

NATIONAL GEOGRAPHIC

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NATIONAL GEOGRAPHIC

September 1973

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NOW WE'VE ALL been to the moon, all of us who thrilled to Apollo 8's Christmas message from lunar orbit, who saw Neil Armstrong's booted foot make the first human track on lunar soil, who watched as space-suited astronauts bounded kangaroo-like over stark moonscapes. And we think back to a prophecy by President John F. Kennedy in 1961, when he pledged that the United States would put a man on the moon within a decade: "In a very real sense, it will not be one man going to the moon. . . it will be an entire nation."

He understood how that single feat would lift the spirits of all mankind. Apollo epitomizes what a nation can do when it commits itself. Therein lies our hope for an answer to the energy crisis, the environmental crisis, and to every other major problem of humanity. Apollo proves to us that man can do almost anything he dares.

There are more tangible rewards, of course, in 841 pounds of moon rocks and soil—the prizes of six lunar landings. Generations of scientists will study these fragments of an alien world for clues to the origin of the moon, of their own planet, and of the universe.

Increasingly tangible, too, are far-ranging spin-off benefits, from worldwide weather forecasting by satellite to vastly improved testing for tires, from better electrical circuitry for homes to more-antiseptic procedures for surgery.

Despite such practical aspects, our thoughts keep turning back to those breathless moments when the first man took the first steps in a world apart from his



ASTRONAUT RONALD E. EVANS SAYS A FAREWELL HUG FROM HIS WIFE, JAN, AT CAPE KENNEDY. (JOE SCHREIBER)

own. As the dramatic moon landings conclude and the mass of findings begins to yield appreciable results, NATIONAL GEOGRAPHIC publishes a special salute to the space program. On the following pages you will find the climactic story of Apollo 17, the final mission, as described in the words and photographs of its crewmen. Space editor Kenneth F. Weaver draws on lunar knowledge only now available to re-create significant events that helped shape the moon. Astronaut David R. Scott of Apollo 15 writes a personal revelation of

how it feels to walk on the moon.

A special supplement brings to members an enlarged photograph of our own space-voyaging planet, as the astronauts saw it, aglow with the hues of its continents, seas, and swirls of cloud. On the other side a painting unites 32 Apollo astronauts as artist Pierre Mion visualizes them at an earth training site. The light on their faces reflects a shared dream of reaching the moon—first port of call on man's greatest voyage of discovery.

Bilbert A. Browner

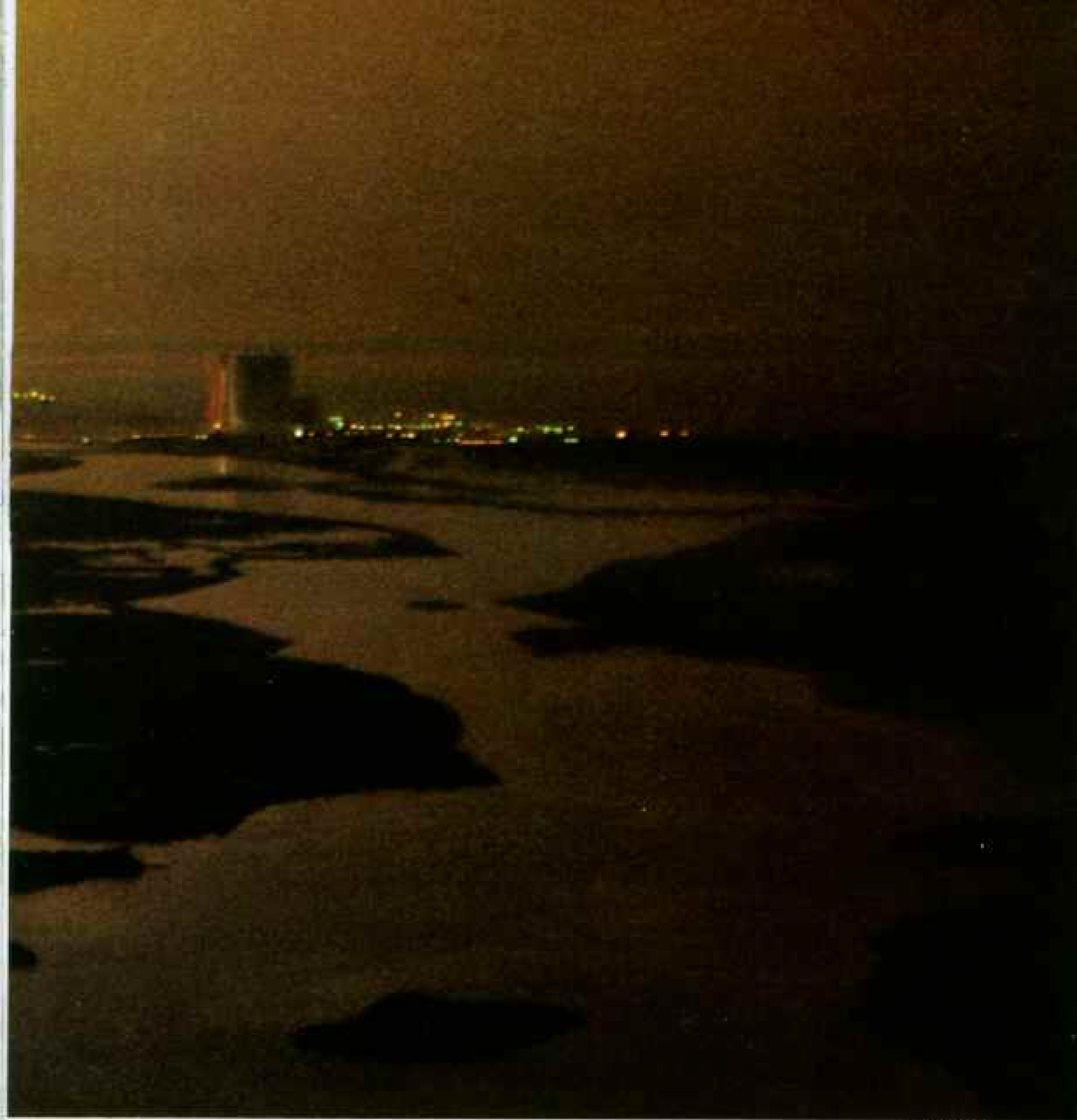


Exploring Taurus-Littrow

By HARRISON H. SCHMITT

Photographs by the crew of Apollo 17

BILLOWING FLAME that seems to rival the sun, our Saturn rocket pulses the humid December night, spreading a false dawn across central Florida. As far away as North Carolina, spectators spot the bright wake of this unique Apollo night launch. Yet directly atop the five engines that lift Apollo 17, only faint flickers invade the spaceship *America*, whose cabin I share with Mission



JONATHAN BLAIN

Commander Eugene A. Cernan and Command Module Pilot Ronald E. Evans.

Our launch has had its brief tense moments. Thirty seconds before takeoff an automatic sequencer discovers what it thinks to be an unpressurized liquid oxygen tank in the Saturn rocket and abruptly stops the countdown. More than two-and-a-half hours drag by before the problem is resolved and our journey begins.

Now we feel the battering vibrations of engines shouldering $6\frac{1}{2}$ million pounds into space, feel the gradual weight of acceleration

as our race to orbit quickens. These physical sensations and my duties crowd from my consciousness any anticipation of being the first geologist to walk on the moon.

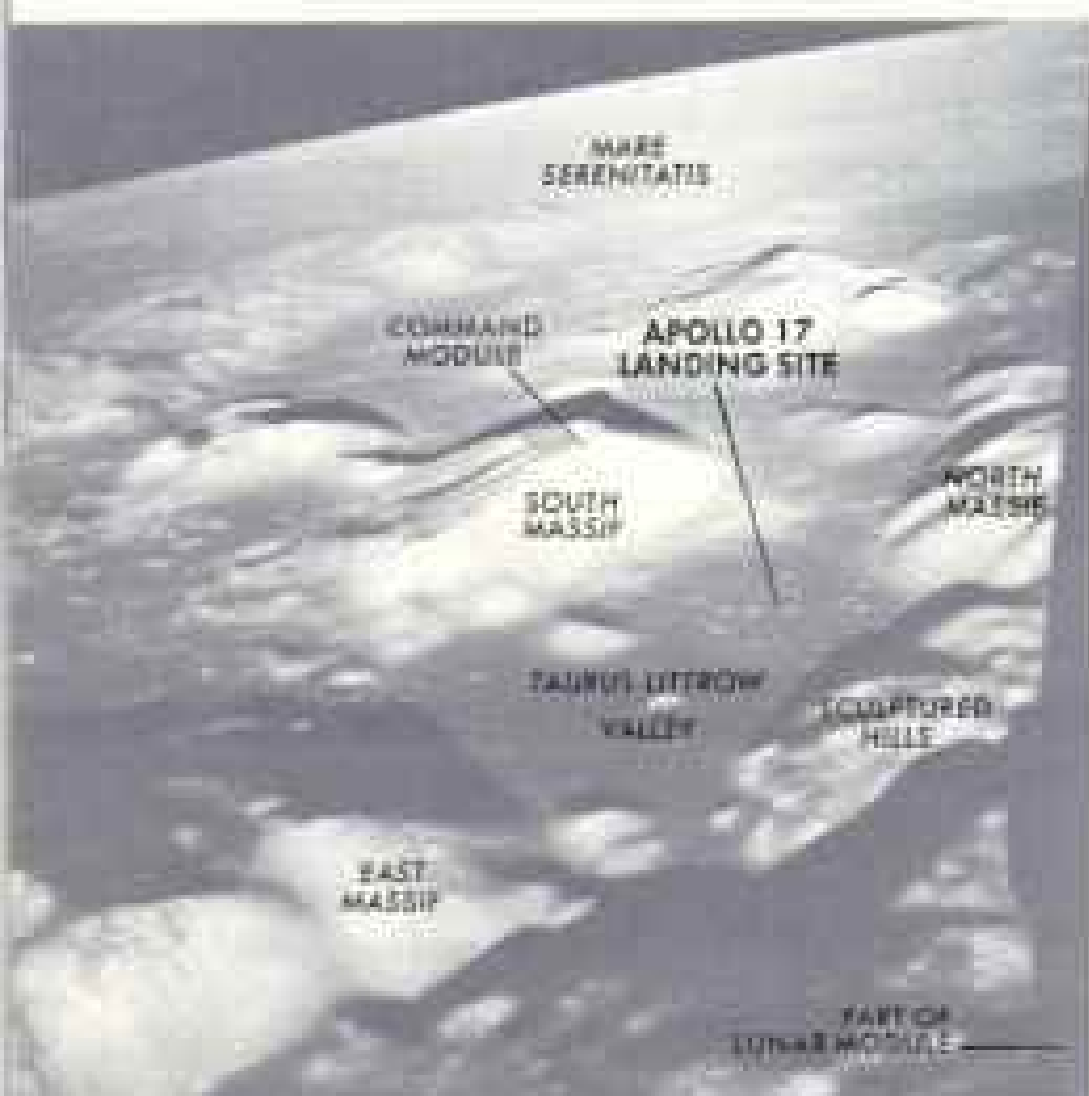
Aloft in *America* with the lunar module *Challenger* locked in tandem, we speed toward the intriguing valley of Taurus-Littrow, which lies near the coast of the great frozen "sea" of Serenitatis. Our newly won knowledge of the moon indicates the site will richly reward those who read the library of the planets. This helps to mitigate the sadness that our visit signals the end of the era of Apollo exploration.

“A pitted, dusty
window into our
own past...”

THE VALLEY of Taurus-Littrow is confined by one of the most majestic panoramas within the experience of mankind. The roll of dark hills across the valley floor blends with bright slopes that sweep evenly upward to the rocky tops of the massifs. The Taurus-Littrow valley does not have the jagged youthful majesty of our Rockies. Rather it has the subdued and ancient majesty of a valley whose origins appear as one with the sun.

Here Gene and I, who have already transferred to *Challenger*, view our destination from an altitude of ten miles. On a course that takes it a few thousand feet below us, *America* continues in lunar orbit; it appears insignificant against a ridge of the South Massif (right, center, and in the locator drawing below).

We complete our final orbit. Then: “*Challenger*, you’re GO,” announces Mission Control in Houston. As we monitor our instrument dials and gauges, Gene lets the spacecraft’s computer have its head.

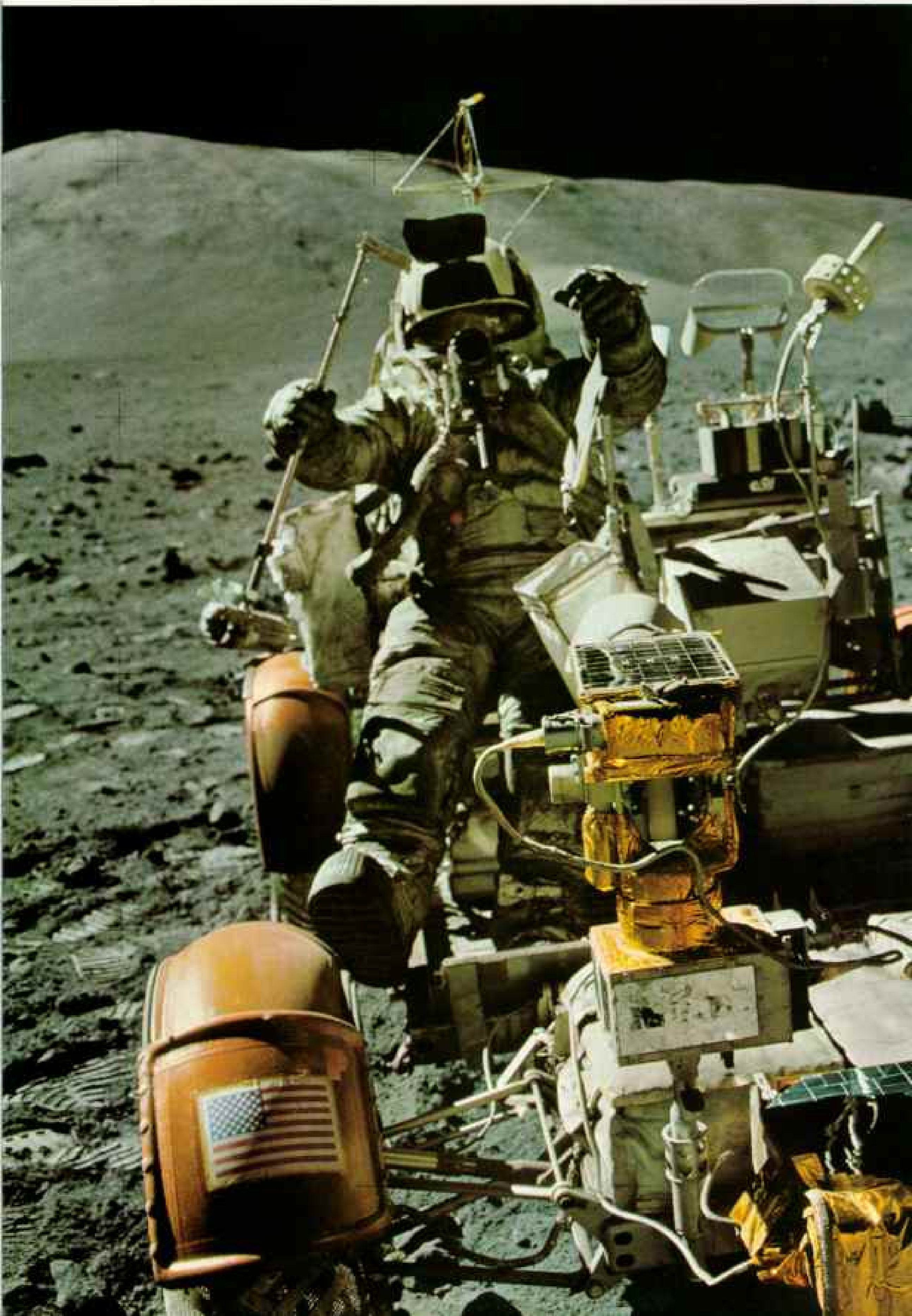


EUGENE A. CERHAN, APOLLO 17 COMMANDER





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EUGENE A. CERNAN

GENE LANDS THE LM as if it were an everyday event. Our camp established (top), we begin unpacking—no small chore when the luggage includes your automobile. Unfolding the battery-powered Rover, we load it with TV camera and scientific accessories. A gentle leap in the moon's gravity—a sixth that of earth—easily vaults an eager geologist into the seat (left), soil sampler in hand.

A hammer Gene carries accidentally tears off part of a fiber-glass fender, and dust from the wheel threatens to be a problem. Happily, Astronaut John Young and other friends back in Mission Control conceive a replacement, using clamps, maps, and tape. With their guidance, Gene and I perform the first successful automotive repair job on the moon (above).



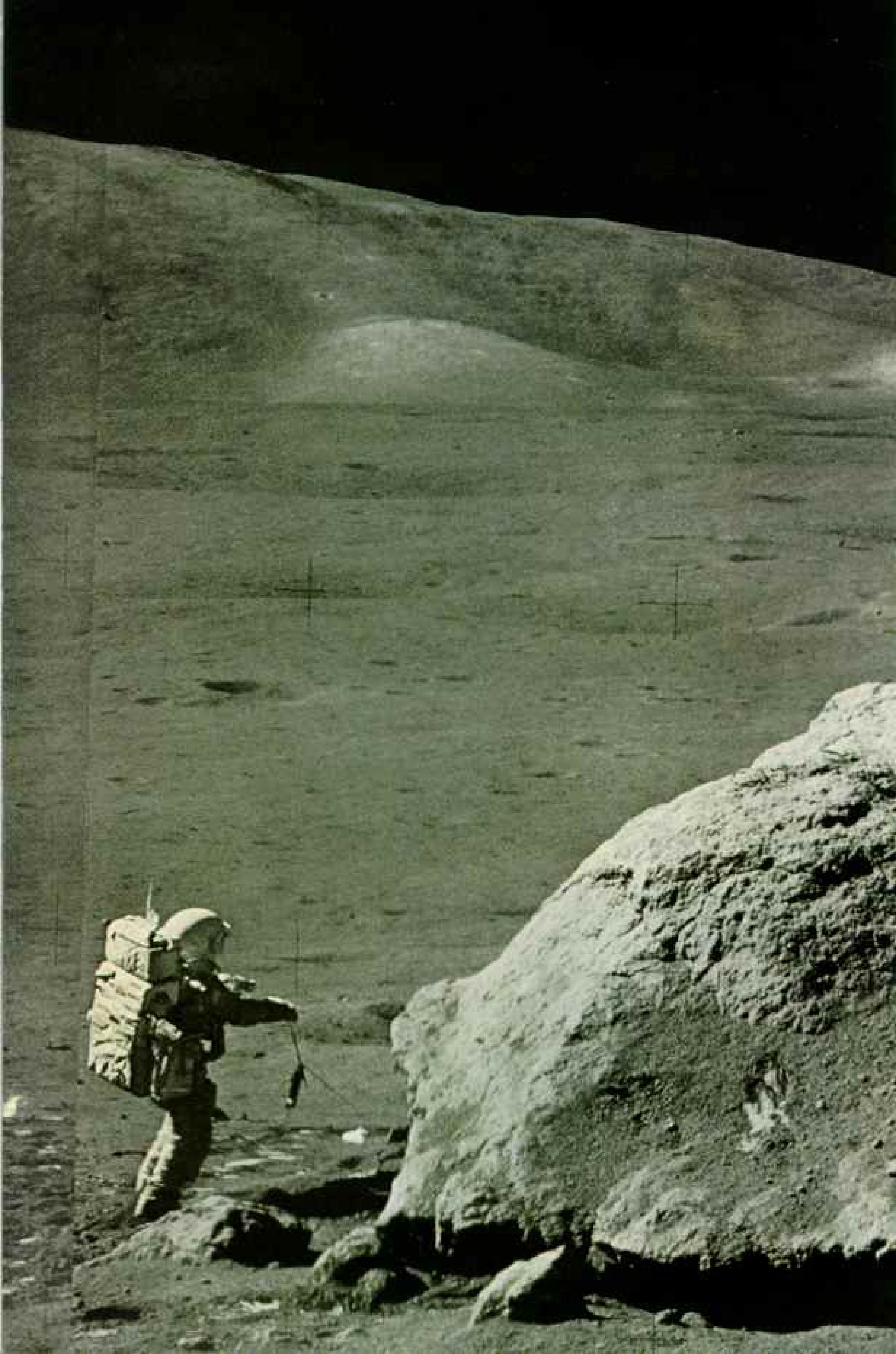
DESPITE sophisticated equipment, a rake is still the best tool for picking up dime- and quarter-size fragments (left), which often hold information not found in fine soils or larger rocks. Clean suits advertise that we are new on the job; dust quickly begrimed us and eventually seriously clogged moving parts of some equipment.

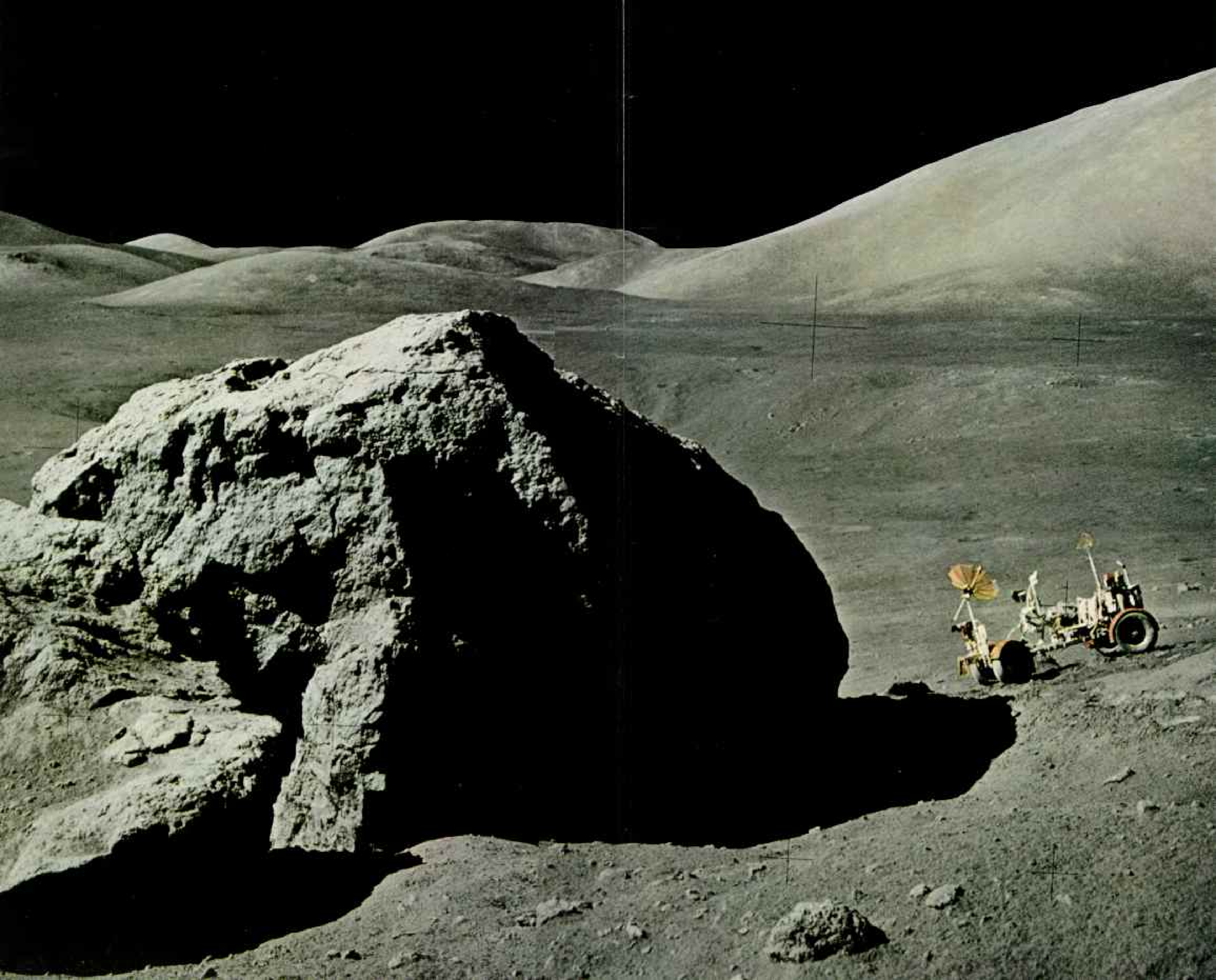
Three miles beyond the Rover, a boulder nearly fifty feet across had plowed a path down the North Massif (right), tracing its signature on a massive page of history. The track suggests that the rock waddled from side to side down the slope.

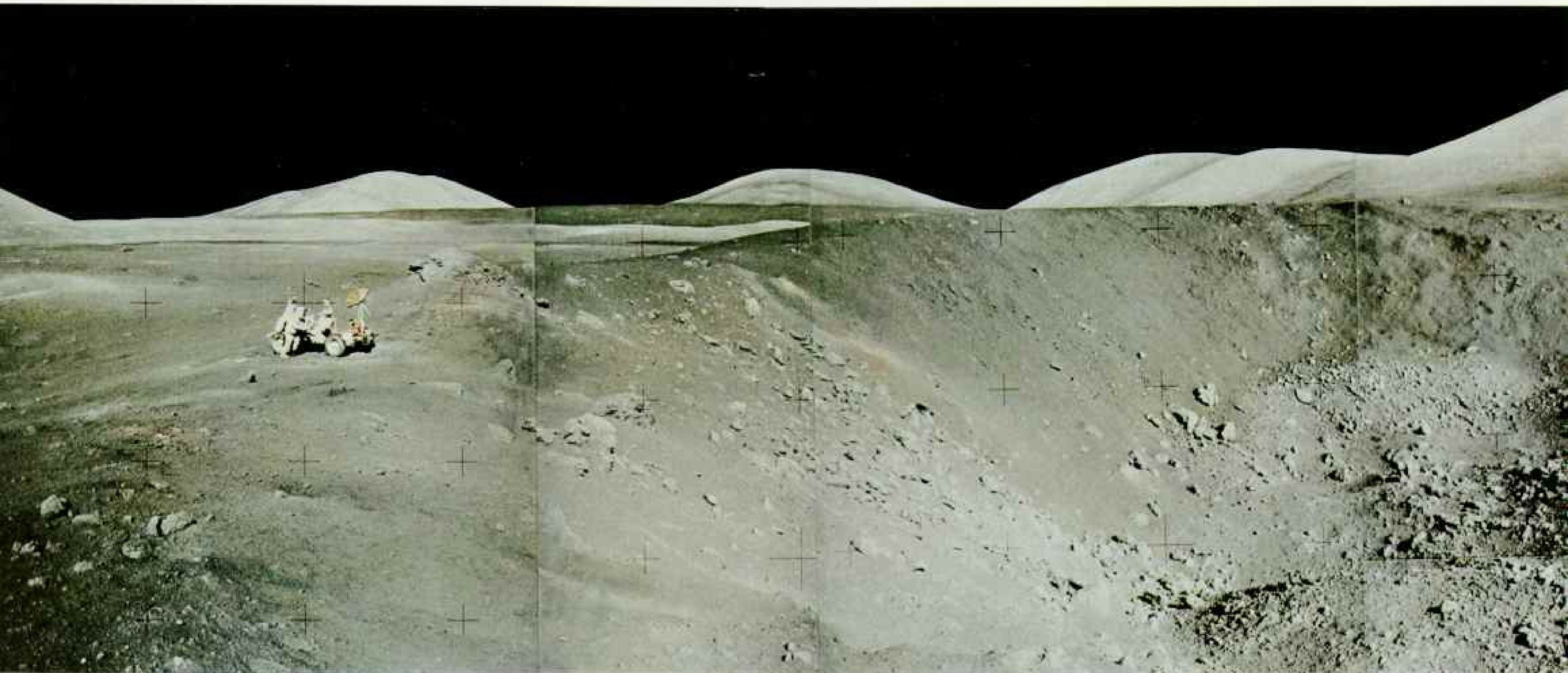
Lunar seas converge in an orbital view taken only 150 miles from our landing site (below). The darker basalt, lower, spread when lava flooded Serenitatis perhaps 3.7 billion years ago. Then a younger pale basalt crept in during the final filling of the basin. Long narrow rilles, crater chains, and an eight-mile-wide crater pattern this fascinating region.



EUGENE A. CORMAN (LEFT AND TOP) AND DONALD E. CRYSL, PHOTO BY EDWARD WITTELL (LEFT)







PHOTOGRAPHY (ABOVE, RIGHT, AND OVERLEAF) BY EUGENE A. CERMAN

“A geologist’s paradise, if I ever saw one...”

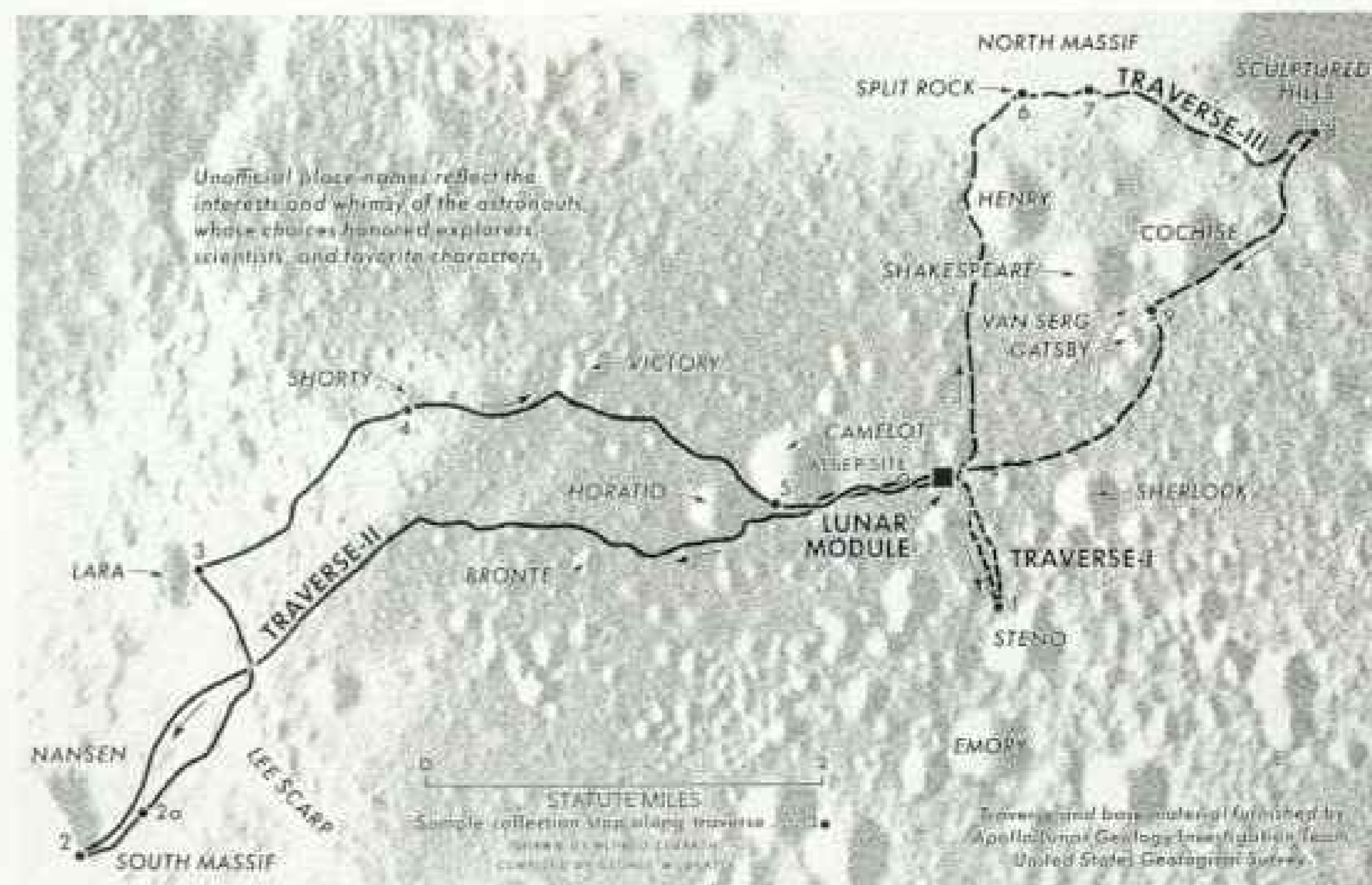
GARAGE-SIZE BOULDER on the valley floor (left) once perched high on the North Massif. Probably dislodged by a meteorite impact, it rolled down the mountain and split into five segments as it came to rest.

Our samples show that the boulder is composed of two types of rock, which probably formed during different cataclysms some four billion years ago. Any geologist who helps solve the riddles of Split Rock’s history will add new pages to the calendar of violent events that helped shape both the infant moon and the earth.

I retrieve a gnomon, which we had placed to indicate color, scale, and angle of slope for our photographs.

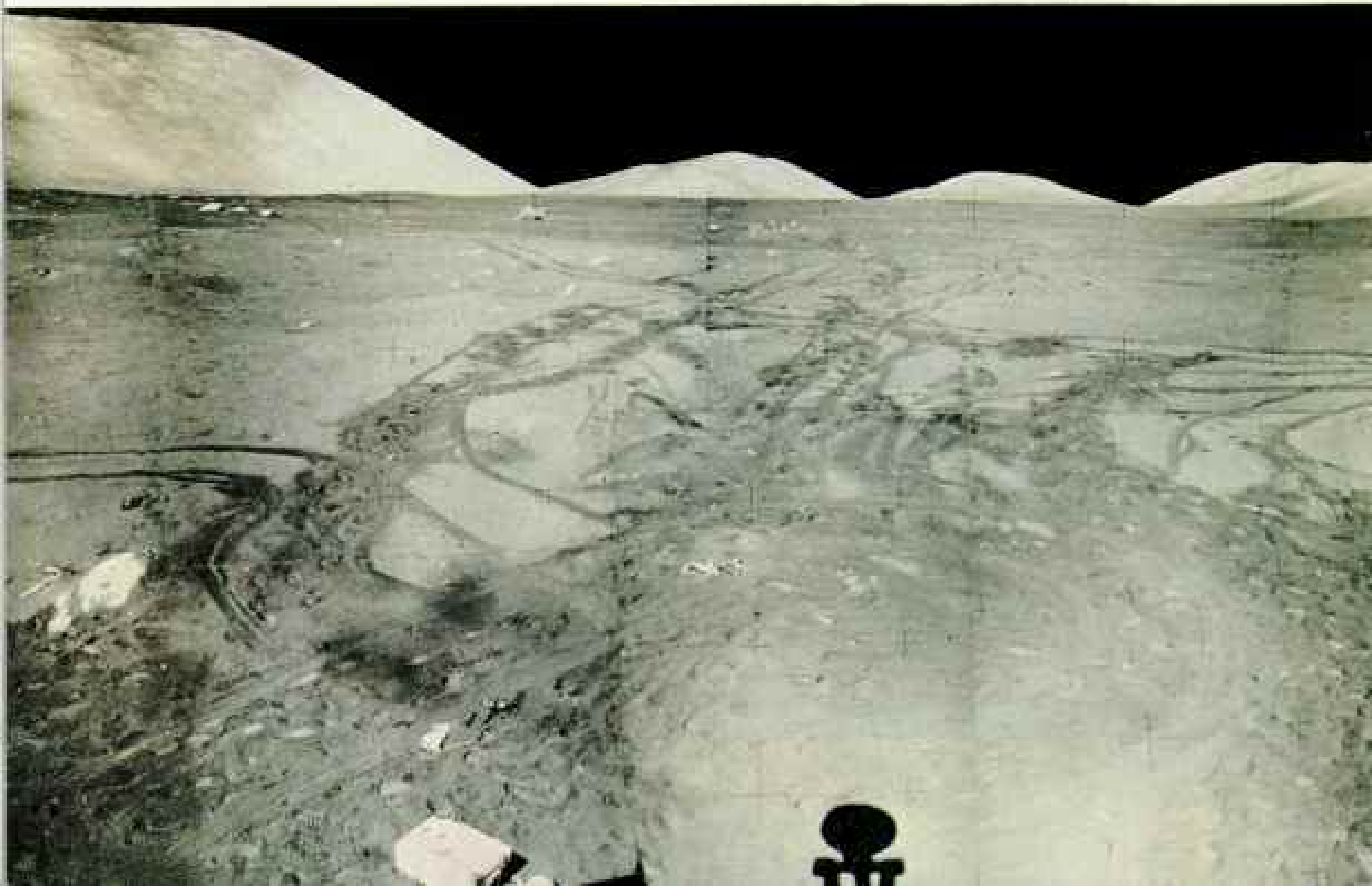
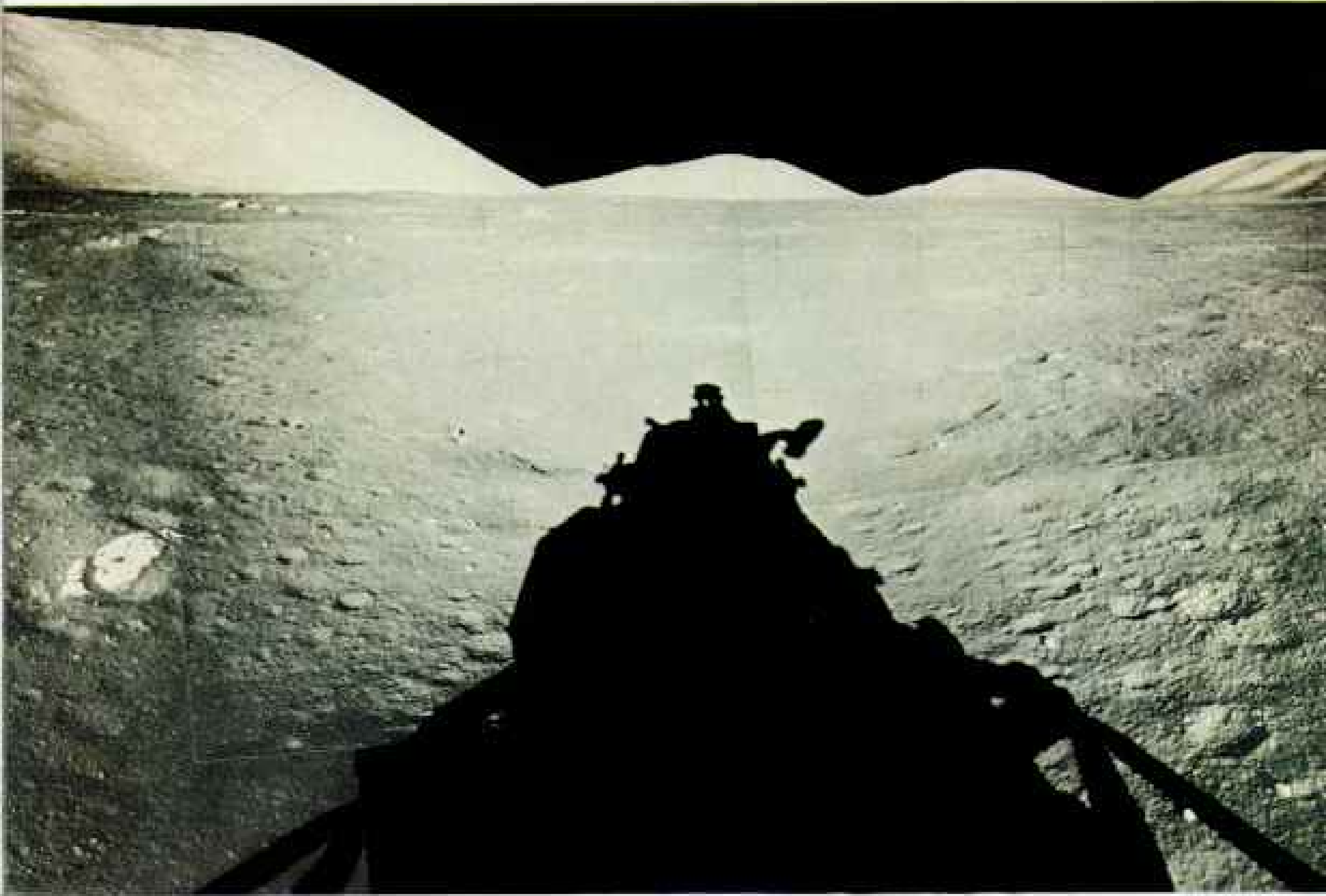
THIS PAGE FOLDS OUT

A landmark on our second traverse (map at right), Shorty crater (above) could accommodate a football field. As we skirt the rim, our feet scuff the surface and produce the unexpected. “There is orange soil!” It almost glows in a sampling trench (far right). Gases escaping from a fumarole—an indication of recent volcanism—could cause such coloration. But later studies show the bright soil to be microscopic glass beads, tinted by titanium, that formed 3.7 billion years ago from molten rock thrown skyward by a volcano or a meteorite. After cooling, the beads were buried, then blasted to the surface again only a few million years ago by the impact that dug Shorty.





Shadows shorten and the lunar



trails lengthen outside the LM window



HERBERT H. SCHWITZ, APOLLO 17 LUNAR MODULE PHOTO



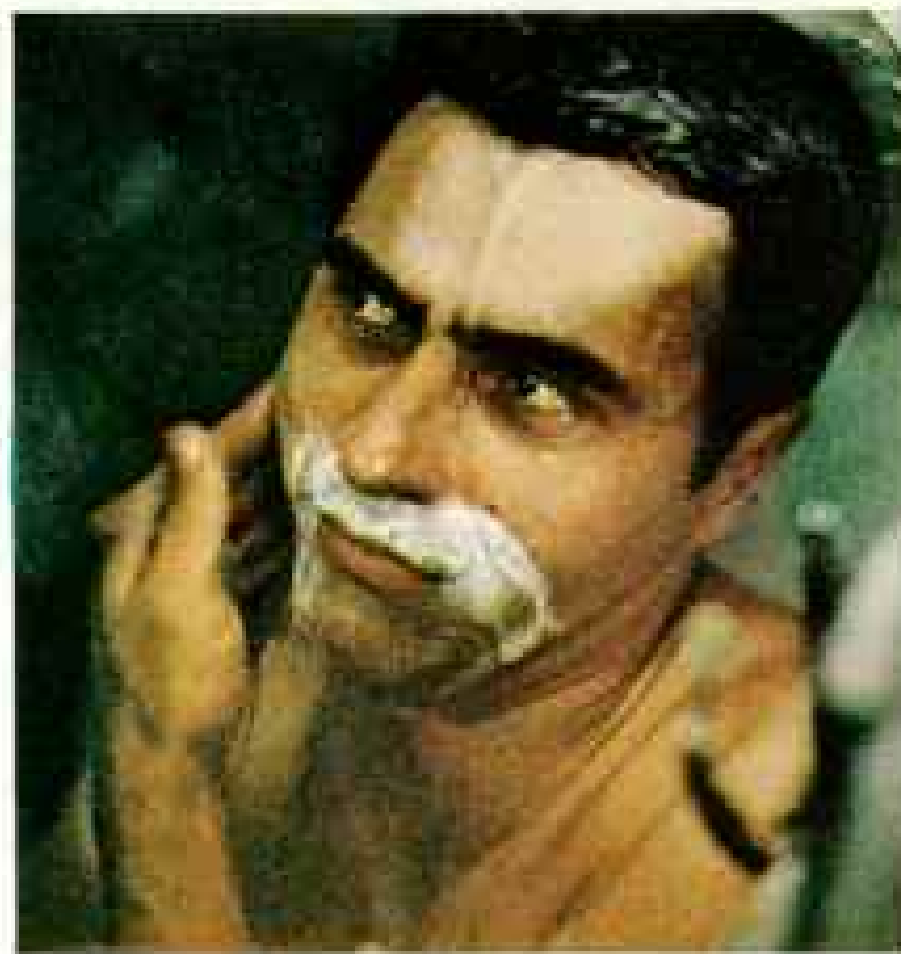
LONG A SILENT WITNESS to unfolding time, the Taurus-Littrow valley has been altered by its visitors from another world. When *Challenger* first alights (upper), our view embraces a pristine moonscape of craters, rocks, and sunny slopes agleam like virgin snow. This is just after the dawn of a lunar daytime that will last for 13 more earth days—a dawn when shadows etch the smallest features in high relief, prime time for the lunar explorer.

As we complete our third and final day on the surface of the moon, *Challenger's* miniature picture window looks out on a valley transformed, though less so than its explorers. To the right of the LM's shrunken shadow, an array of thrusters frames the United States flag a dozen yards beyond, the sixth that men have planted on the moon.

Our feet have churned our "front yard," while a tangle of Rover tracks unravels in the direction of the second traverse and toward shining components of ALSEP, the Apollo lunar surface experiments package. There, powered by a nuclear generator, precision devices in continuous communication with earth have begun to take the moon's temperature, make seismic soundings, analyze the tenuous atmosphere, record the impacts of micrometeorites, and look at the nature of gravity.

This valley of history has seen mankind complete his first steps into the universe. From this larger home we move to greet the future.

Time to relax on the long road home



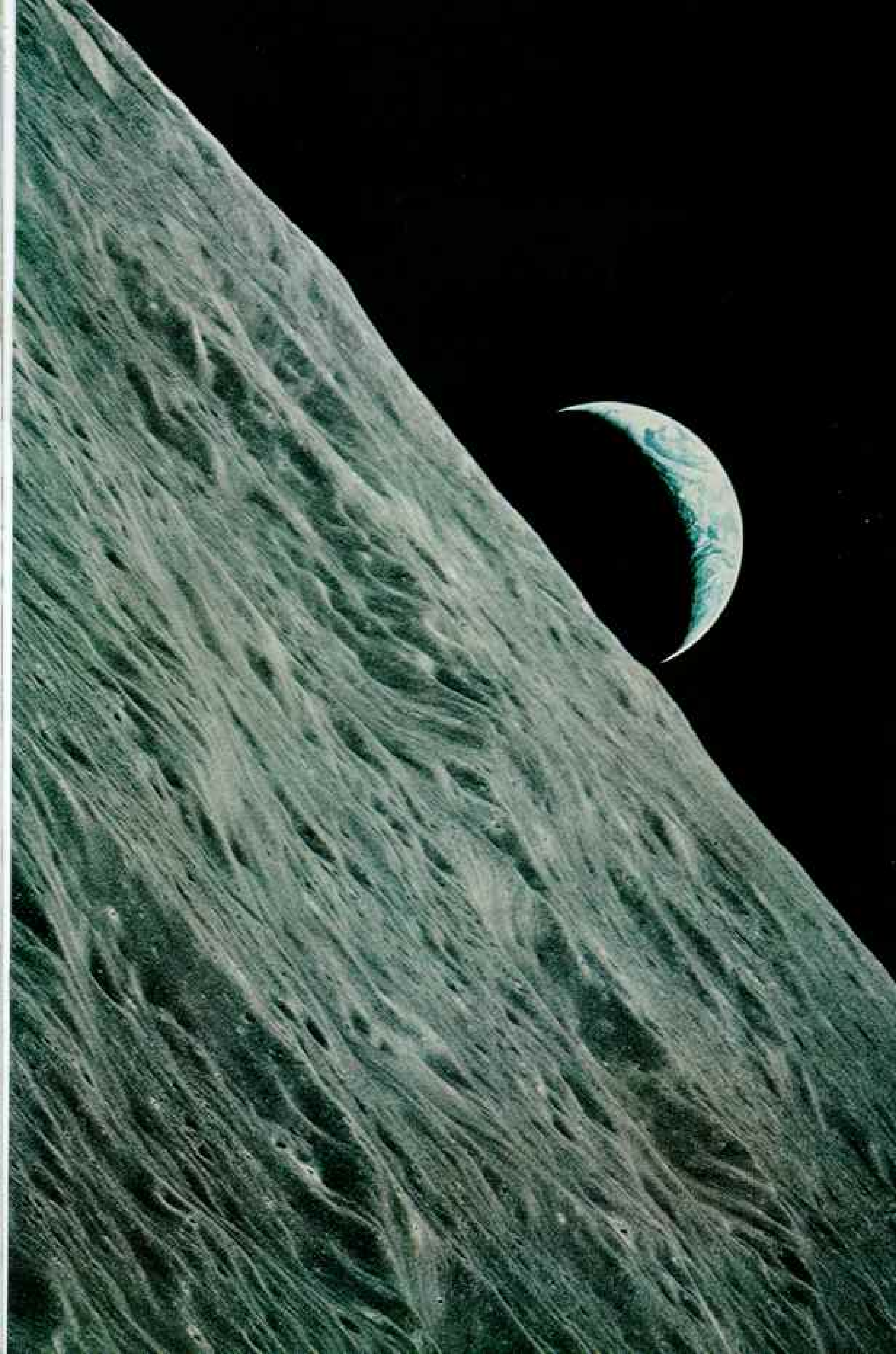
WARRICK H. SCHMITZ (TOP LEFT AND LOWER RIGHT); RONALD E. EVANS (TOP RIGHT AND LOWER LEFT); APOLLO 17 CREW (OPPOSITE)

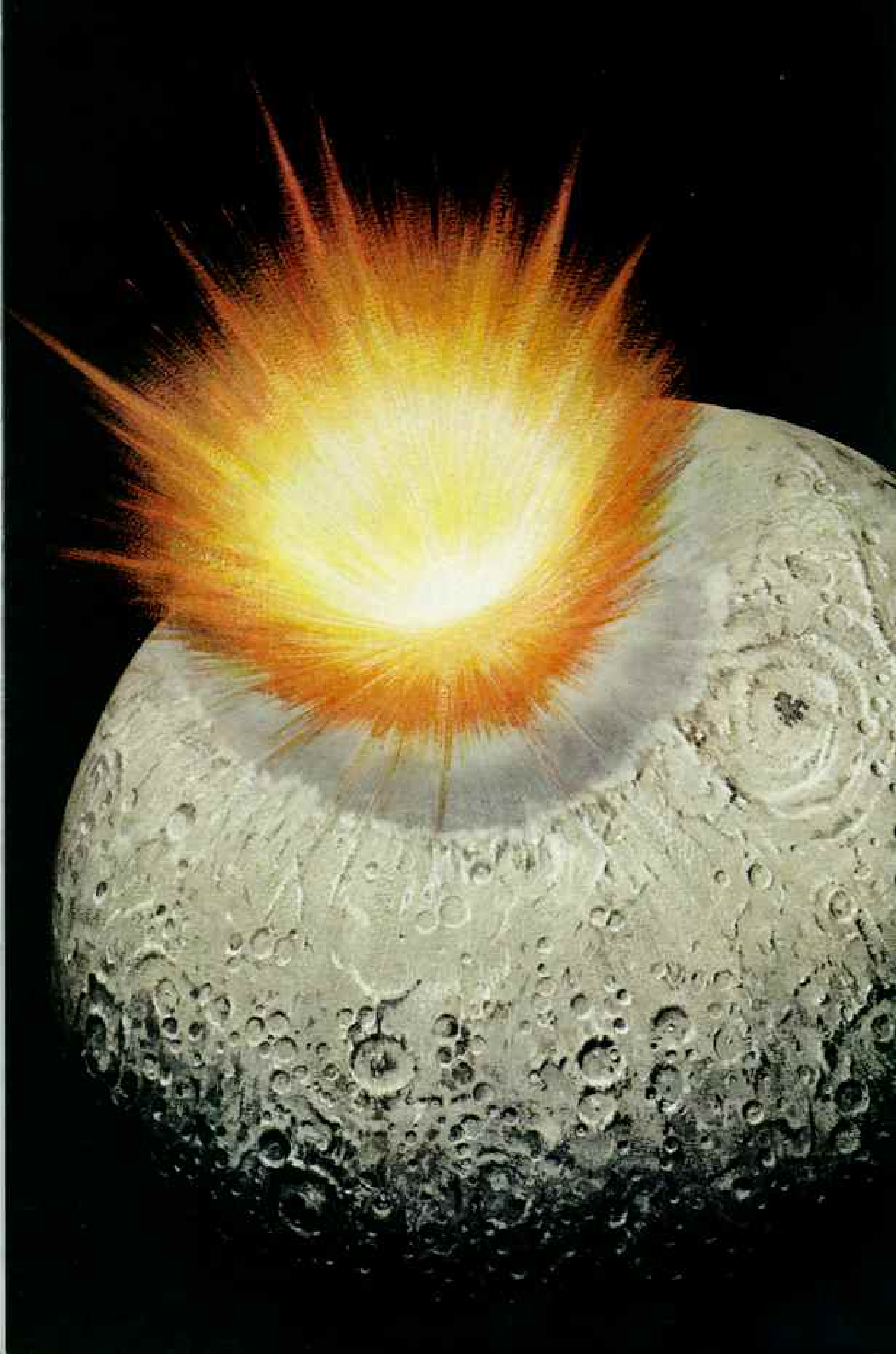
DEPARTING THE MOON as flawlessly as we landed, Gene and I rendezvous with Ron in *America*, then jettison the faithful *Challenger*. After further lunar observations and Ron's space walk to recover exterior film canisters, we settle down for the relatively relaxed trip home.

Gene (left), and Ron debate what is up and what is down (top left). Weightlessness affects everything—canned fruit sticks to Gene's spoon no matter

how he holds it (top right), while Ron demonstrates the squeezable "glass" (bottom right) that enables us to drink in zero gravity. Then comes a time of reckoning: the painful shaving of a fledgling beard (bottom left).

For more than six days earth has been our friend in the lunar skies (right). That fragile piece of blue with its ancient rafts of life will continue to be man's home as he journeys ever farther in the solar system. □





HAVE WE SOLVED

The Mysteries of the Moon?

By KENNETH F. WEAVER

ASSOCIATE EDITOR

Paintings by WILLIAM H. BOND

NATIONAL GEOGRAPHIC STAFF ARTIST

NO MAN KNOWS how big that celestial traveler was. A dozen miles across, at least; perhaps twenty, even fifty. It rushed toward its rendezvous with the moon at relentless speed—an estimated ten to twenty miles a second—yet soundlessly, without flash or fire.

Then, in one awesome instant, cataclysm wrenched the moon. In that moment, as the shock wave penetrated the surface, the monstrous missile disintegrated and vaporized. The frightful energy of its headlong flight—equal to that of billions of hydrogen bombs—was perhaps almost enough to split the moon asunder. Part of the energy turned into a vast, searing fireball that momentarily rivaled the light and heat of the sun itself.

Torn loose by the blast, thousands of cubic miles of rock shot outward—some vaporized, some molten, the remainder pulverized and broken. As the hard-flung fragments arced back into the surface, they gouged myriads of craters and excavated additional rock.

The swift chain reaction reached at least 1,000 miles in every direction. It laid a carpet of ejecta as much as a mile thick, tapering off

to a score of feet or less at the outer edges. Some of the displaced moon stuff reached a velocity that overcame lunar gravity and escaped into space.

On the lunar surface a sea of molten rock and newly created rings of mountains marked the scar of the shattering blast. Earlier collisions had left their heavy marks, but none so vast as this. About 650 miles across, it was the largest (and almost the last) of the huge ringed basins to be formed by impacts on the face of the moon.

It was Imbrium, whose lava-filled bowl we see today—some four billion years later—as the right eye of the man in the moon.

In understanding the mysteries of the moon, few features are more important than Imbrium. Apollo 14 landed directly on its ejecta blanket, and many of the rocks brought back to earth are souvenirs of that lunar cataclysm. Significantly, the ages of many lunar rocks cluster around that four-billion-year mark, leading most lunar scientists to conclude that the Imbrium collision, and perhaps several other major events, occurred about the same time. And so the Imbrium

Slamming into the moon with the power of billions of H-bombs, an exploding meteorite blasts out the Imbrium basin, largest scar on the ravaged lunar face.

Complex sensors

event is a major landmark in the history of the moon, a history that is slowly taking shape in the massive flood of data from Apollo.

Man's desire to know about the moon has produced a formidable effort going back to 1958. Consider these statistics:

More than 50 spacecraft, U. S. and Soviet, have flown near or landed on the moon. Of 24 Americans who have observed the moon close up, 12 have walked on its surface. There they spent 160 man-hours, traversing 60 miles afoot and by Rover. Thirty thousand photographs from Apollo alone have captured the moon in intimate detail.

On the moon's surface, nearly 60 major scientific experiments were performed by Apollo; in orbit, some 30 more. Five of the six scientific stations left by Americans on the moon continue to transmit information. And, until last May, an unmanned Soviet rover, Lunokhod 2, roamed Mare Serenitatis, telemetering its intelligence to earth.

All told, more than 1,000 scientists in 19 countries have been studying the Apollo samples—a priceless trove of 841 pounds of lunar rock and soil. And a third of a pound of lunar soil brought to earth by Russia's unmanned Luna 16 and Luna 20 spacecraft has added importantly to the growing body of knowledge because it came from areas not sampled by Apollo.

There is a particular fascination in comparing some of our pre-Apollo ideas about the moon with what we know today. I recall, for example, a prominent scientist who told me in 1968, "I see no evidence for lava flows on the moon." Another predicted that the moon material would explode the instant an astronaut's boot touched it. A third asserted confidently that we would find water on the moon. Still others firmly maintained that the moon has always been a cold, dead body, a simple relic of the primitive solar system.

And the possibility of life on the moon led the National Aeronautics and Space Administration for a time to quarantine both the returning astronauts and their lunar rocks, lest pathogenic organisms infect the earth.

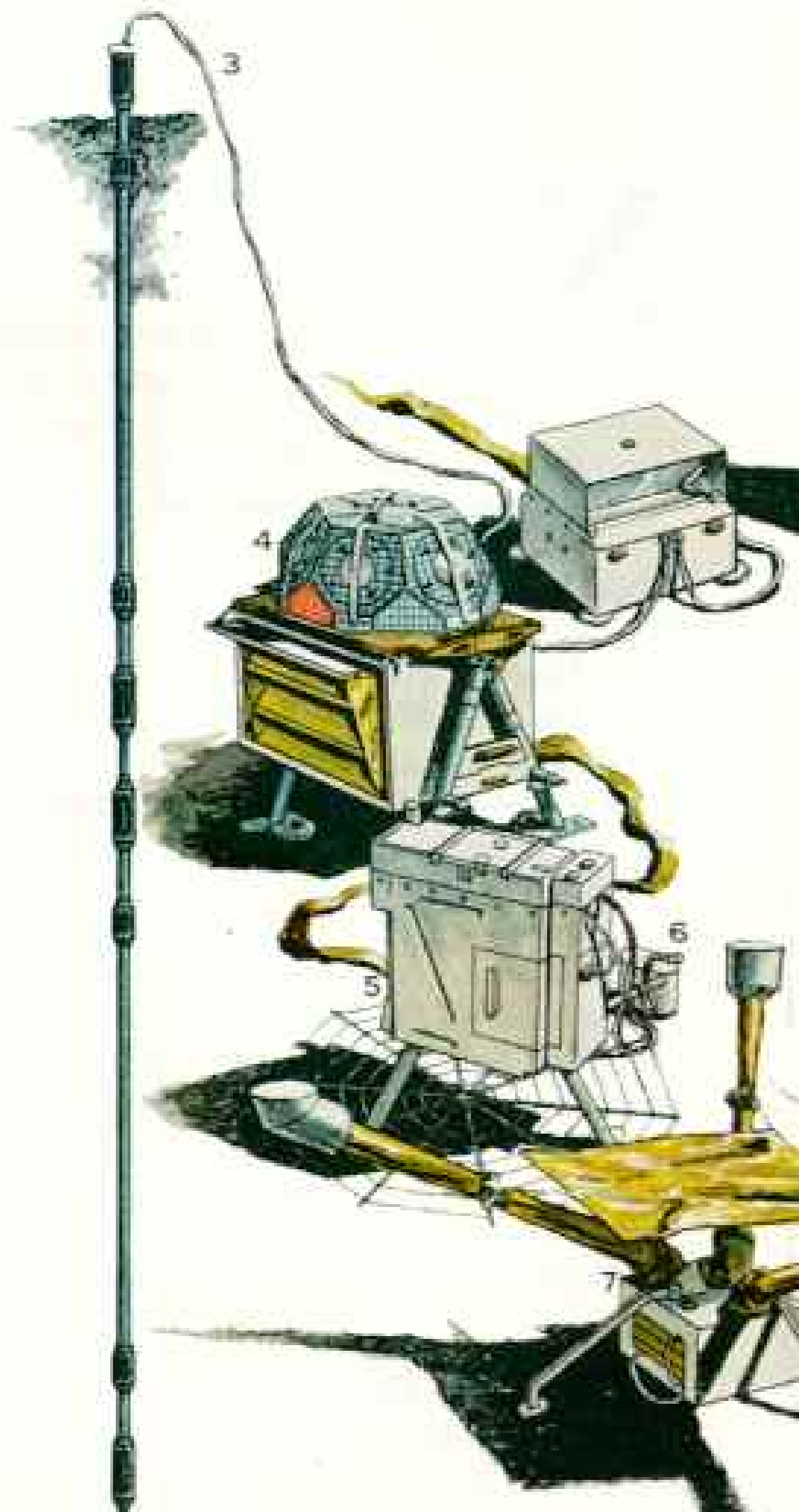
Today none of these ideas is tenable. We have come a long way in understanding our satellite. And yet, as Dr. Robin Brett at NASA's Lyndon B. Johnson Space Center near Houston notes, "The more we see of the moon, the more complicated we know it is." For every question answered, new ones spring up.

WITH INSTRUMENTS of increasing sophistication, six Apollo landings on the moon set up a network of miniature laboratories. Exceeding their life expectancies, most of the devices—here drawn to scale—still send torrents of data to earth.

SUBSATELLITE (1): Deployed from the orbiting command module, this unmanned satellite radios data on solar wind, cosmic rays, the moon's weak magnetic field, and its irregular gravitational field.

ACTIVE SEISMIC EXPERIMENT (2): After the lunar module departs, a mortar hurls grenadelike charges as far as 3,000 feet. Detonations send seismic signals to geophones, revealing subsurface differences.

HEAT-FLOW EXPERIMENT (3): Probe planted eight feet in the lunar soil holds sensors that measure heat flowing from the interior.



installed by Apollo astronauts busily "bug" the moon

SOLAR WIND SPECTROMETER (4): This measures the number of electrons and protons streaming from the sun, as well as their velocity, direction, and temperature.

SUPRATHERMAL ION DETECTOR (5): Registers the rate at which ions are created in the moon's tenuous atmosphere and detects ions from space.

COLD CATHODE ION GAUGE (6): Capturing particles of the moon's thin atmosphere, the gauge monitors its constantly changing density.

LUNAR SURFACE MAGNETOMETER (7): Sensors at the ends of three booms record the moon's slight magnetic field.

CHARGED PARTICLE LUNAR ENVIRONMENT (8): This device records the flow of particles hurled outward by the sun, including those that cause earth auroras.

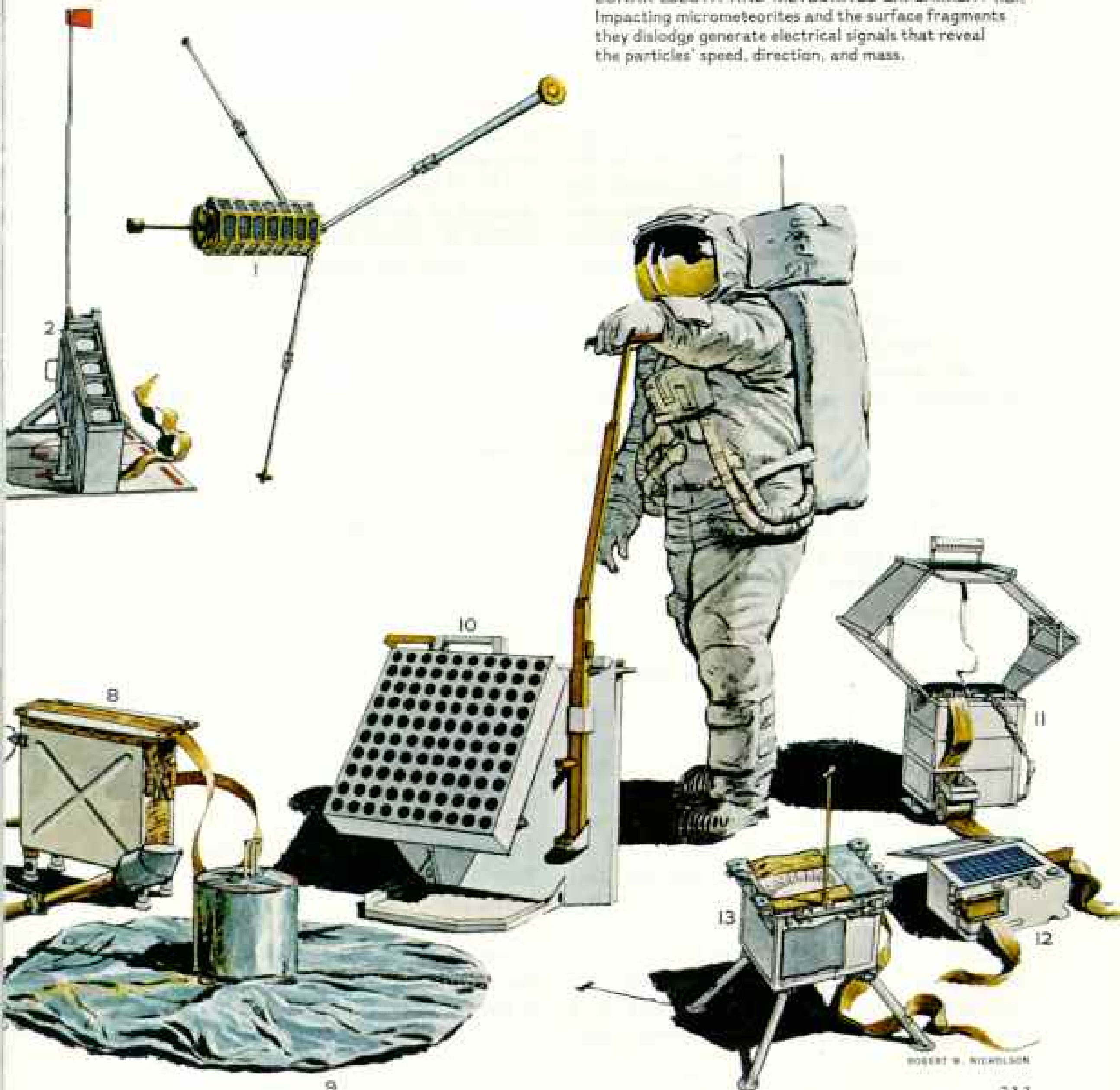
PASSIVE SEISMIC EXPERIMENT (9): Recording moonquakes and meteorite impacts, the seismometer enables scientists to draw profiles of the lunar interior.

LASER RANGING RETROREFLECTOR (10): Bouncing laser pulses back to earth, the reflector measures earth rotation, polar motion, and continental drift, as well as aspects of lunar physics. It gauges earth-moon distances to an accuracy of less than six inches.

LUNAR SURFACE GRAVIMETER (11): Detecting changes as small as 1/10 billionth in the force of the moon's gravity field, this experiment is searching for the gravitational waves predicted in Einstein's theory of relativity.

LUNAR ATMOSPHERIC COMPOSITION EXPERIMENT (12): This sophisticated analyzer of lunar gases was carried only by Apollo 17, as were devices 11 and 13.

LUNAR EJECTA AND METEORITES EXPERIMENT (13): Impacting micrometeorites and the surface fragments they dislodge generate electrical signals that reveal the particles' speed, direction, and mass.



ROBERT W. WOODLAWN

What we know—and what we still do not know—can perhaps best be summed up in six questions, six mysteries of the moon:

1. Is the moon like the earth?

Yes, more so than many scientists thought before Apollo. Like the earth, it is layered, with a crust and mantle and possibly a core, and it “burns” with internal heat. Like the earth, it has had a dynamic history, although volcanic violence has given way to an occasional burp and the shivers of small quakes.

But in more obvious ways, the moon is unlike the earth. No hint of life has shown up in the moon samples, although some analysts find small quantities of substances that they consider the forerunners of amino acids, the building blocks of life. There is no free oxygen. The moon is dry, even though three of its flat maria, or “seas,” are named Humorum (moisture), Imbrium (rains), and Nubium (clouds). Rust stains in some Apollo samples may well have been caused by melted ice from comets or water in meteorites falling on the moon, although some scientists blame contamination within the spacecraft.

Apollo’s instruments detect tiny amounts of the gases argon, neon, and helium, much of which comes from solar wind. So the moon has an exceedingly tenuous atmosphere, though it is a high vacuum by earth standards.

As Dr. John H. Hoffman of the University of Texas points out: “If you took all the molecules in a cubic centimeter of the moon’s atmosphere and lined them up end to end, they would fit on the tip of your pen. But if you did the same thing with the air you are breathing, the chain of molecules would reach to the moon and back with some left over!”

2. Of what is the moon made?

For an answer to this question, I visited some of the laboratories where lunar samples are being analyzed. Scientists twirled the dials on safes, then proudly lifted out little vials of moon dust and rock fragments to show me. I saw bits of orange glass, green glass, red glass, pieces of pitted gray basalt, and speckled chunks of breccia—aggregates of many materials welded together in a single rock.

At the Johnson Space Center I saw sections of moon rocks ground thinner than the page you are reading. Under polarized light in a microscope these now-transparent slices

glowed in psychedelic colors, giving ready identifications of minerals.

In an adjoining laboratory automation is being applied to chemical analysis with an instrument called an electron microprobe. Electrons striking a rock sample cause it to give off X rays. The precise wavelengths of the X rays are a kind of fingerprint for identifying the elements in the sample. Driven by computer, the instrument can automatically scan a one-inch disk with a thousand moon particles embedded in it, analyzing each particle in turn within ten minutes.

Some of the tiny orange spheres from the Apollo 17 mission were being analyzed by the microprobe as I watched, and Dr. Arch Reid showed me the readout on an oscilloscope. A series of peaks traced by a rapidly moving dot on the screen revealed the chemical elements present. The scientist pointed to the magnesium peak, then aluminum, then a very high silicon peak, then calcium, titanium, and iron.

“Even with the computer, it’s an enormous amount of work,” said Dr. Reid, “but we’re taking the lunar soils apart, piece by piece.”

Analyses like these tell us that the moon is made of the same chemical elements as the earth and the rest of the solar system, but in quite different proportions. The moon is rich in refractory elements—those with high melting points, such as calcium and titanium—that apparently condensed early in the solar nebula from which the moon came. But the moon is poor in volatiles—those elements that vaporize easily, such as sodium or lead.

Carbon, that backbone of living things as we know them, is rare on the moon. Much of what we do find probably came from gases continually escaping from the sun—the solar wind—and from meteorites.

The moon as a whole has much less iron than the earth, though metallic iron—rare on the earth’s surface—is common in lunar samples. Some of it shows up as nickel-iron pellets—splashed remnants of meteorites.

The late Dr. Paul W. Gast, head of the Planetary and Earth Sciences Division at the Johnson Space Center, summarized in this way our knowledge of the kinds of rocks found on the moon:

“The moon lacks the large outcrops of granite so common on earth’s continents. Also, since the moon has had no oceans or streams, it has no water-laid sedimentary deposits.

(Continued on page 317)

Earth and moon differ greatly, despite similarities

NO LONGER do scientists regard the moon as a celestial cinder pile, cold and inert. Today, thanks to Apollo's seismic and geochemical advances, the moon and earth appear more similar than previously had been believed—both hot internally, divided into layers, and even sharing the same birth date—4.6 billion years ago.

Yet important differences abound. From surface to center, the moon measures only 1,080 miles—a fourth of earth's radius. The moon's density is only about three-fifths that of earth, and its variable magnetic field derives solely from magnetized rocks on the surface. Moonquakes, though frequent, are fewer and weaker than earthquakes, and they occur at greater depths. Perplexingly, the chemistry of the moon tells that it was formed of the same elements as earth but in different proportions—contributing to a theory that the moon could have been born in a different part of the solar system.

Earth

SURFACE FLUIDS: A dynamic atmosphere sweeps the earth, and great oceans wash 71 percent of its surface.

CRUST: Averaging 10 miles thick, earth's mobile outer shell drifts and contorts as it rides atop the shifting mantle. Lava periodically squirts to the surface through volcanic vents.

MANTLE: Some 1,800 miles thick, earth's mantle consists of rock heated to temperatures that may reach 7,000° F. The lithosphere, a more rigid outer layer, slides slowly on the hotter, plastic asthenosphere, carrying the continents.

CORE: Liquid on the outside, solid in the center, earth's iron-nickel core extends inward the final 2,200 miles and seethes at temperatures that may range around 7,500° F.

Moon

SURFACE FLUIDS: A thin, scarcely measurable atmosphere and the absence of oceans hint that the moon never had the kinds of gases that formed earth's atmosphere and oceans, or that they escaped because of weak lunar gravitation.

CRUST: The moon's outer layer, almost four times thicker than earth's, where measured, presents a lifeless panorama of craters, fractures, and ancient lava upwellings. No proof exists of recent volcanism.

MANTLE: Still little understood, a lunar mantle apparently extends almost 600 miles, with temperatures possibly as high as 3,000° F.

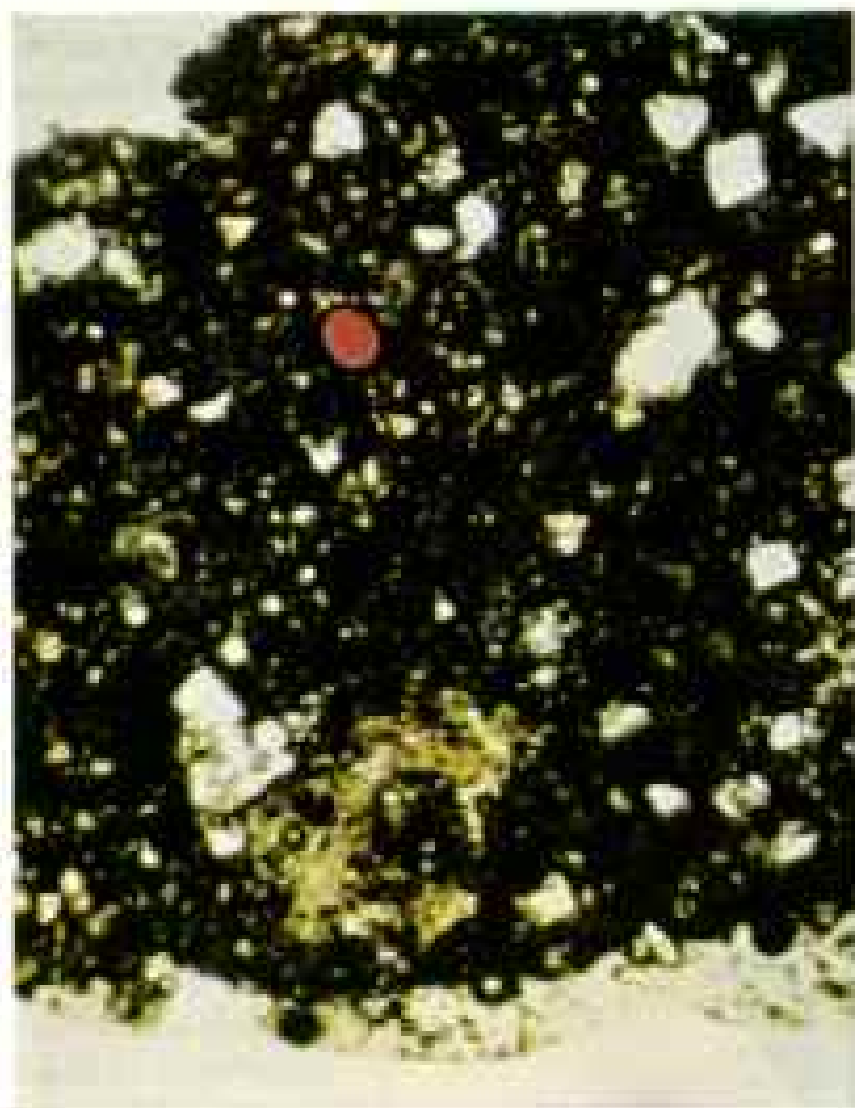
CORE: Seismic soundings suggest a partially molten outer zone in the lunar center, which extends inward the final 400 miles. But the material does not resemble earth's iron-nickel core. As with earth, heat from decaying radioactive elements probably fuels this inner furnace.





100 TIMES ACTUAL SIZE

Like an empty bird's nest, elongated feldspar crystals mix with blue, red, and yellow pyroxene grains in highland basalt brought back by Apollo 14. Such a basalt, unknown on earth, is rich in radioactive elements that may account for the moon's "hot spots" (page 330). It is called KREEP—for potassium (K), rare earth elements, and phosphorus.



25 TIMES ACTUAL SIZE

Glassy mixture of particles from both highland and mare—or lunar "sea"—harbors a bead tinted red by titanium. This Apollo 15 breccia is typical of the moon's meteorite-churned surface.



50 TIMES ACTUAL SIZE

Kaleidoscope of crystals marks mare basalt from Apollo 17. Whites and grays are feldspar. Black armalcolite is named for Armstrong, Aldrin, and Collins of Apollo 11, who first brought back the mineral. Rainbow hues are pyroxene; olivine adds a touch of green.

Moon's history sought in gaudy slivers of rock

AFTER APOLLO spacecraft freighted a mounting treasure of moon rocks to earth, technicians at NASA's Johnson Space Center near Houston sliced and ground many into wafers less than half the thickness of this paper. Then they exposed them to the light of a polarizing microscope, outlining striking patterns in brilliant hues that identify the rocks' mineral components. Knowing the conditions of heat and pressure that produce such minerals on earth, petrologists will construct a picture of the forces that created these samples of the lunar crust.

The intriguing sections shown here, photographed and interpreted by Dr. A. E. Bence of State University of New York in Stony Brook, add colorful new pages to the moon's ever-unfolding biography.

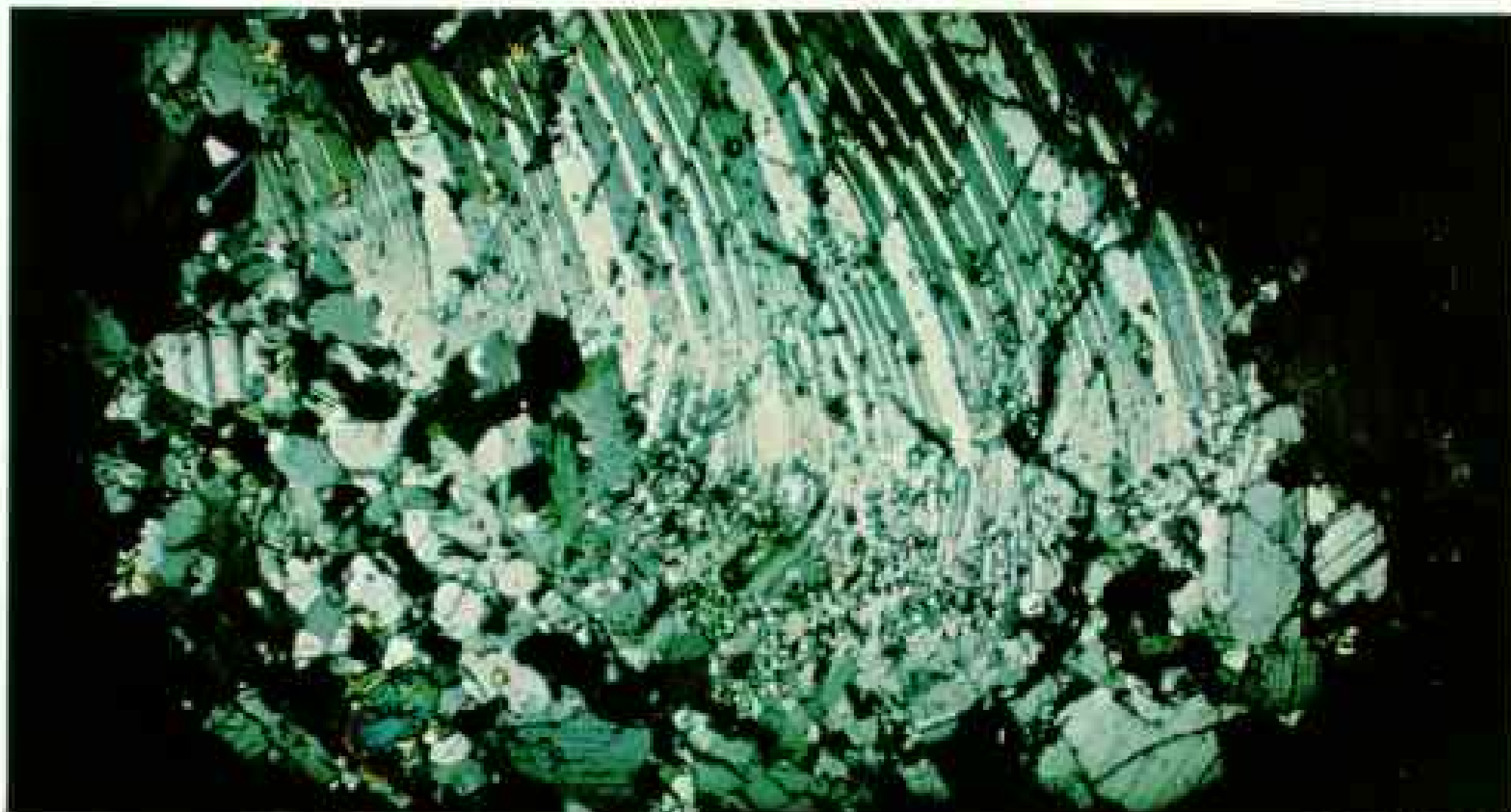


82 TIMES ACTUAL SIZE

Beak-shaped growth of pyroxene nestles among feldspar needles. Apollo 12 collected this sample of basalt.

Dark cavity, formed by gas, hides in a vivid matrix of Apollo 15 mare basalt. The hollow originated when molten basalt containing dissolved gas reached the surface. The drop in pressure allowed the gas to expand, just as bubbles flash up when a soft drink is opened.

60 TIMES ACTUAL SIZE



60 TIMES ACTUAL SIZE

Bent bands in the mineral plagioclase indicate deformation of a crystal that felt the shock of a meteorite impact. This bit of rock, known as anorthosite, was collected at Stone Mountain by Apollo 16.

APOLLO 12: Nov. 14-24, 1969
 This second mission to land on the moon alighted on a ray, or band of ejecta, blasted from the crater Copernicus, 250 miles to the north. The ray lies atop Oceanus Procellarum, composed of layers of dark mare basalt that welled upward from the mantle some 3.2 billion years ago.



APOLLO 14: Jan. 31-Feb. 9, 1971
 Ejecta thrown up by the Imbrium impact, 700 miles distant, formed the Fra Mauro hills of Apollo 14. Mission samples give a date for the cataclysm: about 4 billion years ago. Basalts of Oceanus Procellarum lap against the hills, proving that the uplands predate the lava flows.

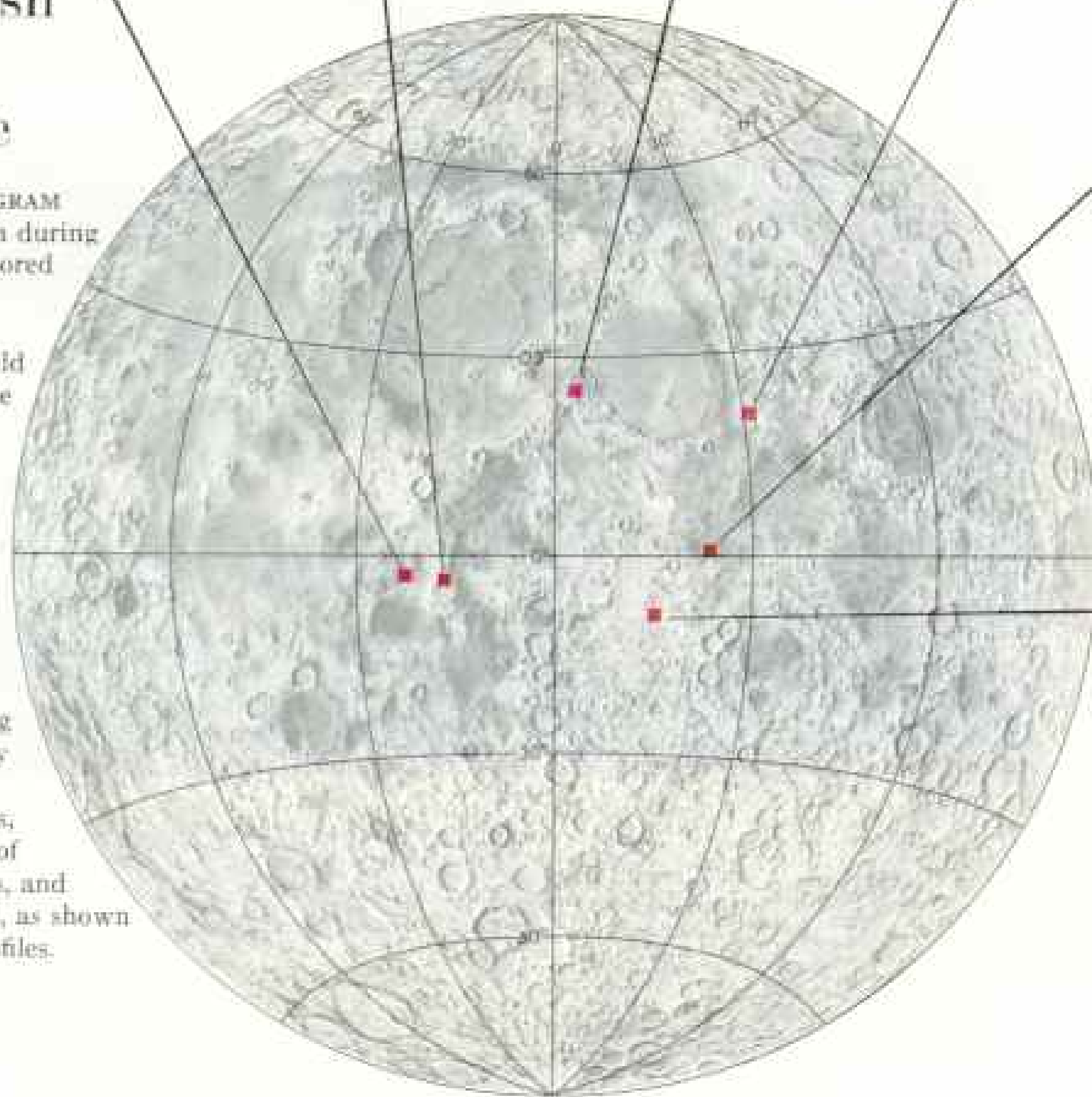


APOLLO 15: July 26-Aug. 7, 1971
 The Apennine Mountains soar nearly three miles, and enigmatic Hadley Rille slashes a 1,000-foot canyon at the spectacular site of Apollo 15. This mission and Apollo 16 collected highland rock dated as being more than 4 billion years old.

Landing-site profiles flesh out the moon's face

AS THE APOLLO PROGRAM gained momentum during the 1960's, scientists pored over lunar maps and photographs to select landing sites that would be the most productive scientifically. Successive moon flights reconnoitered for missions to come.

Today, by putting together the voluminous surveys of the six Apollo landings, scientists gain a growing understanding of the moon's anatomy—its vast level maria, or "seas," its highlands, rilles, craters, regions of overlapping landforms, and its subsurface features, as shown in these schematic profiles.



APOLLO 17; Dec. 7-19, 1972 Massifs created by the impact that dug the Serenitatis basin guard the valley of Taurus-Littrow, scene of the final Apollo landing. After lava filled the valley some 3.7 billion years ago, an avalanche brought down highland rock, putting it handily in reach of the lunar explorers.



APOLLO 11; July 16-24, 1969 Jumbled boulders ejected from whitish West crater threatened this first lunar landing with disaster; only seconds of fuel remained when Neil Armstrong, clearing West's debris, found a level area for setting down. The site lies in Mare Tranquillitatis, which filled with lava 3.7 billion years ago.



APOLLO 16; April 16-27, 1972 Seeking rocks from loftier terrain, Apollo 16 visited the Descartes highlands. Debris hurled from North Ray crater, right, and nearby South Ray crater strews the surface, while beneath lie deposits from more ancient meteorite impacts. These highlands and those of Apollo 14, 15, and 17 abound with breccias — rock fragments and soil that have adhered because of the heat and pressure of impacts.

"In the areas we have been able to sample, four kinds of moon materials predominate. First, basalts in the maria that are rather like the most common volcanic rocks on earth. Second, feldspar-rich rocks, especially a type called anorthosite, that are found in the highlands. Third, an enigmatic rock type named KREEP* that is relatively high in radioactive elements; it is found chiefly in the regions of Mare Imbrium and Oceanus Procellarum, but is not known on earth. And finally, a recently identified basalt type that I've called VHA, for 'very high aluminum,' found in the Descartes region by Apollo 16."

Jack Schmitt, the geologist-astronaut of Apollo 17, points out that "anorthosites on earth are uncommon and sometimes extremely old. They are of special interest for that reason, and also because earth's anorthosites, such as those in the Adirondacks, are frequently associated with titanium deposits."

This suggests, in fact, a real value of moon exploration. Although we have found no lunar resources worthy of exploiting, the knowledge we have gained from another celestial body enhances knowledge of our own earth, and—some geologists say—may lead to more efficient exploration of our own resources.

3. *Is the moon hot or cold?*

Before Apollo, few questions roused more raging controversy among scientists. Cold moon adherents were numerous. But today, as Dr. David Strangway at the Johnson Space Center puts it: "We've changed the question. Now we ask: How much of the moon was hot, and when, and for how long?"

Many scientists today agree that some of the moon was hot for at least a time. We see abundant evidence in the rocks from the moon that they were once melted.

The surface itself gives no hint of the heat that may now lie underneath. No active young volcanoes or fumaroles have been found.

Surface temperatures near the equator, as Apollo measurements show, fluctuate violently, depending on the sun's position. They range from about 230° F. at lunar noon to as low as minus 290° F. just before dawn.

But the Apollo temperature probes, a series of ultrasensitive thermometers sunk eight feet deep, show that these surface variations disappear completely only about three feet down.

*K for potassium, REE for rare earth elements, and P for phosphorus.

Below the three-foot level, temperature increases with depth, the result of a flow of heat from the interior. According to Dr. Marcus G. Langseth, Jr., who is in charge of the heat-flow experiment, the measured rate of loss indicates a lunar heat production per unit of volume nearly twice that of earth. This suggests melting conditions somewhere in the moon.

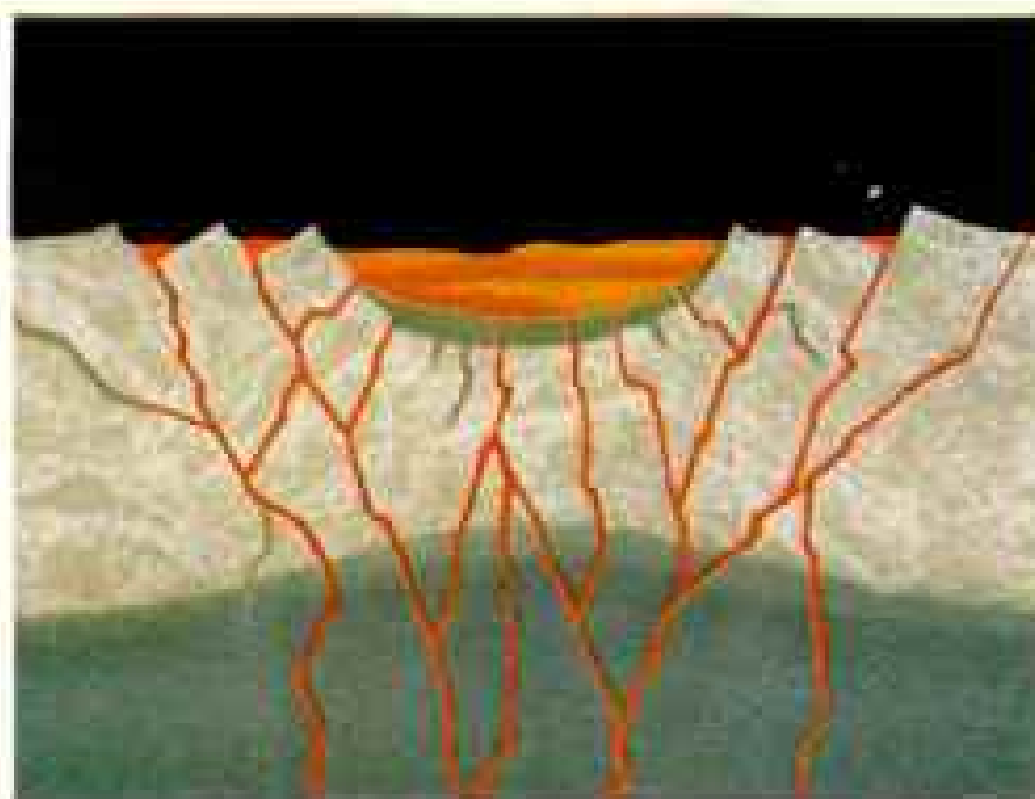
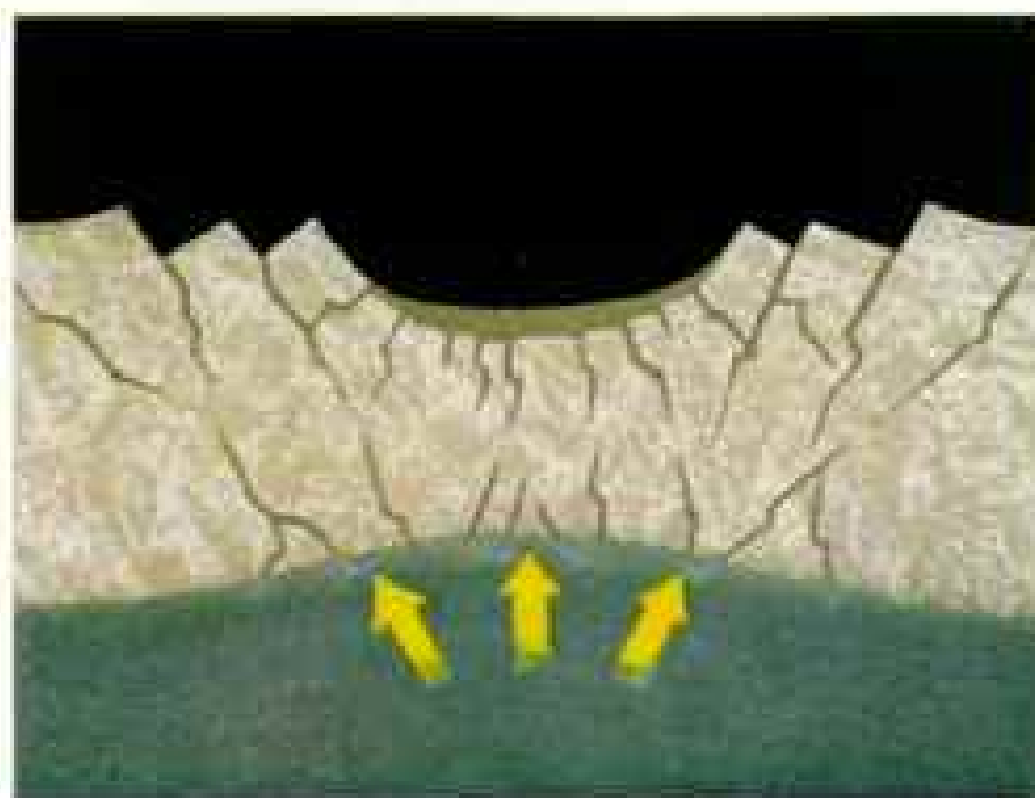
Oddly enough, strong additional evidence for heat in the moon's deep interior comes from the quake-sensing seismometers, of which there are now four operating on the moon. By measuring the various kinds of seismic waves from quakes and meteorite impacts as they pass through the moon, we get a rudimentary picture of the lunar interior.

The jittery lines on the seismograms show a sudden change in velocity of seismic waves at a depth of about 35 miles—at least in the region of southeastern Procellarum. Such a change implies that the material of the lunar surface has given way to rock of different composition, in which seismic waves travel faster. So, in the view of Apollo's chief seismologist, Dr. Gary Latham, "This discontinuity may well mark the end of the lunar crust and the beginning of the mantle."

Below the 35-mile boundary, seismic waves seem to travel with fairly constant speed all the way up from the deep moonquakes that trigger them. Since most of the quakes detected by Dr. Latham (and he records as many as 3,000 a year) come from two long belts 500 to 600 miles deep, the material in the mantle seems to be fairly homogeneous to that depth.

But what lies below? Is there a core, possibly iron? Is it in part molten, like earth's? These questions have been a source of prolonged speculation. But no one had an inkling of the facts until July 17, 1972, when the seismograph recorded a startling event on the far side of the moon—the crash of a meteorite estimated to weigh more than a ton.

Some vibrations from this event passed through the interior of the moon and were recorded by the Apollo network on the other side. But one type, known as shear waves, was absorbed by something in the interior. It happens that shear waves pass through solids but not through liquids, so the conclusion may be that the moon has at least a partly molten center! Dr. Latham puts the beginning of the melting at about 600 miles down, or 480 miles from the center of the moon. Here,



Mighty wounds, slow in healing, shaped the moon early in its history, as an Imbrium-type impact demonstrates. Disintegrating and vaporizing as it strikes, a meteorite blasts debris outward (top), while a shock wave creates fractures in the rock. A pool of rock melted from shock heat solidifies in the crater (middle), and the slightly plastic mantle adjusts to the loss of mass above it by pushing upward, causing additional fractures. The blast has hurled up mountain rings around the crater. Later, interior heat from radioactivity causes partial melting, and basaltic material rises along fractures, filling the basin layer by layer to form a mare (bottom).

temperatures for melting rock must be at least 2,600° F.

Since about a third of the earth's mass is iron, and since much of this metal is in a large molten core, the question naturally arises as to whether the zone of melting within the moon could also be iron. If there were iron in the moon originally, and the moon had been sufficiently hot, the dense metal presumably would have sunk to the interior.

The moon presents a magnetic mystery that might be solved if indeed there is an iron core. No magnetic field is being generated in the moon today, yet lunar rocks show a weak magnetic field, unmistakable evidence that they were magnetized long ago. One explanation might be that a liquid core, rich in iron, acted as a dynamo early in the moon's history and created a magnetic field that has since dissipated.

The entire question of iron in the center raises controversy. It is generally agreed that the low density of the moon (about 3/5 that of earth) would not permit a large dense core. But perhaps the core is small, or holds a low percentage of iron. Some experts argue that a molten iron core would require such a high temperature (about 3,000° F. at that depth and pressure) that much of the moon would melt. But others, notably Dr. Brett, suggest that the iron may be mixed with sulphur, which would permit a melting temperature as low as 1,800° F.

In summary, then, we have reason to speculate that the moon is hot today in its deep interior. In the distant past, it must also have been hot much closer to the surface. Vast sheets of lava in the maria, such as Serenitatis, Tranquillitatis, and Imbrium, testify to widespread volcanism long ago. Such flows, scientists say, could easily have come from depths of as much as 300 miles, finding their way to the surface through the massive networks of fractures caused by the impacts that created the circular basins.

Scientists conclude that the moon's heat engine seems to be cooling, at least in its upper levels. About the only hint of contemporary volcanism comes from suspected venting of gases. Orbiting instruments in the Apollo spacecraft have detected radon, a radioactive gas, possibly seeping from the vicinity of the craters Aristarchus and Grimaldi. Such gases may be linked to elusive bright spots sometimes seen on the moon.

As far back as the 1500's, observers reported

brief sightings of such spots, sometimes glowing with color. Just ten years ago at Lowell Observatory, three reddish patches were seen near Aristarchus, and they remained visible for more than an hour.*

These transient phenomena seem to be closely connected to tidal forces which are many times more powerful than those affecting earth. Actually, the distortions caused by these forces are also believed to be the chief source for Dr. Latham's quakes.

4. *Why is the moon lopsided?*

The moon displays a number of peculiar anomalies, or irregularities. For one thing, its mass is mysteriously off center.

When a Ranger spacecraft plunged into the moon on a photographic mission in 1964, scientists monitoring its passage were perplexed because it crashed slightly later than expected. Careful analyses of radar measurements, photographs, and spacecraft orbits showed that the center of the moon's mass and the geometrical center were not the same. In fact, the center of mass is displaced toward the earth, and the near side of the moon is about two miles farther away from earth than expected, as confirmed by Apollo's laser altimeter. Small as it seems, it is significant to geodesists.

No one has a certain explanation of this anomaly. However, some scientists believe that the crust on the moon's far side may be thicker than the 35 miles indicated by seismometer readings in Oceanus Procellarum. If so, the two irregularities probably have some connection.

In several other ways the near and far sides of the moon exhibit remarkable differences. The front side, as the most casual glance at the full moon reveals, displays vast flat stretches of dark maria, many of which, scientists believe, are enormous impact basins filled with lava. These are interspersed with heavily cratered highlands, the brighter areas of the moon's face.

By contrast, the far side, which we never see from the earth, is almost entirely highlands. Only a few of the far-side basins and craters, such as Moscoviense and Tsiolkovsky, have been filled with lava.

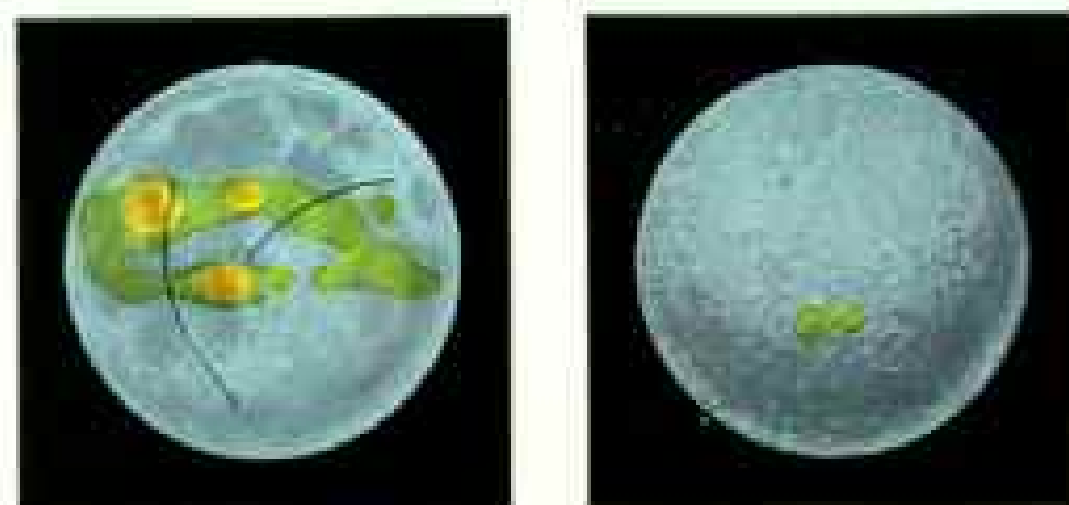
Why is this? Why did lava in enormous quantities rise to fill the big basins on one side

*See "That Orbed Maiden . . . the Moon," by Kenneth F. Weaver, NATIONAL GEOGRAPHIC, February 1969.

Near and far sides wear different faces



Vast mare areas, composed of dark basalts, smudge the familiar near side of the moon (left). Brighter highlands dominate the far side, where a suspected thicker crust may have checked the flow of mare material to the surface.



Lunar "hot spots"—areas rich in radioactive rocks—pattern the front side, while the back is largely "cool." Red indicates greatest concentrations of radioactive elements in the fifth of the lunar surface that has been tested. Yellow and green chart areas of lesser radioactivity. Lines show where most moonquakes occur.

of the moon but not on the other? Perhaps a thicker crust on the back made it harder for lava to break through.

Another anomaly: Radioactivity on the surface seems to concentrate in a few near-side areas, as shown in the adjoining diagram. Again, explanations are inconclusive.

Finally there are the mascons, those strange concentrations of material that are detected in the largest circular basins on the face of the moon.

Mascons were discovered by two scientists at the Jet Propulsion Laboratory in Pasadena, California—William L. Sjogren and Paul M. Muller. While analyzing the radio-tracking data from Lunar Orbiter 5, which circled the moon in 1967, they found that when the orbiting vehicle passed over each of the large ringed basins, the spacecraft speeded up temporarily. That increase, Mr. Sjogren tells me, was only about a quarter of a mile an hour out of some 3,000 miles an hour, but such a difference is highly significant.

The best scientific guess about mascons is that the moon reacts after being struck by a very large object, pushing upward to replace all the mass that has been lost by the impact, reducing the depth of the newly created crater. Later, lavas from the mantle break through and partly fill the basin. This additional material tugs with extra gravity on the spacecraft and thus alters its velocity.

5. *What is the moon's origin?*

A veteran student of the moon once said that it would be easier to explain the non-existence of the moon than its existence.

Time, and all the evidence from Apollo, has not altered the truth of that statement. All the classic theories about the origin of the moon, plus several recent variations, have their proponents and detractors; there is no consensus.

Traditionally, three theories have competed for attention. The fission, or daughter, theory argues that the moon was born from the earth. The sister, or twin-planet, theory suggests that the earth and the moon were born together at the same time from the same cloud of gas and dust. And the spouse theory holds that the moon was born elsewhere in the solar system, then captured by earth's gravity and forced into eternal wedlock.

Severe problems beset each theory. The marked chemical differences between earth

and moon make it very difficult to see how the satellite could have been torn from the earth, or how the moon and earth could be twin planets. And problems of orbital dynamics argue that earth's gravity could not easily have captured the moon and swung it into its present orbit.

Yet, as a Lunar Science Institute study says, "The lunar studies of the last decade have not produced conclusive evidence against any of the theories of the Moon's origin."

And, as Professor George W. Wetherill of the University of California at Los Angeles remarked to me, "I personally would guess that some kind of capture is the proper theory, but I would give it only a 20 percent chance compared to 10 percent for each of the others. The other 60 percent represents things we haven't thought of yet!"

6. *What is the moon's history?*

The plaque on the door said "Lunatic Asylum," but there was nothing lunatic inside. It was a model of order and cleanliness, in which dedicated scientists from several countries were doing ultraprecise dating of moon rocks. I was visiting the geochronology laboratory of Professor Gerald J. Wasserburg at the California Institute of Technology.

At the door I removed my shoes, then stepped onto a squishy pad to clean lint and dust from my socks. From the hall inside I could peer through windows into sparkling rooms where white-garbed scientists worked. Heavily filtered air under slight pressure flowed outward from the rooms, so that contamination could not come in.

I was not allowed into the holy of holies, where lunar samples were being prepared for analysis, but I observed that surgical standards prevailed. Stainless-steel bone chisels and tweezers that had extracted a small fragment from a rock were immediately discarded for electro-cleaning; for the next operation new tools were taken from a plastic box marked "clean." Surfaces not in use were covered with special paper. In some areas Teflon was used to cover metal surfaces. And, Professor Wasserburg told me, the floors are regularly scrubbed down with distilled water.

The reason for such scrupulous cleanliness is that the laboratory works with infinitesimal quantities of material—as little as a hundredth of a gram. Contamination would seriously distort the results.

Professor Wasserburg is a past master at measuring radioactive materials in rocks and determining how long radioactive decay has been going on. This gives him a rock's age.

The technique of radioactive dating is complicated, but a simple analogy helps explain it. If you know the size of a log and the rate it is burning, you can tell how long it has been burning by measuring the amount of ash.

In effect, Professor Wasserburg measures the proportions of strontium or lead or argon, which are the "ashes," or decay products, as compared to their radioactive parents—rubidium, uranium, or potassium, respectively. Thus he can calculate with considerable accuracy when the rock was last crystallized from a melt. Or, as scientists put it, he determines when the radiometric "clock" was reset.

Before Apollo no one had any way of knowing how old moon rocks would be. When Professor Wasserburg and others began dating the actual moon samples, they made a surprising discovery: The youngest rock, a piece of basalt brought back by Apollo 12, was 3.16 billion years old, far older than many people had expected. That fact becomes all the more remarkable when you consider that 99 percent of the earth's surface is less than 3.1 billion years old. That is, most of the earth's surface rocks have been melted, recrystallized, or deeply covered by younger rocks since that time.

The very oldest moon rock that Professor Wasserburg's group has dated—also from Apollo 12—is just four billion years old. So many rocks have been dated at nearly that same time that some scientists have attributed them to the Imbrium event.

Other laboratories have reported older dates for several lunar rocks—4.2 to 4.3 billion years ago. It is not yet clear whether these variations in dating result from differences in the methods of measurement or in the type of rocks, but they have triggered a lively discussion among lunar scientists.

Is this, then, the age of the moon? Not at all, for we believe from calculations about the original radioactive materials in the lunar rocks that the moon began forming about 4.6 billion years ago. That age coincides with the ages of meteorites, which some authorities regard as debris left over from the birth of the solar system.

Similarly, on earth the very oldest rocks that have been dated are found near

(Continued on page 325)

From microscopic worlds, bold lunar vistas: Studying a scanning electron microscope's enlargements of minute moon fragments, Dr. David S. McKay, left, and Dr. Uel S. Clanton of the Johnson Space Center near Houston gain clues to great

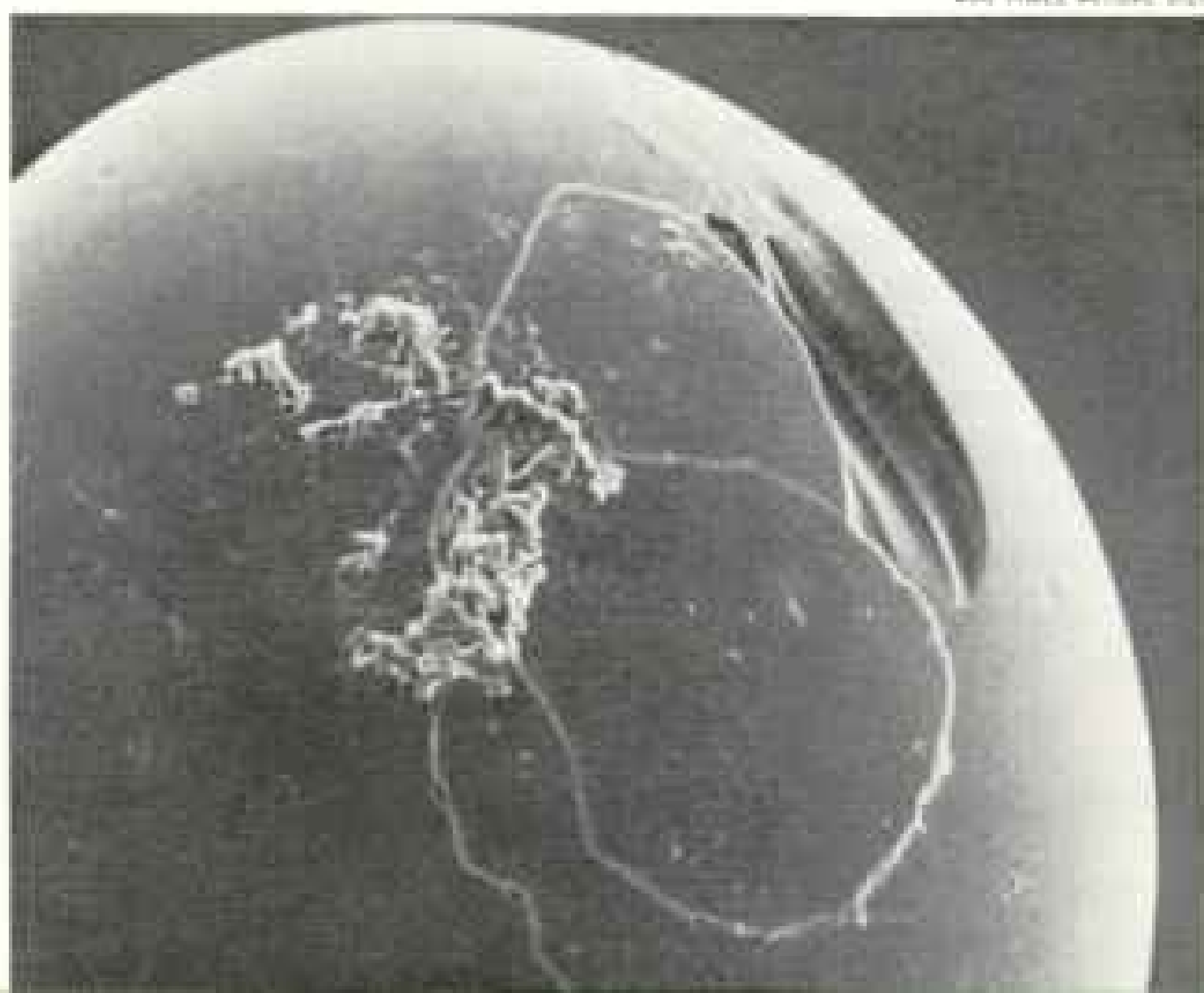
events that wracked the moon. Tiny glass particles such as those of the Apollo 17 "orange soil" (page 305), enlarged 2,500 times in the mosaic behind them, suggest that lava fountains similar to Hawaiian volcanoes once belched molten rock.

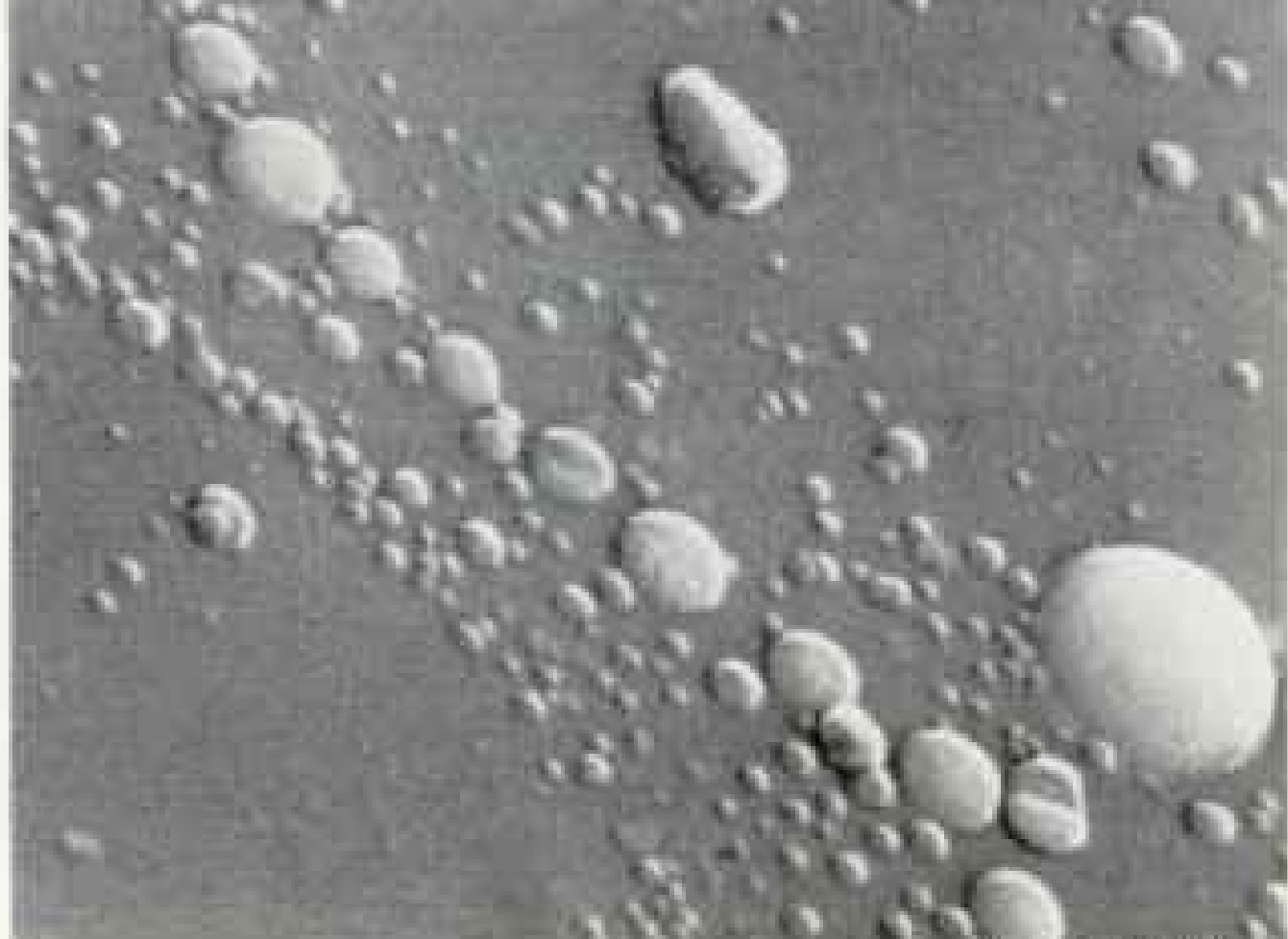


MARTIN BOGERS (LEFT)

400 TIMES ACTUAL SIZE

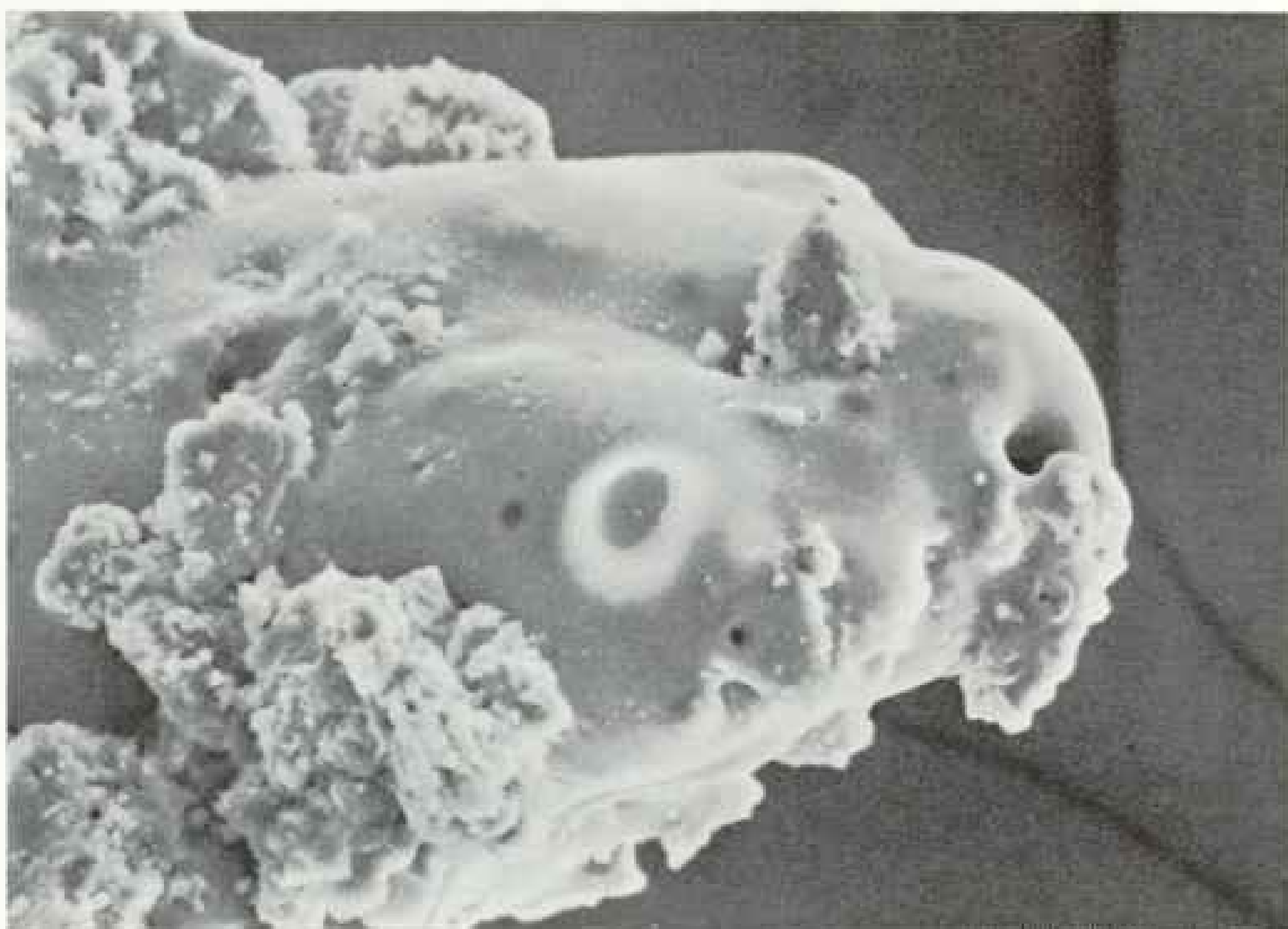
Rigors of birth mark a sphere of glass brought back by Apollo 15. More than 3 billion years ago this droplet may have formed in a lunar volcanic eruption. Molten glass struck it in flight, fracturing and spattering it.





20,000 TIMES ACTUAL SIZE

Offspring of dynamic change, tiny iron droplets, some of them only 1/4,000 the diameter of a human hair, cling to glass formed by micrometeorite impact.



600 TIMES ACTUAL SIZE

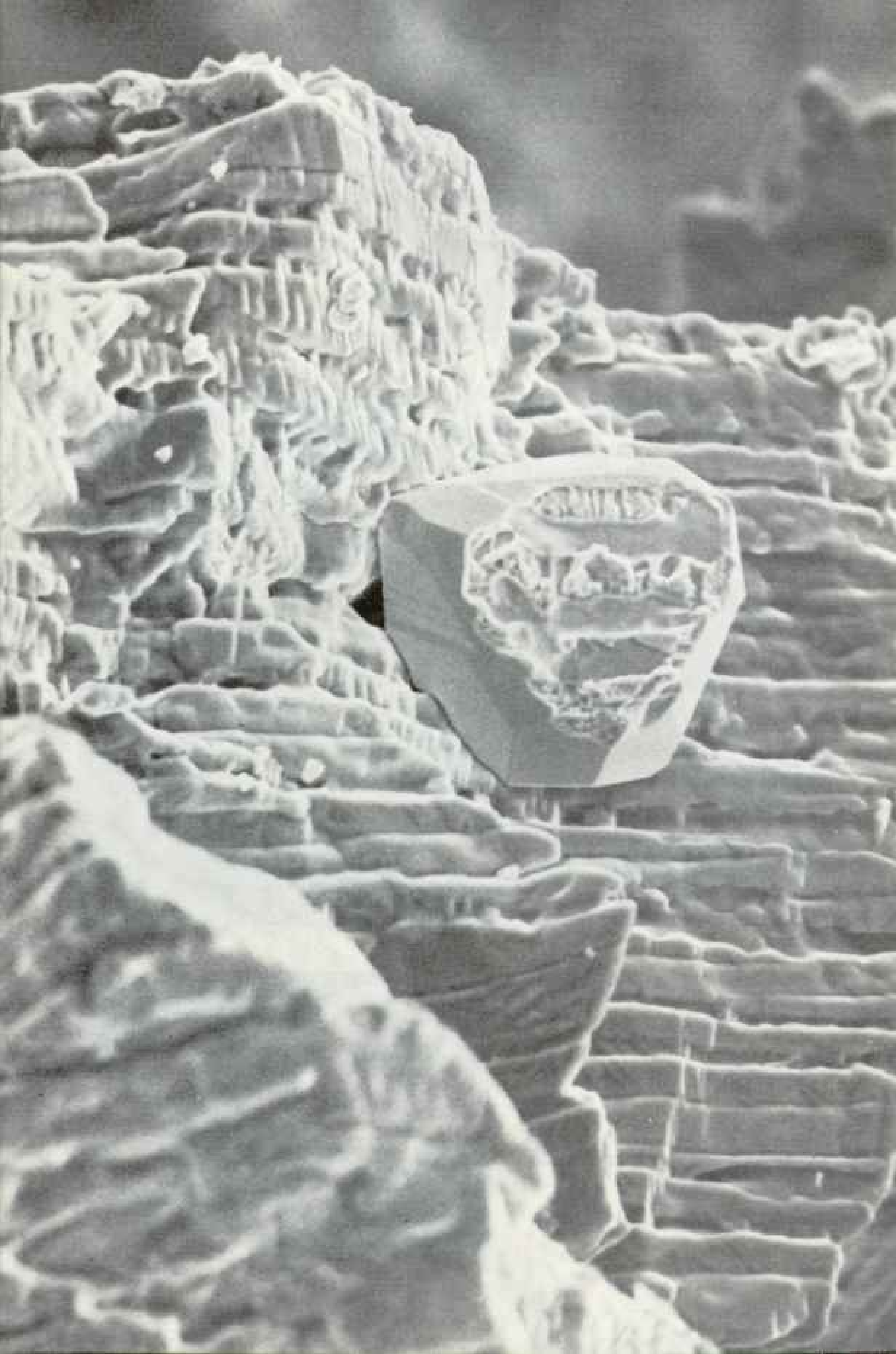
ALL BY DAVID L. MERRIFIELD AND GIL S. CLANTON

"Parrot's head" emerged when molten glass from a micrometeorite impact captured bits of soil. Such particles, known as agglutinates, are still being formed as micrometeorites continue to bombard the moon.

Small glass mounds cling to a larger bead of Apollo 17 soil (right). Like the glass at left, the bead's structure suggests that it originated in a lava fountain.



600 TIMES ACTUAL SIZE





Gem from another world, an iron crystal perches on the pyroxene setting where it grew. The crystal formed from an iron-rich vapor during the cooling of a massive blanket of debris thrown out by a large meteorite impact.

Flowerlike iron-oxide crystals of a rusty rock (right) collected by Apollo 16 contain water, possibly from a comet, a water-bearing meteorite, or contamination in handling. Apollo's payloads of rocks and data will challenge scientists for decades.



8,000 TIMES ACTUAL SIZE (LEFT); 4,000-TIMEZ CARBONZ
DAVID L. MURPHY AND GILL S. CLANTON (LEFT PHOTOGRAPHS)

Godthaab, Greenland. Their age has recently been set at 3.75 billion years. Yet we believe that earth, like the moon, is 4.6 billion years old.

So we have never found—and may never find—any of the original crust of either the moon or the earth. But even if the moon's scars and rocks do not date back to the very origin of the solar system, they have opened up an extremely important period in its history and have stimulated our thinking about the earth during this same obscure period.

From all this evidence about rock ages, temperatures, chemical makeup, and interior structure, scientists are beginning to sketch outlines of the possible history of the moon. Here is one such outline.

About 4.6 billion years ago the great solar nebula began condensing to form the bodies of the sun and the planets. Some of this condensed material gathered to form the moon.

The enormous energy of the infalling material melted the outer portion of the moon, perhaps to a depth of 100 miles or more. In a process called differentiation, denser materials settled, and lighter materials floated to form a scum. Thus the moon's crust was developed.

Even after the moon accreted to its present size, it kept sweeping up celestial debris, such as the Imbrium object. The cataclysmic effects of such impacts not only tore out the huge basins but also reset the radiometric clocks of the surface rocks. This process virtually ended with the Imbrium event, about 600 to 700 million years after the moon began to form.

Successive flows of lava, melted by radioactivity in the interior, rose and gradually filled the excavated basins. Meanwhile, smaller meteorites constantly battered the moon, pulverizing the surface and producing the pockmarks we see at every hand. The rate of this meteoritic rain decreased, however, as the leftover debris of the solar system was swept up.

Since about three billion years ago the cooling moon has apparently produced no more substantial volcanism. For all that time its surface has been, in the words of Sir Richard Burton, a "ruined world, a globe burnt out, a corpse upon the road of night."

It was fashionable only a few years ago to regard the moon as the Rosetta stone of the solar system, which was going to lay bare the very earliest beginnings of the solar system. No longer can we say that. Explains Dr. Farouk El-Baz of the Smithsonian Institution: "Maybe the moon is the Stonehenge of the solar system, but not the Rosetta stone. It tells us a great deal, but there are still many mysteries."

That, to me, is an apt comparison. The moon, like Stonehenge, is still in part a riddle from the distant past, a mystery that continues to intrigue the mind of man. □

What Is It Like to Walk on the Moon?

By DAVID R. SCOTT
APOLLO 15 COMMANDER

SIXTY FEET ABOVE THE MOON, the blast of our single rocket churns up a gray tumult of lunar dust that seems to engulf us. Blinded, I feel the rest of the way down "on the gauges." With an abrupt jar, our lunar module, or LM, strikes the surface and shudders to rest. We have hit our target squarely—a large amphitheater girded by mountains and a deep canyon, at the eastern edge of a vast plain.

As Jim Irwin and I wait for the dust to settle, I recall the 12 revolutions we have just spent in lunar orbit aboard our Apollo 15 spaceship *Endeavour*. Each two hours found us completing a full circuit of earth's ancient satellite—one hour knifing through lunar night, then sunrise and an hour of daylight.

As we orbited, I found a particular fascination in that sector of the darkened moon bathed in earthshine. The light reflected by our planet illuminates the sleeping moon much more brightly than moonlight silvers our own night. The mountains and crater rims are clearly seen.

I will always remember *Endeavour* hurtling through that strange night of space. Before us and above us stars spangled the sky with their distant icy fire; below lay the moon's far side, an arc of impenetrable blackness that blotted the firmament.

Then, as our moment of sunrise approached, barely discernible streamers of light—actually the glowing gases of the solar corona millions of miles away—played above the moon's horizon. Finally the sun exploded into our view like a visual thunderclap. Abruptly, completely, in less than a second, its harsh light flooded into the spaceship and dazzled our eyes.

As we looked into the early lunar morning from *Endeavour*, the moonscape stretched into the distance, everything the color of milk chocolate. Long angular shadows accentuated every hill, every crater. As the sun arched higher, the plains and canyons and mountains brightened to a gunmetal gray, while the shadows shrank. At full lunar noontide, the sun glared down upon a bleached and almost featureless world.

Now we have come to rest on the moon, and the last of the dust settles outside the LM. We throw the switches that convert this hybrid vehicle from spacecraft to dwelling. Thus begin our 67 hours of lunar residence.

We are on a still and arid world where

each blazing day and each subfreezing night stretch through 355 earth hours. We have landed in the bright morning of a moon day. When we depart, the sun will not have reached zenith.

It is sobering to realize that we are the only living souls on this silent sphere, perhaps the only sentient beings in our solar system not confined to earth. Though we have slipped the bonds of our home planet, we remain earthmen. So we keep our clocks set to Houston time and gear our lives to the 24-hour cycle we have always known.

OPENING THE TOP HATCH for a preliminary reconnaissance, I peer out at a world seemingly embalmed in the epoch of its creation. Each line, each form blends into the harmonious whole of a single fluid sculpture. Craters left by "recent" meteorites—merely millions of years ago—stand out, startlingly white, like fresh scar tissue against the soft beige of the undulating terrain.

I steal a moment and glance straight up into the black sky where the crystalline sphere of earth—all blue and white, sea and clouds—gleams in the abyss of space. In that cold and boundless emptiness, our planet provides the only glow of color.

For 30 minutes my helmeted head pivots above the open hatch as I survey and photograph the wonderland of the lunar surface. The incredible variety of landforms in this restricted area (on the moon, the horizon lies a scant mile and a half from a viewer) fills me with pleasant surprise. To the south an 11,000-foot ridge rises above the bleak plain. To the east stretch the hulking heights of an even higher summit. On the west a winding gorge plunges to depths of more than 1,000 feet. Dominating the northeastern horizon, a great mountain stands in noble splendor almost three miles above us.

Ours is the first expedition to land amid lunar mountains. Never quickened by life, never assailed by wind and rain, they loom still and serene, a tableau of forever. Their majesty overwhelms me.

Eight years' training in lunar geology make me instantly aware of intriguing details. A dark line like a bathtub ring smudges the bases of the mountains. Was it left by the subsiding lake of lava that filled the immense cavity of Palus Putredinis, on the fringes of

Mare Imbrium, billions of years ago? Mare Imbrium, on whose edge we have landed, stretches across the face of the moon for some 650 miles. The celestial projectile that excavated it must have been huge—perhaps as much as 50 miles across—and it slammed into the moon with a velocity many times greater than that of a rifle bullet.

WHEN WE DESCEND the ladder of the LM and step onto the moon's surface, Jim and I feel a gratifying sense of freedom. For five days we have been crammed into the tight confines of the spacecraft that brought us here. Now, all at once, we regain the luxury of movement.

But, we quickly discover, locomotion on the moon has its own peculiar restrictions. At one-sixth of earth's gravity, we weigh only a sixth our normal poundage. Our gait quickly evolves into a rhythmic, bounding motion that possesses all the lightness and ease of strolling on a trampoline.

At the same time, since the mass of our bodies and personal gear—and hence, our inertia—remains unchanged, starting and stopping require unusual exertion. I learn to get under way by thrusting my body forward, as though I were stepping into a wind. To stop, I dig in my heels and lean backward.

To fall on the moon—and I did several times—is to rediscover childhood. You go down in slow motion, the impact is slight, the risk of injury virtually nil. Forsaking the adult attitude that regards a fall not only as a loss of dignity but also a source of broken bones, the moon walker—like a child—accepts it as yet another diversion. Only the clinging moon dust, the untoward demand on the oxygen supply occasioned by the exertion of getting up, pall the pleasure of a tumble.

Personally I find the one-sixth gravity of the moon more enjoyable than the soothing weightlessness of space. I have the same sense of buoyancy, but the moon provides a reassuringly fixed sense of up and down.

As we unload and begin to assemble our equipment—including the battery-powered four-wheeled Rover that will carry us across the moonscape at a jaunty six or so miles an hour—I gaze around at the plains and mountains that have become our world. My eyes trace a curiously contoured, totally alien wasteland. I scan the lofty mountains

and feel a strange, indescribable emotion: No naked eye has ever seen them; no foot has ever trod them. I am an intruder in an eternal wilderness.

THE FLOWING MOONSCAPE, unmarred by a single jagged peak, reminds me of earth's uplands covered by a heavy blanket of fresh snow. Indeed, the dark-gray moon dust—its consistency seems to be somewhere between coal dust and talcum powder—mantles virtually every physical feature of the lunar surface. Our boots sink gently into it as we walk; we leave sharply chiseled footprints.

Color undergoes an odd transformation here. Everything underfoot or nearby is gray, yet this hue blends gradually into the uniform golden tan that characterizes distant objects. And this small spectrum moves with the walker.

Most of the scattered rocks share the same gray tint as the dust, but we find two that are jet black, two of pastel green, several with sparkling crystals, some coated with glass, and one that is white.

As we advance, we are surrounded by stillness. No wind blows. No sound echoes. Only shadows move. Within the space suit, I hear the reassuring purr of the miniaturized machines that supply vital oxygen and shield me from the blistering 150° F. surface heat of lunar morning.

Any of a thousand malfunctions in a space suit or the LM could condemn an astronaut to swift death. Yet we have a quiet confidence in our own abilities, and a boundless faith in the engineers and technicians who have fashioned the ingenious devices that transport and sustain us in space. Often, in the course of my stay on the moon, I recall the words of American poet Edwin Markham: "There is a destiny which makes us brothers; None goes his way alone."

At first we experience a troubling deception with perspective. Without the familiar measuring sticks of our native planet—trees, telephone poles, clouds, and haze—we cannot determine whether an object stands close at hand or at a considerable distance, or whether it is large or small. Gradually our eyes learn to cope with the craters—mammoth, medium, and minuscule—that dot virtually every inch of the surface. And gradually the moon becomes a friendlier place. A thought occurs to

me: Would human beings born on the moon be able to find their way among the trees and clouds of earth?

Each excursion on the lunar surface is planned to last seven hours, almost to the limit of a space suit's life-sustaining capabilities. We dig and drill into the surface, gather rocks and soil, take endless photographs. The photographs, it seems to me, provide us with a testament that transcends time, for we may be photographing the distant past of our own planet.

The Rover functions impeccably as we ride from site to site, accumulating fragments of history. We bounce and pitch across omnipresent chuckholelike craters. The motion exactly resembles that of a small boat in a rough sea; so does the physical effect. Incredible as it seems, in the arid environment of the moon, seasickness could become an occupational hazard.

After each of our expeditions, we climb—sapped of energy—back into the LM. With its oxygen and food and water, it is a tiny artificial earth that comforts us in the void. Removing our space suits and attending to our housekeeping chores consumes two hours. For the first twenty minutes we are conscious of a pervasive odor, similar to that of gunpowder, from the moon dust we have tracked in. Our air-purifying system soon dispels the acrid scent, but the fine, adhesive dust clings to everything. Back on earth, no amount of cleaning will convert our space suits from the gray hue acquired on the moon to their once pristine and sparkling white.

The better to sleep, we create the illusion of night. We place opaque shades over the windows of the LM to exclude the harsh sunlight reflected from the moon's surface. Then we go through all the homey activities of sunset on earth, even to snapping on overhead lights. When finally we switch them off, we settle into hammocks. On earth, I have always found hammocks uncomfortable. But here my 30-pound body adapts marvelously to the canvas crescent, and I easily fall into dreamless sleep.

BOUNCING ALONG IN THE ROVER on our third and final expedition, we begin to feel fully at home in our new habitat. The craters now seem familiar and help us gauge distances. And we venture across the horizon—the first astronauts ever

to do so—without anxiety. Should the sophisticated Rover navigation system fail, we have a small cardboard sun compass fashioned by a technician in Houston—a frail instrument much shriveled by the savage lunar sunlight and coated with moon dust—that will give us our bearings. But our newfound confidence stems less from instruments than from the fact that we have come to know and understand our surroundings.

On our return we even dare a shortcut. The Rover bounces between undulations and crater walls that mask our view of the LM for long minutes, but we emerge on target.

Arriving at the LM, I experience a sense of impending loss. Soon I will leave the moon, probably forever. And, in a peculiar way, I have come to feel a strange affection for this peaceful, changeless companion of the earth.

As I mount the ladder for the last time, I halt and glance back at the Rover. It seems poised and ready for its next task. And poised in that same eager attitude it could remain for thousands, perhaps millions of years—a driverless vehicle lost in the loneliness of this lifeless realm. Beside it, like staunch sentinels through the long millenniums, will hulk the LM descent stage and the assorted equipment of our mission. The vacuum of space, which knows only negligible decay, will confer upon all of it—even to the footprints we have left in the undrifting dust—a permanence akin to immortality.

The thought haunts us that the end of the Apollo flights may mark man's last visit to the moon for a long time. American manned exploration of deep space is scheduled for an indefinite hiatus. Most scientists have already suggested that, when it resumes, all effort should concentrate upon reaching Mars and beyond. So our lunar artifacts—bypassed in the race to the planets—could remain undisturbed for eternity.

Clutching the ladder, I raise my eyes from the now-familiar moonscape to earth, glowing in the black heavens—that incredibly vivid sphere, so blue, so beautiful, so beloved. And so bedeviled: by ecological balances gone awry, by scattered starvation, by a shortage of energy that may motivate us to seek sources beyond our earth. Our Apollo crew believes that a technology capable of exploring space can and will help resolve such problems. We feel a sense of pride in the accomplishments of our program, yet we

cannot escape a sense of deep concern for the fate of our planet and our species.

This concern has led us to add certain items to the equipment we are leaving on the moon. The sum of these articles, we hope, will form a résumé of our era in the continuing story of the human race.

In eons to come, should astronauts from the deeps of space—from other solar systems in other galaxies—pass this way, they may find our spoor, our abandoned gear. A plaque of aluminum affixed to the deserted LM descent stage portrays the two hemispheres of our planet; upon it are engraved the name of our spacecraft, the date of our mission, and a roster of the crew. From these data, the equipment, and even the dimensions of our footprints, intelligent beings will readily deduce what kind of creatures we were and whence we came. We leave a piece of fauna—a falcon feather—and of flora—a four-leaf clover.

In a little hollow in the moon dust we place a stylized figurine of a man in a space suit and beside it another metal plaque bearing the names of the 14 spacemen—Russians and Americans—who have given their lives so that man may range the cosmos. Finally we deposit a single book: the Bible.

Our mission ends in fatigue and elation. Amazing success has rewarded the first extended scientific expedition to the moon. After debriefing and helping in the analyses of our findings, our crew disbands.

NOW, TWO YEARS LATER, I continue to work in the Lyndon B. Johnson Space Center near Houston. Frequently I reflect upon those three most memorable days of my life. Although I can reconstruct them virtually moment by moment, sometimes I can scarcely believe that I have actually walked on the moon.

Occasionally, while strolling on a crisp autumn night or driving a straight Texas road, I look up at the moon riding bright and proud above the clouds. My eye picks out the largest circular splotch on the silvery surface: Mare Imbrium. There, at the eastern edge of that splotch, I once descended in a spaceship. Again I feel that I will probably never return, and the thought stirs a pang of nostalgia. For when I look at the moon I do not see a hostile, empty world. I see the radiant body where man has taken his first steps into a frontier that will never end.





“We came in
peace for
all mankind.”

FROM A PLAQUE
LEFT ON THE
MOON BY APOLLO 11

Symbolizing man's feat, Apollo 17 Astronaut Harrison H. Schmitt stands on the moon beside the United States flag planted by him and Mission Commander Eugene A. Cernan, whose image reflects in the geologist's visor. A beckoning earth floats nearly a quarter of a million miles away.

EDDIE K. CLARK





Charlie Carter's cabin glows at dusk. One of a dwindling handful who

Golden Ghosts

By ROBERT LAXALT
Photographs by
DAVID HISER

IT WAS FEBRUARY, the month of the deep snows, and a new storm had begun when I came with nightfall into La Porte. On the lonesome road up, I had surprised a doe that vanished into the forest gloom with one great dancer's leap, a wildcat with short ears and wicked eyes that regarded me disdainfully, and a hawk plummeting down



still seek the Sierra's elusive treasure, he has worked the nearby Hardscrabble Mine for 22 years.

of the Lost Sierra

with outspread talons upon a squirrel that had lingered too long in a clearing.

This was the "Lost Sierra," an isolated, once all-but-forgotten corner of northeastern California that the forty-niners penetrated for gold. In the beginning most of them had abandoned their diggings with the first heavy snowfall and retreated to the protection

of the lowlands and valleys below. Then, from Scandinavian miners, they had learned to make skis, and so had conquered a region that was snowbound for seven months of the year, with drifts as high as forty feet.

In a ski museum at Boreal Ridge, near the Donner Pass, I had chanced on some faded photographs of women in long skirts and



floppy hats and children in tight-fitting jackets—all wearing skis. In the background were houses with only the rooftops showing above the snow. It was these photographs that had first captured my curiosity and sent me, starting the summer before, in search of old mining camps with such exotic names as Poker Flat, Port Wine, Poverty Hill, Whiskey Diggings, and La Porte (map, page 337). In my explorings I was to learn that gold and snow were still inextricably entwined in the life of the Lost Sierra.

Only 20 Face the Freeze

Now in winter, the old saloon in the La Porte Hotel, built in 1906, was frequented by a handful of the town's 20 wintertime residents (page 350). There is a high stand-up bar with a brass railing, a ceiling fan, a player piano, and the inevitable print of "Custer's Last Fight" in a huge frame on one wall.

Outside, the main street of La Porte was deserted. I walked along it at night with the beginning slivers of snow pricking my face like needles. Though it was what the durable year-round residents called a mild winter, the street was banked by huge drifts.

Next morning the snow was falling with determination, slanting like a white curtain across the window of my hotel room, obscuring the houses and tall trees beyond. I strapped on snowshoes, long and narrow "Indian webs," for a solitary trek into the forest.

In the undulating white wilderness, bushes and undergrowth and rocks were buried, and the trees so feathered with snow that they were more white than green. The woven track of my snowshoes filled in behind me as I tramped toward the nearby cabin of Pat O'Kean, an old prospector I had met the summer before.

It was snowing harder as I circled through the forest, and in the swirling flakes I experienced the brief panic that the Lost Sierrans of times past must have known when they were not sure their bearings were right. It was with huge relief that I came upon Pat's Kelly-green cabin and the plume of smoke rising from its chimney. Stacking my snowshoes outside, I went in for the warming drink of Irish whiskey and the crackling fire I knew would be waiting there.

"Pat, I'm ashamed of myself," I told him. "I almost got lost."

Pat had been busy waxing his ten-foot "long-board" skis for a walk into La Porte.



"They call 'em skis now. We called 'em 'snow-shoes,'" says Truman Gould of La Porte (facing page), shouldering ten-foot boards made from Douglas fir. "In 1917 we had 18 feet of snow," says Mr. Gould. "Nearly covered the roof. I never saw daylight for four days. If you didn't have a pair of shoes then, you were dead."

Working the winter away, Mrs. Gould fashions a barn owl from a pinecone (above). Summer brings a steady flow of visitors to the Goulds' store.

His lean face, remarkably unlined for his 80 years, was kindly. " 'Tis nothing to be ashamed of," he said in his lilting brogue. "I mind me the time I took a wrong canyon in a snow-storm and had to spend the night out in it, lying on top of a fire hole I dug in the snow. In the morning my face was as black as the ace of spades from all them smoking embers."

Pat O'Kean is to me the epitome of the eternal gold seeker of the Lost Sierra. He had lived through 40 winters in the snow-covered isolation of Poker Flat, and if he had his way, he would still be there. But he broke his back going over the side of the road in a truck four years ago, and that put a stop to his 30-mile round-trip ski treks from Poker Flat to La Porte and Downieville for mail and provisions. Pat moved to the winter cabin near La Porte, but his injury does not prevent him from returning to Poker Flat to pan for gold as soon as the snow melts (page 339).

I'd met Pat toward the end of my summer

sortie into the mountain fastness that enfolds the Lost Sierra, when the green landscape was a disarming contrast to the scenes of snow around us now. From the time I entered Beckwourth Pass till Pat introduced me to the decaying mysteries of his Poker Flat region, I seemed to have moved back a century and more, to a place where the pioneering spirit still etched the land and the character of its people.

Forty-niners Off to a Skiing Start

On that summer's exploration my guide was William Berry, who gave the name "Lost Sierra" to this out-of-the-way region when he stumbled upon it 40 years ago. A vibrant man whose energy and hardy frame belie his 70 years, he is the official historian for the U. S. Ski Association, and among the first to prove that organized ski racing in the United States began with the forty-niners.

With Bill Berry, I meandered through tiny



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Hearts and flags flutter, Blairsden citizens turn out in 1910 to greet the first passenger train to run the Feather River Route. With the mines in decline, the railroad opened the country to large-scale logging and to lowlanders seeking mountain solace.

farming and logging communities to the upper reaches of the Feather River's Middle Fork—a chain of ponds connected by only the slightest ripple of movement from one to another. It was hard to reconcile this tranquility with the mighty onrush of water that periodically devastated the lowland trading and farming centers and turned the Sacramento Valley into a sea of mud and water. The answer lay in the winter snows of the ominous mountains looming in the distance.

Today the Feather and Yuba Rivers, along with their tributaries, are being harnessed by dams to provide a power source for northern California.

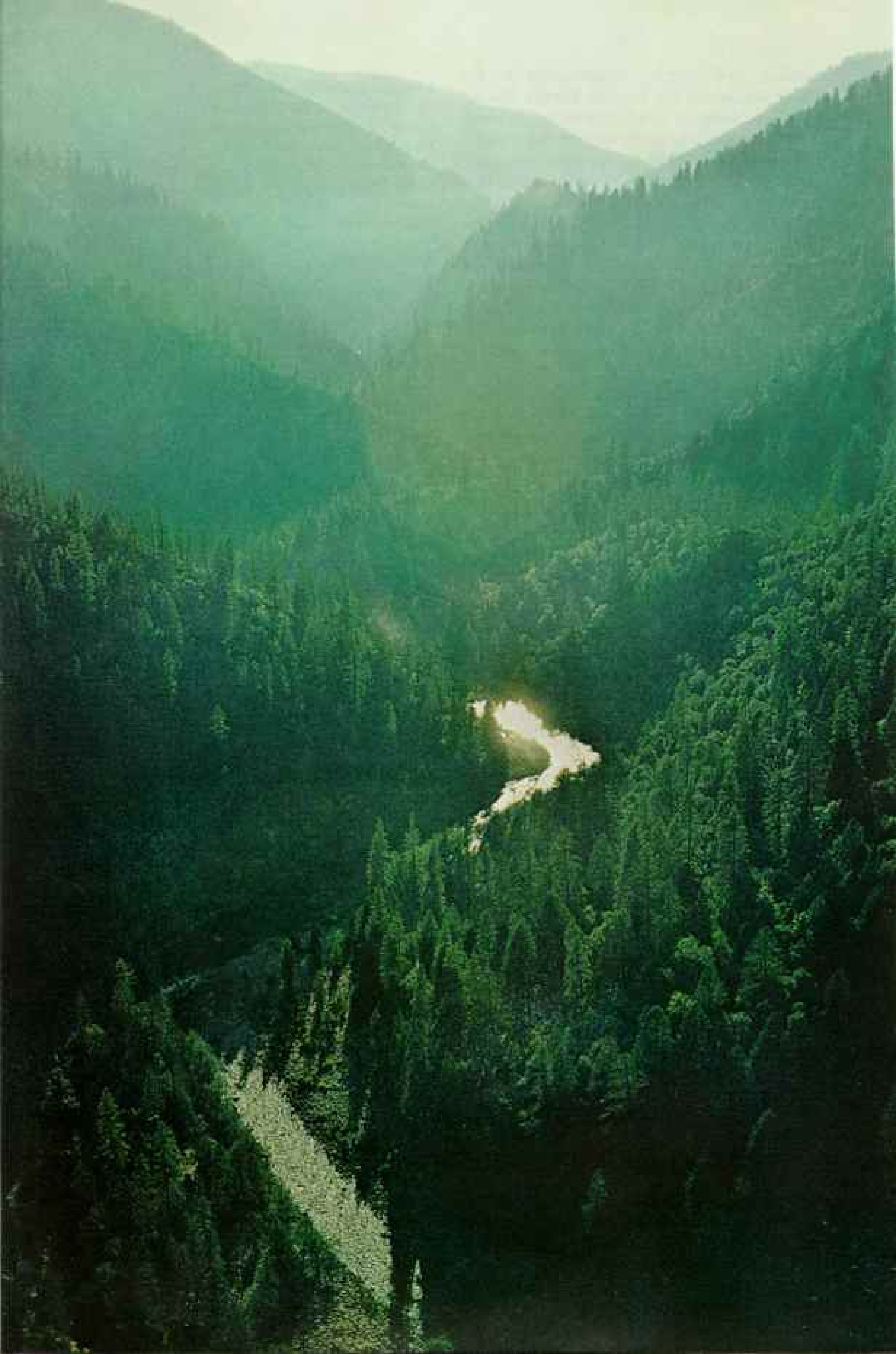
Nestled between two forks of the Feather River is Quincy, a lumbermill town on the edge of the Lost Sierra. Bill and I talked there with big, genial Francis O'Rourke. Until motorized vehicles penetrated the Lost Sierra on improved roads after 1912, the O'Rourke

(Continued on page 342)

Pristine pocket laced with rugged canyons, the Lost Sierra slumbered relatively unknown until recent years. Gold-rush towns crumble in its deep valleys and gravel flats. Rock-strewn tracks as well as modern roads thread the area.



Girls sprint to the tape as Fourth of July fever grips Downieville's 500 residents. In 1850 some 5,000 people lived here. "Stores and saloons sprang up," a newspaper reported. "Whiskey was 50 cents a drink and most of it was made in the back rooms."





Survivor of a vanishing breed, Ireland-born Pat O’Kean (above) pans in Canyon Creek near his summer cabin at Poker Flat. Pat has found more than gold in the Lost Sierra. “Man, it’s the best country in the world,” he says. “Mountains shootin’ up to the sky. Good air, good health, good everything. I wouldn’t live in any other kind of country.”

Gateway to gold, the Middle Fork of the Feather River elbows past knobby ridges (left). In the summer of 1850 hordes of miners stormed up this canyon. Nelson Point, a supply town for river camps, was described as “one of the roughest places in California” when the miners came to town on a Sunday. At Rich Bar, on the Feather’s North Fork, a pan of gravel paid as much as \$1,000 in nuggets and dust.

When surface yields diminished, men tunneled underground for veins and gold-bearing gravel. In a Loyalton bank Marian Lavezzola (right) exhibits gobbs of gold taken from the Ruby Mine and worth more than a quarter of a million dollars today.





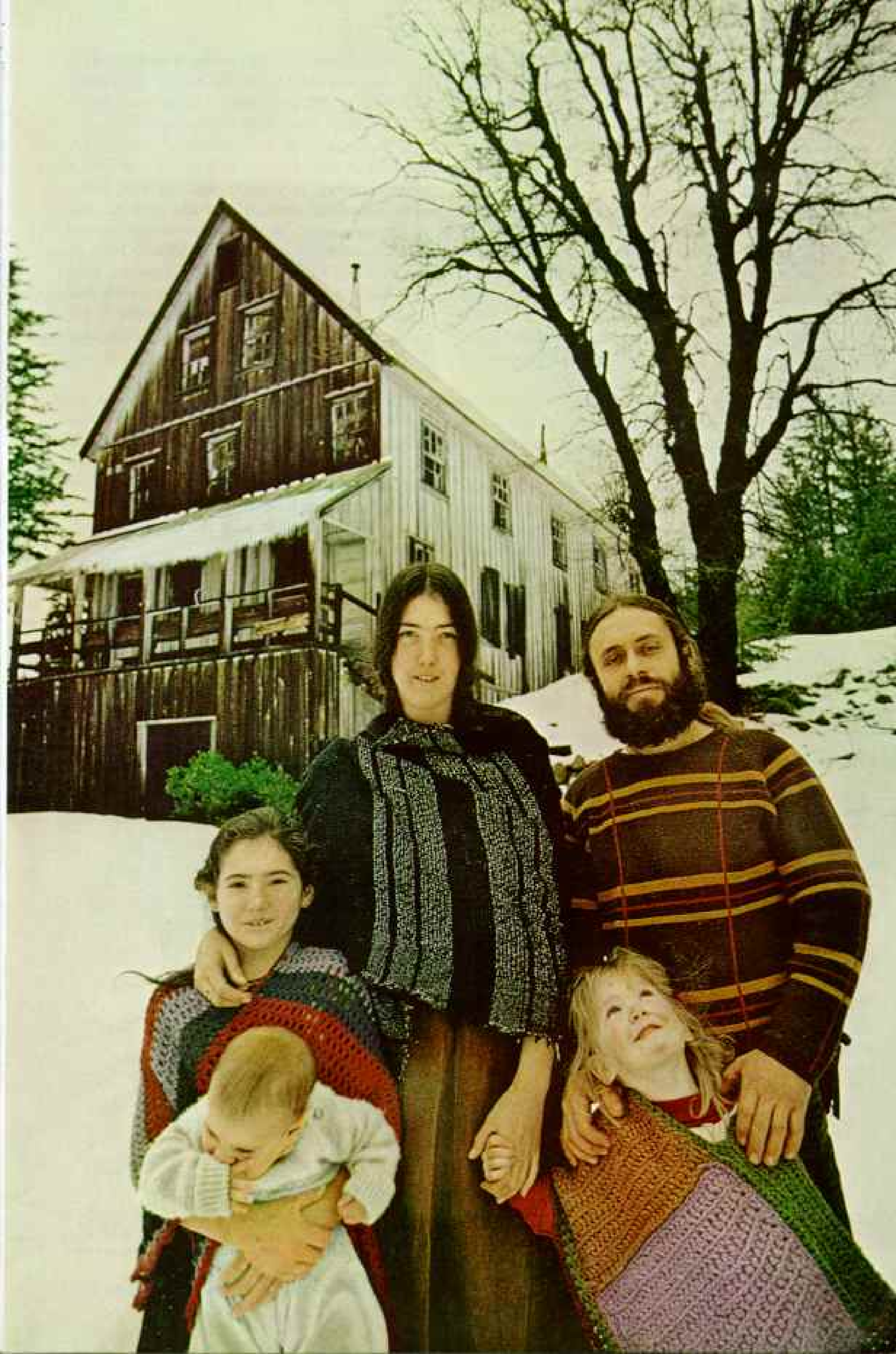
Face-to-face in pursuit of truth (left), participants in an "enlightenment exercise" at Origin, a onetime trout-fishing camp near Sattley, ponder such questions as "Who am I?" and "What is life?" Ranging from doctors to dropouts, they spend as much as \$50 for the three-day course; the daily regimen runs from 6 a.m. to midnight.

Waiting for a friend on the porch outside, a pet yearling deer (below) cools her heels among the shoes of the participants, who encounter one another unshod.

"Mining is my trip," says Cliff Sasselli, an ex-Navy scuba diver who once prospected for gold in South America. Coming to the Lost Sierra, he first tried his luck at Scales (right). Now he hopes to find fortune at Poverty Hill. His success so far? "Fair to middling," he answers.

The Sasselli family winters in a simple cabin. In summer they switch to a homemade 20-foot-wide tepee, "waking up to mother nature's alarm clock, the light," says Cliff. Wife Mary Jo cooks over a wood fire. Children Sandi and Summer attend school by correspondence course. Cliff assisted at the tepee birth of his son, Sierra Stave. Here the family stands outside a bunkhouse built during the Depression to house miners.





family for years had run horse-drawn stages in summer and sleighs in winter, carrying supplies and mail into the high mountains and bringing back gold and mail. The old route—the wagon road first hacked out by the early wagon trains—crossed a ridge known as The Hogback.

"Summers were easy going then if you had the stomach for looking down 2,000 feet," Francis O'Rourke told me. "But winters were another thing, with howling blizzards and snowslides. We could only go as far as Nelson Point, and there the skiers from La Porte would meet us. The men would load up 50-pound packs, and the kids hauled supplies on sleds and corrugated iron sheets."

When I asked him how his stage horses could make it through the drifts, he answered, "They wore snowshoes. Metal contraptions a foot wide, with felt or rubber bottoms, and a clamp that screwed down over the hoof."

"Did they take to them?" I asked.

"Most did but some didn't. Some never could catch on, but we had one black mare that could walk a tightrope with them."

I told O'Rourke we were going to jeep next day over the same old-time wagon road to La Porte. He said, with a dismissing wave of his hand, "It's a superhighway now."

If the route's 35-mile ribbon of rocky one-track road was Francis O'Rourke's idea of a superhighway, it wasn't mine. It was, however, hauntingly beautiful. Falls of cold, clear water cascaded down over moss-covered rocks, eventually to reach the Middle Fork of the Feather River. In one placid pool a lone deer raised his dripping head to watch our passage. The constant waterfalls were so inviting that I stripped and stepped into one. The force of the icy water drove me to my knees, and I emerged gasping.

As we climbed higher, we overlooked the rugged canyon of the Middle Fork. It is one of the deeper and more inaccessible canyons in the Sierra Nevada, and many parts of it may never have known the footfall of man. The trees at the bottom of it seemed no larger than spikes of grass, and the river was only a silver vein.

When we crossed over the last high rim



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and penetrated the heart of the Lost Sierra, we were surrounded by dark groves of pine and fir interlaced with delicate hues of maple and oak. Heady scents of wild flowers cut through the hot pine smell in the air.

Mythical Lake Led the Way to Real Gold

This was the mountain bastion the forty-niners had stormed in search of fabled Gold Lake. Thousands of miners had become disillusioned with the hard work required to get gold out of the Mother Lode country. All they needed to trigger a rush into the region was the legend of Gold Lake.

In 1849 a half-starved man named Stoddard staggered out of the mountains with a handful of nuggets and a tale about a lake whose shores were lined with chunks of gold. An expedition, taking Stoddard as its guide, decided to find out whether the tale was true, and hundreds of miners fell in behind.

Stoddard led them on a wild-goose chase for weeks, the story goes, and they never did find the lake. His followers, enraged at being made fools of, set up an impromptu miners'

court and, for his deception, sentenced Stoddard to hang. But he escaped into the forest, only to turn up again several years later, trying to revive interest in the lake lined with chunks of gold.

In their quest for the mythical Gold Lake, a few tenacious miners made promising strikes along Lost Sierra creeks. When news of that got out, the mountains were deluged by miners, merchants, and gamblers—a gold-rush potpourri of Yankees, English, Irish, Scots, Scandinavians, Chinese, Latin Americans, and Hawaiians. Some were veteran miners who passed their skill along to their inexperienced companions. In four decades they extracted 93 million dollars in gold.

The thriving gold camps the forty-niners erected here in the wilderness are nearly gone. Many have vanished, their sturdier buildings moved to towns like La Porte; the others have been completely recaptured by the forest. What little remained of old bottles, iron beds, and discarded skis was taken away by souvenir hunters.

At Whiskey Diggings alone, there had been

DOPE IS KING.

THIRD ANNUAL MEETING

—OF THE—

**ALTURAS
SNOW SHOE CLUB**

LA PORTE, PLUMAS COUNTY, CAL.

FOUR DAYS' RACING

COMMENCING ON MONDAY, FEBRUARY TWENTY-SECOND, 1888.

SIX HUNDRED DOLLARS IN PURSES.

COURTESY CALIFORNIA STATE DIVISION OF
PARKS AND RECREATION, SACRAMENTO

"Dope," as ski wax was called, ruled the slopes when miners (left) squared off for down-mountain racing. Aboard 12-foot "snow-shoes" greased by secretly prepared dope, many attained reported speeds of 80 miles an hour. Johnny Redstreak (right) holds the skis on which he rode to victory in a celebrated 1941 race against conventional skiers, including Hannes Schroll, U. S. downhill and slalom champion in 1935.

Golden Ghosts of the Lost Sierra



20 mining camps in a small perimeter. Now they are marked by little cemeteries with illegible wooden grave boards and a jumble of brown-board ruins. It is as if the houses, untenanted and uncared for, held on as long as they could, and then collapsed in upon themselves with a weary sigh.

At uninhabited Gibsonville, Bill Berry and I rummaged through the remnants of one of those old houses. I found a pair of delicately turned skis that had belonged to a child and gave them to Bill for his Western America Skisport Museum at Boreal Ridge. There he has gathered a formidable display of long-board skis as part of his personal crusade to revive the lost art of long-board ski racing.

"The long-boards are what opened up the Lost Sierra year round," he said. "The Scandinavians jumping ship in San Francisco to join the gold rush taught the forty-niners to make these 'Norway skates.'"

Before my first venture into the Lost Sierra, I had seen Bill Berry's museum collection of

prodigious skis from 10 to nearly 13 feet in length. They seemed to me impossibly cumbersome, and I said as much. In answer, he showed me photographs of old-time racers with high laced boots poised for a run down terrifyingly sheer slopes (page 342). "I'm convinced," Bill said, "that they reached speeds unequalled in down-mountain racing today."

Towns Live On Only in Memory

I was to recall the ghosted gold camp of Gibsonville later, in astonished retrospect, when I visited with 80-year-old Elizabeth Merian in Oroville. She told me she had spent her youth in Gibsonville.

"You have to imagine those towns as I saw them," she said. "The houses were painted white, and there were picket fences, and flower and vegetable gardens, and even orchards. The families with kids had a cow for milk and butter, and a calf and pigs for meat.

"In the winter the houses were often buried under mountains of snow, fifteen to twenty



feet deep. When the storms began, we had to lengthen our chimneys to let smoke escape, and we dug slanting access tunnels down to the attic windows, the snow was that deep. Inside, we burned lamps all day for light. But winter wasn't a sad time at all. The grown-ups had sewing circles, card parties, and dancing to the fiddles. Us kids skied all day long—but we called it 'snow-shoeing' then." She regarded me with a mischievous smile. "I was a racer, you know, and I raced in short skirts. That really scandalized 'em."

A few miles down the road from Elizabeth Merian's beloved Gibsonville lies La Porte, the hub of the Lost Sierra. In the early 1860's, at least 3,000 people lived in and around the town.

La Porte in its big days was a hydraulic-mining center. Taking advantage of the pressure of water drawn from higher up, great hoses tore at gravel deposits and washed gold-bearing sand into races and sluice boxes. Every year the spring runoff gathered up the

waste material loosened from hillsides by hydraulic mining and carried the entire mass into the Sacramento Valley.

This eventually prompted a federal law in 1893 which attached such rigid controls that hydraulic mining died out in California. That meant the end of the big days for the already dying La Porte. Today only 80 people live there, even in summer.

The town has dwindled to a single hotel, a general store, two saloons, a number of houses, and neat rows of cabins once occupied by miners. Suggestive of a cathedral aisle, the main street is wide and flanked on both sides by towering pines.

La Porte's general store, owned by Truman Gould (page 334), is the year-round town center, being also the post office and gas station. Until it was destroyed in a fire a few years ago, a set of gold scales was employed to measure out miners' nuggets and gold dust in exchange for goods.

"There aren't many miners left these days,"



"The His and Hers Logging Company," as they are affectionately known by friends, Sue and Oliver Hillman (above) salvage patches of timber "too small for the big outfits to bother with."

"I'm not doing this for women's lib," says Mrs. Hillman, who assists her husband in hauling and loading. He adds, "She's the brains and I'm the brawn. We've been working this way for 12 years. I guess we're too old to get any bigger." The Hillmans bring their timber to the Holstrom Mill near Sattley (left), where a pondman corrals logs.

Truman told me, "The townfolk are the steady income. But I also cater to loggers, road crews, and lots of fishermen, hunters, and campers. Not many of them as colorful as the old prospectors.

"They were a curious breed. I never had the gold bug, but with them it was a fever. There was that Luxembourger fellow, found a pocket of gold that brought him \$800. He spent the next 35 years tunneling the mountain where he'd made the strike. He never found another nugget, but he kept on saying, 'I'm just a few feet away from fortune.' When he died at 84," Truman added dryly, "that fortune was still just a few feet away."

The Mail Went Through—on Skis

Back at the La Porte Hotel, in the saloon, I talked with Dick O'Rourke, a cousin of the Francis O'Rourke I'd met in Quincy. A blue-eyed, ruddy Irishman, Dick had been one of the area's last mail carriers on skis.

"I guess it was a hard life," he said, "though I didn't think anything about it then. I would start out from La Porte and make the climb to Howland Flat. I wore the long-boards and carried a canvas mail sack weighing fifty to sixty pounds on my back. Going uphill, I slipped 'moccasins' of mattress ticking onto my skis for traction. I rubbed charcoal under my eyes, but even then, there were times when I got nearly snow blind. In heavy storms I just wouldn't go out, except in extreme emergencies."

It was in the same saloon that I had first met Pat O'Kean. We fell to talking about Poker Flat and Pat agreed to guide me there.

We jeeped down a dirt road cut through miles of loose rock piled so deep on the hill-sides that nothing could grow, the ravages of last century's hydraulic mining. While we bumped along, Pat talked of how he had come to the Lost Sierra. He had been born in Ireland, and had worked in mines near Los Angeles.

"I had me a partner," said Pat, "an Irish-English lad, called Whitey. He got the urge to see the Sierra gold country. When he came

back, he said, 'Ye have got to see it. It's the new country.' I said I would go for two weeks, and, by jingo, I found a nugget, and I've been here ever since."

He added philosophically, "I've made enough to live all these years, sometimes \$20 a day in the short season, between snows. That's all a man can ask for. I never had much patience with the kind who hate a man because he had the good luck and the know-how to make a million."

Poker Flat today is only a ghost of what it was in 1852, when several hundred miners panned for gold on Canyon Creek and its tributaries, or tunneled into its sharply rising slopes. When we jeeped through what was passable of the long narrow valley, we saw a dozen houses in various stages of ruin, and a lone miner.

The miner, Vern Overby, explained that he worked his claim only in the summers. He showed us two magnificent gold nuggets he had found after a rainstorm uncovered them. I should never have felt their water-worn smoothness growing warm in my palms, because I was instantly seized with gold fever.

Water and Patience Do the Trick

After that I was hard put to tear myself away from clambering over the boulder-strewn creek in search of nuggets. I would not be content until Pat O'Kean showed me how to pan gravel mixed with water. Dexterously he rocked the pan with circular motions, tipping it from side to side to let the gold-bearing sand work its way to the bottom. "The secret is in letting the water do the work," said Pat. "That and patience." Several tries with the pan without finding color, and I began to understand the disappointment that had sent all but a lucky few back out of the California gold country penniless.

"The Chinee were the ones with true patience," Pat told me as we sat on the broken-down stoop of the house in which he had lived for so much of his life. "The white men always looked for the rich stuff. They took the cream and moved on. Then the Chinee would

Night music of the outdoors—coyotes yapping and crickets chorusing—plays for Mary and Forest Sheehan, grandparents of smiling Jerry Weirton, when they sleep on this sugar-pine bed during summers at their isolated ranch near Scales. "In the tree branches," says Mr. Sheehan, "we can see silhouettes of ladies in hoopskirts, witches, and goblins. How much some people miss huddled in their lairs!" The Sheehans' 40-acre spread is guarded by a fierce black dog called Tattycoram. "Name's from a girl in Dickens's *Little Dorrit*," Mr. Sheehan explains. "She was subject to fits of temper," he adds dryly.





Going where the grass is greener, 75-year-old Mrs. Guy Robinson (center, left) drives her stock through Downieville on the way to summer pasture in the high country. Packing a

work the same gulches and pick up a lot of fine gold. But when they left a gulch, there was nothing left for nobody."

Across Canyon Creek was a log cabin that seemed to have weathered the years better than most. When I asked Pat about it, he said, "That cabin was built in the Depression. I was the only resident here, and then, one by one, they began coming in until there was 350 people here, if ye can believe it. Good people who were too proud to go on relief. They lived hard, but they made their few dollars a day, mostly panning. It was enough to keep food in their stomachs."

He gestured to the cabin. "The luckiest one of them all was a rambling lad who built that cabin. He couldn't have been 12 years old, he had run away from home, and he had neither family nor friends here. I was working my sluice box on the bank when he first come down the mountain, whistling as lads will. He had a pick and a shovel and a pan, and when I asked him where he was going to try his luck, he said, 'Right down there below.' Well, I'll be jingoes but he didn't pick the only spot on the creek that hadn't been worked. He comes back up to me with his hands full of \$10 and \$20 nuggets, and says,



pistol to kill rattlesnakes, the indomitable lady from Rough and Ready, 30 miles to the southwest, has convoyed her cattle this way for 45 years. Grandchildren and friends assist.

'Is this good?' I'm here to tell ye I nearly fainted. Before that lad left here to seek his fortune elsewhere, he had made ten hundred dollars."

Stories of such gold finds abound in the Lost Sierra—of a man who in firing at a game bird dislodged a piece of ore that marked a strike; of a miner who noticed a string of ants carrying precious specks and followed them to a rich pocket; of a highway construction crew that unearthed a promising vein, left their machines, went digging like crazy, and took out metal worth \$70,000.

Gold mining in the Lost Sierra has just about come down to a hobby. There are no

full-time company operations remaining, because an operator can't make enough above the \$50-a-day cost of employing and feeding a mine worker. But the recent rise in the price of gold has brought on a surge of weekend prospectors and could stimulate the reopening of company operations.

Panning can be a profitable hobby. In Poker Flat I talked to young Don Albrecht. On weekends sandwiched into his job as a postal employee, Don pans in the mountain creeks. Pouring out a pouchful of nuggets into my hand, he said, "That's \$2,000 worth of gold you're holding. Not bad for a 'sniper.'"

A sniper, he explained, is gold-country vernacular for the occasional miner who, with gold pan and suction dredge, probes for nuggets in crevices and bedrock ridges along stream banks.

Scuba diving has added a new dimension to prospecting techniques. At the ghost camp of Scales I found bearded, long-haired Cliff Sasselli, who scuba dives in deep creeks and old hydraulic pits (page 341). When I saw him in late autumn, he was patching up an old cabin and laying in health foods and firewood against the imminent snows.

"For the past three summers my wife and I have been living and gold hunting in the area," he said, "but this year, we're going to try and make out the winter. We won't have electricity, but we've got kerosene lanterns and that old cast-iron stove."

I asked about the three children, ranging in age from 8 years to 3 months. He told me he had delivered the youngest child himself in a tepee. "They'll do all right," he said. "If they get sick, we'll just take care of them ourselves, and if necessary, go for help."

When I went back to La Porte in winter, I

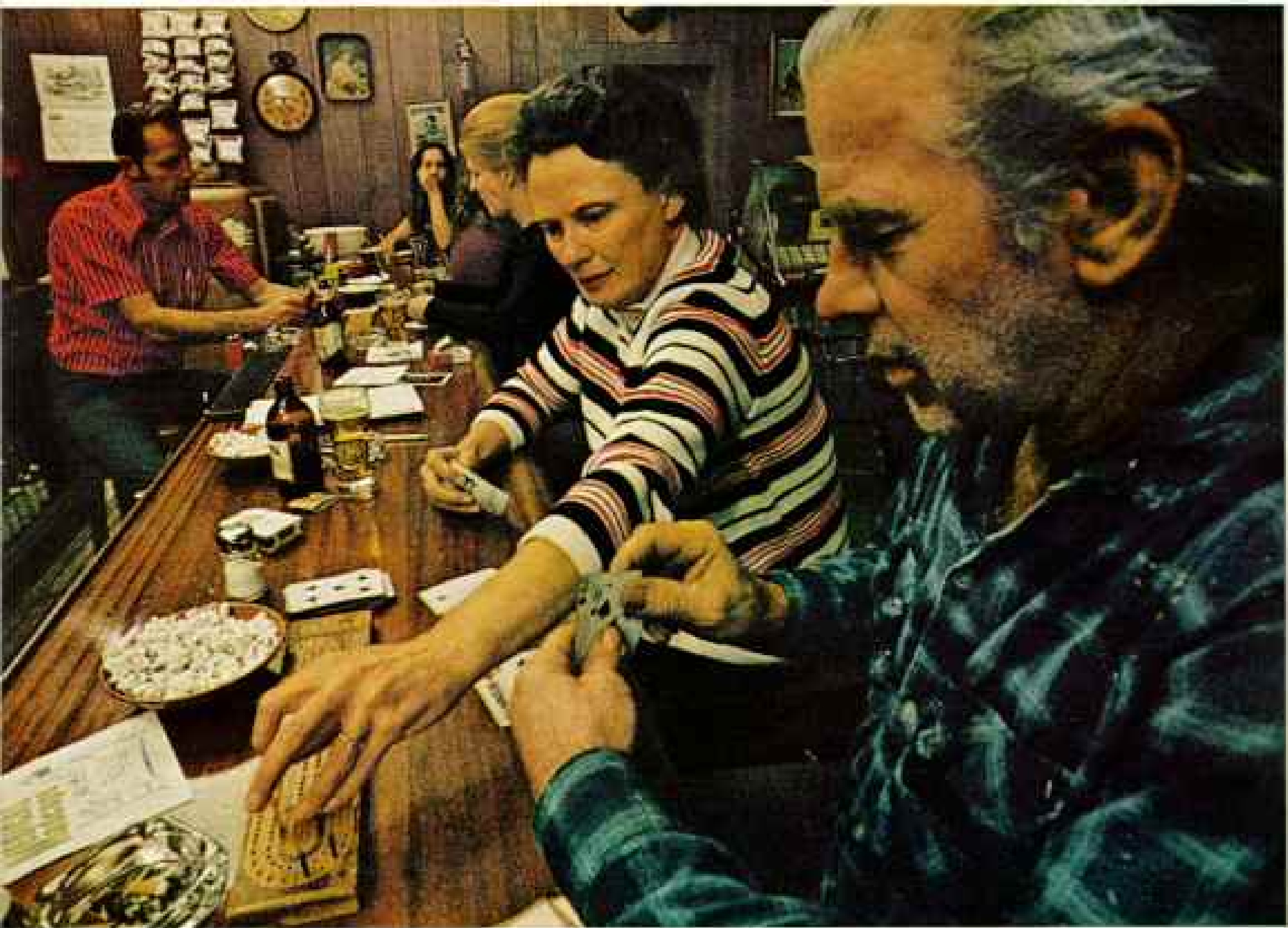
learned that Cliff and his family had indeed managed to stick it out through the trying times—like the pioneers and their children of a century or so ago.

No Nostalgia for the "Good Old Days"

Crusty Jim Dugan, with the gaunt face and gnarled hands of 86 years, had been one of those pioneer children. Bill Berry and I sat with him on a worn bench beside a wooden boardwalk in Downieville. The sunlight was hazy with autumn, and there was the dry scent of dying leaves in the air.

Jim Dugan's grandfather had been among the "Gold Lakers" who had settled the Lost Sierra. His mother had raised ten children in Poker Flat, and his father had been an unlucky miner "who just managed to get along."

"People looked up to my father, though," Jim said, wagging his chin sharply. "He was a sort of preacher, and he buried a lot of people in Poker Flat. If they was Catholic, he gave them a Catholic funeral. If they was Methodist, he gave them a Methodist funeral." Pausing in afterthought, he added, "It wasn't all that easy to bury the dead in winter. We



had to dig through 18 feet of snow and 6 feet of dirt."

I made the mistake of remarking nostalgically, "Still and all, those must have been good times to live in."

Jim Dugan snorted. "I hear people on the TV talking about the good old days," he said. "Well, in the good old days, you couldn't hardly make enough to keep a dog alive. Listen, mister. Every time you wake up in the morning, you better shake hands with yourself for living now."

Jim's temper cooled and his eyes lighted up when Bill Berry asked whether he had known many of the old-time ski racers.

"I knew all of them," Jim Dugan said, "even Tommy Todd. Tommy was the one, you know, who made the fastest time of all—a 600-yard run in 13 seconds, and that from a standing start."

Bill interrupted. "That could have been an all-time speed record over a short run."

"I wouldn't doubt it," Jim Dugan said. "These boys who race now couldn't hold a candle to the long-board riders. And you know the reason why? Short skis, that's why!"

On my last trip into the Lost Sierra, in winter, I saw a revival of the old long-board racing. Bill Berry had offered his treasured museum pieces, skis—some almost 13 feet long—handcrafted of spruce and fir, bent and tempered in boiling water, and saturated with pine tar.

The day of the race dawned dazzlingly clear, and we went into the backcountry beyond Sierraville on whining snowmobiles. Then the youthful racers—most of them short-ski competitors—made the long climb to the top of the hill.

While we were waiting beside the red-flagged finish line for the race to begin, I talked with Johnny Redstreak (page 343) and Jerry Burelle, two of the last long-board racers. Their racing days were over, but they had volunteered to wax the long skis with the secret concoctions that had been handed down from the early ski makers.

I asked Johnny about the classic confrontation between long-boards and modern skis in 1941, when he competed with Hannes Schroll, a former U. S. champion.

"Hannes was a nice man," he reminisced,

Pegging her point, Lynn Webb clashes with Earl Hartman during La Porte's annual cribbage tournament (left), convened in a saloon. When winter snows send summer visitors scurrying, the town's 20 residents settle in for the long haul toward spring. Like the miners of old, they look to each other for friendship and entertainment.

Part-time barber, retired miner Rinaldo Daneri of Downieville trims the hair of Mrs. Virginia Weaver, proprietress of one of the town's motels. Mr. Daneri came from Italy in 1921 to seek his fortune. "Once I helped dig a tunnel 2,700 feet long," he recalls. "We lived like moles, but we found nothing. In another mine I found a 37-ounce nugget. I called the superintendent, and he damn near fainted!"



"but he couldn't hide a grin when he saw me getting into my long-boards. I was set to teach him a lesson, and I went all the way out. My skis were rattling like rifle shots, and I couldn't see two feet in front of me, because, you know, I was averaging more than 60 miles an hour. But I had aimed my balance pole like a gun to the big flags at the end of the runout, and I just sighted along that and kept to the grooved track." He chuckled. "Hannes Schroll was one surprised man. He told me afterward, 'Never did I believe that skis could go so fast.'"

There was a warning shout from the top of the hill, and two racers in the first heat pushed off. When they hurtled between the red flags, they were an unrecognizable blur of speed. In trying to brake down with his wooden balance pole on the runout, one of them fell. The long-boards sailed off to the side, but the downed racer performed cartwheels that seemed to have no end. Finally, he sat up and grinned dazedly. "Boy, those things move!" he said.

When the races finished, I asked young Don Demosthenes, a ski racer from Nevada, what it was like on the long-boards. "It's a weird feeling," he said. "You have no control, no turning, no nothing. You just go with your skis and hope you come out in one piece." He paused in reflection. "It's not only the long skis," he said. "It's that wax they put on. That's something!"

I went to see Jerry Burelle in Sierraville just to ask him about the round cake of wax he had rubbed onto the long-boards that day.

He took me into a workshop aromatic with chunks of early-day ski wax. "Making ski 'dope' was a fine science a hundred years ago in the Sierra," he said. "Those old-time ski riders had as many as twenty different secret recipes to match any kind of snow, and they would have shot anyone who tried to pirate them."

When I asked to see the recipe he had used that day, he reluctantly opened a book with a worn black leather cover and turned to a page of spidery handwriting:

February 28, 1895—No. 20

2 oz spermaceti

20 drops oil of spruce

18 drops oil of cedar

10 drops coal oil

10 drops oil of hemlock

1 teaspoon turpentine

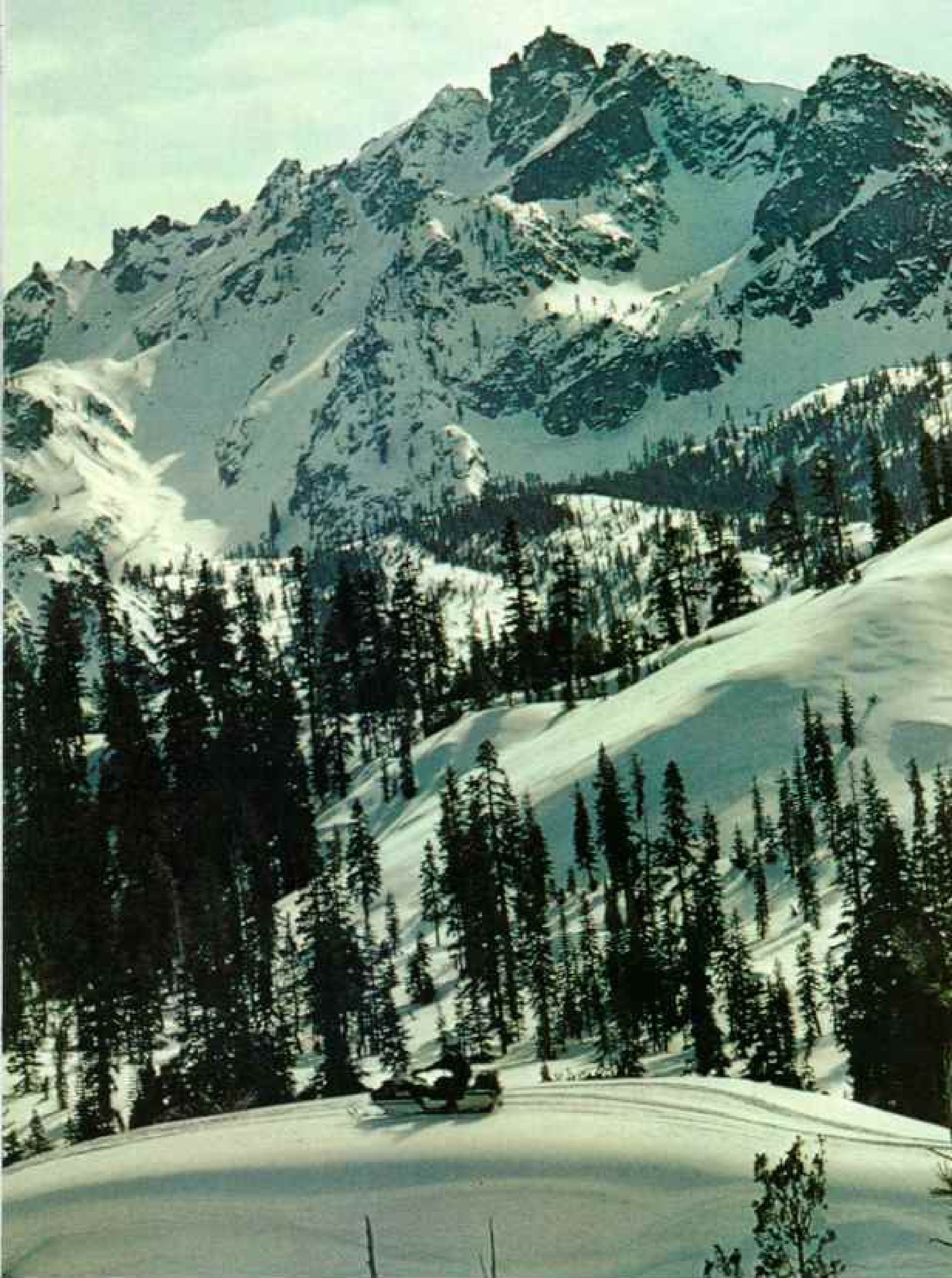
1/8 oz camphor

COOK 45 MINUTES

Afterward, we talked about the Lost Sierra—its crumbling gold camps, and its heritage of strength and kindness, the helping hand of good neighbors in times of trouble. "Nobody has much money up here," said Jerry, "but they're not afraid of work, and they can always find an excuse for a good time. They know how to enjoy life. I hate to see it all die, but dying it is. What a great thing that it has lasted this long." □



Discovering the Lost Sierra's



winter beauty, a snowmobile rambles where once only mountain men ventured on skis.

Change Ripples New Guinea's

ARTICLE AND PHOTOGRAPHS BY MALCOLM S. KIRK



Child of the Sepik naps in a *bilum*, or net bag, oblivious to crosscurrents of change tearing at the fabric of a society little

Sepik River



more than a generation removed from headhunting.

THE LAST WORK CANOES are straggling homeward as afternoon wanes. Near the river, smoke from the cooking fires hangs like a fog in the humid heat, shrouding the thatched roofs of Melawei village. In the *haus tambaran*, the spirit house, a man naked except for a loincloth pounds a staccato message on a hollowed-log drum: Visitors have come.

Deep in the jungle the distant thuds are heard by barrel-chested Gwoyap, a villager, and his hunting party, hurrying back with the carcass of a wild pig they have speared. Presently, in the twilight, Gwoyap strides up to our stilted hut and bids my wife, Barbara, and me welcome.

We are about to start dinner, so Barbara invites him to join us. Hungrily gulping down a huge plateful of corned beef, Gwoyap runs an envious eye over our stock of food and camping supplies.

"*Yupela gat moni faktari long Amerika?*" he asks in pidgin English. We both nod. "*Mipela nogat nating,*" he continues fiercely. We have nothing, he is saying. Why do you Europeans have plenty of money and tinned foods and outboard motors, while we have so little? Why don't you show us how to build money factories too, so we can all be rich?

Europeans Came Early to the Sepik

This is our third expedition to New Guinea in the past five years. On the two previous visits Barbara and I penetrated remote corners of this huge island to photograph and write about tribes that still practice headhunting and cannibalism.* But here, on the 700-mile-long Sepik River, the white man's presence has been felt for years. Now, inexorably, it is changing the colorful life-styles of these primitive people, and the result, more often than not, is confusion and frustration.

Australia administers Papua New Guinea, the eastern half of the island. The western half—West Irian—is part of Indonesia (map, page 357). Australian patrol officers impose strange new laws over the old unwritten ones. Traders create a demand for money and goods, or "cargo." And missionaries try to

*The author described western New Guinea's headhunters in the March 1972 NATIONAL GEOGRAPHIC.



Lifeline of tribal culture, the Sepik River meanders through swamplands where headhunting tribes battled in decades past. Peace ensured by Australian administrators has transformed the 700-mile river from an avenue of war into one of cultural interchange—and a highway for occasional boatloads of adventuresome tourists. Daubed in ceremonial whiteface, a lad at Angoram (left) attends a National Day celebration looking ahead to imminent self-government in Papua New Guinea.



BARBARA KIRBY



Swamps, floods, mosquitoes, and a hothouse climate have held settlement along the Sepik River to a scattering of villages. Population density increases in the cool and relatively insect-free Highlands.



stamp out traditional religious ceremonies, while urging the people to hide their nakedness with ill-fitting European clothes.

Such a setting finds this wild tropical land's once-savage tribesmen on the eve of independence. Australia increasingly relinquishes control to Papua New Guinea's House of Assembly, which has been working for full self-government since its election in 1972. Only last spring this emerging nation took over direction of its 23,000-member civil service, of which 18,000 are native-born. Independence is expected within a few years.

Yet our friend Gwoyap and untold thousands more pathetically long for "money factories." They believe that the white man obtains his goods, his wealth, through trickery and his own peculiar magic, which involves his church services and Bible studies. Since the whites will not share their cargo, the people try to imitate this magic.

This is the purpose of the Peli Association, a cargo-cult movement founded by Matias Yaliwan, a tall, hypnotic-looking onetime Catholic mission worker (page 362). For months New Guinea buzzed with rumors that he had declared himself God's appointed leader of the country. By studying the Bible, he reputedly had unlocked the secret of "power."

"Flowers" Labor in a House of Power

In our Melawei hut Gwoyap tells us that tomorrow he and his friends will leave for Marambanja village, headquarters of the Peli Association, in the Maprik hills above the river. Matias is holding a rally to show his followers how to use power to make money.

"Can we come with you?" I ask.

But suspicion clouds Gwoyap's eyes, and I immediately realize my mistake. He thinks we will trick him out of getting his cargo. We must remain behind.

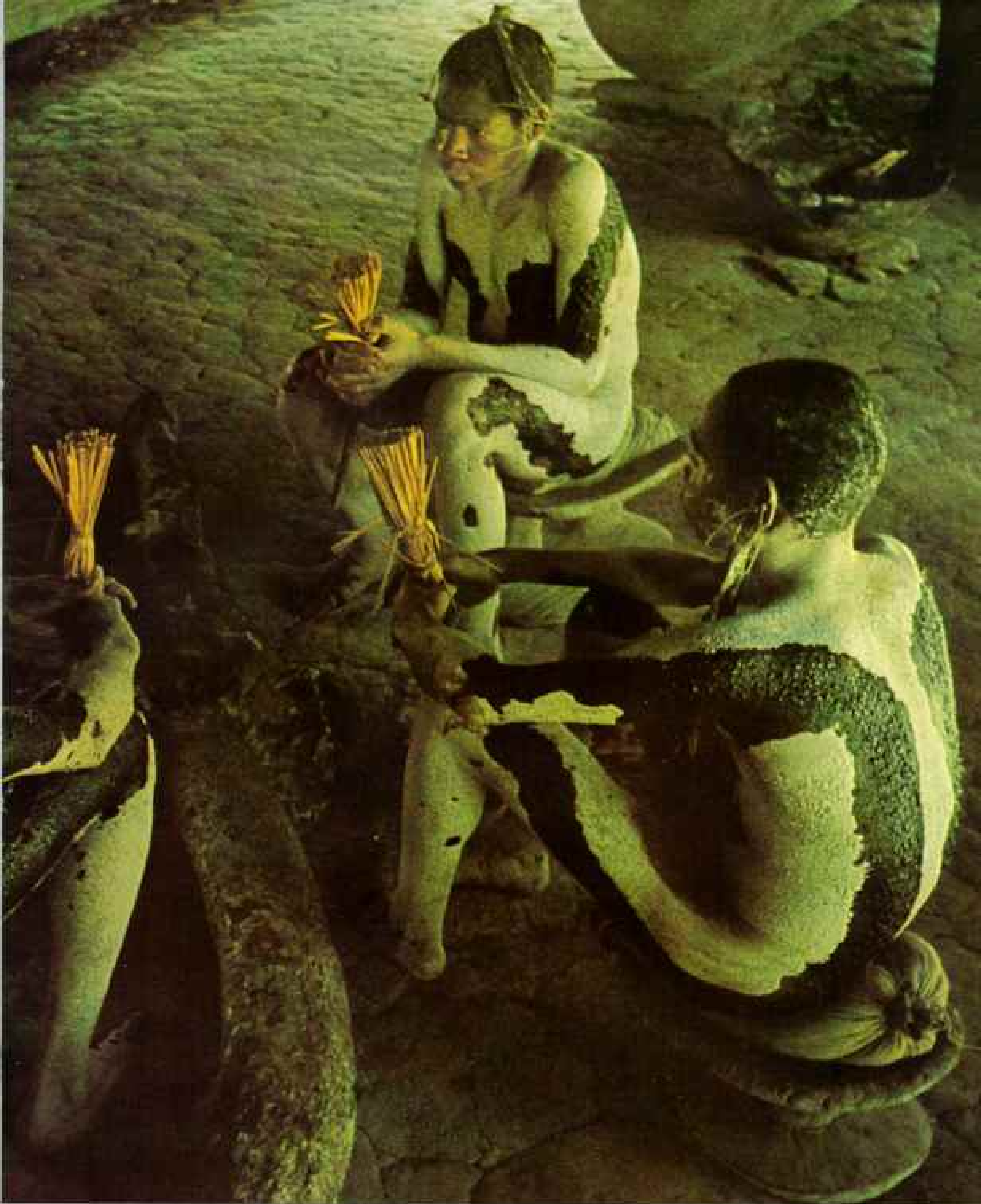
We soon hear more about Marambanja: Teams of girls and young men, called Flowers and Workers, are busy making money there at night in a newly built Power House.

At last, unable to restrain our curiosity, we decide to risk the people's hostility and go there ourselves. We canoe down the Sepik to the patrol post at Pagwi. There we rent a four-wheel-drive vehicle. An unpaved and dusty road runs from Pagwi into the hills. By the time we alight from the vehicle and begin the trek to Marambanja, my throat is parched and my nostrils are clogged with dust.

But our fear of a hostile reception departs



Tight-lipped with pain, boys in Parambei village undergo a grueling initiation into manhood, in which the "mother's blood," deemed inferior, is cast out to allow them to form virile blood of their own. After



their elders incise the youths' skin with scores of small cuts, the wounds are rubbed with ash and oil to raise permanent welts. White clay covers unscarred body areas. The rite takes place in the *haus tambaran*,

or men's ceremonial house, focal point of the village's religious and social life.

As outside influences erode such old ways, tribespeople find themselves marooned in a cultural no-man's-land between old and new.



Long-nosed mask from the village of Murik is believed—like many ritual and everyday objects—to have a soul of its own. During spirit-cult rites, tribesmen don such ceremonial masks and stride about the village, frightening women and children.



Spectral gallery of spirit faces peers from the upper facades of haus tambarans in the Maprik area (upper right) and at Angoram. The wood-and-thatch structures differ markedly from tribe to tribe. When a dilapidated haus must ultimately be replaced, its sacred support posts are sometimes left in the ground (above). In former years human skulls garnered on headhunting expeditions were buried in each posthole.

Often superbly carved, original house posts have fetched thousands of dollars on the international art market.

with the friendly greetings, "Apinun [afternoon] mastal Apinun misis!" We are escorted to Jimmy Simbago, a wiry little man with a broad grin and twinkling eyes, wearing a felt hat that seems molded to his scalp. Jimmy is the Peli Association's secretary.

In his Western-style office he says, "The Australians try to stop us from getting power, but you Americans have shown us. You have more power than Australia, because your men go to the moon. Now we make money by hand. Later we will buy a machine, like the one in Washington. Look what the Americans send us!"

He pushes some books across the table: *Seven Steps to Power* and *Power is Born of Belief* and *Great Voodoo Man of the Bible* and *With God All Things Are Possible*.

"Now, because you come a long way from America, we will show you how we make

money," Jimmy continues, beaming. We follow him down a path to a simulated cemetery, laid out in small plots with wood markers.

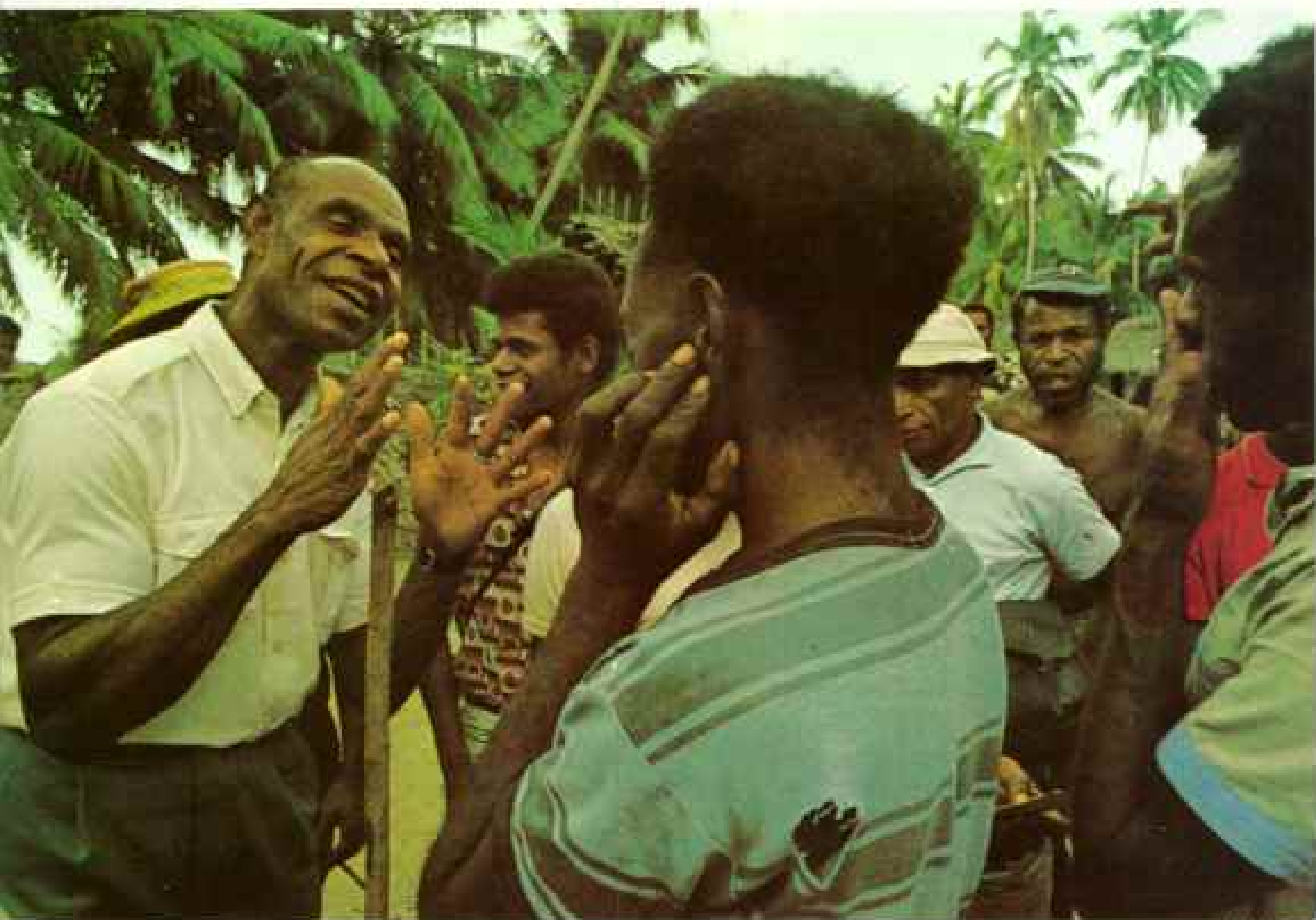
"The Eden Memorial Gardens," Jimmy informs us, pausing to roll a cigarette from twist tobacco and newspaper. "When Matias tells us, all Peli Association members come here at night to pray."

Stopping at one "grave," Jimmy points dramatically and says, "One member found five thousand dollars* in a suitcase there!"

We walk on toward two long thatched-roof huts, one the Power House, as it is called, and the other a dormitory for the Flowers and the Workers.

"The people pay many dollars to learn how to use the power," Jimmy hints, coughing politely. With a nudge from Barbara, I pull

*Papua New Guinea uses Australian currency; one dollar equals \$1.42 U.S.



BARBARA KYLE

Messiah of money, Matias Yaliwan—leader of a quasi-religious cargo cult—tells disciples in Mundjiharangi village how, by mimicking the white man's ways, they too can become rich in material goods, or cargo. Cult members believe that whites win their seemingly infinite wealth not by work but by a form of magic, and that such magic, as taught by Matias, can work for anyone.

out two packets of coins. A Flower and a Worker materialize, and we enter the Power House. The interior reminds me of a cowshed, with a central corridor and stalls on either side. Each stall contains a rough table with a couple of enamel bowls on it.

Worker Gives a Lesson in Moneymaking

The Worker positions himself in one of the stalls, and the Flower stands shyly behind him, holding his waist. Solemnly the Worker empties my coins into a bowl, then begins pouring them back and forth from one bowl to the other (below).

"Watch!" whispers Jimmy excitedly. "They are playing the dishes. They will make plenty of money!"

We watch. Very closely. After twenty minutes the Worker stops, perspiring. We count the change in the bowl.

"How much did I give you?" I ask Jimmy.

"Ten dollars."

"And how much do you have now?"

"Ten dollars!" answers Jimmy. He makes no move to return it.

"Then you've made ten dollars!" I exclaim. "Off us!"

Jimmy is triumphant, and the Worker modestly shuffles his feet in the dust.

From the money factory, we head west to the government station of Maprik. On a steaming-hot Friday night we are slaking our thirsts with chilled beer at the bar of the Maprik Hotel. This is the watering hole for the lean young Australian patrol officers, who gather here each weekend as a respite from their lonely lives in the bush.

"Big initiation ceremony coming up at Iahita," an officer calls over to us. "Probably the last such sing-sing there anyone will get



"Playing the dishes," cargo cultists in Marambanja "make money" by pouring coins back and forth between bowls. Occasionally a stash of money is "found" nearby, reinforcing members' belief in the efficacy of their efforts. Government officials try to discourage such activities, since cult members often abandon normal occupations in their mystic strivings after cargo.

to photograph. Tell Don Tuzin I sent you."

On Saturday morning we drive to the village of Ilahita along an incredibly rough track, praying that it won't rain. Otherwise we might never get our vehicle out. Don Tuzin, a tall, intense-looking American anthropologist, meets us at the end of the trail. He has been living here almost two years. Don leads us to the haus tambaran, around which the activity is centered.

The ceremonial house is as breathtaking as any cathedral: a graceful triangular spire soaring above the coconut palms, with a facade of painted bark panels (below, right). "Come and take a look inside," invites Don.

We duck through a low opening and stand in the womblike interior. As my eyes adjust to the darkness, I gasp. About a hundred painted, larger-than-life wood figures are ranged shoulder-to-shoulder along the walls (page 370), gazing mutely at another huge gallery of painted bark strips.

Don says, "I figure it has taken around ten thousand man-days to prepare all this, so you can understand why the men don't repeat the ceremony often. In fact, they say they can't afford to do it again. They've lost too much money already on their cash crops of dry rice and coffee.

"This haus tambaran has been built for the spirits to live in. At night the men play sacred bamboo flutes to make the women and children think they're hearing the spirits' voices. And those who are being initiated into the tambaran cult tomorrow believe they are going to meet the spirits."

Early next morning men from neighboring villages carry in valuable carved shells, slung on poles. That creates considerable excitement; everyone gathers to admire the shells before they are taken into the haus tambaran. The haus itself is guarded by human "spirit figures," impassive as sphinxes and magnificently attired with headdresses, leaves, and shell ornaments.

In the sweltering midday heat, several men in long body masks have been roaming around the village frightening the women

and children. Now they come bounding into the clearing before the spirit house. A chattering stream of women follows them, balancing pots of food and net bags bulging with cooked yams and sleeping babies. Women have been barred from this area for months; at last they can crush excitedly around the arena to watch the action.

"Male chauvinists!" scoffs Barbara. "The only reason the women are allowed here now is because the men need them to show off to."

"Look out!" I cry, as the crowd of women suddenly scatters.

The initiates, scores of them, are charging toward the haus tambaran, which is guarded by the initiators. A furious mock battle ensues, and the attackers are repeatedly driven off with ferocious howls and jabbing spears (pages 368-9).

Finally the initiates are ordered to crawl into the haus tambaran. Several women begin

Keeping a respectful distance, women and children of Ilahita gather around a haus tambaran as their menfolk prepare for initiation into the traditional spirit cult. Colorful modern dress reflects outside influence.



sobbing, and Barbara hurries over to comfort a small boy who is screaming hysterically. "He thinks his father is being gobbled up by the spirits inside," she reports back.

"What does go on inside?" I question Don.

"The initiates are doused with ashes and foul-smelling magic water intended to turn them into men old enough to keep their cult's secrets. Then they're shown the sacred objects. Afterward they'll creep out the back entrance, so the women can't spot them, and run down to the river to wash."

Eerie Tones Mourn a Child's Death

Ceremonies over, we return to the Sepik and fly to the patrol post of Ambunti. I am fascinated by the river, coiling like a gigantic brown serpent across the swamp-fringed plains. At Ambunti our friend and guide Nggaru meets us. Immediately we transfer our camping gear and supplies into his canoe

and motor upstream to his village of Yambon.

Once there, I sense something unusual going on. Nggaru smiles enigmatically, points at my tape recorder, and says, "Be ready."

It is past midnight when I am startled awake by a haunting noise that curdles my blood. It comes from the other end of the village. Barbara mutters in her sleep and rolls over on her air mattress. But I am intrigued; I unzip my mosquito net, setting off an excited whine from the waiting insects. Lighting the kerosene lamp, I grab my tape recorder and cameras and stumble down the path toward the source of the noise.

Nggaru somehow knows I am coming, for his slender figure appears at my side and guides me into the haus tambaran. I seem to be gazing into Dante's Inferno. The place is full of smoke, to drive off the mosquitoes, and by the flickering firelight I can see two

(Continued on page 372)

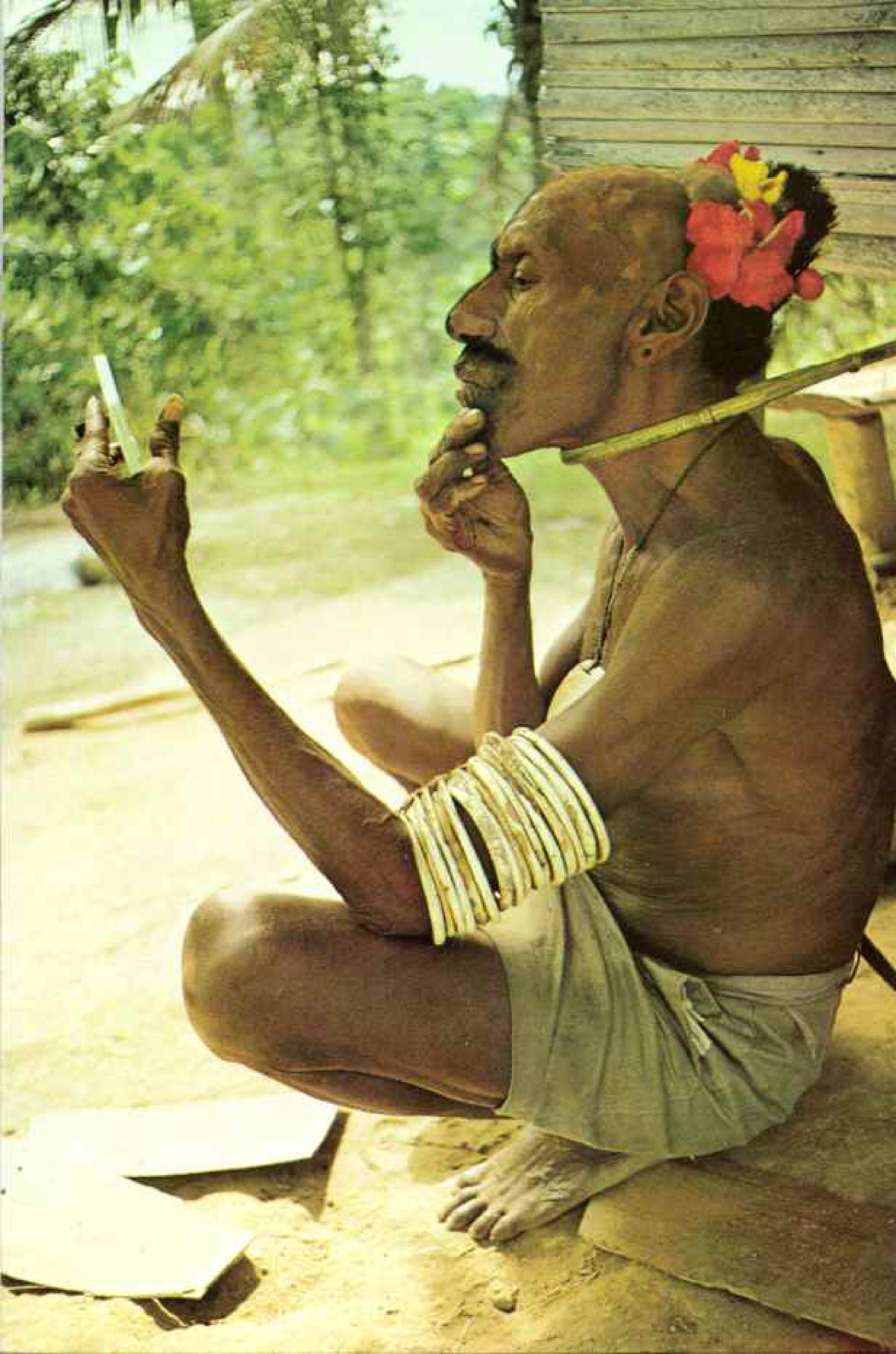


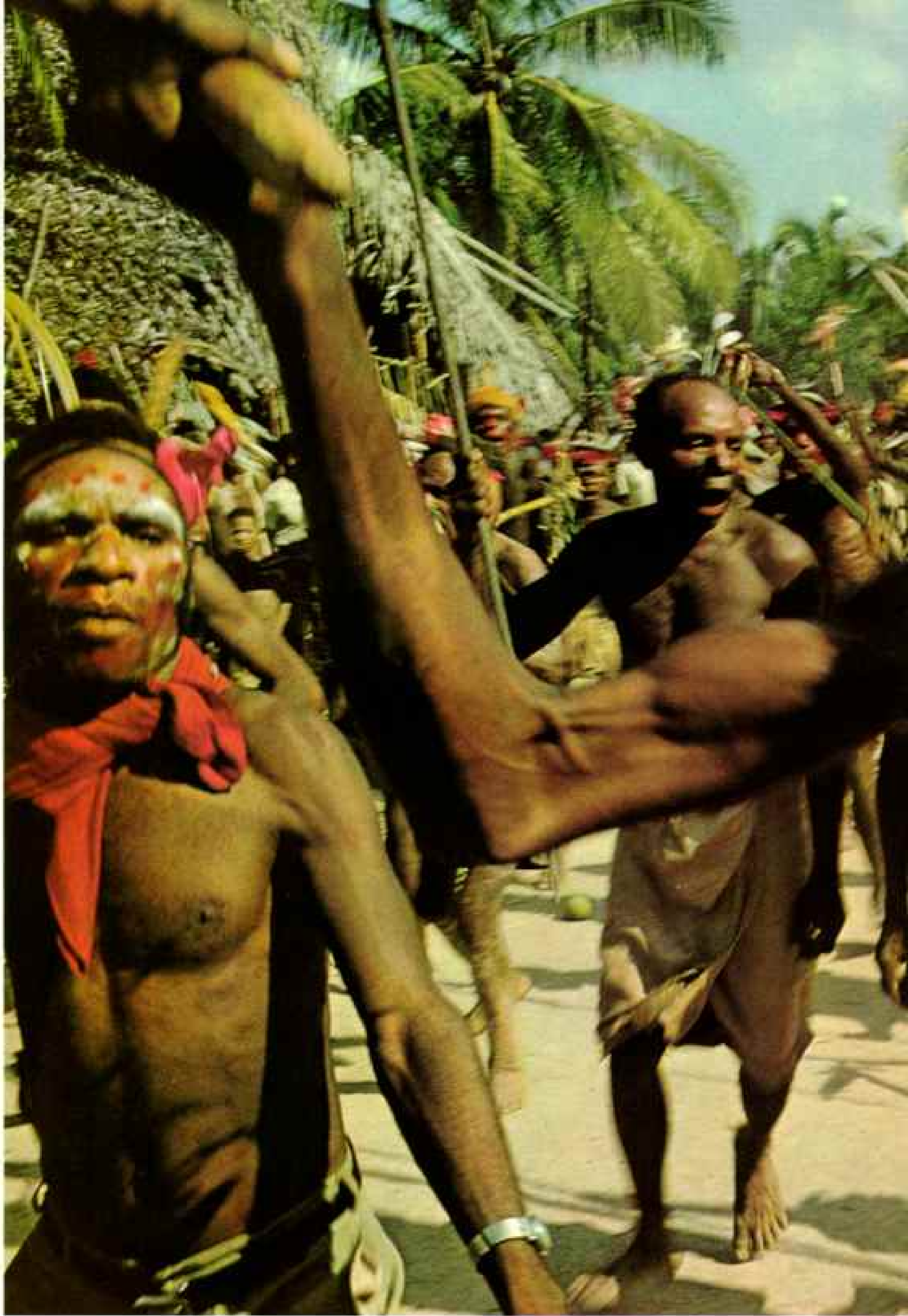


BARBARA GINN (ARIVE)

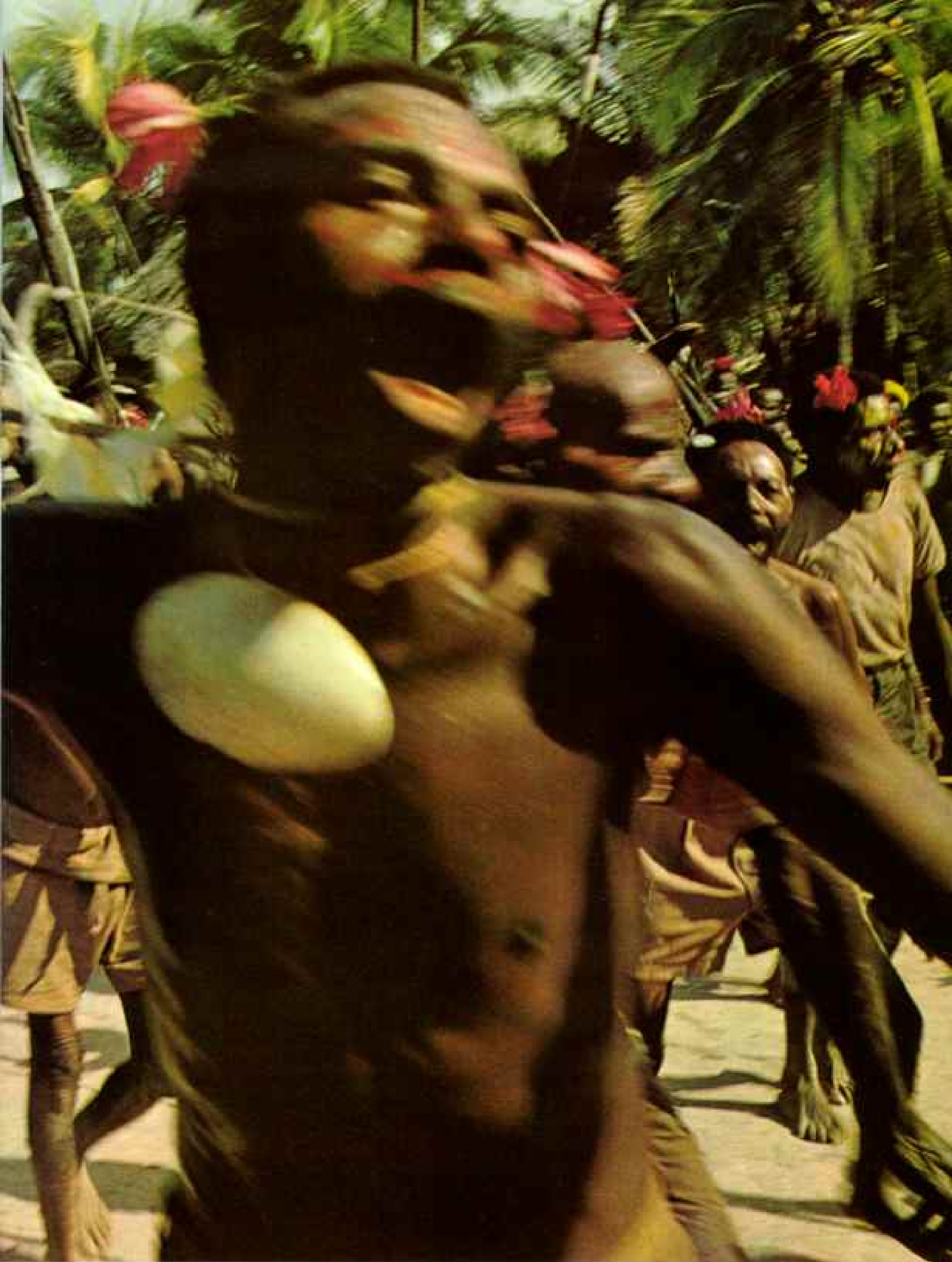
Style makes the man as elders in the spirit cult don makeup for the long-awaited initiation ritual. So infrequent are these ceremonies that many middle-aged men observed by the author had their first—and perhaps last—chance to participate.

Flotsam of the white man's world mingles with traditional elements in costumes and decoration. A piece of red plastic (above) fits nicely into a headdress adorned with cowrie shells; red and yellow earth hues complete the color scheme. Viewing the ritual through sunglasses, a villager (left) decks his Australian hat with bright blooms and cassowary feathers. A trade-goods mirror (right) prompts a bit of primping by a man wearing an ornamental bamboo neckpiece.





Mock melee during initiation rites in Iahita whips spear-flailing tribesmen into a near frenzy. A shell pendant gyrates wildly from one participant's neck. Repeatedly the initiates "attack"



elders guarding the haus tambaran. Each time, amid much simulated slaughter, they are driven off. At last the defenders relent, allowing the initiates to enter and meet the cult spirits.

Dispensing terror, masked tribesmen garbed in costumes of shredded sago fronds and collars of fruit (right) guard secret rites in the haus tambaran. These "spirits" often break into swaying dances, sending quivers through the watching crowd of women and children.



Carvings bigger than life line a wall (above) in the haus tambaran. Each represents a cult spirit, which lives inside it. Meeting these spirits and viewing the sacred flutes and drums mark the high point of initiation rites.



Ducking into the unknown, initiates enter the haus tambaran through a crawlway at the base of the soaring facade. Grave warnings of what might befall them if they reveal any secrets keep each in a state of anxiety. After the rite, the men—grinning sheepishly—feast on pots of food left by their women, who intended them for the spirits.



swaying demoniac figures blowing into long bamboo tubes. At last I understand. They are playing the sacred flutes.

I sit down, enthralled. No wonder women and children think these are the voices of the spirits. It's like sitting in an empty church in darkness while an invisible presence plays Bach on the organ. It stirs me, this incredibly spiritual experience.

"We are playing because a small girl died several moons ago," whispers Nggaru. "But you must never talk about what you see tonight. You can use your tape recorder, but you must take the music back to America. No one in New Guinea must hear it, or we will get sick!"

It suddenly occurs to me that the religion of these people has a body and a soul. The body may die eventually under the impact of our Western ways. The music of the soul will remain alive and vibrant, whatever happens.

Next morning, Nggaru slips furtively into our hut with his wizened old uncle, Ndjam, and fastens the door.

"Ndjam wants to listen to the..." he breaks

off to make sure no one can hear us, "...to the bamboos!"

Wearing a pair of my large earphones and looking like a wrinkled gnome, Ndjam listens intently to the recorded flutes, his head nodding in apparent satisfaction. Presently he turns and mutters to Nggaru.

"Ndjam asks if you like to make tape recordings of the *garamut* drums tonight," Nggaru translates. Of course we do.

There are seven slit drums of varying sizes in the haus tambaran. As Barbara and I set up the recording equipment, Ndjam gives final instructions to the seven men who will play them. At last he is ready, and there is a hush. He chops the air with his hands, and the silence is split by the rapid beat of fourteen pounding drumsticks.

Ndjam, normally a taciturn old man, is transformed into a bolt of energy. His arms gesticulate wildly, his crinkly hair is thrown into a dark blur, and when someone misses a beat, he scowls and shakes his head and paces menacingly toward the offender.

Eventually he cuts the air crisply once





Leader of a nation-to-be, Michael Somare guides the diverse tribes of his country toward mutual tolerance, self-government, and independence. Behind Papua New Guinea's Chief Minister hangs the national emblem, a bird of paradise perched atop a *kundu* drum and ceremonial spear.

Lesson in democracy: A woman of the Sepik River village of Avatip points to the candidate of her choice (left) on a ballot for delegates to the national House of Assembly. Australian and local administrative officers assist in the transition to self-government.

For the future, a common language. A young member of the Voluntary Service Overseas—a British version of the U.S. Peace Corps—Linda Rogers teaches at a Catholic mission school in Kapaimari. Here students learn English, the official tongue of Papua New Guinea. In a land whose people speak more than 700 languages, pidgin English has served as a lingua franca for decades.



more with his arms, and the final roll of thunder softens to a heartbeat, then abruptly ceases. Ndjiam's body falls limp, beads of sweat tremble on his brow, and his tiny rib cage heaves convulsively.

"I feel as though we're at a concert at the Philharmonic Hall with Leonard Bernstein!" exclaims Barbara. The powerful performance leaves me too moved to reply.

Art Inspired by the Spirit World

We were introduced to Ndjiam and Nggaru by Douglas Newton, Curator of the Museum of Primitive Art in New York. Douglas has made several visits to the Sepik River region to study and write about its art and mythology. As with its soulful music, this inspiration springs from the people's deep belief in the spirit world.

Surprisingly, although Western dealers and collectors have been scouring the villages for half a century, several great masks and figures still remain. We discuss this one humid evening with Wayne Heathcote, cooling ourselves with ice-cold drafts of beer aboard



Grisly relic of headhunting days, a man's skull—trophy of some long-forgotten ambush—stares with startled shell eyes. Clay, paint, cowrie shells, and tufts of human hair create a semblance of the original features.

Such heads were popular souvenirs in decades past—until the administration banned their export after World War II.

the houseboat he operates out of Ambunti. Now about 30, Wayne came to New Guinea from Australia as an 18-year-old patrol officer, quit to open up a trade store and deal in crocodile skins, and today has cornered a large slice of the lucrative tourist business.

"These ancient carvings are tremendously important, especially to the older people," he says. "The older people believe that if they sell them, they risk sickness and death. So the entire clan has a stake in them. But the younger people believe this less and less. They want outboard motors instead, which they haven't a hope of buying on dollar-a-day wages. So they agree to sell an old piece, for a thousand dollars or more.

"However, the government is now trying to prevent any material that is needed for Papua New Guinea's principal museum, in Port Moresby, from being sold abroad. Protecting the cultural heritage, they say."

Sad Search for a Lost Carving

Several nights later we make camp downstream at Korogo village. Curtains of water are sweeping over the huts in a tropical cloudburst. Flashes of lightning illuminate the river with dazzling brilliance. Amid thunder, we hear a knock at the door.

Four men stand shivering outside, their skins shining in the cold deluge. "*Sori tru, masta!*" one apologizes as we invite them inside. "Last week one misis from America buy carving belong mipela. Now pikinini got sick. Mipela like give pay back." He holds up a bag containing \$250, which they wish to return for their carving. In their minds, there is no other way to save the sick child.

Our hearts bleed for them. They have paddled several miles through the storm, thinking Barbara might be the person who bought the piece. We try to reassure them that the child might recover if they take him to a medical post. But we know we haven't convinced them. With distraught faces they turn back into the storm, and begin the wearying paddle home.

A few weeks later we pass through their village, and I ask what happened to the child.

The village councillor points to a small boy splashing happily in the water. "We sacrificed some pigs, and he recovered," he explains.

The various mission stations along the Sepik River, Catholic and Protestant alike, are playing a large role in changing the old

ways and beliefs. They established a network of village schools long before the administration did, and through their numerous churches they preach the power of Christianity over paganism.

"But soon after I came here, I realized my role was not to convert and baptize as many people as I could. For this reason I am criticized by many of my older colleagues." The speaker is a young Dutch priest named Alphonse Ruijter, who lives at Angoram, an administrative center some 80 miles from the mouth of the Sepik. With his shoulder-length, reddish hair, unconventional approach, and easygoing manner, he is one of the most controversial figures on the Sepik.

"I think it's ridiculous in this day and age to preach sin, Satan, and hell to these people," he continues, flashing an irreverent grin. "In fact, when you come to think of it, we're almost as superstitious as they are."

"One of the main barriers to unity and progress here stems from a man's duties to his kin. For example, a man who sets up a store in his village soon goes broke—his relatives remind him of his tribal obligations to share goods, and strip the shelves bare."

"Another difficulty is the educational system. In my opinion, these kids don't need to know algebra and geometry; they need to know how to fix an outboard motor."

Priest Hopes to Aid Teen-agers

Pouring tea in his untidy living room, the priest tells us about a project that he hopes will start to break down these barriers.

"I'm raising funds to set up a vocational school and a community center a couple of miles north of Angoram. Good grassland, no swamps. The administration has bought it for us. We're going to attract teen-agers from different villages; teach them modern methods of farming, fishing, and carpentry, and encourage them to go out in groups and develop the land for themselves. Under this sort of cooperation, village enmities should disappear. And then, of course, the older people will want to come and live with their children..."

We stroll across Angoram's airstrip to visit John Benson. Formerly a teacher with the Catholic mission, he now sells new carvings in the Angoram council house, which he rents from the local native council. By encouraging talented young men to carve, and by sharing the profits with them, he is one of the very

few traders genuinely working with the natives rather than exploiting them.

"Angoram looks peaceful enough on the surface, doesn't it?" he says softly, gesturing with his arm at the scene. His rotund figure is ensconced in the shade of his veranda. Below us a row of native huts and stores lines the river's edge. A parklike slope leads up past the stalls of the native market to the Angoram Hotel, and the cluster of European-style houses around the airstrip.

"Here we are, a small white community of traders, government officials, and missionaries. You'd think we'd all get along famously. But it's a miniature Peyton Place! All sorts of hatreds and heated passions boiling underneath. It's the perfect place for the local people to get a really good look at us!"

Warfare Yields to Commerce

In their own villages, Sepik people are congenial, the men scrupulously democratic. During debates any man may stand and air his views, no matter how unpopular. A man rises to leadership by wisdom and power of speech. Elders are revered as statesmen.

Not long ago, in the days when warfare was common, one could become chief through prowess as a warrior. Men spent much of their time in fighting, preparing for fights, and participating in the endless cycle of ceremonies. Now that warfare has been stopped and the ceremonies die out, they are searching for new roles.

Our guide Nggaru is turning into an astute businessman and politician. At meetings of village councillors in Ambunti, he bolsters his reputation for airing his views bluntly. He makes some money growing coffee, and he hires out a couple of wheezing outboard-motor canoes to occasional tourists. He tells us that he wants to buy a freezer, to export fish from the Sepik to protein-poor natives in the Highlands.

On the other hand, Yambunamb and his two sons, who are neighbors of Nggaru, are turning their carving talents into making crocodile-shaped tables for sale to tourists. And Taga'pui, once a good friend of Nggaru, is pinning his hopes on instant wealth by attending Matias Yaliwan's cargo-cult meetings. Since Nggaru is fighting to prevent the cult's influence from spreading in the village, the two have become bitter foes.

Ndjam, Nggaru's warmhearted, helpful old uncle, is inclined to brood on the past. He





The village: still the pivot of Sepik life. Doing double duty, a cigarette-smoking woman of Cham-bri village (left) busily weaves a sleeping mat while nursing her child. Women traditionally undertake many of the daily chores.

Lad romping in a visitor's shoes (below) may not follow in his father's footsteps; today young men often seek jobs in larger towns.

Houses of Tambanum (lower left) each hold several families. Stilts lift the dwellings above floods; thick thatch wards off heavy rains. To escape the Sepik's ravenous mosquitoes at night, some people sleep in huge reed bags; others use fine netting acquired at trade stores.



BARBARA KYRIE (BOTTOM AND TOP LEFT)

remembers the Germans who ruled here before the Australians replaced them in 1914. He recalls those days with nostalgia, but with questionable accuracy.

"The Germans had ways like our ways," he says, sighing. "Once they came with us when we attacked another village. We killed many people together. Afterwards they brought us to their camp at Ambunti, and we made a big sing-sing.

"But the Japanese—ah, they were bad men," he adds fiercely, spitting a red jet of betel-nut juice through the door of his hut. "In the big war with Australia they bombed our haus tambarans. Some Japanese soldiers made a camp not far from here. When they were hungry, they killed our pigs and drank

the blood of our chickens like soup. They even ate other men."

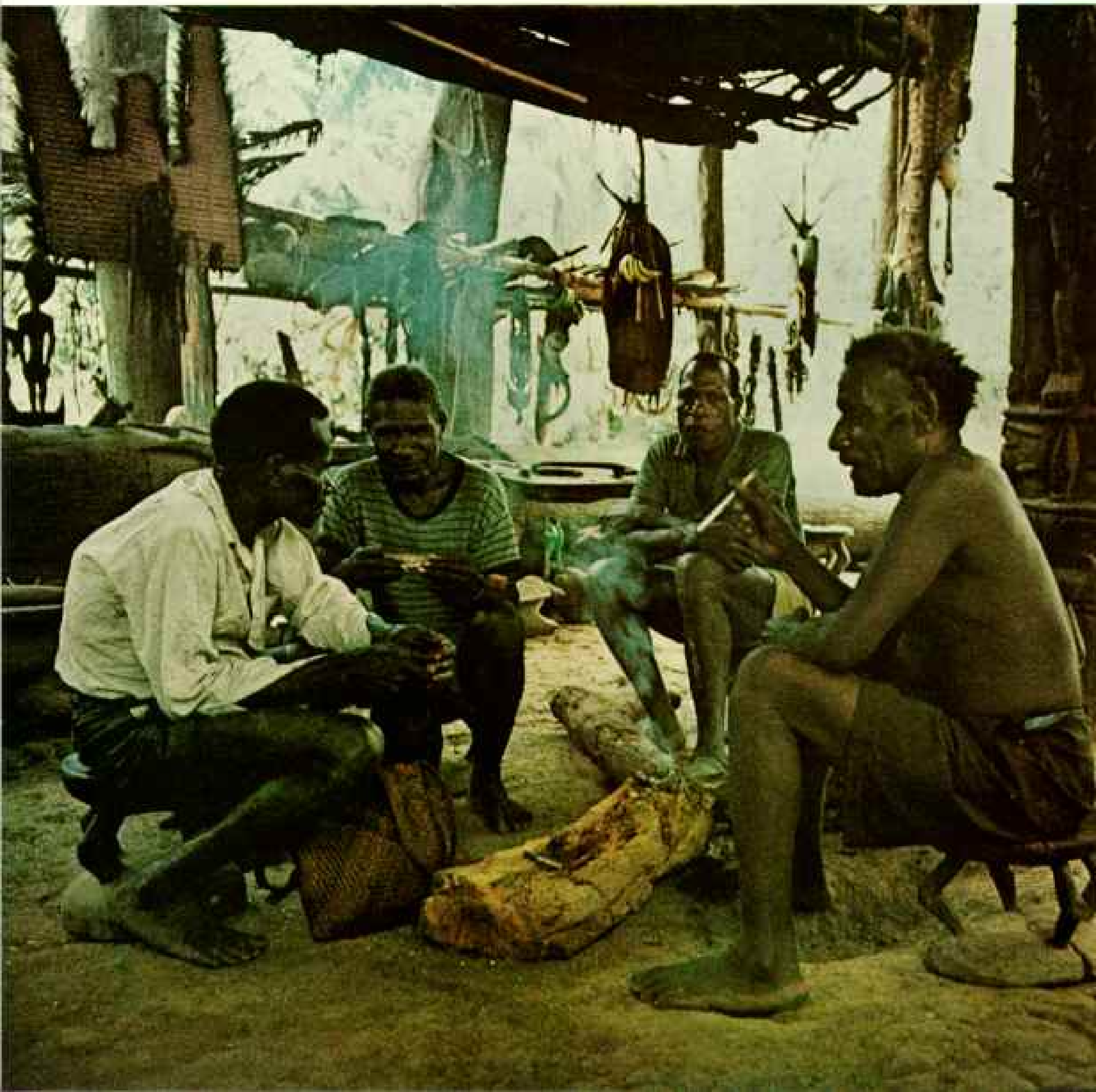
"But your people ate other men too," I remind him.

"Yes, but we cooked the flesh," he retorts indignantly. "The Japanese soldiers ate it raw!"

Yambon Extends a Friendly Welcome

We have a special warmth for our friends in Yambon, who have accepted us into their lives almost as if we belong here.

It is nearly dusk as we stroll homeward beneath the coconut palms by the river's edge. The harsh brilliance of the water has mellowed to burnished gold. A lanky tribesman perches on the edge of a new canoe he



has been hollowing out with an adz from the trunk of a cedar tree. "Going to spear eels in the morning," he says with a grin.

His wife is standing waist-deep beside the river's bank, where she has just set some conical fish traps between a row of bamboo stakes. She is washing her uncomplaining baby, splashing the silty water over the infant.

Beyond her lies the broad sweep of the Sepik, fringed by the tall, delicate tracery of pit-pit grass. In the distance rises the faint blue outline of mountains, where the Sepik begins its long journey to the sea.

Threading between floating debris and sucking whirlpools, the dugout canoes silently glide home: women, with their children, who have spent a tiring day under the

blazing sun—fishing, making flour from sago palms in the swamps, or gathering firewood. Now they must start cooking for their men-folk, who are comfortably relaxed and chattering among themselves.

"Maybe we Europeans have got our roles all mixed up!" I tease Barbara.

She tosses her hair. "Well, it's obvious who keeps things going in *this* society," she retorts. "The men wouldn't know what to do without the women. Perhaps that's why they try to keep the women out of their debates and ceremonies. They've got to do something that makes them feel important, after all!"

We have invited Nggaru and his wife, Monica, to join us for dinner. Afterward, Barbara teaches Monica how to sew an



BARBARA HAY (1971)

Caretakers of a dying tradition, men of Kanganaman smoke twist tobacco and talk away the afternoon in their haus tambaran. Only sacred flutes and a few costumes remain hidden in the loft above. Craft items, purely for tourists, line the interior. For a dollar or two, the men may exhibit a spirit-figure costume similar to the one pictured in Parambei village (above). Then they return it to storage with other relics of the fast-crumbing past.

attractive dress from some material we have bought in Ambunti. I talk to Nggaru about the future. "What will happen if the Australians should leave?"

His answer is mixed. "Self-government is good for us," he replies thoughtfully. "Michael Somare, our Chief Minister, says on the radio that he wants the Europeans to share their businesses with us. It is not right that the white people make so much money. We work hard, and we get paid a dollar for one day. If we complain, we get fired.

"There is a rich mining company up at the April River. They have helicopters and boats and plenty of money. They camp on our people's land. They cut down trees and dig holes in the ground and spoil the hunting. They bring in workers from the coast, because they say our men will go home when they are tired. And what do our people get? Nothing!" His eyes flash with bitterness.

"The white people do not understand us. But they have built schools and roads and medical posts for us. We need more. I am afraid that if the Australians leave," Nggaru concluded, "everything will fall down, and our people may start fighting again."

Waiting for the Clouds to Vanish

I am thinking of such things a few days later at Kopar village, which stands like a lonely sentinel beside the sea at the blustery mouth of the Sepik. Hoary-headed Anjom, at 70 or so the oldest man in Kopar, gazes out to sea with us. He clears his throat. He has a story to tell.

"Long ago, our original ancestor-mother gave birth to a son. She hid the child in a coconut shell, along with colored paints from the earth, and put him on an island that was floating out to sea.

"Later, Akambep the Sun hatched out of the coconut shell, and the sea carried him to the land of the white men. There he taught them all the magic they now know, how to make outboard motors, how to be rich.

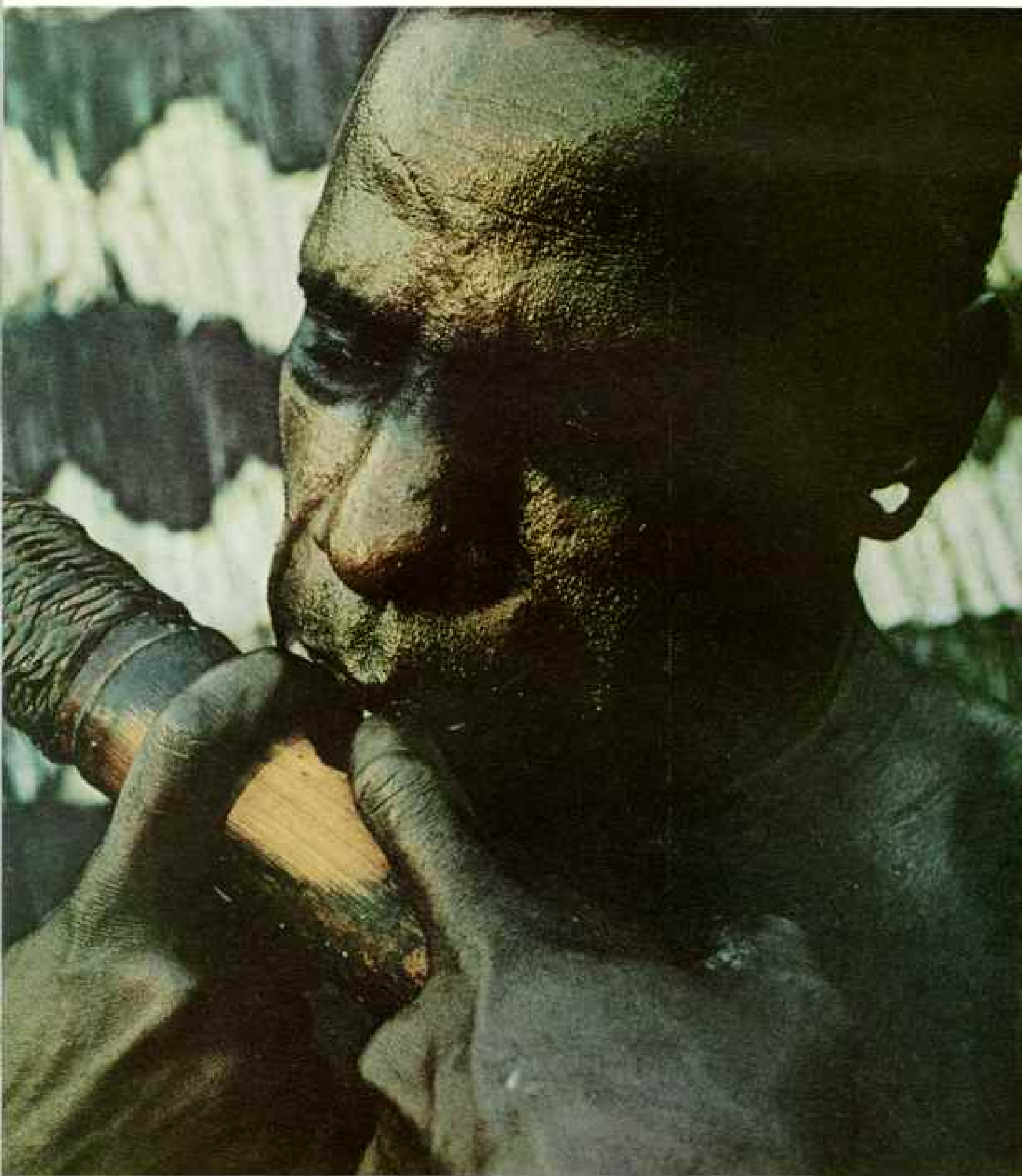
"Then Akambep the Sun climbed up into the sky, and painted his rays with the colors his mother had left him. He wanted his brothers and sisters in Kopar to see him, so he could teach them the magic also.

"But the clouds hid him from us, so we never found out. Only the white man knows." Anjom shakes his old head sadly.

"Be patient," Barbara tells him softly. "Look! Those clouds will soon go away." □



"Music of the soul"—thus author Kirk describes the ghostly pipings of a sacred bamboo flute played by a tribesman in Korogo village. Head of a crocodile adorns



one end of the single-stop instrument, whose eerie strains are said to be the voices of spirits. As outer trappings of the old culture are sold, discarded, or lost to memory, the

music happily remains—resonant with the traditional meanings and evocative of a way of life that fades inexorably from the shores of the Sepik River.





Last Stand for the Bighorn

ARTICLE AND PHOTOGRAPHS BY
JAMES K. MORGAN

IHUNG ON with my left hand and leaned far out from the skid of the helicopter. Snow whirled away from the rotors as the ground sped by. I tensed as we closed with the fast-running bighorn ewe just below. *A little closer, I breathed. Now!*

I dived headlong from the speeding helicopter, aiming for where I thought the bighorn would be when I arrived. We collided with a swooshing jolt, went down in a tangle of flying legs, and tumbled into a kicking, end-over-end roll down the steep hillside.

Clinging to the struggling 150-pound animal, I gave pilot Ron Shane the "all's-well" signal. He grinned. We had proved it possible to capture a wild

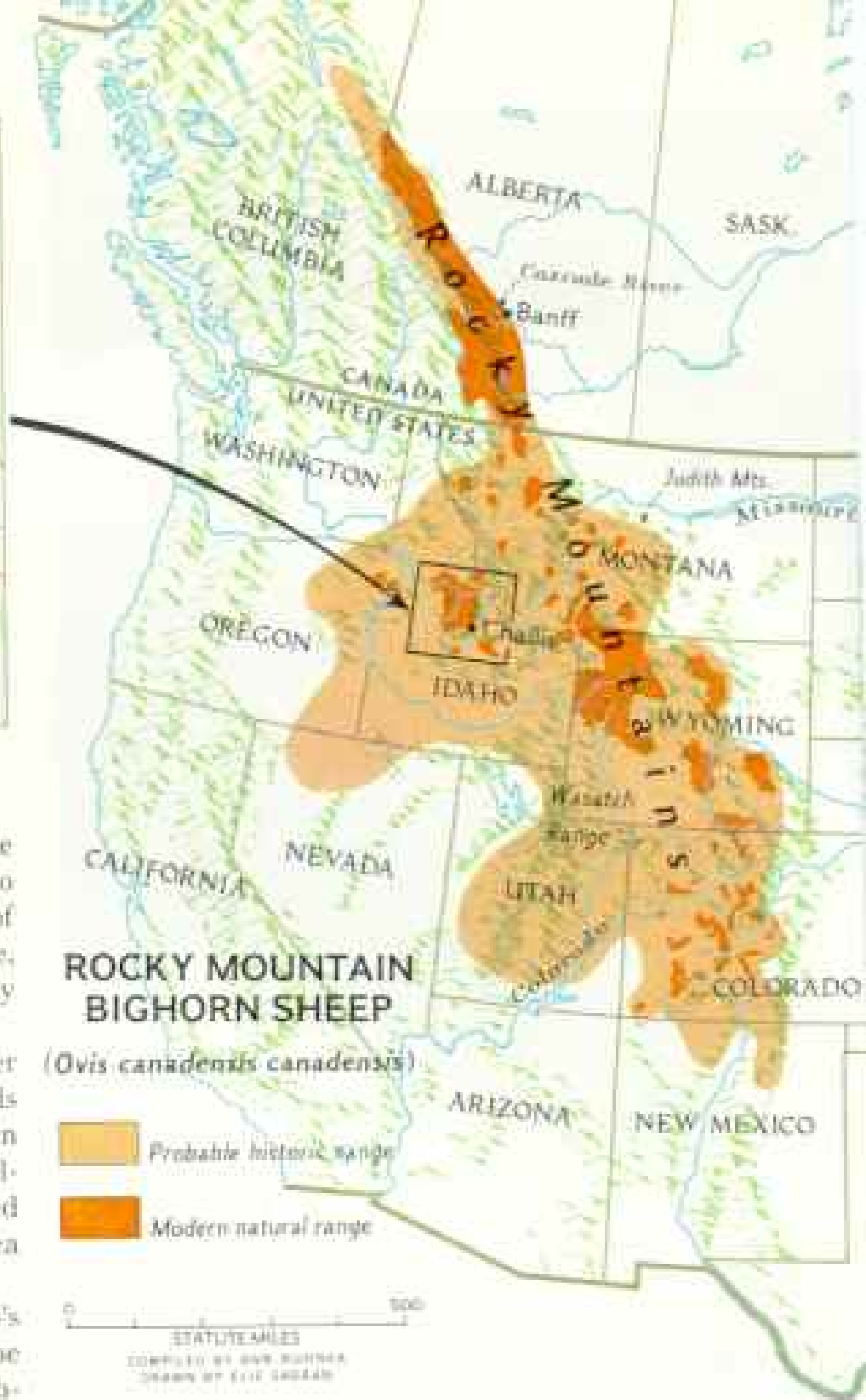
Wilderness monarchs still roam amid the grandeur of Cascade Valley in Canada's Banff National Park. Massive horns and keen eyes protect Rocky Mountain bighorn sheep from all their enemies but man, whose continued overuse of the land drives them ever closer to extinction.



Realm of the Rocky Mountain bighorn once stretched from British Columbia to New Mexico (right), and the sheep grazed by the hundreds of thousands. Now, diminished by hunters, disease, and competition from domestic foragers, they survive in only a few pockets of wilderness.

No one knows how many exist today, but fewer sightings are reported each year, as remnant bands follow their traditional migration routes between the highland ranges of summer and winter's sheltered foothills. Author James K. Morgan studied the animals' decline in the Salmon River area (above).

Should this alarming trend continue, Idaho's only reminders of its once proud herds may be Indian petroglyphs (below), rock carvings probably fashioned by tribes that depended on the sheep for meat, clothing, and tools.



Rocky Mountain bighorn sheep by diving on it from a helicopter.

The mechanical bird swooped away, heading for base camp to pick up my assistants and the telemetry gear I would need to instrument the bighorn. While waiting for it to return, I held the ewe firmly, calming her, and reflected on the century-old series of historical events that had brought us together on this windswept Idaho mountain.

There are far greater threats to *Ovis canadensis canadensis* than plummeting biologists. Victim of an ever-shrinking habitat, the Rocky Mountain bighorn sheep—like the four other American bighorn races—is in danger of becoming extinct.

The story begins—and perhaps ends—with grass: vast shrub-sprinkled grasslands that once carpeted multitudes of high mountain valleys and slopes of the Rockies.

Before the white man came to the West, a diversified animal community inhabited those



DAVID SHACKLETON

Too close for a long lens! Biologist-author Morgan meets three Banff National Park rams tamed by a fellow biologist for research purposes. Climaxing a five-year study of bighorns, Morgan concentrates now on photography.

productive grasslands. Burrowing animals rooted and aerated the soil. Eagles, weasels, hawks, and coyotes pursued the burrowers and the fleet-footed cottontails.

Flocks of male sage grouse acted out their ritual displays on traditional spring mating grounds as ancient as the grasslands themselves. Scattered bands of sharp-tailed grouse danced amid herds of bison that followed the new green grasses upward in the spring. Pronghorn, elk, and mule deer roamed the valleys to feed upon shrubs and golden sun-cured grasses during the cold harsh winters.

Livestock Ravaged Pristine Meadows

Trapping and mining brought the first white men to the western mountains. But the grass brought the permanent residents. Huge herds of domestic cattle were trailed up the Missouri River in search of the tantalizing golden pastures. Legends were created and fortunes made as entrepreneurs and their

livestock flooded the western rangelands, from the Judith Mountains of Montana to the alpine meadows of Colorado.

At first the grass seemed forever. Armed with no knowledge of plant physiology, ranchers believed that grass always rejuvenated itself following grazing, and any not eaten by livestock was wasted. But the overgrazed grasses rapidly began to disappear. Competition between cattle ranchers and sheepmen intensified, and by the early 1900's great herds of livestock sent dust pluming into the sky as they moved across the nearly denuded land.

The impact of livestock was catastrophic to mountain grasslands unable to cope with the hordes of cattle, horses, and sheep. The grasses, aristocrats of the mountains, were nearly destroyed, allowing the hardy native sagebrush to spread relentlessly. Unprotected soil washed away to clog the rivers below, taking with it the nutrients of ages and the potential of tomorrow.

From the foothills of Utah's Wasatch Range to the remote valleys of central Idaho, the diversity and stability, and much of the productivity, of the grasslands had been traded for monotonous sagebrush expanses.

The bison were gone and the number of sharp-tailed grouse had been drastically reduced. Cougars, coyotes, bears, and bobcats were shot, poisoned, and trapped, largely because of their presumed threat to livestock. Elk were hunted to extinction in the valleys, leaving only a few wary mountain bands. Pronghorn and sage grouse were confined to unwanted corners. Prairie dogs and hawks were ruthlessly destroyed. Grizzlies vanished from all but a few inaccessible spots.

Rocky Mountain bighorns, because of their dependence on the grasslands as a food source and their limited ability to adapt to new conditions, best reflect the ravages of overgrazing. Ages of togetherness had shaped them to almost total reliance on grass. The long dependence had cost them the ability to switch to new foods or to colonize new areas. They suffered massive losses in the late 19th and early 20th centuries.

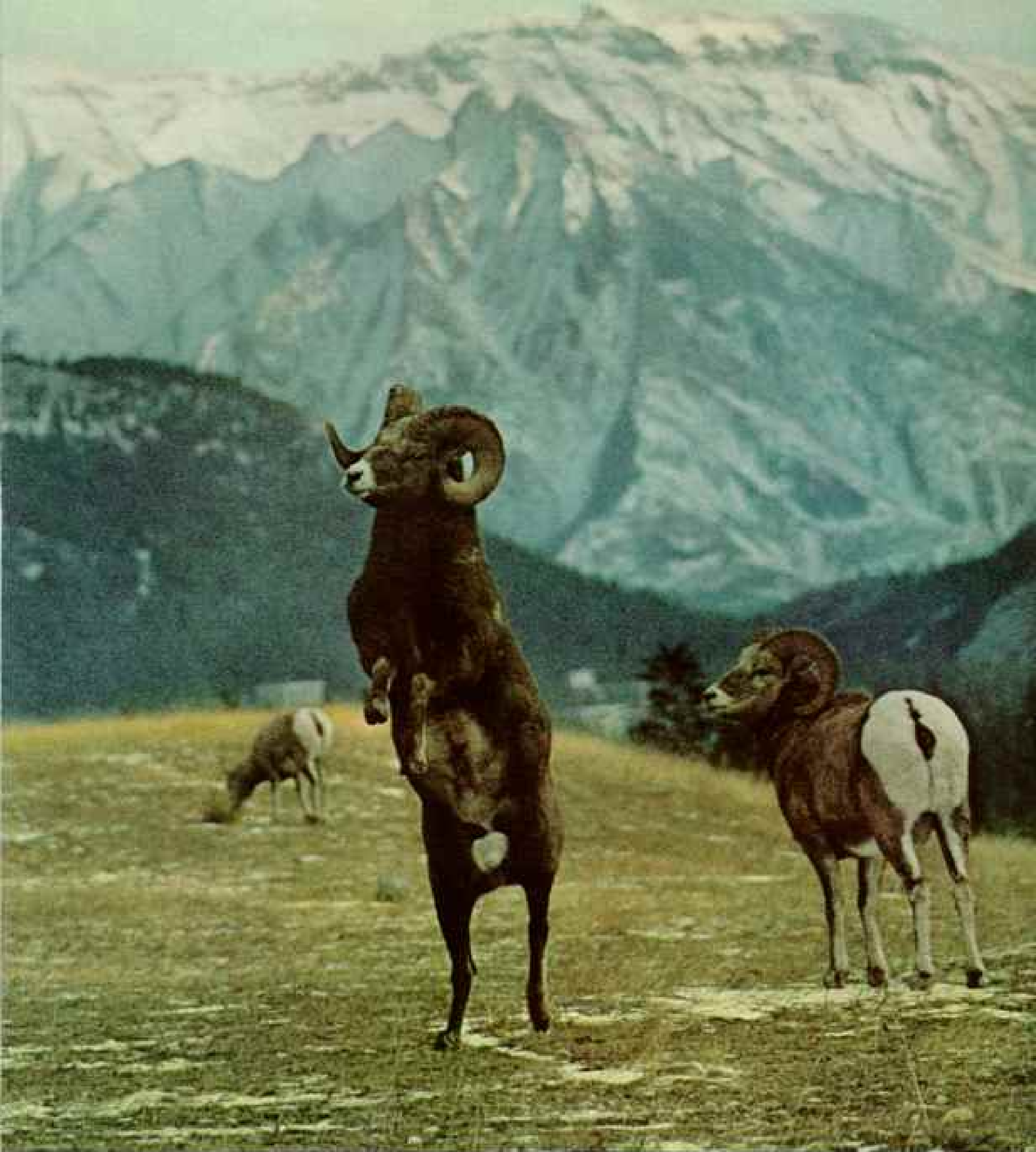
Market hunting and diseases introduced by domestic livestock took their toll, but the deterioration of the grasslands, I feel, was the major factor in reducing the bighorns to scattered remnant herds.

Agency Formed to Control Land Use

The Bureau of Land Management, the agency today charged with the responsibility of administering public lands in 11 Western States, inherited a monumental problem when it was formed in 1946. Fertile bottomlands had been homesteaded and higher tree-clothed mountains set aside as national forests, leaving the bureau in charge of the intermediate foothill lands. All that acreage had already been overgrazed, and 80 percent had been taken over by sagebrush, shrubs, and weeds. And the bureau had 50 range administrators to supervise 180 million acres!

Faced with the need to restore and improve these public lands, the fledgling agency developed seeding and shrub-elimination programs to correct foraging damage, but did not adequately reduce grazing. Recovery has been gradual, and even today about 30 percent of the public rangeland remains in poor condition and suffers from critical erosion. Most is slowly improving, but at least 15 percent of the land is in a declining trend.





Toe-dancing duelists face off during the rutting season (above). Dropping to all fours, rivals eye each other (left), then rear up again and charge, meeting in classic horn-splintering clashes (following pages). Such bouts establish the male butting order so basic to bighorn life. A frequent winner gains leadership of the herd and usually gets the pick of breeding females. But dominant rams must wage more fights with youthful challengers, and consequently can expect shorter life-spans than also-rans.



CRACK! Armored heads down, bodies thrusting at full speed, 250-pound rivals collide horn against horn with an impact that can be heard a mile away. Again and again they charge like jousting knights, until one of them abandons the battle.

Thick facial hide and a porous double-layered skull cushion the combatants during such head batterings. Even so, victors and vanquished soon wear the nose scars and blunted horns that mark veterans of past campaigns (right). Such contests also exhaust much of the rams' stored fat, increasing the risk of starvation in the winter.





The range of the Rocky Mountain bighorn continues to shrink. The initial decades of heavy livestock competition left herds of the mountain dwellers broken into small isolated bands, many of which subsequently disappeared. Others, unable to cope with change, are even now dying off in those areas where the cattle and sheep industry drastically altered the grassland ecology.

It was one of these still-declining herds that brought me to Challis, Idaho, in 1966. The Idaho Fish and Game Department, aware that the Morgan Creek herd in Idaho was dwindling, had hired me to try to determine the reasons for the decline and to seek solutions. In those days I hadn't made the

connection between diminishing herds and overgrazing. That was to come later in the five-year study. In the early stages of my work I was concentrating on a trapping and tagging operation to seek an understanding of migrations and movements.

Electronic Devices Aid Observation

Arrival of the helicopter with my telemetry equipment brought me back to the present. I grinned with satisfaction. By attaching radio transmitters to selected bighorns I could soon be unlocking the secrets of their migrations.

Assistants held the ewe as I fitted a collar with a loop-antenna transmitter around her neck. When I released the bighorn, she lay



Close companions when not in rut, rams travel in bachelor bands during most of the year and nuzzle or rub other rams, especially those larger and more dominant. Males take no part in rearing and protecting the young.

watching for a moment, suddenly realized that she was free, jumped to her feet, and bounded off down the mountainside.

The use of modern techniques and equipment, such as telemetry and aircraft, greatly increases the amount of data that can be collected in a given period. But the means to real understanding of wild animals is spending time with them.

Bighorns Seek Fire-blackened Areas

I trekked the winter ranges daily, trying to be a part of all that occurred. Bighorn locations, behavior, food habits, and interactions with other animals were all recorded in my field notes. During the summer I stocked three base camps with provisions and traveled from camp to camp, searching for the widely dispersed bighorns or following them as they moved from one glaciated basin to another. The mountains caught me up in their dusky blue splendor, and I enjoyed every moment spent there.

By the end of the second year's study certain patterns of bighorn life were becoming apparent. The sheep were summering in the Idaho Primitive Area at about 9,000 feet, spending most of their time in the vicinity of high mountain lakes, associated meadows, and burned-off areas. Burns were preferred

for feeding because fire had removed the spruce and fir overstory and released a proliferation of tender new grasses, herbs, and sedges.

From the bighorn sheep's viewpoint, fire is a constructive force; to some extent, the herds depend on fire for survival. If some areas aren't periodically burned, the grassland will dwindle and the bighorn habitat will shrink. Also, on winter ranges fire apparently kills a species of snail that harbors the intermediate stage of the lungworms that infest bighorns, predisposing them to pneumonia.

Summers are so short in the high country that I wasn't always sure there had been one. One year there was a four-inch snowstorm in June, followed by an eight-inch snowstorm in August.

The first heavy snows of autumn find the bighorns migrating from summer to winter ranges. Most years the first substantial snows arrive in October, and bighorns indulge in a leisurely downward drift that brings them to lower ranges in late October and early November. Some diehard individuals, apparently reluctant to leave the high pastures, straggle in as late as December.

The migration of the bighorn is a complex and fascinating mixture of social and ecological traditions. Parts of the Morgan Creek herd summered near Sleeping Deer

Mountain and wintered 26 airline miles away, near Challis. The trek was made twice a year over rugged mountains and deep valleys, along routes followed by bighorns for centuries. Dr. Valerius Geist first provided evidence that young bighorns learn traditional migration routes by following their elders. In some cases a bighorn will learn more than one route as it hooks up with different bands during its younger years, before group attachments become fixed.

Migrations show a strong tendency to follow ridgelines, and the bighorns often travel single file when moving from one place to another. I discovered that if I sat and watched the trail along the crest of one ridge, a group of bighorns would file by every day or so during the month of October. They seem more comfortable when in sight of rocky escape routes.

The migration tradition, passed on from generation to generation for centuries, benefits both bighorns and their limited winter ranges. Bighorns become highly susceptible to disease and parasite infestations when crowded together. They disperse as the vulnerable new grass shoots appear in the spring, and are gone during the critical early growing season of the grasses. They return in the fall to graze the leaves of already dormant grasses that are little harmed by grazing.

In a sense, the pattern of bighorn migration is more important than the bighorn itself. If a particular herd becomes extinct, one might think that a nucleus herd could be trapped elsewhere and transplanted to restock the vacant range. But the migration tradition, once it has been lost with the original herd, may easily be lost forever, crippling the future of bighorns on that particular range.

Youngsters Rely on Old-timers

Young bighorns will follow only adults, from whom they learn the way of migration. Thus animals transported to unpopulated regions can neither learn nor teach migration routes until—and unless—they develop their own. Instead, the newcomers often confine themselves to small areas and suffer losses from overcrowding and overgrazing. It is critically important, therefore, to preserve the few surviving migratory herds.

Bighorns undergo hormone changes, perhaps triggered by the first cold of fall, that bring on the breeding urge as they start down

from the summer ranges in October. The rams remain segregated from ewes throughout the summer and into October. During that month there is intensified social interaction among the rams as they reinforce the dominance hierarchy, or peck order, and young rams seek to move up the social ladder by challenging a superior.

There is fighting and scuffling during this time. The sneak attack, in which the opponent is charged from the side or behind when he least expects it, is a common occurrence. I have never examined a ram skeleton that didn't show at least one old rib fracture or crack from such encounters.

Great, elaborately stylized head-butting fights are also common during October. These battles determine the dominant ram, who usually will have greater opportunity to breed than will the subordinates.

Crack of Heads Signals Mountain Duel

Two rams that haven't settled the peck-order question may feed to within fighting distance of each other, apparently unaware of the other's presence. As if by signal, they will suddenly square off, rear high on their hind legs, run at each other, and butt heads with a resounding crack (pages 386-89).

Force from the impact ripples back through their bodies and jerks their hind legs off the ground. The rams bounce back and stand still for a few seconds, dazed by the crash. I have seen collisions that left both rams standing with tongues hanging out of their mouths and their eyes rolled up into their sockets.

The two contestants often go back to feeding, seeming to ignore each other but in fact maneuvering for the best position for the next attack. Some are adept at getting uphill from their opponent; needless to say, a downhill charge is most effective.

Rocky Mountain bighorn rams have a double-layered skull, interconnected with bone, that allows them to absorb the tremendous impact of head butting without injury to the head or brain. The fighting often results in other damage, however. I have seen pieces of horn fly high in the air as two rams collide. Not too many rams' horns ever reach the full-curl mark. The humped, or "roman," nose so common on bighorn rams is battered into that shape during fighting, and rams are often seen with bleeding noses.

I have stood near bighorns when the fighting ritual occurred, but have never been



Horned protectress watches over her week-old youngster (*above*), born in late May, six months after mating. Able to walk almost at once, newborn lambs—usually only one per ewe—soon follow their mothers to a craggy nursery (*right*), where they will be safe from predators. Here they learn to nibble tender foliage, and the tight ewe-lamb bond gradually gives way to the security of the group. At times, a ewe apparently will leave her young in the care of another female in the herd.

threatened. Once I narrowly escaped being hit by a competitor when his opponent dodged a sneak attack and left me standing in the path of the charge. We both scrambled for a moment to avoid a collision, and the ram was apparently as relieved as I that contact did not occur.

In later years, as I worked with bighorns, a ram did knock me down—unintentionally. He had approached me very curiously and shyly to taste a potato chip I held in my hand. We were on a very steep hillside and I was reaching toward him at a sharp upward angle when another ram suddenly butted him from behind, knocking him into me. The ensuing melee resulted in camera equipment scattered twenty yards down the hill, and a shaken biologist and frightened ram trying desperately to get disentangled.



Bighorns arrive on the winter range fully prepared to breed. The peck order has been established well enough to reduce fighting and make the breeding activity relatively efficient.

Rams do not attempt to collect and hold harems of ewes, but instead wander, seeking out ewes that are ready to mate. The dominant ram expends much energy and time attempting to drive away other hopeful rams loitering nearby. It is not uncommon for a subordinate ram to breed a ewe while the dominant ram is busy chasing off another insistent subordinate.

Winters Bleak for Foragers

After the rutting season, most rams spend winter in sites separated from the ewes. Winter doesn't seem to be a particularly interesting time in the life of a bighorn sheep—

just a quiet, desperate struggle for survival.

The world begins again for the bighorn just before spring greenup. Social behavior intensifies, and rams begin to band up completely apart from the ewes and move to different parts of the range. The rams usually leave the winter range earlier than the ewes, gradually following the retreating snow line.

In the Morgan Creek study area most ewes give birth to their lambs on the winter range, then gather into large groups of as many as thirty ewes with lambs in what I call the nursery area—a jumble of nearly vertical rock cliffs and loose angular boulders (above). The nimble lambs are relatively secure from predators in this environment, and the ewes keep them there until about mid-July, before moving on to the summer ranges.

Eagles have been blamed for bighorn lamb



Nimble mountaineer, a young ram negotiates steep cliffs with cloven hooves superbly adapted to his precarious world. Hard, pointed toes cling to the barest niche, while fleshy pads give traction. "Sometimes sheep seem to climb for sheer pleasure, just to explore," notes the author. And sometimes they slip, knocking each other over like falling dominoes. But they usually recover quickly and continue the climb, apparently unhurt. One yearling lightly taps another with a harmless kick (right), mimicking a challenge that rams issue in earnest as adults.



predation since the first settler saw the birds circling over the cliffs where bighorns live. From my personal observations on Morgan Creek, however, I find it difficult to believe that eagles take any significant toll.

Bobcats, adept at traveling the rough, tumbled rock cliffs, may take an occasional lamb in the nursery area, but they do not seem predisposed to tangle with an angry ewe, and probably have to catch a lamb that has drifted away from its mother.

I have never observed a coyote in the rugged lamb nursery area. If they are a threat to bighorns, it would be out in the more open and level country where they could chase them.

Cunning Coyote Outsmarted

On a backpack trip down the Middle Fork of the Salmon River, I once saw a coyote chasing three bighorns across a long grassy hill. They led the coyote about a quarter of a mile away from the main band of seven others that were standing in a defensive group, watching, then circled and led the coyote back to the group.

There was a confused scramble as the band dispersed in all directions and the coyote turned from one bighorn to another, trying to snatch one. Then two fresh bighorns led the predator off in a different circle while the others rested.

When they returned several minutes later, the group again scattered. By this time the coyote's tongue was hanging out and the animal was clearly slowing down. When I last saw them, seven well-rested bighorns were leading a panting coyote out of sight across the hill in an obviously futile chase.

Cougars have long had a local reputation as bighorn sheep killers. While they may occasionally prey on sheep, the number they dispatch is insignificant. During my five-year study in the Morgan Creek area, I found remains of 11 deer killed by cougars, but no bighorn victims. Later in the study, hunters began using snowmobiles to transport themselves and their dogs into difficult areas; the result was an immediate increase in the number of cougars killed.

I believe killing cougars was a disservice to the bighorn sheep, because deer were increasing each year and competing more and more with bighorns for food. By helping to keep the deer population down, cougars had been alleviating at least some of the competition problem on the study area.

The Morgan Creek herd exemplifies the hundred-year losing battle of the bighorns on public ranges throughout the Western States. These herds, which must migrate down to public grazing lands to winter, are caught in the pincers of ecological damage and increasing livestock demands. Today a third of the public range is primarily sagebrush. Subtracting rocks, gullies, timberland, and other unsuitable regions leaves only a fraction of the range available for bighorn grazing.

Range analysis in the Challis area revealed that only 7 percent of the available winter range was quality bighorn habitat. The spread of sagebrush has benefited the adaptable mule deer, which have increased tremendously and added their own measure of competition for crucial winter forage. The bighorns, faced with a shortage of preferred habitat and unable to adapt to the proliferating sagebrush, are besieged with diseases and parasites fostered by malnutrition and crowding on the shrinking range.

The Morgan Creek herd near Challis has declined from an estimated 2,500 in the 1870's to fewer than 200. Four other herds in the immediate vicinity have declined to fewer than 50 animals each, which could be beyond the point of no return. Three herds have become extinct in the area since 1930. Similar situations exist in all the Western States.

Man Aids the Bighorns' Competitors

A practice that figures heavily in the continued decline of some remnant bighorn populations on public land is the Bureau of Land Management's range-improvement program. Acreage with easy accessibility and available water was the first to be used for livestock grazing, and bighorns have long been extinct on those grasslands. Remnant bighorn herds have hung on by utilizing the remote and difficult-to-graze nooks and crannies. But as range-improvement money becomes available, the bureau develops roads, trails, fences, water holes, and water pipelines in remote parts of the range to facilitate dispersal of livestock. This steady invasion of their last winter ranges subjects bighorns to intensified human activity and competition for preferred forage.

A new approach to the problems of overgrazing on public lands is "rest-rotation grazing"—resting the grass plants during at least one year out of three or four. The merits of rest-rotation grazing under certain conditions



JOHN MORGAN



Wilderness tragedy, a dead yearling found by the author near Challis, Idaho, attests to the Rocky Mountain bighorn's main problem—malnutrition. Cattle, sheep, horses, and deer all overgraze eroded foothills. Wildlife conservationists seeking to set aside some reaches that are vital to remaining bighorns face opposition from cattlemen whose livelihoods depend on the same land.

Morgan points out that much of the original range reestablishes itself if given a chance. One part-time Idaho rancher fenced his overgrazed land, allowing the grasses to reappear and flourish (above right), in sharp contrast to public land that continues to deteriorate beyond his fence.



have been proven. But it also brings problems. Some studies suggest that rest-rotation grazing, *unless accompanied by a reduction in livestock numbers*, may sometimes increase the damage. Streams suffer as heavy livestock use causes fish-sheltering banks to cave off; fencing necessary for the rest-rotation program is detrimental to wildlife.

Spending tax money for the program is viewed by many conservationists as a direct subsidy to the relatively few livestock operators it benefits. (They represent only about 3 percent of the forage-fed-livestock industry in the country.) In general, grazing fees do not equal the fair market value of the forage taken, even though much of the Bureau of

Land Management's fund outlays are used in direct support of grazing.

But the blame cannot simply be put on the bureau. It is charged with administration of public grazing lands, but has lacked public and legislative support to reduce the number of grazing permits, and has no legal authority to apprehend and prosecute those who graze their stock illegally.

As one concerned with the future of the bighorn, I hope ways can be found to assist livestock operators to shift from public grazing lands to private operations—at least in those areas where ecological damage is costing the public lands dearly in soil, watershed, wildlife, and recreational potential.



I believe we need legislation to guard the total environment of public lands. The Senate Committee on Interior and Insular Affairs recently held hearings on two such bills, one sponsored by U. S. Senators Henry Jackson, Frank Church, and others.

Protection, Preservation, Participation

The Jackson Bill would make it Congressional policy that these regions be managed "... under principles of multiple use and sustained yield in a manner which will, using all practicable means and measures, protect the environmental quality of such lands to assure their continued value for present and future generations; protect the quality of scientific, scenic, historical, and archeological values; preserve and protect certain areas in their natural condition; provide habitat for fish and wildlife; provide for outdoor recreation; balance various demands on such lands; assure payment of fair market value by users of such lands; and provide maximum opportunity for the public to participate in decision-making concerning such lands."

Such legislation would help brighten the gloomy outlook for the Rocky Mountain bighorn in the United States by ultimately easing livestock pressure on public grazing lands.

Thus, as I said earlier, the bighorn story begins—and unhappily may end—with grass. Plants are the key to the quality of an environment. They are energy fixers, soil builders, holders and protectors, water sponges, and cover producers.

Bighorns are among the most majestic of the creatures that live at peace with the grass. The decline of these magnificent animals speaks sad volumes about what man is doing to his surroundings—and, ultimately, to himself. □



Come winter's icy blasts, bighorns find meager forage on windswept foothills below their summer range (left). Thick, heavy coats help them weather blizzards as they await the coming of yet another life-renewing spring.





Sunny Corsica: French Morsel in the Mediterranean

By ROBERT CAIRNS

Photographs by

JOSEPH J. SCHERSCHEL

NATIONAL GEOGRAPHIC PHOTOGRAPHER

ROCKETS BURST in the night sky, illuminating palms and tiled roofs. Out on the black surface of the bay a small boat framed in fire drifted toward the citadel. Against its hull flickered a set piece in the shape of the bicorne hat made famous by Napoleon Bonaparte.

I was in Ajaccio (Ah-YAH-cho), the capital of Corsica, and this was the eve of Napoleon's birthday. The entire city had turned out to throng the streets and watch the fireworks. A marching band with white-skirted majorettes struggled bravely through the crowd, drums thumping to a solemn rendition of "L'Ajaccienne," which acclaimis "the son rich in glory . . . Napoleon! Napoleon!"

That man of furious action was born at Ajaccio on August 15, 1769. Honored by the fortuitous event, this home of 43,000 people

Exuberant fisherman shows off his catch near Ajaccio, queen city of Corsica. Even on the open sea, wind-borne perfumes of myrtle, lavender, and thyme beckon from France's "Scented Isle."

Prize in the path of conquest

THE ISLAND OF CORSICA attracted seafarers with its strategic ports and magnificent pines, which became masts for their ships. Greeks, Carthaginians, Romans, Vandals, and Byzantines left their marks. Then came Italians from the city-states of Pisa and Genoa. The French won the island in 1769, and today Corsica enjoys full political equality as a *département* of France.

Corsican patriot Pasquale Paoli established an independent régime at Corte in 1755. French troops defeated him in 1769 at Ponte-Nuovo.

The many Greek families of Cargèse trace their heritage to Christians who fled Ottoman rule in the 11th century. Their church shelters treasured icons.

Birthplace of Napoleon, Ajaccio spreads broad boulevards where many of its 42,000 residents stroll each evening, enjoying cooling sea breezes. From Quai Napoleon, launches offer promenades en mer, excursions around the gulf.

Roads and trails in yellow
Elevations in feet
Soundings in fathoms



DRAWN BY LEO E. ZERBATH
COMPILED BY GUNARS J. ROTHS



Genoese watchtowers dot Cap Corse. The tip of this northern peninsula lies only 115 miles from Nice.

Corsica's most famous religious pageant unfolds in the somber stone town of Sartène on Good Friday. A masked penitent, in days past often a bandit, portrays Christ in the Passion procession.

today is pleased to style itself “the Imperial City.” Still, Ajaccio remains what it must have been when Napoleon was a boy: a sunny and amiable Mediterranean port on Corsica’s sheltered southwest coast.

I roamed the old quarter, with its shuttered windows and yellowed walls and shepherd’s-crook lampposts, seeking traces of the city’s most illustrious citizen. Napoleon’s days in Corsica were brief. At 9 he went to France, where for six years he attended military schools at Brienne-le-Château and Paris. As an artillery officer in the French Army, he came back to Corsica for short periods, but after age 23 he never lived there again.

The four-story house in which Napoleon



Portraits in granite—no two alike—bear witness to a skilled prehistoric people who flourished at Filitosa some 3,500 years ago. The awesome sculptures, some rising ten feet, stand near what appear to be stone tombs spacious enough for communal burials, a custom practiced by some islanders until the 20th century.

was born still stands, secluded in a narrow alley facing an intimate fenced garden. The square thus formed is named for Napoleon’s mother, Letizia Ajacciens, even today, refer to her affectionately as “Madame Mère.”

I reminded myself that in these rooms Napoleon had lived and played as a child. Out that front door he had been taken at the age of 2, with a newly born sister, to be baptized. When the priest shook dripping fingers at him, Napoleon nearly threw himself out of his godmother’s arms, yelling furiously. It has been suggested that Napoleon wanted to baptize himself as, years later, he would crown himself emperor.

Of the school run by the Beguine Sisters—who received Napoleon when he was 5, found him brilliant at arithmetic, and disciplined him for misconduct—there remains only a garden.

No one can know what boyhood memories brightened Napoleon’s lonely years in exile when he was banished to the island of Saint Helena. But he recalled the Corsica he would never see again with deep longing:

“Corsica had a thousand charms for me. Everything there was better and more beautiful than anywhere else. By the fragrance of its soil alone I would know it with my eyes closed.”

Peaks Tower Above a Blanket of Shrubs

My first glimpse of this remarkable island, the most mountainous in the Mediterranean, came through the triangular window of a Caravelle flying in from Nice. Corsica rises out of the sea like a chunk of the Alps that has broken away from the mainland, a hundred miles to the north. One hundred and fourteen miles long by 52 miles wide—a third the size of Vermont—it numbers upward of fifty mountain peaks thrusting more than a mile into the sky.

It was July. The gray peaks of Mont Cinto, almost 9,000 feet high and still streaked with snow, passed my window. Below, Ajaccio’s sail-flecked bay curved away to the south. We came in to land amid treeless hills that seemed clothed in fur.

Later when I got into it, the “fur,” in hues from violet to yellow, revealed itself as dense, tangled thicket—Corsica’s *maquis*.

This is the island’s herb garden, where aromatic shrubs flower every spring, and where Corsicans string thousands of tiny homemade nooses to strangle the dark thrushes, called blackbirds, as they dart

Napoleon's hometown celebrates August 15, the birthday of its most famous citizen. In 1969 Ajaccio loosed a summer-long whirlwind of festivities to honor the two hundredth anniversary of the emperor's birth. The French Foreign Legion, which has posts in Corsica, parades past a statue of Bonaparte (below). From other regions of France came folk dancers; two of them (facing page) share an icy treat.



about feeding on berries. *Pâté de merle*, blackbird paste—gamier than *pâté de foie gras*—is a Corsican specialty.

For generations, in this island's turbulent past, bandits by the hundreds sequestered themselves in the *maquis*. The outlaws were mythicized as *bandits d'honneur*—bandits of honor—men who had killed for personal reasons; killing for gain was almost unheard of in Corsica. These brigands were not entirely suppressed until the early 1930's.

"You never refused a bandit a meal," Sylvestre Raffalli, 82, told me at Morosaglia. "When I was a boy, bandits would arrive out of nowhere after dark. We gave them food. When we got up in the morning, they were always gone."

In more recent history the *maquis* sheltered heroes. It was this very same *maquis* that gave its celebrated name to members of the French Resistance of World War II, in which Corsicans played a major role. Despite Mussolini's allegation that this French island formed a natural part of Italy, Corsican guerrilla groups, along with Free French units from North Africa, had driven Italian and German forces from the island by October 1943. Corsica thus became the first liberated *département* of France; as such, it served as a valuable base for the Allies.

The Maquis Grows as Forests Shrink

A Corsican student home from Nice whom I had picked up hitchhiking informed me that the fabled underbrush was not always of such vast extent. Nor did he hold any romantic view of it.

"Unhappily," he said, "the *maquis* is an indicator of the degradation of our forests. They have been destroyed, mostly by fire."

During Corsica's parched summers, fires remain a major menace. In the center of the island, rounding a curve, I was stopped by the sight of the black and ghostly forest near Ghisoni, burned out the previous summer. Since 1955, largely as a result of increased tourism and a combination of carelessness and lack of rain, nearly half a million acres of timber have become cinders—40 percent of Corsica's woodland majesty.

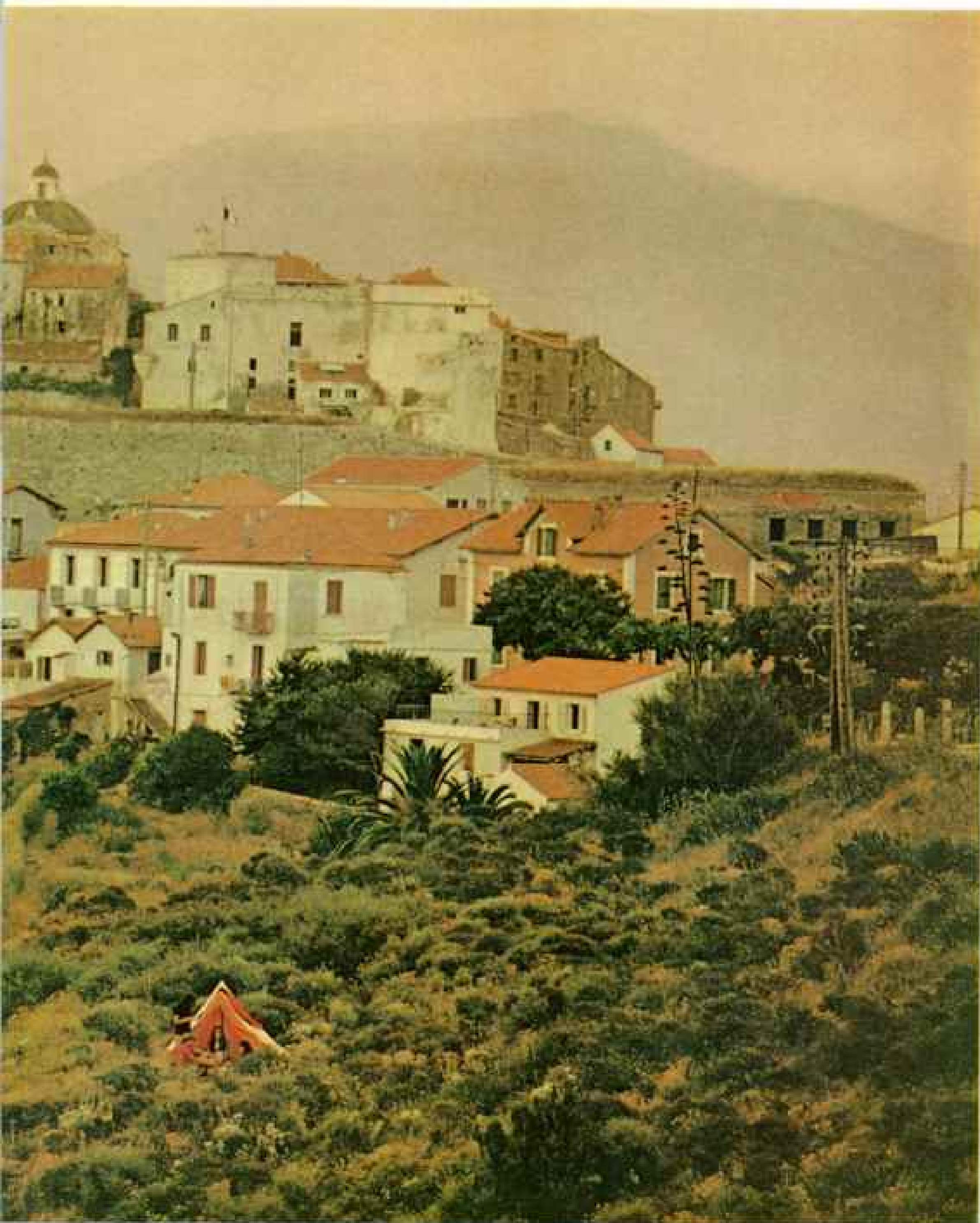
But spectacular woods remain, such as the *Forêt d'Aitone*, where I drove past the towering trunks of Corsica's celebrated *laricio* pines. Some of these giants soar to 150 feet and are branchless nearly to their tops.

(Continued on page 410)





Sunset's afterglow bathes the citadel of Calvi in a peace seldom enjoyed during the city's turbulent past. In the 13th century, Genoese rulers fortified and colonized Calvi. The bastion endured attacks by Turks,



French, and British. While foreigners fought for the coasts, Corsicans in the interior— isolated much as were the highland clans of Scotland—followed their own code and meted out justice with blood feuds. To

escape retribution, men often took to the *maquis*, the island's dense blanket of aromatic shrubs. The refuge's name became synonymous with French Resistance guerrillas during World War II.



Modern Corsica welcomes invaders

SPONTANEOUS SINGING erupts at an outdoor café in Ajaccio, popular port of call for French seamen (left) and for the crews of other Mediterranean fleets.

Mariners who sail the Mediterranean for pleasure anchor their boats in the Old Port at Bastia (below left), one of many yacht harbors on the island. Near the twin-towered 17th-century church of St. Jean-Baptiste, steep narrow streets lead to the modern part of Bastia—with 52,000 people, Corsica's largest city—and to the deepwater

commercial anchorage that lies beyond.

Where summer lasts from May until November, sun-bronzed bathers on a Calvi beach (below) play *pétanque*, the Corsican version of lawn bowling. Another favorite pastime of natives as well as visitors: Joining fishermen for a morning on the sea and landing at a rocky cove to sample sea urchin and langouste, or to simmer a traditionally spicy Corsican bouillabaisse. Last year some 500,000 vacationists gave a needed lift to the island's economy.



The Romans used the pines for masts on their galleys—and they used their galleys to take the Corsicans away as slaves. But Strabo reported 2,000 years ago that the fierce obstinacy of the Corsicans astonished the good people of Rome.

Perhaps it was this obstinacy, still notorious, that angered the gods. From the start, someone clearly had it in for Corsica. Even the island's prehistoric relics tell a strange tale of violence.

In an olive grove in the southwest, near the tiny hamlet of Filitosa, stand strange man-like statues, as tall as ten feet (page 403). The granite blocks with sculptured heads were carved by a megalithic people 3,500 years ago.

I saw them at dawn when the first sun gently touched the pocked stone, throwing into faint relief the wasted eyes and eroded mouths. Six stand intact, and more than a dozen others lie smashed—probably by men whose armed images they represented.

It is theorized that the fierce-visaged statues, many of them bearing swords and daggers, depict not the megalithic Corsicans who carved them, but, inexplicably, their rampaging enemies—seafaring warriors of mysterious origin who swept into the country around 1500 B.C. and occupied the southern part of the island.

Corsica Ruled by a Parade of Masters

But the first recorded settlers of Corsica were Greeks, around 560 B.C. They were overwhelmed within a quarter of a century by a combined Etruscan-Carthaginian force. In the third century B.C. the Romans won Corsica from Carthage, planted grain along the east-coast plain, and used the abundant timber as a source of resin and charcoal.

Roman farming aside, Corsican history with rare exceptions—such as the mild rule of the Pisans—has been a black tale of foreign exploitation. Romans, Vandals, Goths, Byzantines, Lombards, Aragonese, Genoese, Moors, and Barbary pirates all took part in ravaging, enslaving, taxing, and hounding the Corsican people.

To take but one appalling encounter, in

1421 at the fortified town of Bonifacio, perched atop chalk cliffs (pages 414-15), the siege of Alfonso V of Aragon threatened famine. Tradition holds that the desire of the starving Bonifaciens to conceal their plight was so desperate that they threw loaves of fresh bread over the walls, and their women, who suckled fellow combatants to keep up their strength, even sent to Alfonso fresh cheese made from their own milk.

An old man of Bonifacio, wearing the traditional flat cap and lacking most of his teeth, told me that before the terrible five-month siege of Bonifacio was lifted, his ancestors were reduced to eating rats and dogs. There was hand-to-hand fighting with scythes and torches, and slaked lime was dumped into the enemy's eyes. On that occasion Bonifacio was not taken.

Oppressed Islanders Took to the Bush

The most vicious domination of Corsica was that of the Republic of Genoa. From a foothold gained in the 13th century Genoa defeated first the Pisans, then the Aragonese, and with but few interruptions ruled Corsica until the mid-18th century. Massive citadels and 67 of the original watchtowers erected by the Genoese still stand.

During part of its rule, Genoa entrusted control of Corsica to the Banca di San Giorgio, a powerful financial company whose sole aim proved to be grinding taxes out of Corsicans. To escape this oppression, the islanders were reduced to a furtive existence.

They retreated to their glens, which were organized into a *terra di comune*. Each glen elected councils, who chose *caporali*, or chiefs, to look after the rights of the people of all the glens. But under the rule of the bank, the confederacy of the communities fell apart. Isolated from one another by mountains, lying low from tax collectors, the Corsicans of the glens bitterly confined their loyalties within a clan system in which blood ruled: loyalty first to the head of the family, then to the chief of the glen.

In the absence of any rule of law, "justice" was served by the notorious *vendetta*. It

Stripping a living oak tree, a villager near Casamozza gently pries off the outer bark without damaging the tender inner layer that will form the next cork harvest—six to nine years hence. Mainland factories process the raw cork, chiefly as wine-bottle stoppers. Much of the pine, chestnut, and oak that once canopied the island has fallen victim to timber cutters, charcoal makers, and fire, leaving only a fourth of Corsica in woodland.



might begin with an insult answered by a killing. Under the unwritten code of collateral revenge (*vendetta trasversa*), if the enemy himself could not be reached, any member of his family would do. Retaliations echoed down the generations. At least one Corsican historian has reported an incredible 28,000 murders of vengeance in 30 years!

Families would preserve the bloody shirt of a slain father to incite the son to his terrible obligation when he was old enough to handle a gun. Men confined themselves to their homes or hid in the maquis, sometimes for years, to escape being shot.

On a terrace in the hills of the Balagne in northwest Corsica, I talked with Joseph Renucci, a slight, aristocratic figure of a man. He is proprietor of the Hotel Mare e Monti

at the small village of Feliceto, high above the coastal plain.

"Our family was nearly wiped out by vendetta in the 16th century at Fozzano," said M. Renucci. "But one father had the courage to urge his sons to drop it and leave. Two of them found their way here. They raised domestic animals; most certainly they were hunters, too. The wild boar was plentiful then. And so was the mouflon."

Wild Boars Remain a Favorite Prey

Once decimated by hunters, mouflon—wild mountain-dwelling sheep with large curved horns—are now protected by law. But numerous boars still roam the hills, eating roots, wild apples, and chestnuts, and occasionally raiding the vineyards for grapes.



Pioneer in an antique land, an immigrant from Algeria plants a lemon grove on the eastern plain, once a granary for Rome. Barbarian invasions 1,500 years ago sent Corsicans fleeing to the mountains, and the lowlands became malarial marshes. After World War II, DDT eradicated mosquitoes, and irrigation installed later by the French made the land bloom again.

"Boar meat," said M. Renucci, "is best when marinated in salted wine."

We talked beneath a pale awning. Above us hung carafes of sugared wine to attract bees that otherwise would descend upon the breakfast jam.

Below, beyond the road and the church, the land fell sharply away in broken terraces, thick with maquis in the blazing sun. The terraces, built so laboriously with dry-stone walls, were once carefully cultivated. Now crumbling, they had been given over to the goats whose bells tinkled distantly among the olives, which also were abandoned.

With so many of its gardens withered, Corsica now relies heavily on its tourist potential to boost the economy of an island extremely short of exports—aside from a

major exodus of people, for which Corsica is famous.

Every year several thousand young men leave this island that has no industry. They find jobs on "*le continent*," many with the military. "The pay is no great thing," I was assured, "but you can touch a pension in 15 years." In Paris the police force has traditionally listed Corsicans on its roster.

To be sure, not all Corsicans in Paris are in uniform. One, Achille Peretti, was President of the French National Assembly until April of this year. For Corsicans have also traditionally played a vigorous role in the French Government.

But as Corsica's youths continue to depart, older Corsicans return to the family domain. Retired Corsicans, with their pensions and related social benefits, account for a third of Corsica's income today. Forty percent of the population, officially tallied at 200,000, is above 45; more than 16 percent is over 65.

The old men are hardy. I encountered them often, side-sitting their donkeys and clip-clopping along in that windless hour before dawn, when the hills were silent and the roads deserted. Although they were generally up to very little, I was struck by the number who made a point of telling me they were free to go anywhere and to do what they pleased. Clearly the memory of those centuries when freedom was only a word is strong in the Corsican consciousness.

Corsica's Don Juan Is Still Remembered

Two old men one morning, in the treeless hills above Calvi, said they were off to the nearby village of Montemaggiore—the village, they said, of Don Juan. I said I thought that Don Juan had lived at Seville.

"He did," I was told, "but his family had also lived at Montemaggiore. He returned once and managed to seduce a half sister who had remained here. He escaped her family's vengeance by fleeing back to Spain." So Don Juan had been a Corsican? "But certainly," my new friends assured me.

I learned later that, indeed, there had been a Corsican—one Miguel Manara—whose outrageous romantic escapades earned him the nickname and notoriety of the famous fictional libertine of the same era.

Watching the two laughing men depart on their donkeys—both men and beasts clearly well-fed—I realized that although primitive aspects endure, there is little real poverty in



Frenchmen fleeing newly independent Algeria in 1962 purchased most of the new farmland, which now produces the greatest part of the island's vegetables, fruits, and wines.





Cliff-hanger town, Bonifacio plays chance with the relentless sea, which forever gnaws at its limestone foundations (left). Grottoes cut by the waves rival Capri's. The town, retaining much of its medieval character, guards the strait between Corsica and Sardinia. A narrow street (below) that once reverberated with the clank of soldiers' armor echoes now with the clatter of a bread cart as a baker's boy makes a delivery.



Corsica. But there is also very little wealth.

What there is can be found mainly in the cities and along the coasts. In Ajaccio, François Bourgin, then the Prefect of Corsica, told me, "The emptying of the interior is a phenomenon of our times. More than a hundred villages now have fewer than a hundred inhabitants. Nearly half of our population lives in the cities of Bastia and Ajaccio."

The prefect is in a position to do something about this alarming situation. Though the island's administration is in the hands of an elected General Council and local mayors, he wields the executive power. He reports directly to Paris, the seat of all French legislation. There Corsica has the same rights and privileges as France's other départements.

"We are out to strike a balance," M. Bourgin stated. "To this end we are encouraging

development along three fronts. Modern agriculture: principally vineyards and citrus orchards. Traditional farming: livestock and animal products. And tourism."

Whether development in these three sectors will ultimately stabilize the island's shifting population—and keep young Corsicans home—remains to be seen. Although plunging population figures have begun to rise, hotels are heavily staffed with continentals, and modern farm labor is performed largely by salaried North Africans.

Pride Rules Out Many Service Jobs

In all this Corsican temperament plays its role. "The Corsican traditionally prefers the more noble tasks of administration," I was told. My informant, a Corsican in Bastia, was himself an administrator.



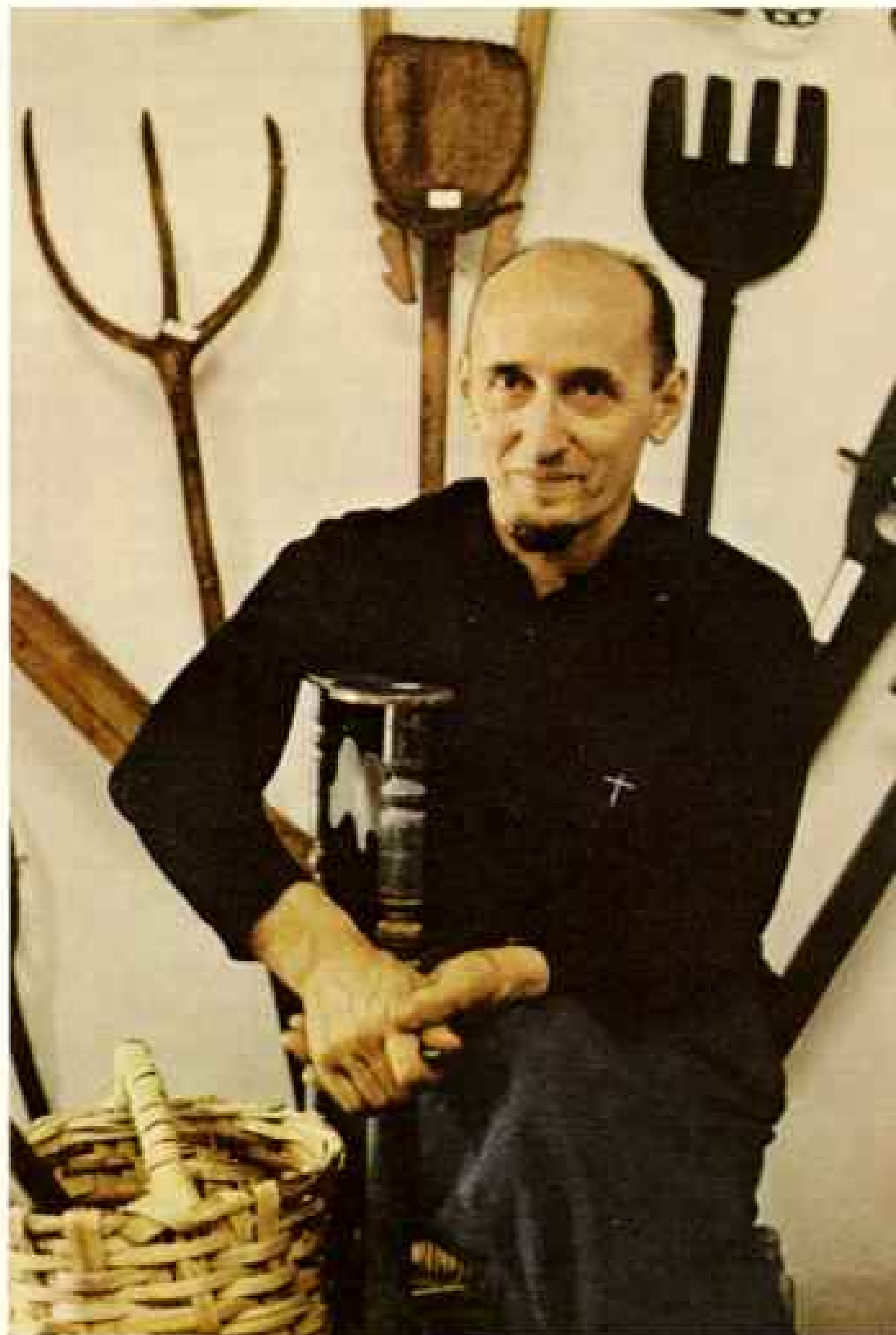
M. Bourgin hopes that the money to be made in ever-increasing tourist jobs will soften such pride. "Revenues increase substantially each year," he said. "Last summer we had 500,000 tourists."

They are drawn to an island whose 600-mile coast is patched with nearly 200 miles of beaches, and broken into myriad coves, some accessible only by boat. For centuries much of this breathtaking coast was denied to the Corsicans by malarial marshes at the river mouths. Not until DDT was sprayed along the eastern plain after World War II was the malaria mosquito dealt a deathblow.

Although the greater part of the Corsican coastline remains undeveloped, there are a number of yacht basins, some with shopping centers and with villas for rent or sale. Back in the hills, away from the brilliant

Ritual draws friends to "The Rendezvous of the Hunters" in the mountain village of La Porta. Mailman, roofer, bar owner, and disabled World War I veteran play the French game of *belote* each afternoon for a round of wine. At least one of every ten Corsicans, like 75-year-old Antoine Vinciguerra, right, receives a government pension.

Clergyman and collector, the Reverend Louis Doazan ministers to some 500 souls in La Porta; his two-room museum overflows with artifacts he calls "the paraphernalia of a self-sufficient and isolated people." Wooden threshing tools fill this wall; elsewhere homemade stilettos and rifles attest to the days when vendettas ruled.



Mediterranean, lay those spectacular and silent wilds so inviting to campers: I looked down often on clustered tents as I drove the looping and narrow roads through the shattered sunlight of Corsica's forests.

More than half the island lies above 1,300 feet, with wind-slanted birches on the high cols, snowbound in winter. Pigs roam wild there, and goats feed on heather. The slopes sparkle with nearly eight hundred miles of streams, where trout are plentiful, as are eels. Corsicans catch the eels by stuffing raw meat into rough "brooms" made from brier. The eels penetrate deeply for the meat and are unable to back out.

Chestnuts Boost Diet and Economy

Up in the hills I would sometimes simply sit inhaling the stillness in the shade of giant chestnut trees. The unripe chestnuts in their new shells hung like chartreuse sea urchins.

In times past these "potatoes" of Corsica were the staple of the diet—chestnuts dried in the smoke of a fire that also cured hanging hams from chestnut-fed pigs. The *charcuterie corse*—fine sausages and smoked hams coated with pepper—is justly famous.

For centuries chestnuts provided the flour from which Corsican women prepared a variety of breads and fritters and cakes. But the chestnut now has been largely replaced by imported flours, potatoes, spaghetti, and commercially baked bread.

Sylvestre Raffalli of Morosaglia remembers when chestnuts were a valuable item of barter. "Come June, I would load a donkey with chestnuts and follow the trails over the mountains, where I traded for cheese."

M. Raffalli's itinerant nights on the trail are behind him. Now he looks after the Maison Paoli, birthplace and final resting-place of Pasquale Paoli, who took Corsica closer to complete independence than any man before or since. As we walked through the three-story rough-stone house, M. Raffalli told me of Paoli's difficult life.

In 1739, at 14, Paoli went into exile at Naples with his father, fleeing from the Genoese. At 16 he entered Naples' army, and ultimately became a second lieutenant.

He also became an outspoken patriot, with a cool head and sound ideas, and the Corsican exiles urged him to return to Corsica to lead a revolt against Genoa. In 1755, at 30, Paoli was elected General of the Corsicans.

His achievements are memorable. He drafted Corsica's first constitution, rallied his people to put down the vendetta, and inspired in his soldiers a fierce, general heroism.

Paoli Sang Paeans to Corsican Courage

"If I should lead into the field an army of Corsicans against an army double their number," the general once explained to the biographer Boswell, "let me speak a few words to the Corsicans, to remind them of the honour of their country and of their brave forefathers, I do not say that they would conquer, but I am sure that not a man of them would give way. The Corsicans have a steady resolution that would amaze you. I wish you could see one of them die."

Within nine years Paoli and his rough-clad followers defeated the army of Genoa. The complete man, Paoli is also honored for having established at Corte a university with seven chairs, including those for theology, law, ethics, and philosophy.

Paoli's Corsicans excited the enthusiasm of leading philosophers of the Enlightenment. Voltaire wrote of their "violent enthusiasm for liberty." Rousseau declared, "There is still one country in Europe capable of legislation; it is the island of Corsica."

In 1768, however, France bought Genoa's "rights" to the island and attacked the Corsicans, finally defeating them in May 1769. Paoli fled to safety at Livorno, Italy, and from there to England and 20 years' exile.

Tito Franceschini, a descendant of Paoli's sister (the general never married), lives at Corbara in the Balagne. The villagers respectfully call him "Gio" (Signor) Tito. At his imposing residence above the village I talked with Gio Tito, who is 72.

Paoli, he told me, had been recalled from exile to lead Corsica after the Constituent Assembly in 1789 declared the island to be a part, rather than a possession, of France. But three years later the French withdrew their

Windowsill aristocrat surveys the quiet main street of Campana in the forested northeast. Though of dubious pedigree, such family pets earn their keep as guardians of chicken houses and as trackers of wild boar that village men still hunt every Sunday in season.



support of Paoli's administration. He then declared for independence, obtaining British aid for his revolt. Among those who opposed him in this rebelliousness was Napoleon. Napoleon prevailed, and Paoli returned to final exile in England. He died in London, where there is a tablet to his memory in Westminster Abbey.

Before leaving I asked Gio Tito if Corsica had changed much in his time. "Completely," he said. "We have abandoned the land. In my day a man lived from his olives for two years, until the next big harvest. We didn't use money, we paid workmen in produce. Today everybody works for money—so when they have any, they don't work." He was shaking his head in disgust as I left.

New Programs Urge a Return to Farming

Corsica's internal economy—a fine balance of barter and self-sufficiency—began to collapse after World War I, as competitively priced goods, created by a new technology, flowed in from outside. The incentive to farm was severely affected. In 1913 Corsicans farmed some 35 percent of their mountainous island in myriad small patches. Thirty years after the first World War—in which more than 40,000 Corsicans died defending France—barely 8 percent was under cultivation. Emigration was in full swing, and Corsica was importing more than half those goods she could most easily produce herself: cereals, fruits, vegetables, and meat.

In 1957, with disaster in sight, the French Government created SOMIVAC—*Société pour la mise en valeur agricole de la Corse*, the society for agricultural development. SOMIVAC's mission: To resurrect Corsican agriculture by acquiring land and preparing that land for modern farming, to build dams and supply irrigation, to expedite renting of farms, and to generate technical savvy.

In Bastia, Paul-André Carlotti, SOMIVAC's Chief of Services, spoke of the vineyards and orchards on the eastern plain. "Until malaria was wiped out, no one farmed here. Today this plain accounts for 60 percent of Corsica's agricultural production. That means 85 percent of our wine production, whose value has nearly doubled these past few years, and 75 percent of our citrus production."

Backbone of Corsica's farming venture on the eastern plain are the so-called *pieds noirs*, or black feet. These are Frenchmen (none I met could explain their nickname with

certainly) repatriated by the government from newly independent Algeria.

"More than a million were repatriated," said M. Carlotti. "Some 20,000 came to Corsica—French citizens who had lost large holdings. The government permitted them guaranteed, low-interest loans, while Corsicans paid the going rate—perhaps twice as much—and scraped together their own collateral. Yes," he nodded, "there was bitterness." But the *pieds noirs* are now largely accepted. With their expertise in modern farming, developed in North Africa, they put timely muscle into the SOMIVAC venture.

On a smoking-hot August afternoon I visited Alain Suavet, a 30-year-old *piéd noir*, at a farm below the slumbering hills of the Castagniccia near the sea. He greeted me with an iron handclasp, and, after a quick word in Arabic to his Moroccan foreman, showed me his 53 acres.

He raises citrus fruits and avocados—and flowers under glass, including the exotic South African *Strelitzia reginae*, or bird-of-paradise, of which he produces some 20,000 yearly. They sell to a cooperative for 40 cents each, and in Paris may command \$3.

SOMIVAC also hopes to revamp the pastoral scene. Corsica has more than 1,200 shepherds. They whistle like birds to their flocks as they tend the 120,000 sheep and 40,000 goats that roam nomadically over the island. Their income derives largely from their ewes' milk, 90 percent of which is used in producing Roquefort cheese.

Shepherds Accused of Thoughtlessness

"We are at war with many shepherds over their fires," said M. Carlotti. "They burn off the maquis in reckless fashion so grass will sprout. With the winds in Corsica, this is incredibly dangerous. And they overgraze."

"We have tried to get them to settle down and plant proper forage, like lucerne and sorghum and winter oats. This would eliminate their need for fires, and be more nutritious for the flocks. But we can't even get them to improve the flocks by killing the feeble and unproductive. They say: 'God gave me the beast, I must see that it lives.'"

As the farming program gathers momentum, the days of the colorful Corsican shepherd, as he lives now, clearly are numbered. But for the moment the shepherd remains rugged and free, heedless of the organized 20th century.

As my own time in Corsica drew to a close, I thought of those islanders over the centuries who, from necessity or ambition, had exiled themselves from this vision of beauty that was their home. Corsican tenacity and force of mind drove some of them to remarkable heights while—Corsicans to the last—they managed still to carry on their battles with each other.

Two famous Corsicans were lifelong rivals—Napoleon, Corsica's most spectacular export, and Count Carlo Andrea Pozzo di Borgo

(below), who rose high in the court of Russia. They were enemies from the day Bonaparte's cohorts seriously manhandled Pozzo's brother, who was running against Napoleon in a military election. The election, which Napoleon won largely by force, promoted the future emperor to lieutenant colonel in the Ajaccio National Guard.

Pozzo became Paoli's top administrator. But shortly the French Government, armed with denunciations by Lucien Bonaparte, indicted Paoli and Pozzo as traitors.



PAINTINGS BY FRANÇOIS GIARD (LEFT) AND JACQUES-LOUIS DAVID

Adversaries in life, companions after death, Corsicans Carlo Andrea Pozzo di Borgo (left) and Napoleon Bonaparte face each other in the Château de la Punta—the Pozzo mansion, now a museum. Friends in their youth, as ambitious men they became enemies—Pozzo backing island independence while Napoleon cast his lot with the French. As Napoleon rose to power on the march to empire, his rival became a brilliant

diplomatic adviser to Bonaparte's enemies in the courts of Europe.

The diplomat's descendants continued the vendetta, building their château overlooking Golfe d'Ajaccio with stones from the Tuileries Palace—Paris home of Napoleon III, nephew of the former emperor. Now, in a gesture of reconciliation, the Pozzo di Borgo family has hung these oil portraits in the Grand Salon of the château.



Tenacious as the Corsicans themselves, the tranquil village of

Napoleon led his French troops against Paoli's fortress at Ajaccio. The attack failed, and Napoleon fled. The Paolists condemned the Bonaparte family to "perpetual execration and infamy," drove Madame Mère and her younger children to the maquis, and plundered Napoleon's home. Napoleon tried a second attack, by sea this time, but was repulsed by the citadel's deadly cannon. Rescuing his family where they huddled on the shore below Ajaccio, he fled to Toulon.

Increasing Power Fuels Mutual Dislike

While Napoleon's career was angled upward to the stars, Pozzo's was angled inexorably to help bring Napoleon down. At almost the same moment that Napoleon took the crown from the hands of Pius VII at Notre Dame Cathedral and crowned himself emperor, Pozzo offered his services as personal adviser to Alexander I, Czar of Russia.

Pozzo functioned brilliantly behind the scenes throughout Europe. He never abandoned his efforts to restore the Bourbons to the throne of France. Equally unceasing were the efforts of Napoleon's secret police to lay hands on the elusive nobleman.

Victory was Pozzo's. With Napoleon's defeat accomplished at Waterloo, Louis XVIII was safely on the throne, and Pozzo rode into Paris with him.

Today on a hill behind Ajaccio stands the elegant Château de la Punta, built by the Pozzo di Borgo family from stones once part of Napoleon III's Tuileries Palace. The Paris palace was burned in 1871 during the Commune after the Franco-Prussian War had toppled the Second Empire of the Bonapartes. Pozzo's heirs, delighted to assemble their own château from those ruins, bought the stones and shipped them to Corsica. In the words of historian Dorothy Carrington,



Carcheto clings to a ridgetop that rises above morning mist.

the château stands today as “a memorial to the most extravagant of all Corsican vendettas.”

For better or worse, Pozzo, the Bonapartes, Paoli, and others took their talents into the world outside, intending, partly, to help Corsica from without. Now talent is flowing the other way—into Corsica.

Corsica Calls Her People Home

On her 175-acre farm on the eastern plain, Mlle Lucette Poggi, a handsome lady of 48, told me, “I am Corsican, but I was born in Morocco, where my father worked for the French Government. I wanted to be a chemical engineer.” With the wind blowing her blond hair, we walked toward the barn. “Now here I am with 700 sheep.” She laughed. “I’ll have 1,200 in another four years.” The flock, in an uproar of bleating, was arriving at the barn.

“I went to Paris after the war,” said Mlle Poggi. “But then, when my father retired to

Provence, I was converted to the soil. I learned farming, and we came to Corsica.”

Mlle Poggi spoke warmly of her land. “It’s the most beautiful country anywhere.” To the southwest, jagged crests bit the sky at nearly 7,000 feet. “In winter those mountains are white with snow. It’s a magnificent sight to wake up to in the morning. And there”—five miles away lay the Mediterranean—“I can be swimming in 15 minutes.”

She folded her arms and grinned at me. “I’m free here. My own woman. I look after my father and his sister, and with three Moroccans I run the farm. I can drive that tractor when I have to.

“I’ve seen all those films about California, the settling of the American West. You think it is not the same here?”

I was certain that it was the same—just as I was certain that the future of Corsica is in some very capable hands. □

Abundant Life in a



Desert Land



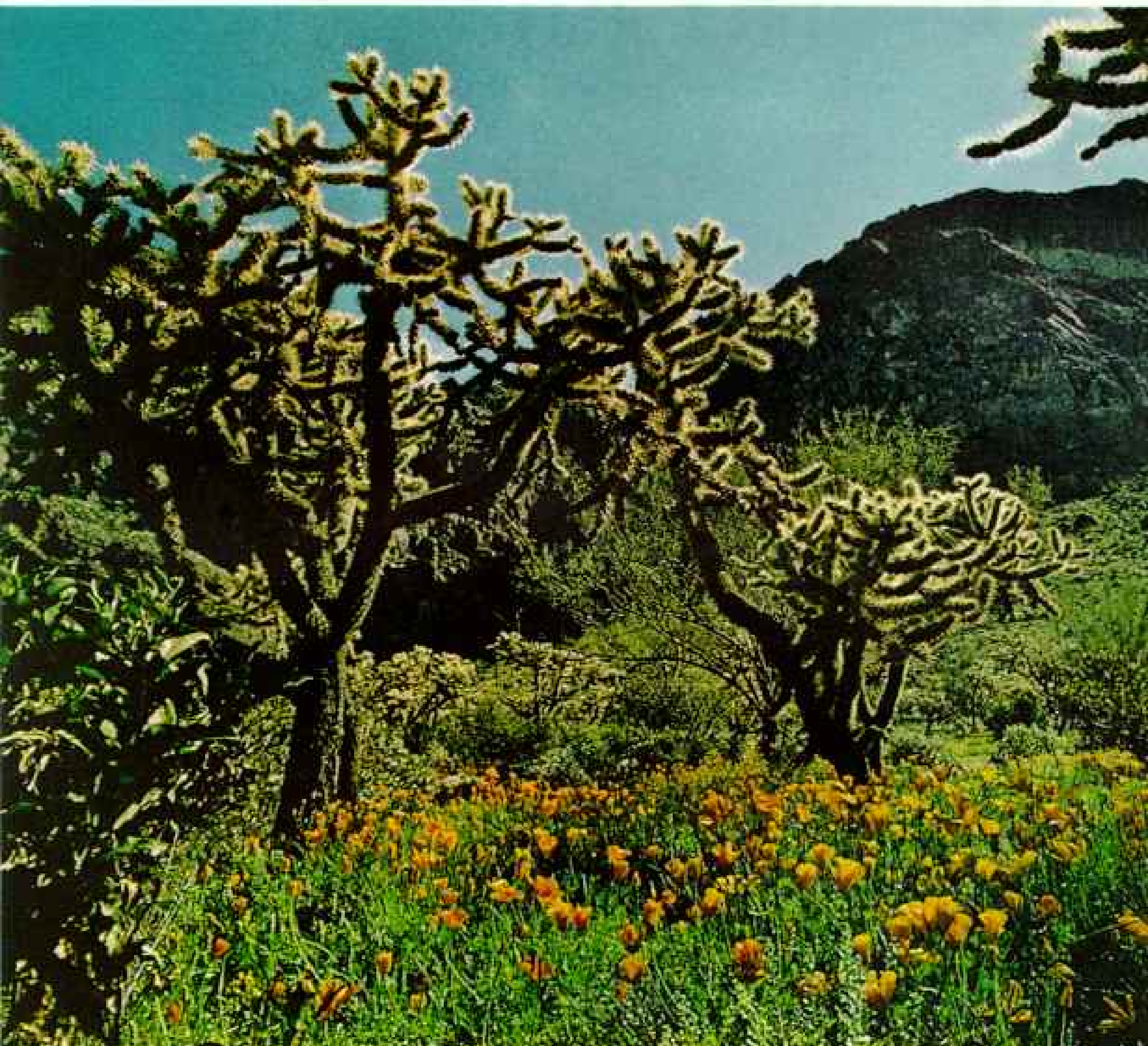
CACTUS, GENUS *OPUNTIA*; LUPINE, *LUPINUS SPARSIFLORUS*

SHIMMERING as if in moonlight, a shaded slope glows with lupine and the silvery spines of cholla cactus (left).

My wife, Mary, and I are crunching along the winding trails of Arizona's Organ Pipe Cactus National Monument, where such eye-stopping swatches of color appear on slope after slope. In the most spectacular spring show of recent years, brittlebush blooms yellow near paloverde trees; deep-pink owl clover grows in roadside gardens, and orange poppies wave from foothills and gullies.

Belying the popular image of our great southwestern drylands—a dead and dusty realm—the Sonoran Desert supports an amazing mélange of life. Kit foxes, jackrabbits, and small rodents by the thousands prowl the night, scurrying from an occasional bobcat. Dawn finds rare desert bighorn sheep grazing cliff-top pastures, the golden eagle and its mate taking to vibrant blue skies. Throughout the year some 530 species of plants—from delicate wild flowers to thorny cactus giants—spring from the pebbly soil of the 516-square-mile desert preserve.

The national monument was set aside in 1937 to protect a segment of this curious and arid land. Each year some 100,000 visitors from many countries come to see its towering clumps of organ-pipe cactus, found in the United States only near or within the preserve's border (map, following page).



Organ Pipe Cactus

NATIONAL MONUMENT





POYEHUILTIS, MEXICANA

EARTHBOUND sunbeams, Mexican gold poppies (above) once fed pioneers' cattle. Papago Indians, learning to survive in this hostile land, ate the bulbs of the desert hyacinth (upper right). Spanish explorers named the desert lily *ajo*, or garlic, because of its oniony-tasting bulb. Now a town, valley, and mountain range (maps, left) share the name.



BRODIAEA PICHUELLA PRUCIFLORA



HEPERICALLIS UNGULATA



Chasing the sun from the Ajo mountains, storm clouds shadow the earth. The reserve's rainfall, less than ten inches a year, comes mostly in summer downpours. Then torrents race down the arroyos.



ORGAN PIPE CACTUS, *CYLINDROPUNTIA THURBERII*; SAGUARO CACTUS, *CYLINDROPUNTIA GIGANTEA*

and barren plains turn verdant. But the candelabra-like saguaro cactus, left, and the many-branched organ-pipe, center, from which the monument takes its name, endure through wet seasons and dry.



PHOTOGRAPH BY MICHAEL HARRIS



CECTOPUS OROPHYLUS OROPHYLUS

SPINY STRONGHOLDS and prickly pantries attract the desert's feathered homeseekers. This Harris's hawk (left) built its nest atop a roadside saguaro. Cradled in the towering branches, the thorny roost protects eggs and young from becoming a meal for other creatures.

Perforated by busy beaks, an organ-pipe's dead branch (above) provides a lunchtime perch for a Gila woodpecker: The diminutive "ladder back" drills in search of beetles and grubs. By excavating fist-size holes in living cactuses, the pugnacious birds build comfortable homes that are almost predator proof.

Protected by a tangle of thorns, a road-runner (right) nests in a cholla. When hunting the open desert, the fleet bird may sprint at some fifteen miles an hour in its chase for a lizard, an insect, or a young rattlesnake—or to escape a wily coyote!



GEOPHILA CALIFURNIARDE



BEETLE, *PHODONIA SPLENDENS* (RIGHT)

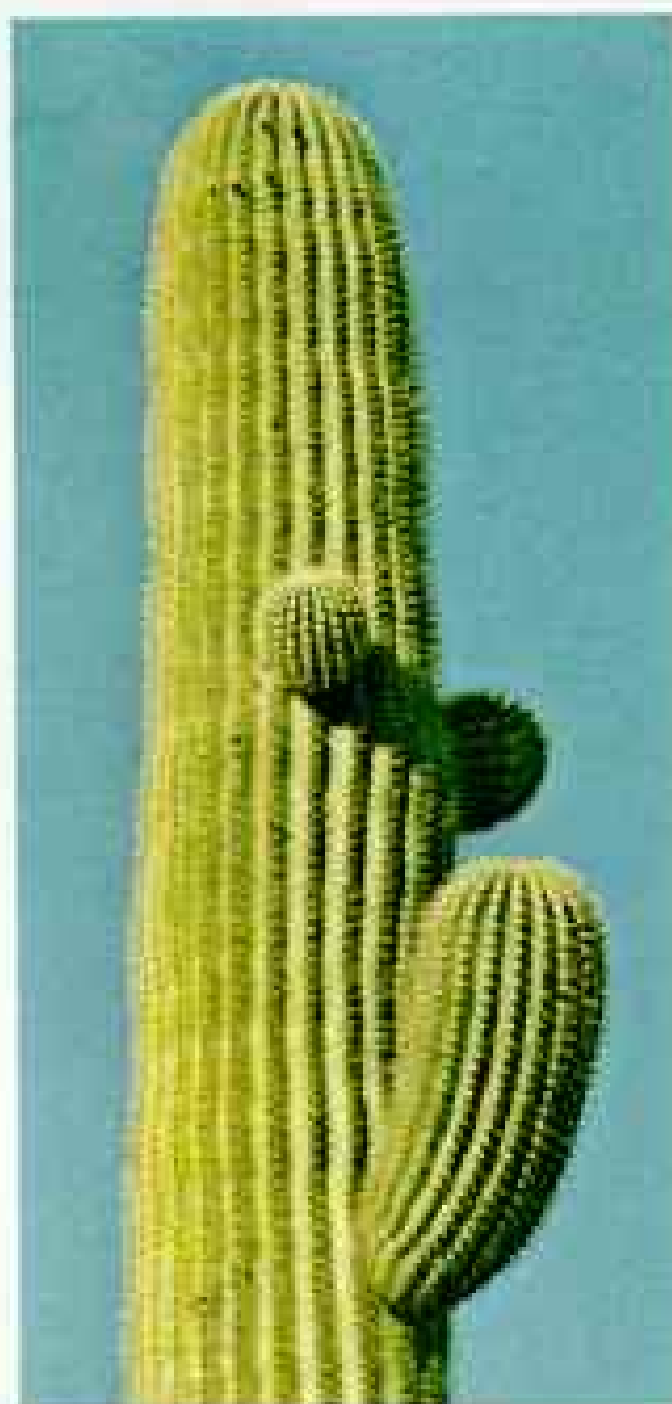
IT JUMPED AT ME," Mary claims as she dislodges a cholla joint from her hiking boot. At the slightest touch of man or animal, the jumping cholla's barbed branches, growing like links, break off and stick to unsuspecting victims. When such hitchhikers ultimately fall free, they root where they land and another cholla begins to grow.

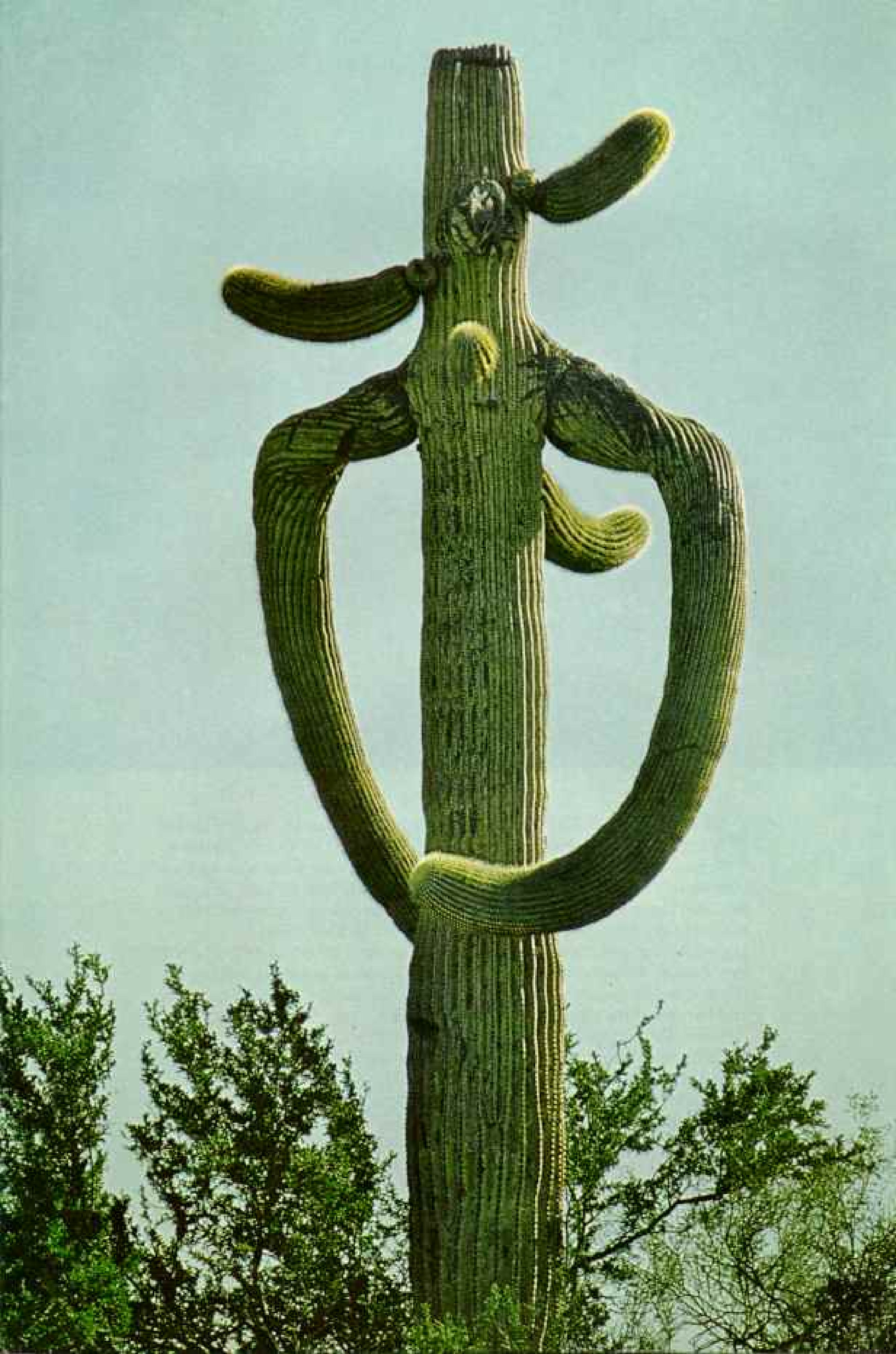
A near relative of the jumping cholla sprouts plump clusters that earn it the name teddy bear (right). Near the center of this stand, a lone organ-pipe makes its home; young saguaros raise their as yet branchless trunks beyond. Some 35 species of cactus, including the six-inch-high fishhook variety, flourish in the monument. Willowy ocotillos quickly sprout tiny leaves following rare rains.





CACTUS COWPOKE with a ten-gallon hat (facing page), a saguaro with misshapen branches seems to reach for its six-gun. Another (below) looks like the bullet-riddled loser in a phantom shoot-out. Other pincushion oddities resemble a giant, not-so-lucky prizefighter with a bulbous nose and swollen eyes (right), and a grotesque neck-craning dinosaur (bottom right). King of American cactuses, saguaros grow as tall as 50 feet, draw up water by the ton, and may live for two centuries. Long after death, cactus hulks grant haven to scorpions, termites, and the poisonous Gila monster.







STRAIGHT AS RAMRODS, a regiment of young saguaros guards the route of Indians, conquistadors, missionaries, bandits, and prospectors who wrote the early history of Arizona. Near the jagged Ajo mountains, background, live Papago Indians, whose ancestors roamed the desert centuries ago and harvested the sweet fruit of the saguaro and organ-pipe cactuses.

Coronado's men in 1540 penetrated the Papagos' sun-parched world. A century and a half later Jesuit missionary Eusebio Francisco Kino brought Catholicism to the land. Father Kino charted a trail through the broiling wilderness that

came to be known as El Camino del Diablo—The Devil's Highway. Forty-niners on their way to California in search of gold struggled along the same route—and many died for lack of water.

The early 1900's saw Pancho Villa's Mexican banditos seeking refuge from the law in the Ajos, while beneath the heights cattlemen strove to sustain their herds on the desert's sparse grasses.

Today, despite the 20th century's steamrolling urban growth across the Southwest, Organ Pipe Cactus National Monument remains a sanctuary of nature in a thirsty, fragile world. □

Sails across the desert

CHALLENGING an ocean of sand and gravel, a fleet of bright-sailed land yachts dares one of the world's most forbidding corners in "Wind Raiders of the Sahara" on ABC-TV, Thursday, September 6.

In this first color documentary of National Geographic's 1973-74 season, you join a crew of European, Canadian, and U.S. pilots at the Algerian oasis of Tindouf. There blue-robed Re-guibat women celebrate the sailors' departure with the same sinuous dances that once bade farewell to salt caravans embarking for fabled Timbuktu.

On their 1,500-mile odyssey, the sailors endure the lash of sandstorms, the agony of lying becalmed under the noonday sun. Suddenly you hear jubilant shouts; in sight now lies the cool surf of the Atlantic and journey's end.

Leslie Nielsen narrates "Wind Raiders of the Sahara," produced by the National Geographic Society in association with Wolper Productions. The sponsor is Western Electric.

PHOTOGRAPHS BY MICHAEL ST. JOHN



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COVER: Pig-tusk and cowrie-shell spirit figure beards a New Guinea tribesman (pages 354-81)

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In search of the living Inca

"COMPUTERS" of string, bridges of grass—from such frail stuff did the Incas fashion the ligaments of one of history's great empires.

This December, author-photographer Loren McIntyre will take readers into the soaring world of the Sons of the Sun, who forged an empire nearly as far-reaching as Rome's.

Seeking vestiges of Inca civilization, Mr. McIntyre found a Peruvian who still tallies crop yields on a knotted-string counter called a *quipu* (top). Incas of old used the device to record statistics—counts of resources and of subject peoples.

Mr. McIntyre also discovered the only known remaining *keshwa-chaca* (below)—a hanging bridge of twisted-grass fiber, like those crossed by Inca armies marching to remote reaches of the Andes.

Such discoveries make every issue of NATIONAL GEOGRAPHIC a reader's delight and a collector's keepsake. Why not share this bounty by nominating a friend for membership on the form below?



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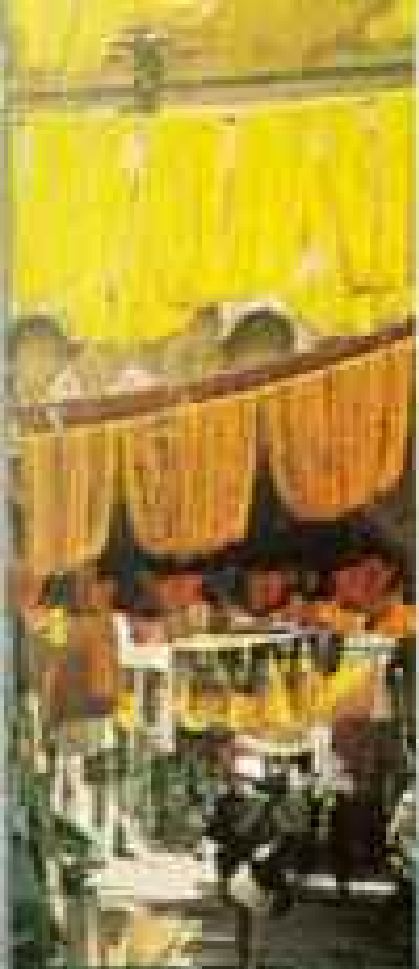
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The Black Sea and Mediterranean. Our three 13-day *Black Sea/Greek Islands* cruises go to places like Yalta and Istanbul in September '74. A 24-day version adds places like Naples and Majorca. And a 44-day version adds the Caribbean and Mexico. Other Mediterranean cruises: the 11-day in August and 14-day in October.

Africa and the Atlantic. Bahia, Rio, Cape Town, plus ten other ports are on our 50-day *Africa/South America* cruise in October from the East Coast. In August, a 14-day *Atlantic Islands/African Coast* cruise visits Spain, Portugal, and Morocco.

The Americas. The year begins with our 13-day *Mexico* cruise in January, followed by nine

Caribbean/Mexico/Trans-Canal trips: Eastbound, Westbound, or both, of 12 to 34 days through '74. Finally, happy holidays: two three week *Central America/Christmas/New Year* cruises, one from each coast, and 13 days to Mexico from the West Coast.

The Pacific and Orient. The Vikings cover the biggest ocean from bottom to top. Our four 6-week *South Seas* winter and fall cruises visit Polynesia, Australia, and New Zealand (including Milford Sound). You can see Japan at Cherry Blossom time on the first of our two 68-day *Spring Circle Pacific* cruises. Our 51-day *Alaska/Orient* cruise in June circles the Northern half of the Pacific, and there are two 4-week cruises, *Mexico/Tahiti/Hawaii* in May and *Canada/Hawaii/Mexico* in August.

Around the World. We do it Eastbound in January '74, on a cruise you can board from either coast. We do it Westbound via the South Seas from the East Coast on January 8, 1975. And on the same day, we do it Eastbound from the West Coast. 94 to 100 days. Take your pick: nobody does it like the Vikings.

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Photograph by Francis Woods

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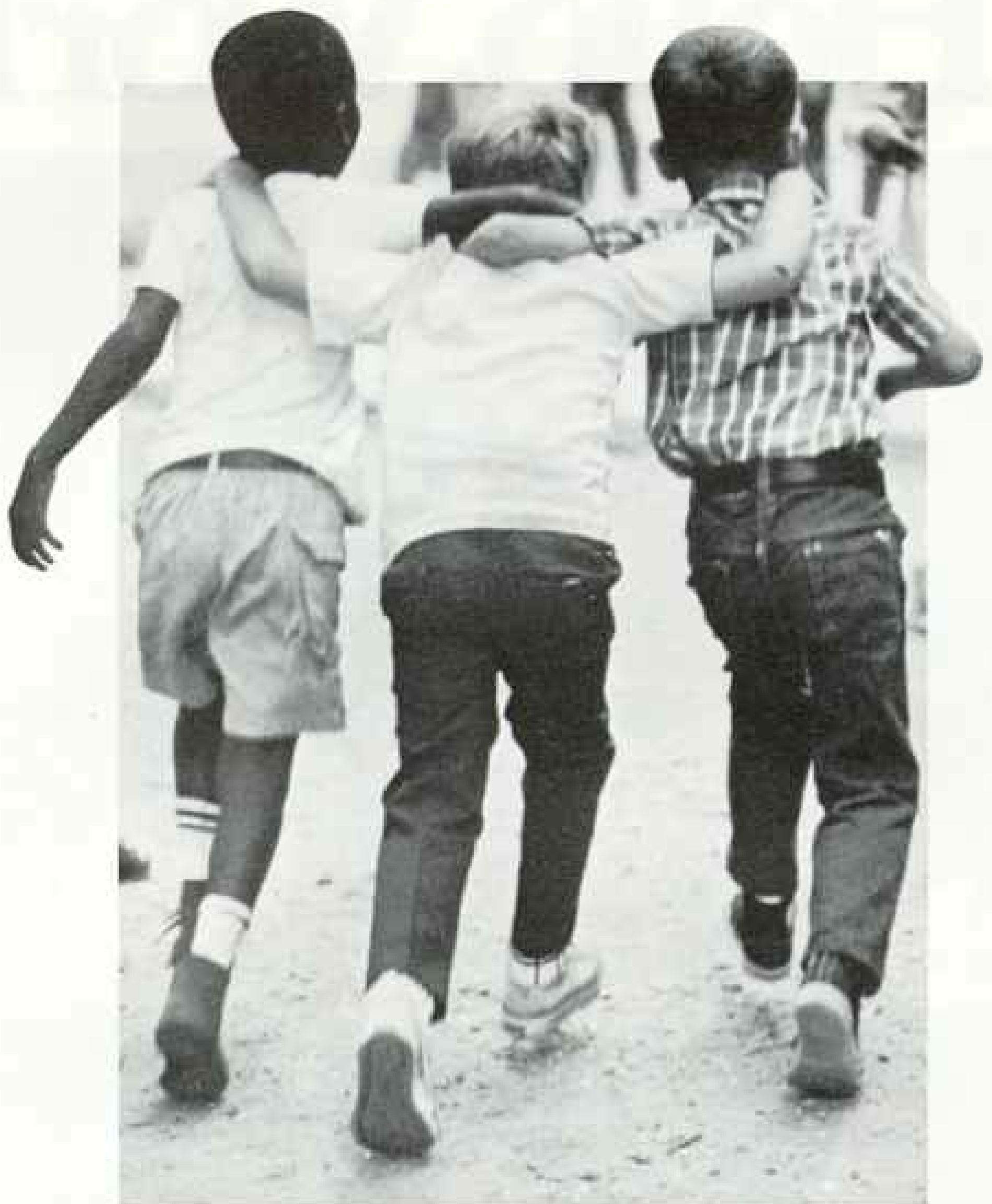
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up is
never
easy.
But you
had lots
of help.**

Your first grade teacher who showed you how words turn into stories. Your high school teacher who helped you solve the mystery of planets. The moon. Stars.

There are so many more you remember. Good teachers. Who helped you become...yourself.

Today, the National Education Association is working hard for smaller classes, better facilities and professional standards throughout the educational system.

That's what today's teaching is all about...finding new ways to help your child grow up.

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...helping teachers teach.

Hello, World.



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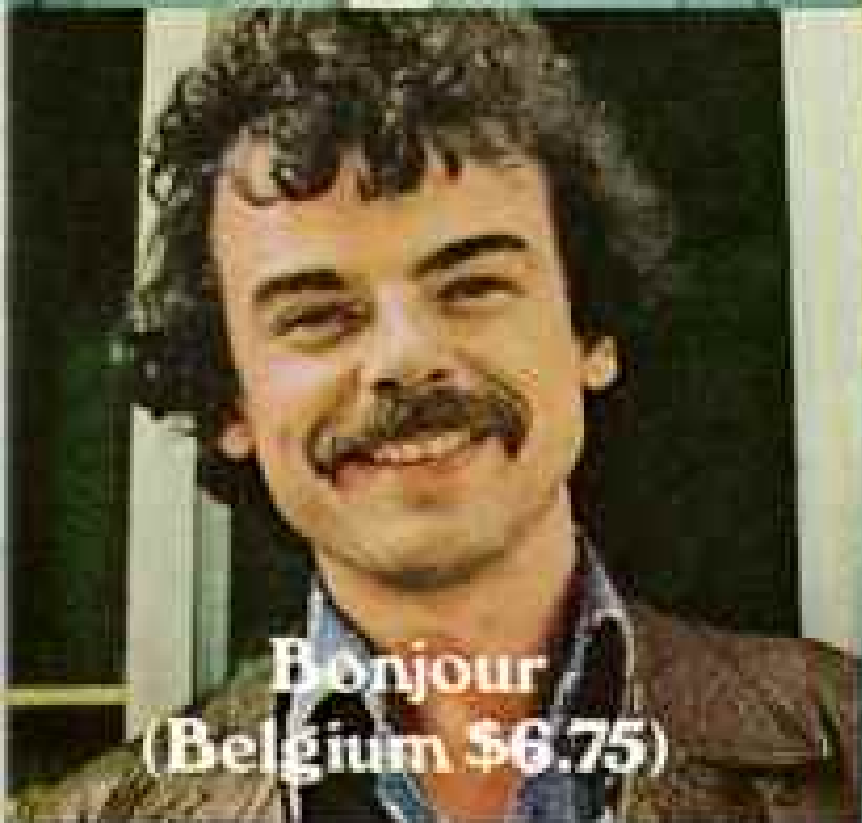
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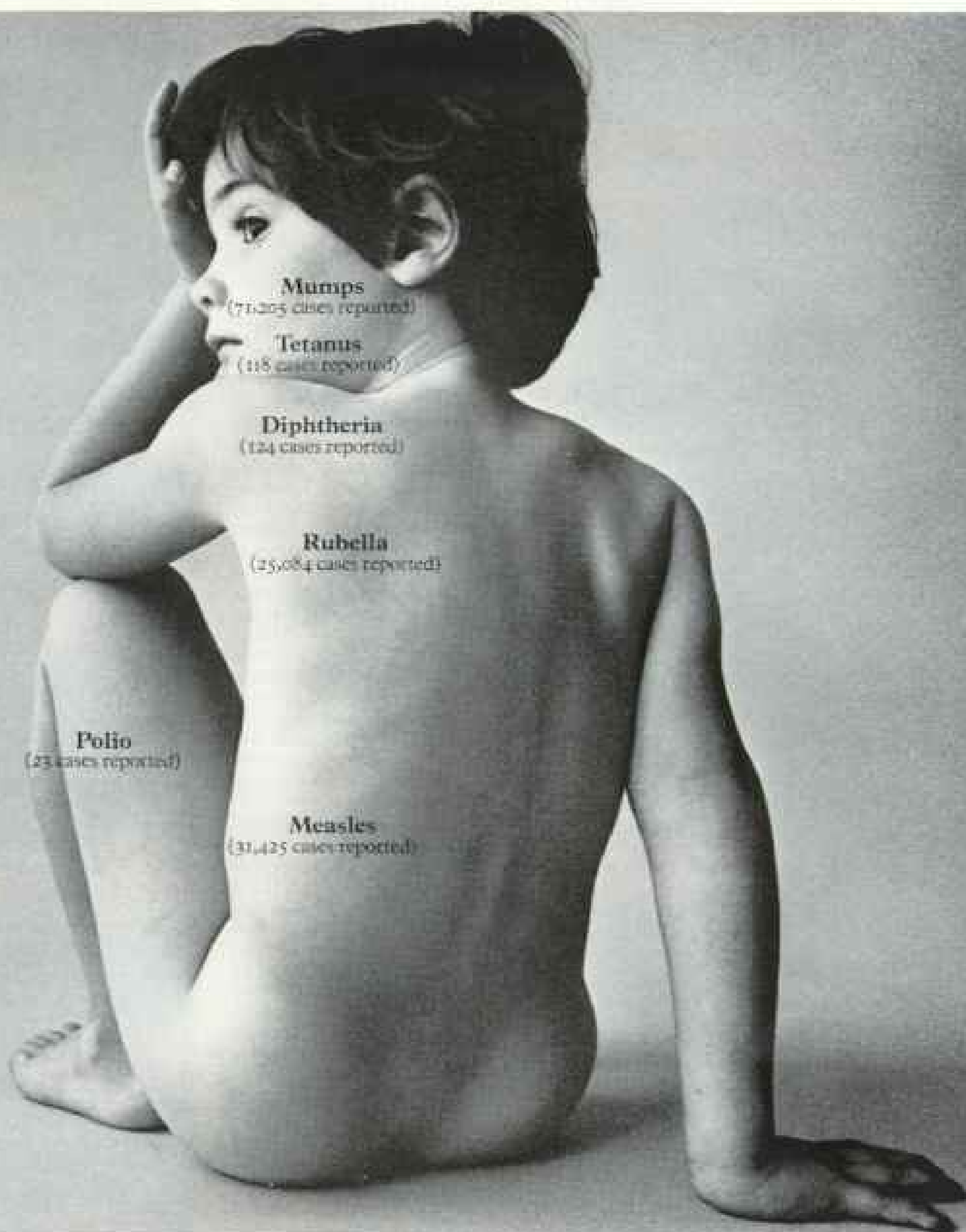
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At other times, rates to some of these countries are even lower — check the international operator for night and Sunday rates, rates to other countries, and rates from Hawaii and Alaska.

So, if you have something for the world to hear, make it your business, or pleasure, to spread the word by phone. It's the next best thing to being there. 

If your child hasn't taken these 6 inoculations, his health is in danger.



These 6 diseases aren't a thing of the past.

They're still very much around. Take a look at the latest annual statistics above, and you'll see.

We think you should know what is happening, because it will serve as a reminder to see that your child is immunized.

With all the things a parent has to remember, immunization is easy to forget.

Many of these diseases require several "boosters." The surest way to see he gets them is to keep a record. To be certain, check with your doctor. Your child's

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If you'd like more information about these childhood diseases, write for our free booklet, "Immunization." It has a complete immunization schedule to guide you.

Write: "Immunization," Metropolitan Life, One Madison Avenue, New York, N.Y. 10010. Or call your local Metropolitan office.

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**“A subway’s
the only way
to fix this mess.”**

In most of our cities, one form of transportation can't keep everybody happy. The problem remains: how do we keep everybody moving?

Rail mass transit can move lots of people quickly. San Francisco's BART system covers 28 miles in 33 minutes including station stops. The same trip takes a rush-hour motorist over an hour. Such trains are clean and quiet. But they won't fit every city. They operate in a fixed line within heavily populated areas.

Buses work better in most cities. They can pick up people closer to home, take them more places easily.

But both buses and trains in urban systems depend on high ridership and ever-increasing fares to meet expenses. As a result, few mass transit systems pay their own way.

Is the answer more expressways? 80% of all city workers commute by car. Add trucks and other vehicles to that congestion and it's no wonder some cities are considering limiting cars downtown. But even if that happens, expressways must continue to play an important role in total urban transportation problems. Almost 100% of the goods and services city dwellers depend on move by motor vehicle.

No single answer is "right." City planners must evaluate alternatives and investigate approaches like "dial-a-bus," jitneys and other people-movers.

The optimum solution must be multi-modal transportation whose components are dictated city by city. No generalization can accommodate every need, every city. All cities urgently need to develop and execute a total urban transportation plan. Not just for today, but tomorrow.

To learn more about urban transportation write "Mobility," Dept. 3075, Caterpillar Tractor Co., Peoria, Ill. 61602.

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choices.**



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get me from
where I live
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And there's nothing better than pure corn oil to bring out the flavor of all the summer vegetables in our Mediterranean salad dinner. Specially since you know that every bite will taste delicious.

After all, who knows more about corn oil than Mazola?



SALAD A LA NICOISE

- | | |
|---|---|
| 1 package (9 oz) frozen whole green beans | 1 medium tomato, cut in wedges |
| 1/2 cup Mazola corn oil | 1 can (1 1/2 oz) pitted ripe olives, drained |
| 1/2 cup red wine vinegar | 1 can (2 oz) anchovy fillets, drained and chopped |
| 1 teaspoon sugar | 1 can (7 oz) tuna, drained and broken in chunks |
| 1/2 teaspoon salt | 2 hard cooked eggs, sliced |
| 1/2 teaspoon pepper | |
| 1 medium red onion, thinly sliced | |
- Cook beans; drain and place in 1-quart bowl. Measure corn oil, vinegar, sugar, salt and pepper into jar. Cover tightly and shake well. Pour half of dressing over green beans; toss. Cover and chill 1 hour. To serve, place beans in salad bowl. Add onion, tomato, olives, anchovy, tuna and half of egg slices; toss. Garnish with remaining egg slices. Drizzle remaining dressing over salad. Serves 4.



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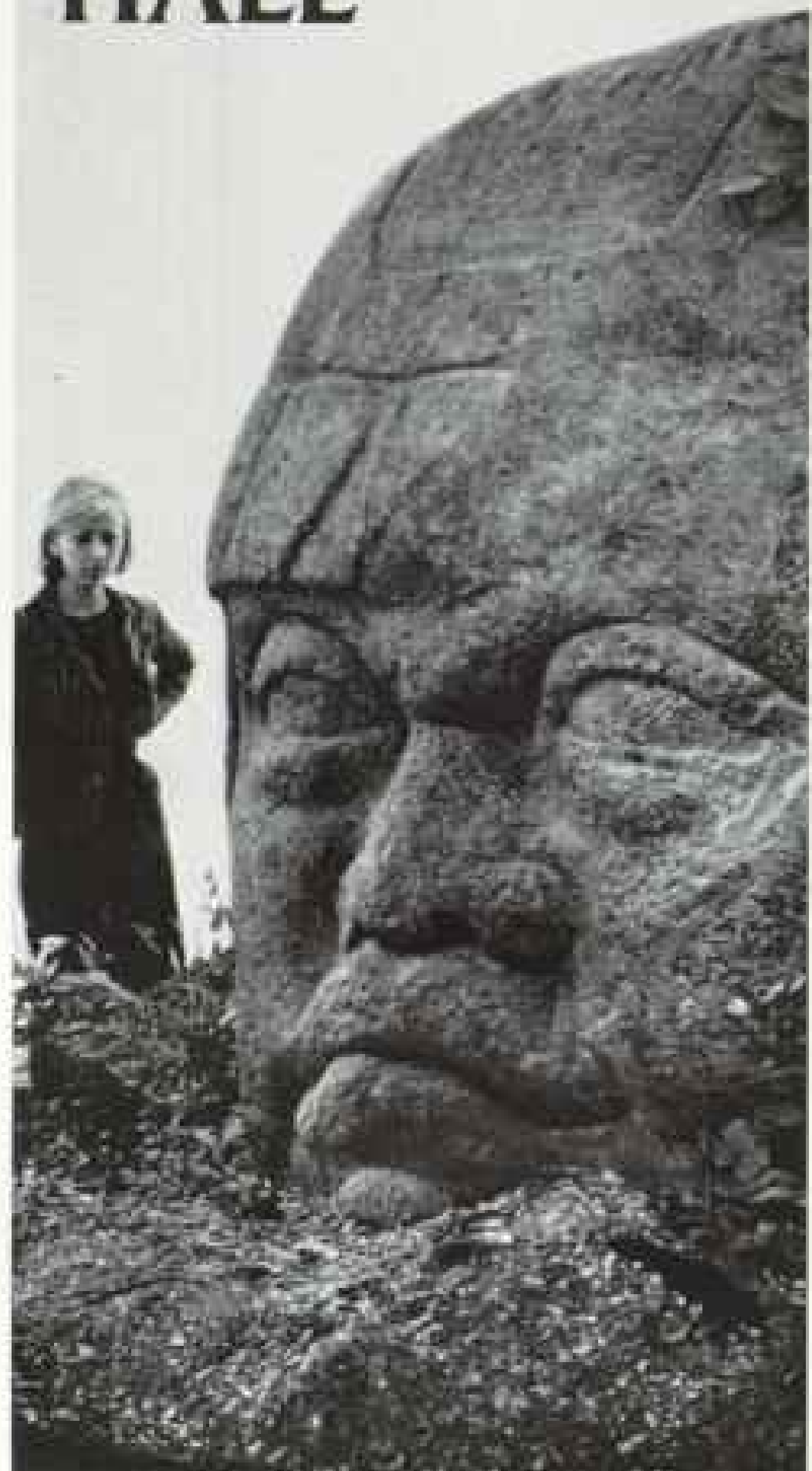
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Kodak XL movie cameras. Kodak Ektachrome 160 movie film.





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This adventure classic is not for everyone

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