tioga Pass entrance to the park, and this young-old Mexican American greets them with an infectious grin and gift of gab. He's done it for 31 years and has the coveted Yosemite Award for dedication to his job.

"They'd ruin this beautiful alpine meadow if I didn't keep 'em on the paths," Ferdinand told me. "You should see people walk right up in front of me, standing here in uniform and right under this American flag, and start picking the flowers!"

Ferdinand's cheerful smile can also give way to fleeting shadows of hopelessness at some of the questions tourists ask: "Who plants the wildflowers?" "Which way to Old Faithful?"

There's hope though, he told me. "People used to hack off branches of living trees for firewood or pine-bough mattresses. They don't do that any more." Increasing consciousness about the environment is showing up as new reverence by citizens for their national parks. Despite crowds and commercialism, much of Yosemite's glory is being maintained unimpaired.

For three days I hiked the Tuolumne River's superb upper canyon. Its lower half, once perhaps as spectacular as Yosemite Valley itself, was inundated to form the Hetch Hetchy Reservoir, to fill the taps of San Francisco. At least what I was witnessing now hadn't been destroyed—the Tuolumne dancing and plunging and foaming down this wild stairway of cascades and waterfalls. This wilderness valley was one of John Muir's passions; the decision to flood it nearly killed him.

Down its remaining rocky reach a trail crew was building a handsome granite staircase. Like dedicated hikers, the trail crew, too, had John Muir books in their tents or packs. Most of them were youths enlisted in the California Conservation Corps, modeled on the U. S. Civilian Conservation Corps that worked on Yosemite trails here during the Depression of the 1930s.

Around their campfire these young CCCers told me their motto was "hard work, low pay, miserable conditions." They were proud of it. It was accurate, too, except for the food heaped on our plates by a black-haired, 22-year-old Julia Child named Nadine Azevedo. She'd graduated from splitting rocks to a higher calling, creating gourmet dinners, and this one now hushed everyone for half an hour of sacramental silence in this templed wilderness.

The art of trail building owes a lot to a little guy named Jim Snyder, whose sideburns are partly a tribute to his patron saint, John Muir. For 20 years Jim has developed masonry techniques that he first learned from studying the construction of ancient Greek and Roman temples. Trails, and Yosemite, are his religion.

One day Jim and I climbed up miles of switchbacks to the top of Yosemite Falls. His crew was bringing this trail back from disaster. Four years before, thousands of tons of rock, loosened by earthquakes and water and ice, had collapsed off the canyon wall, wiping out the trail and leaving three people dead and seven in the hospital.

"If it had happened in July instead of November, the toll could have been a hundred," he said. To bring down hundreds of tons of still threatening granite, Jim had been lowered about a thousand feet down the Forbidden Wall to set dynamite charges.

"It wasn't fun," he admitted. "I'd like to have let the rangers do it, but they weren't trained in handling dynamite. So they led

Next door to heaven, *this view from Triple Divide Peak looks to 13,114-foot Mount Lyell, upper left, the park's highest point. To entice hikers into the backcountry—*

89 percent of Yosemite—the Park Service has constructed 770 miles of trails, and since 1916 has allowed concessionaires to build tent camps with dining halls and showers.

*"**Walk away quietly** in any direction and taste the freedom of the mountaineer."*
Hikers follow John Muir's advice descending from Parker Pass, still snowbound in

the climbing and the trail crew handled the explosives. Between us we managed to get the job done."

As we walked up the switchbacks, Jim recited quotes to me from John Muir books in his pack. His avocation is reading (he's taught American history at three colleges and is working toward his Ph.D.). His passion is this park, and his hobby is finding the places where Muir stood or sat a century ago to write entries in his journals.

Holding onto a steel railing, we inched our way down to where Muir defied death to crawl to the vertical lip of Yosemite Falls. "I discovered a narrow shelf," Muir had written, "about three inches wide on the very brink, just wide enough for a rest for one's heels. . . . Here I obtained a perfectly free view down into the heart of the snowy, chanting throng of comet-like streamers. . . . the death song of Yosemite Creek, and its flight over the vast cliff."

That night we hiked in the moonlight to the exact spot, Jim assured me, where Muir first saw Yosemite Creek. I held a flashlight while he read aloud from what Muir had written here: "I see groups of domes rising above the wavelike ridges. . . . glacial inscriptions and sculptures, how marvelous they seem, how noble the studies they offer! I tremble with excitement in the dawn of these glorious mountain sublimities, but I

July 1983 after a record winter fall. Treacherous dips called sun cups form in spring and early summer, a revelation to many of the 53,000 trekking the backcountry that year.

can only gaze and wonder."

The four CCCers with us there in the darkness were as touched as I by the sensitivity of the words and the way Jim Snyder read them. We knew we were all learning about more than just trail building from this disciple of John Muir.

ANNIE BARRETT is one of Jim's trail-crew protégées. It was near the end of my stay in Yosemite when I watched her fitting stone into a switchback stairway and listened to her summation of what this park means to her:

"I stop work sometimes and look down at the valley, and across at Sentinel Dome and Glacier Point, and think how insignificant I am in this wilderness.

"But then I realize that I do have a place and a significance in it. If people were not here, would these mountains and waterfalls be really here? It is the *experiencing* of our world that truly makes reality. The philosophers tell us that."

Annie then sculptured another rock with her hammer, and I watched as she tenderly tapped it into the exact position for which she'd designed it.

"So I'm helping to make the experience both possible and real. After me others can come, to love it as John Muir did. And as Jim Snyder does. And as I do." □

The New Face of

Displaying a high profile, *President of Iraq Saddam Hussein maintains a heroic image with a profusion of larger-than-life posters, such as this one in front of a new shopping complex in Baghdad, the country's capital. Flush with construction*

Baghdad

By WILLIAM S. ELLIS
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by STEVE McCURRY

financed by oil riches, the city exudes a sense of prosperity that masks the grim reality of war with Iran.

THE FRONT LINE of the fighting is less than a day's drive away, yet there is a heavy sense of well-being in this city of myth and legend. The breath of war—that grim rale of agony—wafts here as something spent, like a sea wind too long upon the land.

Now in its fifth year, the conflict between Iran and Iraq has often been in the shadows of world events, although few, if any, such two-combatant struggles have been so costly. Iran's dead may number 500,000; Iraq's perhaps 70,000. The war is costing the latter country close to one billion dollars a month.

Among other things it is a war of sacred law versus secular, a nasty kidney-blow fight in which child conscripts and outrageous tactics, such as the use of poison gas, have been employed.

For all of that. . . .

Turn back to the summer past when Baghdad, the Iraqi capital, was frequently lashed by winds and desert sands. At such times it was possible to walk the streets and, blinded by the mustardy haze, let the mind's eye search out the trails of history and legend. But when the air cleared to exorcise the ghosts of Sindbad and Ali Baba, there was this to be seen: Baghdad rising on the shoulders of the great River Tigris with a brazen presence of peace and prosperity.

As recently as 15 years ago Baghdad was patched with shantytowns. The sanitation facilities were antiquated, most of the roads unpaved. There was not a single first-class hotel in the city. Drained of its passions, Baghdad had only its name with which to evoke the sweetness of Arabian nights.

Elsewhere in Iraq, oil was being drawn from in-ground reserves of an estimated 100 billion barrels. When the decision was made to rehabilitate Baghdad, costs were of minor concern. By 1980, the year the war started, exports of oil had reached 3.2 million barrels a day, earning 25 billion dollars in that year

Islam's jewels, *turquoise-tiled domes and minarets of mosques like the 19th-century Haydar Khanah, foreground, adorn the left bank of the*

Tigris. Islam thrives in Iraq, with 55 percent of the population following the Shiite branch of Islam. About 40 percent are Sunni Muslims.

CITY OF CALIPHS, Baghdad was founded in A.D. 762 by Abu Jafar al-Mansur, who commanded 100,000 workmen to build a round city. It shortly outgrew its walls and by the tenth century was among the world's largest metropolises, rife with riches and knowledge. But a Mongol invasion in 1258 presaged decline and centuries of destruction. Today's Iraq was created by the British after World War I from a remnant of the Ottoman Empire. The country holds oil reserves of some 100 billion barrels. Although the Iraq-Iran war has halted exports through Syria and the Persian Gulf, construction of proposed pipelines through Saudi Arabia, Jordan, and Turkey **(right)** *should help assure the flow of oil abroad.*

alone. Some of the world's best architects and engineers were invited to Baghdad and commissioned to design and build a capital city worthy of a nation aspiring to leadership of the Arab world.

"The major development started in 1979, and by 1981 Baghdad was one huge construction site," said Husham al-Madfai, deputy mayor of the city. "We were working against a deadline. We wanted things to be ready for the meeting of the nonaligned nations scheduled to be held here in 1982. But the meeting was switched to another country because of the war."

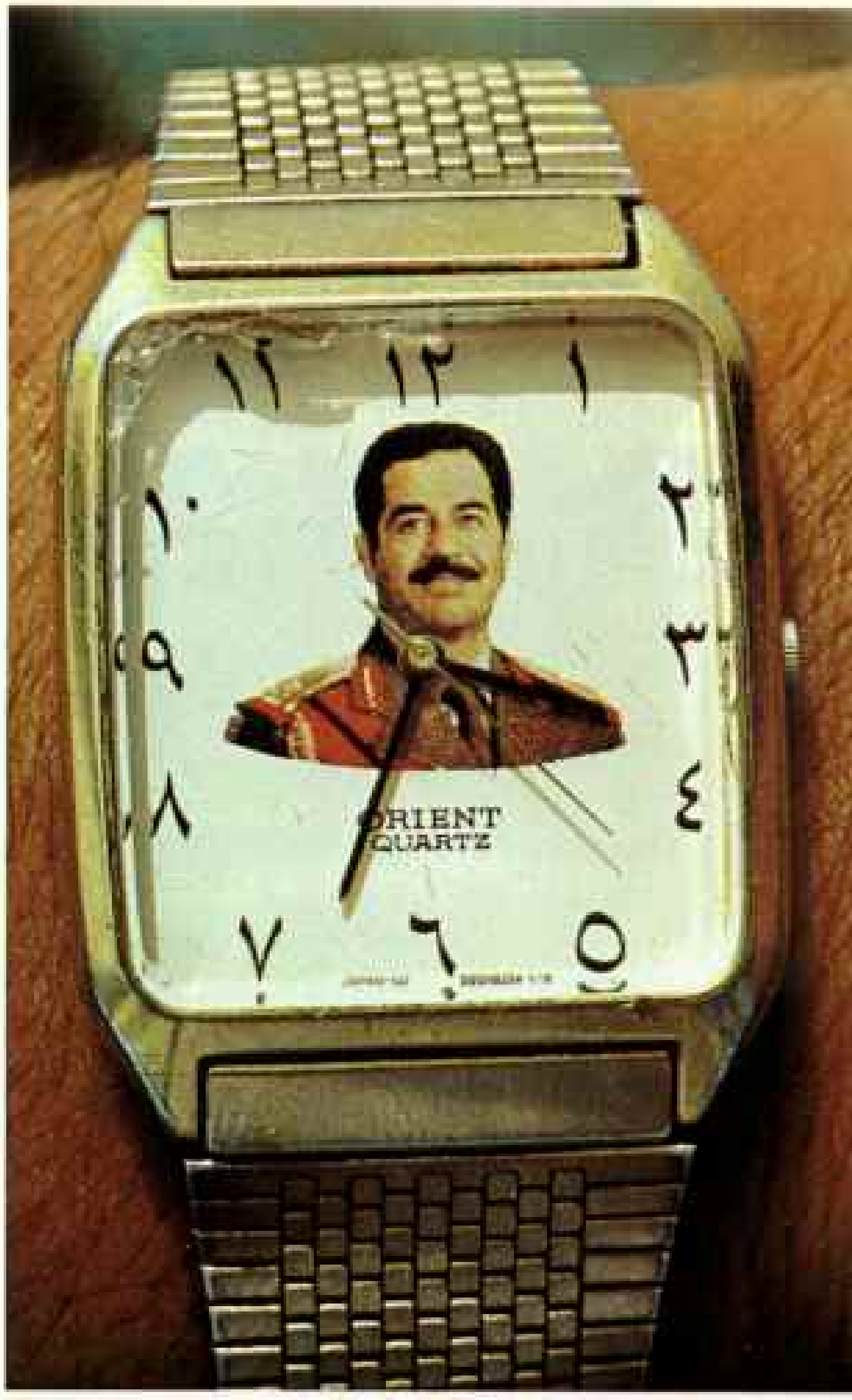
Although jilted, Baghdad still wore its wedding gown. And so the round walled city founded more than 1,200 years ago by the Abbasid Caliph Abu Jafar al-Mansur is today a wartime anomaly, a gathering of luxury hotels and block after block of modern apartment complexes. Hundreds of miles of new sewer and water lines have been laid in the ground, while above, a network of superhighways traces around and through the city. There is a new airport. There are new government buildings. Twelve bridges now cross the Tigris along its course through the center of Baghdad.

Monuments of grand scale, rich and cryptically symbolic, have been erected in Baghdad, along with many lesser works depicting some of the fanciful tales from Baghdad lore. On Sadun Street, for example, a traffic circle carries as its centerpiece a huge bronze with a scene from "Ali Baba and the Forty Thieves" as its theme. For good or ill, depending on the artist, the street art is plentiful, and none more so than the omnipresent portrait of Saddam Hussein, President of Iraq. Mustached and toothy, he beams from billboards, from the walls, from storefronts, even, alas, from the faces of wristwatches.

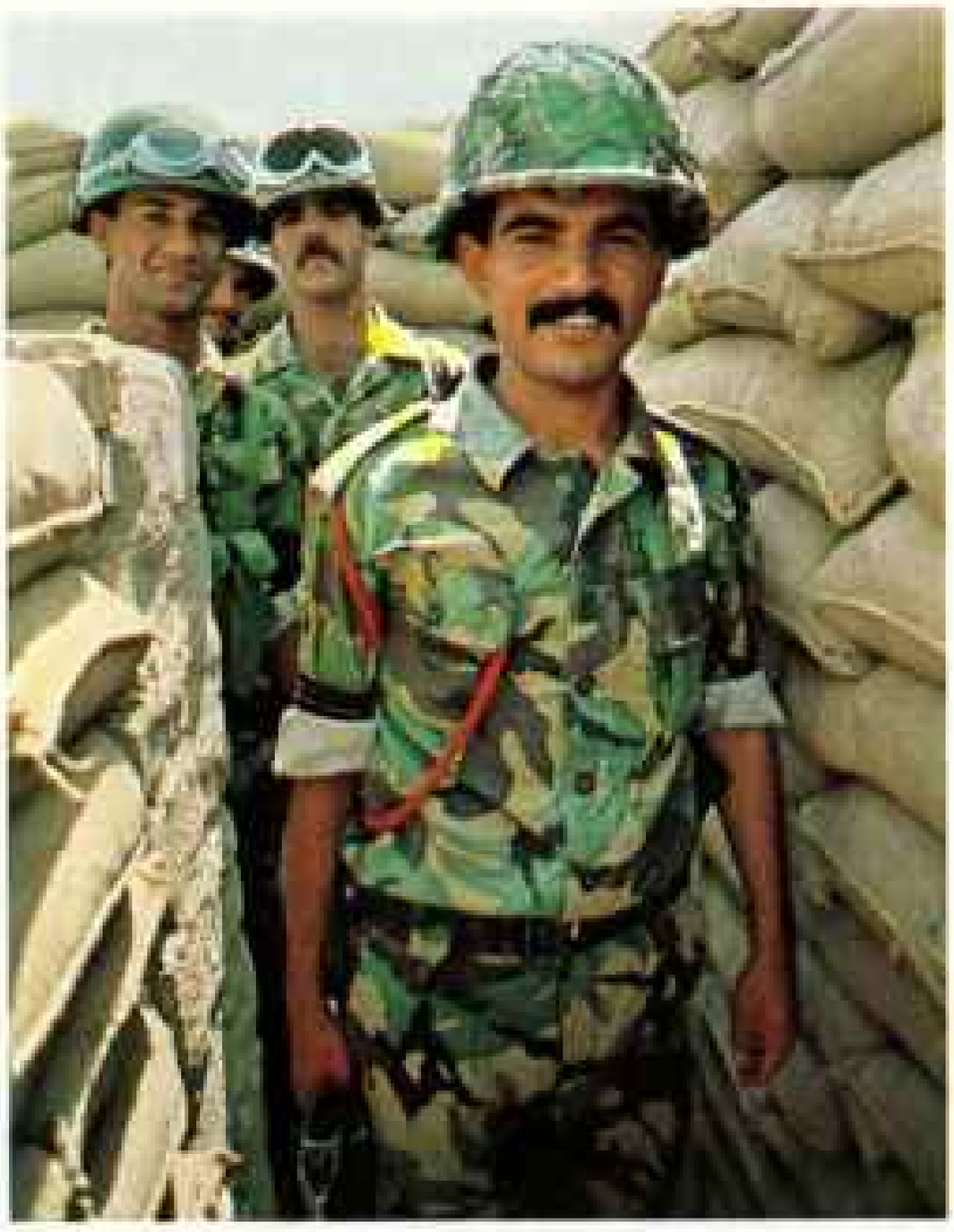
You see few posters on the streets exhorting the citizenry to greater wartime efforts. Iraqis in Baghdad are reluctant to speak of the war. They seem to have shut it out of their minds and certainly out of their city. Outside observers are taken to the front in a bus, there to walk through a trench, eat with the troops, and be briefed on the terrible fate awaiting Iranian forces massed on the border should they decide to launch an offensive. It is all programmed and carefully timed, not unlike a pit stop at Daytona.

And when the bus leaves for the return to Baghdad, the war is left behind, barred from the city by a wall of insouciance.

THE NEW FACE of Baghdad has gone largely unnoticed by the outside world because access to Iraq by foreign journalists is tightly controlled. And most who come are here to cover the war. Also, unlike Cairo, this is not a city with a



As time goes by, *Saddam Hussein's rule by personality seems to grow, enlarged by the conflict with Iran. His nightly TV appearances often feature visits to the front. President since 1979 and leader of the ruling Arab Baath Socialist Party, Saddam pushes a mix of socialism and Arab nationalism.*



Fifteen minutes at the front

I SWELTERED in the heat of Baghdad; it must have been at least 110°F on that summer day last year. I was squeezed into a bus with 60 other journalists. We just sat. And sat.

Finally, after three hours of waiting, we left for Basra on the southern front. The spokesman from the Ministry of Information had said we would travel to the best places for picture coverage and could photograph everything. But not quite yet. We weren't allowed to photograph anything from the bus. "No pictures. No pictures," they kept saying.

*Eight hours later we arrived at Basra. Although we could walk around town, pictures were forbidden. The next day we drove by gun emplacements and barbed wire to the trenches, where things were quiet. I raised my camera to photograph a soldier standing in a trench, and he said, "No pictures." I turned and saw a TV crew filming another group, so I photographed it. Dressed in crisp new uniforms (**top left**), the soldiers stood around doing nothing, laughing at the foreign photographers. After shooting a few frames, we were told to leave. I had spent a day and a half in a hot, dusty bus to cover 15 minutes of a non-event. We couldn't photograph any guns or tanks—just one trench.*

*Earlier I had visited Zawra Park in Baghdad (**left, middle**), where the government exhibits captured Iranian tanks, U. S.-made and sold to Iran when the shah was in power.*

*The government also arranged a tour of a POW camp at Ramadi, 70 miles west of Baghdad. It's a showplace, obviously. We went to the kitchen to watch meal preparation. The prisoners played football for us. These fellows (**left**) tell you how great they are treated and how evil Ayatollah Khomeini is. It seems a practiced routine.*

—STEVE McCURRY

character that invites attention, or embraces visitors with warmth. In truth, Baghdad is a city with great age but little soul.

It may be that too much of its historic fabric has been shredded by all the new construction. Ihsan Fethi, a professor of architecture at the University of Baghdad, is working to save what is left.

Fethi began his campaign 15 years ago to preserve some of the old traditional houses of Baghdad. He was raised in such a dwelling, and he remembers it as a cool and pleasant private world.

"Each house was built around a courtyard," Fethi said. "It was inward-looking, sealed off from the street on the ground floor except for a single door. It was cool and shaded, with pipes on the roof to trap the breezes and circulate them all the way down to the cellar. Now the houses look outward, have big windows, and therefore heat. The privacy is gone, so they build high fences. That's twisted logic, in my opinion."

It was the custom to sleep on the roof of the house on summer nights and to retreat to the cellar for the afternoon nap. "Even in a humble house the cellar was rather elaborate," Fethi said as we walked through Bab al-Shaykh, an old district of the city he had gotten designated as a preservation area. "As you can see, the houses are works of art." Almost all had overhanging balconies and oriel windows with closely woven screens of carved wood *(mashrabiyah)* to allow viewing out on to the street but not in.

Now there were craftsmen from India restoring the houses—replacing the rotted timbers, painting over old, good stains of family life.

What cannot be brought back is the covenant of the neighborhood. That is gone forever. The neighborhood coffeehouse, where the men gathered to smoke and play dominoes and dared to host seditious thoughts—that is gone. They go now to the community swimming pool. Wash once unfurled to the wind is now toasted dry in machines, and there is talk in Baghdad of static cling.

"The change in life-styles is of great concern to us," said Deputy Mayor al-Madfai. "There are social problems involved, but the fact is that the people need more and better housing, more paved streets, better water supplies, and so on. There is the danger that Baghdad will lose its character, but we are taking measures to combat that. That is why we have preservation areas and why we insist that our history, our heritage, be reflected in much of the architecture."

So it is that one of the new hotels has an exterior resemblance to the Hanging Gardens of Babylon.

IT IS STILL POSSIBLE to find vestiges of the Baghdad that was the richest city in all the world, the Baghdad with Mongols at the gates and caliphs in their harems. The old suq is still there, spilling out of a labyrinth of arcades and narrow streets. A great din arises from the place in the market where coppersmiths beat out designs on the metal, and in another section there are bins filled to overflowing with spices and herbs. There is frankincense, and kohl with which to darken the eyelids. And there is saffron, bright orange and pungent.

Elsewhere in the suq there is an old man who has for sale a pocketwatch with the word "Constantinople" on the face, a legacy from the Ottoman occupation of Baghdad. He winds it with a key, and the tick is soft but strong, like rain falling on a lake.

"How much?" I ask.

"Many dinars," he replies.

"How many?"

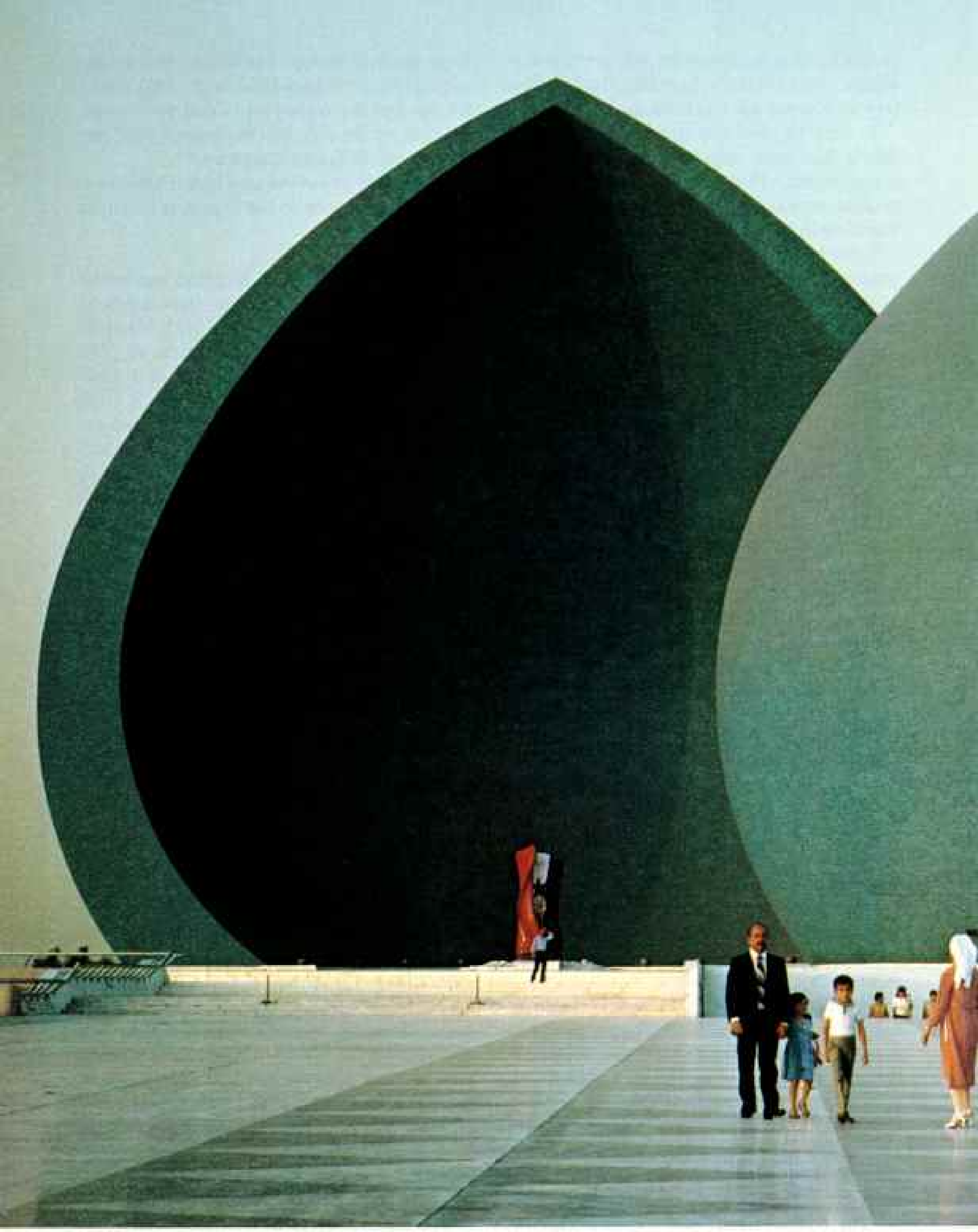
"One hundred twenty-five [$400]."

"That's a lot of dinars."

"I told you."

The suq will survive the severe modernization of Baghdad, as will the 13th-century Mustansiriya School, a seat of learning of wide renown during the time of Abbasid rule. Erected in the same era and still standing is the Abbasid Palace. The Khan Murjan, a building of architectural distinction and significance, was built a century later. Designed for use as an inn and a place where traveling merchants could stable their horses, the Khan Murjan has a central hall more than 45 feet high (page 108). There are crenellated arches of brick, and perforated windows through which sunlight filters.

The Khan Murjan now functions as a restaurant, and, as restaurants go in Baghdad, one of some merit. For nearly 200 years the building was in disrepair, with water standing waist-high in the hall (flooding of the Tigris and heavy seepage from the high



Expressing monumental grief and pride, *this 150-foot-high tiled dome, split in half, commemorates Iraqi soldiers killed in the war with Iran. Known as the Monument of Saddam's Qadissiya Martyrs, it also honors the memory of an A.D. 637 battle when Arabs defeated the Persians, thereby conquering land that lies in present-day Iraq. The modern war, begun in September 1980*

when Iraq invaded Iran, pits ideologies and territorial claims of secularist Iraq against Iran's religious-fundamentalist government. It has claimed the lives of an estimated 70,000 Iraqis and 500,000 Iranians and wreaked havoc with the economies of both countries. Despite funding from other Arab nations, the war drains nearly one billion dollars a month from Iraq's treasury.

New York on the Tigris, *Baghdad and its building boom have attracted top-rate architects from Europe and the United States, who have reshaped the skyline. New construction includes (**right, clockwise**) the Haifa Street Housing Project, a community of nearly 2,000 high-priced units; the 312-room Ishtar Sheraton Hotel, one of five luxury hotels built in the past five years; and Housing Project Number 10, one of several new developments that will provide low-rent living space.*

Baghdad's development plan honors the past and allows for renewal of some of the city's centuries-old homes. With government backing, two preservation zones have been identified and several hundred houses restored to their former splendor.

*Electrical engineer Ghadah Mahuk (**left,** at right) discusses plans with a colleague in front of a project on Abu Nuwas Street. Iraqi women, among the most progressive in the Arab world, constitute 25 percent of the country's work force and are guaranteed equality under Baath Party doctrine.*

groundwater table plagued Baghdad before the construction of canals and other control devices), but now the floor is dry and covered with handsome carpets.

It gets on toward midnight before Suad Abdallah appears on the stage of the Khan Murjan, and when she does, the somber mien of the Iraqis at dinner takes fire. She is a singer—no, more than that; she is an entertainer whose empathy with the audience is so immediate and complete as to set emotions stampeding like gazelles on the plain.

As she sings, men leave their tables and come onto the stage to shower money over her head. Children bring her flowers, and the great soaring hall of the Khan Murjan is as it might have been 600 years ago, when travelers from Damascus and Persia and other parts of the world sat here and rejoiced in the jeweled delights of old Baghdad.

THERE ARE OTHER reminders—subtle, to be sure—that this is, after all, Baghdad and not Milwaukee. It is not unusual for workers to uncover ancient and valuable artifacts while excavating for one of the many new buildings.

"We find almost everything, everywhere," said Muayad Said Damerji, president of the State Organization of Antiquities. "In Baghdad and throughout Iraq there are now about 10,000 archaeological sites. The digs here have been going on for more than a century, and they will continue, no doubt, for many centuries to come."

Even as I was speaking with Dr. Damerji, there was news of a find on the outskirts of Baghdad, on the banks of the Tigris. It was a three-foot bronze statue of Hercules leaning on a stick draped with the skin of a lion. On the legs of the figure were writings in Greek

and Aramaic, revealing new information on the kings of that period, the second century B.C. The find also drew attention to the claim by some Iraqi archaeologists that Hercules is but another name for Nergal, a god worshipped in ancient Iraq.

Well, of course, this land of the two rivers (the other is the Euphrates) has more to offer to the diagraming of civilization than mere speculation on the true identity of Hercules. Iraq—ancient Mesopotamia—is where much of it began, including, in one interpretation of the Bible, the Garden of Eden. The first writing came from here, and so did the first code of law. Sumerians, Akkadians, Babylonians, Assyrians—all built their civilizations in this land.

Nowhere is this all chronicled so well as in the Iraq Museum, in Baghdad.

"With 28 galleries, it is the largest museum in the Middle East," Bahija Khalil Ismail, the director (page 102), said. "Our exhibits cover a time span from 100,000 years ago well into the Islamic period." Dr. Ismail, an expert on cuneiform writing, is the first woman to hold the position of director of the museum.

A pebble from a 10,000-year-old stratum rests in a glass case. It has 12 deep scratches on it. An ancient calendar? Quite possibly. And seals used by the Sumerians 5,000 years ago to legalize documents are there, along with a relief from the ninth century B.C. showing, for the first time as far as is known, the ritual of two persons shaking hands.

Some of the objects in the Iraq Museum are reproductions, and that is a matter of concern to many here. The originals were removed by conquering powers and foreign archaeologists in accordance with then prevailing laws. The Ishtar Gate is in East Berlin, and the shaft of black basalt inscribed with Hammurapi's code of law is in the Louvre, having first been taken to Iran as war booty in the 12th century B.C. Other pieces are in the British Museum and in the University of Pennsylvania museum.

"Our treasures were delivered to Europe, but we are trying to bring them back," Dr. Damerji, the antiquities chief, told me. "The French have returned certain fragments of the Code of Hammurapi—about 59 paragraphs—but they continue to keep the main shaft. The British Museum has a large Assyrian slab, and while hundreds of clay tablets with cuneiform writings have come back from the United States, other pieces remain there. The British Museum has sent nothing. It is a long, very long process."

And what would Hammurapi have said about such dubious conduct? Not one for coddling wrongdoers, the sixth king of the First Dynasty of Babylon (he reigned 1792-1750 B.C.) issued a stern code of laws, not the earliest legislation to come out of Mesopotamia but certainly the most famous. His code covered a wide range of evils, including theft. This, for example: "If a fire has broken out in a man's house and a man who has gone to extinguish it has coveted an article of the owner of the house and takes the article of the owner of the house, that man shall be cast into that fire."

So it is written, in cuneiform script, on the

Children of the party, *youngsters belonging to the Vanguards (**right**), a group founded by the Baath Party, listen as a girl recites patriotic verse. The camouflage pattern on their fatigues depicts silhouettes of the Arab world. Young girls in uniform (**above**) participate in a traffic-safety program.*

nine-and-a-half-foot-high piece of stone now on display in the Louvre. It is represented in the Iraq Museum by a copy.

This pillage of a nation's legacy could only add to the zeal of Arab nationalism that began to flare with the coming to power in Egypt of Gamal Abdel Nasser. Iraq shook off the last remnants of foreign control on the morning of July 14, 1958, when the British-installed Hashemite regime in the person of young King Faysal II (cousin of Jordan's present King Hussein) was overthrown.

Blood was thick in the streets of Baghdad that day. Other revolutions followed; today the country is firmly controlled by the Arab Baath Socialist Party and its leader, Saddam Hussein. At the top of the Baath Party hierarchy in Iraq is the Revolutionary Command Council, a nine-member group with Hussein as chairman. There is also a National Assembly of 250 elected delegates.

Nationalization of the oil industry in the 1970s was the culminating thrust of socialism in Iraq, but today emphasis has shifted to what is called the mixed-sector economy, or participation by both government and private investment.

There are few political parties in the world so strictly disciplined as the Baath Party in Iraq, and few operate under such a heavy veil of secrecy. Dissent, even whispered, is not heard here. Nor is much laughter heard.

WHENEVER I was able to escape the government's tether on foreign journalists, I would walk for hours in Baghdad, falling in step at times with craggy-faced Kurds and some of the hundreds of thousands of Egyptians working at

menial jobs vacated by Iraqis called to military service. I would cross the Tigris on the Jumhuriyah Bridge, where the river is more than halfway along its 1,200-mile journey from Kurdistan to its meeting with the Euphrates before both enter the Persian Gulf as the Shatt al Arab.

The need to restore the important role once played by the river in the life of the city has been stressed by city officials and others responsible for the rebuilding of Baghdad. Meanwhile, the Tigris flows on, not boisterous as it once was but, rather, calm and silvery, a blessing to this desert land.

TAHRIR SQUARE stands at the end of the bridge on the left bank of the river. It is the heart of Baghdad, from which radiate some of the main streets of the city. There is Rashid Street, with arcaded sidewalks; and Sadun Street, wide and baking under the 120-degree heat of the noonday sun. Vendors of ice water do a brisk business on Sadun Street.

Red double-deck buses made in Britain sway down the streets. Life in Baghdad is too rigid to call down the chaos found in other large cities of the Middle East; here, all the passengers ride *inside* the buses.

Saddam Hussein's picture hangs in the window of a bookshop. This time he is shown wearing a kaffiyeh, the Arab head cloth, and he holds a cigar. There are few publications in English for sale in the shop, other than a student's crib book for Thomas Hardy's classic *Jude the Obscure* and a manual for increasing farm production with the use of fertilizers. There are no foreign publications such as news magazines.

I met a man during my walks, an English-speaking guide at the Baghdad Museum, who told me that once there were mellow streets in Baghdad, streets where old women could be found sitting by large pots of beans boiling in water, selling the right to dip bread in the tasty liquid. There were

Blotting out the sun, *frequent summer dust storms shroud the pool of the Al-Mansour Melia Hotel* ***(top)****, leaving a heavy coating before moving on. At the close of a clear day* ***(left)****, the Tigris is revealed with two of its 12 city bridges.*

***A limited selection** leaves shelves nearly bare (**right**) in a new mall, some imports curtailed by the war. Small-scale trade rocks on Rashid Street, where a vendor hawks a rug portrait of Elvis (**below**). During Baghdad's heyday 1,200 years ago, trade was the city's wealth, and ships laden with spices, pearls, and ivory crowded the wharves.*

barbers, he recalled, who set up shop on the sidewalks, not only to cut hair, but to treat boils as well. And there were times of celebration on the streets, when, for example, banners were strung and music played to mark the circumcision of a young boy.

Occupying Ottoman forces showed little concern for the welfare of Baghdad, he said, and the British who moved in after defeating the Turks in World War I were equally errant. When they left in 1932 after installing a monarchy, Baghdad was a shambles.

Once I heard the skirl of a bagpipe band performing at a ceremony in Baghdad, and that, along with the double-deck buses, is about all the debris of British stewardship still afloat in this city of nearly four million.

There are discos in the new hotels, and there are other nightclubs where stripteasers perform. Liquor is legally available. There are gambling casinos. The vices are not practiced flagrantly here, but they do taunt the fundamentalist sensibilities of Ayatollah Ruhollah Khomeini in Iran. Probably even more sinful in his eyes are the rights accorded women in Iraq.

Women in Baghdad dress fashionably. They attend universities and hold some of the highest offices in the land. There are women engineers here, and women pilots, doctors, architects, and lawyers. Overall, nationally, women now account for 25 percent of the work force. It is official doctrine of the Baath Party that women have full equality with men. On the other side is Iran, where, it is reported, lipstick is removed from women by a swipe of cotton in which a razor blade is imbedded.

"Long ago, in the history of the Islamic world, women worked as traders, and they participated in battles," said Iftikar Ahmed Ayoob. "So what Khomeini is doing today is against Islamic law. He is using Islam as a curtain to hide his illegal and barbarous treatment of women."

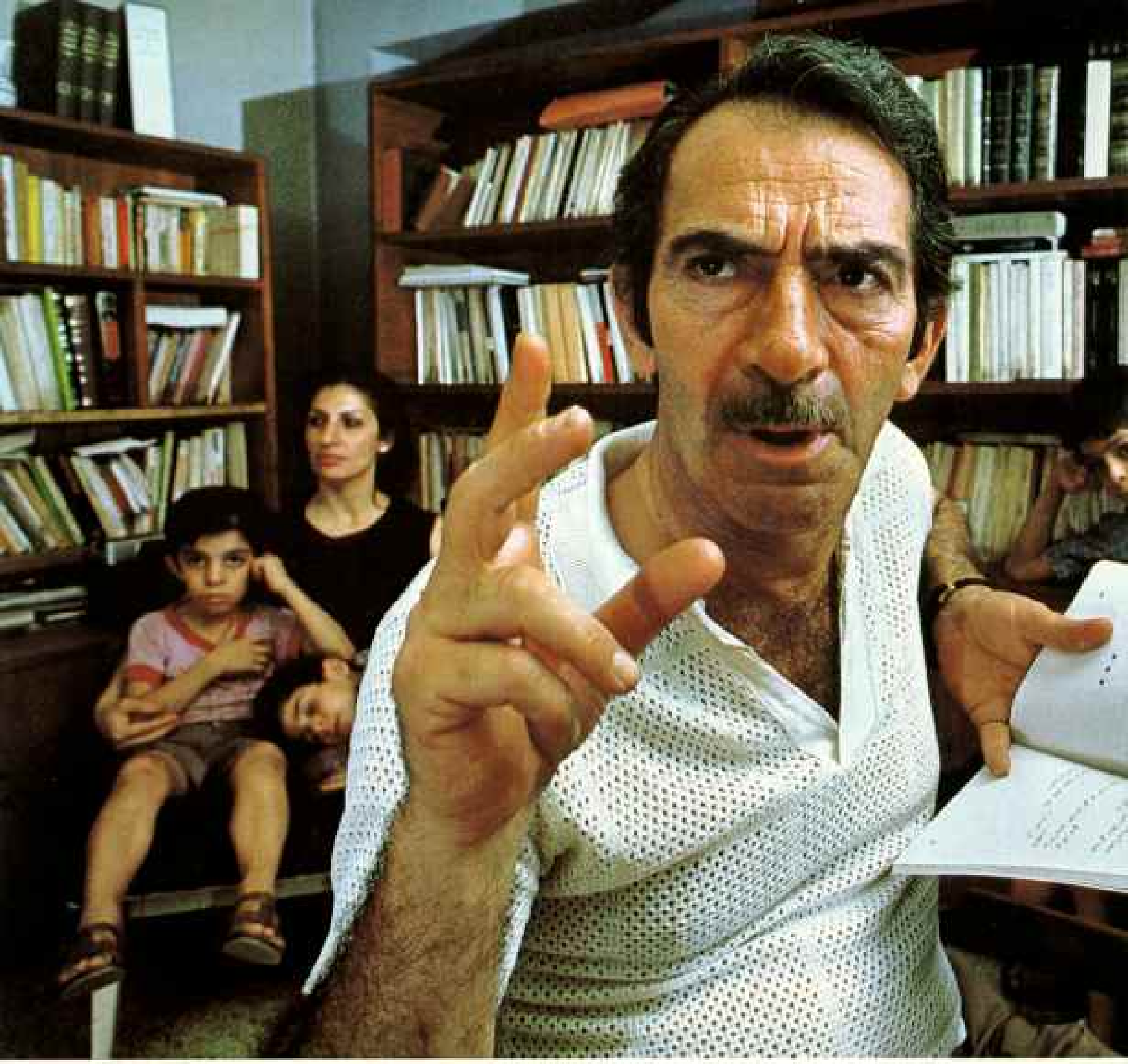
Mrs. Ayoob is deputy director of the General Federation of Iraqi Women, an organization of considerable influence.

"When the present government decided to eliminate illiteracy, 1.4 million women went to the centers to learn to read and write," Mrs. Ayoob said. "Now we have programs to get them jobs. Many go into factories. Others go on to higher education and the professions. We now have 16 women, including myself, in the National Assembly."

The war accounts in part for the many women in the work force, but the acceptance of equality between the sexes has other strong reflections in the social aspects of life.

"There was a time when the Iraqi male was very spoiled," Mrs. Ayoob said with a trace of a smile. "For example, his manliness would not allow him to pick up and hold his baby. And then President Saddam Hussein was shown holding a baby, and it was no longer a shameful thing for the male to do."

The issue of women's rights, as much as anything, is a true measure of the distance between the ideologies of the two warring nations. Saddam Hussein allows no compromise with the secularism of Iraq, and Khomeini allows none with his interpretation of koranic law. I was in Baghdad during the Islamic holy month of Ramadan and found only scant adherence to the practice of



fasting from sunup to sundown. Even the Shiite Muslims in Iraq—the majority of the population—appear unmoved by the ayatollah's call for brotherhood.

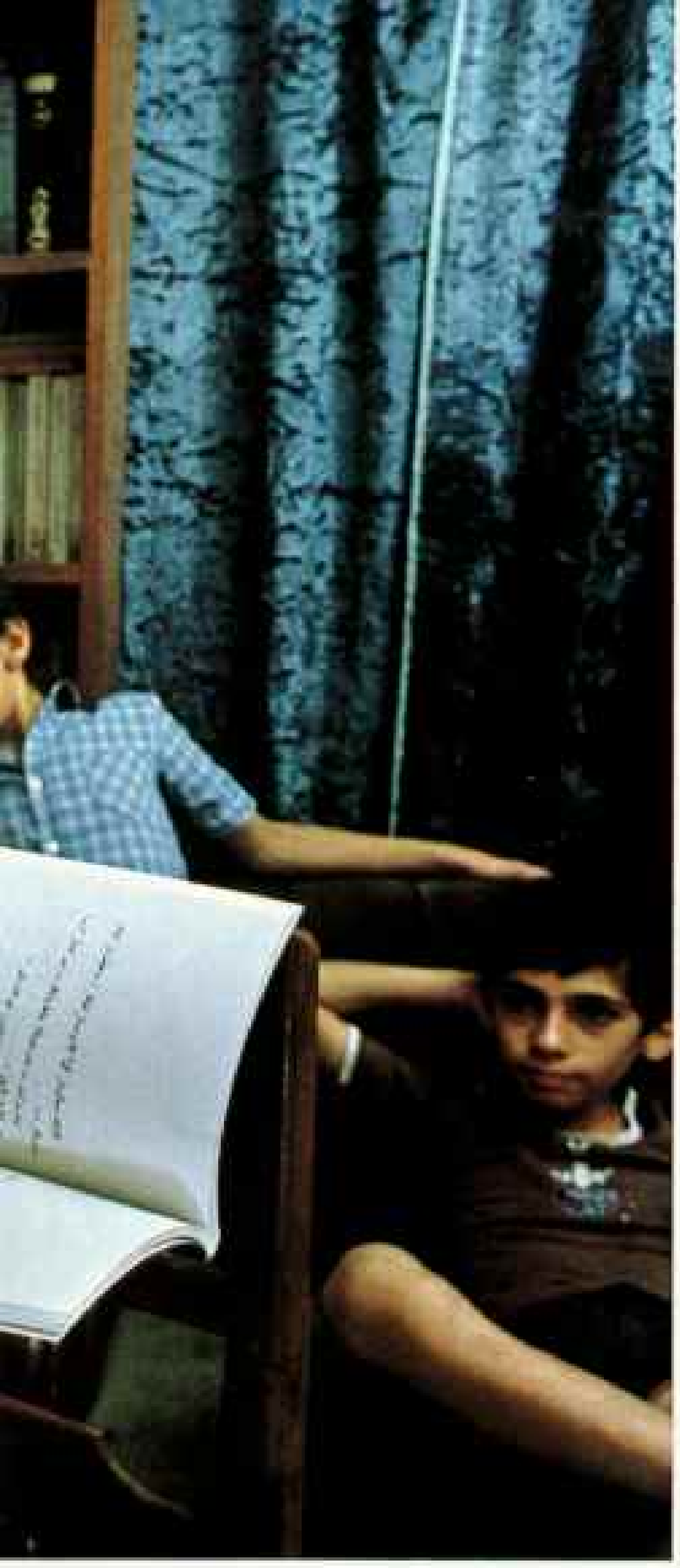
"THE OTTOMAN TURKS were here for 400 years. There were others before and after. Now the Persians want to come in and turn us back 1,500 years." Khalil Khoury, a poet living in Baghdad, is talking to me. When a young woman wearing pedal pushers walks past, he says, "She would be shot in Iran for wearing that."

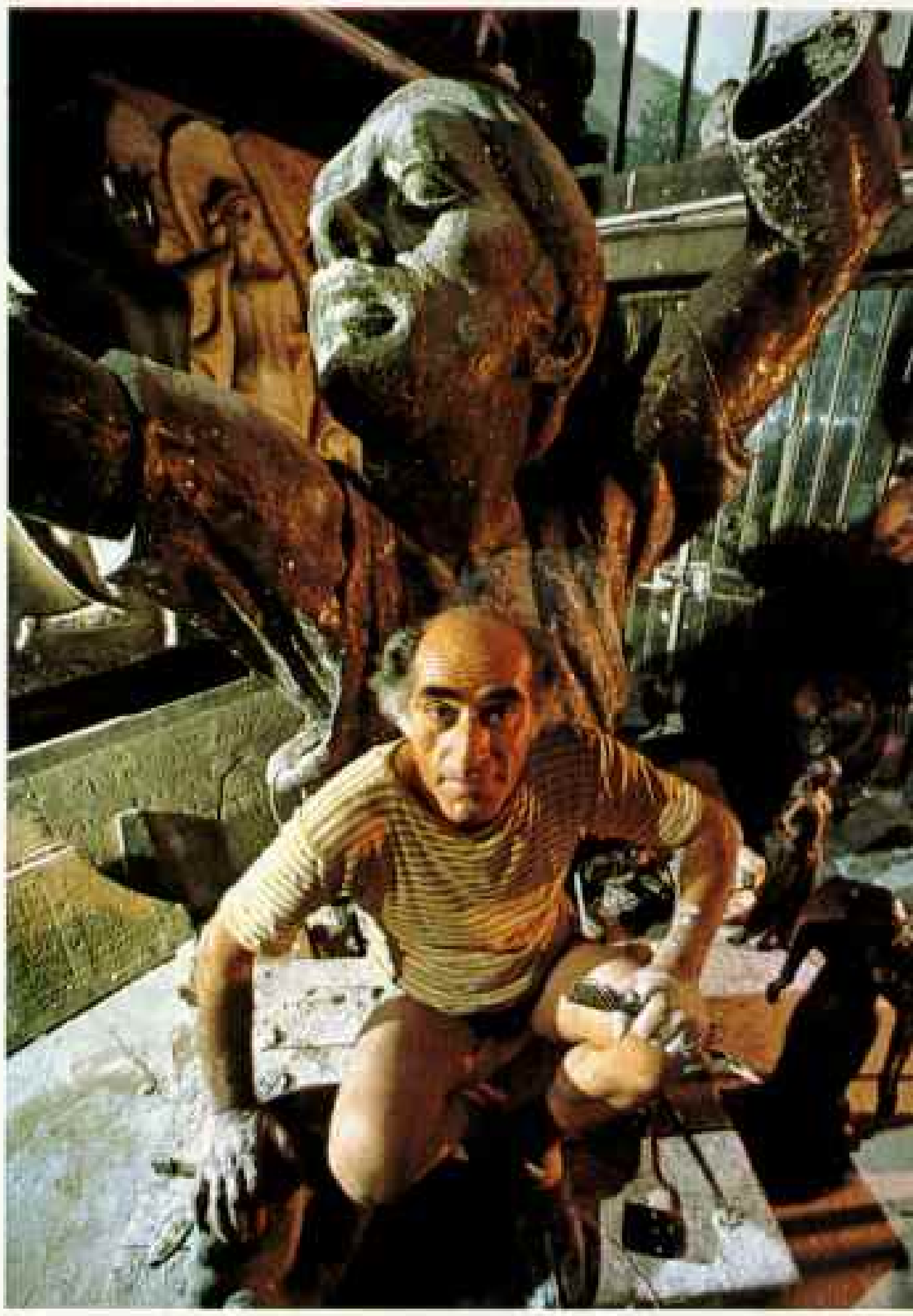
Born in Damascus, Khoury has lived in Baghdad for the past 15 years. Well known for his seven books of poetry, he also works as an interpreter of French for President Hussein. He is a dedicated socialist and a man sharply aware of the greatness that was ancient Mesopotamia.

"You can feel thousands of years of civilization in Baghdad," he told me. "It is, for me, a city full of the spirits of the past. You will discover stories about the Deluge—you know, Noah—in ancient accounts here, before the Bible. The same about Paradise, the Garden of Eden."

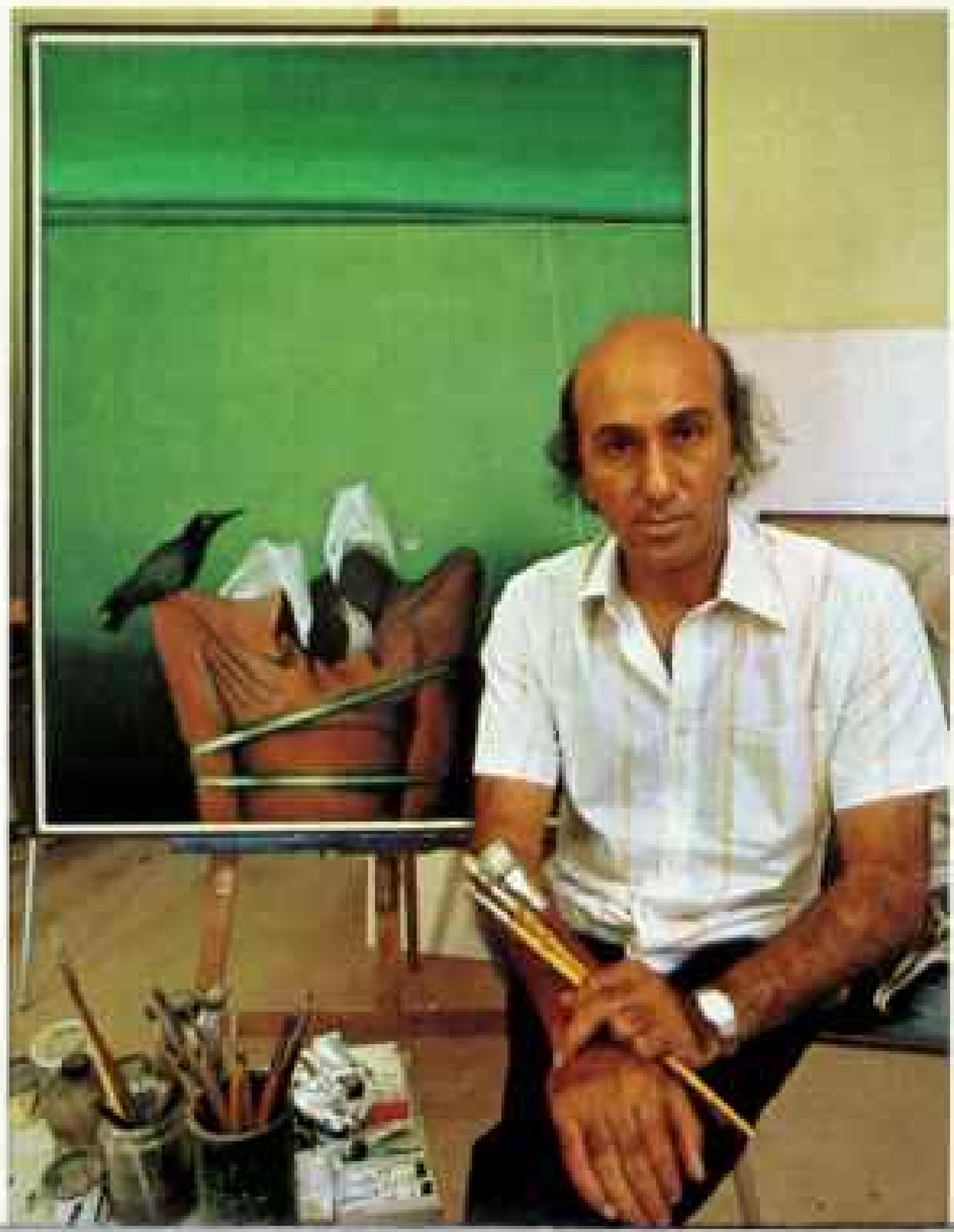
Khoury, like many of the people of Baghdad, clings to the past as if to set a standard for the future. Meanwhile the new face of the city becomes more finely drawn.

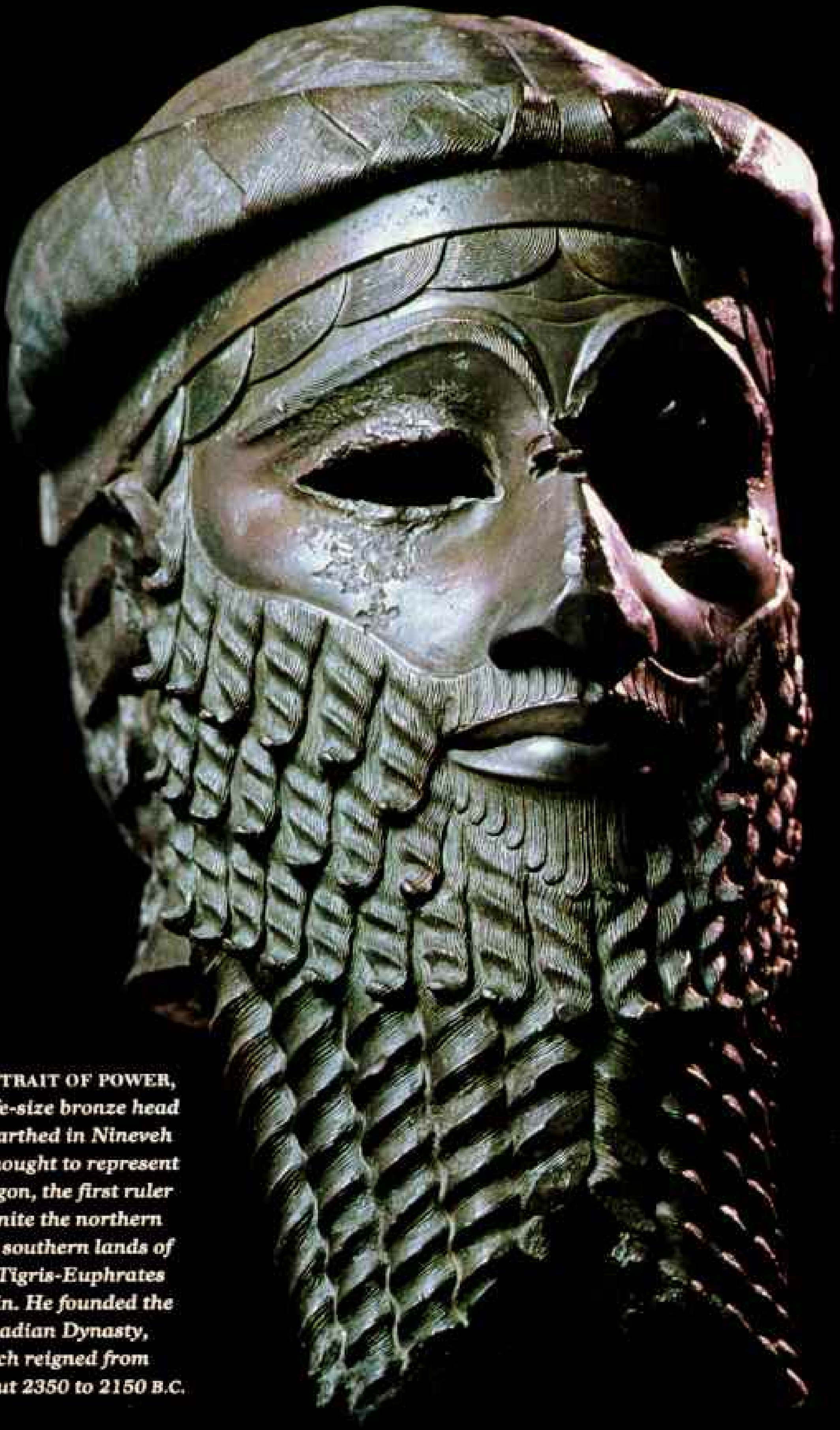
There is in Baghdad a street called Haifa, and it is the site of one of the largest urban housing construction projects in the world.





The creative voice *speaks in the words of Baghdadians like poet Khalil Khoury, here reciting in his home to members of his family (**above**). Besides seven volumes of poetry, he has written five plays. Bringing myth to life, internationally known sculptor Mohammed Ghani (**above right**) works on a bronze of Sindbad the Sailor, to be anchored in the Tigris when completed. "I paint the sufferings of the human spirit," explains Ala Hussein Bashir of his portrayal of a tormented man (**right**). Though some Iraqi artists depict contemporary—and often sensitive—political subjects, many rely on the past for ideas and themes.*

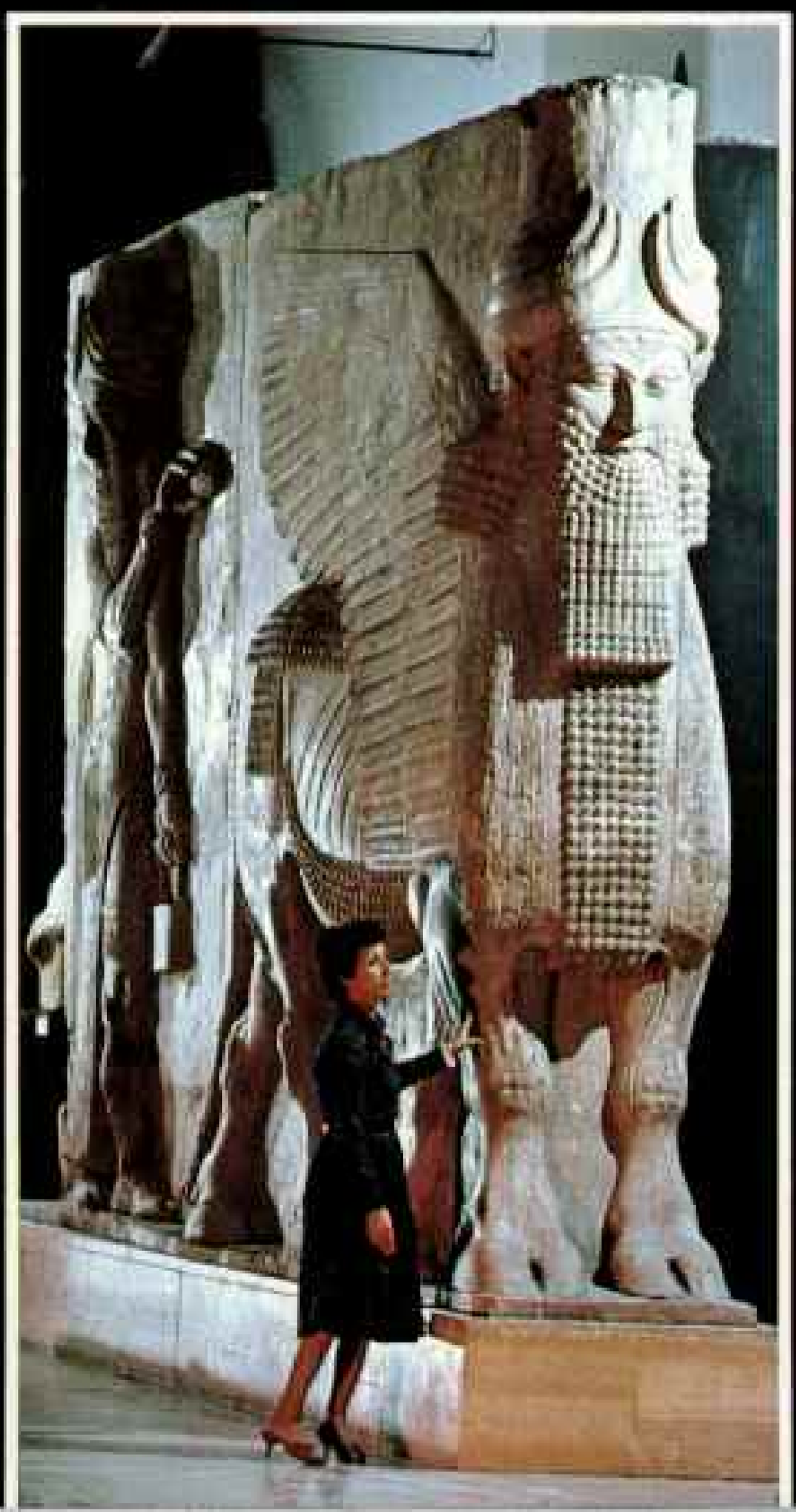




PORTRAIT OF POWER, *a life-size bronze head unearthed in Nineveh is thought to represent Sargon, the first ruler to unite the northern and southern lands of the Tigris-Euphrates basin. He founded the Akkadian Dynasty, which reigned from about 2350 to 2150* B.C.

Treasures from Iraq's past

THE "AWE OF THE GRANDIOSE," *in British sculptor Henry Moore's admiring phrase, radiates from artifacts of Mesopotamian empires that dominated the land known today as Iraq. A human-headed winged bull with five legs (below) guarded the gate to the palace of Sargon II at Khorsabad. Behind it, a bearded genie carries a ritual cup and purifier. The palace, encircled by 26-foot-thick walls, covered 25 acres. An ivory head, called the "Mona Lisa of Nimrud" (below right), was found preserved in sludge at the bottom of a well in the palace of Ashurnasirpal II. A lyre (right), unearthed in the Royal Tombs of Ur, boasts a bull's head of gold and dates from about 2500 B.C.*



ALL PHOTOGRAPHED AT IRAQ MUSEUM; NATIONAL GEOGRAPHIC PHOTOGRAPHER J. BAYLOR ROBERTS (TOP)

THE PRESENCE OF THE PAST *is evoked by a gown based on Assyrian designs and created by the Iraqi Fashion House for a government-sponsored exhibition.*

FIT FOR A QUEEN, *4,500-year-old jewelry from the Royal Tombs of Ur (left, top) is the pride of Iraq Museum director Bahija Khalil Ismail. Such treasures also influence modern jewelry (left) seen at a Baghdad fashion show.*

Plans call for nearly 2,000 housing units on Haifa Street, along with schools, nurseries, shopping centers, clinics, parks, and entertainment centers. Contractors from many nations are participating in the work.

"The development is now nearing completion," Deputy Mayor al-Madfai said, "and we hope that immediately after the war we can continue to build projects similar to Haifa Street throughout the city."

With the financial drain of the war (Iraq, it is believed, nearly exhausted its reserves of more than 30 billion dollars in the first two years of fighting) much of the development slowed. However, Saudi Arabia and Kuwait have injected massive doses of aid. And Iraqi oil exports, once down to 600,000 barrels a day, now flow by pipeline and truck through Turkey at the rate of a million barrels a day. The outlook for new developments in Baghdad seems promising.

Already completed is Saddam City, a sprawling development in the northern reaches of Baghdad. A million people live there on a site where once stood a muddy camp for squatters. President Hussein ordered the shantytown razed and a new city built in its place.

Many, if not most, of the residents of Saddam City are from rural Iraq, and they brought with them the life-styles of the village. There are goats in the yards, and there are women swathed in black, and men hunkered down on the sidewalks. The houses are small and adobe colored, and the smells coming from them are of leafy vegetables aboil. And there are marigolds growing along the property lines where neighbors meet for their summits of gossip.

IT IS MORNING in Saddam City, and I have boarded a bus there, not knowing where it is going or what route it will take to get there. I am eating from a bag of pistachio nuts, but most of the shells are sealed tight, the meats locked up like jewels in a vault. Sensing my frustration, my seat companion, a man who resembles Pancho Villa, looks around and then leans close to whisper. "Iran has better nuts," he says.

The bus goes to the center of the city over roads knotted in interchanges of two and three levels, high-speed roads of many lanes, one of the best systems of urban roads to be found in the Middle East and most of Europe. Indeed, a motorist here might imagine himself in Germany but for such highway signs as "Babylon, 100 kilometers." Sometime after the war ends, a subway, now in the advanced stages of planning, will be opened.

Later that day I came to a place called Thulatha Market, one of the five Western-style shopping centers in Baghdad. Thulatha means Tuesday in Arabic, and in ancient Baghdad the market held on that day was the busiest of all. Opened in 1983, or, in the words of the market director, "during the era of our struggling leader, His Excellency Saddam Hussein," the state-run Thulatha Market of today is housed in five large and modern buildings.

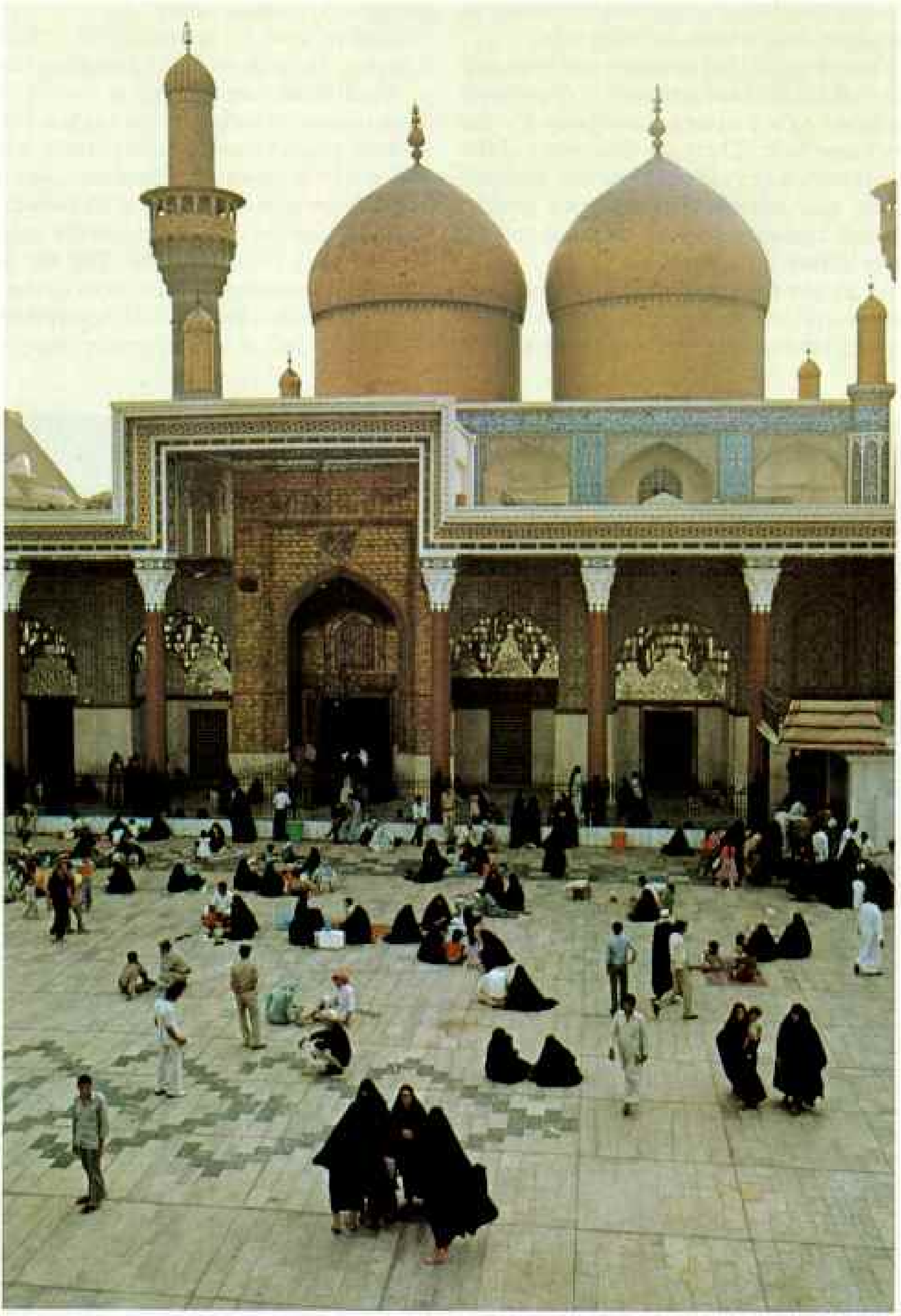
"We get a minimum of 30,000 shoppers here each day," the director, Adel Abud Abbas, said. "We sell food, clothes, appliances, everything. We provide for the young and for the old one."

On that day there was a big run on seven-piece cookware sets from Korea. In the food section a Danish-made item called chicken sausage was selling well. Sporting goods was pushing, of all things, the discus. There were some indications of wartime shortages, but most shelves were well stocked.

There are no typewriters for sale in the Thulatha Market. Special permission is required for an Iraqi to purchase one, for a typewriter might be used to produce revolutionary tracts. Saddam Hussein used one himself for that purpose.

There is heavy security in the market. Customers must submit to a search before entering. Additional controls are in force elsewhere in the city to prevent trouble by Iranian terrorists. As a precaution against car bombs, taxicabs and private automobiles are not allowed to approach the entranceways of government buildings or major hotels. At the new Ishtar Sheraton (page 91), arriving guests and their luggage are left on the street, no closer than 50 yards from the reception desk.

But like almost everything else in Baghdad, there is no feeling of wartime urgency in the security measures. Even the printed instructions in the rooms of the Sheraton, advising guests where to proceed in case of an air raid, come as an afterthought to



Passing from the realm of the sacred *to the world of the profane, a girl and her grandmother emerge from al-Kazimayn Mosque, one of the most important shrines in the Islamic world* (**left**). *Gold-capped domes rise above the courtyard* (**above**). *Completed in 1534, the present mosque was built at the site of the tombs of Musa al-Kazim and his grandson, Muhammad al-Jawad, two of twelve imams believed, according to Shiite tenets, to be descendants of the Prophet.*

greetings from the manager and a notice that the coffee shop is open 24 hours a day.

Completed in 1982 at a total cost of 80 million dollars, the Sheraton rises in downtown Baghdad as a 21-story centerpiece for the city's new look. There are fine views of the Tigris from many of the 312 rooms, and balconies and terraces banked with plants. Though contemporary in design, it still reflects Islamic influence.

Of all the foreign firms participating in the resurrection of Baghdad from its pit of neglect, none has been more active than The Architects Collaborative Inc., a group formed in 1946 by famed architect Walter Gropius. In addition to the Sheraton, TAC, as the Boston-based group is known, has been commissioned to design a major development project along Khulafa Street, a central artery in downtown Baghdad, and the spectacular new University of Baghdad.

It is estimated that the university project will cost 1.5 billion dollars. The 860-acre campus is bordered on three sides by the Tigris. There are to be 273 buildings erected on it. Among them is the university mosque, a

striking dome-like structure resting on three points. When completed, it will stand not only as a house for the faithful, but also as a symbol of the architectural boldness now rampant in the city.

Peter W. Morton, a partner in TAC, has visited Baghdad many times to oversee his firm's projects in the city. "The Iraqis had the vision to bring in the best architectural brains in the world," he told me. "At the same time, they set very high standards."

Architects must adhere to certain traditions when designing a building for Baghdad. "The *farash* system, for example, must be maintained," Morton said. "In the Middle East there is always a guy who serves coffee in the offices. He is the farash. He is a very old and very important tradition in Baghdad, and so we must include a place for him in the plans—a place where he can cook as well as sit and wait for the buzzer."

DESPITE the equalizing effect of Baathist Socialism on the social and economic life of Iraq, there remains in Baghdad a neighborhood of elite status. It is called Mansur. There are villas there, and, truthfully, Volvo station wagons in the streets. It is said that there are families in Baghdad who continue to have substantial financial holdings, but wealth is a relative thing in a city where the police patrol in Mercedes and where a cup of coffee and an order of toast in a hotel coffee shop costs $12. Still, in Mansur, the *sense* of wealth is present.

Mohammed Ghani (page 99) lives in Mansur, but his wealth is in talent. He is a sculptor, being responsible for much of the best of the street art in Baghdad.

"I am a Baghdadian, and I feel the glory," Ghani said. He is a warm, short man with thick tufts of hair on the sides of his head. "My goal is to give honor with my work to this city that gave so much to the world."

Most of Ghani's works have themes taken from the mythology of Mesopotamia. One large bronze, for example, depicts the genie emerging from Aladdin's lamp. Another is of Sindbad on a raft; it is to be anchored in the Tigris. Others draw from tales of life in Sumer and Babylon and Ur, such as the one where an eagle takes a man on its back to visit the gods. "There is nothing in reference to flight older than this bit of Sumerian mythology," Ghani said.

Iraqis have a curious appreciation of sculpture. Probably it is related to their ancestors. For the Assyrians to have produced such magnificent (and massive) sculpture

In the shadows of antiquity, *women in long black abayas walk in one of the older sections of the city. Streets in this quarter—lined with shops not much wider than a man's reach—were built narrow to shade pedestrians from the sun.*

Songs of passion, *songs of pain, are poured out by Suad Abdallah (**above**) at the Khan Murjan, a 600-year-old inn converted into a restaurant. In a room upstairs (**above right**) men enjoy tobacco and thimblefuls of thick, bitter coffee. For years a recluse, Baghdad is emerging from behind its veils to make a bid as a power broker for the Arab world. But a stalemated war, debilitating in terms of lives and dollars, stalls its momentum.*

without passing on their flame of talent seems unlikely. For the genius of the Sumerians and Babylonians to have died with the last of their kings seems equally unlikely. The legacy has been weakened by time until what remains today is not so much creativity as it is appreciation.

That must be it.

THE MOST PROMINENT monument in Baghdad today is the Unknown Soldier Monument, which

especially honors those who have fallen in the present conflict with Iran. It is heavily symbolic, meant to communicate the presence of the ziggurat of Ur and the spiral minaret at Samarra. There is an iron dome weighing 550 tons, and that represents the shield of the dying soldier. Rising above that to a height of some 100 feet is a flagpole, and at night the sculptured Iraqi flag is lighted in four colors (white, black, green, and red).

"It's something, isn't it?" an official of the government information office asked as we entered the coolness of the marble crypt.

It *is* something. An outsider can only marvel at the busyness of the monument—at, indeed, the energy of all Baghdad. After a decade of self-imposed isolation, the city has now revealed itself as a focal point, a potential center of the drive for Arab unity.

Much, of course, depends on the outcome of the struggle with Iran. Until that is settled, the new face of Baghdad will appear as a clip-on—like a mask on the skull and bones of war. □

Koko's Kitten

Text by JANE VESSELS
NATIONAL GEOGRAPHIC EDITORIAL STAFF
Photographs by RONALD H. COHN

CAN A KITTEN *raised by a dog find happiness with a 230-pound gorilla who converses in American Sign Language?*

*Well, you can ask Koko, a 13-year-old female lowland gorilla who for a dozen years has been the focus of the world's longest ongoing ape language study, sponsored by the Gorilla Foundation of California with past support from the National Geographic Society. According to Dr. Francine "Penny" Patterson, Koko uses more than 500 signs regularly and knows some 500 others in American Sign Language, or Ameslan—the hand language of the deaf. That's how Koko came to tell Penny that she wanted a cat—a word she signs by pulling two fingers across her cheeks in the manner of whiskers (**left**). So Penny gave her a toy cat. Koko pouted.*

Then last June a litter of three kittens was brought to the rural compound near San Francisco where Koko lives with Penny and Michael, an 11-year-old male gorilla also versed in Ameslan. Abandoned at birth, the kittens had been wet-nursed by a cairn terrier for four and a half weeks. "Love that," signed Koko to the kittens. Gingerly examining them, she chose the tailless male and named him All Ball.

For Koko's July birthday, Penny drew a cat—as requested—on her cake. "What did I draw?" she asked. "Ball," replied Koko. "Koko love visit Ball."

"I THINK KOKO *is infatuated with Ball because he doesn't have a tail. It makes him more like us," says Penny, here introducing Ball to Koko on one of their early visits (***above***). Softly gripping Ball (***right***), Koko sniffs the kitten, treating him much as she would a baby gorilla. She carries Ball tucked into her thigh and attempts to have him nurse. Like a child with a pet, she dresses Ball in linen napkins and hats. And she signs to Ball that they should tickle each other—one of her favorite games. "She seems to think that cats can do most things she can do," says Penny.*

*Stroking the unfrightened kitten (***bottom***), Koko demonstrates the gentle behavior that gorillas—vegetarians—have been observed to show with small creatures in the wild and in captivity.*

That Koko would ask for a cat didn't surprise Penny. "The Three Little Kittens" and "Puss in Boots" are two of Koko's favorite stories, and cats are often mentioned during her daily lessons.

*Though there are quiet moments when Ball nestles in Koko's lap, watching her wipe her sweaty brow (***facing page***), Ball is an eager biter of gorilla and human alike—not unusual behavior in a kitten. Koko's response to such treatment? Sometimes she laughs. But usually she signs "obnoxious."*

Koko's maternal responses to Ball most interest Penny. Koko is of breeding age,

and it is hoped that she and Michael will mate. But gorillas in captivity have a poor record of mothering, and many refuse to nurse. Nursing human mothers visit Koko to provide role models, and Penny talks to her about bearing and caring for young. "It's encouraging that Ball can hurt Koko and Koko won't hurt him," says Penny. "She seems to like his feisty nature."

Koko's last word on the matter? "Soft good cat cat." □

Psychologist Francine G. Patterson first introduced NATIONAL GEOGRAPHIC readers to Koko and Michael in the October 1978 issue. Their education and care are now provided through grants and contributions from members of the Gorilla Foundation, established by Patterson, Ronald H. Cohn, and Barbara F. Hiller in 1976. The foundation also plans to apply its research to teaching humans disabled in communication and to preserving the endangered gorilla in the wild. For information write Gorilla Foundation, P.O. Box 620-530, Woodside, CA 94062.

JAMAICA

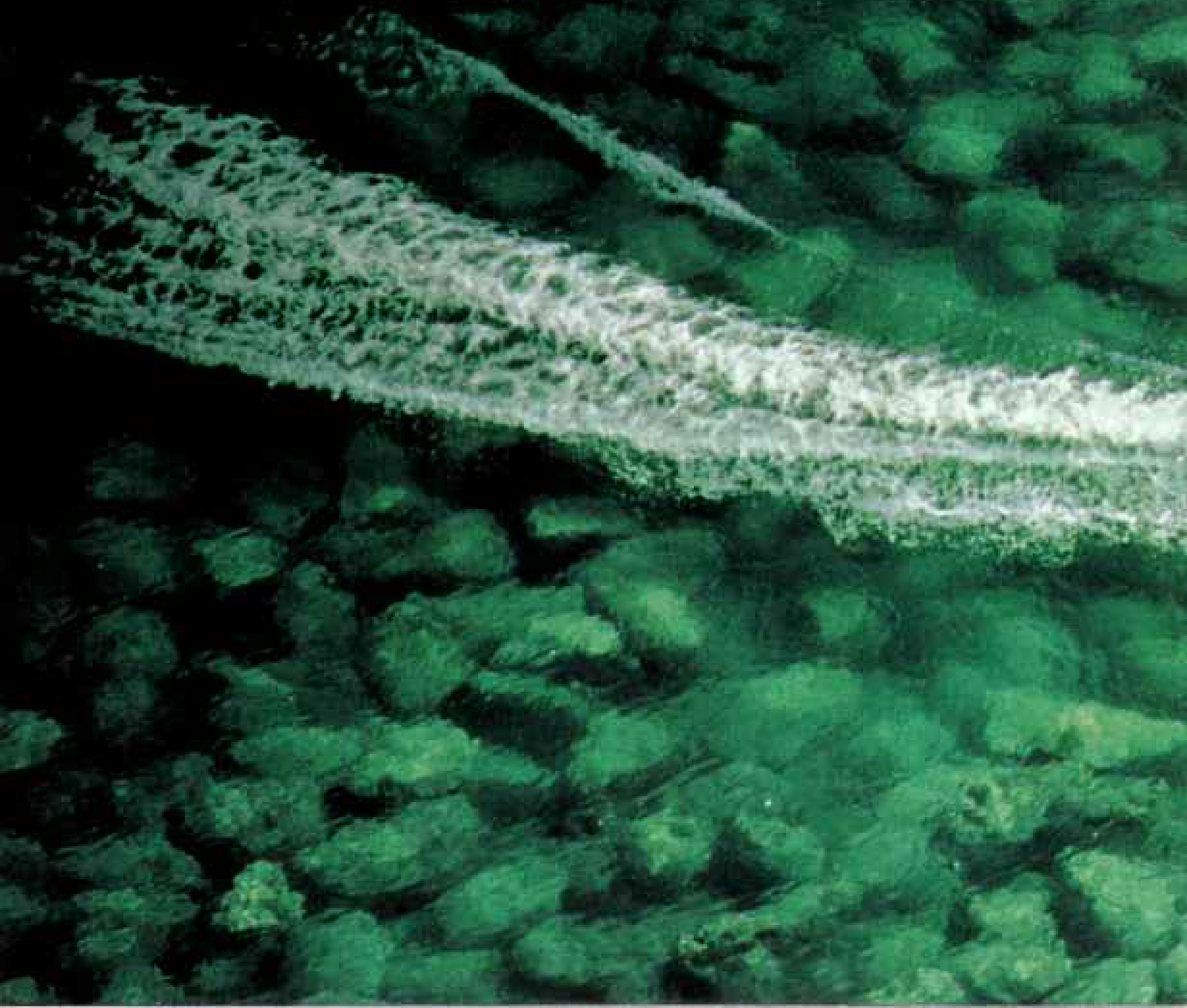
Hard Times, High Hopes

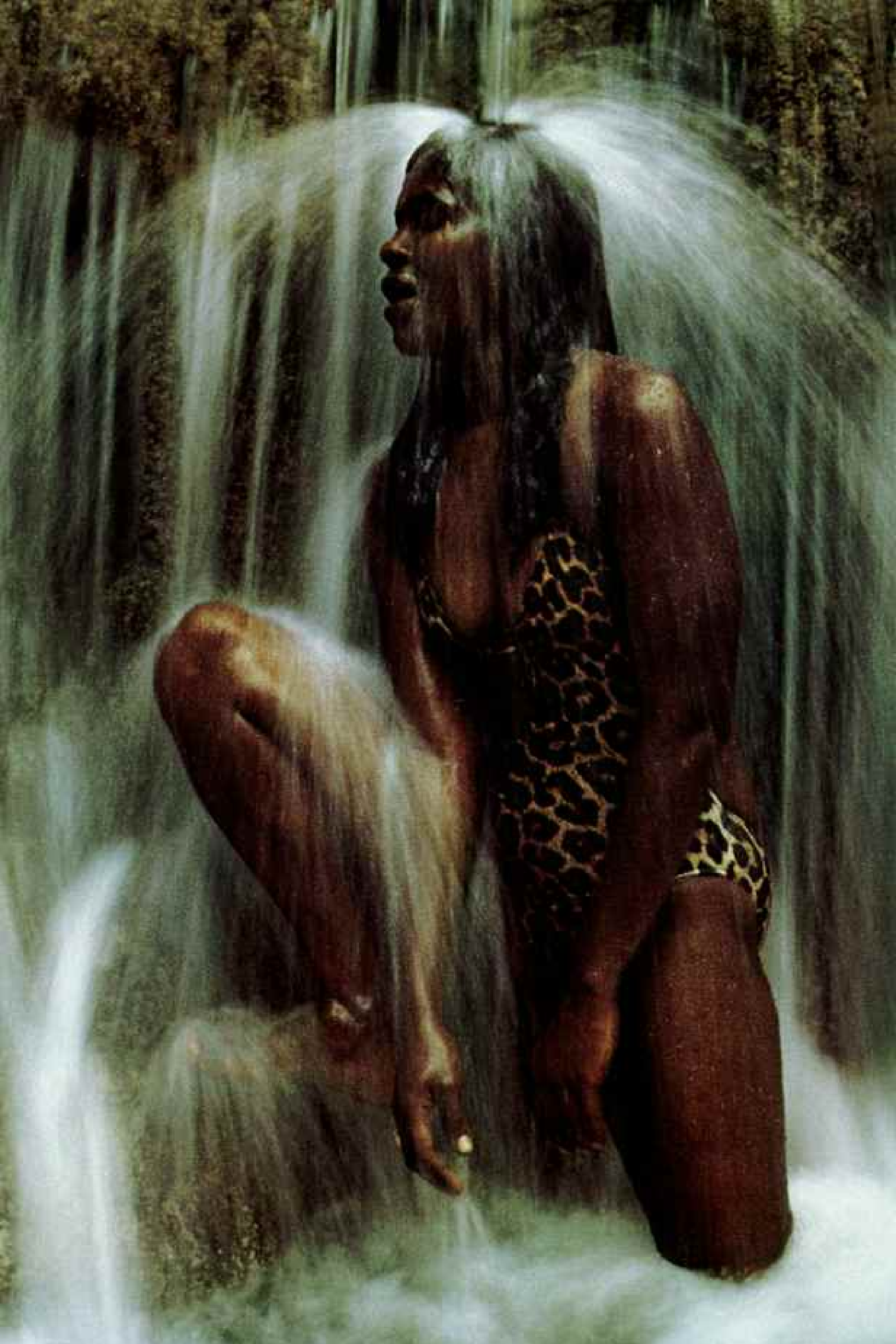
By CHARLES E. COBB, JR.

Photographs by DAVID BURNETT

CONTACT PRESS IMAGES

While tourists have returned to bask in Montego Bay's translucent waters, elsewhere on this fabled island murmurings of discontent are heard.





MOTHER MYRTLE THOMAS symbolizes the Jamaica I came to love most.

It was early morning—3 a.m.—at the small rural homestead near Point Hill where she lives with her husband, Elusu. I was gently roused from bed, and by 3:30 I had gulped down a cup of tea and was outside in the chilly morning, walking beside a donkey that insisted on going the wrong way until Mother Myrtle's daughter gave it a whack with a piece of wood.

The Spanish Town market is a two-hour bus ride from the farm. But catching the bus required an hour-and-a-half's walk down to the main road. So, while night's dark still enveloped everything and much of Jamaica was sleeping, market women like Mother Myrtle had already loaded up their produce—chocho (a roundish, nubby squash-like vegetable), yams, turnips, pumpkins, carrots, and corn—for the trek to the road.

I wondered at the small amount of produce, and Mother Myrtle explained that unusually heavy rains had damaged much of the crops planted on the terraced hillsides. "Life isn't easy here," she said.

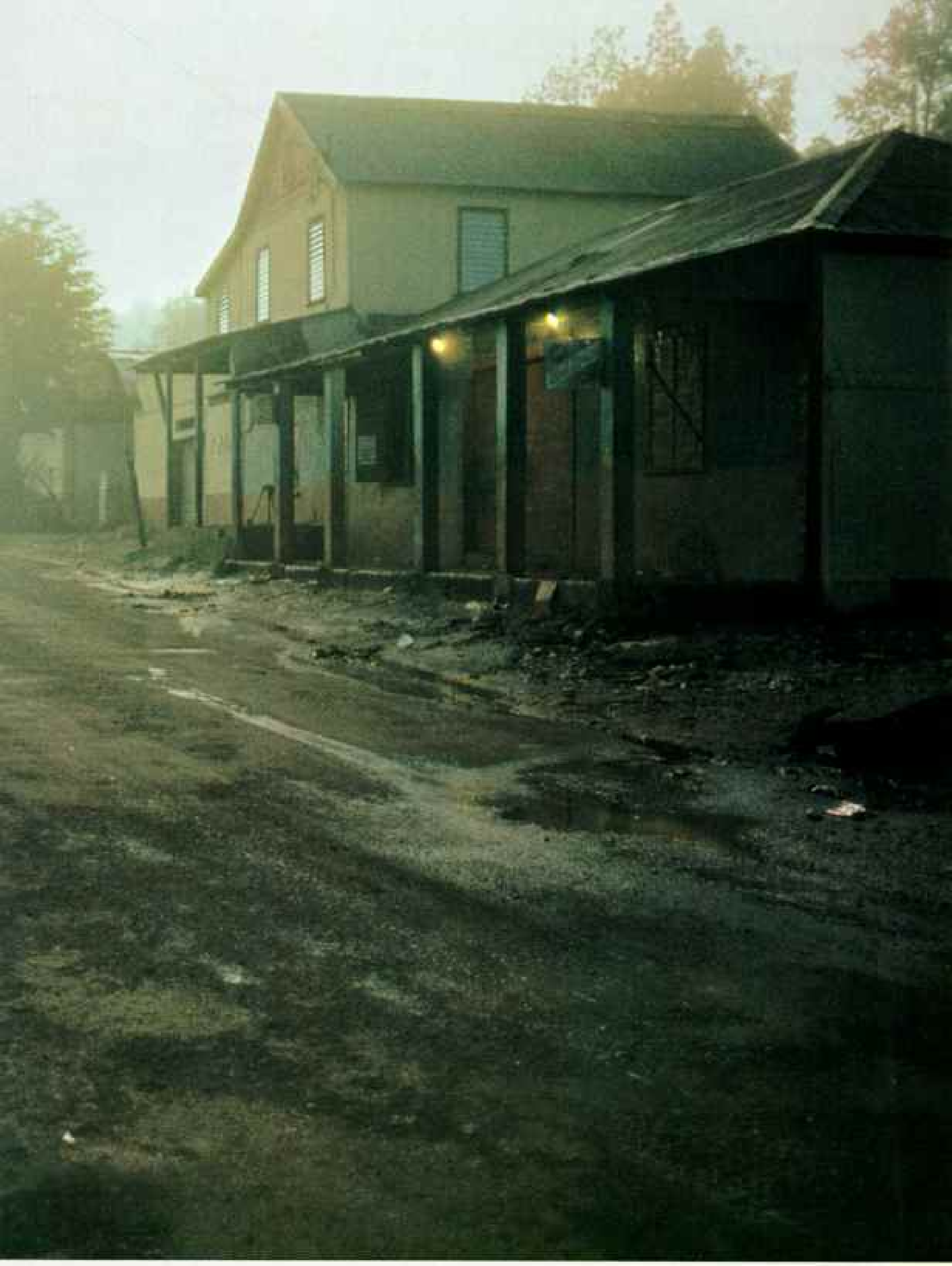
"Not easy . . . hard." These words came up often. The previous day I had sagged wearily in front of Mother Myrtle's home after a five-mile walk to get there. One of her sons offered a stalk of sugarcane. I took it, eagerly sucking out its reviving juice. Mother Myrtle smiled knowingly and said, "Hard here." But when I suggested that life might be better in the city, she responded, "We've been here from my grandmother up to now."

I thought of Anancy. In Jamaica the spider—Anancy—is a folk hero, like Brer Rabbit in the American South. Anancy grapples with a harsh world by exercising a sharp intelligence, a quick wit, and a determined, devious, even cruel self-interest. Anancy is a survivor.

Once, hanging from a rafter, trapped by Brother Death waiting below, Anancy told him: "Bro'er *(Continued on page 123)*

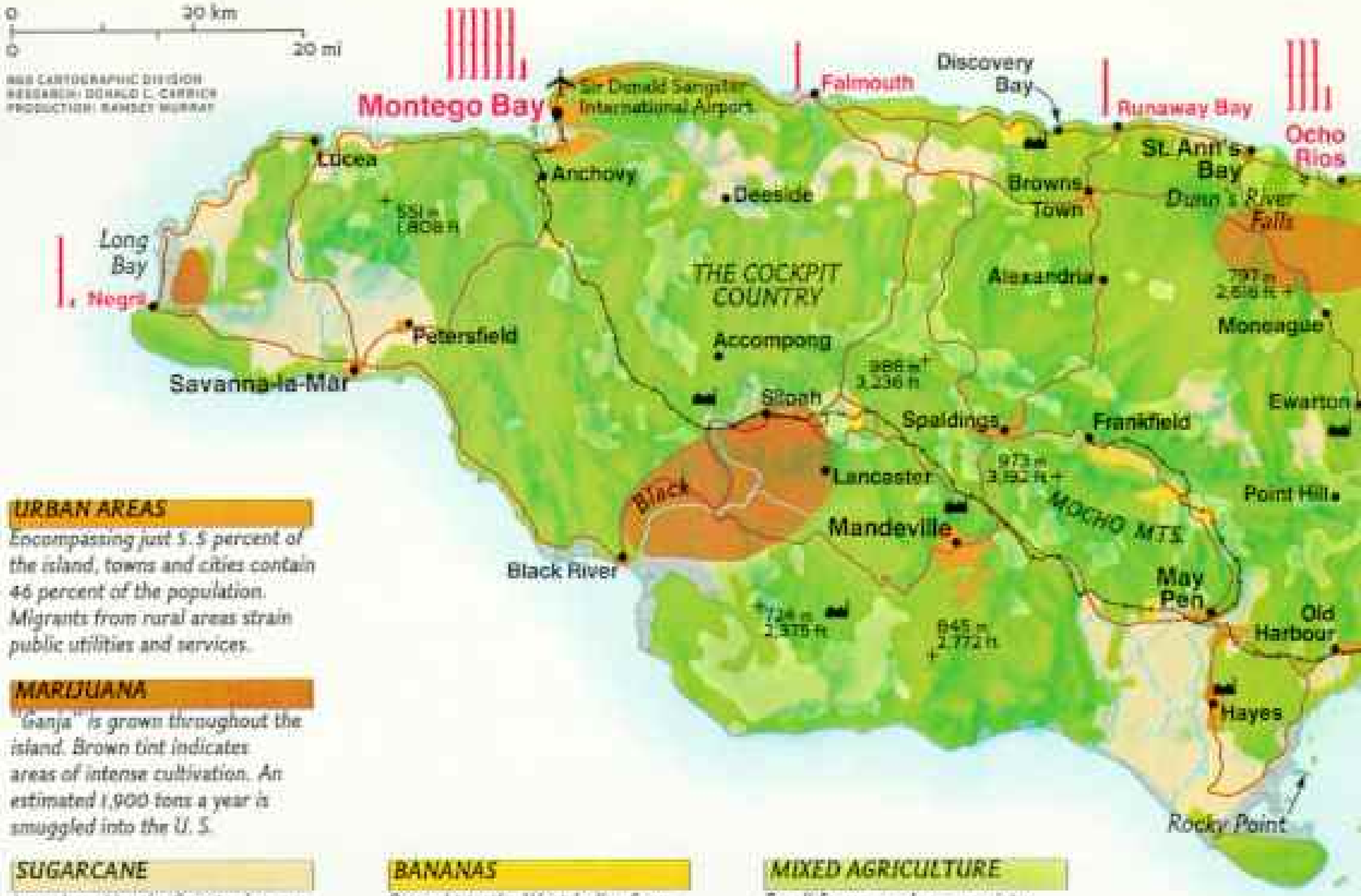
Cool waters *refresh a visitor at Dunn's River Falls, which cascades over stone ledges onto the beach near Ocho Rios. Thousands of sightseers climb the 600-foot-high falls each year.*

The other Jamaica. *Preceded by rain, dawn comes softly to the village of Siloah. Across the street from the general store, two sugarcane workers meet*



before another day's labor in the nearby cane fields and distillery operated by J. Wray & Nephew Ltd., producers of the famed Appleton brands of rum.

LAND USE IN JAMAICA



URBAN AREAS

Encompassing just 5.5 percent of the island, towns and cities contain 46 percent of the population. Migrants from rural areas strain public utilities and services.

MARIJUANA

"Ganja" is grown throughout the island. Brown tint indicates areas of intense cultivation. An estimated 1,900 tons a year is smuggled into the U. S.

SUGARCANE

Introduced by the Spaniards, cane yields sugar, molasses, and rum. Sugar production has declined since 1967, although it remains the principal export crop.

BANANAS

Brought to the West Indies from the Canary Islands in the early 1500s, bananas are a major export crop. Port Antonio is the main shipping facility.

MIXED AGRICULTURE

Small farms produce a variety of crops including corn, cassava, coffee, papayas, yams, and coconuts, mostly for domestic consumption.

JAMAICA

AREA: 10,991 sq km (4,244 sq mi). **POPULATION:** 2,388,000. **CAPITAL:** Kingston, pop. 578,000. **RELIGION:** Protestant, Roman Catholic, Rastafarian. **LANGUAGE:** English, Creole. **LITERACY:** 86%. **LIFE EXPECTANCY:** 71 years. **ECONOMY:** Industries: bauxite/alumina, tourism, manufactured goods. Export crops: sugar, bananas, coffee, marijuana (unofficial). **PER CAPITA INCOME:** $1,300.

"COME BACK TO JAMAICA," *the slogan urges tourists, whose visits to the island of lush mountains, rushing rivers, and golden beaches declined after the political violence of the 1976 and 1980 election campaigns. Now they are coming back, 780,000 in 1983, an estimated 850,000 in 1984, leaving behind more than 400 million dollars at such resort areas as Ocho Rios (**left**), Montego Bay, and Negril. In the process, income from tourism has become the country's second leading source of foreign currency.*

But in a country beleaguered by massive foreign debt and dwindling demand for bauxite, its chief export, the government seeks to diversify its products.

In addition to bolstering such traditional exports as bananas, coffee, and cocoa, an ambitious program called Agro 21 is stimulating the production of new commodities: winter vegetables, flowers, honey, shrimp, and freshwater fish.

NATIONAL GEOGRAPHIC PHOTOGRAPHER JODI COBB (ABOVE)

(Continued from page 117) Deat', I goin' to drop, an' bein' me so fat . . . go and fetch somet'ing fe catch me. Go in a room you will see a barrel of flour." Death agreed, but the barrel actually contained lime. So, according to Walter Jekyll's version of this tale in *Jamaican Song and Story*, "Just as he fixing it up under where [Anancy] hanging, [Anancy] drop on Deat' head *pum* an jam him head in . . . lime an' blind him. So he an' all him family get 'way." Jamaicans admire such ingenuity. They are survivors too.

THIS JAMAICA, engaged in determined survival, is hardly seen by the hundreds of thousands of visitors who come to enjoy the island's wondrous beaches and azure skies. But in the months I spent wandering the island, I found much else to love and admire.

The Arawak Indians, Jamaica's original inhabitants, called it Xaymaca, meaning "land of wood and water," or perhaps "land of springs." There are magnificent contrasts: mountains wrapped in forests, beaches that sparkle for mile on mile—white sand in the west and north, black sand in the south—lovely river-carved valleys, and abundant waterfalls. Three thousand species of flowering plants flourish, 800 unique to the island. Pineapple seedlings from Jamaica helped give the industry in Hawaii its start; bananas from Port Antonio, Jamaica's lush, tropical, northeastern city, were the origin of the United Fruit Company.

Christopher Columbus, who held the island for a time as his personal property, thought Jamaica was "the fairest isle that eyes have beheld." Jamaica was Spanish till

***High-rising hotels** and banks and the low, rectangular Jamaica Conference Centre put a modern look on Kingston's once dilapidated waterfront (**left**). The multimillion-dollar waterfront project was initiated by Edward P. G. Seaga in 1967, when he was minister of development in another administration.*

Prime minister since 1980, Seaga inherited a dismal economic situation: a country on the verge of bankruptcy, with high unemployment, high inflation, and domestic unrest. Backed by international loans, Seaga undertook to deregulate the economy and encourage private initiative. Foreign exchange is Seaga's major problem, but inflation and unemployment continue.

*On a visit to Tivoli Gardens, once a slum area known as Back o' Wall, Seaga (**above**, center) joins in a game of dominoes. A favorite project of the prime minister, the transformed Kingston community includes a health clinic, maternity center, home economics center, and recreational facilities.*

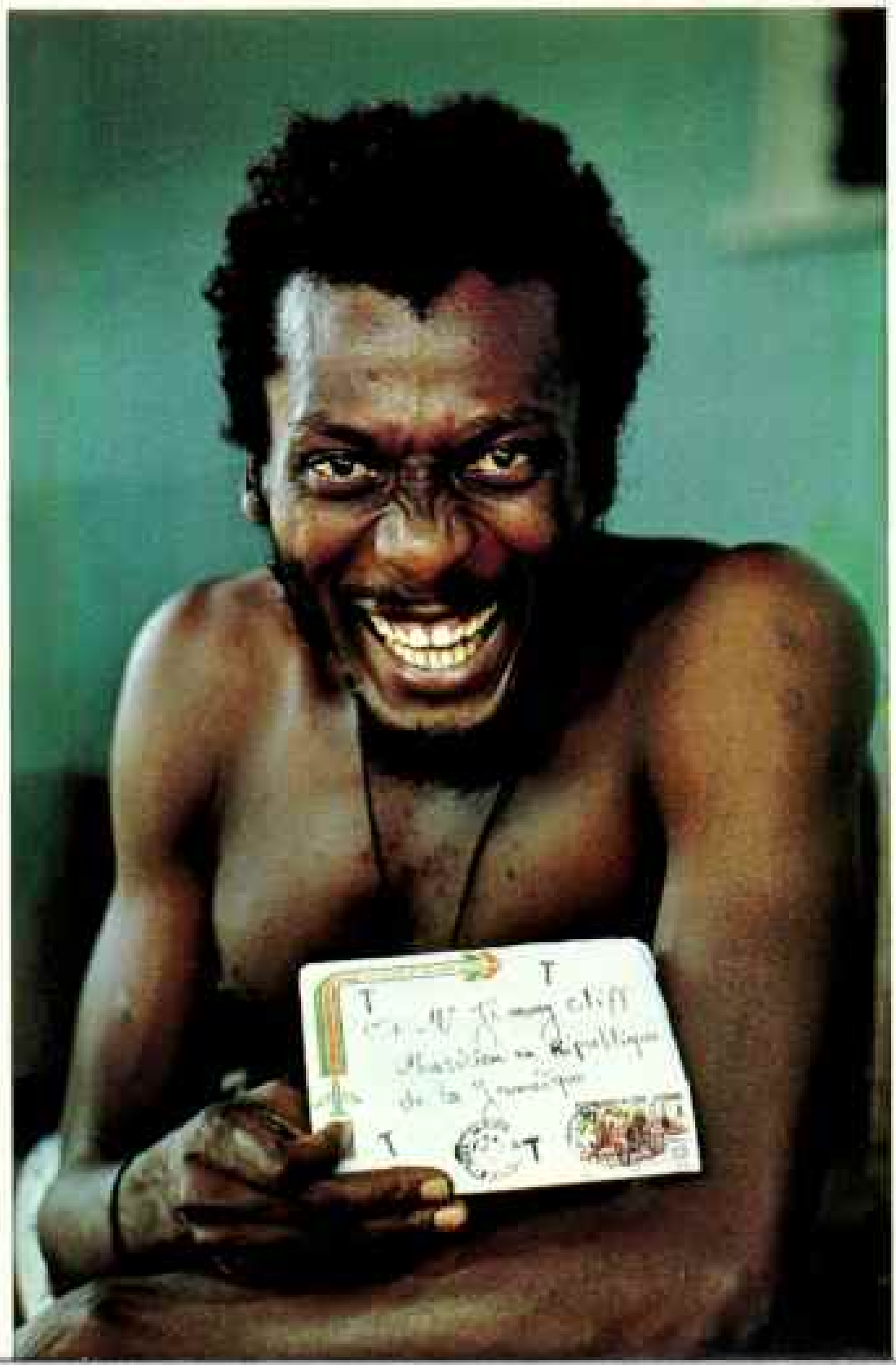
1655, when the British captured it. Its ties to Latin America were never broken, however; in 1815, Simón Bolívar, El Libertador, to whom at least five Latin American republics owe their independence, took refuge there and wrote "La Carta de Jamaica," one of his impassioned letters urging revolution.

Bolívar wrote his letter while living in a house in a now dilapidated but once elegant section of Kingston, Jamaica's capital. Even today his words seem to touch a truth about Jamaicans: "A people that loves freedom will in the end be free."

SINCE achieving complete independence in 1962, Jamaicans have been free, still love freedom, want more of it, and are quick to say so. I did not meet many Jamaicans who did not hold strong opinions. I told Carey Robinson, who worked on cultural issues in the prime minister's office, that it seemed at least half Jamaica's problem was that with two million people there are two million political parties. He laughed and said, "A sheeplike quality is what I would be very afraid of."

Inevitably opinions clash, and nowhere more sharply than in Jamaica's politics. I first arrived on the island about a year after the 1980 elections. The then new government of Prime Minister Edward P. G. Seaga and his conservative Jamaica Labour Party (JLP) won that race by campaigning on a political slogan I saw and heard often: Deliverance. For eight years before that, the government of Michael N. Manley's People's National Party (PNP) had attempted a "democratic socialist" program of economic and social reform, without much success.

As one woman in the West Kingston ghetto of Trench Town recalled, "Even chicken backs became a luxury." Jamaica was on the edge of bankruptcy, foreign exchange vanished, inflation stood at nearly 30 percent. "The survival of Jamaica was at stake," Prime Minister Seaga told me.



Fame needs no address. *A letter from the Ivory Coast addressed simply to "Jimmy Cliff, Musicien en République de la Jamaique," reached the well-known reggae singer in Kingston in five days* ***(left)****.*

Reggae, the soulful and syncopated mix of calypso and Jamaican folklore, began in Jamaica in the 1960s because, as Cliff says, "We needed a way to express ourselves." Another reggae singer, Dennis Brown ***(right)****, demonstrates the point at a Kingston concert.*

"American music is about girls and cars; our reggae is about truth and rights," says Cliff, whose lyrics are inspired by the Rastafarian religion.

"Rastafari means to live in nature," he says, "to see the Creator in the wind and the sea and the storm. Other religions pointed to the sky, and while we were looking at the sky, they dug up all the gold and diamonds and went away with them."

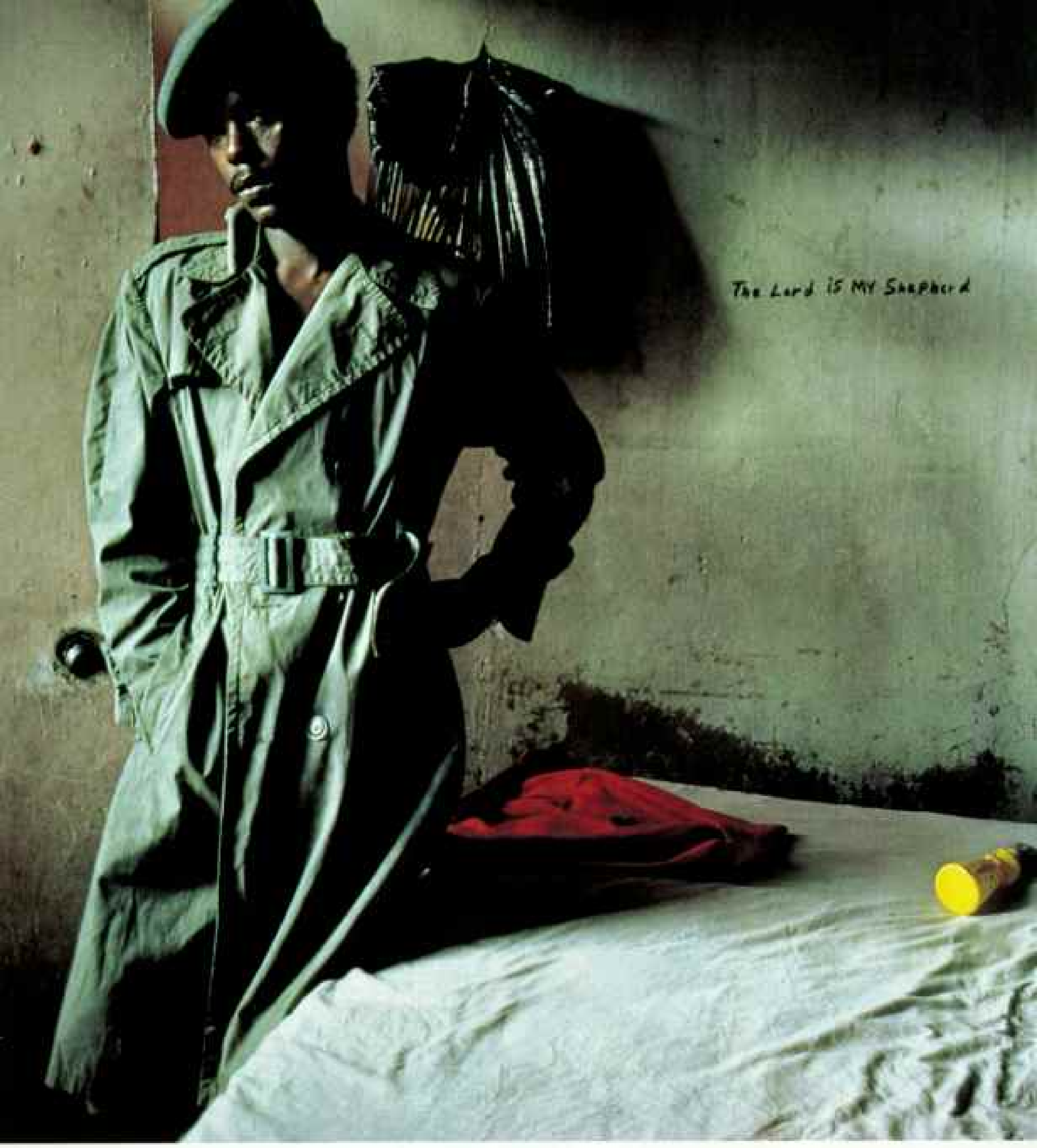
These days Seaga also believes the survival of Jamaica was threatened by events on the Caribbean island nation of Grenada.* He holds the view that both the Maurice Bishop government and the group that executed Bishop in October 1983 represented different stages of a Soviet-Cuban plan to subvert the Caribbean. "It would have reached Jamaica," he told me last February, explaining why Jamaica joined the U. S. in ousting Grenada's new military leadership. Michael Manley accused Seaga of joining a "neocolonialist" plot and believes that four years ago his PNP government suffered a similar, if less violent, fate.

Manley believes his government was sabotaged. In his view Jamaica's middle and upper classes worked hand in hand with a hostile United States to undermine needed reform. "Change provokes intense reaction in this society," he said ruefully.

The PNP and JLP have traditionally wrangled and worked together within a parliamentary system inherited from Great Britain. But there is only one party in Parliament today. In November 1983 Manley's PNP accused Seaga of deceit in reporting Jamaica's financial condition while negotiating with the International Monetary Fund, and called for his resignation as finance minister (Seaga is also minister of culture). Seaga promptly set a date for new national elections, which were held December 15, 1983.

The PNP boycotted the vote, and Seaga won handily. So, for the first time, Jamaica has no loyal opposition. The PNP says it could not participate because promised electoral reforms—issuance of new voter identity cards and an updating of voter rolls to include an estimated 150,000 young people who have become eligible to vote since 1980—were not completed.

*Free-lance writer **Charles E. Cobb, Jr.**, also contributed "Marking Time in Grenada" in the November 1984 issue.



JLP spokesmen say that the PNP simply wasn't ready and knew it would lose. Seaga, when I asked him if he thought there should be yet another vote to reestablish two parties in Parliament, responded, "We feel no compulsion to regularize something the opposition chose to make irregular."

Nevertheless, the issue is hotly debated. The voting rolls are now in order, and the PNP is calling for immediate elections.

The absence of a formal parliamentary opposition has raised fears that political violence might begin again. During the 1980 campaign, nearly 700 people were killed—the startling equivalent, in terms of comparative populations, of 70,000 persons killed in the United States. My search for the causes of this grim toll led me into the festering ghettos of West Kingston, where political allegiance is worn like a pistol ready to be

A tale of poverty: *Barely able to support himself by selling pet fish on a Kingston street, Joseph Petgrave now looks for a job in a factory.*

His daughter Kaya, abandoned by her mother, lives with her grandmother and cousins in Franklin Town, a poor but clean Kingston neighborhood.

In the ghetto areas of Kingston, crowded with Jamaicans from rural areas looking for work, desperation gnaws at the edges of the good life and sometimes flares into violence as gang leaders rule their territories with guns. Nearly 700 people were killed, mostly in the ghettos, during waves of violence that preceded the election of 1980.

drawn against uncertainties of the future.

In the ghettos the greatest uncertainty is put simply: Will my life get any better? Tiny houses of wood and corrugated zinc sag against the sidewalks. Streets are dirty and crowded. Many in the crowd, especially the young, are unemployed. In a country where 50 percent of the population is under 20, more than half the youths have no jobs and survival is not easy.

Gang leaders rule many streets. Revolvers and M-16 rifles are part of the currency of power. The sharp crack of a pistol shot split the night air at a dance I attended. Someone had fired high to scatter the crowd blocking the entrance. I was not surprised to see a companion shift a pistol from pocket to belt.

The most powerful gang leaders are known as "top rankin'" or "mos' wanted." The power of some is based on their success

Charismatic and controversial, *Michael N. Manley* ***(below)*** *of the People's National Party steered Jamaica to the left during his term as prime minister from 1972 to 1980. Defending his ties with Cuba, he says, "Whether you like their system or not, they have an astonishing record in such areas as health and education."*

Now leader of a party that, because of disputes over voter rolls, occupies not a single seat in Parliament, he stumps the country to sustain his supporters' spirits until the next election.

Dressed for the hunt, *Patrick Tenison stands beside his Labrador retrievers on the lawn of his Good Hope estate south of Falmouth (**above**). A Jamaican of Anglo-Irish descent, Tenison grows coconuts and raises cattle and horses on the 1,900-acre estate that originated with a British land grant in 1742. Such grants led to the establishment of some hundreds of plantations, which flourished until slavery ended in 1838.*

As a member of the Jamaica Cultural Development Commission, Tenison works to help islanders rediscover their cultural roots. "In recent years it's all centered around reggae music," he says. "But we're a multiracial society of Africans, East Indians, Scots, Chinese, and English. It's an exciting time to live in Jamaica. I wouldn't want to be anywhere else."

*Eyeing his Wild Orange liqueur (**facing page, bottom**) at his distillery in the Blue Mountains, Ian Sangster says, "Bloody good; this is the stuff." Sangster came to the island in 1966 from his native Scotland to teach chemistry, then turned his skills to the manufacture of liqueurs, using local rum, fruits, and spices. His products have won three gold medals in international competitions.*

Brave deeds of warriors past *live in the memory of Col. Collin L. G. Harris (**right**) of Moore Town. When the British took Jamaica in 1655, Collin's slave forebears fled to freedom in the mountains. Masters of camouflage and ambush, the warriors, called Maroons, so harassed the British that they finally gave up in 1739 and signed treaties recognizing the Maroons' independence and granting them land in Moore Town and in the hills of the Cockpit Country (**below**).*

ROBERT S. PATTON, NATIONAL GEOGRAPHIC STAFF (ABOVE)

in marijuana, or ganja, smuggling. Many were armed by political operatives of both parties. Frustrations still blister city ghettos. Finding solutions to urban problems is urgent. Mr. Seaga believes that centers linking job training, community services, and recreation should be developed in rural areas in response to these pressures.

But Kingston is not all, or even mostly, ghetto. Richly layered, the city is vibrant with music, theater, and dance. It is the intellectual center of Jamaica, and sometimes astounding in its complexity. Ideas fairly zoom in all directions.

Jamaica is still in search of itself. Kingston throbs with debate. I went to Victoria Park, where, under a large tree in the area known as the People's Parliament, a sizzling argument was in progress:

"Manley jus' for de people," a PNP supporter stated.

"Den how he lose de election?" shot back a JLP Seaga backer.

"Somebody tol' you he lost it. If all Jamaica voted for Manley, he would have lost it. The CIA, all a dem no wan' him."

A loud chorus of "nos" broke out at this.

"Yeah, mon," the PNP supporter argued, "Seaga's a American. Spyaga!"

Exasperated, the Seaga advocate demanded, "What you mean? Him a Jamaican. Him represent de poorest constituency in dis here country."

THE STURDY, sometimes belligerent independence so ingrained in Jamaicans has deep roots in the island's history. "To really understand Jamaica, you have to understand the hills," Dr. Ena Campbell at the African Caribbean Institute told me. "That's where our independence began."

And in the hills the story of independence begins with a group that today represents a tiny fraction of the population: the Maroons. Nothing else in Jamaica looks like

JEDI COBB

Blooms for export, *anthuriums and other ornamental plants are grown as part of Agro 21, Jamaica's new agricultural development program.*

their Cockpit Country, the huge, virtually townless territory that spreads through southern Trelawny and into neighboring parishes. The land is pitted with deep limestone sinkholes, and underground streams course everywhere. Bush-covered hummocks jut up, giving the land an eerie, malevolent look.

Three hundred years ago, Maroons—runaway slaves—fought the British to a standstill across this landscape. Today their descendants still live here.

Setting out from Falmouth on the north coast, I headed toward the Maroon town of Accompong on the southern edge of the Cockpits. Past Deeside the narrow road began to wind upward, becoming increasingly difficult. Trees and thick bush distorted the contours of large boulders. It was easy to imagine the sudden shot of a musket ringing out from some hiding place. British soldiers called this area the "land of look behind."

In Accompong, Martin Luther Wright, once chief of the Maroons here, settled down on a couch in his modest home to talk of ancient deeds.

The long-ago tales sound recent: "There is a cave over there where we would just wait until the soldiers passed, then open up on them from both sides. We once wiped out a company—no, we left the commander, so he could tell what we did."

In 1739, after 80 years of struggle, the Maroons secured treaties from the British granting them a measure of independence. Today the Maroons, numbering perhaps as many as 7,000 in the Cockpits and the Blue Mountains to the east, are still a nation within a nation. But Wright often talked of what he wanted from the national government. I asked whether Maroon independence was not diminished by dependence on the government. "We have treaties, and this is what they're supposed to do," he said.

Lorna Jones, cultural officer for St. Elizabeth Parish near Accompong, put the Maroons in a larger framework: "In a sense, all Jamaicans, all of us, are Maroons."

WHILE the Mother Myrtles of Jamaica stay in the hills, young people are leaving in increasing numbers. As Loren E. Lawrence, former U. S. Ambassador to Jamaica, told me, "The kids came down to where the discos were."

Near Mother Myrtle's farm I joined a group of teenagers at a home that serves as a bar after dark. The young Jamaicans peppered me with questions about jobs in the States. "I tell you, mon, dis place here, nothin' fe do. Jus' work dese field fe no money. No life here, mon, no life," one told me.

Thousands get to America; many more swell the Kingston ghettos. Others find an alternative in growing marijuana. Although ganja is illegal in Jamaica, many people are prepared to run the risk of growing it, calling it "the poor man's friend."

A teenage girl dressed in what seemed her Sunday best took me to a ganja field. Outside Ewarton we plunged into a thickly wooded area, crossed a river by rope, and began a two-mile uphill climb. The girl shouted ahead to identify herself, and the responses of invisible watchmen echoed through the countryside.

At the field, racks of drying leaves stretched across a small clearing. A cave held 200 pounds of cured marijuana. I asked one of the three young brothers who owned the field why he grew ganja. "I used to work in a garage in Spanish Town," he told me. "Dere I make 40 dolla a week. Now if it's a good year, I make $15,000."

Top-quality Jamaican ganja sells for as much as $1,600 a pound to U. S. consumers, and I was told at the U. S. Embassy that the 1983 wholesale value of Jamaican marijuana in the U. S. was 1.5 billion dollars.

Under pressure from the U. S. government, Jamaica has attempted a crackdown. This has met with limited success. Ironically, ganja money had become a major source of foreign exchange for businesses. Prime Minister Seaga maintains that new controls make it more difficult for illicit marijuana income to be used in legitimate enterprises. He also says that the black market for U. S. dollars no longer flourishes. Nevertheless, as with urban violence, containing the ganja traffic depends on Jamaica's finding an answer to its economic woes. And one of those woes *is* an imbalance in foreign exchange.

Mr. Seaga, who emphasizes deregulation, is working to rebuild the national economy on its four traditional bases: mining (bauxite), tourism, agriculture, and manufacturing. This restructuring, however, along with a severe austerity program designed to balance the budget and a painful devaluation of the Jamaican dollar, has brought sharply mounting costs for transportation, food, and electricity. To counteract that, the government has launched a program to help underwrite food costs for 600,000 schoolchildren, nursing and pregnant mothers, and the elderly and indigent. "Self-start" loans are available for people wanting to begin their own small businesses.

Mr. Seaga's development strategy is reflected in a mix of investment and experimentation, especially in agricultural diversification. The fertile island already produces world-famous coffee, ginger, pimento (allspice), cocoa, and rum. It has developed two new easy-peel citrus fruits, the

Sea grass *planted in bays and lagoons may help restore marine life in waters denuded by industrial and urban pollution. Anitra Thorhaug, a marine biologist from Florida International University (FIU), left, together with Jamaican biologist Peter Gayle, plants the grass in a lagoon near Rocky Point, long contaminated by dust from a bauxite plant. The pilot project was sponsored by FIU, the U. S. Agency for International Development, and Jamaica.*

Ortinique and the Ugli, and has created tropicalized pedigree herds of both dairy and beef cattle.

An Israeli investor is applying modern technology to the growing and packing of winter vegetables for overseas markets, and other Jamaican/foreign partnerships are being actively encouraged. Incentives are also being offered to local farmers to switch from the traditional crops. Experiments in solar power are under way. All this is aided by the U. S. 1983 Caribbean Basin Initiative, which creates possibilities for economic growth in officially "designated" countries by excluding most of their exports from duty. Jamaica was one of the first countries so designated.

TOURISM PRESENTS perhaps the brightest picture. In 1980 political violence kept thousands of potential tourists away. In 1981, partly because of an aggressive advertising campaign, tourist numbers began to nudge upward again, and they have continued to increase every year.

From the solitude of Negril in the west to the tropical beauty of Port Antonio in the east, ribbons of powdery, coconut-fringed sands quickly wash away the burdens of the workaday world for Jamaicans and foreigners alike. The rhythms of Jamaica's resort areas vary and offer something for every taste. In Negril, with a fisherman named Happy, I silently and contentedly watched a splendid sunset on a virtually empty beach. "Peace," he murmured, perhaps as much to himself as to me, when I left.

In frenetic Ocho Rios, which has become the main destination for cruise ships, and where too few visitors travel the network of inland roads that are doorways to the traditional life of the Jamaican hills, I watched the organized rituals of the major hotels that dominate the beaches. "Dese people, they don' really see Jamaica, ya know," a Jamaican named Rifle told me, "but it's all right, mon, we need the money. Yeah, mon, I need the money." Rifle sped off toward a tourist he had promised some black coral.

I was prepared to dislike Montego Bay, Jamaica's premier tourist mecca, yet found myself enjoying its hurly-burly pace. On the surface it is the least "Jamaican" spot on the island. Airplanes seem to disgorge sunseekers hourly; they quickly clog Gloucester Avenue, the twisting intown hotel strip where sellers of carvings, baskets, and simple woven garments arrange their wares on and in front of the fences that border the beach.

Posh hotels on lovely beaches are found a few miles east of the city center. But "Mo'Bay" is best enjoyed at the fine intown public beaches where Jamaicans play. There a good sense of the ironic comes in handy, as when watching blond secretaries being fitted out in African cornrow hairstyles.

THE OLD-TIME sugar industry, Jamaica's largest employer, poses more difficult problems than the newfangled tourist industry. As I walked through the cane fields and factory at the Appleton Estate, where Appleton rum is produced, I realized how little has fundamentally changed since the 18th century, when sugar and slavery dominated the island's economy. Men still wield their machetes, skin sweaty and toughened from the labor. Fires are lighted to burn away the cane leaves before cutting.

In the factory a yeasty smell hangs everywhere. "We are still in the days of the artisan," chief chemist Maurice Dilworth told me, "guided by taste, sight, and touch."

But sugar is no longer the engine of Jamaica's economy. In 1980 the world price for a pound of sugar was 29 cents. The price in August 1984 was about 4 cents a pound. The tiny island of Barbados produces 127,000 tons of sugar on 40,000 acres of land. Jamaica on 130,000 acres produces only 220,000 tons. In 1984 about 2,000 sugar workers

High in the mountains *near Ewarton a youth harvests marijuana—here called ganja—and stacks it on racks to dry. Though government agents destroyed nearly 20 percent of the country's crop in 1983, 1,900 tons of marijuana, with a wholesale value of 1.5 billion dollars, found its way to the United States. U. S. officials estimate that drug dealers pay some 175 million dollars to their contacts in Jamaica, thus making marijuana one of the island's major industries.*

Home, church, and family *spell contentment for Winston Brown of Hope Bay (**right**), who relaxes by the roadside with three of his nine children. A stonemason, Brown built his colorful house himself.*

On Sundays Brown spreads the word of the Lord as a part-time preacher in a church that he helped build. "If I had the time," he says, "I would walk all the way through Jamaica and shake hands to show love to everybody."

*As tourists who travel through the island discover, such goodwill and courtesy seem to be part of the national heritage. A young girl (**above**) in Spanish Town looks shyly at a visitor.*

were laid off. Thus it comes as no surprise that many islanders wonder if they have been "delivered" as promised.

"No better fish, no better barrel"—one government hardly any better than another. This Jamaican proverb reflects the skepticism that exists even among Jamaicans who voted for the JLP.

THE RASTAFARIANS, of whom there are thousands in Jamaica, believe that what is needed will not be offered by any government in power. Rastafarian singer Bunny Wailer fixed his eyes hard on me and disdainfully dismissed all politicians. "Power, mon. Dey wan' me to know dere power. Let dem make one pea seed dat grows, and I fall down and worship dem."

No visitor to Jamaica will fail to notice the Rastafarians, or "Rastas." They are most often spotted by their "dreadlocks," hair allowed to grow without combing until it twists and mats into sun-reddened locks that sometimes dangle below the waist.

Rastafarians believe Jamaica is "Babylon," a hell that cannot be reformed. Life is dreadful, thus "dread." Salvation lies in a heaven not in the sky but in Africa, where they seek repatriation. They believe that God, whom they call Jah, was incarnated as the late Emperor of Ethiopia, Haile Selassie. Many believe he lives and walks today as a man among men in a different identity.

I stayed for several days with a Rastafarian couple and began to acquire a vocabulary that, while specifically Rastafarian, also reflected much that I had come to admire about Jamaica.

"I and I give thanks for this that you give," my host, Tony Cole, said when I left some money to help with food and utilities. The pronoun is doubled because Rastafarians believe you must refer to both God and the human who live together in each person. "Cool runnings," Tony called out when I left him. It is a slang good-bye, but also seems to be both blessing and encouragement.

Serious discussion with a Rasta is a "reasoning." If other Rastas are around, they may shout approval of ideas or, even when they disagree, may express approval of the way an issue is reasoned.

I reasoned over several days with Rastafarian poet Carl Gayle, who writes

Afternoon tea, *served against a backdrop of booming surf and pigeons* ***(above)****, is part of the daily ritual at Trident Villas and Hotel near Port Antonio. Perched on a coral promontory* ***(right)****, the hotel's luxurious accommodations include individual villas and an "imperial suite" that rents for $480 a night in the winter season.*

Jamaica builder Earl Levy constructed the hotel in 1967 and saw it nearly destroyed by a hurricane in 1980. "So I had the pleasure of building it again," he says. "I prefer to put my money into concrete." If tourists keep putting their money into Jamaican vacations, the country may have a brighter future.

brilliantly of urban Jamaica and modern Jamaican music. I told Carl I did not think Haile Selassie was God, and I thought he was dead. "Life can't dead," Carl reasoned, "ya can't see life, ya know. It's a man you see movin' you call life."

Most Rastafarians are grouped into organizations. To visit the Bobo Ashantis, I followed the sound of drums rolling down a hill in Bull Bay. I came on a structure painted in the Rasta colors of red, gold, and green. At the entrance I tried to reason with several guardians, seeking permission to enter. I was eventually allowed in, but not before I had been told several times, "This is not Jamaica, this is Jah-mekya [God made here]."

They sing the Psalms of the Bible, the drums providing a pulsating, hypnotic base to their music. It is a music that forms the base of reggae. Reggae is a synthesis of African, Caribbean, and black American music. It is a music that reflects the raw edges of the ghettos. When ghetto gangs were known as "rude boys," their music was "rude," outlaw in its stance. Consider Desmond Dekker's "Shantytown (007)":*

And the rude boys go a wail . . .
Cause them out of jail
Rude boys cannot fail
Cause them must get bail
Ooh, dem a loot, dem a shoot, dem a wail, shanty town.

Reggae was embraced by the Rastas and has propelled Rastafarian influence on and off the island. The songs retain the ghetto anger, but a biblical vision, drawn largely from the Old Testament and the Book of Revelation, has been added, as in Rasta prophet Bob Marley's poignant and popular "Redemption Song":†

Old pirates yes they rob I
Sold I to the merchant ships . . .
But my hand was made strong
By the hand of the Almighty
We forward in this generation triumphantly.

"Now music," or the "now psalms," Carl Gayle called reggae, which led me to wonder whether the nowness, and the growing commercial success of reggae, did not endanger its spiritual values. I put this question to reggae superstar Jimmy Cliff on the porch steps of his home in New Kingston. Jimmy once embraced Islam, but I noticed the beginning twists of dreadlocks. Jimmy ducked the question of whether he is Rasta now but acknowledged: "Commercialism creepin' into the music, but it still maintain the roots because I and I are the roots. I and I are David [King David of Israel] who are musician. I and I are David right now."

The reggae group Chalice lays no claim to biblical guidance, but the yard where I met them was crowded too. I could hear a bass guitar behind the house. Wayne Armond, lead guitarist for the group, told me, "While we believe reggae music is Rasta music, we also think it's Jamaican music."

WAYNE'S REMARK helped open my mind to the reach of reggae. The real base of reggae is not Rasta but Jamaica. Strip Rastafarianism to its basics, and you are in any one of the countless churches that fill up each Sunday around the island. The Rastas themselves are changing now, wrestling with what it means to stay in Jamaica with little chance of finding heaven in Africa. Though repatriation to Africa is still the dream, the rehabilitation of Jamaica is also talked of frequently.

The island motto, "Out of many, one people," is not to be mocked. The only real tradition is synthesis. New processes constantly unfold, giving Jamaica an exceptional vigor, even when it seems weakest.

"Come back to Jamaica. . . . Come back to the way things used to be." This slogan on American television won the island a dramatic increase in tourists. But the reality of Jamaica is not that simple. Many things do stay the same: the beauty, the warmth of Jamaica's people, the splendid beaches. But Jamaica, ever changing as it works out its destiny, is not the way it used to be.

Come to Jamaica. And, as I was advised when I first arrived, "Don't miss the magic. Get off the main roads and beaches." Look for the change and that Anancy web of culture, its fibers woven everywhere, stronger and more protective than its delicacy suggests. Jamaica is a special island, some part of which I'll always carry with me. Jamaica or Jah-mekya, cool runnings. □

* © Ackee Music, Inc.
† © Bob Marley Music, Ltd.

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O N I T O R

An extraordinary television series begins a new season

AS TELEVISION KEEPS TIME, two decades add up to several eternities. Yet this month the Society begins its 20th year of National Geographic Specials by telecasting "Land of the Tiger." In 1965 such a future seemed remote.

Melville Bell Grosvenor, then President of the Society, and his successor, Melvin M. Payne, were determined to launch National Geographic into color television, as it was rapidly moving from expensive novelty to affordable reality for the millions.

PHOTOGRAPH BY ROBERT S. OAKES

NATIONAL GEOGRAPHIC DIRECTOR OF TELEVISION DENNIS B. KANE WITH A SAMPLING OF AWARDS GIVEN TO SOCIETY SPECIALS.

The commercial networks were skeptical that color documentaries could draw sizable prime-time audiences, and they were hesitant to allow any outside organization full editorial control. Nevertheless, sponsors were lined up, and the Society's first program, "Americans on Everest," was aired by CBS September 10, 1965.

Nine years of Specials followed on commercial television, a remarkable record given the short life span of most series.

National Geographic Specials were not renewed for the 1974-75 season, and we were swamped with letters expressing frustration and anger at the cancellation. The next season the series was back on the air, this time on the Public Broadcasting Service, with new programming and new partners: WQED/Pittsburgh and Gulf Oil Corporation, now part of Chevron.

"The Incredible Machine," our very first program on PBS stations, became the most widely watched program ever shown on public television, since surpassed only by another Society Special, "The Sharks."

High ratings are gratifying—13 of the top 25 most watched evening programs ever shown on PBS have been Society Specials—but with us ratings are secondary to content. Naturally, we strive to reach large audiences, but we do not live or perish by the numbers game.

We regard our television viewers as a highly intelligent, thinking audience, as does Gulf Oil, whose financial support has been extremely generous. With such backing, the National Geographic-WQED/Pittsburgh team has produced excellent, well-received films that range the world in subject matter and treatment.

Society Specials have won nearly 200 awards, including 12 Emmys. More important, I think, we have proved that American audiences truly appreciate quality programming. More and more, fine documentaries are appearing on both PBS and commercial TV.

Our Director of Television, Dennis Kane, has been involved through almost all the ups and downs. He says, "In a way, we are just beginning. We have our vision for the future, and we will do a lot more."

I agree. As they say, "Stay tuned."

Gilbert H. Grosvenor

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MIRACULOUS MACHINES · April 10, 8 p.m. ET

Members Forum

Dallas

A most interesting article and photographic story about Dallas (September 1984). Griffin Smith told us nearly everything, including who founded that great city, John Neely Bryan. But he failed to tell us—where did Dallas get its name?

Eric Tainter
Walnut Creek, California

The origin is uncertain. The settlement may have been named for Commodore Alexander Dallas, a friend of a riverboat captain who was an associate of John Neely Bryan. Dallas County was named in 1846 for George Mifflin Dallas, James K. Polk's Vice President.

Your article on my hometown of Dallas I found biased, myopic, and frequently offensive. I cannot understand why Griffin Smith chose to perpetuate the plastic banality of North Dallas and its suburbs. He virtually ignored Dallas's southern sector and the Hispanic population. Where are the tidbits on Glen Oaks, Redbird Heights, Kessler Park, and Wynnewood Hills—integrated neighborhoods that rival any in North Dallas in beauty? The southern suburbs may yet be slumbering, but they wait on the brink of explosive development. Dallas, as a whole, is a great city to settle in and raise the all-American family. Do not malign us by dividing us.

Charles Edward Turner II
Dallas, Texas

Kudos galore for "Dallas!" by Griffin Smith, Jr., along with the illuminating photographs. It was a great experience to read it to the blind and print-handicapped listeners on Insight Radio.

Alice Brickach
Providence, Rhode Island

I hate to inform you that the fur jacket being presented by Mary Kay (page 285) is not a mink, but an inexpensive blue fox jacket.

Marvin J. Tarlow
Tarlow's Furs, Inc.
San Jose, California

Mary Kay Cosmetics, which confirmed the original identification, gives both mink and fox as sales awards. You're right—this one was fox.

Manatees

In your September 1984 article entitled "Man and Manatee," Dr. White states that the manatee Ariel's baby was born tail first. I have read of this type of birth in dolphins. However, on page 416 there is a sequence of photos showing a baby manatee being born *head first!* It also states that from the time the baby broke the amniotic sac with its nose to the time it was released was an interval of two hours. How did it breathe during that time?

Brian Smith
Stevensville, Montana

Most scientists believe tail first is the normal method, but few manatee births have been observed. Hurricane received oxygen through the umbilical cord until separation from the mother.

Manatees are being used to clear Lake Kariba, between Zambia and Zimbabwe, of the vegetation that clogs it.

Patrick J. N. Bury
Dublin, Ireland

Iceland

"Iceland's Wild Glacier-born River" (September 1984) was another stunning adventure. Jules Verne (*Journey to the Center of the Earth*) would have been proud.

Richard Hansen
Appleton, Wisconsin

Topsoil

I just finished your excellent article on the soils of America (September 1984) and how we treat them. Having lived at the head of Lake Pepin for 72 years, I am well aware of the devastation caused by erosion and siltation. Lake Pepin is silting in at an average rate of an inch a year and is in the process of becoming one of the cleanest mud puddles on earth. In 1978, Pierce County Farmers' Union passed a proposal that soil and water conservation be made a requirement for participation in the farm support program. The proposal was written into the National Farmers' Union program for that year. Senator Bill Armstrong's sodbuster bill deserves the support of every American who now enjoys the abundance of this land. It was initiated by the farmers and will be the first move in taking the government out of the business of subsidizing those who lay waste the lands and waters of this nation.

Lloyd V. Spriggle
Bay City, Wisconsin

Your article should make farm and nonfarm people alike aware of the urgent need to protect one of our most precious natural resources—soil. However, I was disappointed not to read even one word about the efforts of Soil Conservation Districts, which work cooperatively with the Soil

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Conservation Service but rarely get their just recognition because few take time to distinguish between the two organizations.

Kathryn A. Weaver
Idaho Falls, Idaho

Et tu, Geographic? In the early 1950s I read somewhere that Patrick Henry had said, "He is the greatest patriot who stops the most gullies" (page 376). Making as many as a dozen conservation speeches a week, I gleefully quoted Henry right and left. I wanted documentation, but neither the Library of Congress nor the Soil Conservation Service could find proof that Patrick Henry ever said it.

William Voigt, Jr.
Blacksbear, Georgia

Since the Virginian was a noted orator, not a writer, most of the quotes attributed to him are the recollections of eyewitnesses. Such hearsay is very difficult to verify.

Puffer Fish

"The Preposterous Puffer" (August 1984) was fascinating. Although there is no firmly proven antidote to the tetrodotoxin, there is hope. Recent experience with 16 cases of poisoning by the species *Sphaeroides maculatus* and *Arothron stellatus* in Alexandra Hospital, Singapore, has shown that anti-cholinesterase drugs such as edrophonium and neostigmine produce dramatic improvement of symptoms and may be life-saving.

H. S. Lim, M.D.
S. K. Chew, M.D.
Singapore

Colorado

The exquisite autumn photograph of a quaking aspen stand (August 1984) illustrates an interesting aspect of the population genetics of that species. Once established, aspen seedlings tend to reproduce themselves vegetatively by root suckering. In this manner, large clumps of genetically identical trees develop around the original seedling. Many stands in the Rockies and other regions of the West actually comprise extensive mosaics of such clones. In the photograph, the trees with leaves remaining are all members of a clone that differs from its neighbors in the physiology and timing of leaf abscission.

Gary A. Ritchie
Olympia, Washington

Central Rockies Map

Using dogs to haul tepees was an impossibility. The tepee, a large conical lodge made of heavy skins, came onto the Indian village scene after the arrival of the Spanish horse. Long poles attached to the sides of the horse formed the simple but effective travois, the only suitable means for transporting a heavy tepee. However, dogs were used for carrying components of the wickiup, a much smaller dwelling used by many Indians.

Leo Kimmett
Canon City, Colorado

Great Plains Indians were dependent on the buffalo for food, clothing, and shelter (buffalo-skin tepees) before the arrival of the horse. A strong dog could drag as much as 75 pounds on a travois, and a small tepee made of six to eight buffalo hides was the maximum load. With the arrival of the horse, able to haul some 300 pounds, the average size of a tepee grew larger, from 12 to 20 skins.

Burma

I greatly enjoyed your perceptive article on Burma in the July 1984 GEOGRAPHIC. What particularly attracted my attention, however, was your account of the return of the four small Pyu bronzes to Burma.

I was involved briefly with what can only have been those same bronzes. In 1968 or early 1969, Denison University in Granville, Ohio, decided to photograph Burmese art objects and antiquities in various collections in the United States and send a set of color slides to Burma. The slides were sent through the U. S. Information Agency. I was the embassy political counselor at the time.

The slides were presented to some highly appreciative Burmese academics. A few days later, one of them contacted us in considerable agitation. Among the slides was a photograph of four small Pyu bronzes that had been discovered near Prome a year or so earlier, and had almost immediately been stolen.

I cabled the Department of State and asked if they would check to find out where the bronzes were located and how they might be recovered.

Denison reported that the figures were in the personal collection of a private individual. He did not contest the claim that the bronzes had been stolen but insisted he had acquired them legally. He indicated his willingness to leave instructions in his will for the return of the bronzes to Burma after his death.

And that's where the story ended—at least until I read your article. I'm delighted to learn that the Pyu bronzes have finally, after 16 years, found their way back to Burma.

Edward C. Ingraham
Bethesda, Maryland

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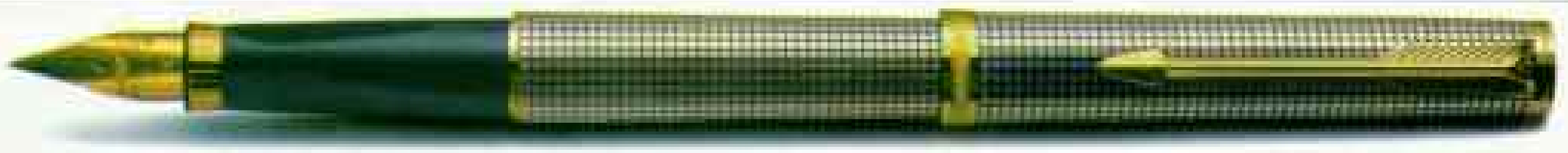

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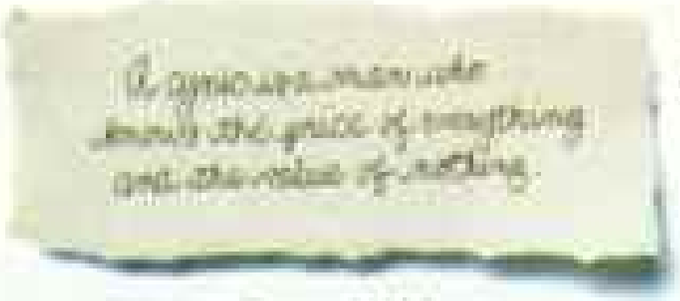

Oscar Wilde

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On Assignment

THERE'S MORE than meets the eye in this snapshot of ***Francine "Penny" Patterson*** and ***Ronald H. Cohn*** (***below left***). The photographer is Koko, a gorilla who has been their student of American Sign Language for the past 12 years. Koko proved that gorillas can be shutterbugs when she took her self-portrait for the cover of the October 1978 NATIONAL GEOGRAPHIC (***below right***). "She learned how to use a camera by watching me," explains Cohn, who documents the gorilla language project with photographs and videotape. "Koko wants to do what I do," he says, so occasionally they reverse roles (***bottom***). A molecular biologist, Cohn received his doctorate from the University of Illinois and taught electron microscopy there. He pursued a fellowship at Stanford University, where Patterson earned her doctorate in developmental psychology with her study of Koko and a male gorilla, Michael. Since leaving Stanford, the scientists have made the project a lifelong commitment.

KOKO (ABOVE AND LEFT)

FRANCINE PATTERSON

Photographed by team of N. Rettig, W. Salb, A. Degen. *Harpy Eagle: Genus: Harpia Species: harpyja*
Adult size: Average length, 81—100cm; wingspan, 168—213cm Adult weight: 4—8kg
Habitat: Tropical lowland forests in southern Mexico, Central and South America
Surviving number: Unknown; scarce throughout its range

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

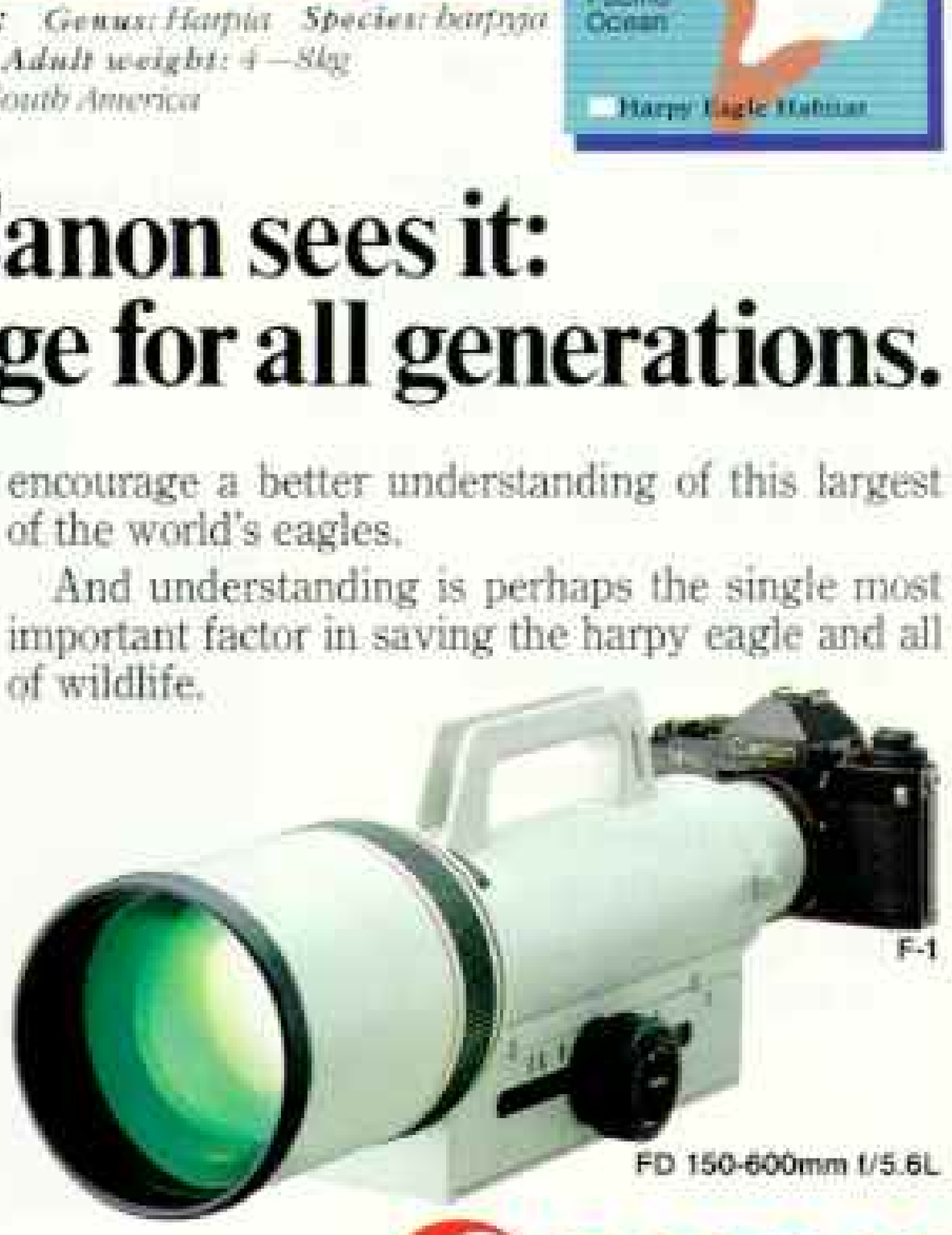
Returning with a fresh branch, a harpy eagle brakes to land at its nest, over 125 feet above the forest floor. A silk-cotton tree towering above the rain forest canopy provides the favored nesting site for these majestic birds.

This formidable eagle deftly maneuvers through the forest canopy to capture monkeys, sloths, and other small animals for its prey. Widely scattered, with its numbers continuously decreasing, this magnificent raptor in its natural environment is a rare sight.

The harpy eagle could never be brought 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.

Photography is an invaluable research tool, especially when studying a creature as elusive and remote as the harpy eagle. Photography can also help alert people to the plight of the harpy and encourage a better understanding of this largest of the world's eagles.

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



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