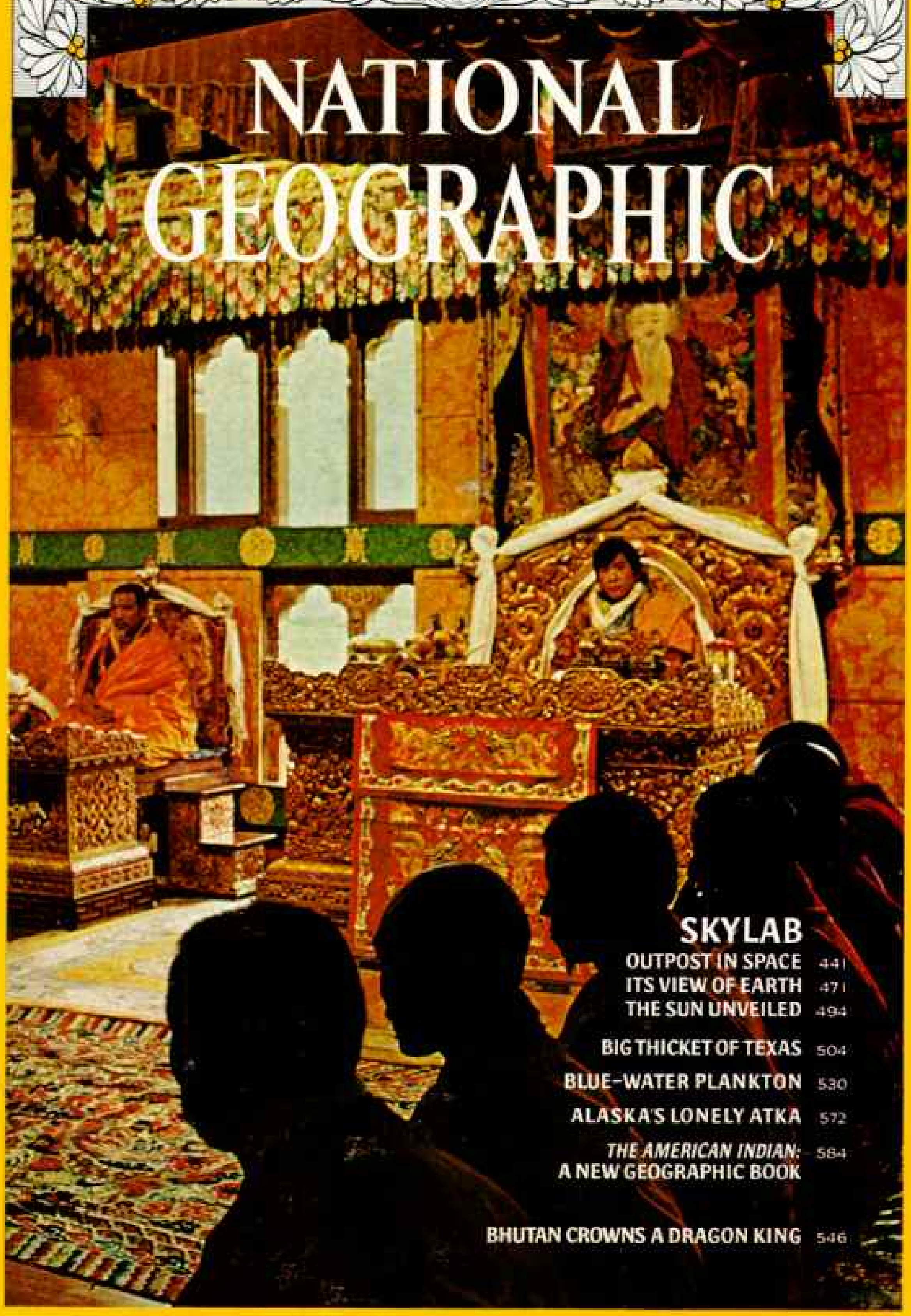
VOL. 146, NO. 4 OCTOBER 1974

NATIONAL GEOGRAPHIC



SKYLAB

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

NATIONAL GEOGRAPHIC

October 1974

Skylab, Outpost on the Frontier of Space

By THOMAS Y. CANBY
SENIOR EDITORIAL STAFF

Photographs by THE NINE MISSION ASTRONAUTS

STRANGE REPAIRMEN, these. The short wiry one is a celebrated astronaut—third man to walk on the moon. The other, a lanky space rookie, is a physician by trade, and by nature a bit of a poet.

Stranger yet is their repair job. Clad in bulky life-support suits, the men cling precariously to the side of Skylab, a titanic space station that bears an unlikely resemblance to a flying Dutch windmill. Inside the lab a third repairman stands watch over monitoring dials. Two hundred and seventy miles below, the curving earth unfolds majestic panoramas of greens, blues, and browns, periodically punctuated by the black of night.

From their perch near the windmill's vanes, the men can look along the lab's tanklike flank and see a twisted aluminum strap. This is their target. Without ladder or handholds they must somehow reach the strap and cut it, to release a huge solar "wing" now pinioned to Skylab's side. Once unfolded to the sun, the wing can produce electrical energy, for which the lab is starving.

Their task this June 7, 1973, is without precedent—to salvage a complicated scientific laboratory, by far the largest and most sophisticated payload ever sent into space.

Skylab and the Apollo spacecraft that rides with it stretch 118 feet from end to end. Skylab is equipped with unique instruments: an intricate package of solar telescopes; complex sensors for scrutinizing earth; ingenious instruments for medical research; even a furnace to make alloys and crystals in space.

The lab's three occupants, already two weeks on the job, will attempt to stay aloft a total of 28 days, twice as long as American spacemen have flown before. After they depart, later crews will stay for 59 and 84 days.

Conceived in the shadow of the glamorous Apollo lunar voyages, the 2.5-billion-dollar Skylab project is the ungainly flagship of a new era—an advance beyond the exploration of space into its occupation and exploitation.

"The Mercury and Apollo programs gave us our Columbuses and Magellans," notes Dr. Rocco A. Petrone, *(Continued on page 451)*

MERCURY . . . GEMINI . . . APOLLO. For fifteen years, NATIONAL GEOGRAPHIC has brought to Society members an unparalleled series of reports on the nation's march into space. Now, combining the adventures of all three Skylab crews and assessing a spectacular harvest of scientific discoveries, the magazine continues its tradition of definitive, in-depth accounts with this three-part look at the accomplishments of America's first manned orbiting laboratory.—THE EDITOR

The ungainly bird that soared for science

ORBITING SILENTLY 270 miles above the cloud-veiled earth, Skylab seems almost a caricature of a sleek spaceship. The main body, adapted from a Saturn rocket fuel tank, wears a wrinkled awning to shade it from the sun. From one flank a mammoth solar panel thrusts outward like a huge flag, while at the forward end four other solar wings spread like windmill vanes atop a stubby, girdered tower.

But appearances deceive. The 100-ton laboratory is the largest, most complex object ever hurled into space. Sophisticated scientific instruments crowd beside an inventory of supplies so numerous that a special computer program keeps track of what is where.

As the mission unfolded, three successive crews of three astronauts each shuttled to the lab in Apollo spaceships. The first team occupied it for 28 days, the second for 59, and the third—which made this picture on leaving the station—for 84 days.

Launched from John F. Kennedy Space Center in Florida on May 14, 1973, Skylab almost died aborning. Shortly after lift-off, atmospheric drag tore off a thin metallic shield designed to protect her from micrometeorites and the sun's intense heat. The debris pinioned one solar wing to the lab's flank; the blast of a retro-rocket tore another panel off completely. Although she slipped smoothly into orbit and unfolded her overhead solar wings, Skylab began her odyssey as virtually a derelict, so heated by the sun as to be uninhabitable, so underpowered as to be unable to perform all her scientific tasks.

Salvaging the station called for repairs of a scale and complexity never before attempted in space, indeed scarcely even contemplated. Backed by a massive support effort by NASA and the aerospace industry, the astronaut crews restored the lab to health and cured a succession of in-flight ailments as well.

Throughout their 5½ months aloft, the crews pursued an exhausting regimen of research, with results exceeding all expectations. Training a battery of eight solar telescopes, the men discovered a sun of unsuspected violence. Earth sensors brought back hints of new ore deposits and fishing grounds, new ways to monitor croplands and weather. In a compact furnace the crewmen produced alloys and grew crystals vastly superior to those on earth. Carefully monitoring one another's bodies, the astronauts demonstrated that man can adjust to space flights months in duration.

When the final team left the station, on February 8, 1974, Skylab had carried her crews 2,476 times around the globe—70 million miles—one of science's most productive journeys.

SKYLAB 2 (ABOVE AND LEFT); SKYLAB 3 (PRECEDING PAGES)

Free of gravity's fetters, astronauts flex their wings in the wondrous world of weightlessness. Alan L. Bean (**left**), a gymnast during college days, flips without worry about landing on his feet—or even landing at all. Swooping swan dive—a standard means of locomotion in the lab—carries Jack R. Lousma across the main chamber.

The crews quickly mastered the tricky art of maneuvering in zero gravity and delighted in televising their antics to earthlings. Their mobility assured NASA that similar teams will be able to work productively in the Space Shuttle, scheduled to begin its flights by the end of this decade.

THIS PAGE FOLDS OUT

ALAN L. BEAN
Captain, USN

JACK R. LOUSMA
Major, USMC

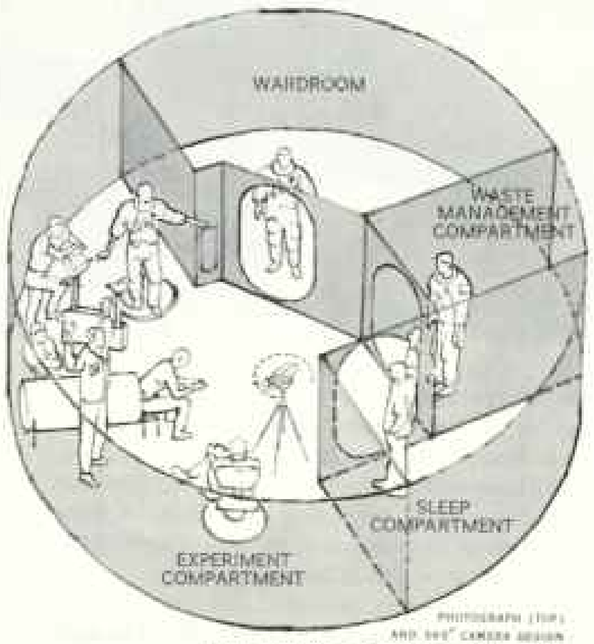
CHARLES CONRAD, JR.
Captain, USN

JOSEPH P. KERWIN, M.D.
Commander, USN

GERALD P. CARR
Lt. Colonel, USMC

EDWARD G. GIBSON, Ph.D.
Solar Physicist

PAUL J. WEITZ
Commander, USN



PHOTOGRAPH (TOP) AND 360° CAMERA DESIGN BY MICHAEL LAWTON; DIAGRAM BY ROBERT T. MCCALL

Together on earth as never in space, the nine members of the three Skylab crews gather in a training simulator at the Johnson Space Center near Houston, Texas. For this unique photograph, the astronauts range around the lab's living and medical-experiment quarters as shown in the diagram at left. An ingenious new 360° camera, set up near the chamber's center, rotated to record the panorama without apparent distortion.

Clad like his crewmates in Skylab jacket, Bean perches on a chair that rotated to test effects of weightlessness on the spatial and motion sensors of the inner ear. Lousma grips the metal-grid ceiling. Beside him, members of the first mission cluster around a tanklike device that monitored the men's cardiovascular systems. Carr, in a space suit, rests a foot on a collapsed shower stall, while Gibson and Pogue appear at doors to the wardroom and hygiene chamber. Garriott, third member of the second crew, stands at the door to the lab's compact sleep compartment.

SKYLAB 1 (ABOVE, BELOW, AND RIGHT CENTER)

SKYLAB 3 (ABOVE AND BELOW)

WILLIAM R. POGUE
Colonel, USAF

OWEN K. GARRIOTT, Ph.D.
Electrical Engineer

SKYLAB'S BARBERSHOP (far left) gets its first customer. Weitz holds a vacuum hose to catch hairs snipped off by Conrad.

"JOE'S BLOB," a dollop of water set adrift by Kerwin, fascinated the first crew. As surface tension shaped it into a perfect sphere, the physician poked in a straw and blew a bubble within the blob.

GRACEFUL GLIDE carries Gibson through the workshop hatch.

HIGH-RIDING CONRAD (lower left) pedals a stationary bicycle used for exercise and for monitoring the men's metabolism.

SPREAD-EAGLED Carr wears cleated shoes for steadying him on the lab's grid flooring.

BEARDED SPACE WIZARDS show their magic. Carr "supports" Pogue with a single finger (left).

"BEDDED UP" instead of down (right), Garriott retires in one of the lab's three sleeping bags, attached to walls to save space.

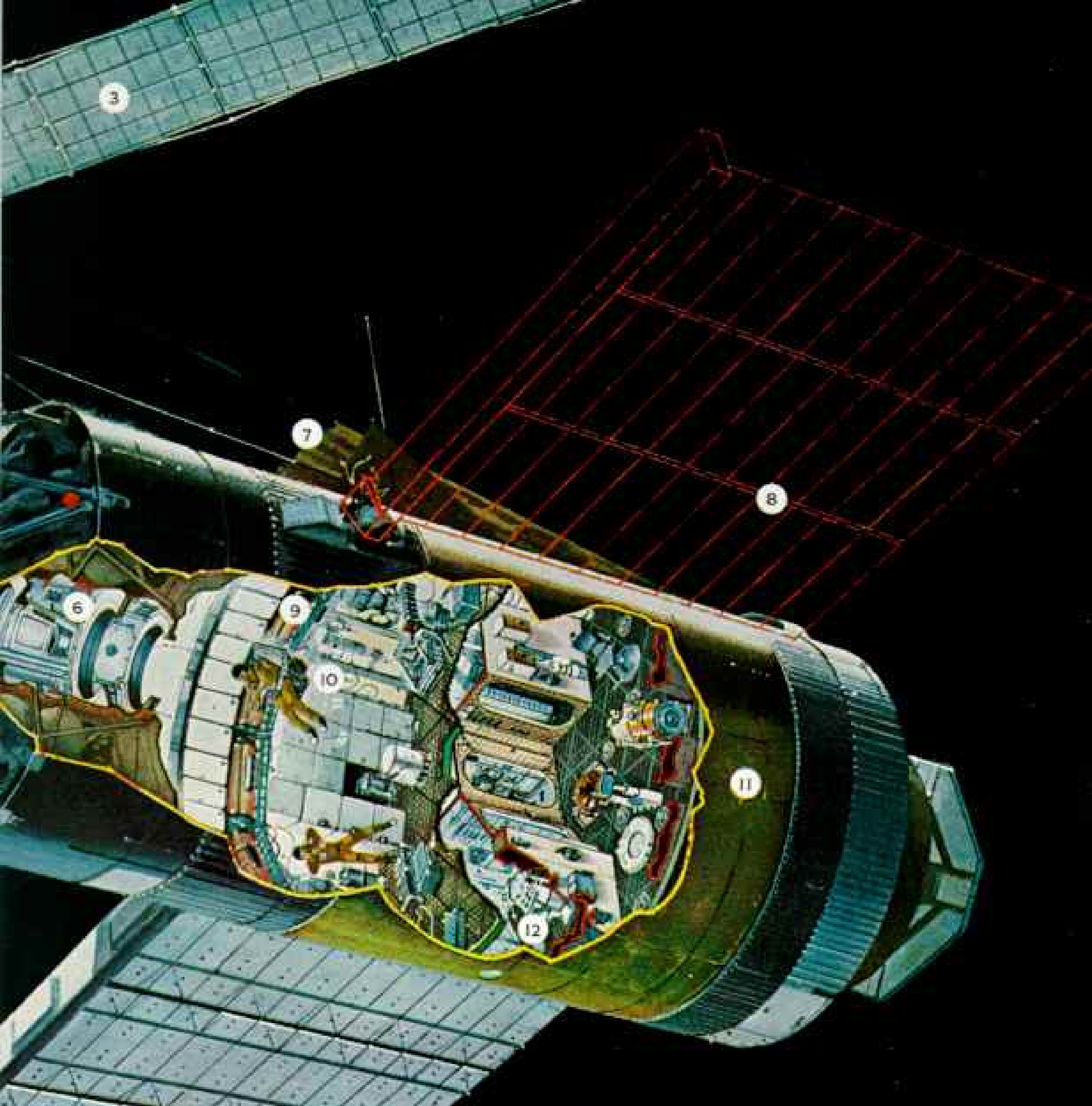
Room to work, to live, to park the taxi

MEASURING 118 feet from stem to stern, Skylab carries the most varied assortment of experimental equipment ever assembled in a spacecraft. Her size and complexity become apparent in this artist's cutaway.

1 COMMAND SERVICE MODULE. An Apollo spacecraft ferries each three-member crew, docking at the lab's forward end during the mission.

2 APOLLO TELESCOPE MOUNT. Eight sophisticated solar telescopes, the largest ten feet long, view the sun high above earth's obscuring atmosphere. Three large stabilizing gyroscopes also ride in the ATM.

3 ATM SOLAR ARRAY. Four solar wings, each capable of producing 2,600 watts, sprout from the ATM. This system powered the lab until the first crew freed a jammed main solar panel.



PAINTING BY ROBERT T. McCALL

(4) AUXILIARY DOCKING PORT: If a command module fails during a mission, a rescue craft can be launched from Kennedy Space Center and docked here to pick up the stranded crew.

(5) MULTIPLE DOCKING ADAPTER: In addition to providing entry into the lab, this chamber houses consoles for controlling the telescopes and earth sensors.

(6) AIRLOCK: By sealing a hatch at each end, space-walk crews can depressurize the chamber, then venture outside the lab.

(7) SUNSHADES: To protect the area exposed to the sun by the shorn-off heat shield, two successive nylon-Mylar shades were spread.

(8) MISSING SOLAR ARRAY: Red lines sketch the intended position of the solar wing that ripped off soon after launch. The first crew extended the opposite wing manually after it was jammed by debris from the heat shield.

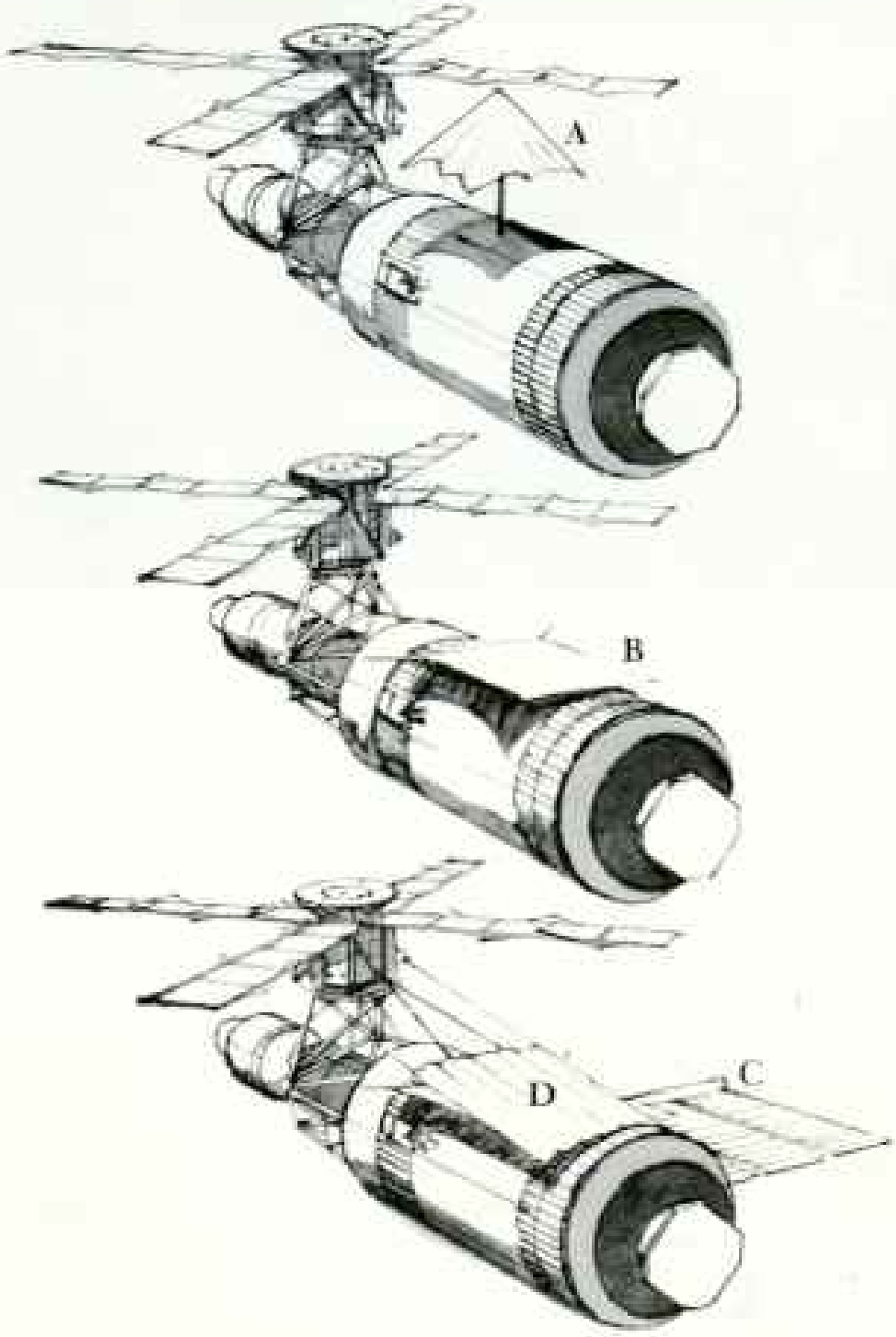
(9) WATER TANKS: Ten tanks holding 72 gallons apiece ring the workshop. Nearby storage lockers hold supplies ranging from clothing to gourmet foods such as filet mignon and lobster Newburg.

(10) SPACE MANEUVERING UNIT: A crew member tests a hand-controlled backpack such as will propel astronauts performing space-walk chores outside future space vehicles.

(11) ORBITAL WORKSHOP: This main living and working area, 27 feet long and nearly 22 wide, occupies a Saturn rocket fuel tank that serves as the lab's main body.

(12) WARDROOM: A table with electronic heaters warms the crew's meals, and a circular window provides breathtaking views of earth below.

ARTHUR C. CLARKE'S ORBITER BY ROBERT T. MCCALL



Sun-ravaged skin, bared by the missing heat shield, wears blister scars and tarnish from temperatures that reached 300° F. A port designed for astronomical instruments looks from the workshop, where heat threatened to destroy film and food and unleash deadly gases from deteriorating plastic.

To NASA engineers the message from the yet-unmanned spaceship was clear: Shade Skylab from the sun, or abandon the mission. Racing against time, they devised a huge yet delicate parasol with collapsible ribs and sent it aloft, plus two alternative shades, in the first crew's CSM. Rendezvousing with the lab, the men assembled the parasol staff inside the sweltering station and extended the shade (**A**) through the port. Once opened and lowered against the lab (**B**), it reduced temperatures dramatically, making the lab habitable. The crew then could release the crippled solar panel (**C**).

Concerned that the parasol might deteriorate in the searing sun, NASA instructed the second crew to deploy another sunshade during a space walk. Extending two 55-foot rods over the workshop, the crewmen unfurled the shade (**D**) along the rods, much as seamen raise a sail.

Associate Administrator of the National Aeronautics and Space Administration. "Now we need our Jamestown settlers, our Pilgrims. Skylab is the precursor of these, man's first outpost on the frontiers of space."

The lab's body, called the workshop, is the converted upper stage of a Saturn moon rocket left over from Apollo days. To this chamber for working and living is added a narrower cylinder to house controls for pointing the telescopes and earth sensors, and two sets of solar wings for electric power. Packed into lockers are supplies and equipment on a scale never known in space. Skylab's film and film vaults alone—4,760 pounds—weigh more than did John Glenn's entire Mercury capsule with Glenn inside.

Trouble Strikes Within Seconds

On May 14 of last year thousands of onlookers watch the great ship, heavy as Columbus's *Santa Maria*, slowly lift off atop the man-made volcano of a Saturn V rocket in a perfect, classic launch. But even as its roar reverberates, catastrophe strikes.

As the rocket accelerates, atmospheric drag claws at the meteoroid shield, a thin girdle designed to protect the workshop from tiny space particles and the sun's scorching heat. Sixty-three seconds after launch, at 28,600 feet, the shield rips away from the lab. As it flies off, it trails an aluminum strap that catches on an unopened solar wing, tethering it to the lab. At the same time the shield pries the opposite wing partly open. Minutes later a staging rocket blast tears loose the partially deployed wing and flings it into space.

Once in orbit, Skylab obediently unfolds its telescope mount to point at the sun. Atop the mount four smaller solar panels blossom —the vanes of the windmill.

But Skylab, still unoccupied, is a stricken spaceship. With the loss of the heat shield, sunlight beats mercilessly on the lab's sensitive skin. Inside, temperatures soar, rendering the station uninhabitable and threatening food, medicine, and film.

Within hours, Skylab Director William C. Schneider halts countdown on the Saturn 1B rocket scheduled to be launched next day, carrying the lab's first, all-Navy crew: Capt. Charles "Pete" Conrad, Jr., in command; Comdr. Joseph P. Kerwin, science pilot and physician; and Comdr. Paul J. Weitz, pilot. Across the country NASA centers and contractors race to devise emergency repairs.

At the Lyndon B. Johnson Space Center near Houston, Technical Services Chief Jack A. Kinzler grapples with the problem of a makeshift sunshade to replace the heat shield and lower the ovenlike temperatures. He ponders a mammoth parasol to cover the workshop. But how to carry this in a crowded Apollo command module?

"I'm no fisherman," Jack says later, "but I *am* a gadgeteer. Right away I thought of telescoping fishing rods as models for extendible parasol ribs. I sent downtown for five at $12.50 each." Twenty-four sleepless hours later he successfully demonstrates to NASA officials how his rods can unfurl a tough nylon-Mylar sheet over the lab to shade it.

Simultaneously NASA and industry teams search for a way to free the stuck solar wing. But how do you cut an object on a part of the ship that seems inaccessible, with not even a foothold to steady the repairman?

Cut the inaccessible . . . Men do it every day along the highways, pruning limbs from overhead lines with long-handled shears operated by pulling a lanyard. NASA machinists set about making a collapsible-handle model that will fit into the command module.

A potential launch date for the crew comes on May 20, when Skylab's orbit brings it over the cape. But repair tools are not yet ready. Already some medicines and films are ruined. Worse yet, the heat may be producing a gas so deadly that breathing two parts in a million could be fatal. If a salvage mission does not lift off on one of Skylab's next passes over the cape, the station will become a derelict adrift in the sky.

Repairmen Go to the Rescue

Countdown begins for the May 25 pass. With only hours to spare, a jet streaks in from Houston bringing the parasol. It goes into the CSM beside the pruning shears, backup tools, and replacement medicine and film.

Conrad, Kerwin, and Weitz squeeze into the capsule. After a perfect countdown their Saturn 1B rocket, spewing fire and pealing thunder, roars aloft. The voice of Conrad crackles over the radio: "We can fix anything!"

With Conrad at the controls, the capsule pursues the space station. "Tallyho, the Skylab!" the commander reports as it comes into view. He jockeys around it, confirming that one wing is gone—"completely off the bird."

Later, as they approach the other panel, Weitz stands up in the capsule hatch, snags

the wing with a long hooked stick and vainly struggles to pull it free.

Defeated, they approach to dock with the lab. But even this routine maneuver fails. Eight times Conrad approaches; eight times the docking latches fail to lock. The tired men put on space suits again and make an impromptu repair of the docking mechanism.

On the next try they dock. After a night's sleep Weitz and Kerwin, using a detector before entering each part of the lab, find no toxic gas. "We pass with flying colors," Weitz tells Capsule Communicator Henry Hartsfield, the astronaut guiding them from the ground, as he will in repair jobs to come.*

Top priority goes to erecting the parasol. Carefully Conrad and Weitz extend it through a workshop port, then expand it over the lab's scorching sun side. One corner rumples a little, but it works; temperatures immediately begin dropping. Skylab is now habitable.

But the many experiments on board demand far more energy than the four telescope panels can generate. Only if the crew frees the crippled solar wing can Skylab fulfill its scientific mission.

And so, after 13 days in space preparing for the job and adjusting to their new environment, the strange repairmen are ready to try.

Rehearsals Preceded High Drama

Clinging to the outside of the station in a clumsy pressure suit, Conrad assembles five sections of an aluminum pole, each five feet long, as Kerwin hands them to him. To one end he attaches a cutter head. Now they have their long-handled pruning shears.

Weitz, inside the lab, checks off each step, which another crew has carefully rehearsed in the simulated weightlessness of a huge water tank at the George C. Marshall Space Flight Center at Huntsville, Alabama. Skylab passes into earth's shadow, compelling the men to ride out half an hour of nighttime.

The craft heads into sunrise, and the spacewalkers confront their next move: to lock the cutter jaws on the aluminum strap 25 feet away. This is Kerwin's job. But he finds himself enmeshed in a snarl of umbilicals and tethers. Whenever he tries to extend the pole, the effort sends his feet flying.

He struggles harder. Mission Control, monitoring his heart rate, sees it soar from a normal 70 beats a minute to 150. "Cool it for a minute, Joe," Conrad advises.

Radio contact with Houston has broken off as Skylab traverses a region not covered by tracking stations. After ten minutes of silence, NASA hears them talking again.

"Sounds like you got it hooked on," ventures Mission Control. "Yes," announces Conrad calmly. "Dead center." Kerwin has emplaced the cutter after tethering himself to a ring at the base of an antenna for stability.

Just in Case, a Bone Saw

Now Conrad moves hand over hand along the pole, stringing a line behind him. His tools include a pry bar and a wire bone saw from Skylab's medical stores to sever the strap if the shears fail. Reaching the wing, he attaches his end of the line to it.

Another nighttime stops them. The craft sweeps across the Indian Ocean. Finally daylight glints ahead. "I can see sunrise," observes Kerwin at his perch by the antenna. "Out of China, 'cross the bay, kinda."

He pulls the lanyard to close the jaws and cut the strap. But it resists. "Man, I am really pulling!" he gasps.

Then: "Whoops! There she goes," explodes Conrad as the strap parts, and the crewmen burst into the laughter of intense relief. Using the line, they pull the stuck wing free.

"We see amps," reports a delighted Mission Control. The wing panel is already reaping the treasured solar power. Conrad and Kerwin reenter Skylab, and the astronauts resume their increasingly familiar day-to-day life in the exotic world of weightlessness.

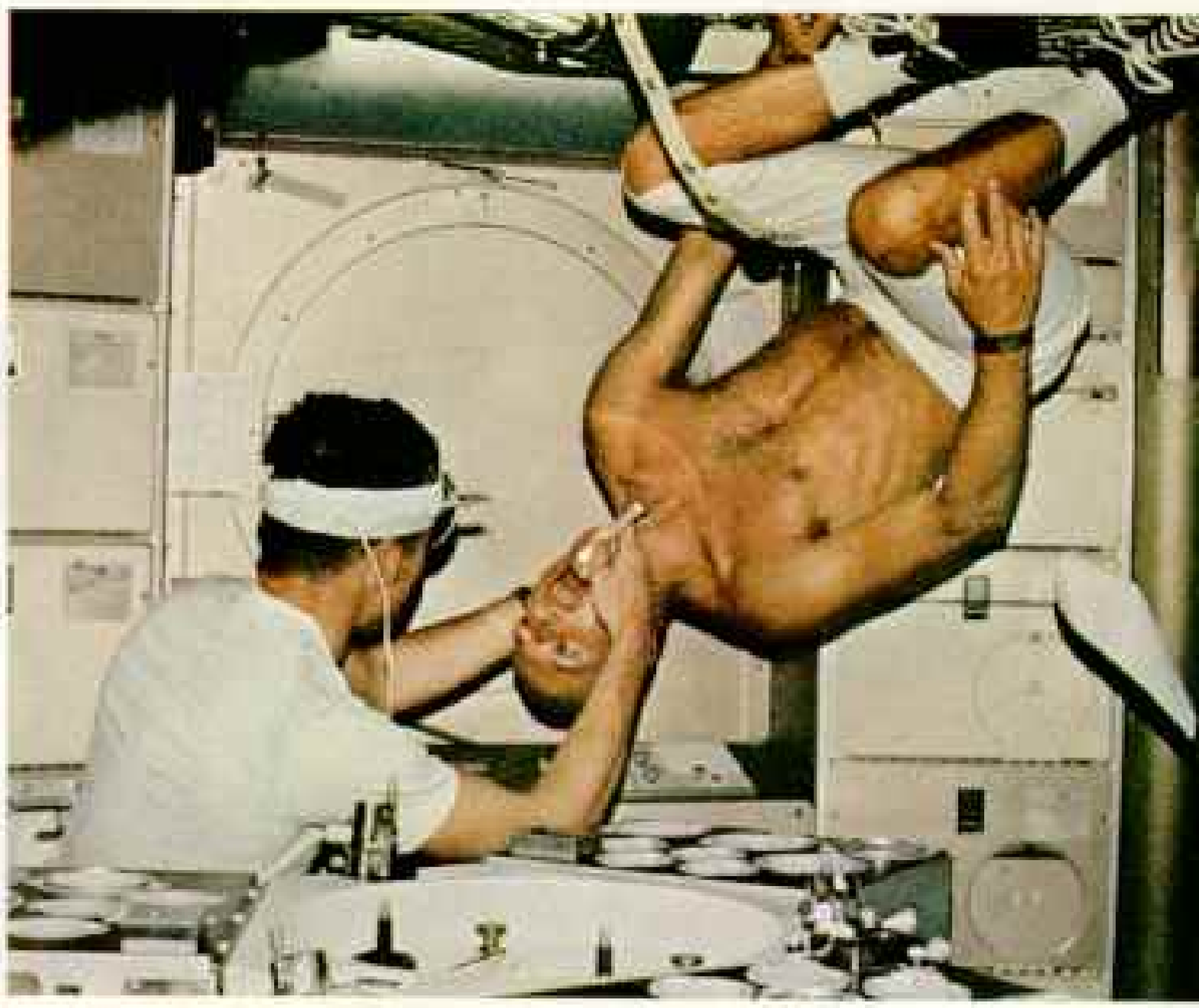
Worries have long plagued Skylab planners on this score. How do you move from point A to point B when your feet have no traction? Will the men feel the need of an "up" and "down" where none exist? Worst of all, will they be assailed by crippling motion sickness in so roomy a residence?

Skylab *is* roomy. The cavernous workshop, 27 feet long and 22 wide, is lined with storage containers. Living quarters at one end contain a small wardroom table, with built-in heaters for tinned and frozen foods. Three sleeping bags fit incongruously on walls to save space, as does a suction-operated toilet.

*An inspired team effort saved the 2½-billion-dollar Skylab program from total failure. A key member of this team, Lt. Col. Henry W. Hartsfield, Jr., USAF, has been named winner for 1973 of the Gen. Thomas D. White Space Trophy, to be awarded at National Geographic Society headquarters in Washington this October. The trophy is presented annually to the member of the United States Air Force, military or civilian, deemed to have made the most significant contribution in the preceding year to the continuing conquest of aerospace.

Squatting on the ceiling in a world without ups and downs, Conrad undergoes a mouth examination in Dr. Kerwin's wardroom "office." Only the first crew enjoyed the care of a physician. All members of the other two, however, had trained as paramedics and dutifully tested one another every three days, even drawing blood samples for analysis on earth. Except for early motion sickness that struck four of the nine crewmen, good health reigned.

Equipped like a modern clinic, the lab held hundreds of medical items, from aspirin to bone saws.



SKYLAB 1

Forward of the workshop, a smaller chamber houses controls for operating the sun and earth sensors and regulating the lab's environment (pages 448-9).

Reports from the men in the lab dispel any doubts about its habitability. "Mobility around here is super," Conrad assures the ground. "Nobody has any motion sickness." With a little practice the men almost effortlessly move objects that on earth weigh more than a hundred pounds.

Inevitably, vexations arise. The men discover that when they open containers of liquid foods, droplets waft into the atmosphere, coming to rest on instruments or the grid floor. When they open a drawer quickly, objects floating inside tend to slurp out.

Several times Mission Control piles on too many chores at one time. Conrad quickly calls them to task. "About two or three times now you got us doing things where we got 89 pieces of gear out, and you got us running all over the spacecraft." With the air thus cleared he adds, "Now I'll go ahead and do this procedure for you."

The huge workshop invites cavorting. The men try flips and cartwheels while moving from place to place. They learn to sprint around lockers ringing the workshop, gaining more traction the faster they go. Conrad announces that with a little more practice—"I might add not on company time"—they will demonstrate their prowess on TV.

On a day off they are ready to televise the "Skylab 500." To the music of *2001*, they speed around the lockers performing a daring repertoire of front and back flips. They turn graceful cartwheels and glide horizontally like cruising sharks. The capers "ought to be good for at least an Emmy," applauds Mission Control. "We've just had offers from Ringling Brothers, if you can bring that show down to earth."

Three-way Concert After a Banquet

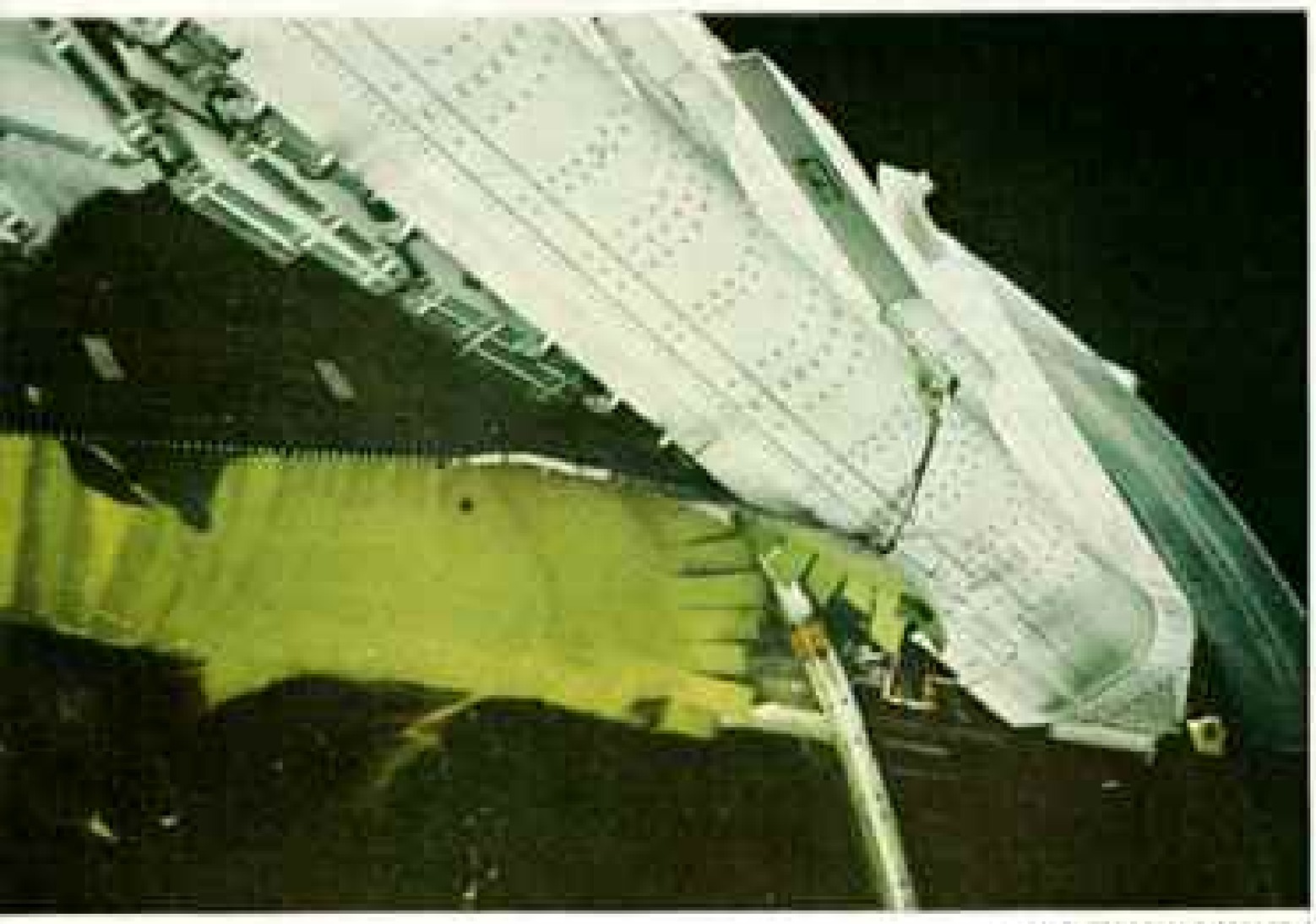
The day off also provides a chance for extra earthgazing from an 18-inch window in the wardroom. At one moment Weitz can see "clear up into Canada and clear down to the Keys." Other recreation—darts, books, playing cards with holders that won't float off the wardroom table—cannot compete with their unique window on the world. (For something of what they saw, turn to pages 470-93.)

That evening Conrad and Kerwin dine on prime ribs of beef and Weitz on filet mignon—gracious living indeed compared to the pastes and concentrates of earlier and more spartan days in space.

Later, before the men slip into their sleep cocoons, tape cassettes and earphones transform Skylab into an orbiting music hall. Pete Conrad plays country and western, Weitz listens to popular tunes, Kerwin enjoys classical music.

Early in the flight Kerwin answers the

DRAWING BY ROBERT T. McCALL

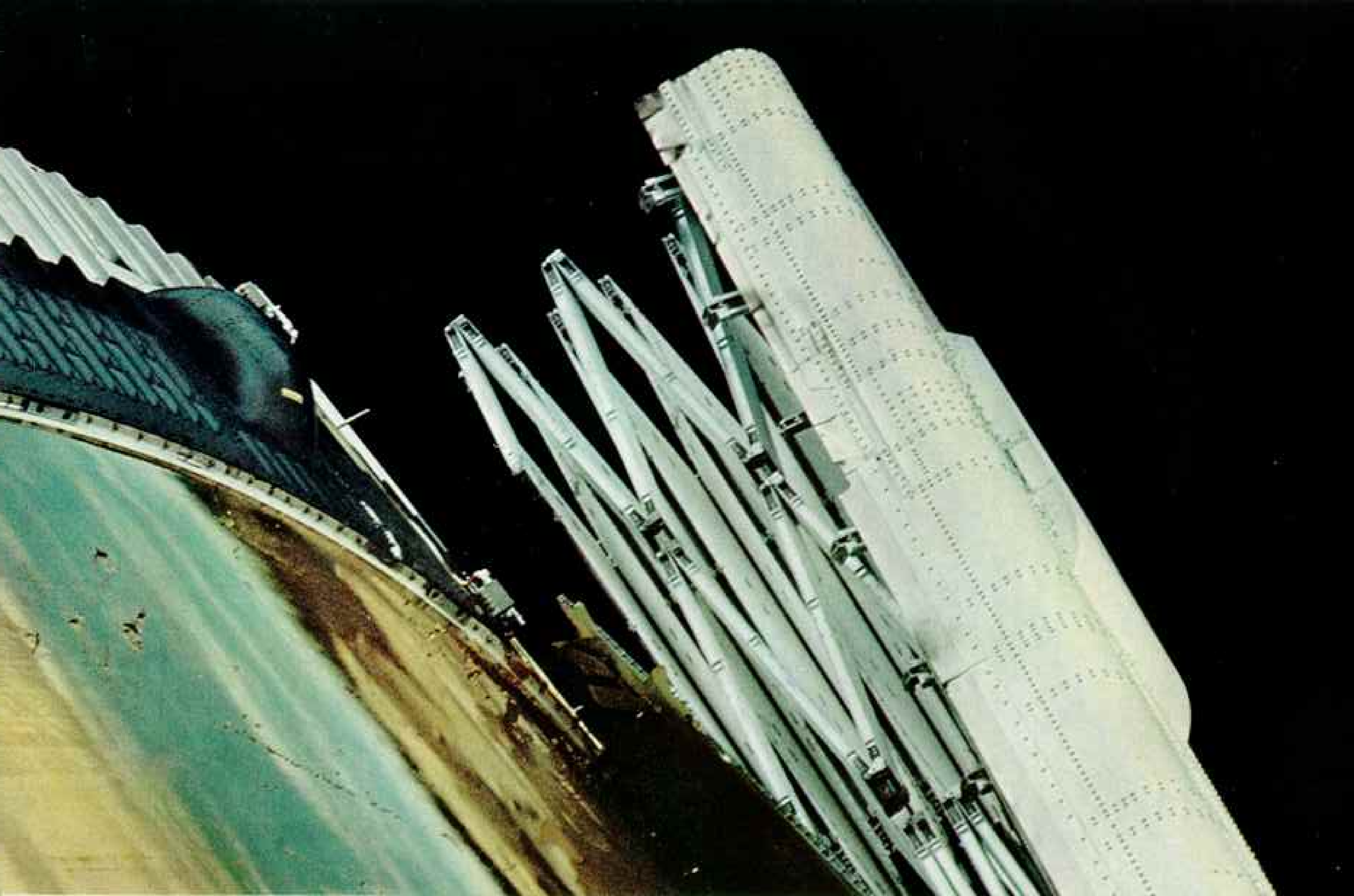


ALL PHOTOGRAPHS SKYLAB I

Spreading Skylab's crippled wing

LIKE A CLOSED ACCORDION, the station's remaining solar panel lies caught against its side (**right**), held by a thin aluminum strap entangled with green-hued remnants of the lost heat shield (**left**). To start the flow of the panel's vitally needed electricity, the first crew must somehow sever the almost inaccessible strap and pull free the ponderous wing.

Spacewalking to tackle the task, Conrad and Kerwin screw together sections of long-handled pruning shears such as those used for cutting tree limbs. This done, Kerwin (**lower**) extends the shears until they lock onto the distant strap, providing Conrad with a handhold for reaching the wing. Moving along the handle, Conrad trails a line that he attaches to the wing, then Kerwin snips the strap. Now, to unfold the panel, the two men brace against the line and yank the wing free, an action that sends them somersaulting the length of their tethers (**top**).



question about human orientation in zero gravity. "You *do* have a sense of up and down," he tells colleagues on earth, "and you can change it in two seconds, whenever it's convenient to you. If you go from one module into the other and you're upside down, you say to your brain, 'I want that way to be up,' and your brain says, 'OK, then that way is up.' It's strictly eyeballs and brain."

The men find that they have to shout to be heard. "We're hoarse all the time," notes Kerwin. This is because sound carries poorly in the lab's thin atmosphere, only a third the pressure of earth's. Kerwin also discovers that for the same reason he can't whistle. "You've got to hold your lips a little farther apart," advises Weitz.

A change takes place in the astronauts' appearance, a phenomenon space travelers have observed before. Part of the body fluid, no longer pulled by gravity into the lower limbs, has migrated upward. Their faces fatten and cheeks rise; Conrad calls it "our Chinese look." Also, their spines, freed of gravity, have lengthened. Each astronaut has grown at least an inch since launch. They'll lose it quickly after the mission ends.

Crewmen Aim a Battery of Telescopes

The men pursue Skylab's scientific experiments, involving complex devices whose functions—and malfunctions—will largely dominate their lives in space.

Kerwin, the science pilot, has already activated the solar observatory. Eight telescopes, as much as ten feet long, cluster inside the structure that holds the solar panels (page 462). Five telescopes view the sun in its X-ray and ultraviolet wavelengths—radiations that our atmosphere cuts off. A sixth telescope, blocking out the solar disk, creates artificial eclipses for studying the corona, the sun's little-understood outer atmosphere, best seen from earth during natural eclipses. The other two scopes televise images of the disk, serving as eyes for the crew as they search for targets to study.

Taking turns at the telescope control console, the crew members grow familiar with solar features—lacy filaments and prominences, turbulent active regions, and huge "holes" in the corona that may spew high-speed streams of the solar wind.

Auto-racing buff Conrad is not distracted from a down-to-earth interest, the impending but postponed Indianapolis 500. He is not surprised when Mission Control tells him torrential rains have again delayed the classic. "We can see the weather," he says as Skylab whisks them over the cloud-covered Great Lakes region.

The solar phenomenon they want most to see is a flare. The largest of these awesome eruptions usually last only an hour or so, yet send billions of tons of matter hurtling outward, bombarding the earth with X rays and particles that disrupt communications, and may even affect the weather. The astronauts search intently for a flare amid the features writhing on the TV consoles. An alarm will alert them if a flare erupts while the console is unmanned.

The Sun Obliges at Last

HONK! HONK! H-O-N-K! The flare alarm blares, and Kerwin mans the solar telescopes. The crew have forgotten to disconnect the device as they pass through the radiation-charged South Atlantic anomaly, a region where earth's magnetic field bends the Van Allen radiation belts abnormally close to the surface. The anomaly has triggered the automatic alarm.

Days later, with Weitz at the console, the alarm blares again. As he zeroes in the telescopes, Kerwin announces to Mission Control, "I'd like you to be the first to know that the pilot is the proud father of a genuine flare."

On earth, solar scientist Dr. Giuseppe Vaiana of American Science and Engineering, Inc., hails this look at the solar eruption as "hundreds of times better than anything we've had before."

A battery of six cameras, covering the entire visible spectrum and part of the infrared, surveys the surface of the earth passing below. Another camera's vision is so acute that even at this altitude—farther than from New York City to Washington, D. C.—it can spot trailer trucks on the highways.

A scanner, recording the distinctive "signatures" of vegetation, can tell a computer not merely that a crop is corn, but what type—field or pop. A radarlike device can detect the height of ocean ripples within inches. A radiometer maps the ever-changing regions of ice and snow—vital factors in navigation, water supply, and weather forecasting.

In rapid unseen sweeps Skylab takes crop inventories of Holt County in Nebraska, studies land use in Indiana's Wabash River basin, measures the extent of strip mining in

Ohio, charts the drainage system of central Florida.

By midflight, crew and ground personnel are confident about completing the full 28-day mission. But Skylab is seldom free of ailments. A camera blows its fuses. Water pipes clog. Telescopes jam; lines lose pressure; gyroscopes misbehave. Conrad remarks wryly that "one of these days one of these pieces of gear is going to work right the first time we take it out."

With each breakdown, ground crews work feverishly to figure out a repair and transmit the procedure to the crew, who almost invariably restore the device to action.

Mission One Sets a Record

In mid-June the crew surpasses the 18-day flight time of the Russian cosmonauts of Soyuz 9. (The three cosmonauts of Soyuz 11 flew 24 days but perished during descent.) Conrad, Kerwin, and Weitz cross a new frontier—into a world of the medical unknown.

Already, subtle changes have been taking place in the men's bodies. On day 13 Kerwin fails to complete a routine designed to test his cardiovascular system, indicating that his heart and circulatory system have so adjusted to weightlessness as to reduce their ability to withstand the stress of earth's gravity. Soon Weitz too is unable to finish a test.

But the men feel no decline in health. For half an hour each day they exercise on a bicycle device that also periodically monitors their metabolism.

Outside Skylab, one of the battery units damaged earlier by the heat has shut down. Astronaut Russell L. Schweickart, who preplans each space walk with rehearsals in the Huntsville tank, relays a procedure easily appreciated by anyone who bangs his radio to remove the static: Go out and rap it with a hammer.

Setting forth with Weitz on the repair job, the commander pounds the battery strategically. Instantly Mission Control detects current flowing through the unit.

"Gentlemen," says Schweickart elatedly, "you've done it again."

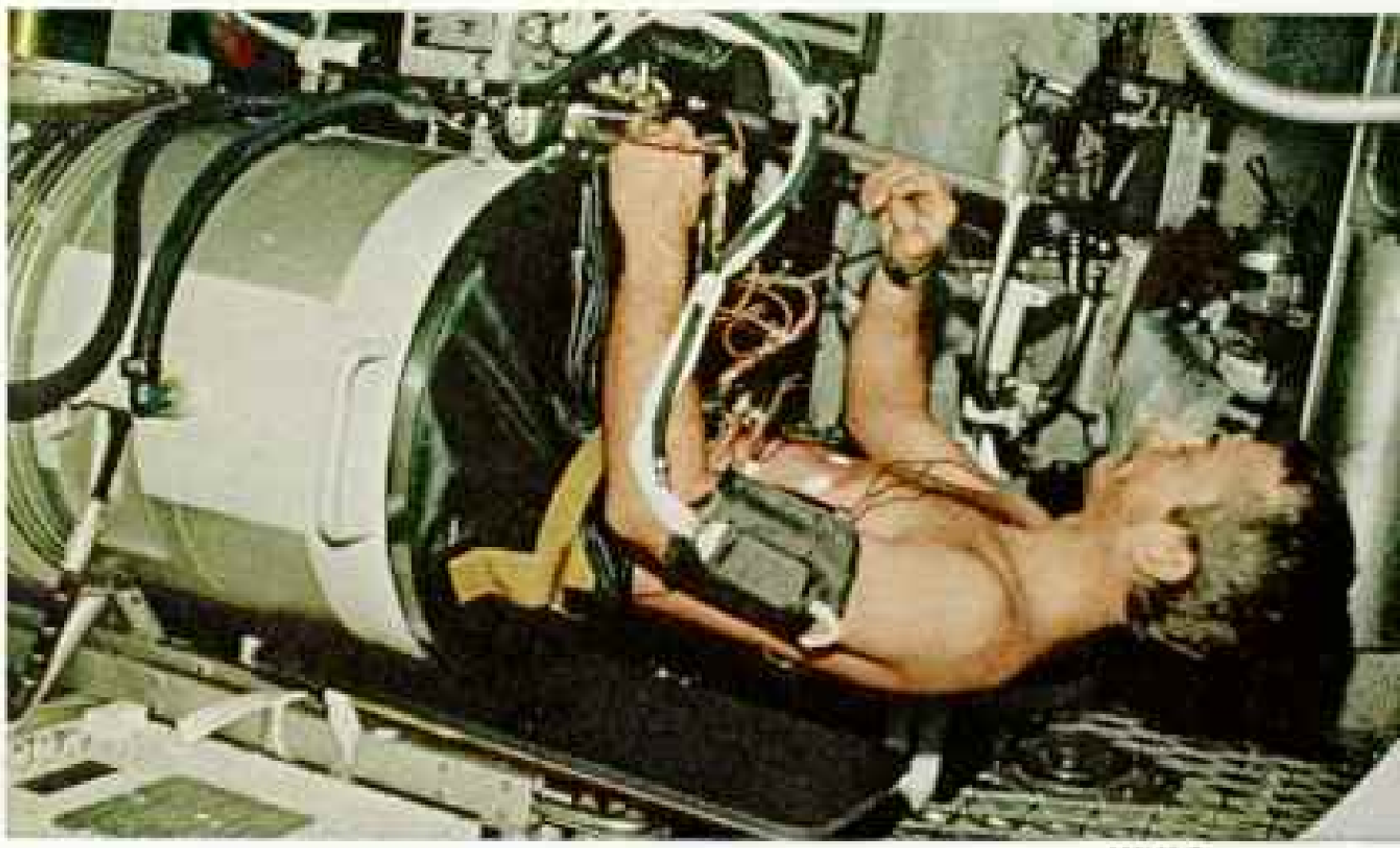
Conrad also clambers along a ladder to the muzzle of the telescope mount. With a touch as light as the other was heavy, he uses a squirrel's-hair brush to whisk away a stray thread on the coronagraph. At once ground astronomers see an improvement in the image.

For Conrad and company, the title "Fix-it Crew" is secure.

Packing to Go Home

Before reentering the lab, the commander retrieves film magazines from the solar cameras, for the mission is closing. Already the rocket to launch the next shift has been trundled out to its pad at the cape. The crew packs films, blood and urine samples, and gear into the CSM. Finally they turn off the air conditioners and lights—"like leaving a vacation home, when you know friends are coming behind you," as Weitz puts it. Sliding away in their Apollo taxi, they splash down 800 miles from San Diego on June 22, precisely on schedule.

They have spent 28 days and 50 minutes aloft; flown 404 times around the earth; made



SKYLAB 2

Space Age gravity tank tests Garriott for adaptation of his cardiovascular system to weightlessness. A partial vacuum in the tank, simulating the tug of gravity, causes blood to pool in his legs much as would happen on earth. Sensors then register the heart's ability to pump the fluid through his system.


LOUISMA
093

25,600 priceless solar portraits and 7,400 earth photos. Take any space record—time aloft, distance traveled, number of space walks—and they have broken it. Noting their lab-saving repairs, the NASA Administrator, Dr. James C. Fletcher, labels them the "master tinkerers of space."

Even as the countdown progresses for the second mission, a tentative tasting of the data brought back by the first foretells feasts to come. Solar physicists suddenly see a radically different sun, a tormented body glittering with violent, mysterious bright points, gripped by an unexpectedly capricious magnetic field, enveloped in a corona of undreamed-of turbulence (pages 494-503).

Earth scientists, scanning Skylab photos, already see features that hint of ore deposits, and perhaps even oil. Medical findings reveal good news and bad. Though cheered by the men's general good health, doctors detect significant physiological changes: a 3 percent shrinkage of heart size, a 14 percent loss of red blood cells. The flight has "triggered just enough disturbances," notes Dr. Charles A. Berry, then chief of NASA Life Sciences, "to make us plan careful weekly evaluations during the two-month mission."

Miniature Menagerie Goes Into Orbit

The second crew's commander, Navy Capt. Alan L. Bean, has explored the moon on the voyage of Apollo 12. Dr. Owen K. Garriott, the science pilot, has taught electrical engineering at Stanford University. Marine Corps Maj. Jack R. Lousma, the burly pilot, knows the perils of space flight, having been Mission Control communicator when Apollo 13 suffered an oxygen-tank explosion and limped home.

Their craft is a miniature Space Age ark, temporary residence of two minnows and fifty eggs, six mice, 720 fruit-fly pupae, and two common cross spiders nicknamed Arabella and Anita.

They thunder up from the cape and smoothly enter orbit. During the eight-hour chase of

Long look homeward mirrors Skylab and earth in the gold-coated visor of space-walking Lousma. He clambers beneath one of the windmill-vane solar panels during an extravehicular activity (EVA) in which he and Garriott spread the second sunshade over the workshop. S73-33833

Skylab, however, a four-thruster unit for maneuvering their CSM springs a leak. Bean switches it off, yet manages to dock expertly.

"Here's our home in the sky," Lousma announces. Soon the men are bustling around inside the station, turning on lights, fans, and air conditioners, getting the feel of the lab.

As they work, the men detect the onset of symptoms spacemen dread. One man's face grows warm and he begins to perspire. All feel stomach discomfort, and one vomits. Motion aggravates their queasiness, and they slow their work pace. Soon it becomes apparent that the men are suffering from motion sickness.

Caused by zero-gravity effect on the inner ear and aggravated by the headward shift of body fluids, motion sickness has afflicted nearly half of all U. S. space voyagers. Skylab's spaciousness may magnify the hazard.

"We're just not as spry up here right now as we'd like to be," laments Bean. "None of us has been able to eat all our breakfast. There's a desire to just lie still for a while."

The men take motion-sickness tablets, but they fall behind in stevedoring cargo from the CSM and activating the lab.

Weightlessness also plays tricks on the two minnows. "Both these fellows seem to be completely disoriented," Garriott reports. They are swimming in small loops. Scientists hope their behavior in zero gravity will give insights into the effects of weightlessness on man.

Space Age Ark Loses Passengers

Elsewhere in the menagerie, disaster strikes. The pocket mice—with tiny transmitters implanted in their bellies to record their physical reactions—as well as the fruit-fly pupae have been carried aloft to study the effect of weightlessness on their daily "sleep-wake" cycles. But electronic controls on their environment capsules short-circuit, and the two space colonies expire.

By day five the crew is much improved, a fact they happily demonstrate by televising the noon meal. "Food tastes a lot better today," asserts Lousma. At last the men look forward to embarking on their scientific work.

Early the next morning Garriott and Lousma discover that a second set of thrusters on the CSM has sprung a leak. This leaves the capsule with only two of its four sets operable, jeopardizing its ability to ferry the crew home. And the failure of two sets raises concern that the rest are soon to go.

The specter of a vehicle made inoperable in space, carrying its stranded passengers eternally through the void, has always lurked in the wings of the manned space program. NASA puts Kennedy Space Center on an emergency schedule to prepare the third crew's rocket for rescue, and weighs ordering the men to return before their remaining thrusters give out.

By next day Astronaut Vance Brand, flying the CSM simulator at Houston, has rehearsed two entry procedures that can bring them home. Fear of an aborted mission retreats.

The crew begins intensive studies of earth resources. A 6,000-mile sweep surveys a big Pacific storm, croplands of Colorado, an oil-rich area of Oklahoma, and natural resources in Louisiana; measures sea roughness in the Gulf of Mexico; and charts rivers in the broad Amazon Basin.

How to Take a Sea Census

The astronauts find themselves unlikely participants in a fishing derby of armada proportions. Scientists with the National Oceanic and Atmospheric Administration (NOAA) want to know if the ocean's temperature or its color—as influenced by sediment and plankton—can be used to indicate the abundance and location of fish. Skylab's sensors and photographs can tell them much about the ocean. But how do they estimate the fish life? A colossal game-fishing experiment is organized.

Coordinating with Skylab's pass, 138 boats fan out in the northeastern Gulf of Mexico. At day's end the sportsmen-turned-scientists turn in their records of 121 boated fish—and dutifully and happily report even the ones that got away. Eventually their data will be compared with Skylab's.

On August 6 Garriott and Lousma suit up for a space walk to spread a new sunshade over the rumpled original, and to replenish solar-telescope film. Even before they open the hatch, they marvel at the spectacular cyclorama of earth below. "Just passed over my old stomping ground of Michigan," Lousma reports enthusiastically, "and it truly does look like a great big mitten."

After they have spread the awning, temperatures begin dropping in the workshop. Lousma reloads the telescope cameras, then takes a moment to compare the space walk with practice sessions in the Huntsville water tank. Up here, he notes, "it's one heck of a lot farther to the bottom of the pool."

Arabella, the astrospider, chooses this day to try her first web in zero gravity. "Our friend did some good work last night," Garriott reports. "She's got very unusual webs spun around all the corners of the box, with some of the stringers even from corner to corner. So she had to do a lot of improvising."

Arabella and her backup, Anita, accompany the Skylab crew at the suggestion of Judith S. Miles of Lexington, Massachusetts. Her Skylab experiment is one of 19 selected from 3,409 proposals submitted in a nationwide competition sponsored by NASA and the National Science Teachers Association.

Checking the next day, Garriott notes that Arabella "did completely spin a new web last night. And she is a very fast learner indeed." Unlike her disorganized first attempt, this is "like one you would find on the ground." He televises her achievements, and soon letters from classrooms and homes flood NASA, seeking information on the orbiting spiders.

Spacemen Go Into High Gear

With the solar cameras now readied, science pilot Garriott and his crew mates turn to the telescopes in vigils that total 12 and 14 hours a day. They revel in the sun's dancing display of bright spots, whose pulsating ultraviolet intensities in active regions can suddenly signal a rising flare. Garriott trains on a prominence along the sun's edge; it erupts into a stupendous bulge that expands at a million miles an hour. Ground observers share the astronaut's delight at this first nearly complete coronal transient ever recorded by manned telescope (page 500).

A passion for work seems to possess the men. They put in prodigiously long days, sleeping only six or seven hours. By mid-August the crew that started out queasy and behind schedule is straining Mission Control to keep them busy.

Medical tests every three days show the men's bodies slowly changing, but not as quickly as the previous crew's. Doctors surmise that the second team is benefiting from the advice of the first: Take more exercise—at least an hour a day.

With men and space station operating well, Program Director Schneider begins extending the flight week by week.

The minnow eggs begin to hatch. The two adults still swim in disoriented loops, though they eventually adapted to weightlessness. But the hatchlings seem at home from the first. "It's as if they'd already adapted while they were still in the egg," reports Garriott.

Traveling the "EVA trail," Garriott holds Bean's legs while the commander makes a minor repair on the sunshade. Clouds cover most of the earth passing below.

In the first week of September the sun, heretofore only mildly active, suddenly explodes with awesome fury. Thirty-one flares erupt in one day. "It looks like somebody's been kicking the heck out of it," reports Lousma.

Festering active regions, dotted by sunspots and wreathed with looping filaments, torture the solar disk. Towering loops of gases change in ways never before recorded. A huge flare in the northern hemisphere is followed by one in the southern—perhaps eruptive material crossing the sun's equator.

Big Daddy of All Flares

Week's end brings the greatest flare of all—"It's the big daddy!" exclaims Bean. Its outrushing particles disrupt earth radio communications and days later cause a dancing aurora in the atmosphere.

"We've never had data of this superb quality," exults solar investigator Dr. Neil R.

SKYLAB 3

Serving of fresh film rides a sliding boom toward the telescopes, where Garriott waits to reload the instruments. The once-a-month chore reaped a harvest of 163,000 sun portraits from the three missions that promises to revolutionize solar science.

Sheeley of the Naval Research Laboratory, speaking for all the astronomers.

Doctors monitoring the crew's health find another phenomenon: Forty days into the flight, the gradual change in the astronauts' physiological responses appears halted. If they have truly reached a plateau, they may have established man's capability for flights of almost indefinite duration. A few days later NASA's Dr. Royce Hawkins confirms that "the trend has definitely flattened out."

Unexpected Voice Calls From Skylab

Yet another surprise occurs. "This is Helen in Skylab," says a female voice from space. "The boys hadn't had a home-cooked meal in so long, I thought I'd just bring one up." Only after the trip would Garriott explain: He taped his wife's words before the flight, then played them back to earth.

After 59 days in orbit, the crew temporarily shuts down the lab again and enters the space capsule. Bean undocks, and to safeguard the sunshade from thruster exhaust, he forgoes the fly-around inspection of the lab. Following special reentry instructions from the ground, he guides the ship home. The capsule splashes down off San Diego on September 25, only nine seconds and 2.8 miles off target.

Aboard the recovery ship U.S.S. *New Orleans* doctors find that "in some tests the men look better than the first Skylab crew," an improvement attributed to their exercise.

Their achievements exceed all expectations. Instead of the scheduled 26 earth surveys, the astronauts have completed 39. Instead of the

programmed 206 hours at the telescopes, they have spent 305—capturing a bewildering 71,700 photographs of the sun in all its violent moods. They have repaired the lab in the finest fix-it tradition, conducted 12 student-suggested investigations, and gone far to establish man's ability to survive sustained space travel. They have flown around the world 858 times on a record voyage of 24.5 million miles.

Third Mission Joins a Space Visitor

Encouraged by the adaptability of the second crew, NASA sets for the third a grueling goal of 84 days, the limit allowable with the lab's dwindling store of provisions.

The mission, to begin in mid-November, comes at a propitious time. From the outer reaches of the solar system the comet Kohoutek has appeared, threading its way through the planets toward a historic loop around the sun in late December. Skylab, above earth's obscuring atmosphere, offers a unique grandstand view.

For Skylab's final mission NASA has chosen three rookie astronauts, but they carry impressive credentials. Marine Lt. Col. Gerald P. Carr, the commander and an aeronautical engineer, has played a key role in developing the Apollo lunar rover. Appropriately, science pilot Dr. Edward G. Gibson is a solar physicist, author of a textbook, *The Quiet Sun*. Col. William R. Pogue combines the talents of a former Air Force stunt pilot with those of a mathematician.

Troubles start early. Countdown inspection crews, routinely poring over the Saturn rocket, discover hairline cracks webbing the bases of its giant stabilizer fins. Technicians work feverishly to install replacements. Other tiny cracks are found, but computer analysis verifies that the rocket is structurally sound. By November 16, six days late, the flight clears for lift-off.

Never has an Apollo capsule carried so much gear. An additional 160 pounds of groceries, including high-energy food bars, will replenish the lab's larder. Ketchup and film replace items lost during the early heat troubles; two cameras and other equipment fly to greet Kohoutek. To make extra room, technicians remove the capsule's vibration padding and use clothing instead.

"Coming at you, Skylab," announces Gibson as the thirtieth manned launch to leave the cape reaches orbit. Seven hours later the lab comes into view. "She looks pretty as a picture," reports the commander, and docks expertly.

Forewarned by the last crew's malaise, the men have taken medication to ward off motion sickness. Nevertheless Pogue becomes ill. That night, to avoid the disorientation of too-quick exposure to the spacious lab, the men sleep in the CSM.

Like their predecessors, the crew find themselves overwhelmed by the task of unloading thousands of items from the CSM, then finding places to stow them in the lab. Nevertheless they delight in the workshop's wide-open spaces. Gibson finds that a room into which he floats may look unfamiliar, but as soon as he rotates his body to the "up" position he recalls from ground trainers, "then all of a sudden my mind would flash and say, 'Yes, I know where I am.'"

Heeding earlier experience, the astronauts follow the prescribed one and a half hours of rigorous exercise daily. They put impressive mileage on a briefcase-size treadmill designed by physician-astronaut Dr. William E. Thornton.

On Thanksgiving Day, Gibson and Pogue spacewalk to replace the telescope-camera magazines and repair a jammed radar antenna. "Boy, if this isn't ever the great outdoors!" exclaims Gibson as he relishes a look down at the blue Pacific Ocean north of Guam.

No sooner have the astronauts restored the antenna to life than a control gyro expires. Three of these 140-pound wheels, spinning at 9,000 revolutions a minute, control the station's roll, pitch, and yaw. Two of them can still do the job, but if another fails, the station must resort to its thrusters, whose fuel reserves are low.

That evening the men sit down to a lonely but ample Thanksgiving dinner: prime rib for Carr, turkey and gravy for Gibson, chicken and gravy for Pogue.

Crew Performance Lags Mysteriously

Passing days bring home a disturbing fact: Ground and crew are out of step. The astronauts complain of being pushed too hard; ground crews feel they are not working long or fast enough. Concern mounts that some mysterious lethargy is threatening the men's execution of their mission.

Analyzing the problem, NASA officials trace its origins to the last hectic weeks before the flight. A bewildering accumulation of projects was added with little or no training

—new medical tests, new scientific experiments, new pieces of gear to stow. Many of the 20,000 movable items in the lab have not always been returned to designated lockers, resulting in vexing hunts. Improvising ways to operate much-repaired equipment drags the crew further behind schedule.

"The basic problem," concludes Program Director Schneider, "belongs to us here."

Crew and ground have a heart-to-heart discussion, and the air clears. "A guy needs some quiet time to just unwind if we're going to keep him healthy and alert up here," Carr tells the ground. "There are two tonics for our morale—having time to look out the window, and the attitude you guys take and your cheery words."

Solar physicist Gibson, manning the telescopes, finds the sun relatively docile for weeks. At last it cooperates again, this time with a cataclysm that the grateful Gibson lauds as "beautiful." An unusual spear-shaped cloud hurtles out 2½ million miles.

A High Wide Look at Earth

With Carr and Pogue alternating at the controls, Skylab's sensors scan earth's surface. In great swaths they survey the West Coast for geothermal energy sources; assess strip mining in Illinois, Indiana, and Kentucky; record dune patterns in Africa and Asia.

Expanding their terrestrial studies, the crew converts the wardroom, with its picture window, into a miniature earth observatory. The men have taken preflight cram courses in oceanography, geology, and other earth sciences. Now, seeking out suggested sites and targets of opportunity and snapping them with hand-held cameras, they provide a new look at previously little-known physical features of the earth.

The Falkland Current, sweeping from Cape Horn up the Argentine coast, captivates the observers. Oceanographers, following their descriptions of its strange "light green, almost fluorescent" flow, conclude that what they are seeing is a vast river of plankton, the bread of the sea that sustains all other marine life. On several passes the astronauts notice the green current wearing a huge splash of russet—possibly a vast swarm of red planktonic krill in the cold Falkland.

Roving the planet, the men detect upwellings off New Zealand, and see a newly active volcano in the Galapagos Islands. They survey Argentine wheatlands, visibly growing greener as the mission progresses. On northerly sweeps they record the winter metamorphosis of the St. Lawrence River from busy waterway to ice-choked stillness.

Mid-December brings a pass whose beauty burns itself indelibly in their memories.

"Kill the lights," murmurs Pogue, looking down into a nighttime of extraordinary clarity. "There's Acapulco at night." Soon they see the glow of Guadalajara and then of Mexico City, "laid out like a five-pointed star."

Ahead the men make out the Texas coast "from Brownsville to Houston, Beaumont, Port Arthur. . . . Holy cow!" New Orleans takes fiery shape, then "the whole Florida peninsula." Finally they look down on the entire eastern United States, aglitter from Detroit to the Atlantic. "Like a spider web with water droplets on it," marvels the spacecraft commander.

Seeking Better Metals and Crystals

Firing up Skylab's cylindrical furnace, the astronauts become Space Age alchemists, seeking to manufacture crystals and alloys unattainable on earth.

Because of the villain gravity, which affects materials as they solidify, ovens on earth produce crystals and alloys possessing only a small fraction of their potential strength and uniformity. These defects, sharply limiting advances in electronics and other technologies, might be erased or drastically reduced by manufacturing in zero gravity.

Nor is space an unlikely place for a smelter. "The nation's yearly needs for these specialized materials can be met with quantities as low as a few hundred or a few thousand pounds," asserts Dr. Ernst Stuhlinger, Associate Director for Science at Huntsville. "These can easily be produced by the Space Shuttle"—if Skylab proves the feasibility.

Busily the crew melts earth-formed crystals in the furnace, allowing them to solidify again in weightlessness. Later, scientists will analyze these "made-in-space" products, together with crystals and alloys produced by the previous crew.

The space station, never in perfect health, shows ominous symptoms of another gyro failure. One of the rotating wheels is occasionally faltering, sometimes with a "little hiccup," at others with a less worrisome twitch. No known cure exists.

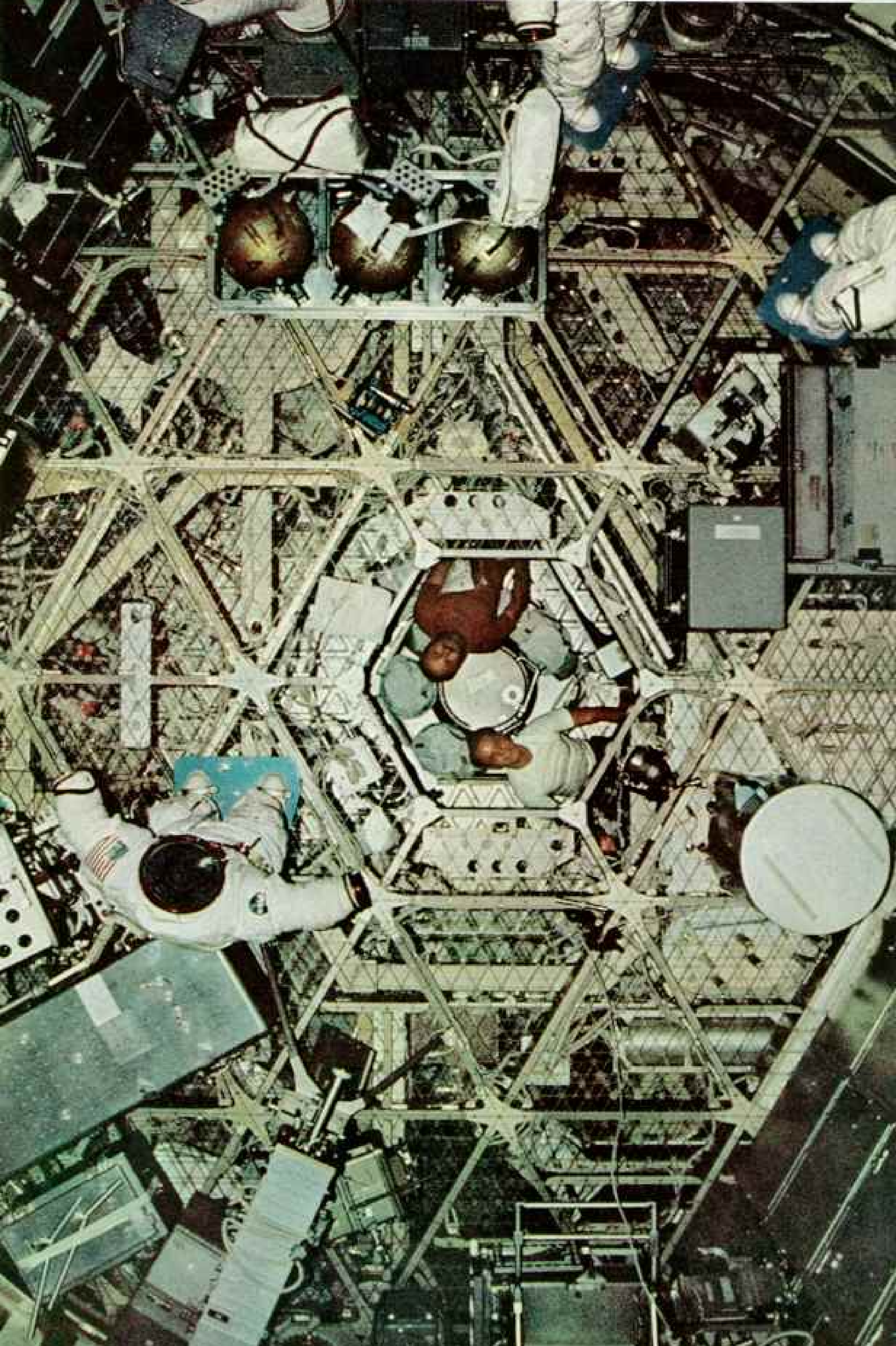
The approach of the Yule season finds the crew in high spirits. On Christmas Eve, with

BOTH SKYLAB 4

All the comforts . . . sort of. In a weekly ritual that proved both boon and bane, Lousma soaps up in a shower stall. Fastening the cocoon to the ceiling, he will rinse with the spray spigot in his left hand, then dry off with a towel and a vacuum hose that sucks up drifting droplets.

The time-consuming process—45 minutes from start to finish—persuaded several astronauts to avoid showers in favor of rubbing down with damp towels.

Toiletries float in a spaceman's locker during the second mission. The unopened package holds fresh items for a member of the final crew.



As if caught in a steel spider web, Carr and Gibson peer from their living quarters beneath a silent audience of empty space suits. Aluminum gridwork, serving as decks between workshop levels, also provides the crews with a convenient surface for steadying themselves as they operate the lab's bewildering inventory of scientific instruments.

Chairlike device at very top enables the men to weigh themselves—no simple task in weightlessness. Strapping themselves in, the men activate a spring that gently rocks them back and forth. Instruments time the oscillations, thus recording the occupant's mass. Putting in long and busy days, all nine astronauts lost weight, including even the largest man and biggest eater, Lousma, whose daily intake averaged 3,500 calories.

From the long silvery case next to the scales protrudes the shaft of the parasol that first shaded the workshop. At the lab's far end, an airlock behind the astronauts leads to a mammoth space-vented receptacle that they gradually filled with empty food cans and other trash.

With a twist of the toes, a crewman can lock his triangular shoe cleats into the lab's grid flooring for stability. Without them, an astronaut struggling to loosen a stubborn bolt would turn his weightless body instead. Numerous hand- and footholds also steadied the men.

SKYLAB 3 (OPPOSITE AND LEFT); SKYLAB 2 (ABOVE)

Buck Rogers flying machine, powered by gas jets and operated by foot controls, propels Bean about the workshop. Anticipating the day when shuttle crews may need to service satellites, NASA took advantage of Skylab's roominess to test three such devices in zero gravity.

their families gathered in Mission Control, the men train their TV camera on a tree fashioned from food containers. Christmas messages flow up through the teleprinter.

Acting on a hint from the ground, the men discover hidden presents from their wives. Gibson reports that Skylab's northerly swings have shown much toy-making activity in Santaland, "so my kids have got some hope, but they had better keep in line at least for another day."

Spacemen Follow a Christmas "Star"

Like the Wise Men of old, Carr and Pogue go forth to follow their Christmas "star"—a space walk to observe the comet Kohoutek. For hours the men train cameras on the comet, now so close to the sun as to be invisible to the eye. With Pogue "holding me like a sausage under his arm," Carr reaches as far as he can with a screwdriver to pry open a stuck filter wheel and restore an X-ray telescope to operation. Their tasks require more than seven hours outside Skylab, breaking all space-walk records.

On the day the comet ducks behind the sun, Dr. Luboš Kohoutek, its discoverer, visits Houston to congratulate the men on their observations. Next day Carr and Gibson emerge from the lab to greet the comet as it reappears. Aglow with yellow and orange, the dainty visitor awes Gibson as "one of the more beautiful sights in creation I've ever seen." *

With the end of the mission in sight, Gibson intensifies his watch for the actual moment of birth of a solar flare—something no other Skylab crew has captured on film. An understanding of this fiery convulsion could help in man's efforts to control fusion as a new source of energy. Day after day the physicist glues his eyes to the monitors.

On January 21 Gibson focuses his attention on a suspicious active region that seethes and writhes on the sun's west side. Suddenly a bright spot intensifies and grows, and he begins a rapid-fire picture sequence. Here Gibson gambles: Film is nearly exhausted, and he may be squandering it on nothing. But as he watches, the bright spot mushrooms into an eruption that leaves no doubt: He has caught a flare on the rise.

Two days later the wavering gyro begins a period of ill health that persists through the rest of the mission. But it no longer poses a threat: now Skylab's thrusters could see the flight through.

Carr and Gibson make a final trip outside to collect the solar cameras, then the men set about closing down their home for the last time. After packing the CSM, they leave a parcel containing food and other perishables —a "time capsule" whose state of preservation can be examined by later visitors to Skylab, "be they Americans, Soviets, or little green men," as Schneider puts it.

"Say good-bye for us," calls up Astronaut Robert L. Crippen in Mission Control. "She's been a good bird."

"It's been a good home," agrees Gibson as they back the capsule away from the lab. "I hate to think we're the last guys to use it."

When the crewmen descend to their Pacific splash site off San Diego on February 8, they bring with them space records that may be destined to stand for a decade. In their epochal journey of 84 days they have circled the planet 1,214 times and traveled a staggering 34.5 million miles. In every phase of their work—solar studies, materials processing, earth surveys, student experiments, medical tests—they have accomplished what was asked of them and more.

Skylab's Third Crew Comes Home

In Houston Julie Gibson and Helen Pogue watch as a television film shows the recovery of the capsule by the *New Orleans* only hours earlier. As eager fingers work the hatch, the women lean forward in their seats. They, too, have endured a long and lonely voyage.

The door opens, framing a beaming Ed Gibson. Grasping the sides of the hatch, he slowly, carefully pulls himself erect against the now-strange sensation of gravity.

Next appears a grinning visage wreathed in a bushy beard. "Is that Bill?" exclaims Mrs. Pogue. "I can't believe it!" Finally the commander emerges, also heavily bearded—last to leave his spaceship.

"That was the visible part of Skylab," observes Rocco Petrone at the final splashdown. "Now comes the science."

"We will be living with Skylab's achievements for a long, long time," affirms NASA Administrator Fletcher.

Certainly so the solar scientists. Deluged with more than 160,000 unique images of earth's life-giving star, they already can see that the existing theories are oversimplified.

*Earthbound views of this dramatic visitor from the edge of the solar system appeared in the August 1974 NATIONAL GEOGRAPHIC.

They will have to rewrite the textbooks, for this is a vastly more violent and complex sun than man has ever known before.

For medical investigators the basic question already may be answered: Humans apparently can physically adapt to space flights of interplanetary duration. But this is the tip of a scientific iceberg. Undergoing stresses to which men have never before been exposed for so long, the astronauts offer insights into the human body that promise a medical spin-off for all mankind.

Scientists Sift a Wealth of Data

Earth scientists, too, at present have only scratched the surface of the mountain of Skylab data. But already they find:

- Possible ore and oil deposits, including alluvial streambeds high in the Sierra Nevada that may harbor placer gold.
- Promising fishing grounds, charted through observations of ocean currents and areas of upwellings.
- Surface hot spots hinting of geothermal energy sources below.
- Intriguing "hills" and "valleys" undulating the ocean surface, perhaps reflecting the topography of the seabed beneath.
- Surface indications of subterranean water sources in drought-stricken West Africa.
- Ocean eddies that may play a significant role in world weather.
- Confirmation that satellites can map remote regions in mere days instead of the years required by conventional means.

And from space ovens such as Skylab's will come scientific confections. Crystals grown in zero gravity, some of them many times larger and more uniform than those made on earth, could lead to a new generation of computers. Metals mixed in space, including one compound heretofore unknown, show promise of vastly superior electrical conductivity.

Now truly a ghost ship, Skylab will silently circle the planet for six to ten years more. Then, her orbit decaying, the ungainly craft will plunge back into earth's atmosphere, to burn up long before reaching the surface. By that time a Space Shuttle will likely be ferrying payloads regularly into orbit, and hawk-eyed satellites will routinely monitor our crops and forests and oceans.

Such are the legacies of the ugly-duckling space station that has become the stately swan of science. □

Elusive visitor from afar, comet Kohoutek, upper right, swings toward its historic sweep behind the sun last December 28. A Skylab telescope blacks out the sun with a dark occulting disk, center, permitting the comet to be photographed at a time when the sun's dazzling light blinded earthbound observers.

Earth's lunar companion passes almost before the sun on June 30, 1973, as seen by a ground-controlled camera while Skylab was unmanned. On this day the moon swung directly between earth and sun, bringing a total eclipse to parts of South America and Africa. Skylab's position here makes the bodies appear out of alignment.

BOTH FROM HIGH ALTITUDE OBSERVATORY AND NASA

Skylab Looks at Earth

AS EARTH ROLLED STEADILY under them like a colossal library globe, Skylab carried her crews north beyond the latitude of the U.S.-Canadian border and south nearly to Cape Horn, crossing 70 percent of the planet's land area. In the striking photograph at left, made by Lousma as the second crew reached the lab, the delta of the mighty Amazon veins the jungle.

Skylab's earth sensors played dual roles: to gather information about the planet, and to perfect instruments and techniques for future satellites and manned stations. An array of six fixed cameras, another for high resolution, and the astronauts' hand-held cameras photographed surface features. Other instruments, recording on magnetic tape, measured the reflectivity of plants, soils, and water. Radar measured the altitude of land and water surfaces.

The sensors' objectives read like a catalogue of earth sciences: to survey croplands and forests, identify soil and rock types, map natural features and urban development, detect sediments and the spread of pollutants, study clouds and the sea, determine the extent of snow and ice cover.

Collaborating in these studies were more than 140 scientific teams from the United States and 20 foreign countries. Often, as Skylab passed over a site to be explored, scientists were busy below, simultaneously gathering data from aircraft and on the ground. Comparing their "ground truth" to Skylab's findings, they would learn to recognize the special radiation "signatures" of earth objects for making automated satellite inventories of the globe's resources.

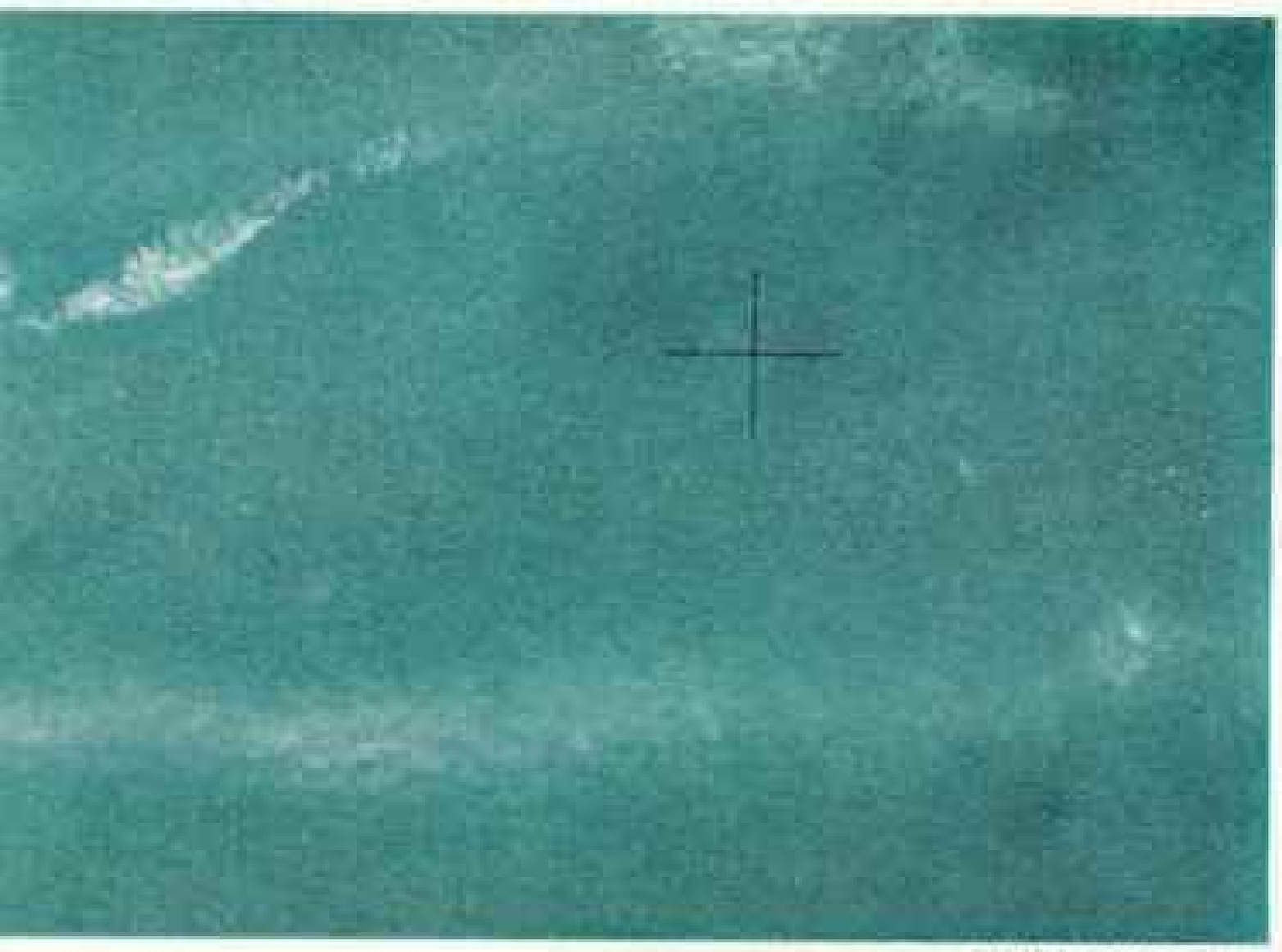
ALL PHOTOGRAPHS FROM NASA, SKYLAB 2 (LOUT)

Windows on California's Bay Area illustrate the specialties of Skylab's earth eyes. During a winter pass, the crew triggered the six cameras of the lab's multispectral facility. Each made an image of the entire scene. Slices from the six photographs, every one informative in its own way, form the montage below.

Surf and beach areas show up vividly on black-and-white film with green filter (**far left**). Scar of the San Andreas Fault slashes the shore north of

the Golden Gate on infrared film (**second from left**). Sediments discolor the bay in a natural-color photograph (**left center**). Finest detail results from black-and-white filtered by red (**right center**)—a cartographer's delight. Another experimental infrared film (**second from right**) contrasts sharply with color infrared (**far right**), in which lush vegetation appears red, water and areas of thin vegetation are brilliant blue, and terrain contours show up with particular clarity.

ALL FROM SKYLAB 4



SKYLAB 3; SKYLAB 7 (YELLOW)

PARALLEL PLUMES of dense smoke drift nearly 100 miles off the Louisiana coast across the Gulf of Mexico. The fires are lighted by trappers and wildlife managers to clear dead vegetation and rejuvenate desirable marsh grasses.

Haze and thin clouds veil the Potomac watershed west of Chesapeake Bay (**below**); the threadlike Bay Bridge at top center links Annapolis, Maryland, with the Eastern Shore. The Potomac, joined by the Shenandoah, cuts through the Blue Ridge at far left; it widens from a river to a tidal estuary at Washington, D. C., all but invisible at left center. Color infrared film turns the region's fields and forests maroon.

SKYLAB 2 (BOTH ABOVE); SKYLAB 3 (BOTH BELOW)

WITH BRUSHES both broad and fine, clouds paint the movements of invisible winds on whose backs they ride. Bold eddies drift for 150 miles in the lee of Guadalupe Island (**upper left**), off Mexico's Pacific coast. The 4,000-foot-high isle disrupts a wind flow from the north, creating the common phenomenon known as Kármán vortices.

Washboard clouds (**left**) lie downwind of the Kyrenia Range on the north coast of Cyprus. The ridge induces a wavelike undulation of air flowing from the Mediterranean. Clouds occur at the crests of the waves, while the troughs are clear.

Fearsome-looking but almost spent, the vortex of tropical storm Glenda (**top**) dissipates over the Pacific a thousand miles west of Mexico.

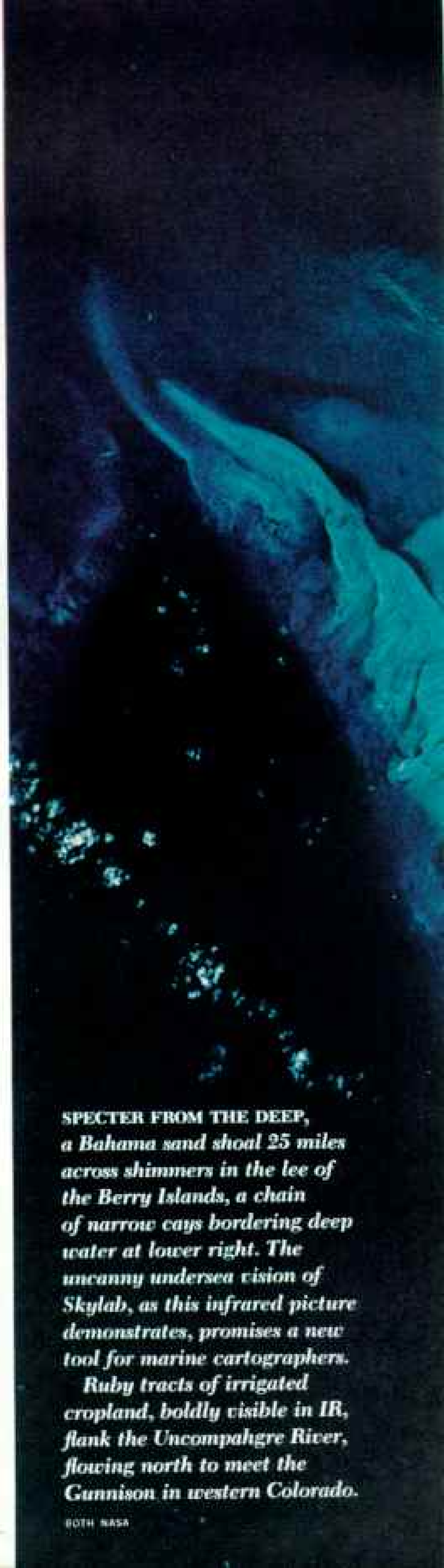
Complex pattern of crosshatched clouds embroiders westerly winds at the edge of a storm over the North Atlantic (**above**). The broad bands run perpendicular to the wind, while the fine billow clouds parallel it.

LIKE A VEINED LEAF, the drainage pattern of the Colorado River breaks the snow-covered desert of Utah and Arizona (**left**). Steep walls of Marble Canyon form the stem at bottom; dark waters of Lake Powell spread north of Glen Canyon Dam, center.

The ability of high-flying spaceships to obtain broad views of snow cover opens a new world to hydrologists, permitting better estimates of the amount of spring melt that will be available for irrigation, power generation, recreation—and floods. Meteorologists can relate the extent of the bright snow cover to earth's reflectivity of solar heat, and thus to its weather patterns.

Rivers straight and contorted etch opposite sides of the earth. The Salween (**near right**), flowing for 1,500 miles through China and Burma, slices directly through precipitous gorges in Burma's eastern highlands. In sharp contrast, South Dakota's White River (**far right**) meanders lazily eastward through grass flats on its slow journey toward the Missouri. Downstream lies at the bottom in both pictures. Milky sediments, picked up in the Badlands and here clearly visible, give the river its name.

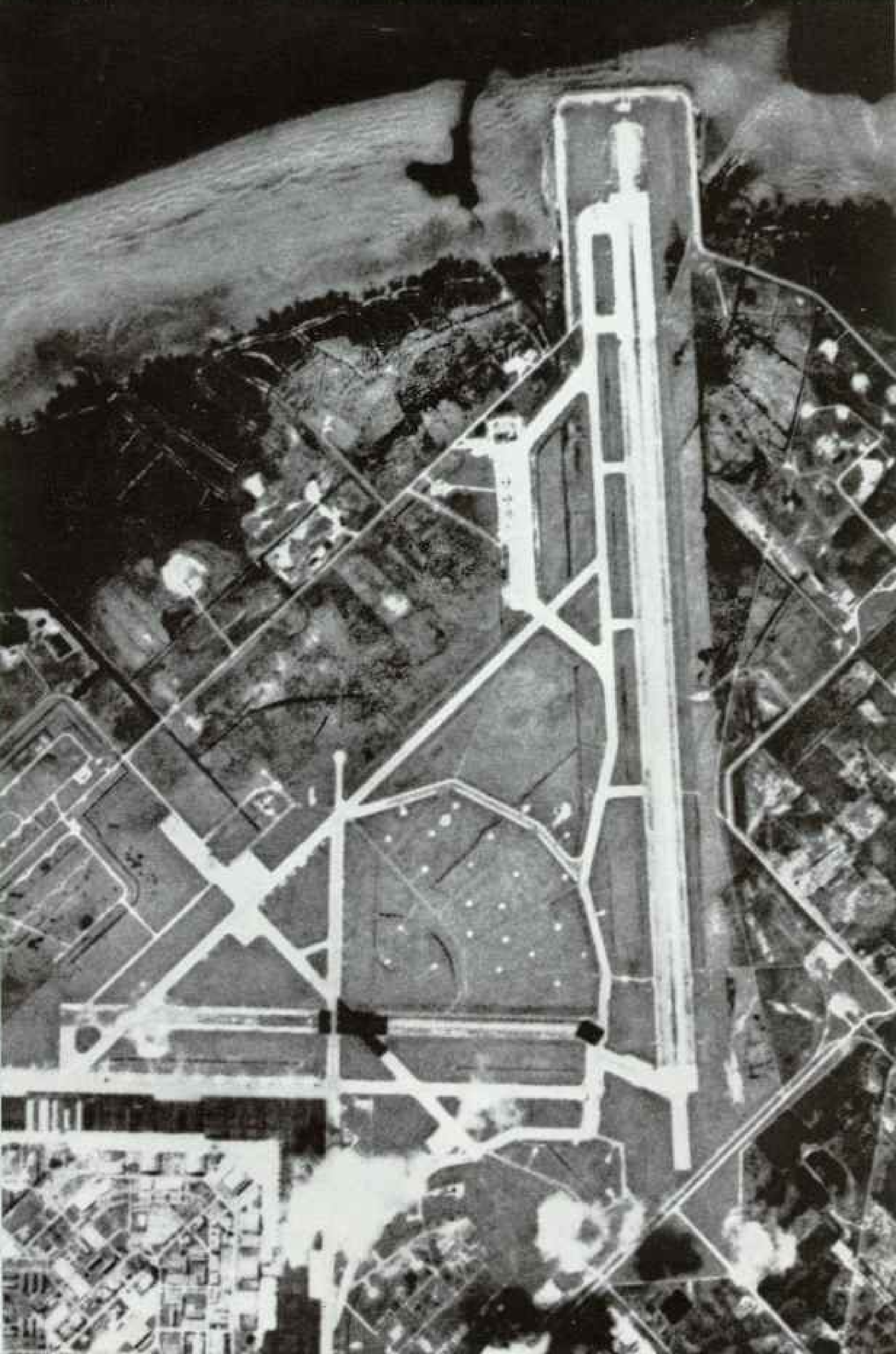
SKYLAB 4 (LEFT), SKYLAB 3 (NEAR RIGHT), SKYLAB 3 (FAR RIGHT)



SPECTER FROM THE DEEP, *a Bahama sand shoal 25 miles across shimmers in the lee of the Berry Islands, a chain of narrow cays bordering deep water at lower right. The uncanny undersea vision of Skylab, as this infrared picture demonstrates, promises a new tool for marine cartographers.*

Ruby tracts of irrigated cropland, boldly visible in IR, flank the Uncompahgre River, flowing north to meet the Gunnison in western Colorado.

BOTH NASA



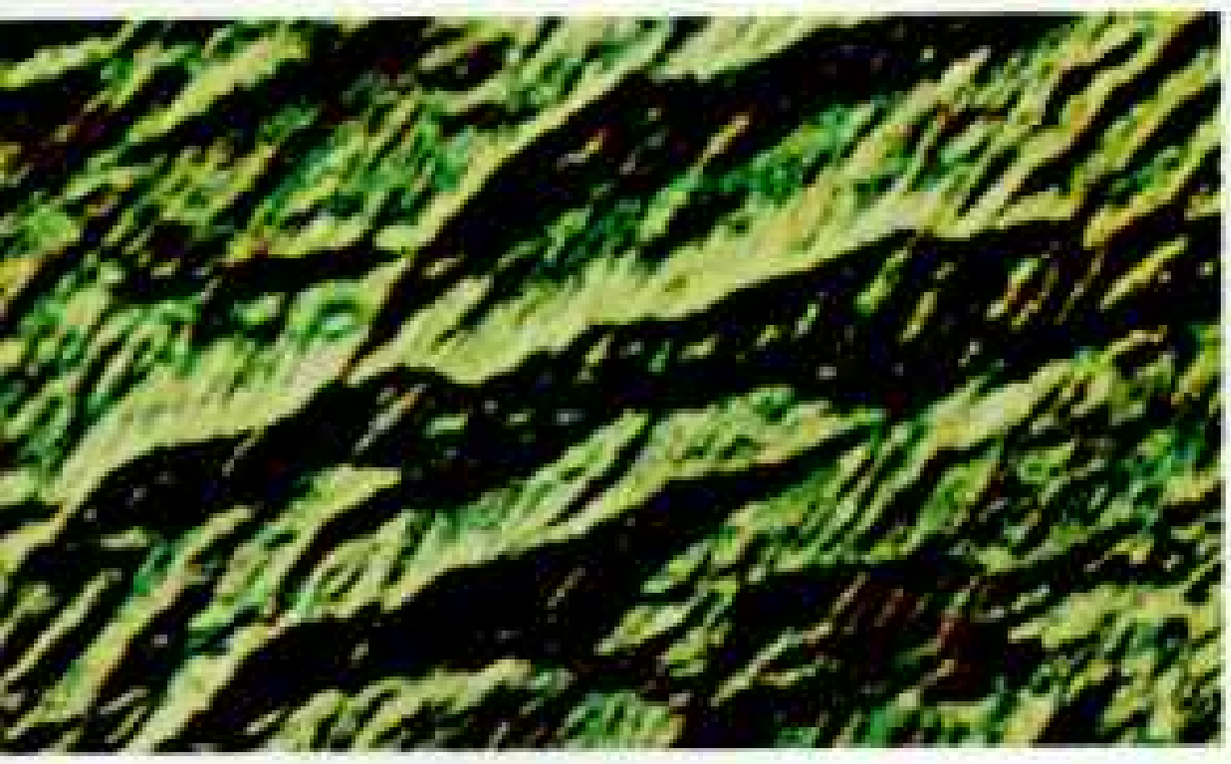
BOTH SKYLAB 3 ENLARGEMENT (LEFT) COURTESY TECHNICOLOR, INC.

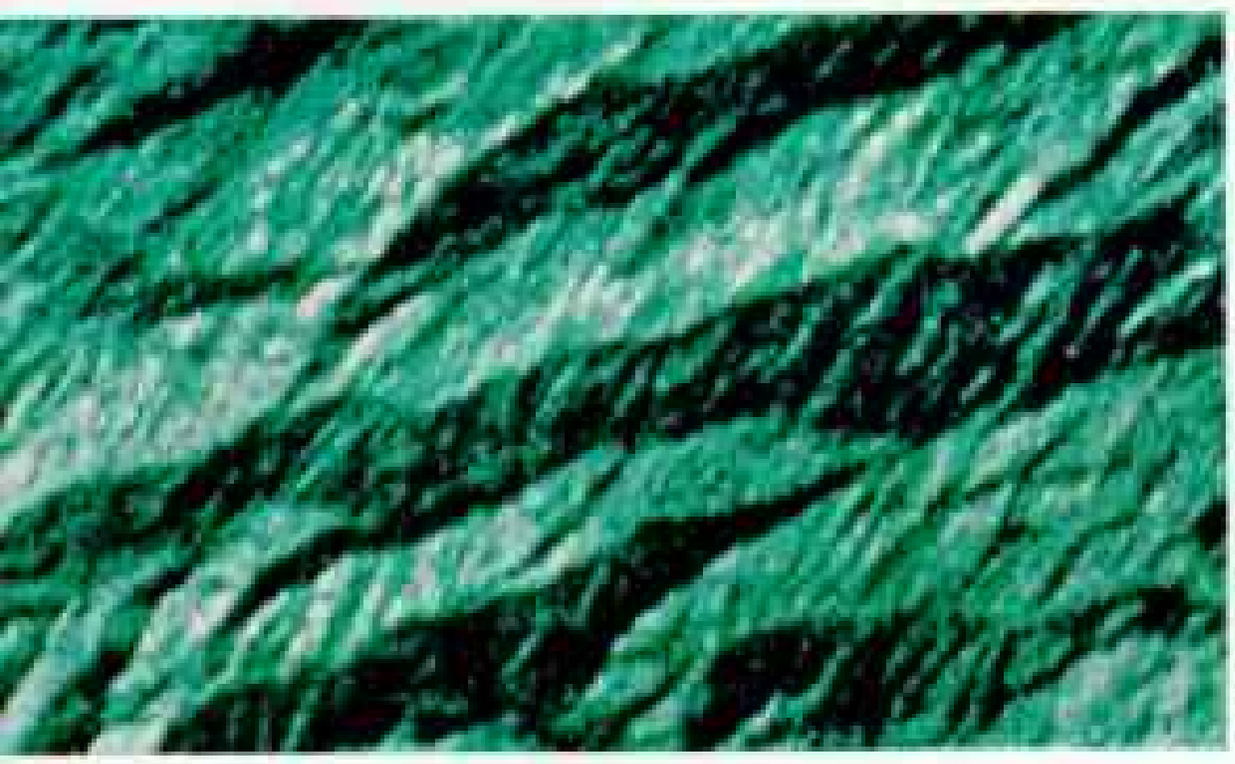
HIGH-FLYING EYE yields bold detail in a striking enlargement of Skylab's imagery. The frame above shows Florida's Tampa Bay. MacDill Air Force Base appears as an angular speck on the Interbay Peninsula, extending into the bay at center. Clock shows time and sequence of the photograph.

Enlarged nearly 50 times (**left**), the airport comes into focus. Aircraft show up on a standby apron at lower left, beside the main runway. This combination of large-area coverage and high resolution makes such photographs ideal for mapping and urban-development studies.

AT ITS MEETING with the Father of Waters, the Ohio River joins the writhing and equally silt-laden Mississippi (**following pages**). Floodwaters fed by heavy rains and spring melt from far up the Mississippi linger in riverside fields; abandoned oxbows mark earlier meanders. Lying like a thread across farms that grid the Illinois prairie, Interstate 57 streaks south toward oft-flooded Cairo, wedged between the converging torrents.

Both with cameras and their own observations from the wardroom window, the astronauts could make quick and accurate appraisals of flooding, often difficult on the ground.

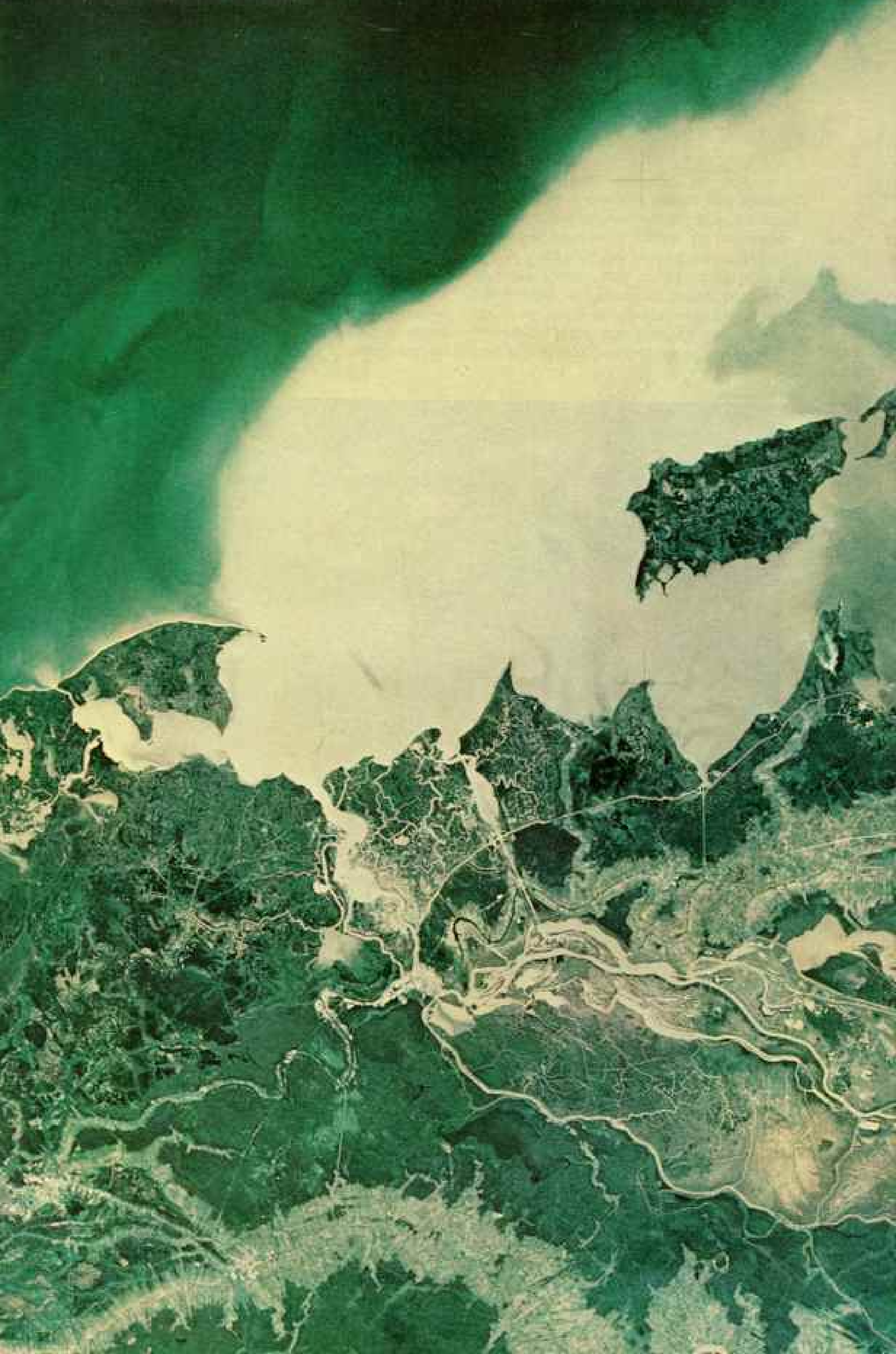




ALL 8X7-LAB 1

NEW ENERGY SOURCES beckon in an image derived from a thermal infrared picture of The Geysers region of northern California (**directly above**). Believed to be "hot spots," a few degrees warmer than their surroundings, the areas could betray the presence of subterranean steam. A utility company now taps one such source, discovered years ago. The hot spots show up as white in thermal IR (**above middle**) but not in other wavelengths (**top**).

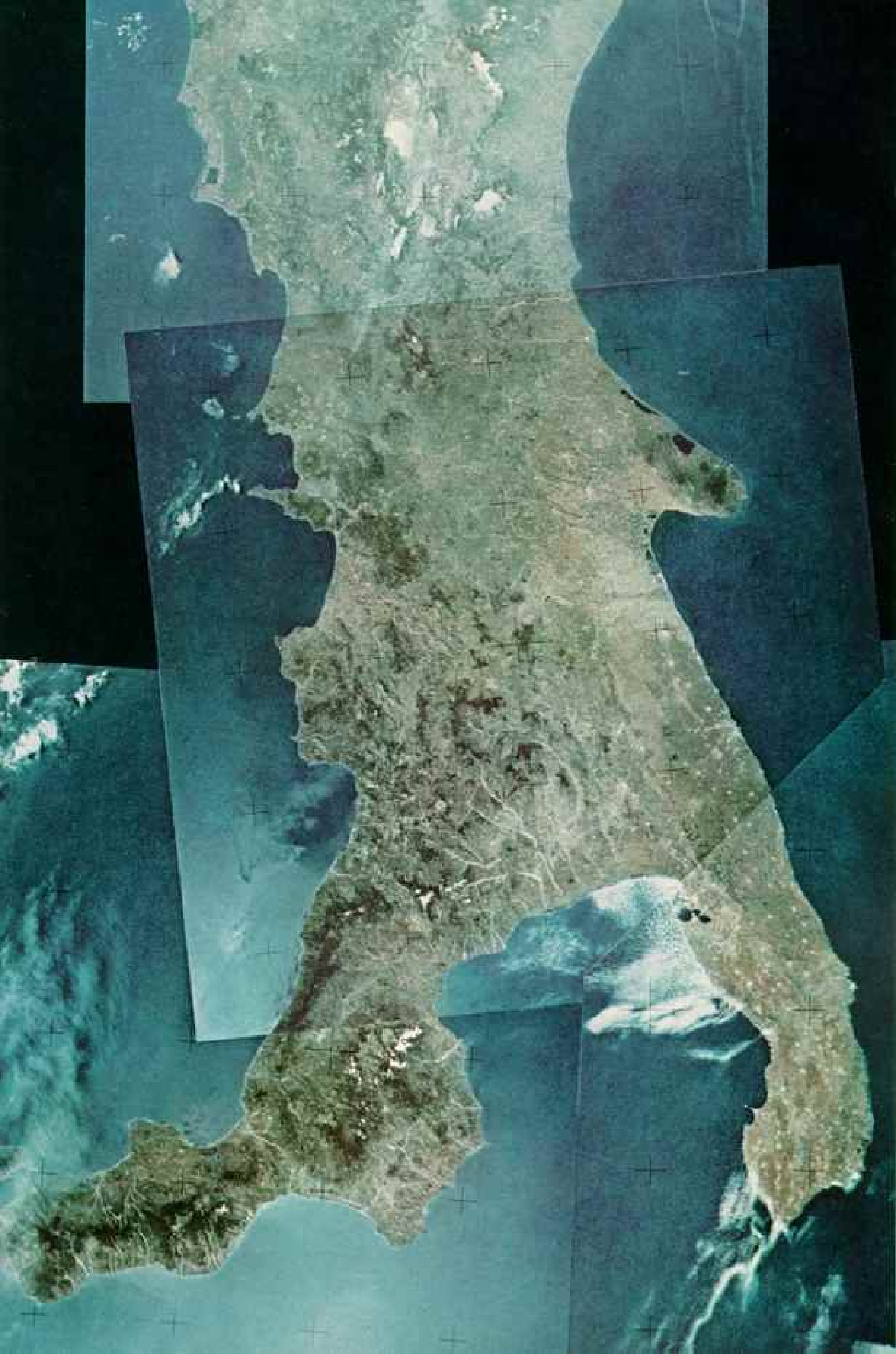
Erosion's turbid trail clouds Louisiana's Gulf Coast (**right**). More than 133 million tons of silt a year flow to the gulf from the Atchafalaya River. Most of the silt originates in the Red and Mississippi Rivers, whose waters are partly diverted into the Atchafalaya for flood control.



BOTH SKYLAB 3

EUROPE AND AFRICA nearly collide at the Strait of Gibraltar, dividing Spain, upper, and cloud-daubed Morocco by a scant nine miles. The famed Rock, a British crown colony, cups Gibraltar Bay at the Mediterranean end of the strait. It is one of the Pillars of Hercules, ancient Roman name for the historic headlands.

New look at Italy's boot gives geologists a revealing perspective of the region's complex morphology—a jumble of mountains, plateaus, plains, and fracture lines. Two-thirds of the way up the west coast, the black cone of Vesuvius stares skyward between Naples and the cloud-anchoring Isle of Capri. At the heel of the boot, tan, arid land dominates Apulia. Its polka-dot pattern locates the region's distinctive villages, whose limestone houses and streets gleam a conspicuous white.



BOTH SKYLAB 3

WINTER'S GRIP settles on the Kamchatka Peninsula on the U.S.S.R.'s Pacific coast (**above**). Snows soften a mountain spine whose peaks climb to 15,000 feet above the remarkably regular shoreline of the Sea of Okhotsk.

Rugged mountains march west across China's remote Sinkiang Province, in this long look into an inaccessible region (**right**). Earthquake faults and river valleys cleave the ranges and furrow the plains of this wintry land.

Made from Skylab's wardroom window, such pictures could be valuable aids for cartographers seeking to chart the little-known area. After being photographically rectified to remove distortion caused by the camera's oblique angle, the images could become base maps on which roads, settlements, and political boundaries could be drawn.

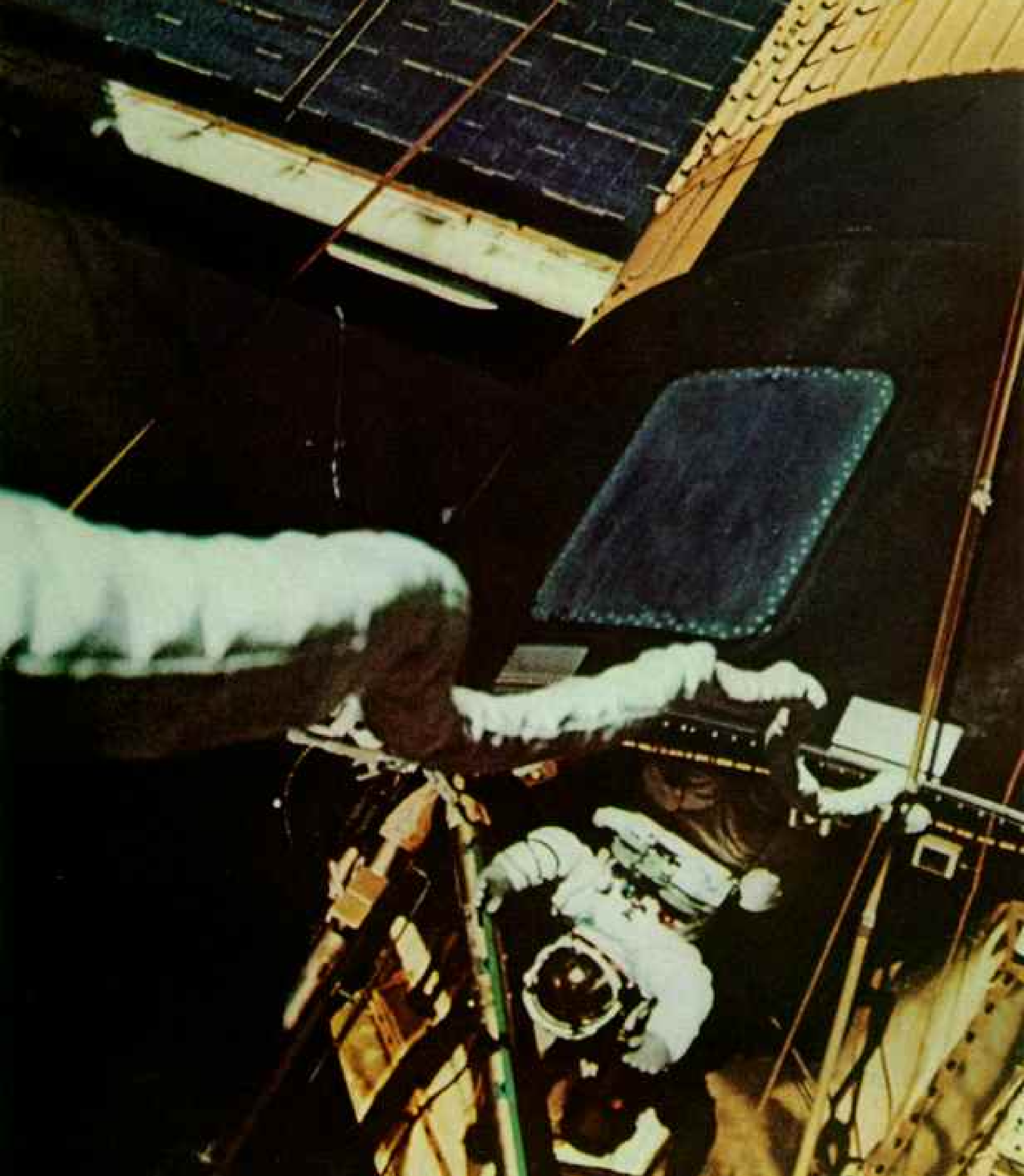
Skylab demonstrated its mapping potential during passes over a similarly remote region in Paraguay. Beaming cameras over an area known as the "Green Hell," the space station obtained photographs that enabled cartographers to map in days an area that would have required far more time and vast expense for ground or aircraft teams to cover.

BOTH SKYLAB II

BLEAK AS THE MOON that hangs above them, mountains of the Hindu Kush shine in twilight. The terminator—line between day and night—draws a curtain over the edge of the earth.

As if waving farewell to the Skylab mission, Gibson emerges from the station's EVA hatch during the final space walk on February 3, 1974 (**right**). Crew commander Carr perched on the telescope mount to make this picture. To the left of his snakelike umbilical, poles and lines of the second sunshade extend out over the workshop.

With the final crew's departure on February 8, Skylab became a ghost ship, destined to circle the earth lifelessly until a decaying orbit sends it flaming into the atmosphere, probably less than a decade from now. □



The Sun As Never

THE SEETHING AREA of the sun's surface that we patiently watch through Skylab's telescopes is sporadically releasing intense radiation from isolated points. Suddenly a small point becomes exceptionally bright. Training all the lab's solar instruments, we catch the elusive target that all Skylab crews have vainly sought—the very birth and total life of a solar flare. Like other events observed from the lab, it will help provide a better understanding of our primary energy source—the sun.

As our nearest star, the sun provides virtually all the heat and light that the earth receives. However, our desire to understand the sun goes beyond our dependence on it. Its diameter more than a hundred times that of earth, it is a giant laboratory that allows us to

Seen Before

By EDWARD G. GIBSON, Ph.D.
SCIENCE PILOT, SKYLAB 3

make unique observations of plasmas, those high-temperature gases that can conduct electricity and interact with magnetic fields.

The knowledge we gain is applicable in many areas, from research into generating energy by nuclear fusion here on earth to understanding the distant stars. Further, the stronger solar emissions affect weather, long-range radio communication, magnetic storms,

Sun's hot outer atmosphere, or corona, color-coded to distinguish levels of brightness, reaches outward for millions of miles. A coronagraph, one of Skylab's eight telescopes, masked the sun's disk, creating artificial eclipses. It permitted 8½ months of corona observation, compared to less than 80 hours from all natural eclipses since use of photography began in 1839.

HIGH ALTITUDE OBSERVATORY AND NASA

auroras, possibly even biological evolution.

Two hundred and seventy miles above the earth makes an excellent vantage point for Skylab's solar instruments. The sun's ultraviolet and X-ray emissions here are not absorbed by the earth's atmosphere but can be recorded directly, exposing a wealth of information unavailable to astronomers on the surface. Also, the extremely faint outer atmosphere of the sun, the corona, can be seen in detail from the ground only during rare total solar eclipses, a few minutes at a time. Above the atmosphere, Skylab could observe the corona nearly continuously.

These advantages governed the selection of Skylab's data-gathering telescopes: two X-ray instruments, one from American Science and Engineering, the other from Marshall Space Flight Center; two ultraviolet instruments from the Naval Research Laboratory and a third from Harvard College Observatory; and a coronagraph from the High Altitude Observatory in Colorado.

The astronauts operating these instruments had great "scientific leverage." Watching televised displays in Skylab, they made decisions on when, where, and how to use each instrument. The challenge of these judgments proved especially rewarding during our long vigils in the lab.

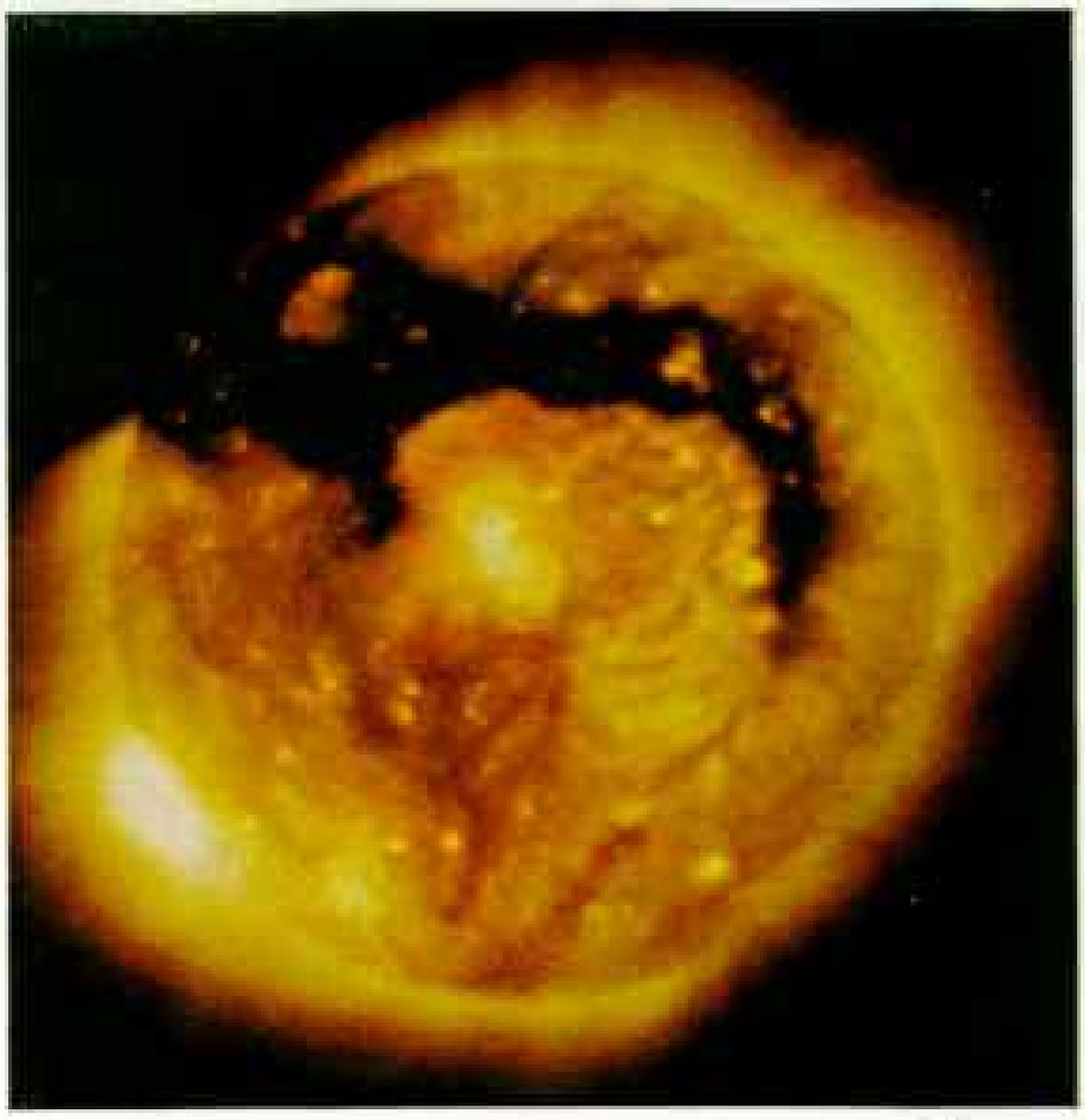
The flight crews were only the visible part of an enormous behind-the-scenes effort. More than 200 scientists and engineers monitored and helped plan daily operations of the instruments. Some 150 solar observers in 17 countries coordinated their efforts with ours, multiplying the data.

Each evening scientists on the ground, weighing information from Skylab and the worldwide support team, sent up the next day's observing plan. On the last mission we discussed this plan in detail the next morning with astronaut Dr. William Lenoir, who spoke for the scientists.

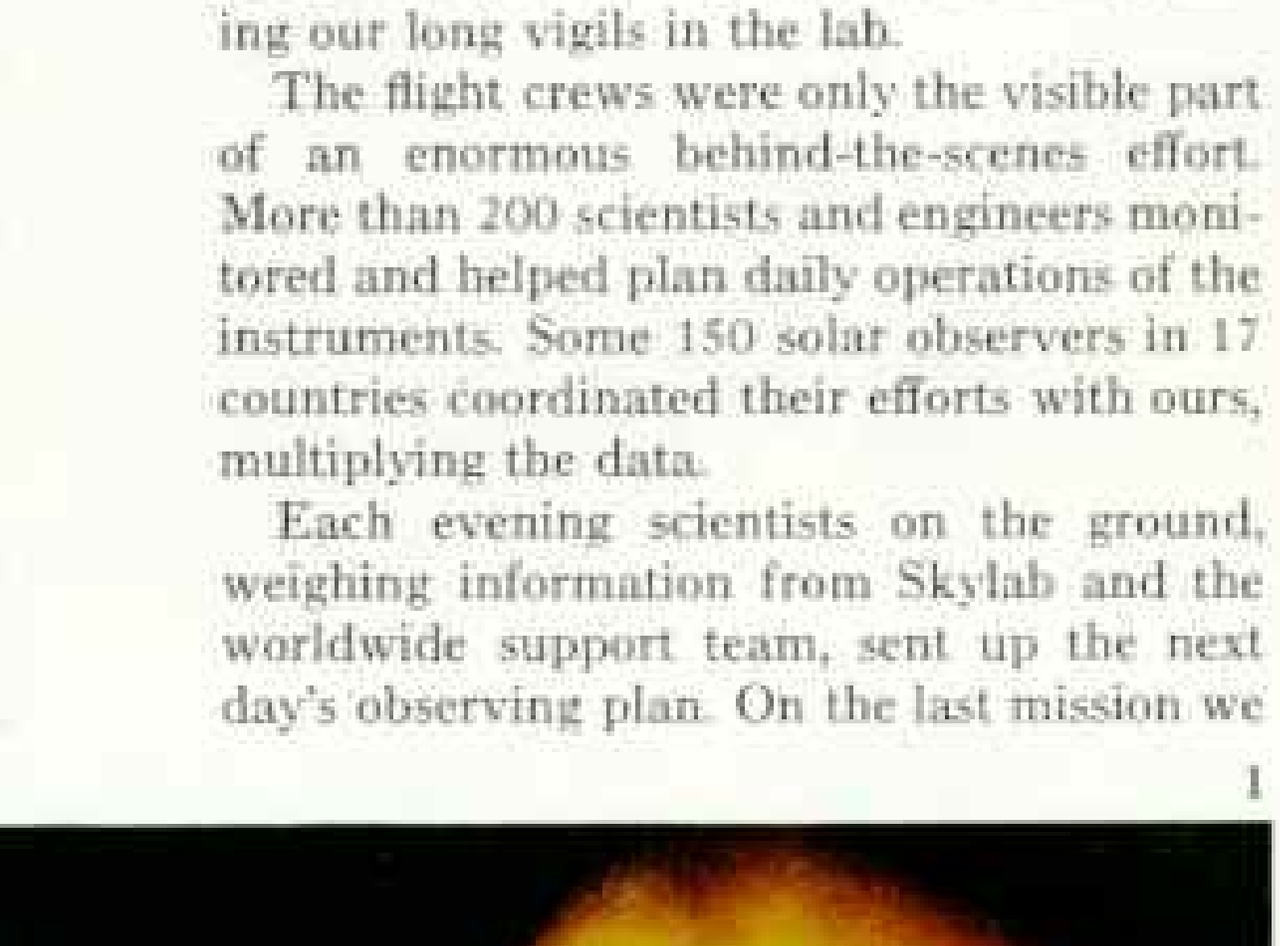
Ground or flight crews could change the plan in response to changing conditions on the sun. For example, on January 17, 1974, a Hawaiian observatory spotted a large prominence erupting. Immediately the information went to a NOAA facility in Houston, to the "czar" representing the solar scientists on duty, to the flight director, to the capsule communicator, and finally to the crew. In a matter of minutes, Skylab's telescopes were observing a unique formation of material speeding outward through the corona.

Skylab marshaled the largest single effort to observe the sun in the history of man. Now comes a less visible but equally exciting and rewarding effort—to turn the data we obtained into knowledge.

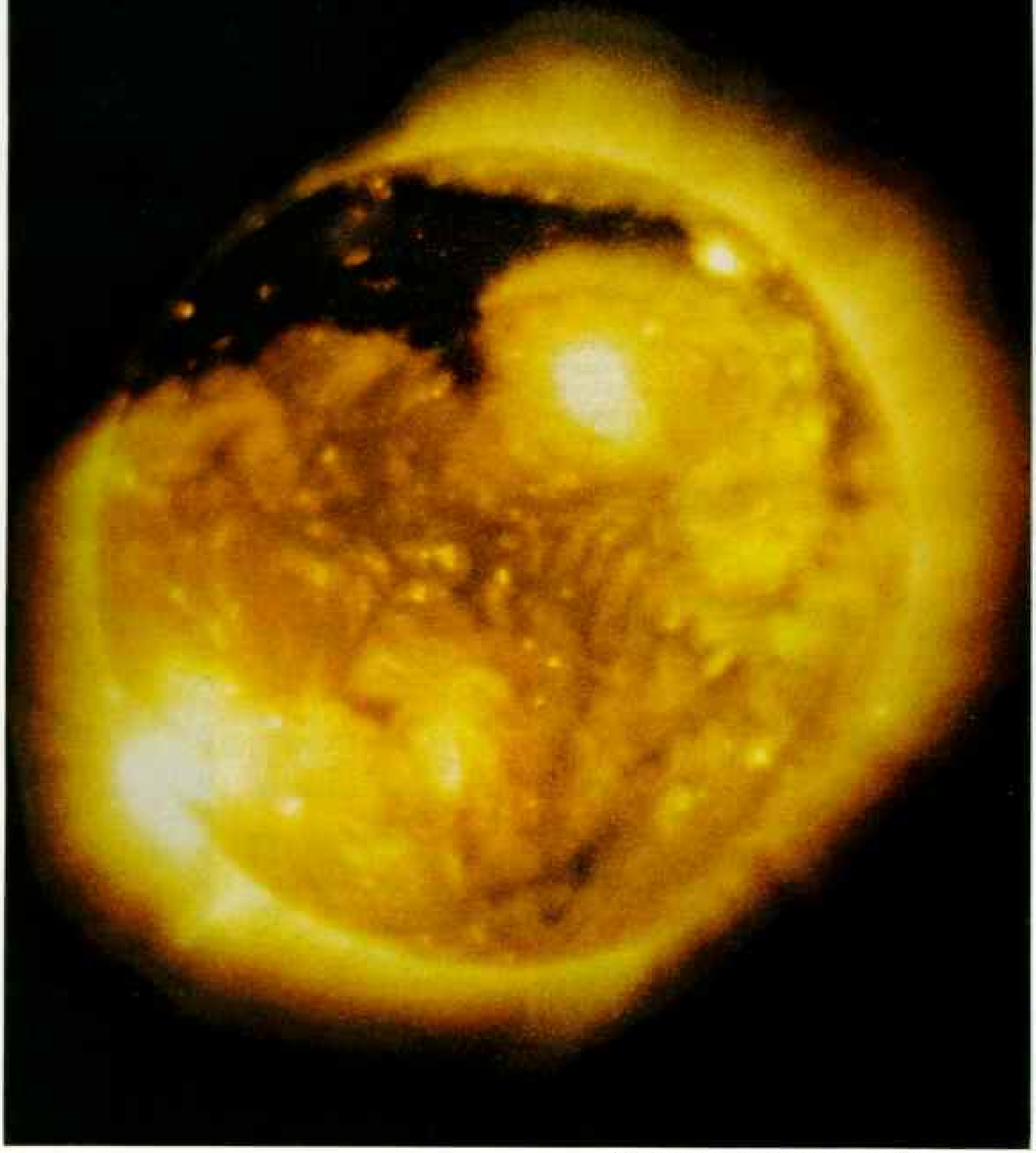
3



2



1



4

ALL FROM AMERICAN SCIENCE AND ENGINEERING AND NASA

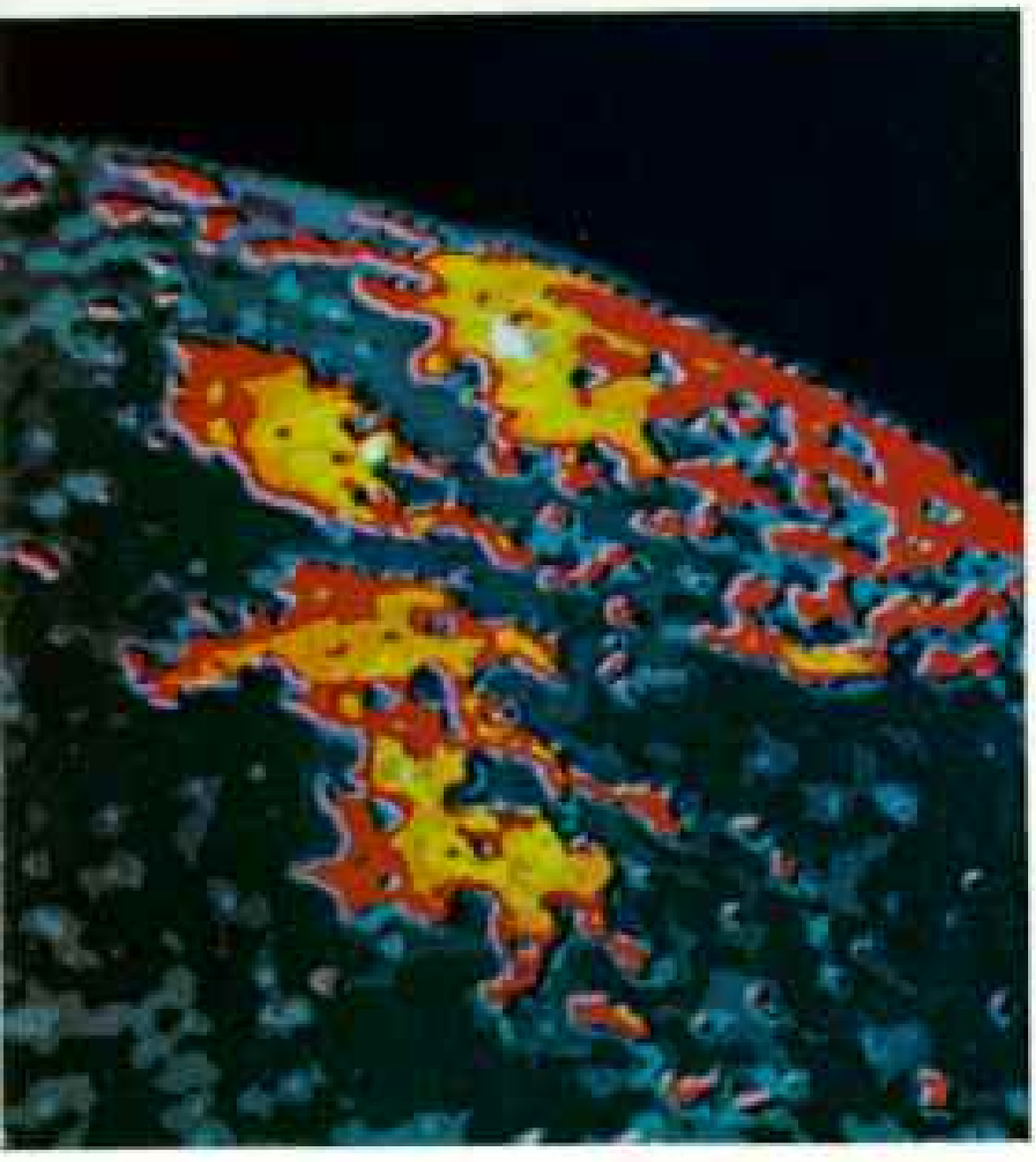
X-RAYS OUTLINE the sun's magnetic fields in a dramatic series of pictures taken during the second mission. Large bright areas—coronal gases at temperatures above two million degrees F.—move along magnetic loops and arches, or lines of force, suggesting a three-dimensional picture of the magnetic fields. The dark zone, running from the north pole (upper left in these tilted images) to below the equator, represents a "hole" in the corona. Such holes, with relatively low temperatures and nearly vertical magnetic fields, may be major sources of high-speed streams of the solar wind that blows outward toward the planets.

Rotating with the sun, the hole travels halfway across the disk in this sequence, shown in numerical order on August 19, 1973, August 21, August 23, and finally on August 25.

The photographs also reveal the sun's numerous "bright points," whose abundance was unsuspected before Skylab. About the same size as the earth, some 1,500 bright points emerge each day, each lasting approximately eight hours. Ground-based instruments show that they carry unexpected amounts of magnetic flux, possibly contributing to the solar cycle in which the sun's magnetic field reverses every 11 years.

SOLAR STORMS, known as active regions, can be dissected and analyzed by observing them simultaneously in different wavelengths of ultraviolet light. The active regions below, observed on September 11, 1973, are relatively hot areas that emit more intense ultraviolet radiation than their surroundings; they appear here in lighter colors.

Each atom radiates light at certain wavelengths that characterize that atom only. When atoms collide with other fast-moving particles at high temperatures, they lose electrons and become ions. As more electrons are torn off, the light from these ions appears in ever-shorter wavelengths, from visible light to ultraviolet and finally X-ray. When light that is characteristic of a particular ion is observed, we know it was emitted from a region where temperature and density favor formation of that ion—and thus we can observe different layers of the sun's atmosphere.

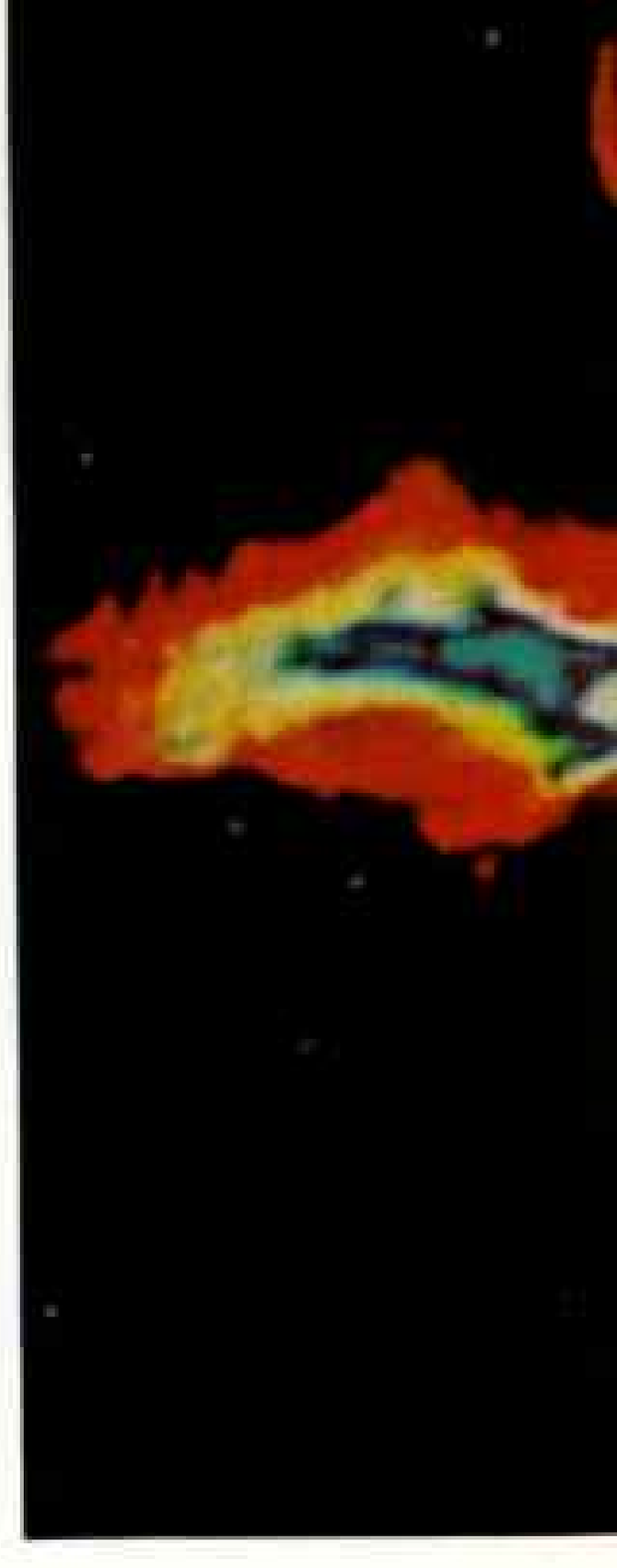


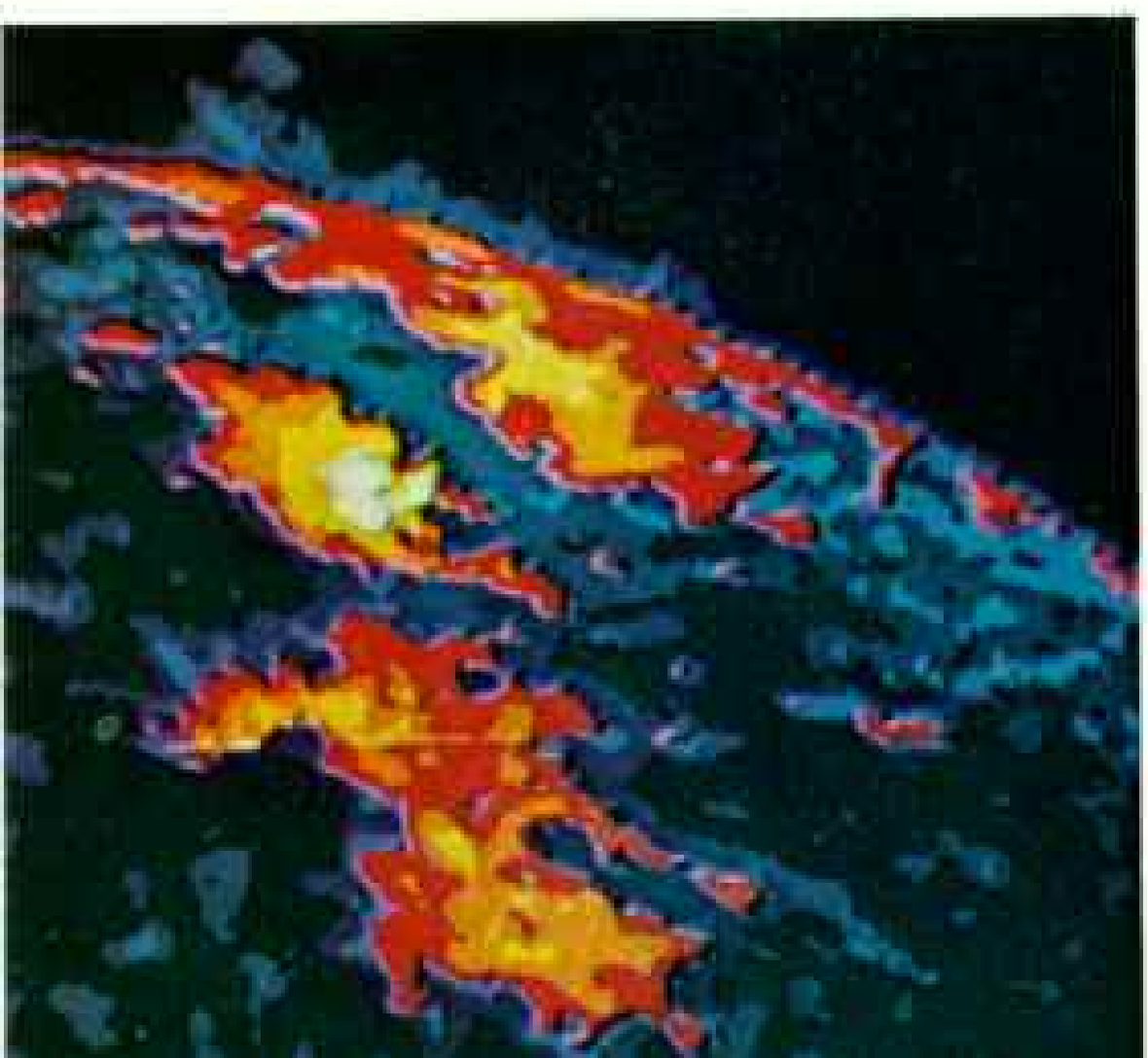
In the false-color photograph at **left**, the presence of carbon ions, missing two electrons, betrays temperatures of about 100,000° F., indicating that this region of the storm occurs near the sun's surface.

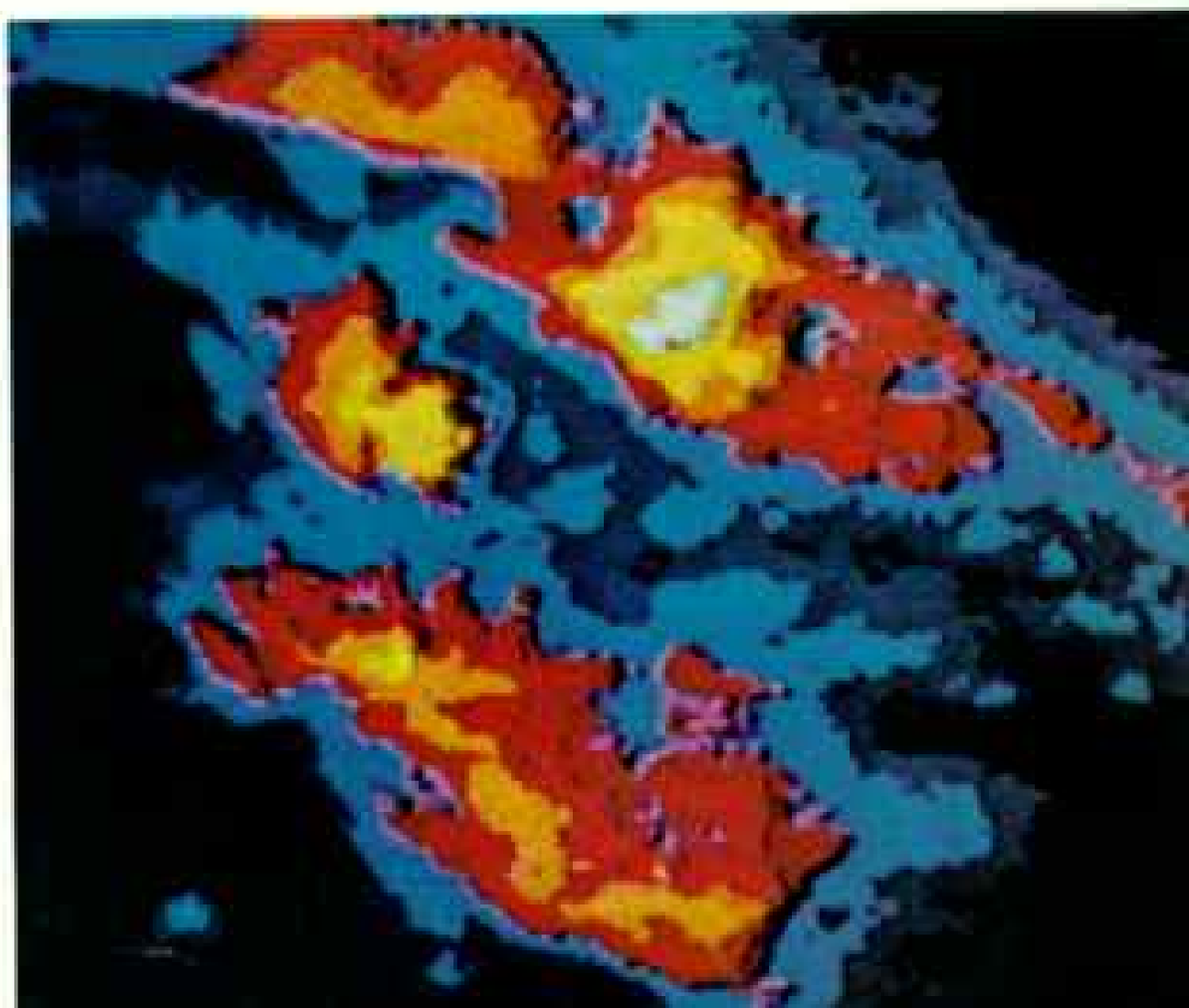
The active region extends to higher altitudes in the picture at **lower left**, whose hot spots represent atoms of oxygen stripped of five electrons.

Searing gases of two million degrees leap more than 40,000 miles above the surface (**below**), as revealed by magnesium atoms missing nine electrons.

HARVARD COLLEGE OBSERVATORY AND NASA







NAVAL RESEARCH LABORATORY AND NASA (ABOVE); HARVARD COLLEGE OBSERVATORY AND NASA (BELOW)

Angular "elbow" prominence erupts half a million miles into the solar atmosphere (**above**). Most likely blocked by magnetic forces, part of its material rains back to the surface. The prominence remains surprisingly compact, especially the bright knot of dense material at upper right. Lighter colors indicate the most intense radiation.

Cloud of cool gas (**left**), about 20,000° F., insulated by magnetic fields, is trapped in the darker, four-million-degree corona. This composite shows atomic hydrogen and ionized oxygen, with different colors indicating different temperatures.

A HUGE CLOUD being driven outward, a coronal transient billows nearly two million miles into space (**left,** at top). Transients, which visibly changed shape in only minutes, were observed on an average of every three days. Often caused by eruptive prominences, the expanding loops or bubbles produce shock waves that may extend to planetary distances.

The ever-changing corona observed by Skylab came as a surprise to most investigators. Most coronal features outline magnetic fields, which are of prime importance in understanding the corona's structure and the outward flow of solar wind.

HIGH ALTITUDE OBSERVATORY AND NASA

Cause and effect between a solar eruption and its disruption of the corona appear in four composites (**right,** above), combining coronograph pictures with views of the eruption in ultraviolet light. Both sun and corona are unaffected at 1333 hours on August 21. Successive comparisons trace an eruption and the loop transient it causes in the corona. By 1615 the eruption has disappeared, but remnants of the loop remain. The bright star Regulus shines through the corona at top.

SOLAR IMAGES NAVAL RESEARCH LABORATORY AND NASA; CORONA IMAGES HIGH ALTITUDE OBSERVATORY AND NASA; COMPOSITES BY ALFRED M. ISZ, NATIONAL GEOGRAPHIC PHOTO LABORATORY

1333 hours

1441

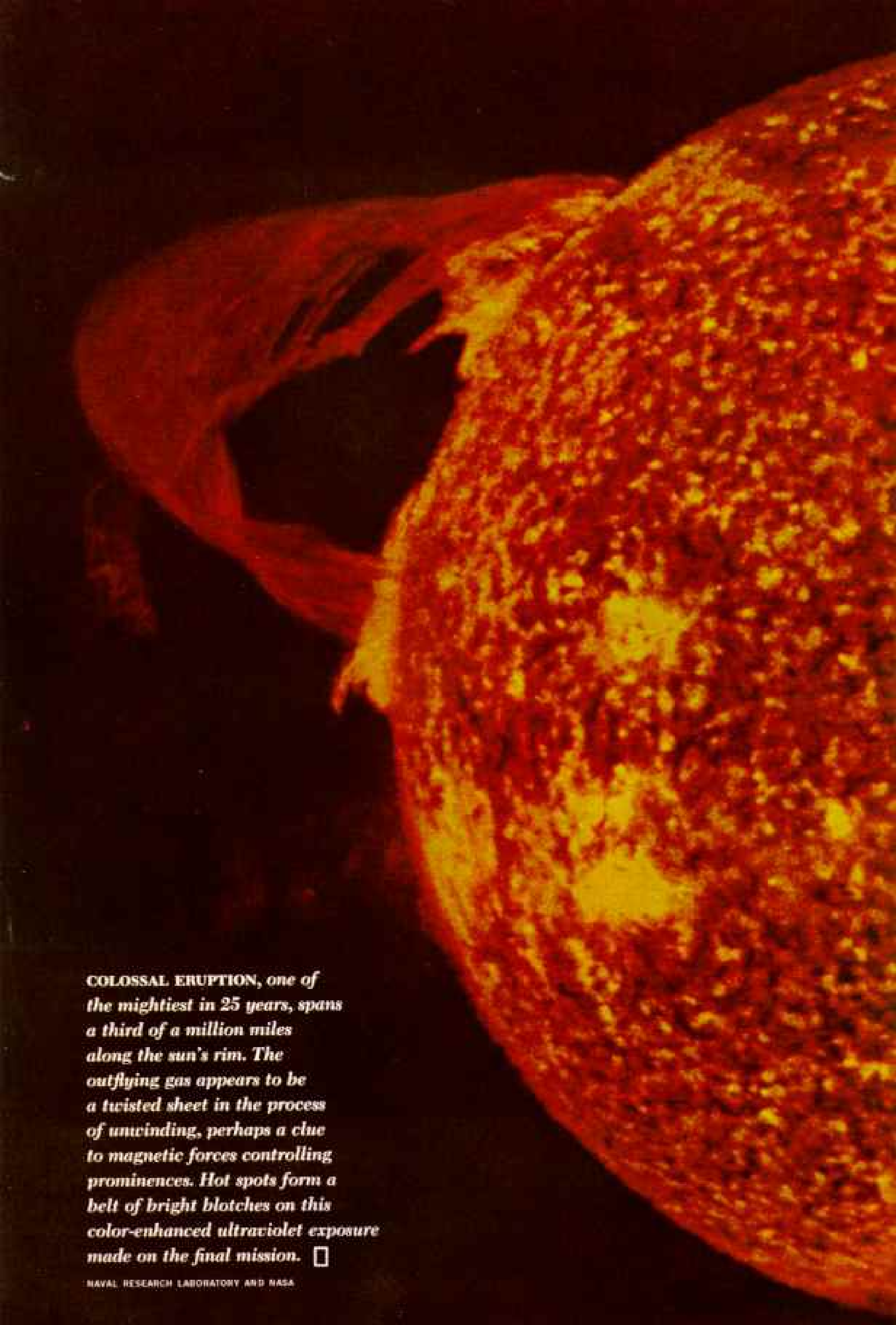
1511

1615

SKYLAB 2 FROM NASA

Control and display console, located in Skylab's multiple docking adapter, gives the author a unique look at the sun on two television screens at bottom center. His right hand rests on the control used to point the instruments. A Polaroid camera, used for making images for later reference, covers the display screen at left.

While working at the console, Gibson's feet were locked into the triangular grid, leaving both hands free.



COLOSSAL ERUPTION, *one of the mightiest in 25 years, spans a third of a million miles along the sun's rim. The outflying gas appears to be a twisted sheet in the process of unwinding, perhaps a clue to magnetic forces controlling prominences. Hot spots form a belt of bright blotches on this color-enhanced ultraviolet exposure made on the final mission.* □

NAVAL RESEARCH LABORATORY AND NASA

All grit and go at 65, Jude Hart churns across a swollen creek. Jude hauled the first steel oil

Big Thicket of Texas

By DON MOSER

Photographs by BLAIR PITTMAN

THE OLD LOG WAGON bucked along the track through the forest, the tires making sucking sounds as they rolled through the hub-deep mud of spring. On the seat in front of me, Jude Hart reached out with a switch and slapped the mule on the rump. "Ho, Rufe," he said. "Don't make that horse do all the work." I looked at Jude's back. He was thin across the shoulders, in the arms and face too, but tough, in that way of stringy men who have worked their bodies hard all their lives.

As we rolled along through the old sweet gums and loblollies, parula warblers buzzed in the canopy above, and Carolina wrens sang exuberantly, their sap up with the spring.

derricks into the area and many a razorback hog out, though he allows, "Cow meat's better."

Jude's hog dogs, exultant at being on the loose, ranged ahead, happily splashing through the mud. It was a lovely spring day, and we didn't have a thing to do but prowl the woods in the old log wagon. The way people around here put it, we were in hog heaven.

When we reached Pine Island Bayou, a dark stream winding among the big trees, Jude reined up Belle and Rufe and looked at the water. "Wonder if the creek's swimmin'?" he said. "Back in nineteen and thirty-four we lost a wagon in here. She floated off down the creek with two skinned deer, two Winchester .30/30's, a saddle, and four live hogs."

I'm not much of a swimmer, but before I had a chance to say anything about that, Jude yelled, "Ho, Rufe!" and drove the team straight into the creek. We rolled along, then the team was swimming and the wagon was awash. After a moment the wagon bed went clean under water, and our gear and boxes of food were floating around in the bed like corks in a bathtub.

I sprawled on the boxes to keep them from sailing off down the creek. Icy water ran down my belly and into my boots. The wagon, I reckoned, was going straight to the bottom, and in just another moment I was going to float off downstream myself. Jude cocked his head around, grinned, and said, "By golly, the creek *is* swimmin'."

I was up to my neck, so to speak, in Texas'

Early pioneers bypassed the Thicket as impenetrable, too forbidding to homestead. Later

settlers, like the Allisons of Turkey Creek, cut dense tangle to put down human roots.

Big Thicket—the remnant of a dark and menacing wilderness that once spread across more than three million acres of east Texas. Not the familiar Texas of the big sky and far-off horizons. This was a region of enormous trees and scattered swamps and black-water sloughs, laced with dense tangles of yaupon and titi and interspersed with open savannas that looked like the plains of Africa.

It was originally the home of the panther, the bear, the wolf, and the ivory-billed woodpecker; later it became the denning-up ground of antislavery jayhawkers, moonshiners, and an assortment of desperadoes, thugs, and misanthropes, along with more-peaceable folk with a taste for pioneering.

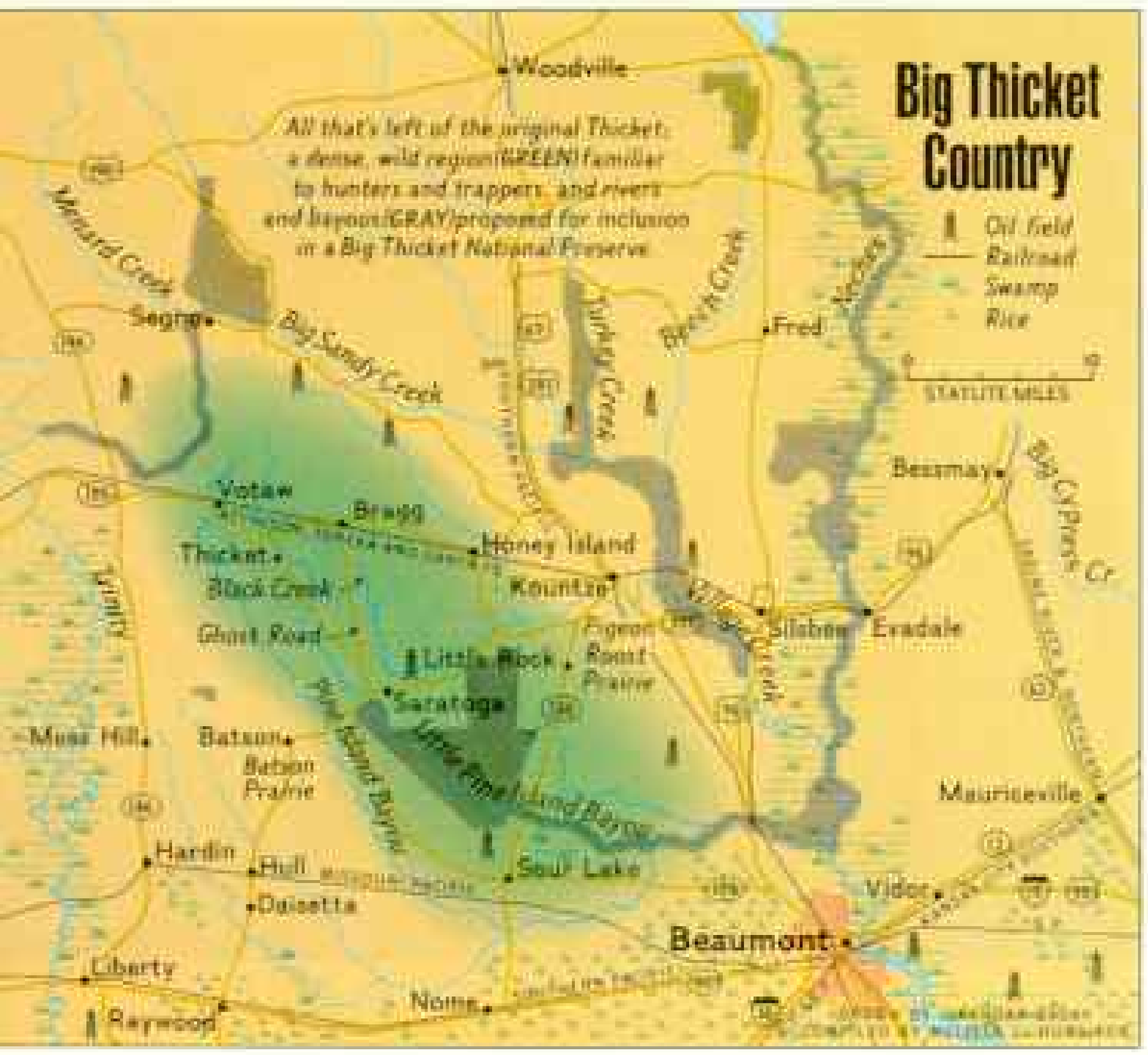
The Thicket was fabulously rich in timber, oil, and game. Out on Pigeon Roost Prairie the passenger pigeons were so thick during migration that, in Kountze at night, people claimed they could hear tree branches cracking under the weight of the flocks. But the pigeons and the bears and the panthers were killed out, and some oil fields ran dry. The timber was logged, and logged again.

Today a casual traveler driving through the Big Thicket country passes miles of orderly tree plantations, where the young pines are dressed to the right and covered down like platoons of infantry; passes the old oil fields, where a few slowly bobbing pumping jacks still suck a last drop of oil from the earth; passes housing subdivisions and roadside honky-tonks, barbed-wire fences and no-trespassing signs. He might well ask, "What Big Thicket?"

Well, it's still there—or some of it is. But to find it you have to poke around in the eddies and backwaters of the country. And if you do, you still find a Big Thicket, of dark and mysterious forests, and wild creatures, ghostly visions, and an independent people so in touch with the past that the words that come from their mouths are history.

HANGING AROUND JUDE HART is like visiting another century. It's not that Jude is old, for he's only 65, which makes him a mere tad of a boy in this country of old-timers. It's just that when the 20th century went marching off to the future, Jude stayed put. He still travels the woods with team and wagon, still plows his garden with a mule. "It's easier mechanical, but I just like to be old-fashioned, I guess."

I'd gone to see him at his little farm near Batson to plan our trip to his hunting camp, and as we talked he kept rummaging around, digging old-timey things out of the back room and out from under the porch: his grandfather's Harmon saddle, which Jude still rides, an old fire pan that hunters used to



Wedge of jungle, the Big Thicket once covered three million acres of east Texas. Now railroads cross it, oil wells puncture it, and loggers have cut over most of it. Yet thousands of acres of wild country remain—one of the last known haunts of the red wolf, and maybe, just maybe, the ivory-billed woodpecker. After decades of dispute, it now appears that Congress may set aside 100,000 acres as a national preserve (**left**).

At Ernest Spell's barbershop near Silsbee (**right**) you can, naturally, get a haircut. Or you can stop by to do a little picking, plucking, singing—or tale-swapping, the Thicket's most perfected art.

As Bill Brett of Hull observes, "You take a fella that don't know how to tell a lie, and generally he ain't got too many friends."

fill with pine splinters and set alight so they could spot the eyes of deer in the darkness.

As he showed me these treasures, he talked of his youth in the Thicket. It was typical of stories I was to hear a score of times—a story of backbreaking work and hard times.

"When I was 13 my daddy died and I refused to go to school. I was small and little, but I went to work in the woods, dollar six bits a day. Caught the log train at six in the morning and if I got in at nine at night I'd be happy 'cause supper would still be warm. Raining and cold didn't make no difference—we was more like varmints than men."

He fished an oilstone out of his pocket and whetted away with an old Case knife, its blade worn to little more than a sliver. "I was a skidder-horse rider—I'd ride with the cable from the steam engine out into the woods and they'd hook the line to a log. Then the drum puller back at the steam engine would reel it in. Pulled a 1,800-pound horse over on me one time. They'd pull a log over on a man, and if they'd killed him at nine, they wouldn't bring him in till they'd knocked off that evening—they'd throw him on that log train and haul him in, just like a varmint."

It was Jude who introduced me to hog hunting. Now the reputation of the pig has suffered latterly, but in east Texas it is still considered a noble beast. Traditionally pigs have been allowed to run free in the forest to fatten on acorn mast, then rounded up and killed when food ran short. "These old razorbacks are smarter than dogs," Jude said. They are also fast, powerful, and utterly brave. The boars, with curved "tushes" beveled sharp as knives, are as formidable as any animal on the continent.

ONE MORNING I went out after hogs with Jude and a couple of men in their thirties, Raymond Hobbs and Birt Thorsen. Raymond and Birt are "big old boys"—strong, rangy, country through and through. Young men like them tend to leave the Thicket nowadays, but these two had stuck—Raymond with a job for the telephone company, Birt going off to work on oil rigs, returning to the Thicket whenever he had money saved up. "These woods are the place I want to be," Birt said. Simple as that.

Around his waist Raymond carried a length of rope; if the dogs bayed a hog he would lasso it, tie it, and drag it out live for further fattening in a pen. An old boar has tushes grown into full circles, and he can't slash you with the points. "All he can do is knock you down and bruise you up and nibble on you some," Raymond said. "It's those 2- and 3-year-old boars that are bad."

"What do I do if I meet a bad hog?"

ROBERT S. PATTON, NATIONAL GEOGRAPHIC STAFF (ABOVE)

Beercannus americanus cannot survive amid wild flowers (**left**) when Geraldine Watson, naturalist and conservationist of Silsbee, leads a field trip. Blooms adorning the rusted can include verbena, spiderwort, and self-heal. To many local residents, the rich botanical diversity of the Big Thicket has meant only more kinds of undergrowth to clear for planting. But attitudes change; most now agree parts should be preserved.

A lucky bouquet of horseshoes blossoms on a restored blacksmith shop at Heritage Garden Village near Woodville (**facing page**). For backcountry work, the horse still clops where pickups fear to go.

Jude grinned. "Just don't try to outrun him, 'cause you can't. Some folks look for a tree to climb. I like to get my back against a tree and kick 'em off with my boot. You might try that."

"Sure," I said.

We entered the woods near Saratoga with five ratty-looking dogs. "For hog hunting we use what we call cur dogs," Jude said. Fine-bred dogs lack the bottom to tackle a bad boar. But in the Thicket generations of rangy mongrels have been bred into a race known as black-mouthed curs. They have sensitive noses, stamina, and courage.

With the dogs ranging in front of us, we walked through the woods. The day was hot. It had rained so much in preceding weeks that the woodland floor was covered with water, and it was like walking through a steam bath. Our boots sucked in the mud as we threaded our way through loblollies and tall palmettos.

A long time passed, but the dogs failed to strike. Jude had to leave us in the early afternoon, and the three of us went on. "Listen," Raymond said finally. We stopped and cupped our hands to our ears. At the very threshold of my hearing I could feel rather than hear the deep *yow, yow* of a cur's baying. "They're on to one," Raymond said. "Let's go."

We went deeper into the swamp. The palmettos grew higher till they were above my head. We got into a brier patch, and the spines snagged in my clothes and raked my skin. Raymond and Birt, tall and fit, moved quickly. I caught up with them only when they stopped to listen for the dogs.

Finally we reached a stream, swollen from heavy rains, impassable. "They must have swum it," Raymond said. We listened for a long time, but the dogs now had got beyond our hearing. Raymond lifted to his lips a graceful, translucent cow horn, passed down through generations in his family, and blew a series of strident blasts, a primordial sound that made my skin prickle.

He said, "They've got a boar bayed up. If it was a pig or a shoat they'd have killed it and come in by now. We'll have to give it up. They might stay all night now."

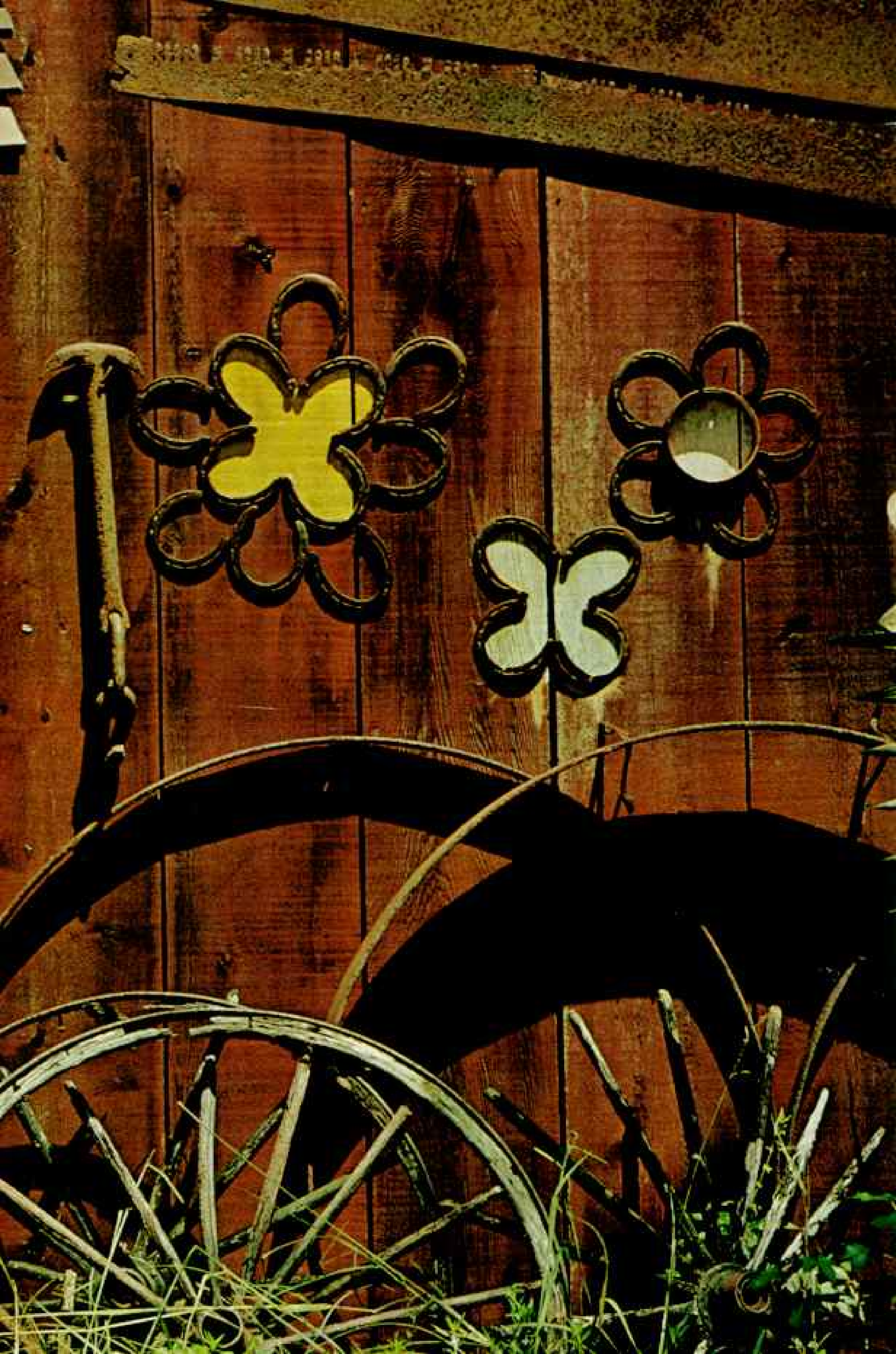
"How will you get them back?"

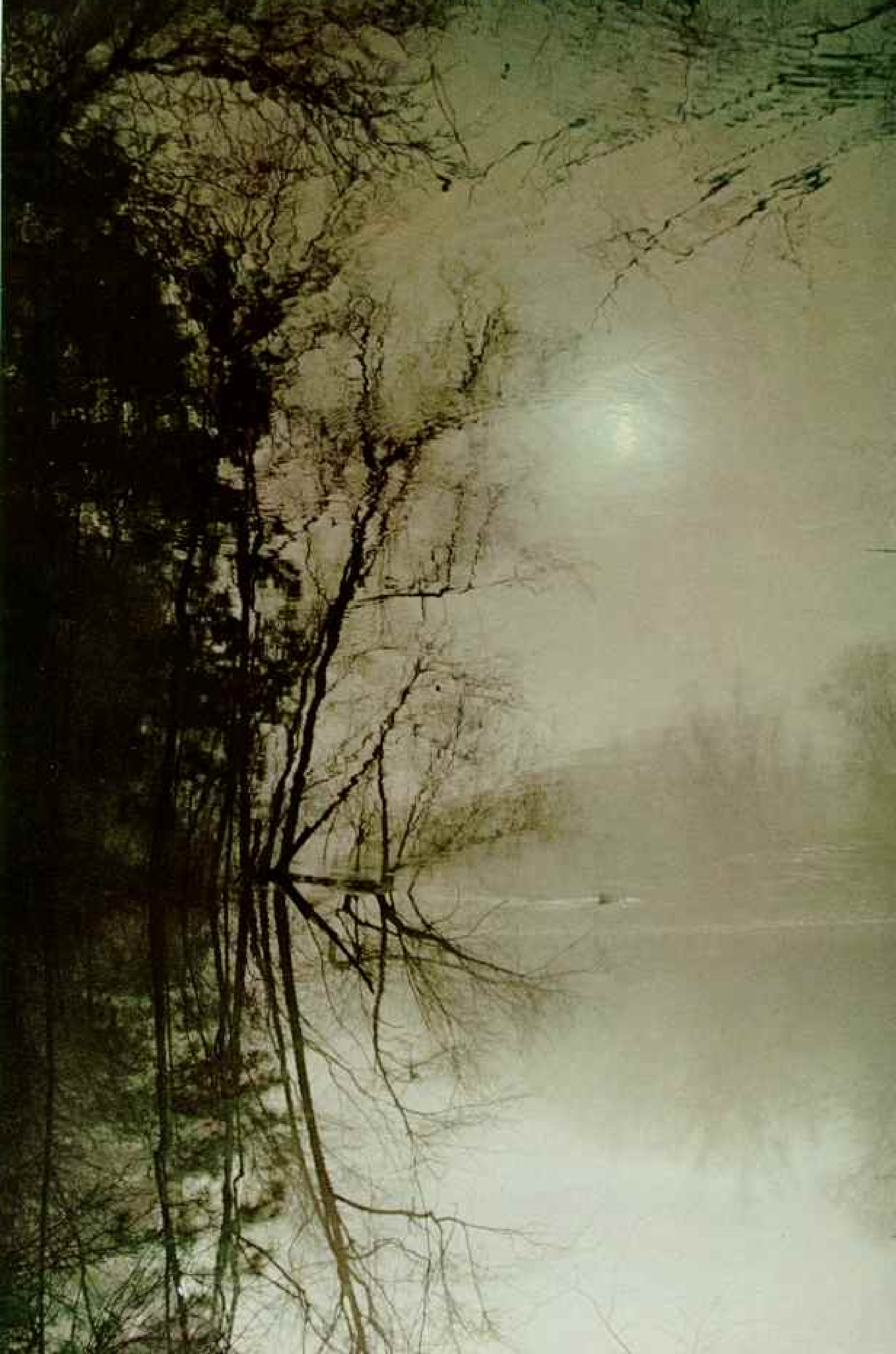
"They'll backtrack themselves to where we let them out and wait for us. Or maybe they'll just go home." When I objected that we'd brought them miles and miles by truck he laughed. "They always find their way home, even if it's fifty miles. It might take them a couple of days, but they make it."

He looked around at the palmetto jungle. "Let's see if we can find our way out of here," he said. "Sorry we didn't find you a bad boar. You'd have seen some action then."

"That's all right," I assured him.

GERALDINE WATSON has brown hair just going now to gray, a figure kept slender by long days in the woods, and the energy output of a nuclear reactor. A largely self-taught botanist, she is building up one of the few significant collections of the Big Thicket's plants, finishing a book on Thicket wild flowers, guiding an endless stream of conservationists and journalists who visit the area, and working in the movement to protect part of the Thicket in a





If plants held conventions, delegates would feel at home in the Big Thicket. Called a "biological crossroads of North America," the area is overlapped by Appalachian and southern forests, flora and fauna of the West, and varieties indigenous to Mexico's subtropics.

The green botanical engine that is the Thicket runs on the fuel of a wet climate, fed by such flood and fog as shroud Village Creek (**left**).

The carnivorous pitcher plant (**below**) dines on an insect caught in its translucent

craw. Native orchids, like ladies' tresses (**right**), flourish in cloistered serenity.

Swamps and bogs, forests and savannas, sand hills and floodplains lie in close proximity. Each supports a complex ecological system of plants and animals. Taken all together, such habitats and their inhabitants make up a luxuriant, diverse, and compact natural laboratory.

100,000-acre national park or nature preserve.

As a fighter for her cause, Geraldine is *formidable*, but when I went on a field trip with her, she seemed more like a lady Johnny Appleseed. She carried a bundle of ladies' tresses orchids from an endangered area to transplant in the woodland we were visiting, a beautiful tract along Village Creek.

We walked among huge scaly-barked pines, hundred-foot-tall magnolias, gray-barked beeches you couldn't reach your arms around. Geraldine pointed out lady ferns and Christmas ferns, their fiddleheads just now unfolding in early spring, tiny orchids not yet in bloom, vines of sweet-smelling yellow jasmine. She found a marshy spot, got down on her knees, and planted the ladies' tresses.

"IT'S THE BOTANICAL DIVERSITY that makes the Thicket so special," she said. In a soft east Texas drawl, pleasant on the ear, she explained that the Big Thicket was an ecotone—a biological crossroad, where a wide variety of plant communities meet and intermingle: plants found in the Appalachians and plants found in the tropics, even plants characteristic of the deserts.

Geraldine counts seven distinct types of plant associations in the Thicket, with thousands of species. There are 40 species of orchids, 26 of ferns, and four of North America's six genera of carnivorous plants.

On that first trip and others Geraldine showed me cactus and yucca, sphagnum moss and sticky-leaved sundew, huge cypress and great oaks with resurrection fern growing like pale-green fur along the branches. She pointed out graceful but voracious pitcher plants (preceding page). A lizard had fallen into one, she said, and "the plant's enzymes had devoured him down to the skeleton."

Once along Village Creek she stopped and smelled the jasmine-scented air. "I spent my childhood in virgin woods," she said. "Our house was in a beech-magnolia forest, and nearby was virgin longleaf pine, and we'd walk in there in the afternoon—it was cool, there among the big trees and the wild flowers. I can just close my eyes and smell the air, and I'm back home again." She looked around at the forest and said, "We ought not to lose these things."

It was easy enough for me to share Geraldine's feeling for the Thicket's remaining wild lands. Three years earlier I had visited the Thicket with ornithologist John Dennis to search for the elusive ivory-billed woodpecker.

The spectacular ivorybill is one of the rarest creatures on earth. It has been considered extinct off and on since the 1920's, and ornithologists argue with spirit over whether any at all are still alive. John had seen an ivorybill in the Thicket in 1966, but on our trip in 1971 we found no firm evidence that the bird still existed there.

But even if the ivorybill is gone, the forest is still alive. Red-tailed hawks patrol the uplands and red-shoulders course the swamps, and wood ducks squeal from the dark sloughs. There are signs of otter, and the beaver are coming back, and once on a rainy afternoon in the woods, sitting by a campfire eating squirrel stew with Jude Hart, we heard the long melancholy howl of a wolf. Not the timber wolf—it's doubtful that they were ever here. It was just one of the local wolves, a cross, probably, between the Texas red wolf and a coyote, but nevertheless one of the best of all sounds to hear.

A BATTLE over how much of the Big Thicket should be preserved in its natural state has raged for years. A bloc of active and vocal conservation groups has fought against—primarily—a handful of timber companies that own most of the land. The Kirby Lumber Corporation, a subsidiary of Santa Fe Industries, and Temple Industries and Eastex, both subsidiaries of Time Inc., control more than a million and a half acres between them. Traditionally these companies have resisted efforts to remove large blocks of land from timber production. It has been a classic confrontation between those who want to preserve wild land and those who want to use it commercially.

To Geraldine Watson and other naturalists, the vast pine plantations with young trees sprouted up in neat rows are ecological abominations; to timber-company foresters

Old friends and dear embrace at a church reunion near the Little Rock settlement. Kin, friendship, and faith bind the people, who provide as they can and trust in the Lord. Earliest Thicketeers were fugitive slaves and outlaws. Had Sam Houston lost to Santa Anna in the Texas War of Independence, one story goes, he planned to retreat into the Thicket.

"**Yes, we'll gather at the river,** the beautiful, the beautiful river...." With Brother Melvin Lowe leading the hymn and Sister Mary Lowe on the accordion, the Moss Hill Assembly of God celebrates the baptism of Larry Tolly (**right**) by its pastors, the Reverends Bob and John Morgan. For about twenty years the congregation has traveled 40 miles to use Menard Creek, whose spring-fed waters run cold and pure.

Heeding his calling, the Reverend John Alpers of Batson Prairie Pentecostal Church (**above**) baptizes Mrs. Darlene Nugent. He gave up an insurance job for carpentry, plumbing, roofing, and tending his flock.

Voice of the chain saw is heard in the land as a logger strips a pine, held almost daintily by a hydraulic claw (**right**). Where trees seem to grow like beans, logging has been a continuing boom that oil fields, close to petering out, have not.

Clear-cutting to the quick, as seen north of Kountze (**below, right**), has left desolate barrens where stumps and all other debris are bulldozed in windrows and burned to make way for tomorrow's forests. Such practices, once unquestioned, are changing as lumbermen and conservationists begin to find common interest in more selective harvesting methods.

What old-timers knew—that periodic burning of forest floors (**below**) would check disease, insects, and underbrush—modern forest-management technicians also favor.

the plantations are places of utilitarian and orderly beauty. Happily, within the past year the timber companies and conservation groups have come closer to a compromise that would save substantial pieces of the old wild Thicket for posterity. As this is written, it appears likely that a Big Thicket National Preserve, administered by the National Park Service, may well become reality.

"THERE SHE IS," said I. C. Eason. "That's Huldy. We call her Huldy cause she ain't nothing but a hull." Indeed.

Before me, somewhere beneath a solid encrustation of Neches River mud, lay a 1949 Ford pickup truck. Huldy had no doors, no muffler, no rear fenders, and no bed save for a crude wooden platform. Huldy *did* have huge tires webbed with chains, a power winch off a wrecker, and a frame patched together with welds. "I've pulled her in half a few times," I. C. said, "winching her out of mudholes."

I. C. climbed onto the seat—a pad of foam rubber over naked springs—fired up the engine, and hollered over the unmuffled roar, "From here on in you got to leave all mercy behind." And took off with a lurch.

I'd particularly wanted to spend some time up on the Neches River with I. C. A small knotty-looking woodsman of 50, he is an unofficial leader of a clan known locally as "Dog People."

The Dog People, so named because they have traditionally hunted deer with the aid of dogs, are offspring of 19th-century pioneers who obtained their lands by squatter's rights, and for years they have been involved in bitter disputes with timber companies over their land titles. They detest sportsman's clubs and private game wardens, and they disdain most constituted authority. They are tough hombres, apt to patrol their fences with shotguns in the crooks of their arms.

Off we went through mud that would have

Fable for a Thicket encounter? Tree frog to the snake: "Croak." Ribbon snake: No reply. Moral: "Climb and the world climbs with you; croak and you croak alone."

reached the running boards had Huldy possessed them. The huge tires threw sheets of gumbo up over the back of the cab. I looked at the dashboard. The gas gauge registered E, the temperature gauge H, the oil gauge zero, and the ammeter said "Dis." The brake pedal, I observed, lay flat on the floor. "Hey, I. C.," I yelled, "does this truck have brakes?"

"Heck no," he shouted back. "I don't want her to stop, I want her to go!"

I. C. wrestled Huldy for six miles, most of which, I am sure, were below sea level, while the engine backfired and the tires gouged and spun. Eventually we reached the little shack that I. C. has built on the banks of the café au lait-colored Neches River.

There I spent three days with I. C., his 22-year-old son, James, and his son-in-law, Clifton McGallion. The provisions I. C. took along for the trip consisted of four loaves of bread and a bottle of ketchup. But the Easons are accustomed to living off the land.

The first night we went hunting swamp rabbits, James carrying a powerful head lamp and a shotgun—the Easons consider rifles toys for city dudes. The night hunting was spooky. Once when some animal went crashing off through the woods, I was so startled that I gasped aloud. "Hoover hog," James whispered. It was an armadillo, the nickname a bitter reminder of Depression times, when Thicket folks ate the armored creatures for want of anything else.

Later James picked up two points of light in the beam of his lamp, swung up his gun, and shot two big swamp rabbits within two seconds. If I'd had reservations about the sportsmanship of jacklighting rabbits, they had pretty well evaporated after a day with only bread and ketchup; they totally evaporated by the time James cut up a rabbit and fried it with flour gravy. It was delicious.

WE TOOK LONG WALKS in the old river-bottom forest, and I. C. talked about his childhood—of working in the fields from dawn till dark on cornmeal soup, of watching his mother plow all day and come in and have a baby that night, of pawning his horse to buy, for his wedding at the age of 18, his very first pair of shoes.

For the Eason family hunger was a frequent companion. "Once Momma traded some eggs for three .22 shells," I. C. said. "I was about 12-year-old, a little old bitty thing, but I could shoot a gun. I found the biggest old doe deer

"**Shootin' food**"—not hunting just for sport—has put the only meat on many a family's table. His dog ambling beside him, I. C. Eason happily escorts a load of deer meat out of his Neches River bottomland. Claiming title, a timber company leased the land to a hunting club. City sportsmen promptly shot the razorback hogs that roamed there. I. C. says, "Them hogs wasn't wild, they belonged to the poor people who tended 'em." Angered, he fenced the land. "I'll tell you frankly, the way I kept it was with my shotgun."

that ever lived, and I shot that son of a gun. Then I heard a big horse comin'. I just loaded that .22 and sat down on that old deer. The game warden rode up, and I said to him, 'I'm hongry and my brothers and sisters is hongry, and I'm gonna keep this deer. If I have to I'm gonna kill you.'

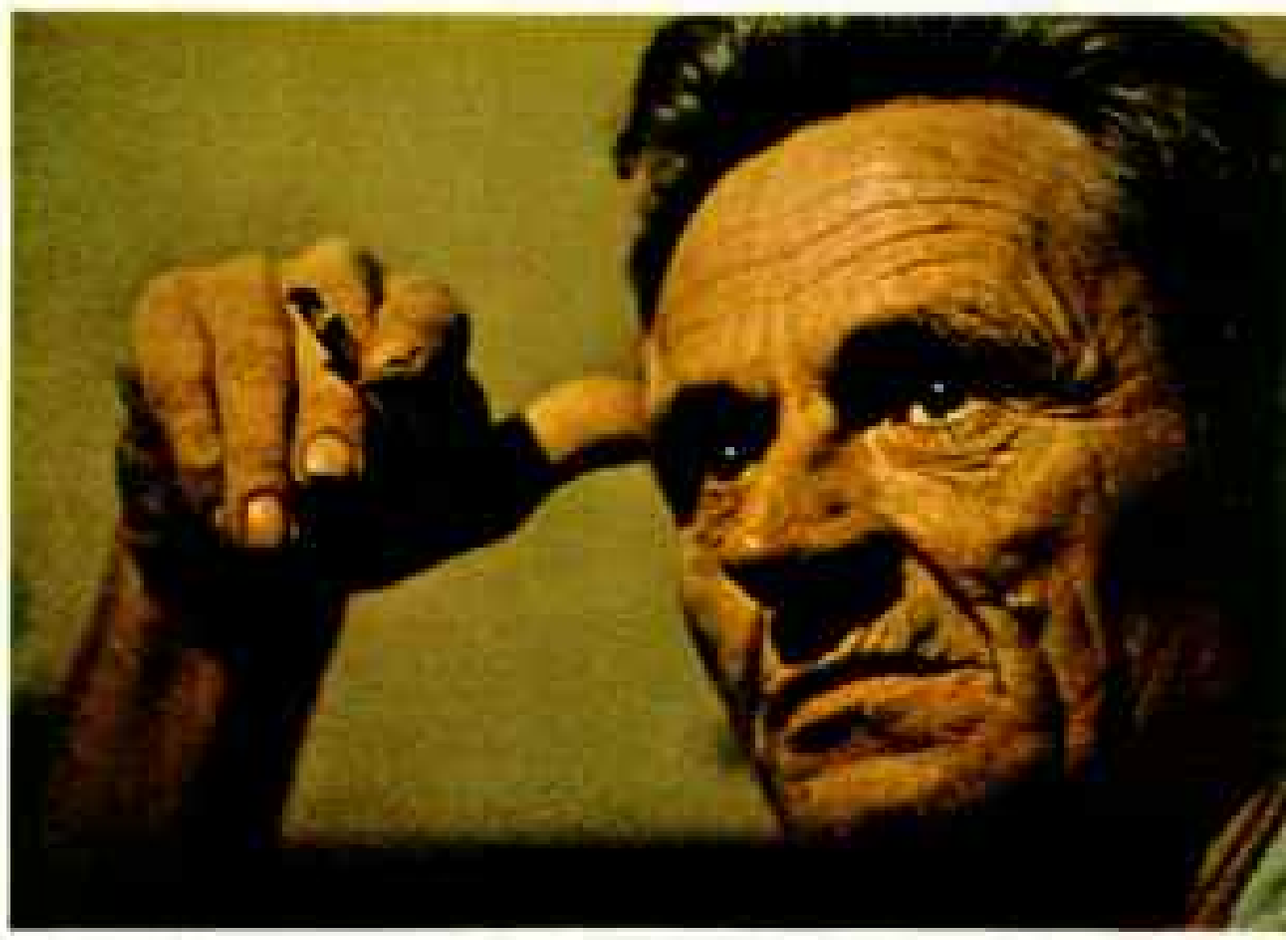
"He leaned way over in that saddle and scratched his old head and said, 'I believe you mean it. I'll let you by this time but get on out of here and don't come back.' I said, 'I got little brothers and sisters back on that hill, and when they get hongry I'll come back.' And that's the way we survived."

BEING AROUND THE EASONS—and other Thicket people—opened a different world to me. They were river-bottom people, deep country, with no education to speak of and many of the prejudices you would expect: quick-tempered, inclined to settle disputes in physical ways. I was Yankee, and a city dude to boot. Yet I kept finding things I liked about these people.

They'd promised a mutual friend that they'd show me the river and take good care of me, and I got the feeling that they'd fight off wild boars bare-handed before they'd let any harm befall me. They were honest, proud of their woodcraft, and, though very poor, they were totally willing to share what they had. And their love of the land was deep and strong.

One day, looking out across the broad, brown flood of the Neches, I. C. said, "I ain't sad about nary a minute of my life." Then he looked at me and asked, "Did you ever have a place you really loved?" I nodded, and I. C. looked back at the river and said, "If it hadn't been for old Neches River and the fish and the game, we never would have made it. There ain't nary another place for us. This is all *of* it. I've kept care of the land, I've kept care of the timber. I ain't got nothin' —what I've got, I'm settin' on it. This is my whole life. Hit's mine, and nobody's gonna take it from me, not as long as I draw breath and gunpowder burns."

The Thicket has a tradition of music, homemade and country fresh, that goes back to days when people made fiddles out of cornstalks and sawed at them with bows whittled from pine splinters. Sadly, it's a tradition that's dying fast nowadays, under the onslaught of the ubiquitous Nashville sound. But you can turn up some good old-time music if you really work at it. The best music



"**The sign ain't what done it,**" says I. C. Eason (**above**) of his fight to keep the land where his children stand guard (**top**). Now that jawboning has replaced shooting, he's been offered $250,000 for timber rights. But he won't sell the things he loves.

you can hear is gospel singing, and the place to hear that, no holds barred, is at a Pentecostal revival meeting.

I went to one near Liberty with the Reverend John Alpers, a medium-size man with the large-size voice necessary for a Pentecostal preacher. The little country church held about forty people: men with hands that showed hard work, women in homemade dresses, barefoot children.

The preacher picked up a guitar and said, "We will now sing number 23, praise the Lord—'There Is Power in the Blood.'" A man with a harmonica and a woman with a tambourine joined him at the altar, and suddenly all the people in the little church were stamping their feet and clapping their hands and singing their hearts out, making the whole room shake when they hit the chorus, "There is power, power, wonder-working power in the blood of the Lamb. . . ."

The music was raw emotion. Across the aisle a girl in a pink blouse began to scream. She stamped her feet and ran around in a little circle. Then a big red-haired woman did the same. The harmonica player had put his instrument down and was waving his arms slowly in the air. He said over and over again, "Praise the Lord." The large red-haired woman by now seemed almost hysterical.

On a pew across the aisle two small boys, barefoot, lay wrapped in each other's arms. They were sleeping peacefully.

FUNDAMENTALIST RELIGION runs strong in the Thicket; so does a belief in the supernatural, which is so mixed with real history that it's hard to tell where fact leaves off and imagination takes over. Everywhere you go you hear legends—legends of ghosts and visits from the dead—and wondrous visions, of huge panthers, always black, that scream with the voices of women; of buried Spanish gold, and phosphorescent balls of fire that follow travelers.

I wanted to investigate one of the stories—a mysterious light that for decades has been seen along a stretch of arrow-straight road near the town of Saratoga. So one night I went searching for it with the perfect companion, the former editor and publisher of the *Kountze News*, Archer Fullingim—who is something of a legend in himself (opposite).

Archer is a shaggy giant of a man, 72 years old. He masks an eye to aid his double vision and wears a printer's-ink-stained rag over his shoulder to help his arthritis, but he still looks as if he'd been put together with oak planks, and his good eye gleams with the zeal of a crusading journalist.

He made his little weekly, read all over the territory, feisty and sometimes outrageous. In his regular column Archer took on all comers with such tenacity that a stuffed snapping turtle in the Big Thicket Museum was named Archer in his honor.

HIS FAVORITE TARGETS were timber companies who logged in the part of the Thicket he loves, the low swamplands along Black Creek and Pine Island Bayou. He concluded one of his columns by writing, "So who will go out with old Arch Fullingim to the Holy Ghost Thicket and lay down in front of the bulldozers?"

The "Holy Ghost Thicket"? What did he mean, I asked, as we drove out the dark highway toward the road where the mysterious light was supposed to appear.

"Now listen at me," he replied. "I can tell I'm in the Big Thicket by the feelin' I get. It's a kind of religion to me. Down there along Black Creek, I call it the Holy Ghost Thicket—you get a mysterious, supernatural feelin'. You look at those yellow and green toadstools, and the overstory of trees, and hear the birds sing. This is where I get the charge, the feeling, the—the *kicks*."

Near the ghost town of Bragg we turned onto a dirt road that ran into the swamps. Archer told me something about the history of the light. A traditional Thicket story was that a railway brakeman had been beheaded by the wheels of a passing train, and his shade still stalked the woods at night with a lantern, searching for his head.

There was a time when people came from all over Texas to see it, and it got downright dangerous to travel the road at night, for many of the ghost hunters came armed and shot at any light they saw. "One night," Archer said, "I came out here and this Pentecost preacher was standing on top of a truck with a loudspeaker, saying, 'God has sent this light. The end of the world is coming.'"

A mile down the dirt road we parked and turned out the lights. I waited, full of the professional journalist's skepticism. Over the years I'd learned that flying saucers, abominable snowmen, poltergeists, Loch Ness monsters, and other mysterious phenomena rarely appear in front of reporters.

The night was black and full of stars. On both sides of the road the trees pressed in, dark against the sky. In the swamps beyond, frogs chirped and ratcheted. The night air was damp, heavily scented with spring.

What was that there, among the trees? Couldn't be a light, I told myself. Eyes playing tricks. Gone now, anyway.

Again. And it *was* a light. Dim, a tiny point. But suddenly it grew brighter, a hot point of light, for all the world like a flashlight back among the trees just to the left of the road. It moved. It grew brighter still (page 528). Then abruptly it dimmed and went out.

"That's *fantastic*." I said the words aloud, I know, because I had a tape recorder with me, turned on. Later, when I played the tape back, I found that I said "That's fantastic" or "I can't believe it" over and over again through the next half hour, for the light appeared several more times. Now it was a point source of light, like a flashlight beam; then it appeared as a dull glow, the color of a pumpkin.

I tried to convince myself that it must be the headlights of automobiles on a blacktop highway eight miles down the Ghost Road, their beams contracted by distance and filtered by the branches of the overarching trees. I promised myself that I'd return to make a proper experiment, to determine once and for all the nature of the mysterious light. Yet at that moment my rational approach seemed a bit like whistling in a graveyard. "Now that's something, ain't it?" Archer Fullingim said when the light appeared again. I am given neither to superstition nor mysticism, but the spirit of the Holy Ghost Thicket laid its cold hands upon me then, and I shivered.

THE HOLY GHOST THICKET—yes. One night I sat by an oak-log campfire and ate filé gumbo with my hog-hunting companions, Raymond and Birt; a wry old-timer named Emmett Hobbs; and Bill Brett, whose job is postmaster of the Thicket town of Hull, but whose true calling is historian and conservator of Thicket lore.

Before long the stories began, old stories burnished from the years and the telling around a hundred campfires. The young men grew quiet. Bill and Emmett batted the yarns soft as shuttlecocks back and forth across the fire. . . .

The time old John got caught in the Thicket and made it out with his hands torn raw, and

Opinions and mayhaw jelly too: Archer Fullingim makes them both tart. He ran the *Kountze News* for 24 years, adopting as his motto a saying of Chief Crazy Horse: "One does not sell the earth upon which the people walk." Sighting with his good eye, he has blasted timber firms and politicians alike in his column "Both Barrels."

Deep in the Devils Pocket, a swamp near Bessmay reflects its own stately images (**left**). Called a baygall from the association of gallberry holly and red bay and sweet bay trees, such remnants of the Thicket primeval shield alligators and orchids.

Armadillos that invaded the Thicket from Mexico (**above**) were served up in Depression days as "Hoover hogs." Now the armor-plated mammal falls prey to few enemies other than automobiles roaring down country roads. An outing of ducklings (**below**) paddle behind a mama wood duck. Once a threatened species, the wood duck has increased its numbers in recent years under the protection of game laws.

Ghost light of the Big Thicket, captured in a 20-minute exposure (**above**), changes color, intensity, and position; it has been explained as headlights, or swamp gas, or the ghost of a brakeman in search of his head, severed by a train when the road was a track. The time exposure also records a star's course.

To help end superstition and ignorance, 98-year-old Ronie Bean (**opposite**), whose parents were slaves, saw that each of her three sons received a college education.

a fella says to him, "I don't see how you made it out of that Thicket. God must have been with you," and old John says, "Well, iffen He was with me I don't know how *He* made it out, 'cause that's a *bad* Thicket." The time we was draggin' that hog and choked it to death and old Birt gave it artificial respiration and he come to, and old Jude Hart says, "I don't want no part of that hog 'cause he done gone to God's country and heard the sweet music." The time old Drian got so lost in the fog he circled round and come to his own back door and asked his wife where he was. . . .

The stories drop from them like sweet-gum leaves in autumn, stories of horses and cattle and panthers and bears, and the men they have known, many of them long gone.

Emmett says, "Back in them days people was each other's security. Somebody got sick, you'd go work his crop for him. Back then the doctors would ride to their patients. But now people aren't *by* each other the way they used to."

"Remember the old cures?" Bill says. "I got stabbed by a limb once and they kept stuffin' the wound with soot out of the stove and spider webs out of the ceilin'."

Emmett says, "We had to take castor oil."

"Yeah, and the kerosene. I used to work to keep from coughin'. Everytime you'd cough they'd holler 'Croup' and pour the kerosene and sugar down you."

Emmett says, "Eat it up, wear it out, make it do. That's how it was."

"Yeah. If we lived now like we lived then we'd have money runnin' out of our pockets," Bill says. "Different kind of people comin' in here now, Emmett."

"Country's changin', Bill."

COUNTRY'S CHANGING. That's right. But ghosts are hard to kill, and don't take up much room, and I hope we'll have the good sense always to keep a patch of Thicket for them, and for us. A sanctuary for specters and visions and things that glow in the night, for the ghosts of bears and wolves, and the panther that screams like a woman, and the last ivorybill; a place inhabited by men long dead who still haunt the dark beyond the campfire's ring of light.

I really did intend to return to the dark road near Saratoga and try to find a sound, rational explanation for the mysterious light. But somehow I never got around to it. □

GHOSTS OF THE GULF STREAM

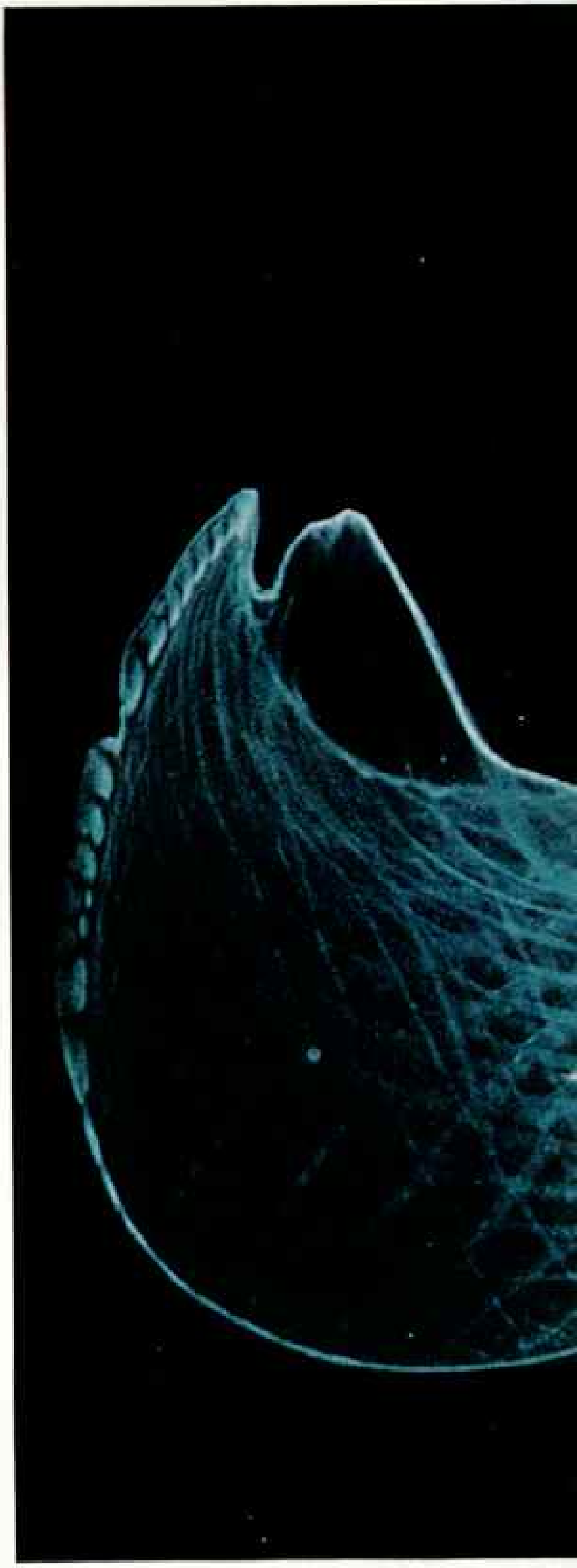
Blue-Water Plankton

By WILLIAM M. HAMNER, Ph.D.

LATE ONE AFTERNOON, far offshore from the islands of North and South Bimini in the Bahamas, I was diving with air tanks at a depth of 80 feet, watching jellyfish waft along in the current like vagrant objects in a surrealist dream.

The sky was overcast, the wind wrinkled the ocean's skin far above me, and daylight filtered softly to my depth in the clear, shadowless sea. The wind blew our rubber raft along at the surface, tugging my three diving companions and me by our safety lines through the blue water like hooked fish.

Thirty feet below, my eye caught the outline of an extraordinary shape. I exhaled forcefully, reducing my buoyancy, and sank deeper into the twilight waters. A large membranous sheet spread out below me, like a transparent veil floating on a silent pool. Beneath the shimmering membrane hung a beautiful pelagic snail that resembled a large butterfly, suspended motionless in the sea. An elongated mouth reached above the stomach, a mouth that touched and delicately manipulated the membranous web.



Phantom water wings latticed with muscle fibers propel *Corolla spectabilis*, a fragile oceanic snail. Classed as plankton —a grab bag of organisms that drift with the currents—this creature has never before been studied alive.

Eyeball to eyeball with . . . what? Scuba diving in the blue water of the Bahamas with collecting jars and clipboard, researcher Alice Alldredge counts barely visible plankton within a Plexiglas reference frame. Convinced that conventional plankton-collecting methods, using nets towed behind ships, crush many frail specimens and completely miss others, the author and his team became the first to use scuba for systematic observation of plankton in a natural environment.

Lack of turbulence in Bahamian waters reduces the circulation of chemical nutrients on which larger planktonic plants depend. Consequently, plant food is scarce and hard to obtain, and planktonic animals must devise resourceful food-gathering techniques. The jellyfish *Orchestoma* trolls for food with yard-long stinging tentacles (**right**).

My fascination with this strange creature made me forget my safety line, and it suddenly went taut, jerking me upward. My movement alarmed the sea butterfly, which broke free of its web, did a barrel roll, and swam downward with firm, rhythmic strokes of its heavy wings. Afraid to lose it, I dived hard, holding a plastic quart jar open in its path, and the sea butterfly flew in, almost filling it. My line snapped taut again, and I rose willingly to the surface.

My three diving companions surfaced too, and soon we were aboard our tender, a 21-foot Boston Whaler. We excitedly discussed our dive and the animals we had found, many of which were new and strange to us. Bottles that imprisoned these rare animals were held against the sky, backlighting exquisite transparent forms that swam undamaged within.

AL GIDDINGS (LEFT); WILLIAM H. HARRIS

First sight of my "butterfly" amazed Ron Gilmer, our mollusk expert. He identified it at once as a pteropod named *Gleba cordata*, a highly modified planktonic snail.

"Only 17 specimens have ever been caught," he exclaimed, "and they've never been seen swimming freely before!"

Snail Swallows Its "Dinnerware"

From Ron's underwater observations, we now know something about the living biology of *Gleba*. It secretes a mucous web that spreads out into a horizontal sheet about six feet across. The snail lies motionless beneath its web, which sinks slowly through the water, snaring tiny plants and animals in the sticky mucus. When the web becomes clogged with food, the snail swallows most of the mass.

Once thought rare and unimportant, *Gleba* is in fact an abundant and significant member of the marine food chain, because its large web traps so many tiny organisms (page 542).

We wondered that plankton—so beautiful, so essential to all life in the sea, so abundant, and so fascinating in their behavior—should be so poorly known! Never before had these animals and plants been systematically observed while alive and undisturbed in their natural environment, the open ocean.

For more than a century marine biologists have collected the animals with nets pulled up from great depths or hauled for miles behind a ship. When the nets are pulled aboard, the plankton sample usually contains a high percentage of crustaceans, with their hard external skeletons. Other animals either avoid capture or are so fragile that they are crushed through the mesh. Thus many planktonic

animals have rarely been seen by those biologists who collect only with standard nets.

In my lab at the University of California in Davis, I had thought about this problem and devised what I hoped would be a safe and effective program to study living plankton at sea. In July 1971 our research group of four undergraduates, three graduate students—one of them my wife, Peggy—and I traveled to North Bimini, where the Lerner Marine Laboratory of the American Museum of Natural History of New York provided an ideal research base.

The unpolluted eastern edge of the Gulf Stream flows northward only a mile offshore. From Bimini harbor we employed small fast boats to run out into the current. Protected by the island lee, we could dive throughout the year to observe the undisturbed plankton and capture undamaged specimens for study.

Each of us focused on a different group within the plankton community. My chief interest was in jellyfish and other pelagic coelenterates. Peggy studied arrowworms and several different kinds of larvae. Alice Alldredge, Ron Gilmer, Larry Madin, and Neil Swanberg respectively specialized in larvaceans, pelagic mollusks, salps, and ctenophores. Later Bonnie Jones and Dick Stone joined us to contribute their help on various projects, including studies on Foraminifera, the marine protozoans whose myriad calcareous shells constitute much of sea-deposited limestone bedrock.

Living Chains, Fanciful Whorls, Hair-trigger Jaws

We could not attempt to study all planktonic organisms, for they cover a vast and diverse group of plants and animals, from tiny protozoans and minute crustaceans to larger forms such as jellyfish and salps. Derived from the Greek work *planktos*, meaning "wandering" or "drifting," the term is somewhat misleading. Most laymen and many biologists think of plankton as too small to see, uninteresting, passive, and dull. Yet we have seen uncounted different forms in blue water, of all sizes and shapes, moving in a variety of patterns at selected speeds, doing extraordinarily clever things.

The translucent barrel-shaped salps, for example, are linked in snakelike chains that may measure six feet long, and in shimmering whorls like fanciful crystal chandeliers. One is *Cyclosalpa affinis*, which is pictured on page 545.

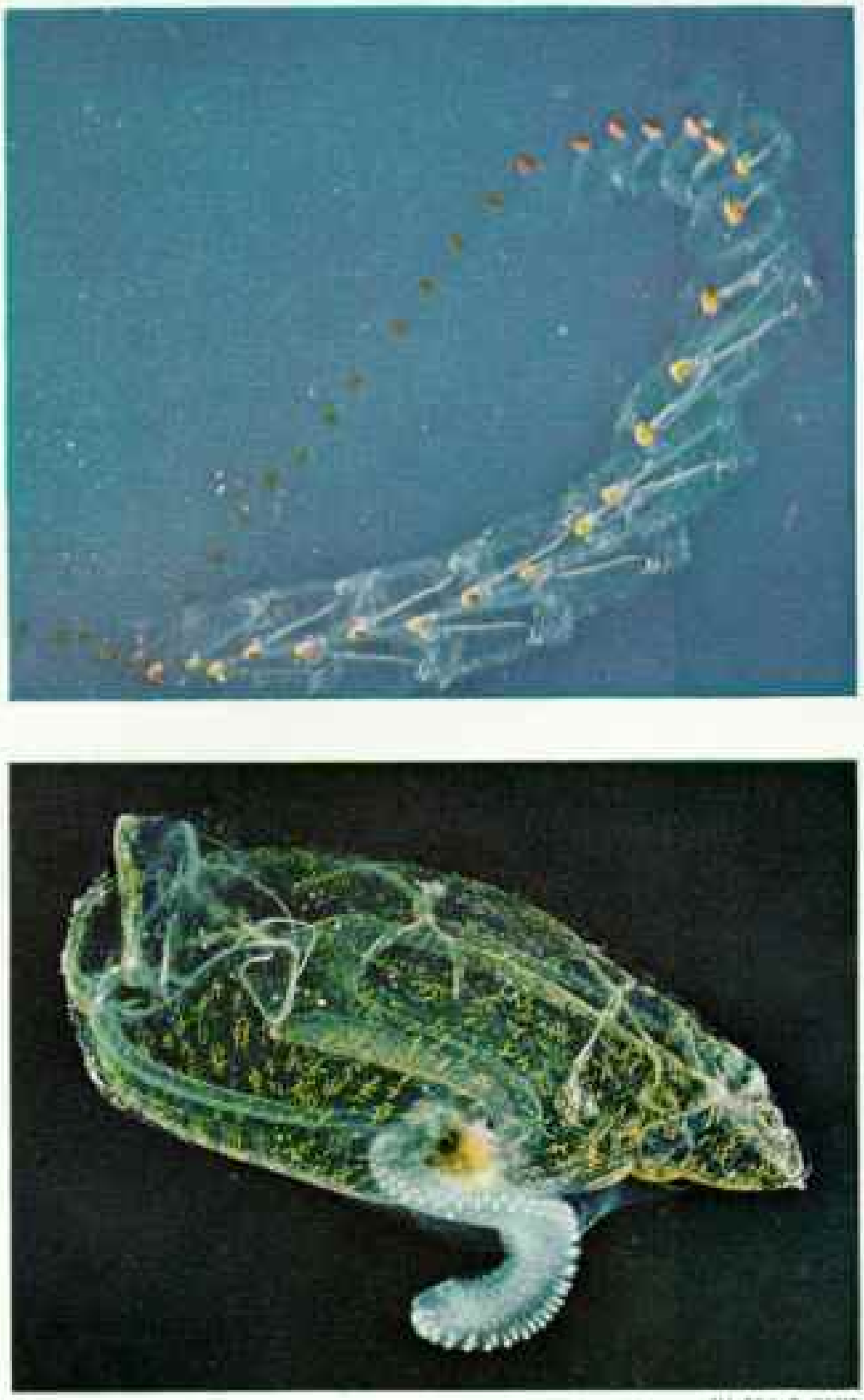
The "bristle-jaws," also called arrowworms, usually no longer than two inches, have spines at their front ends arranged like two hay rakes ready to mesh together. They move in straight lines, as fast as a foot a second. When they hit something small they want to eat, their front ends snap shut.

It's all part of a world of beauty, of fantastic shapes in motion, stately and swift. More than that: These plants, or phytoplankton, and animals, or zooplankton, are essential links in the *(Continued on page 539)*

AL RIDDINGS (LEFT) AND R. W. GILMER

Green sea leaves, appendages that probably aid flotation, stabilize the diaphanous body of *Cavolinia tridentata,* an inch-high snail. It swims with its upper wings, darting sideways, up, or down. Plentiful yet practically invisible to a diver, such transparent creatures are particularly difficult to photograph. Here a strobe light is fired obliquely behind the animal. Since the body tissue's density differs from that of water, it has a different refractive quality, and the bent light is enough to delineate the body.

In the past, knowledge of planktonic snails depended largely on such remains as their empty "shells" (**left**), external skeletons which are transparent in the living snail but become visible when preserved. The shell at far left once held a snail similar to *Cavolinia.*

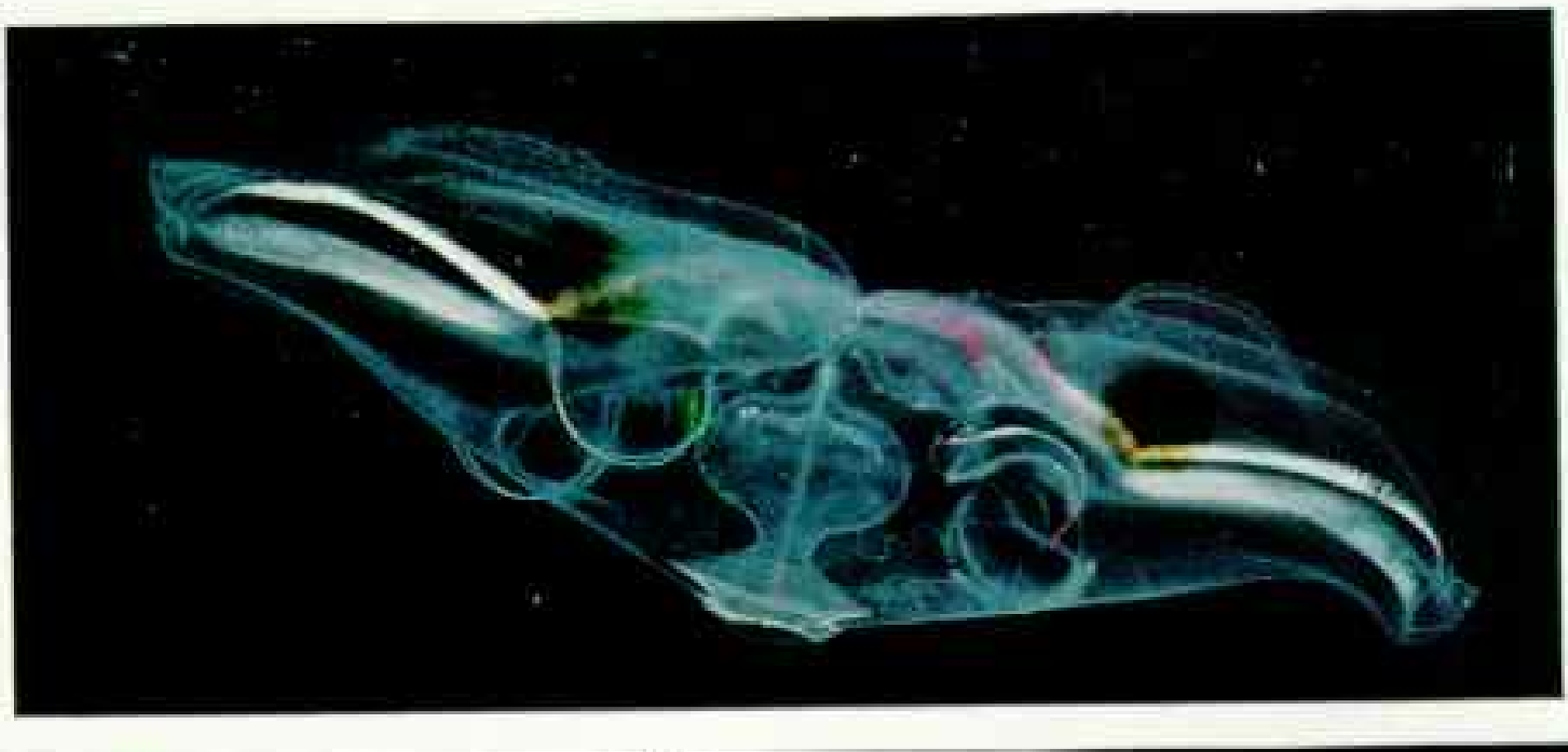


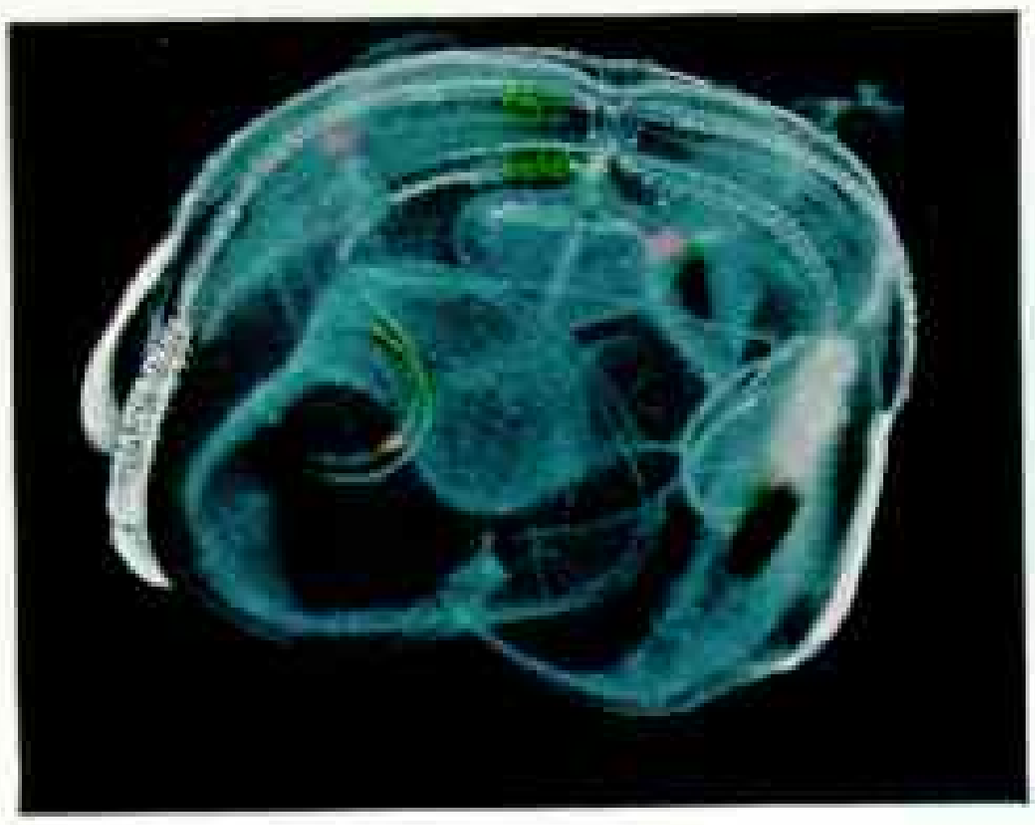
ALL BY L. P. WASN

Shimmering six-foot chain of salps *(Salpa maxima)* undulates like a sea snake (**top**). Generations of salps alternate between those that live solitary lives and those that are linked together.

The salp *Pegea confoederata* (shown in solitary form **above**) reproduces by asexual budding, discharging a strand of young from its underbelly. Coiled like a watch spring, the chain contains as many as a hundred aggregate salps that are sexual. They each nurture an egg that will grow into the solitary form.

Linked *Pegea*, each about two inches high (**right**), force water through their barrel-shaped bodies, capturing food with a conical net of mucus. Here, a harmless carmine dye introduced into the water outlines the nets.





Seagoing spaceship, flamboyant *Ocyropsis maculata* pulsates its way through the water, unlike other ctenophores that move by vibrating rows of cilia (ctenes, or combs). *Ocyropsis* spreads its three-inch wings (**top**), jets forward on the downstroke (**above**), then unfolds them again for a new thrust (**right**). A voracious carnivore in the planktonic jungle, the energetic *Ocyropsis* belies a widely held notion that plankton are dull and passive. Not as rare as originally thought, this swimmer may have simply avoided plankton nets with its surprisingly powerful stroke.

marine food chain, from the smallest single-celled algae on up to fishes and man.*

We concentrated primarily on visual observations of these remarkable animals. To avoid getting lost in the endless blue of the deep ocean—which dropped nearly 500 fathoms below us—we dived within a grid of lines hanging from surface floats in a prearranged geometric array.

Each diver-researcher was free to concentrate on the tiny animals performing six inches from his nose because he was tethered to a safety man suspended at a given depth within the grid. When necessary, the safety man disentangled the lines of the two or three research divers tied to him. He also watched each man's depth and elapsed underwater time, and kept a lookout for sharks.

On many dives, large, curious, and potentially dangerous fishes would suddenly glide into view. Most of these were six- to eight-foot-long gray oceanic sharks, occasionally

*See "Algae: the Life-givers," by Paul A. Zahl, NATIONAL GEOGRAPHIC, March 1974.

ALL BY NEIL SHARKEY

whitetips, and once a large mako. When a shark proved too persistent an intruder, we would form a tight group of divers to appear more formidable. Only rarely were the sharks aggressive enough to spook us out of the water.

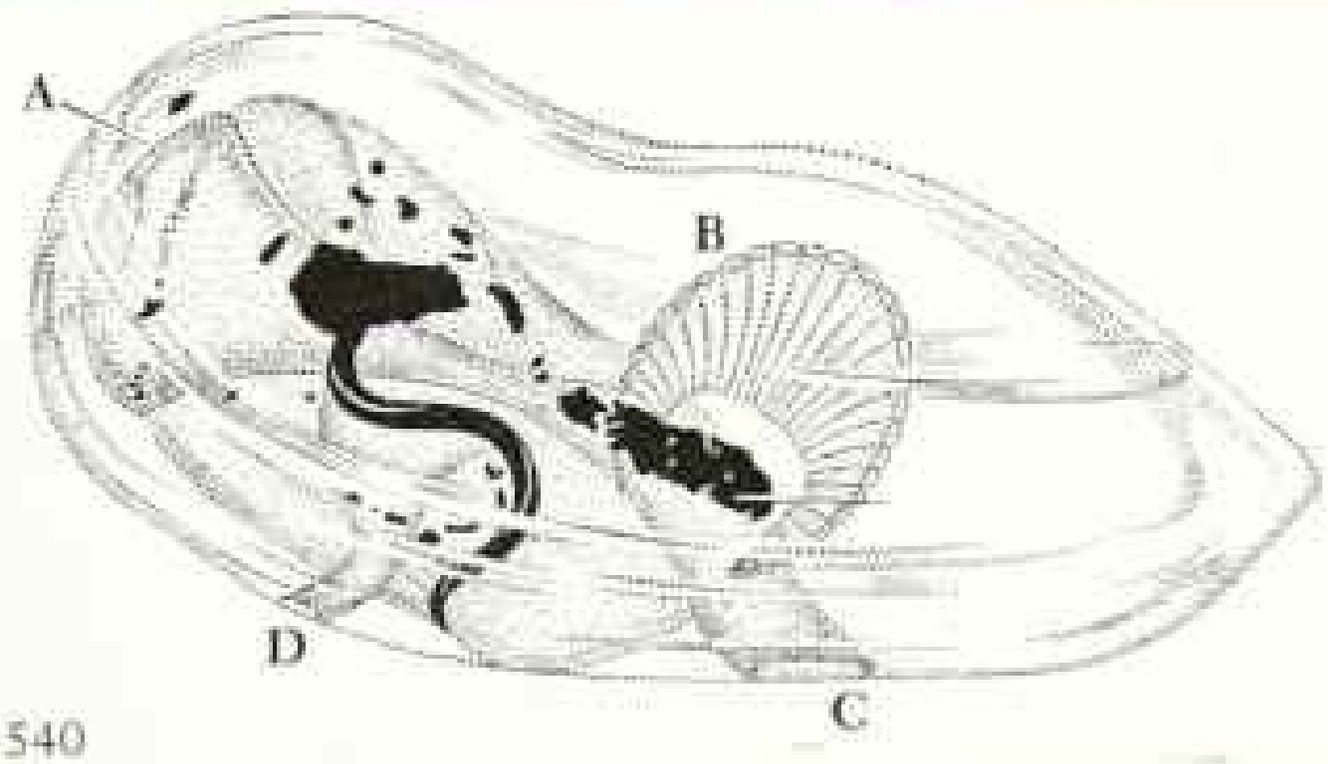
We saw numerous sailfish, and blue marlin visited us on three separate dives. The first marlin materialized out of the turquoise gloom late one day, gliding in toward three of the divers like a huge dirigible armed for combat with a menacing spike. The fish stopped four feet away from the astounded divers and briefly raised its spectacular dorsal fin.

Intrusion of these large fish punctuated our dives with excitement, but most of our underwater contacts were with much smaller creatures. The subjects we sought were as tiny as a tenth of an inch in diameter or, in colonial species of salps and siphonophores, as large as several feet across (page 536).

Problem: How to Film the Invisible

Animals that remain in sunlit waters during the day must avoid predators, and to a great measure this is achieved by the camouflage of transparency, which makes even relatively large animals virtually invisible.

After his first dive with us, photographer



Be it ever so humble, there's no place like these homes. Tadpole-shaped larvaceans *Megalocercus huxleyi* (**above**) and *Stegosoma magnum* (**right**) are plankters, as individual planktonic organisms are called. The two produce and inflate transparent balloonlike dwellings around themselves. The larvacean is one of the sea's most important herbivores, since it can collect tiny plants basic to the food chain. Green dye squirted in the

Al Giddings surfaced looking perplexed. "It sure is beautiful down there," he remarked, "and I think I have some super pictures of divers, but *what* were you looking at?"

If transparent plankton are hard to see, imagine how much more difficult it is to photograph them. Yet instantaneous photography was clearly needed. The Gulf Stream here moves at nearly two knots through the Straits of Florida, and the plants and animals we saw one day would be 50 miles north of Bimini the next.

Dr. Robert F. Mathewson, then director of the Lerner laboratory, explained to us: "The transparent tissues of the animals don't reflect light for even the most sensitive film, but if you fire a strobe obliquely behind the animal, some of that light will be refracted through the tissue toward the lens. The tissue has a refractive index slightly different from that of seawater; therefore this refracted light should be bright enough to show up on film."

It worked with some organisms, but others still eluded the camera until our divers added to their equipment plastic squirt bottles loaded with harmless dyes.

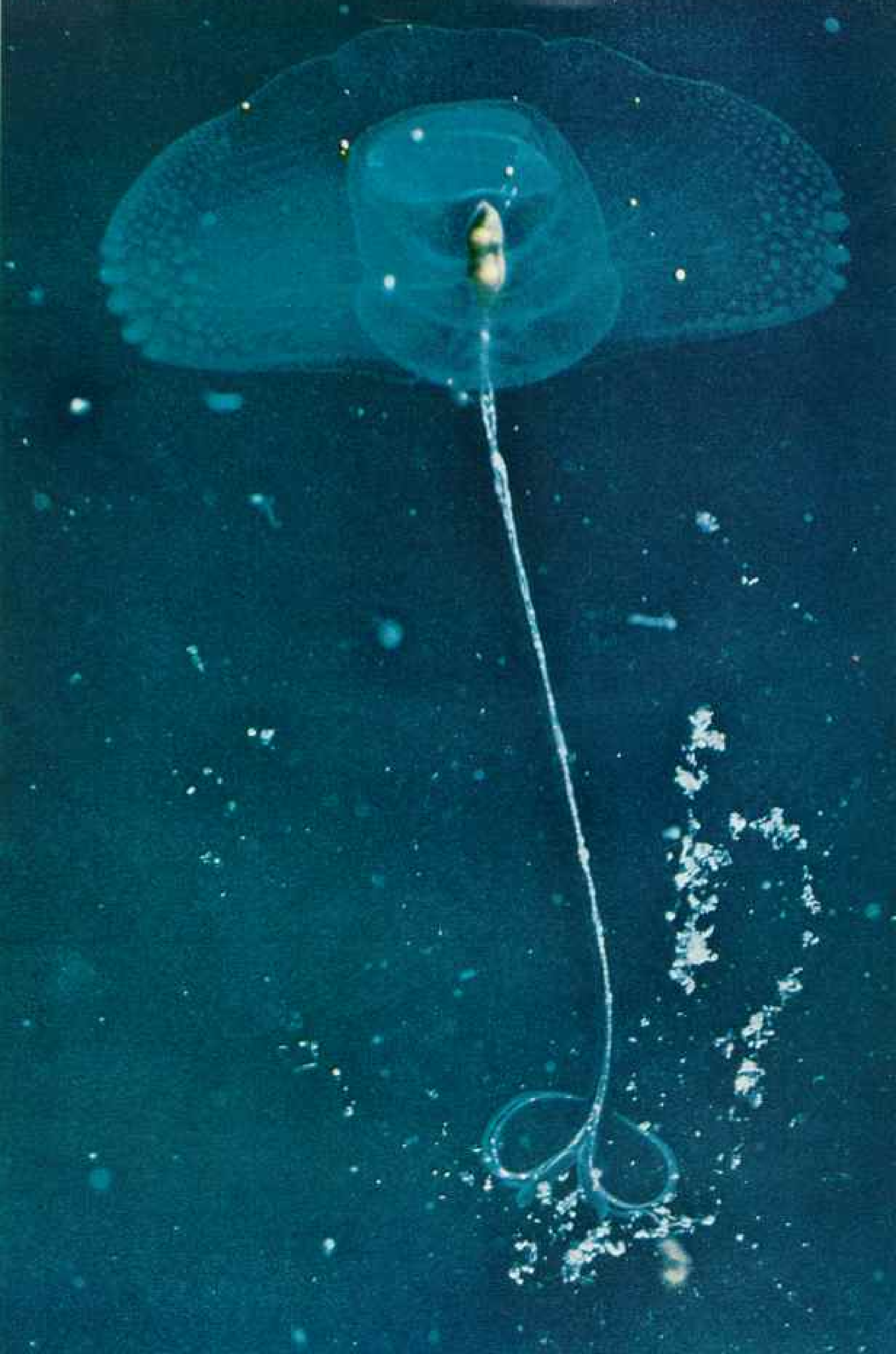
We found that particles of dye will stick to delicate animals—revealing, for example,

PHOTOGRAPHS BY L. P. BABIN; DIAGRAM BY LISA BIANCOLI, STAFF ARTIST

water shows how the house gathers food for its occupant. The drawing (**left**) diagrams the process. By wriggling its tail, the larvacean pulls food-laden water through a set of front screens (**A**) that admit only the smallest unicellular plants. The plants are trapped inside by a complex, microscopically fine filter (**B**) that leads to the animal's mouth. The water, seen above as a stream of green dye, spurts out at bottom (**C**). When the front screens of a house clog, or the animal becomes alarmed, it simply slips out of an escape hatch (**D**) and builds a new structure within an hour.

When abandoned, larvacean houses become pastures for small crustaceans that feed on plants trapped in the screens.

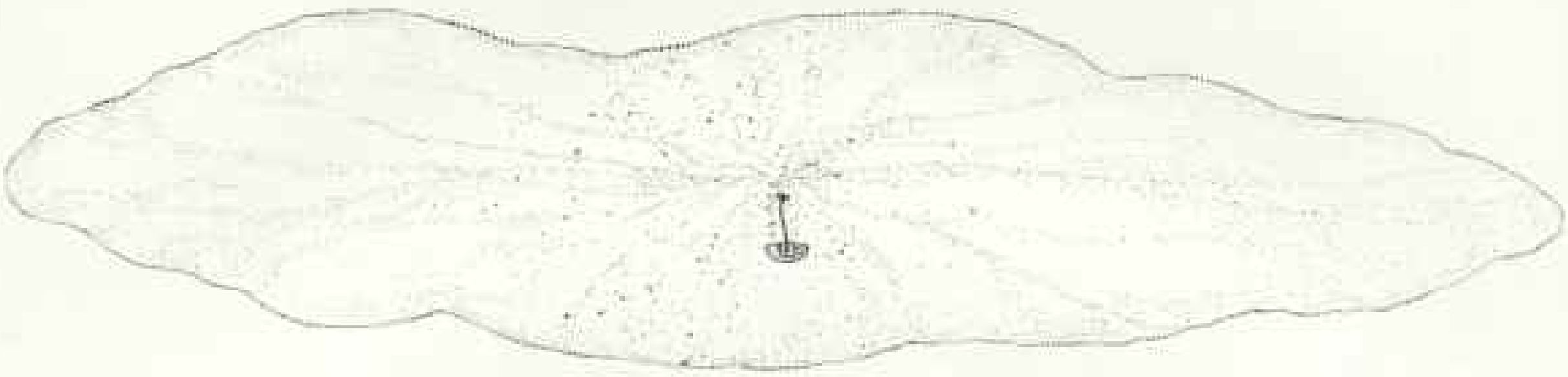
Most collecting methods destroy such delicate houses, whose importance in the ocean's ecological system has probably been underestimated.



Spinning for dinner, the snail *Gleba cordata* (**left**) feeds on organisms it traps in its six-foot-wide web of secreted mucus, invisible in the photograph but illustrated below. Unacceptably large food particles tumble off the lily-shaped lips of its mouth at the upper end of the sternlike proboscis. At its lower end the body mass (two inches across the wings) shows nerves leading from brain to wing muscles. Working its craft in quiet waters, *Gleba* spins a web with glands located at the wing tips. Gently manipulated by the cilia in the animal's elongated mouth, the free-floating membrane slowly sinks, collecting a variety of tiny plankters on its sticky surface. Eventually, *Gleba* draws most of the web down its proboscis and consumes it.

Another snail that spins a web, *Corolla spectabilis* floats like a lace handkerchief before the diving mask of Alice Alldredge (**right**). This unique feeding method of a planktonic animal has never been described before.

PHOTOGRAPHS BY AL GIDDINGS; DIAGRAM BY LISA BIANKTOLT, STAFF ARTIST



how some move with the aid of structures such as cilia: tiny rods lined up like eyelashes, one pressing down on the next, producing a wavelike motion.

Or we'd squirt a cloud of fluorescent green around an animal. It would emerge from the cloud with dye clinging to it, making it eminently photogenic.

Basis for the Ocean's Food Chain

Of the fascinating plankton we were able to observe and photograph in their own world, perhaps the most bizarre and most difficult to photograph were the larvaceans. Not only are larvaceans marvelously strange, they are critically central to the economy of the oceans. Often they are the only creatures that can physically collect the tiny one-celled plants that form the basis for the food chains of the open sea.

The larvacean resembles a tiny tadpole, with a heavy head and body followed by an elongated tail that rapidly propels it through the water. Normally, however, the larvacean does not swim free. It lies harnessed within an elaborate diaphanous "house" consisting of a mucous envelope that the animal secretes and then inflates like a sculptured balloon.

Suspended inside this house, the larvacean beats its tail back and forth to generate a water current through two frontal ports that are covered with a screen to admit only the smaller particles. The current flows into the house and then passes through an internal filter of fine mesh that removes from the water so-called nannoplankton, the single-cell plants measured in microns, or thousandths of a millimeter.

The microscope reveals these organisms to be greenish and variously shaped, but often ovoid. With the stimulus of sunlight and of minerals welling up from the deep, they manage to combine carbon dioxide with the water in which they swim, producing food by photosynthesis.

The larvacean consumes this nannoplankton, and the strained water flows out of its house through a "back door" (pages 540-41). The force of that current provides propulsion for the house.

When the front screens become clogged, or if the larvacean is alarmed, it abandons its house, exiting through a special escape port, and swims free until it can create a new

Goteha! Researcher Larry Madin clamps the lid on an unsuspecting plankter destined for the laboratory (**left**). The author, at upper left, dives to join him as Peggy Hamner hangs above. Face-to-face with marine denizens as elusive and beautiful as this whorl of aggregate salps, *Cyclosalpa affinis* (**above**), the team added significantly to knowledge of the ocean's food chain.

dwelling. Few people have seen these intricate structures because a larvacean's house caught in a plankton net is shredded and reduced to an unrecognizable glob of mucus.

Alice Alldredge of our group took the first photographs ever made of larvaceans swimming free in the ocean. Where they were particularly abundant, she observed traffic problems as the tiny vehicles jostled and pushed for right-of-way. Alice also found that about a third of the empty larvacean houses had acquired new passengers—little copepods, about an eighth of an inch long.

Close study convinced her that these little creatures were grazing on bits of life trapped on the surfaces of the abandoned larvacean houses—in effect, full dinner plates conveniently floating around in the sea. Here was a relationship between two very different kinds of plankton that had been totally unsuspected until Alice observed it in the ocean.

While we confined our research to organisms big enough to observe with the unaided eye, we often found ourselves in water that appeared turbid or greenish, and so we knew that we were amid especially heavy concentrations of phytoplankton. Even when the water was clear, we could sometimes tell that the tiny organisms were plentiful because we could see animals feeding—larvaceans pumping vigorously, others fishing with mucous nets.

Night-vision Device May Aid Discovery

We hope to continue our study of plankton by extending our observations to those blue-water planktonic animals that come up to the top layers of the ocean after dark. We hope to see and perhaps photograph them with the help of remarkable electronic image intensifiers that aid human night vision.

You wear the device like a pair of goggles. It is hardly bigger than a diving mask and is almost weightless in water, but enhances whatever light may be present to such an extent that you could read a book in a dark room. Such tools should lead us to further fascinating discoveries in the sea. □

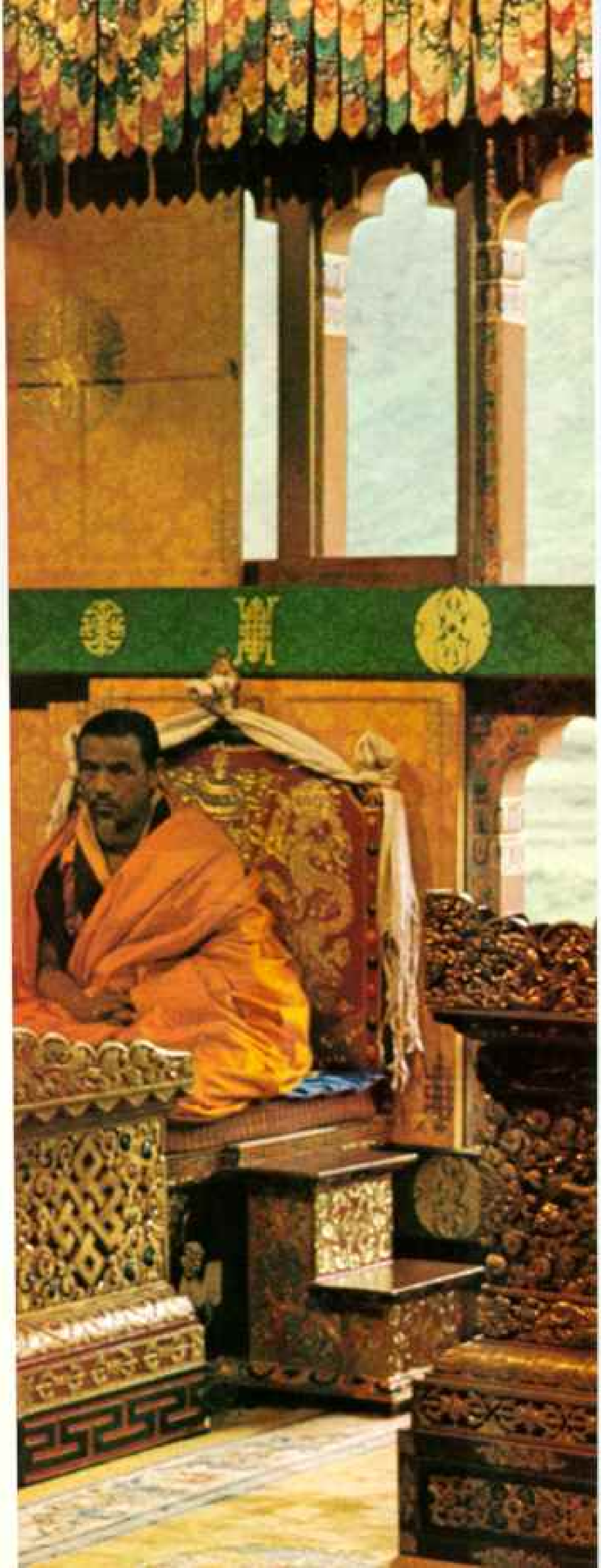
Bhutan Crowns a New Dragon King

A PICTURE STORY BY

JOHN SCOFIELD

ASSOCIATE EDITOR

IN THE FOURTH MONTH of the Wood-Tiger Year, at the auspicious Hour of the Serpent—June 2, 1974, at 9:10 a.m.—a handsome teen-ager rose from his golden throne and placed on his shoulders his great-great-grandfather's five-colored scarf. No hands but his and those of the Je Khenpo, Bhutan's spiritual head, left, may touch the sacred relic. Thus 18-year-old Jigme Singye Wangchuck formally became the fourth hereditary King of Drukyul, the Dragon Land, as his 1,100,000 subjects know their country. Here, moments after the enthronement, the youngest of the world's 29 reigning monarchs calmly faces the challenge of guiding his sequestered nation into the 20th century.



HARMIT SINGH (ABOVE)

FATHER of a new Bhutan, the late King Jigme Dorji Wangchuck started his nation on the road of change. But, with a chronic heart ailment, he also devoted himself to preparing his son to take over. The crown prince accompanied his ailing father on inspection tours (**left**), and at 16 became chairman of the country's Planning Commission. When the king died in 1972, the son was unanimously endorsed by the Tshogdu, Bhutan's 150-man National Assembly. For nearly two years prior to last June's coronation, Jigme Singye capably held the reins of his emerging nation.

Appropriately, youth characterizes the new king's staff. A 20-year-old sister, Dechhen Wangmo (**right,** at center) heads the Ministry of Development and stands next in line to the throne. An equally beautiful princess, Sonam Wangmo, 21, controls Bhutan's purse strings.

A reconciliation born of coronation goodwill may bring other family members into the high command. Queen Mother Ashi Kesang Wangchuck (**lower left**) represents the powerful and progressive Dorji family, which for half a century has ranked below only the Wangchucks. Her brother, Jigme Dorji, became Prime Minister in 1958. Another brother, Lhendup, far right, briefly succeeded him when Jigme was assassinated in 1964, but he and his sister Tashi, near right, subsequently went into exile. Now both are home again. It would be no surprise to find the gregarious "Lennie" and his sister once again holding top government posts.

HULKING amid rice fields, a fortresslike *dzong* overshadows Thimphu, Bhutan's capital. In a major renovation, the great building was torn down in 1962, except for three central chapels, and rebuilt over the next eight years by local artisans; not a line was drawn on paper, and not a nail used. Today the Tashichhodzong—the "Fortress of the Glorious Religion"—houses Bhutan's government, the royal chapel where the coronation took place, and the nation's largest monastery. Until 1968, when Indian Prime Minister Indira Gandhi visited Bhutan, no woman had been permitted to stay overnight within the dzong's massive walls.

A decade ago 8,500-foot-high Thimphu lay at the end of a seven-to-ten-day trek through leech-infested jungles and up steep river gorges. Now an asphalt road coils 112 miles northward from the Indian border to span the 45-mile crow's-flight distance, reducing the journey to six hours by jeep.

THOUSANDS flocked to the capital for the coronation. This family rests beside the town's main street. Shops, though recently built, adhere to traditional style: intricately joined wood, richly painted and sometimes even carved. Inside, they offer such Himalayan staples as buttered tea and embroidered felt boots, silk brocade and parts for jeeps —essential vehicles on Bhutan's heart-stopping roads.

One of Thimphu's two traffic policemen (**right**) shows monumental poise as the town's only elephant ambles by.

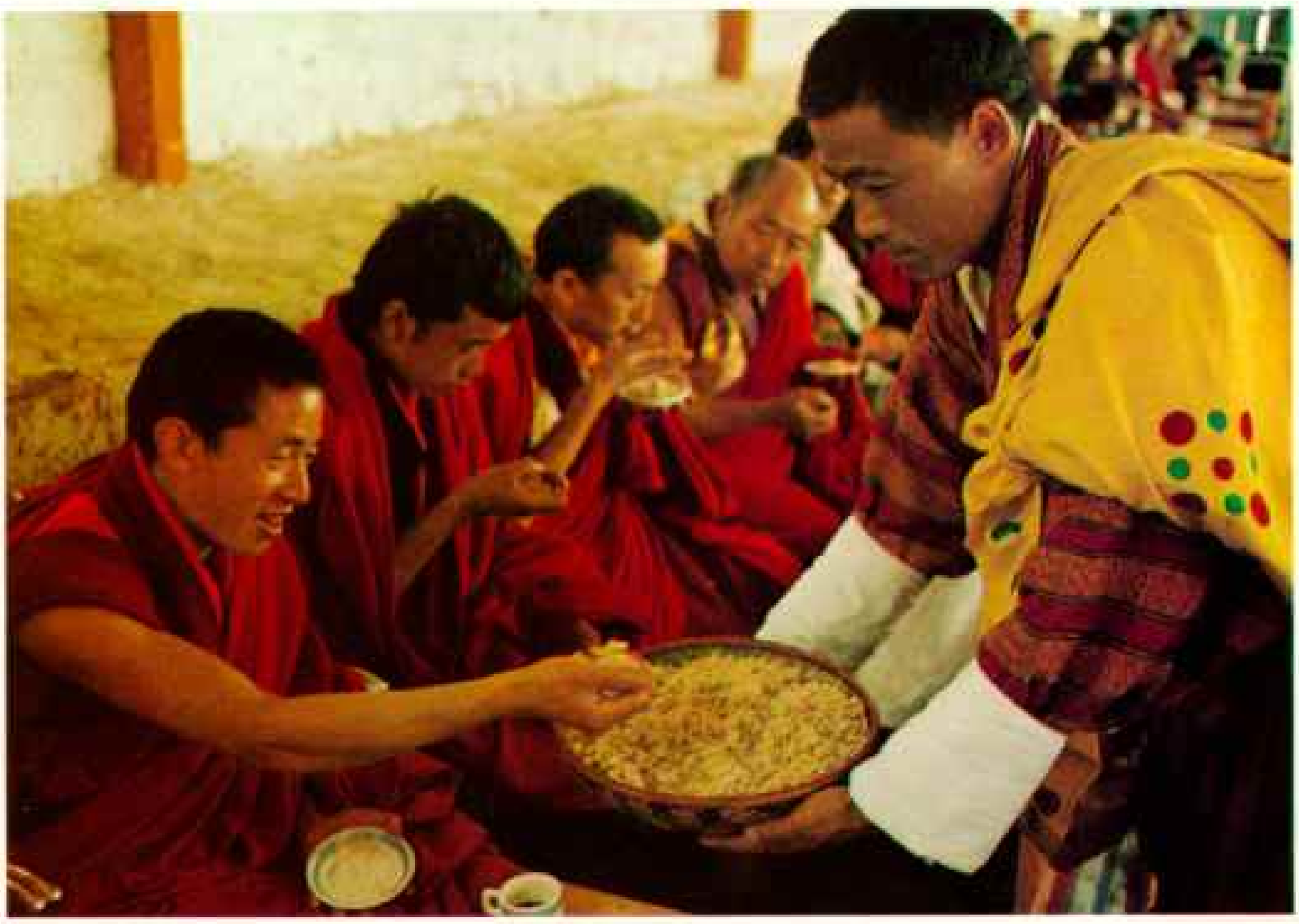
EXOTIC TREATS draw town dwellers and countryfolk to the Ping stand, a highlight of the coronation fair. For most, it was their first taste of ice cream and popcorn. Crowds gathered ten deep to marvel at an automatic vending machine that cooked and dispensed the corn. Proud of their own culture, they also thronged stands offering familiar handicrafts, including the colorful homespun used to make the *kho*, a knee-length garment worn by these Bhutanese.

Chief treasure of the Tashichhodzong, this mammoth embroidery appears only on great occasions, and then only for a few hours. Its central figure portrays the

revered Padma Sambhava, who brought Buddhism to Himalayan lands in the eighth century. Monks carefully roll up the hanging after the coronation ceremony.

GIANT PRAYER WHEELS stand at the entrances to most Bhutanese temples. The huge drums are tightly packed with strips of paper on which a four-word prayer, "*Om mani padme hum*," is repeated, often millions of times. Himalayan Buddhists believe that by endlessly repeating the formula, which roughly translates as "The jewel in the lotus," they can escape the cycle of death and rebirth and be conveyed directly to paradise. They see nothing wrong with letting a mechanical contrivance multiply their devotions; some ingenious worshipers harness a drum to a fast-moving stream, so that it turns day and night.

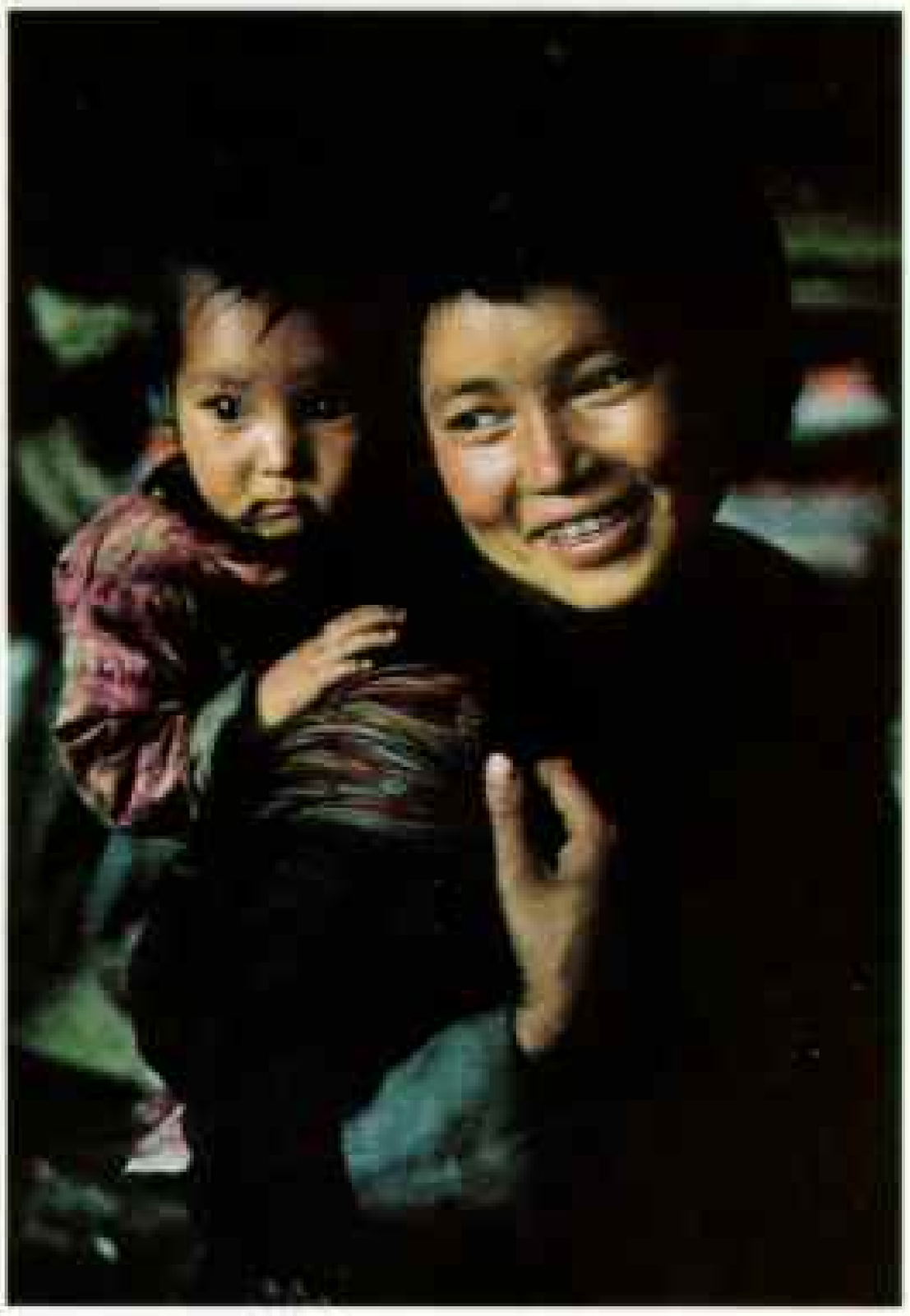
Life for the Tashichhodzong's thousand monks revolves around a complex routine of prayer and ceremony, broken as many as nine times a day by tea and simple meals (**below**). Each monk carries his own bowl, tucked into a fold of his scarlet robe. About half of the "monks" are children in training (**right**), a practice now slowly losing favor.



TWO WORLDS MEET COMFORTABLY as a member of the royal bodyguard takes time out for a cold drink. Bhutan has a modern, efficient army, but cherishes her medieval bodyguards with their centuries-old iron helmets and shields of rhinoceros hide.

The actual coronation occupied only a morning, but Bhutan's big party went on for two and a half more days, unmarred even by the announcement of a plot, aborted several weeks earlier, to assassinate the king and burn the Tashichhodzong. Unperturbed, the young king continued to mix freely with his guests and his people. "Ours is a small country. There really is no security problem," he insisted.

In the Kunrey, a main courtyard of the dzong, the royal dance troupe (**right**) enacts an ancient drama before an audience of monks.



LIKE SMALL FRY the world over, a youngster in the front row of a coronation crowd (**upper left**) makes a face for the camera. But most Bhutanese received their influx of guests—150 foreigners, the largest number ever permitted to enter the kingdom—with innocence and good humor.

The presence in Thimphu of thousands of countryfolk (**above**) was a measure of their loyalty to their young king. No paved road spans the nation. Many easterners traveled south into India, then westward more than a hundred miles before reentering Bhutan for the six-hour ride northward to the capital.

Brandishing bells and rattling hand drums (**left**), dancers precede the king's Rolls-Royce to Changlimithang Stadium for a program of sacred dramas and sports events.

GILDED HANDS cradle a stylized thunderbolt and the replica of a cup made from a human skull, holding a flower offering (**above**). The sculptures are parts of a theatrical costume worn by a monk acting the role of Padma Sambhava, considered by pious Bhutanese as second only to Buddha himself.

Regalia of human bones (**right**) carved with dancing goddesses, fiends, and mystic symbols, was once worn by a sorcerer. Makers of such outfits fashioned them from the skeletons of executed criminals or those who met violent deaths.

Himalayan Buddhists also make trumpets of thighbones and rosaries of 108 disklike beads, each cut from a different skull. Far from seeing such things as gruesome, they look on them as reminders of the brevity of life and the importance of established religion in guiding them toward a desirable rebirth.

CLASSIC ARCHITECTURE thrives in Bhutan, thanks to the insistence of the king and his father before him. Dancers perform here before the new royal pavilion (**left**) in Changlimithang Stadium. Winter winds shriek through Bhutan's high, steep-sided valleys, so the pavilion's hand-cut shingles must be held down by rocks.

Alternating with the simple rhythms of curved sticks on hand-held drums, the royal brass band (**above**) played ruffles and flourishes when dignitaries entered or left the stadium.

Monk dancers don frightsome demon masks (**below**) to remind the faithful of the endless oppression of humankind by the forces of evil.

AS A SPECIAL TREAT, ranking guests were invited to try Bhutan's national sport. The king looses an arrow (**right**) toward a target 160 yards away. Britain's High Commissioner to India, Sir Michael Walker, background, waits his turn. Letting fly, he pierced the leg of one of the spectators who habitually stand around the target artfully dodging arrows. The king rose easily to the crisis. "It happens all the time," he reassured the embarrassed diplomat.

Twenty-five Indian chefs prepared lavish meals for the guests and taught Bhutanese schoolboys the niceties of serving them (**below**). Among the treats: caviar and pâté de foie gras from Hong Kong, champagne and cheeses from France, trout from Bhutan's own rushing streams, and pork from black pigs fattened to perfection on the marijuana that cloaks many a Bhutanese hillside.

ONLY CROWNED HEAD among the guests was Sikkim's fur-hatted Chogyal (**left**), whose queen, the former Hope Cooke of New York, was in the United States arranging their children's schooling. U.S. Ambassador to India Daniel P. Moynihan (**far right**)—sitting with his wife and Australian Ambassador and Mrs. Bruce Grant—brought the king a telescope, a bit of moon rock, and, as a personal gift, a new-model Polaroid camera.

A MASK COMES OFF (**left**) and a careless foot smudges one of the decorations (**below**) so painstakingly created of rice and colored sand only a few days before. The party is over.

The coronation cost more than $3,000,000—nearly a fifth of the country's annual budget. Much went for paved streets, electrical generating equipment, cable and telephone services, and three guesthouses, essential if Bhutan carries out her plan to admit a trickle of tourists in small conducted groups. There will be no tide of young people arriving with little more than a knapsack and the stub of a one-way airline ticket, as there was when neighboring Nepal opened wide her doors.

SUDDENLY ALONE after the festivities, the king slips out of the royal cottage for a reflective moment in the garden. But is it the king? Among the Bhutanese, dress rarely offers a clue to rank. The distant figure could as easily be a palace servant.

As the coronation fades into splendid memories and the medals (**left**) are put away, both the king and his people have much to ponder. The door of the last Shangri-La has

been opened—a little. Bhutan now has her own paper currency and a postal system (though most of her attention-getting 3D and miniature phonograph-record stamps end up in albums). Most important, she is a fully independent nation (unlike neighboring Sikkim, an Indian protectorate) and holds membership in the United Nations.

Bhutan's next goal will be self-sufficiency. India helps generously, as does the U.N. But the king looks to the day when his people can take over by harnessing the abundant energy of plunging streams, by extracting mineral wealth, and by harvesting timber.

Jigme Singye Wangchuck expresses quiet optimism. "I'll be happy," he said recently, "if Bhutan remains an independent and sovereign kingdom, if people are happy and united and self-sufficient. I don't think there's anything else that a king can achieve." □

ATKA

RUGGED HOME OF MY ALEUT FRIENDS

ARTICLE AND PHOTOGRAPHS BY LAEL MORGAN

Welcome news from the mainland absorbs Vera Snigaroff, seen with her daughter Mary. Vera's husband, president of the village council, and other Atkan men must leave home in spring and summer each year to earn support for their families. Mail reaches Atka only once a month via a U. S. Navy tug that also brings supplies and visitors.

Atka's Aleuts, who cling stubbornly to their 422 square miles of rugged beauty (**facing page**), have survived slaughter by early Russian fur traders and bouts with the white man's diseases. They must still battle three old enemies—poverty, isolation, and some of the worst weather in the world.

WE BOARDED at Adak in a pink-etched dawn. Sea otters drifted by our small tug on their backs, breakfasting leisurely on crabs tabled on their chests. A killer whale cruised the placid harbor, apparently without malice.

My Aleut friends and I stowed our duffle with care; though the September breeze was faint, the weather in Alaska's Aleutian Islands can be as wild as any in the world. True to form, the wind and seas picked up as we skirted the jagged volcanic islands.

We clung to the open deck until our U. S. Navy captain ordered us off because of washing seas. Below, we took a beating as the tug bucked the rough water, but there were no complaints. The way home is always rough for these people who inhabit the westernmost civilian community in the United States—and one of the most isolated, closer to the Soviet Union than to Alaska's capital, Juneau. The postage-stamp village of Atka, on the mountainous island of the same name, is home to 145 persons of Eskimo-Aleut stock. They hold onto their native ground against staggering odds.

The previous year I had lived with the Aleuts of Atka for two months, and now I queried my former neighbors for news.

"There is still no hope of getting an airport this far out," Mike Snigaroff, the village council president, told me as the tug bobbed and churned. "And no chance of getting navigational aids for small seaplanes, either."

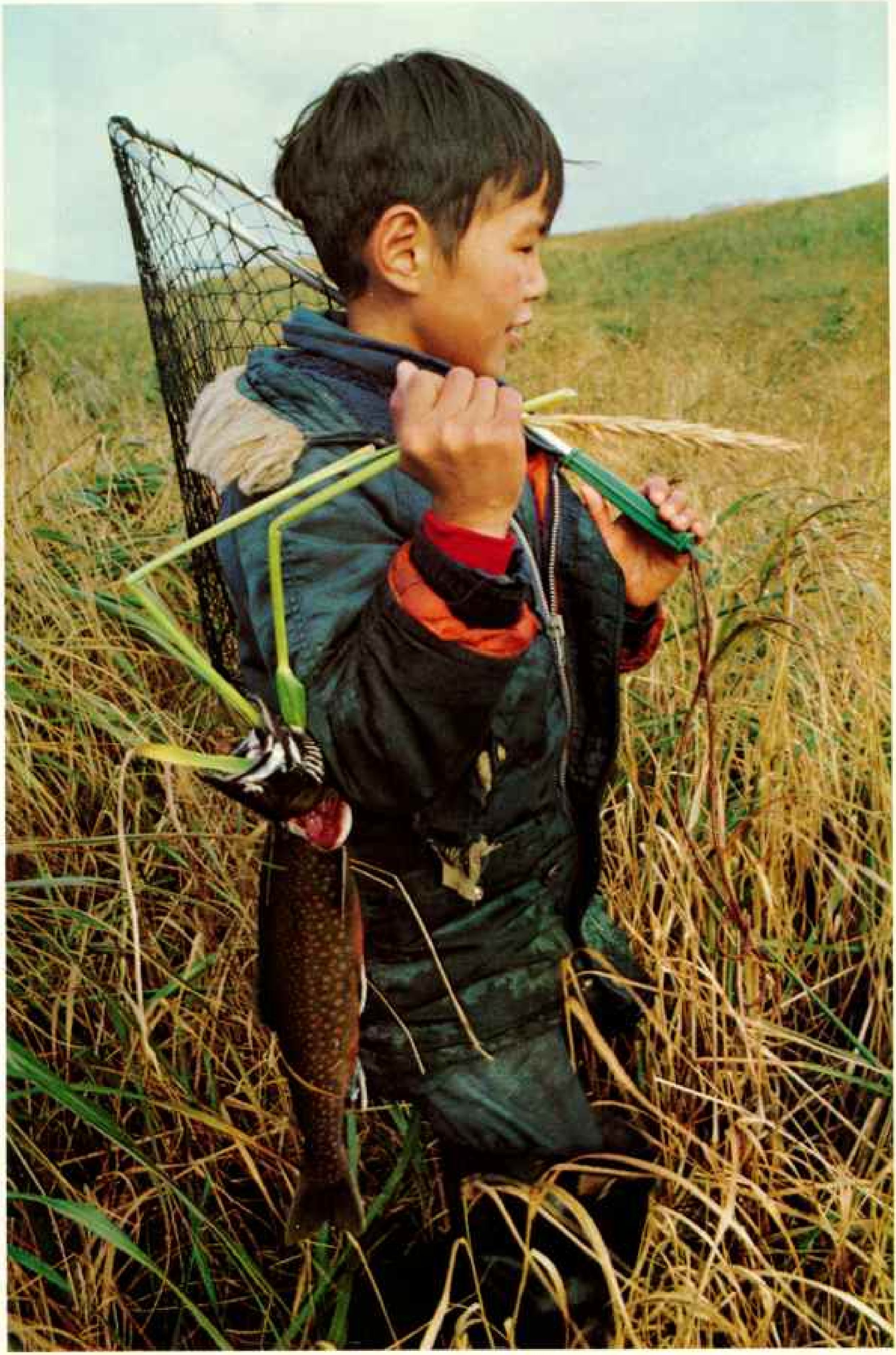
Another Atkan added that the villagers had tried to repair the antenna for the fickle 50-watt radio, but reception was still spotty; they could send only emergency messages.

The radio and our tug, which is operated by the U. S. Navy for the federal Bureau of Indian Affairs, are Atka's only means of communication with the world. Once a month —weather and military commitments permitting—the vessel makes the run from Adak Naval Station, 120 miles west of Atka.

Mike and the other men work off-island as commercial fishermen for five or six months at a time. Returning with their modest savings, they spend the rest of the year fishing and hunting Atka's reindeer, seals, and sea lions. The hunting was improving, but the fishing was not.

"If those Russians and Japanese don't stop fishing in our waters, we won't have anything left to eat but starfish!" said John Nevzoroff, a wiry little seaman who was one of my favorites. Often the men had seen foreign fishing vessels taking halibut, salmon, and crab close to shore. Sometimes the vessels even landed men who poached reindeer. But by the time a message reached the Coast Guard, it would be too late to stop them.

The battering we took on the 12-hour trip to Atka was forgotten when we anchored in Nazan Bay. Cupped in the shelter of green hills with 2,000-foot-high mountains behind, the village was a welcome sight, though less trim than when I had left it. Sergius Golley, the oldest man there, had painted only one side of his store—as much upkeep as he could afford in a year. The Russian Orthodox



church needed a fresh coat (following pages), and some of the dozen or so houses showed no paint at all—just bare, weathered wood.

Half a dozen small boats pushed away from the beach to ferry us through the shallows. My friends were smiling. We received a quiet welcome but a warm one, for Aleuts talk about love with their eyes.

ON MY FIRST VISIT to Atka, the year before, I had come as a reporter for the *Tundra Times*, a weekly newspaper that covers the affairs of Eskimos, Indians, and Aleuts. I had already met Aleuts, working with them in crab canneries on the mainland. I liked them. But I had feared Atka.

I was warned that the villagers were idle drunks; that every family had an active case of tuberculosis; that if I drank the water I would get typhoid; that if I walked the island tundra I would be lost in one of the many bottomless bog holes.

I knew no one on the island, and the Atkans knew nothing of me. Wary of strangers, they had kept their distance until they realized that I, a lone woman, was afraid. Then they showered me with kindness.

I had found no heavy drinking, no typhoid or active tuberculosis. I discovered that Atkan Aleut, the western dialect of the Aleut language, is so soft and gentle that it seems almost impossible to shout in it; that the people who speak it are tough but compassionate; and that the land to which they are so deeply attached is one of addicting beauty.

Now, on my return, several families volunteered to take me in. Rather than choose among them, I elected to rent again the house of the Russian Orthodox priest, who was seldom in residence.

Wedged between the school and the church, the house was light and roomy, painted throughout in airy green with white trim and red floors. Its plumbing, as in other houses, included an ingenious hot-water system. A pipe from the water tank passed through the oil-burning stove that served both for heating the house and cooking. Beyond, the pipe fed a tub in a bathroom that offered a marvelous view of both village and bay.

The house had electricity, too, although on my first trip I chose not to use it because the constant changing of the generator annoyed me and it was expensive to run. Now the villagers proudly reported they had wired the house to a small village generator, free of charge. I preferred the mellow glow of my kerosene lamp but, not wanting to hurt any feelings, I plugged in.

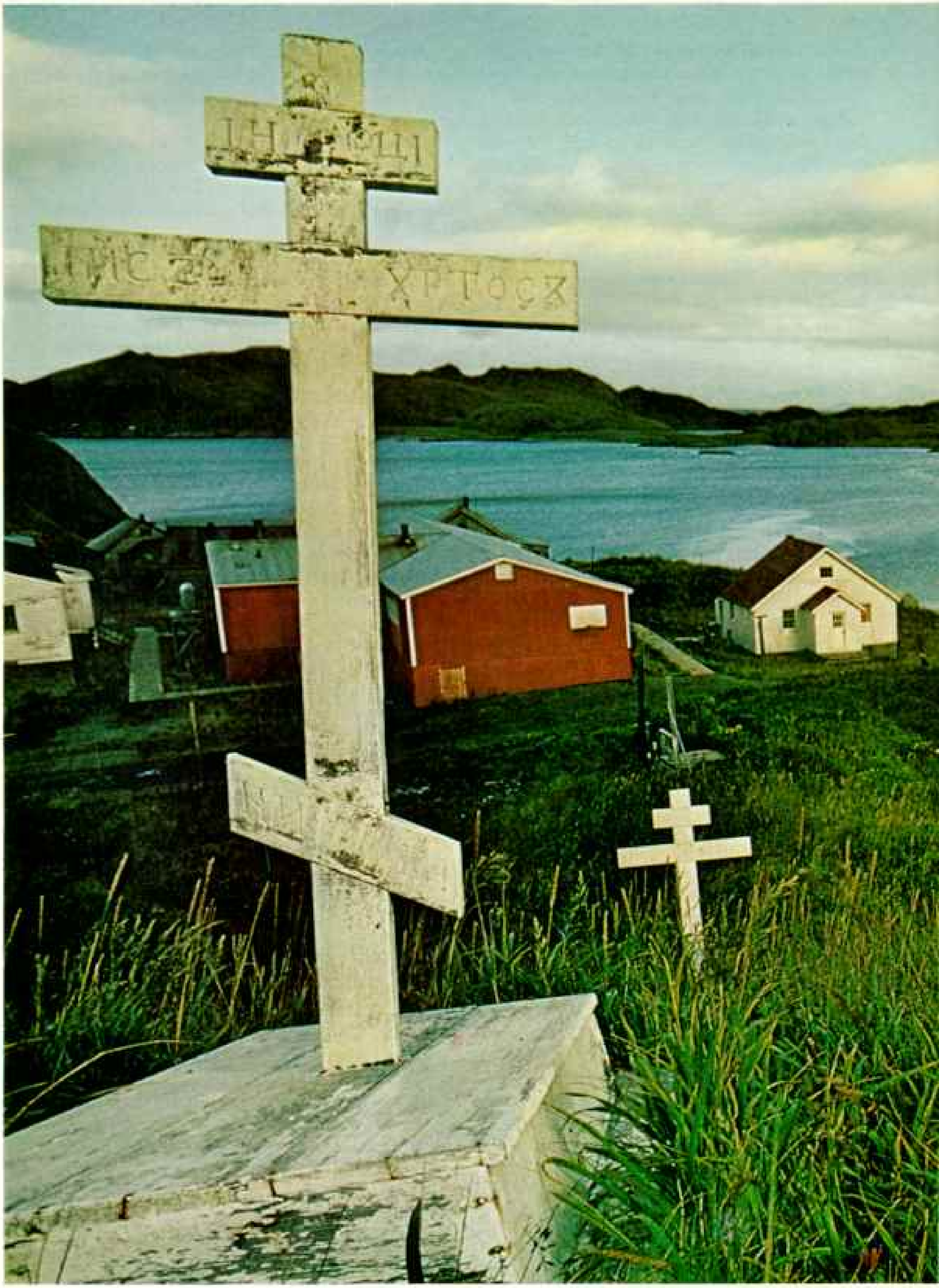
The village was full of life after the arrival of the boat; the men had been away five months. Wives labored over welcome-home suppers while children ran errands and sorted luggage. Nadesta Golley, the unofficial postmistress, sorted out the mail, including telegrams and special-delivery items that had gathered dust at Adak—mostly official letters about village business or problems with Atka children away at school.

Clara Snigaroff's schoolboy son Danny Boy and his friend Michael Dirks helped me settle in. As a gesture of welcome, they offered a pinch of snuff. Their parents forbid it, but older boys keep them supplied. On my first trip they tried to teach me how to use it, and howled in glee when I swallowed the pinch. Now I had the technique down—I thought. But when Michael shocked himself while trying to repair the bathroom light, I got so excited I swallowed another fiery ball. The kids laughed themselves out the door.

EARLY NEXT MORNING the villagers gave thanks for the tug's safe voyage with a solemn stand-up church service in Russian Orthodox tradition. The small choir chanted in old Russian. Poda Snigaroff read aloud in hesitant English from a battered Bible. Then the congregation went forward one at a time to kiss an icon of the Virgin.

The rest of the day was devoted to discussing village business with two representatives of the Aleut Corporation, an organization of 3,300 Aleut people—roughly half the total population of Aleuts in Alaska today. The officials had arrived on the tug to explain details of the land-claims settlement, under which Alaskan natives are being compensated by Congress for lands taken or wanted by the state and the U. S. Government.

Suppertime, and the livin' is easy—at least on this day, as 11-year-old Danny Boy Snigaroff escorts a Dolly Varden trout to the frying pan. Fishing provides a year-round food source as well as jobs for Aleut men who take seasonal work when they can get it, usually with mainland-based commercial outfits or canneries.



Rare splash of sunshine bathes the Russian Orthodox church, rebuilt after World War II when the village was razed by the Navy to prevent use by Japanese invaders. The Russians,

who landed on Atka in the 1750's, exploited the island's fur-bearers for a century, and then sold the territory to the United States. They left behind their religion and their surnames.

Under the legislation, all native villages would have to incorporate to receive benefits. Atka was entitled to four townships of land and about $120,000 in cash as its initial share of the 40-million-acre, billion-dollar statewide settlement. The rest of the island will remain a federal wildlife refuge, which it became in 1913.

I had been present when the villagers first learned of the settlement. They had seemed skeptical, even uninterested. "Out here, you don't believe anything until you see it," one explained to me. Now, however, they seemed to have decided the settlement was more than a flight of fancy.

I remembered that on my first visit Dan Prokopeuff had been thinking about leaving the island. "When I returned to Atka after World War II," he had told me then, "my buddy asked me, 'Why are you going back to the Aleutians? They say even the sea gulls are leaving there.' I told him I was going because it's peaceful and quiet."

But the problems—jobs, communication, transportation—discouraged him. "If we can't get things straightened out pretty soon," he had added, "I'm going to have to go back to the mainland."

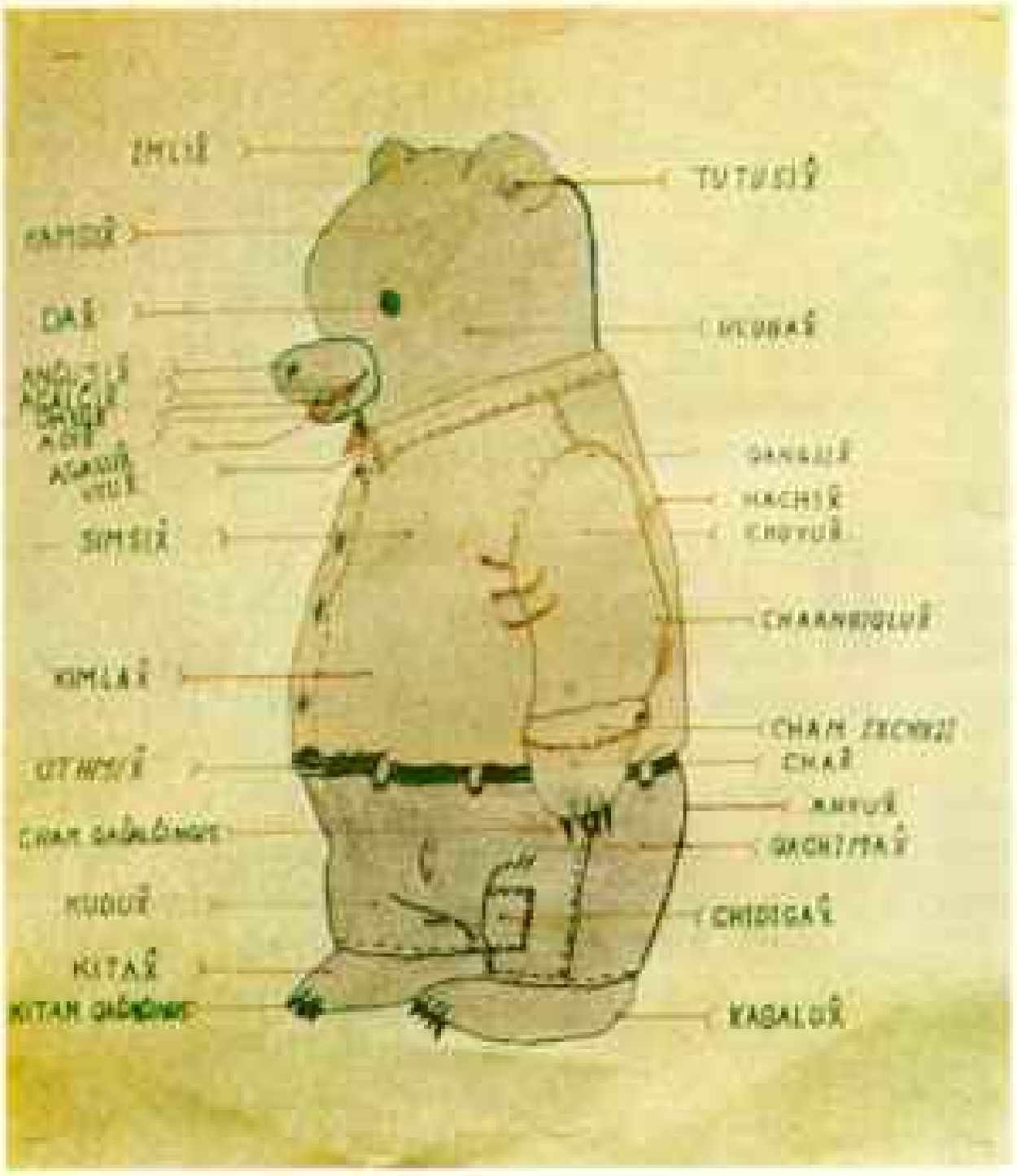
The Aleut Corporation was promising to tackle the village problems—and Dan told me now that he planned to stay. Soon I noticed that he was up before dawn every day, making repairs on his wind-battered house.

IN THE MID-1700'S when the Russians discovered the Aleutians, virtually every island was populated. Fierce, proud, hardy, the Aleuts were marvelously adapted to their rugged climate. They dwelt in sod houses, partly underground, and lived well off the sea. But their bone-tipped spears proved no match for the guns of the Russian fur traders, the *promyshlenniki*, who wiped out entire island populations. The Russians also exploited the Aleuts, forcing them to slaughter the seals, sea otters, and foxes.

By 1867, when the United States purchased Alaska, the population of the Aleutian chain had dwindled to 2,000—about a tenth of what it had been before the arrival of the Russian hunters. With the destruction of the animals on which the natives depended for food, clothing, and skins for boats, starvation and sickness became a way of life.

Twice in the present century, Atka's population has been halved. Possessing scant immunity to foreign diseases, many succumbed to influenza in the early 1900's. Tuberculosis made further inroads.

When the Japanese invaded the Aleutians in 1942, the United States Navy evacuated and burned Atka village so that the enemy could not use it. The Atkans were moved to another island, in southeastern Alaska. They found the climate there colder and damper. Food was inadequate. The population halved again. "Many of the old people just died



Two languages for beginners: Teacher's assistant Nadesta Golley quizzes eager pupils (**facing page**) in the recently introduced written form of the Atkan Aleut dialect; only English had been used in the island school. A bear's anatomy, labeled in Aleut, helps the youngsters increase their vocabulary.

One teacher and two aides staff Atka's two-room schoolhouse. After eighth grade, children may attend a Bureau of Indian Affairs school on the mainland or a state-operated school at Adak, 120 sea-rough miles away. Atkans long for their own high school to end the periods of separation, but their small enrollment and limited resources offer little hope

of broken hearts," a younger Atkan recalls.

Returned to Atka after the war, the survivors were joined by refugees from neighboring Attu. Imprisoned by the Japanese, the Attuans, like the Atkans, had lost half their people. Federal officials refused to let them return to Attu, arguing that their former home was too remote for government agencies to take care of them. Besides, Attu had been heavily mined by the Japanese.

Later in the 1940's, the existence of the combined group was so precarious that Ted Bank II, a visiting American anthropologist, predicted their demise.

"He told us that, too," recalled Nadesta Golley. "But we're still going!"

ATKANS are as social as a big family. My supply of tea bags and 25 pounds of coffee lasted barely a month. In that time, also, 35 pounds of flour went into an informal bake-off with Atka's housewives.

Lydia Dirks showed me how to make *pirog*, the island's traditional Russian fish pie, and *aladika*, fried bread. Clara Snigaroff offered hints on cooking sea lion. From her Dutch oven it tasted like a hearty cross between beef and liver; unfortunately, when I baked it, it seemed more like a middle-aged fish.

In return for game and fish brought by neighbors, I turned out mainland-style fare, crowning my stay with an enormously successful pizza party for the youngsters. Dan Prokopeuff's daughters, Molly, 15, and Ruth, a year younger, helped me.

When I asked to meet their mother, Ruth motioned to the cemetery and said evenly that that would be where I'd have to go. She had been dead two years. They lived with their grandmother, Mary, a fragile little Aleut of 78, who kept house with the traditional broom made from the wing of an eagle—considered superior for getting into corners.

The mainstay of the island diet is reindeer, and I itched to go on a hunt. I was a liability, I knew; when provisions are low, there's no room in a hunter's boat for the deadweight of an unarmed woman.

Twice I'd watched the hunters go out and kept my peace. Finally I broached the subject to Dan Prokopeuff. Though his family had food on hand, he could use some fresh meat, he said, and he would take me along.

Atka's reindeer herd is descended from 30 animals put ashore by the U. S. Government in 1914 to provide food for the nearly starving people. Irony of ironies, the animals had originally been imported from Russia.

The herd has now grown to about 3,000 animals. Some of them had been spotted in recent weeks on the south side of the island, half a day's travel by outboard motorboat from the village.

According to the weather report from a Canadian radio station, a 40-mile-an-hour gale would blow up by the end of the day, making

the return trip hazardous or impossible. But if we were lively, we could beat it.

It would be crazy, of course, to go alone in Dan's homemade 14-foot skiff. Luckily, Spirdon "Spike" Zaochney decided to come along, too, in his own skiff. He would bring his wife, Tatiana; Atka is chaperone-conscious, and I was a single woman.

Dan and I set out in the lead, coasting through colonies of snoozing sea otters under a bright, cloudless sky. I didn't relax, however, until we had negotiated Amlia Pass, reputed to be one of the most treacherous stretches of sea in the Aleutians.

The waters moved in a smooth, broad surge, breaking lazily over the rocky teeth of the entrance to the pass. "Nothing to worry about now," he assured me. Not if we could keep ahead of the weather.

Soon we were running the south side on swells so deep that the Zaochneys' skiff often disappeared in the troughs. But the view was grand. The south side is the magic side of Atka. Mammoth streams of lava appear to have poured into the cold sea and frozen.

ON THIS DAY the reindeer seemed to have vanished. In vain we traveled down the long arm of water that is Vasilief Bay, scanning the faded green velvet of the shore. Clouds began to crowd the sky; I grew cold and discouraged.

"We can't come home with an empty skiff!" Tatiana exclaimed. The Zaochneys had eight children to feed.

We ran farther south. Finally, on the lip of a small bay, Dan spotted two fine deer.

The men maneuvered the boats to the base of a bluff. Spike handed the rope of his skiff to Dan. Then, grabbing his rifle, he started nimbly up the bluff with Tatiana at his heels. I caught up near the top. "You must be very quiet," Tatiana whispered to me. "In a herd, they won't run, but when there are only two like this, they are nervous."

It seemed for a time that we'd lost them. Finally, farther up the hill, Spike motioned eagerly. The two animals were grazing there. The bull was big with a handsome rack, his cow somewhat smaller.

Suddenly they broke. Tatiana, at her husband's elbow, cried, "Don't miss! Don't miss!" He didn't. Two shots downed the animals.

The cow raised her head. Quickly Spike slit her throat. As Tatiana warned him not to get his jacket bloody, it occurred to me that even such gentle nagging might be a reason women aren't invited on many hunts.

I walked over the rise to where the bull had fallen. The animal rose to his feet, wheeled, and fled. Spike's rifle spoke twice more, and the animal dropped for good. Then Spike butchered the kill.

Near us, a raven chuckled to himself.

"Crow say it's going to blow," Dan warned.

We clambered down the cliff. Elated, Tatiana dragged two haunches of meat to the boat. "That meat is $18 a pound in the market at Kodiak," she said, exaggerating.

Atka is so large, and many parts of it are so inaccessible, that many reindeer probably have never seen man. They often show no alarm when a man approaches. Instead they

Two legs up on a full larder, Tatiana Zaochney brings home reindeer haunches. From a Siberian herd of 30, imported in 1914 via mainland Alaska, some 3,000 wild reindeer now roam the island's far reaches. Atkan hunters stalk the creatures to fill out their diet of fish and sea mammals.

exhibit mild curiosity, then go on munching sedges and lichens.

"I'd like to be a reindeer if there's reincarnation," I once said to Moses Dirks.

"No," he answered seriously. "It would be too hard."

"Why? All you do is run over the tundra and climb beautiful hills and eat mosses."

"Not in the winter," he said. "In the winter it's hard. You have to dig through the snow for your food. It's cold. It's hard to walk. You're always hungry."

I had been surprised at the compassion this hunter expressed for his quarry, and I thought of it on the long, rolling trip home with Dan.

HAPPIEST ARE MY MEMORIES of simply hiking the island, at first with Danny Boy and Michael, who showed me the trails, then alone when I'd learned the terrain, much of which is unsurveyed. Walking on Aleutian tundra takes almost twice as long as on normal terrain; you learn never to trust your forward foot. And bog areas do exist—some with holes so deep that no one has been able to plumb their depths. Michael found one and sometimes I'd go to it alone, just to stare at the lazy whirl of water at its four-foot-wide mouth. If you fell in, the villagers say, you might never be seen again, or your body might end up miles away on a beach, months later.

I found wonderful rock formations that looked like pure copper or bronze. The villagers, however, did not know what they were.

"If they are worth anything, wouldn't someone have taken them?" Dan wondered.

One night, wandering under a full moon, I stepped into the midst of a flock of ptarmigan. They burst into flight in a shaft of moonlight that turned their white feathers to gold.

One gray afternoon, high in the mountains, I lost Danny Boy and Michael, only to find them in a rocky nest at the summit, studying the village—a miniature, far below. Suddenly the sun broke through, bathing the settlement in an apricot haze. While I was setting my camera, we were as suddenly enveloped in a thick snow flurry. The boys ran through it, down the mountain, chasing a flock of geese.

No wonder the Aleuts love this land. But it is a hard life, too, when hunting is poor.

I remember when 3-year-old Simeon Snigaroff, the village council president's son, was seriously ill with flu. The villager who had been trained as a medical aide by the U. S. Public Health Service was off-island. We couldn't raise the military hospital at Adak or contact the boy's father on the mainland. Temperatures were dropping into the 40's, and Mrs. Snigaroff did not have enough money to buy oil to heat the home. Self-reliant, Atkans almost never ask for help or credit and most reject welfare.

None of us knew much about medicine. Finally the schoolteacher gave the child an injection of penicillin and pulled him through.

MANY ATKAN WOMEN weave wonderful grass baskets in traditional Aleut fashion, long since forgotten in other villages, and are able to sell them, if they can get them to the mainland, for $100 to $500. Otherwise, it is almost impossible to earn money on the island—one of the main reasons the population has remained small.

Each year village teen-agers travel hundreds of miles to boarding schools operated by the Bureau of Indian Affairs in Wrangell or Sitka, or even as far away as Oregon. Some never return. For those who do, there are often disappointments.

"The problem is that we are living like people did 40 years ago," one young man told me. He had spent two years going to school on the mainland to learn auto mechanics. Not only was there no job for him (Atka has only two autos) but, as he reminded me, it is hard to hunt in winter and hard to keep a young wife happy without electricity, a washing machine, and television.

Why had he come back? His English was good, and with his skill he could have gotten a job anywhere. "Because it's home. Because it's so peaceful," he decided.

He had done well in the city, he told me, but working from nine to five has no charm for a man raised to hunt reindeer. "I just like this country," he said simply. "It doesn't need explaining."

I walked alone to a favorite beach. The evening was warm and mellow. Thousands of silvery candlefish flickered through the calm water—so many of them that the gulls stopped screaming and fighting and feasted in quiet. Misty clouds settled on the hills. A flock of harlequin ducks paddled around the rocks at my feet.

With me I'd brought the manuscript of a narrative by the late Cedor Snigaroff, a village elder, recorded and translated by linguist Knut Bergsland, who had lived here with the

In a land of splendid isolation, two boys wait at the inlet to a tidal pool to catch a fish dinner bare-handed. Ten-year-old Judy Zaochney (**below**) dreams of the future. Recent U. S. payment for ancestral land-rights may enable young Aleuts to stay on their stark but cherished island.

Atkans in 1952. The old man spoke in a fashion that died out with his generation. He spoke of the 1830's, when the worst of the wanton slaughter had been stopped by a conservation policy—though only for a while.

"When the Russian Company dominated Atka, it used to have 300 sea otters caught a year, it's told. It did not let it go beyond that, it's told. But when the Americans came out, one began to kill them without limit . . . until they began to become scarce.

"At that time one began to wear what we now call clothes, it's told. Bird skins they did not put on so often anymore, it's told. However, much subsistence got lost for them.

"From that time on, one hunted sea otter, going on until 1910, when the sea otter was closed. It was gone."

National Geographic, October 1974.

After that, he continued, the island people hunted foxes for their pelts "up to our time, when they in turn are gone. They have lost their price."

The old man recounted stories told to him by his father, of friendships and feuds between the Atkans and the eastern Aleuts. He spoke again of the coming of the white man, the Russian trading posts, and the Russian influence that converted the Aleuts to Christianity. He told how Aleuts from the western islands were forced to live on the north side of Atka, where they died from starvation or were swept away by an avalanche.

"Only Atka village here was left.

"That's how there have been people here until now, but not so many anymore.

"That I have begun to realize."

Yet, last year three babies were born to Atkans; the year before there were none at all. Last year a family of ten had moved back to the village, deciding it was worth another try. Their sons had missed the hunting, and they hated the city.

Another family was scheduled to return soon; a third would return in the summer.

NOW, on the walk in front of my house, I encountered four youngsters fighting lustily over possession of a broken three-wheeled wagon. They argued in Aleut.

Across the way, Spike Zaochney strummed his guitar and played, "Have I Told You Lately That I Love You?"

And I dared hope there would always be an Atka to come home to. □

DAVID HISER

EDWARD S. CURTIS

Meet the original Americans

Follow their footsteps throughout our land– from 25,000 B.C. to the mid-1970's

CENTURIES BEFORE COLUMBUS reached the New World, North Americans built—without wheels or draft animals—great stone cities on high cliffs, temple mounds covering as many as 16 acres, irrigation canals forming a 500-mile network through the desert. They created the Western World's first etchings, used sign language and sunglasses, practiced medicine using nature's remedies, paddled kayaks, and played lacrosse.

These remarkable people—descendants of Ice Age Asians—spread across the vast land, adapting its bountiful resources to their needs, developing cultures as varied as the regions they settled.

Now, to enhance your appreciation and understanding of the original Americans, National Geographic offers you a colorful, sensitively written new book: *The World of the American Indian.*

Of the volume's nine distinguished authors, four are Indian writers and scholars. A

TERRY EILER

EMORY KRISTOF, NATIONAL GEOGRAPHIC PHOTOGRAPHER

JOHN HERGET, COURTESY LORD PETRE OF THAKSTEDINE

Pulitzer Prize-winning Kiowa poetically captures the Indian world view, and a Princeton scholar brings to life the mythical journey of his Tewa people. You'll sample the rich heritage of Indian languages, feel you are there as you pore over vivid picture sequences of famous Indian chiefs, the awesome Sun Dance, Hopi snake dancers.

You'll share the life-styles of the five major types of aboriginal Americans (see table of contents on the following page), meet the Eskimo . . . the Iroquois, Algonquin, Cherokee . . . the Pueblo, Navajo, Apache . . . Nootka, Tlingit, Yurok . . . learn how the Plains Indians lived before the white man brought the horse to America.

Witness the clash of cultures between Old and New World peoples—the latter yielding most of their land, many of their former ways, almost their very existence. And see the Indian rebuild his population, renew his ancestral pride, and search for a future as meaningful as his past.

Five major cultural types of native North Americans have evolved over the past 27,000 years. A modern-day "war dancer" proudly wears his colorful Plains Indian costume for a special powwow. Chief Yakotlus of the Pacific Northwest poses in 1914 for a portrait by Edward S. Curtis, a famed photographer of Indians. A woman's hands weave a basket of wild grasses evoking the Southwest Indian's sun-drenched landscape. An Eskimo whale hunter plies the icy waters off Point Barrow, Alaska, in a walrus-skin umiak similar to those his ancestors used. Mohawk Chief Brant displays his elaborate tattoos in a painting made during his visit with England's Queen Anne in 1710.

For further information about *The World of the American Indian* please turn the page.

Examine without obligation a book every American should read . . .

The World of the American Indian, which supplants the Society's now out-of-print *Indians of the Americas*, gives you a detailed picture of our land's original inhabitants, enriched by the insights of current research. The new volume is in a large 9⅛- by 10¼-inch format, hardbound with cover in striking Navajo woven-fabric design. Its 400 fact-filled pages contain 448 illustrations, 362 in full color. A comprehensive appendix keyed to a 32½-by-37½-inch continental map of the Indian cultures enables you to locate and learn about some 600 tribes. The book's consultants are Dr. William C. Sturtevant, General Editor of the Smithsonian's authoritative 20-volume *Handbook of North American Indians*, and Vine Deloria, Jr., Sioux author of the best-selling *Custer Died for Your Sins*.

$9.95

. . . mail this order form today

585 A

Savor the richly diversified cultures and contributions of a unique people

BEFORE THE CHRISTIAN ERA, Americans were growing crops and making pottery. Skilled designers, they mastered the arts of fabric weaving, tattooing, body painting, woodcarving. They formed a primitive democracy, gave the world such things as succotash, corncribs, husking bees, clambakes. But their crowning achievement was the partnership they formed with nature . . . keeping in tune with the spirits that gave shape and essence to each animal or plant, stone or hill, storm or star that touched their lives. To appreciate fully their many accomplishments, mail the attached order form . . . and enter *The World of the American Indian*.

NATIONAL MUSEUM OF MAN, OTTAWA (ABOVE); SMITHSONIAN INSTITUTION (LEFT AND BELOW)

DENVER ART MUSEUM (ABOVE)

TABLE OF CONTENTS

586

NATIONAL GEOGRAPHIC SOCIETY

WASHINGTON, D. C.

Organized "for the increase and diffusion of geographic knowledge"

GILBERT HOVEY GROSVENOR
Editor, 1899-1954; President, 1920-1954
Chairman of the Board, 1954-1966

THE NATIONAL GEOGRAPHIC SOCIETY is chartered in Washington, D. C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization for increasing and diffusing geographic knowledge and promoting research and exploration. Since 1890 the Society has supported 1,068 explorations and research projects, adding immeasurably to man's knowledge of earth, sea, and sky. It diffuses this knowledge through its monthly journal, NATIONAL GEOGRAPHIC; more than 50 million maps distributed each year; its books, globes, atlases, and filmstrips; 30 School Bulletins a year in color; information services to press, radio, and television; technical reports; exhibits from around the world in Explorers Hall; and a nationwide series of programs on television.

Articles and photographs of travel, natural history, and expeditions to far places are desired. For material used, generous remuneration is made.

MELVIN M. PAYNE, President
ROBERT E. DOYLE, Vice President and Secretary
GILBERT M. GROSVENOR, Vice President
THOMAS M. BEERS, Vice President and Associate Secretary
HILLEARY F. HOSKINSON, Treasurer
OWEN R. ANDERSON, WILLIAM T. BELL,
LEONARD J. GRANT, W. EDWARD ROSCHER,
C. VERNON SANDERS, Associate Secretaries

BOARD OF TRUSTEES

MELVILLE BELL GROSVENOR
Chairman of the Board and Editor-in-Chief

THOMAS W. McKNEW, Advisory Chairman of the Board

LLOYD H. ELLIOTT, President, George Washington University
CRAWFORD H. GREENEWALT, Director, E. I. du Pont de Nemours & Company
GILBERT M. GROSVENOR, Editor, National Geographic
ARTHUR B. HANSON, General Counsel, National Geographic Society
CARYL P. HASKINS, Former President, Carnegie Institution of Washington
CARLISLE H. HUMELSINE, President, The Colonial Williamsburg Foundation
MRS. LYNDON B. JOHNSON
CURTIS E. LeMAY, Former Chief of Staff, U.S. Air Force
H. RANDOLPH MADDOX, Former Vice President, American Telephone & Telegraph Company
WM. McCHESNEY MARTIN, JR., Former Chairman, Board of Governors, Federal Reserve System
BENJAMIN M. McKELWAY, Former Editor, Washington *Star*
MELVIN M. PAYNE, President, National Geographic Society
LAURANCE S. ROCKEFELLER, President, Rockefeller Brothers Fund
ROBERT C. SEAMANS, JR., President, National Academy of Engineering
JUAN T. TRIPPE, Honorary Chairman of the Board, Pan American World Airways
FREDERICK G. VOSBURGH, Former Editor, National Geographic
JAMES H. WAKELIN, JR., Former Assistant Secretary of Commerce for Science and Technology
JAMES E. WEBB, Former Administrator, National Aeronautics and Space Administration
ALEXANDER WETMORE, Research Associate, Smithsonian Institution
LLOYD B. WILSON (Emeritus), Honorary Board Chairman, Chesapeake & Potomac Telephone Company
CONRAD L. WIRTH, Former Director, National Park Service
LOUIS B. WRIGHT, Former Director, Folger Shakespeare Library

COMMITTEE FOR RESEARCH AND EXPLORATION

ALEXANDER WETMORE, Acting Chairman
MELVIN M. PAYNE, Vice Chairman
EDWIN W. SNIDER, Secretary

BARRY C. BISHOP, National Geographic Staff, GILBERT M. GROSVENOR, MELVILLE BELL GROSVENOR, CARYL P. HASKINS, STERLING B. HENDRICKS, Scientist Emeritus, U.S. Department of Agriculture, THOMAS W. McKNEW, ROBERT C. SEAMANS, JR., T. DALE STEWART, Physical Anthropologist Emeritus, Smithsonian Institution, MATTHEW W. STIRLING, Archeologist Emeritus, Smithsonian Institution, JAMES H. WAKELIN, JR., FRANK C. WHITMORE, JR., Research Geologist, U.S. Geological Survey, CONRAD L. WIRTH, FREDERICK G. VOSBURGH, and PAUL A. ZAHL

Assistant Secretaries of the Society:
FRANK S. DELK, JOSEPH B. HOGAN,
ADRIAN L. LOFTIN, JR., LEWIS P. LOWE,
RAYMOND T. McELLIGOTT, JR., EDWIN W. SNIDER
Assistant Treasurer: WARD S. PHELPS

Leonard J. Grant, Editorial Assistant to the President; Edwin W. Snider, Richard E. Pearson, Administrative Assistants to the President

SECRETARY'S STAFF: *Administrative:* Earl Corliss, Jr., Harriet Carey, Frederick C. Gale. *Accounting:* Jay H. Givans, Alfred J. Hayes, William G. McGhee, Martha Allen Baggett. *Membership Promotion and Statistics:* Charles T. Kneeland (Chief), Thomas M. Kent. *Payroll and Retirement:* Howard R. Hudson (Supervisor); Mary L. Whitmore, Dorothy L. Dameron (Assistants). *Procurement:* J. P. M. Johnston, Thomas L. Fletcher, Robert G. Corey, Sheila H. Immel. *Member Relations:* Paul B. Tylor. *Publications:* Geneva S. Robinson. *Data Assembly:* Peter F. Woods. *Promotion:* Robert J. Warfel, Towne Windom, F. William Rath. *Printing:* Joe M. Barlett, Frank S. Oliverio. *Production Control:* James P. Kelly. *Personnel:* James B. Mahon, Glenn G. Pepperman, Nellie E. Sinclair. *Medical:* Thomas L. Hartman, M.D. *Translations:* Zbigniew Jan Luzyk

COVER: Amid Himalayan splendor, Bhutan's fourth Dragon King begins his reign (pages 546-7). JOHN SCOFIELD

POSTMASTER: SEND CHANGE OF ADDRESS FORM 3579 AND UNDELIVERED COPIES TO NATIONAL GEOGRAPHIC MAGAZINE, 17TH AND M STS. N.W., WASHINGTON, D.C. 20036

NATIONAL GEOGRAPHIC MAGAZINE

MELVILLE BELL GROSVENOR *Editor-in-Chief and Board Chairman*
MELVIN M. PAYNE *President of the Society*
GILBERT M. GROSVENOR *Editor*
JOHN SCOFIELD *Associate Editor*

Senior Assistant Editors

Robert L. Breeden, James Cerruti, W. E. Garrett, Kenneth MacLeish, Jules B. Billard, Allan C. Fisher, Jr., Carolyn Bennett Patterson

Assistant Editors: Andrew H. Brown, William Graves, Robert P. Jordan, Joseph Judge, Edward J. Linehan, Samuel W. Matthews, Bart McDowell, Howell Walker, Kenneth F. Weaver

Senior Editorial Staff: Thomas Y. Canby, William S. Ellis, Rowe Findley, Bryan Hodgson, Elizabeth A. Moize, John J. Putman, Myrle E. Severy, Gordon Young; Senior Scientist: Paul A. Zahl

Foreign Editorial Staff: Luis Marden (Chief); Thomas J. Abercrombie, David S. Boyer, Howard La Fay, Volkmar Wentzel, Peter T. White

Editorial Staff: Harvey Arden, Kent Britt, Mike W. Edwards, Noel Grove, Alice J. Hall, Werner Janney, Michael E. Long, John L. McIntosh, Ethel A. Starbird, George E. Stuart (Archeology)

Art Director: Howard E. Paine; Charles C. Uhl (Asst.), Robert E. Pullman

Research: Margaret G. Bledsoe (Chief); Ann K. Wendt (Associate Chief); Newton V. Blakeslee (Assistant Chief for Geographic Information); Carolyn H. Anderson, Susan L. Anderson, Judith Brown, Marcia M. Butler, Susan Day Fuller, Bette Joan Goss, Sallie M. Greenwood, Jan Holderness, Lesley B. Lane, Levenia Loder, Jean B. McConville, Carol M. McNamara, Frances H. Parker, Frances W. Shaffer. *Correspondence:* Carolyn F. Clewell, Clifford R. DuBois

Library: Virginia Carter Hills (Librarian); Patricia Murphy Smith (Assistant Librarian), Louise A. Robinson

Editorial Administration: Joyce W. McKean, Assistant to the Editor; Virginia H. Finnegan, Winifred M. Myers, Shirley Neff, M. Jean Vile (Editorial Assistants); Dorothy M. Carson (Indexes); Evelyn Fox, Dolores Kennedy (Travel); Jeanne S. Duiker, Lois Wendling, Mary Anne McMillen (Records)

ILLUSTRATIONS STAFF: *Illustrations Editor:* Herbert S. Wilburn, Jr. *Associate Illustrations Editor:* Thomas R. Smith. *Art Editor:* Andrew Poggenpohl. *Assistant Illustrations Editors:* David L. Arnold, O. Louis Mazzatenta, Charlene Murphy, Robert S. Patton, Elie S. Rogers, W. Allan Royce, Jon Schneeberger, Mary Griswold Smith. *Layout and Production:* H. Edward Kim (Chief). *Picture Editor:* Bruce A. McElfresh. *Research:* Paula C. Simmons, Barbara A. Shattuck (Asst.). *Librarian:* L. Fern Dame. *Assistant Librarian:* Carolyn J. Harrison

Geographic Art: William N. Palmstrom (Chief); Walter Q. Crowe, John D. Garst, Jr. (Assistant Chiefs). *Artists:* Lisa Biganzoli, William H. Bond, John W. Lothers, Robert C. Magis, Ned M. Seidler, Lloyd K. Townsend. *Cartographic Artists:* Victor J. Kelley, Snejinka Stefanoff. *Map Editor:* John T. Blozis. *Research:* Virginia L. Baza, Dorothy A. Nicholson, Ann Rubicka. *Production:* Isaac Ortiz (Supervisor); Iskandar Baday, Elie Sabban, Leo B. Zeharth

Engraving and Printing: Dee J. Andella (Chief); John R. Metcalfe, William W. Smith, James R. Whitney

PHOTOGRAPHIC STAFF: *Director of Photography:* Robert E. Gilka. *Assistant Directors:* Dean Conger, Joseph J. Scherschel. *Photographers:* James L. Amos, James P. Blair, Victor R. Boswell, Jr., Bruce Dale, Dick Durrance II, Gordon W. Gahan, Otis Imboden, Emory Kristof, Bates Littlehales, Robert W. Madden, George F. Mobley, Robert S. Oakes, Winfield Parks, Robert F. Sisson (Natural Science), James L. Stanfield. Lilian Davidson (Administration). *Film Review:* Guy W. Starling (Chief). *Photographic Equipment:* John E. Fletcher (Chief), Donald McBain

Photographic Services: Carl M. Shrader (Chief); Milton A. Ford (Associate Chief); Jon R. Adams, Herbert Altemus, Jr., David H. Chisman, Lawrence F. Ludwig (Assistant Chief, Photolypography), Claude E. Petrone, J. Frank Pyles, Jr., Donald E. Stemper; Joan S. Simms (Asst.)

RELATED EDUCATIONAL SERVICES OF THE SOCIETY

Cartography: William T. Peele (Chief); David W. Cook (Associate Chief). *Cartographic Staff:* Margery K. Barkdull, Charles F. Case, Ted Dachtera, Richard J. Darley, John F. Dorr, Russel G. Fritz, Richard R. Furno, Charles W. Gotthardt, Jr., Thomas L. Gray, Catherine M. Hart, Donald A. Jaeger, Harry D. Kauhane, Manuela G. Kogutowicz, Mary Anne McAleer, Charles L. Miller, Robert W. Northrop, Richard K. Rogers, John F. Shupe, Charles L. Stern, Douglas A. Strobel, Tibor G. Toth, Thomas A. Wall, Thomas A. Walsh, Charles M. Wilson III

Books: Jules B. Billard (Chief); Seymour L. Fishbein (Assistant Chief); Thomas B. Allen, Ross Bennett, Charles O. Hyman, Anne Dirkes Kobor, David F. Robinson, Wilhelm R. Saake, Verla Lee Smith

Special Publications and Educational Filmstrips: Robert L. Breeden (Chief); Donald J. Crump (Associate Chief); Philip B. Silcott (Assistant Chief); William L. Allen, Josephine B. Bell, David R. Bridge, Linda Bridge, James B. Caffrey, Margery G. Dunn, Ronald Fisher, William R. Gray, Mary Ann Harrell, Jerry Kline, Margaret McKelway Johnson, Geraldine Linder, Robert Messer, H. Robert Morrison, George Peterson, Cynthia Ramsay, Tee Loftin Snell, Joseph A. Taney, George V. White, Merrill Windsor

Recording Division: John M. Lavery (Chief)

School Service: Ralph Gray (Chief and Editor of National Geographic School Bulletin); Charles H. Sloan (Assistant Chief); Joseph B. Goodwin, Ellen Joan Hurst, Anne H. Oman, Patricia F. Robbins, Veronica Smith, Janis K. Wheat

News Service: Windsor P. Booth (Chief); Paul Sampson (Assistant Chief); Donald J. Frederick, William J. O'Neill, Robert C. Radcliffe

Television and Educational Films: Dennis B. Kane (Chief); Sidney Platt (Supervisor, Educational Projects); David Cooper, Carl W. Harmon, Jr., Patricia F. Northrop; Marjorie M. Moomey (Chief of Research)

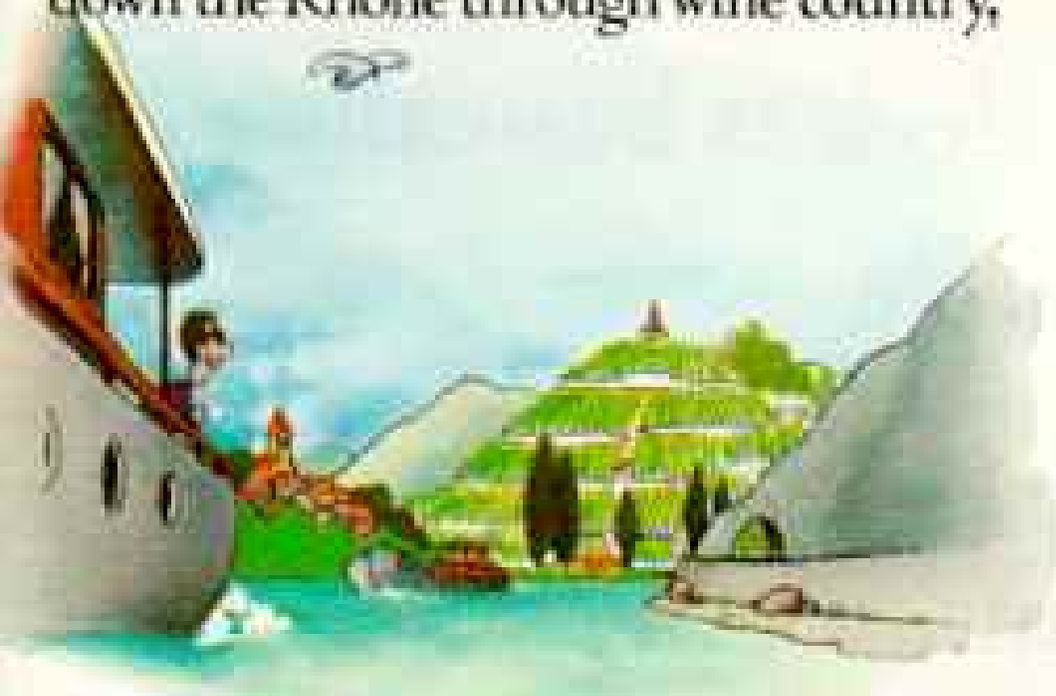
Lectures: Joanne M. Hess (Chief); Robert G. Fleegal, Mary W. McKinney, Gerald L. Wiley, Carl E. Ziebe

Explorers Hall: T. Keilor Bentley (Curator-Director)

EUROPEAN OFFICE: W. Edward Roscher (Associate Secretary and Director), Jennifer Moseley (Assistant), 4 Curzon Place, Mayfair, London, W1Y 8EN

ADVERTISING: *Director:* James L. Till. *Manager of Agency Relations:* William Turgeon, 1251 Avenue of the Americas, New York, N.Y. 10020. *Regional managers—Eastern:* George W. Kellner, New York. *Midwestern:* Robert R. Henn, Chicago. *Pacific:* Thomas Martz, San Francisco; *Los Angeles:* Jack Wallace. *Canada:* Robert W. Horan, New York. *Automotive:* John F. Grant, New York. *Travel:* Gerald A. Van Splinter, New York. *European Director:* Richard V. Macy, 31 rue Jean-Mermoz, Paris 8e, France. *Production:* E. M. Pusey, Jr.

If you've never taken a barge down the Rhône through wine country,



smelled the fresh herbs of Provence,

tasted bouillabaisse in Marseille

or met a Breton fisherman,

you can't say you've really seen France.

France really isn't just one country. It's more like 20. The people, the customs and the diversions are as different from one region to another as bouillabaisse is from truite normande.

Did you know for example that there are over 300 different French cheeses, each one representing the personality of a little corner of France?

Everywhere you go you will find charming little inns and restaurants with surprisingly low prices.

Ask your travel agent about Air France's inexpensive package deals and convenient fly-and-drive plans. And about the extensive air and railroad networks that permit you to travel conveniently throughout France.

So if you'd like a vacation that takes you away from the usual, whatever your interests are, spend some time exploring the many faces of our country. And be able to say you've really seen France.

AIR FRANCE

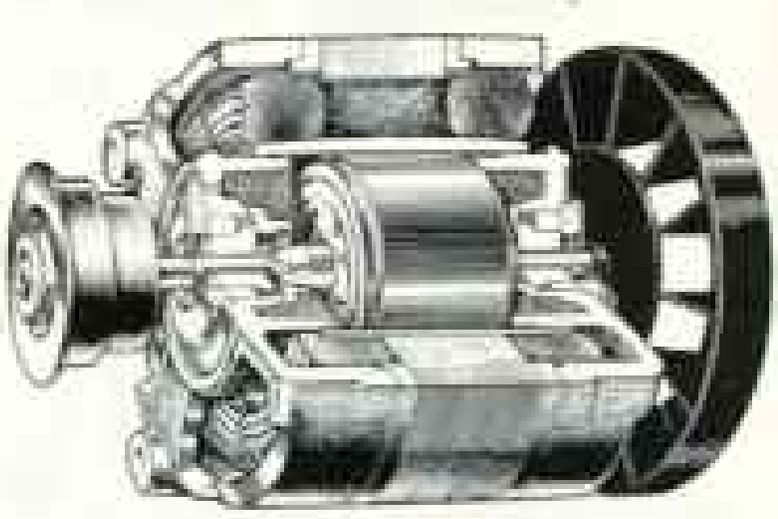
We understand.

The tape deck is basically a pretty simple instrument. It records sound. And

plays it back. If it does this satisfactorily, that's it.

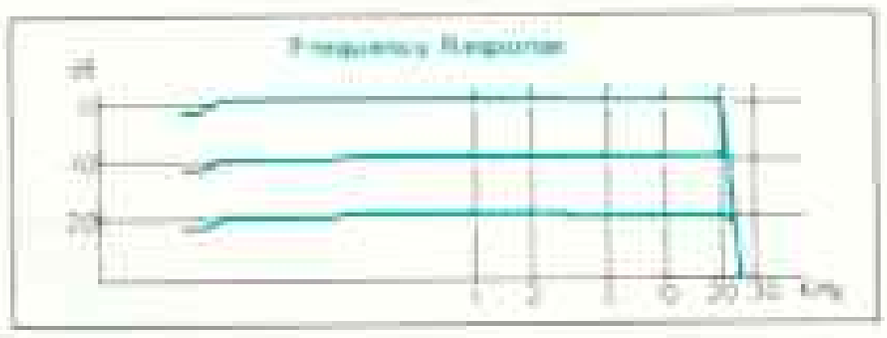
Yet Akai has spent years and years in research and making technical developments so that their tape decks do this simple job better. Akai insists on

quality. Maybe more than is absolutely necessary. Such as a GX head made of glass and single crystal ferrite



which must be made in a high-temperature furnace.

And shafts honed to ±0.0001mm accuracy.



And rotors wound by hand.

Simplicity can be complex when you demand quality. Akai has built real quality into the new GX-600DB. Akai.

It sounds better.

"Dolby" and the Double D symbol are trade marks of Dolby Laboratories, Inc.

Motor: One hysteresis synchronous capstan motor/Two eddy current reel rotor motors

Head: One G.X. Recording Head/One G.X. Playback Head/One Erase Head

Frequency Response: 30 – 23,000 Hz

Wow & Flutter: Less than 0.03% WRMS

Dolby Noise Reduction System

AKAI

BURT KERR TODD (ABOVE) AND JOHN SCOFIELD

Even in Bhutan, the Geographic was there

CROWN PRINCE Jigme Dorji Wangchuck smiles at his new bride (**left**) in a photograph from the December 1952 magazine; the handsome young couple became king and queen of Bhutan only a year after the picture was taken. Twenty-two years later their only son, Jigme Singye Wangchuck (**below**), sits with the widowed Queen Mother during his own coronation festivities. A picture story on the three-day celebration begins on page 546.

Sixty years ago NATIONAL GEOGRAPHIC published its first article on Bhutan, devoting almost the entire April 1914 issue to the adventures of British Political Officer John Claude White, who attended the coronation of the new king's great-grandfather, Ugyen Wangchuck.

Other rare glimpses followed. Burt Kerr Todd, author of the 1952 article, was the first American to be invited into the mountain realm. Bhutan's sometimes uneasy position between quarreling neighbors—India and the People's Republic of China—was described in September 1961.

NATIONAL GEOGRAPHIC will continue to focus on small nations as well as large. Invite your friends to visit such hidden kingdoms; nominate them on the form below.

Come to Belgium in 1975 and we'll ring the bells for you.

Each year the Belgian tourist authority highlights a certain aspect of the country's attractions. Recently we've had the "Year of the Chateaux" and the "Year of the Monasteries." Next year it's the turn of the Cathedrals and Belfries. Now, before you say you don't fancy trekking around a lot of churches, let's just tell you what you'll find in some of them.

In Antwerp cathedral, for example, you can see Rubens' huge masterpiece "The descent from the Cross." A painting which is, today, beyond price.

In other cathedrals and churches across Belgium, you'll find hundreds of works of art on canvas, in stone, silver and gold, which recall the turbulent history of our country.

You'll see the influence of flemish, french, dutch, spanish, german, english and latin cultures - brought together in this fascinating corner of Europe.

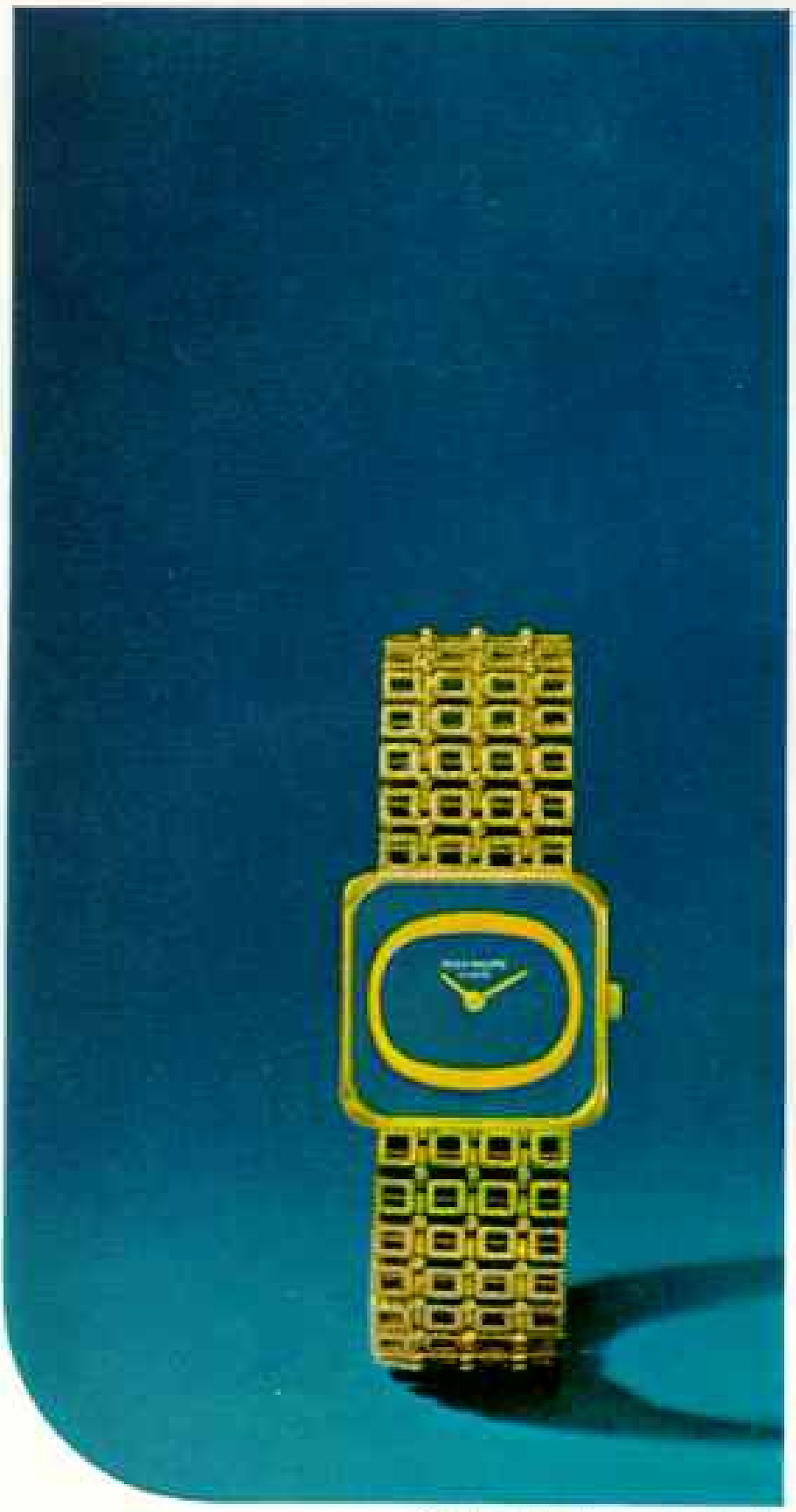
The nearest Belgian Tourist Office or Sabena office can give you all the information you need concerning "The Year of Cathedrals and Belfries" - and about how Sabena can fly you there in one of their luxurious, wide-bodied Boeing 707's, 737's, 747's or Mc Donnell Douglas DC-10-30cF's. Try it and you'll soon agree Sabena is a better way to fly.

Go Belgian. Go Sabena.

SABENA

belgian world airlines

1975 is the "Year of Cathedrals and Belfries" in Belgium.



Ref. 4183/1, 18 ct. yellow gold

A TRIBUTE TO THAT WONDROUS TOOL: THE HUMAN HAND

The watches signed Patek Philippe are entirely finished by hand, today as in 1839. This is true of movement, case, dial and bracelet. Every detail is the work of an artisan, be he watchmaker, goldsmith or jeweller.

The result is necessarily an object of rarity. And also of beauty: Patek Philippe innovates with styles which later become classics of watch design. A Patek Philippe, after all, is frequently a family heirloom and must please successive generations.

To its owner, a Patek Philippe is as much a masterpiece as a Renoir, for it also satisfies a desire some men are born with: the desire to contemplate and own an object of rarity and beauty.

The craftsman's touch is unmistakable in every object signed Patek Philippe, watch or jewellery.

PATEK PHILIPPE

Let us tell you more about Patek Philippe. Please write to: Dept. NG - Rue du Rhône 41 - 1211 Geneva - Switzerland

We're big on little things at Toyota.

There are a lot of things that make a Toyota a great automobile. Big things like computerised quality control. And little things like eye tests.

For the last five years we've been running tests to determine the limits of visibility under various conditions. We test with men and with women. On country roads and city streets. Then we use the results to design our cars – from the shape of the windscreen, to the size of the mirrors, to the position and brightness of the headlamps.

Compared to our more sophisticated testing and research, or compared to our performance and styling, eye tests may seem insignificant.

But the little things we do add up. Because we've been doing them for 37 years. And we'll keep on doing them. Because they go a long way toward making you satisfied.

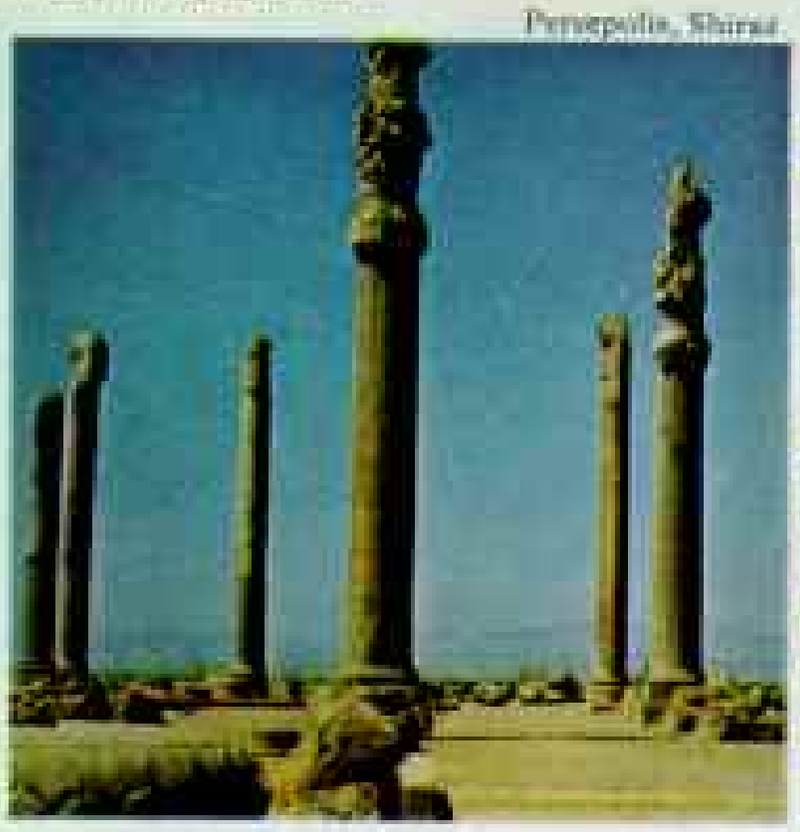
TOYOTA

Fly with the 'Homa' to its fabulous land

Friday Mosque, Isfahan

Welcome Aboard

Discovering Persia's living history



Persepolis, Shiraz

The unbeaten path, near Isfahan

Arya Sheraton Hotel, Tehran

Iran Air's 'Homa' offers many rewards. So does Iran.

Soon it will be dusk. Colossal pillars cast long deep-purple shadows across the ruins of a once great city. The vestiges of ancient palaces, towers and massive assembly halls loom in the dying light.

This is Persepolis, a city which Darius the Great founded and made the centre of an all-powerful nation.

And it is here, so legend has it, that the fabulous 'Homa' bird appeared in the skies. This bird is said to have inspired Cyrus the Great to found the Persian Empire (now Iran). Though Persepolis has receded imperiously into history, the bird flies on.

Today you can see its majestic profile on the tailplanes of Iran Air's all-jet fleet: Boeing 707s and 727s for our international flights, 737s for servicing our 18 destination network in Iran itself.

So come visit Iran. There's so much to see – Isfahan, Shiraz, Persepolis, cities splendid and romantic where history was made.

Or to the unbeaten path . . . through a land of gardens, ornate pigeon towers and dreaming mosques with domes of turquoise or yellow. Hotels? They are luxurious and international with every modern facility.

Get all the rewarding details from your Travel Agent.

IRAN AIR

London · Paris · Frankfurt · Vienna · Geneva · Zurich · Rome · Moscow · Athens · Istanbul · Tehran · Abadan · Baghdad · Kuwait · Bahrain · Abu Dhabi · Dhahran · Dubai · Doha · Muscat · Kabul · Karachi · Bombay. Also sales offices in Milan, Hamburg, New York, Los Angeles and Tokyo.

هواپیمائی ملی ایران ۴۰

Fly SAA
Where no-one's a stranger

South Africa bound? Then fly South African Airways. You'll be among friends. Traditionally hospitable people, who've found that the best way to make friends with you is to offer you frequent flights to choose from. To pamper you every minute you're with us. And to make sure you reach your destination at a reasonable time of the day.

That's why SAA has direct (mostly one-stop) flights south from 12 of Europe's centres. Which leave more than twice a day. And arrive bright and early in the morning.

It's why our weekly flight from the USA via Rio is the fastest way to get to Johannesburg from the States.

Why our new Buenos Aires service comes non-stop, straight from the capital of the Argentine.

And why our twice-weekly flights from Australia are the quickest way up from down-under.

So whichever of these routes you're travelling, make sure you fly on a comfortable SAA Jumbo or 707 friend ship. Where no-one's a stranger after that first hello.

SAA
South African Airways
Where no-one's a stranger

By 1990, about 1,5 milliard more human beings will be living on our earth. Our need for food will be even greater than it is today – and increasing all the time. Our demands will have increased proportionately, too. Fresh vegetables throughout the winter and fruit from faraway places have long since been taken for granted. But good harvests don't just happen. Whether our children and our children's children, too, will have sufficient sources of nutrition to draw on depends also on research in agrarian chemistry.

Those who look after plant life...

...give us our daily bread

BASF Agro-Chemical products ensure a plentiful supply of foodstuffs

For years BASF products have helped to protect those plants which are essential to life and to give them the sustenance they need. Products such as ®Basagran and ®U 46 protect cultivated plants from weeds. ®Nitrophoska artificial fertilisers give the soil the goodness it needs for reliable and healthy yields. Such BASF products as ®Calixin and ®Perfekthion protect plants from disease and pests. Foil made from BASF synthetics protects early harvests: the plants even grow faster, because they are protected from the worst effects of wind and weather. Meadowlands treated with ®Nitrophoska yield high-grade fodder, rich in minerals.

BASF also plays a part in increasing a healthy splash of green in our cities, encouraging woods to spring up and making your balcony or garden an oasis where we can really unwind and forget the cares of the workaday world.

BASF research affects every aspect of modern living

100.000 people are working for BASF. 10.000 of them in research. BASF produces thousands of products. For every branch of industry. And for every aspect of modern living. For flats and houses. For agriculture and nutrition. For traffic and transport. For pharmacology and cosmetics. For communication and entertainment.

BASF Aktiengesellschaft, Abt. VKW, D-6700 Ludwigshafen

BASF - We work for the future with you in mind

BASF

The Vacheron Constantin philosophy is best expressed at 1/64 mm thickness

On this scale it has to be perfection

✠ The thinnest movement in the world – which we launched twenty years ago now – is no one tour de force. It is the sum total of many tours de force in the technical area. For it is no more a question for certain parts of tenths or of hundredths of millimeters, but of thousandths of millimeters. ✠ The making of components and assembly are carried out in such a way that year for year a Vacheron Constantin is always much younger than any other watch. We spend a lot of time, but it is time that proves us right. Fairly rapidly too: the difference is already noticeable after a few years. ✠ Our attention paid to the minutest details is not for nothing. It endows Vacheron Constantin watches with a long lasting quality of a particular kind, and the only one in our opinion, that matters. In a Vacheron Constantin it is the initial precision that endures.

✠ VACHERON CONSTANTIN ✠

In Geneva since 1755

Should you like to know more about the oldest watch company in the world, write: VACHERON CONSTANTIN, P. O. Box 441, 1211 GENEVA 11, Switzerland.

Only 427 watch dealers in the whole world display the Vacheron Constantin sign.

An airline should be big enough to have its own 747 maintenance facility

...and small enough to care about your children.

Did you know that many airlines have no facilities for performing major maintenance on their air fleet? Knowing that, you can better appreciate the fact that TAP, The Intercontinental Airline of Portugal, has a maintenance facility that's totally modern. For example, our people can actually take a giant 747 B's engines apart and totally rebuild them to achieve brand-new performance.

It's one of the newest, most modern maintenance centers anywhere. Over 2,000 skilled technicians keep it in operation 24 hours a day, every day, carrying out meticulous inspections and maintenance on every detail of TAP's 747 fleet. And they know their jobs well: last year they attended 72 Boeing-created courses—for a total of 8,502 class hours!

But keeping our planes functioning perfectly is not our only job as an airline. Keeping our passengers happy is an important one, too. Particularly the children. We Portuguese have a special fondness for youngsters (our big families prove it). So we provide special TAP games and coloring books for the older ones. And complete "mother's helper" facilities for the tiny ones.

Big-airline technology and small-airline thoughtfulness: that's TAP. And that's why we're just your size.

TAP

THE INTERCONTINENTAL AIRLINE OF PORTUGAL

We're as big as an airline should be.

We know how tough it is to put a component stereo system together.

So we did it for you.

When you don't know much about stereo, trying to put a component stereo system together can be a frustrating experience.

Because just choosing good equipment isn't enough. It also has to be equipment that works well together.

And that's where we can help.

We've designed a system that's about as perfectly matched in performance as you could hope for. And we've used some of the best components we make.

Like the Sony ST-5066 FM stereo/FM-AM tuner, for instance. It has a field effect transistor that can pick up and hold distant stations and bring in nearby ones with a minimum of interference.

And the Sony TA-1066 integrated amplifier. We designed it specifically to go with the ST-5066. Besides being all solid-state, it combines low distortion (0.08%) with high output (18 watts RMS per channel at 1kHz).

To this we've added the Sony PS-5100 turntable.

With aluminum diecast platter, precision balanced tonearm and automatic return and reject devices.

Plus two of our newest and most spectacular speakers—the Sony SS-7220's. Each has a tweeter, midrange and a big 10" woofer.

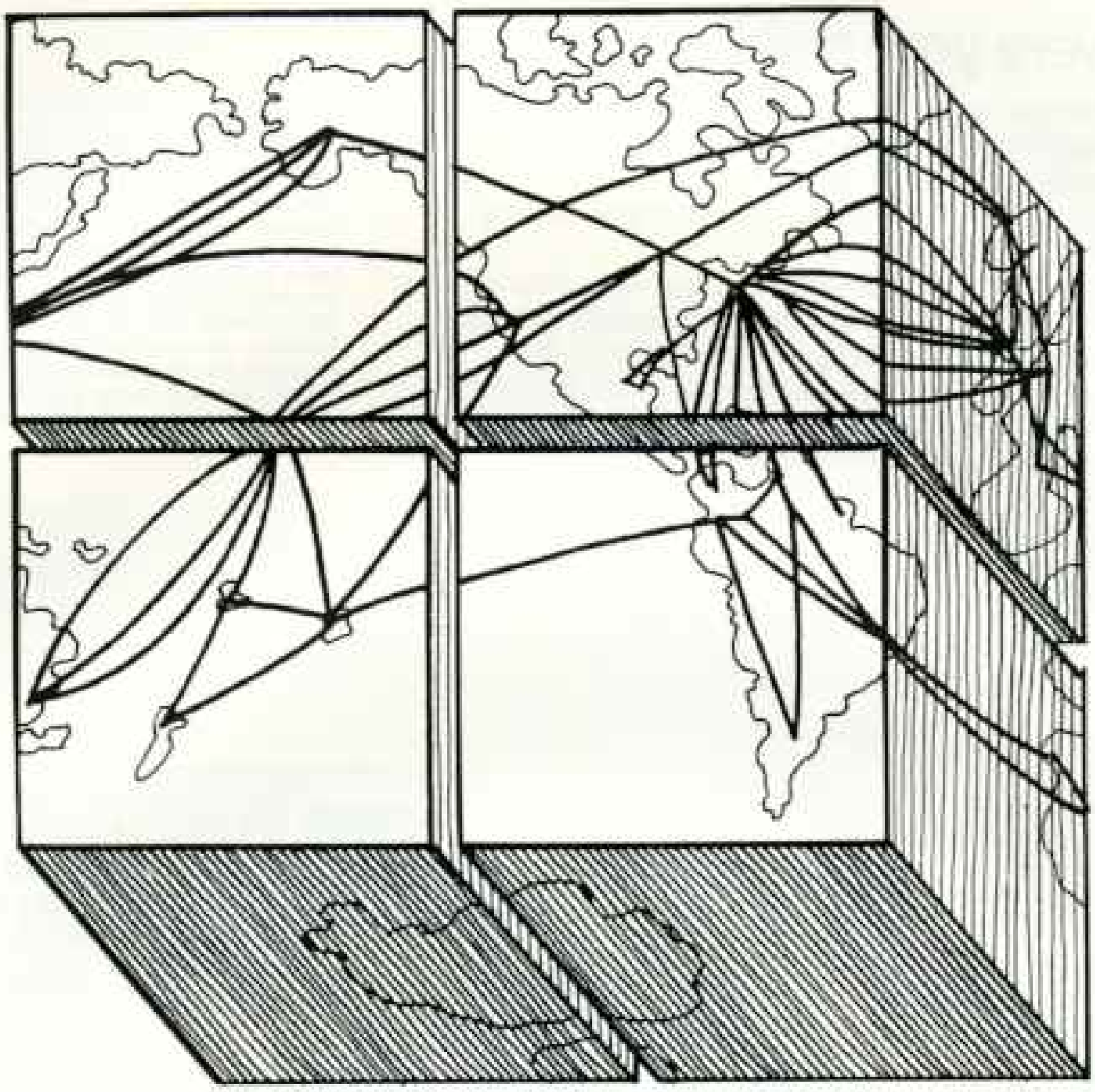
Of course, the only fair way to judge any stereo system is to hear it in person.

Which is why we suggest you see your Sony dealer.

He'll be more than happy to put our entire component stereo system together for you.

After which, you may very well decide to make it yours.

SONY®



We're in your corner.

Pan Am can fly you to the four corners of the world. We fly to more than 100 cities in over 65 lands and offer more tours than any other airline.

And no matter which corner you're in, we're with you...with over 195 offices staffed with experienced Pan Am® people who don't just sell tickets and confirm flights. They give you tips on interesting side trips, recommend good restaurants and shops, and fill you in on special local events. They'll even hold your mail for you, if you'd like to use us as your foreign address.

And when you fly "the full-service airline," one call does it all. Our worldwide communications system can make your reservations for flights to any destination, for hotels, car rentals, or for our exclusive 747 dining room in First Class.

So next time you fly out into the world, remember: we're in your corner. Contact your Travel Agent or Pan Am.

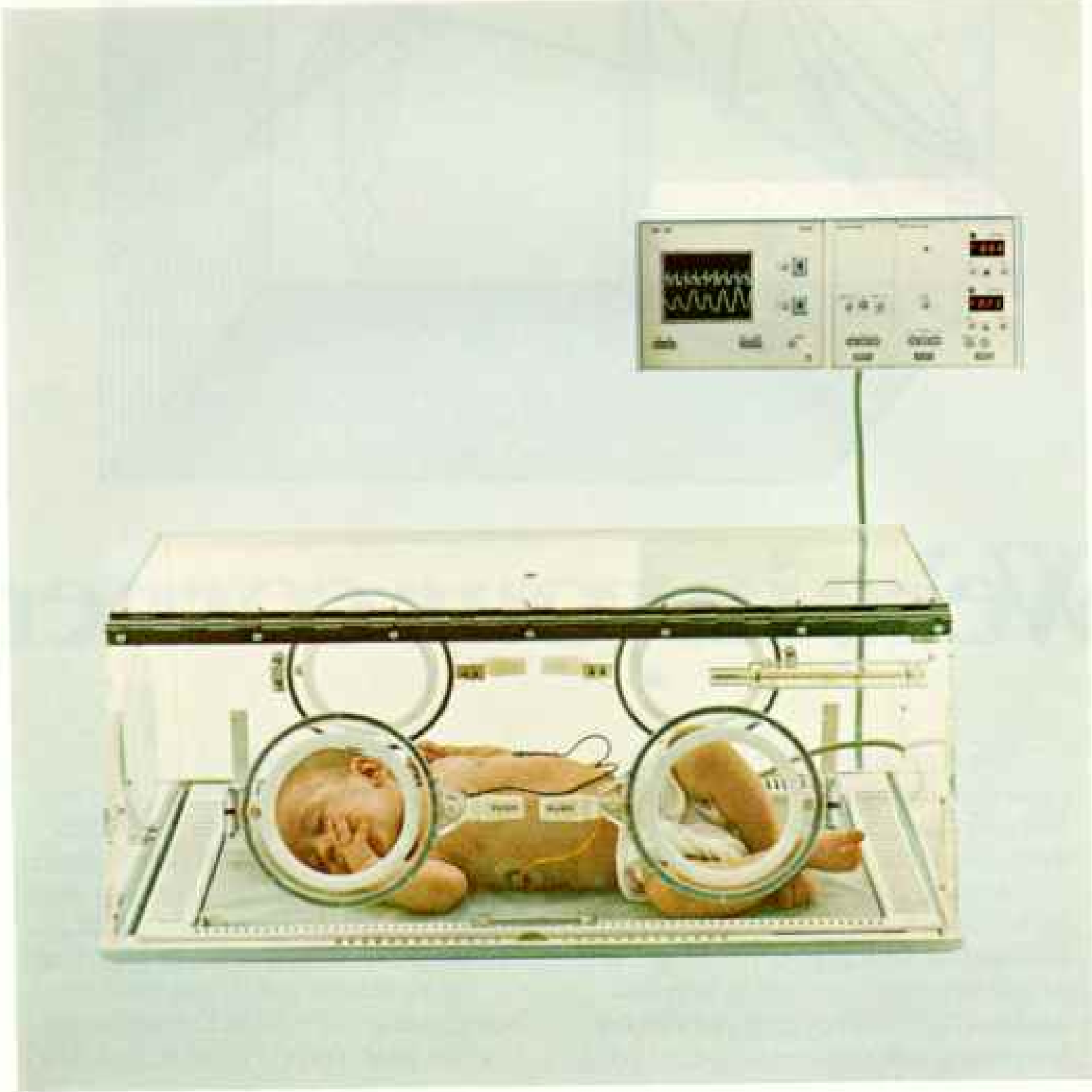
PAN AM®

The world's most experienced airline.

If it were your child.....

His defences against infection are so weak that even doctors and nurses come near him as infrequently as possible.
Yet they must be warned immediately of any change in his condition.
If it were your child you would be very thankful for those monitors keeping constant watch on his heartbeat and breathing. The system is the outcome of an unusual combination of medical knowledge with the skill in electronics for which we are more generally known.

Our involvement in medicine is so complete that we can equip entire hospitals and frequently act as consultants on their design. We make practically everything: from paging systems and lighting, through the most sophisticated diagnostic X-ray systems to the scintillation counters and electron microscopes of the research laboratories. One recent advance is a unique system for radiation therapy in which the treatment planning, which normally takes a specialist half a day, can be done in a few minutes - and done in greater detail.



PHILIPS Working in health care

for art's sake

The SR-T 303 was made to meet the highest, most demanding creative standards.

All the information you need to take inspired photographs is contained in the viewfinder. Aperture setting and shutter speed are clearly visible. The Contrast Light Compensator means perfect exposure in any lighting situation. The dual Micro-Split Screen focusing system ensures crystal clarity.

Then, to further satisfy the requirements of the knowing lens artist we built in multiple exposure capability. And a hot shoe, in addition to cord, for complete flexibility.

Finally, we offer the Minolta system of over 150 accessories, including 27 fine Rokkor Lenses.

Minolta SR-T 303. The fine 35mm SLR camera with through-the-lens metering.

For art's sake . . . and yours.

Minolta

Minolta Camera Co., Ltd. 30, 2 Chome, Azuchi-Machi, Higashi-Ku, Osaka, Japan/Also sold as SR-T 102 and SR-T Super

When Luis Marden found the Bounty...

After Captain Bligh and 18 loyal men had been put into a boat and cast adrift, Fletcher Christian sailed away in the Bounty—and disappeared. Eighteen years later, in 1808, an American ship called at Pitcairn Island and uncovered the grim fate of the Bounty and her crew.

Mr. Christian had run the ship ashore and burnt her. Of the crew, all but one died violent deaths.

Pitcairn Island is 1,300 miles south of Tahiti. Luis Marden went there to see if he could find the Bounty.

He knew some of her charred timbers had been found in 1841 and that her rudder was found in 1933.

It seemed likely that the shallow water round that totally exposed coast would have swept away every trace of the Bounty, but Marden felt there was a chance.

He dived again and again in the rough seas in Bounty Bay and found nothing, but his luck turned.

One day Marden came upon what he believes to be the complete keel line of the ship. All around were fragments of the copper that had sheathed the Bounty's hull, as well as a pintle, an oarlock and fastenings and nails, all covered in hard limey growths.

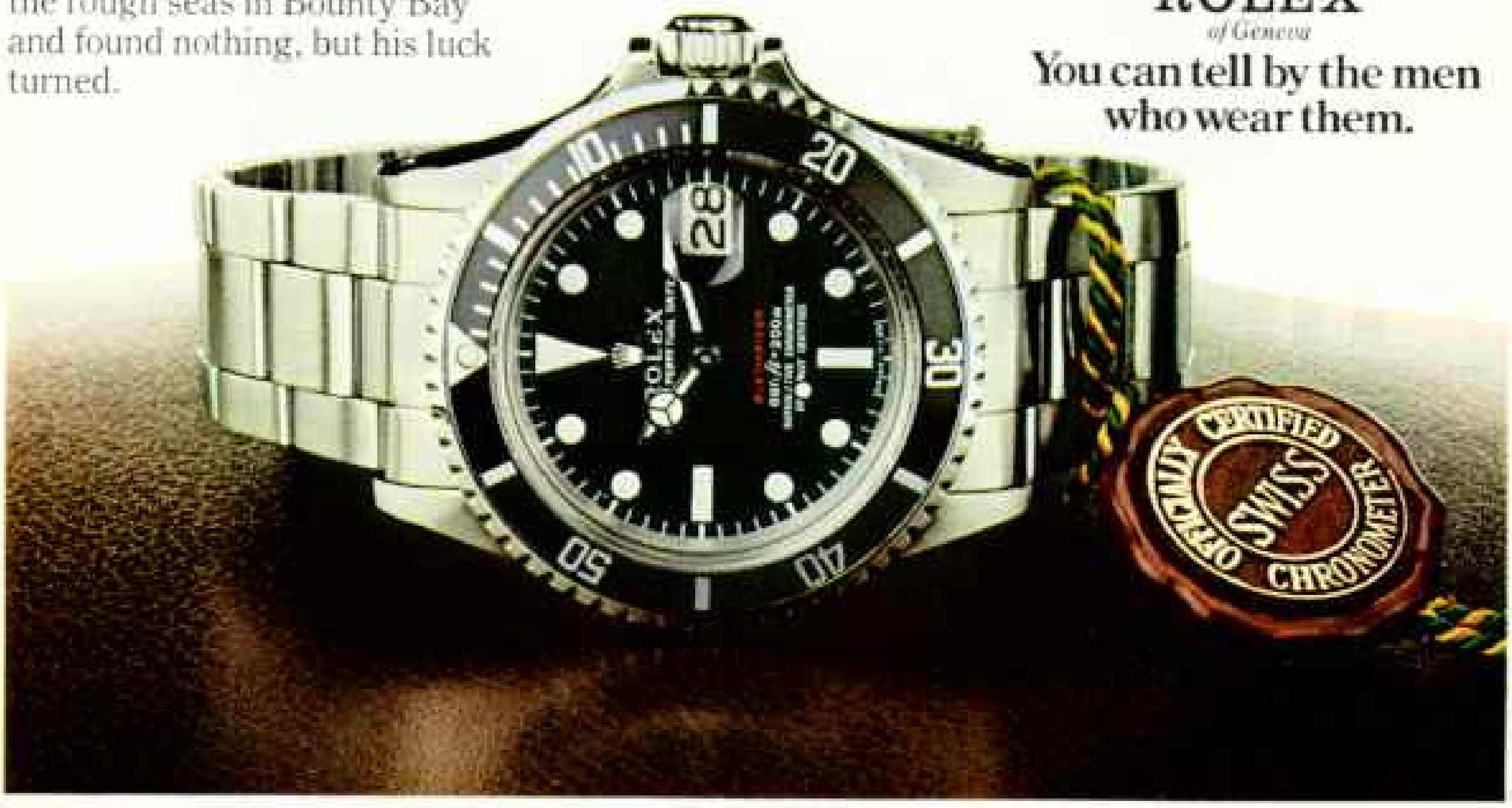
Marden has dived all over the world in his work for the National Geographic Magazine. He always wears a Rolex.

A Rolex Oyster case is carved from a solid block of 18ct. gold, platinum or stainless steel; so you'll find no seam around its elegant circumference. In all other watches the winder is a weakness. The patented Rolex winding crown holds a unique strength, screwing down onto the case rather like a submarine hatch, to provide a perfect, impenetrable seal. The Rolex crystal is another unique device and becomes even tighter under pressure.

Luis Marden has been wearing his Rolex Submariner for over 16 years. He still calls it his new watch. But then he expects to be wearing it for a long time to come.

ROLEX
of Geneva

You can tell by the men who wear them.



Pictured: The Rolex Submariner. Available in 18ct. gold or stainless steel with matching bracelet.

All European centers are central. But one is more central.

The more you fly

Lufthansa
German Airlines

See it our way.

6mm f/2.8 Fisheye
6mm f/5.6 Fisheye
8mm f/2.8 Fisheye
10mm f/5.6 OP Fisheye
16mm f/3.5 Fisheye
15mm f/5.6
20mm f/3.5
24mm f/2.8
28mm f/2
28mm f/3.5

35mm f/1.4
35mm f/2
35mm f/2.8
35mm f/2.8 PC
45mm f/2.8 GN
50mm f/1.4
50mm f/2
55mm f/1.2
55mm f/3.5 Micro
85mm f/1.8

105mm f/2.5
105mm f/4 Bellows
135mm f/2.8
135mm f/3.5
180mm f/2.8
200mm f/4
200mm f/5.6 Medical
300mm f/4.5
400mm f/4.5
400mm f/5.6
600mm f/5.6
800mm f/8
1200mm f/11

500mm f/8 Reflex
1000mm f/11 Reflex
2000mm f/11 Reflex
43mm—86mm f/3.5
50mm—300mm f/4.5
80mm—200mm f/4.5
200mm—600mm f/9.5

Nikkor lenses. By Nikon.

NIPPON KOGAKU K.K. Fuji Bldg., 2-3, 3-chome, Marunouchi, Chiyoda-ku, Tokyo 100, Japan
Offices in: New York, Zürich, Amsterdam, Düsseldorf

We can no longer automobile in terms of

From its very birth at the turn of the century the automobile has been man's most favoured creation / obsession. He has given to it three generations of time and thought and energy and money.

It has given to him a mobility that has enlarged his world and enriched his life.

And along the way it has given him one more thing. A headache. A very large headache.

For the automobile, even before the energy crisis, was beginning to cause problems. Serious problems. It was growing in size as it grew in number. It was strangling our cities, clogging our highways and polluting our air.

Then along came the energy crisis. An even bigger problem, and a hardship for all of us. But more important, a warning for all of us. A warning that we're using up the earth.

In addition to running short of oil, we're running out of copper and zinc and phosphates and other critical resources.

Which brings us to the true price we pay for an automobile (or a refrigerator or a tv set). The true price has to be the money it costs plus the amount of natural resources it uses up. Both in building it and operating it.

Which brings us to big cars vs. small cars, and the tables opposite. As you see, it takes over twice the raw material to build a big car and nearly twice the energy to operate it.

And that, combined with all the other problems it causes, is why the day of the behemoth is drawing to a close.
The price is too high to pay.

This, believe it or not, is going to be more of a hardship on car companies than on car buyers. The car company has to give up big car profits. The car buyer has only to give up the big car habit.

And that shouldn't be difficult. For a small car can be a joy in its own. As rather conclusive proof, Fiat is and has been for years, the biggest selling car in Europe. And the name Fiat *means* small car.

We not only made the world's first small car, we now make the widest range of small cars. We've had more experience at it than anyone. We're better at it than anyone.

Even during recent years, when a great number of car makers (not only in the U.S.) jumped on the big car

measure the cost of the money alone.

bandwagon. 90% of Fiat production remained in small cars.

All of this, you're thinking, leads to one logical conclusion: we'd like to sell you a Fiat.

Most definitely. That's the purpose of any advertisement.

But in this case there's another purpose too.

And that is to suggest that if all of us can learn to live without excesses today, we may not have to live without essentials tomorrow. FIAT

Big car. (2500 cc or more)

What it does.
It carries 5 people and 500 cu. dm of luggage and reaches a top speed of 180 kph.

What it costs.
More than twice as much as the smaller car.

What it uses up.
Fuel: 11 litres per 100 km @ ¾ of maximum speed
Raw materials:

Steel	1 334 kg
Cast Iron	234
Light Alloys	100
Copper	12
Brass and Bronze	15
Zinc, Tin and Lead Alloys	35
Rubber	75
Total	**1.805 kg**

Small car. (1000 cc or under)

What it does.
It carries 4 people and 365 cu. dm of luggage and reaches a top speed of 140 kph.

What it costs.
Less than half as much as the bigger car.

What it uses up.
Fuel: 6.9 litres per 100 km @ ¾ of maximum speed
Raw materials:

Steel	686 kg
Cast Iron	75
Light Alloys	25
Copper	4
Brass and Bronze	4
Zinc, Tin and Lead Alloys	12
Rubber	39
Total	**845 kg**

Why do more people capture life with a Pentax than with any other fine camera?

Because for 22 years Asahi Pentax has been first with almost every technological advance in 35mm SLR photography.
For example, take the Pentax ES II, with:

- an electronic shutter which automatically sets itself for exactly the right speed, from 1/1000 to 8 sec.
- a TTL full-frame-averaging metering system with an ASA range of 20 to 3200
- an exposure-control dial allowing variations of 1/2 X (exposure factor), 2 X or 4 X for high or low key effects
- full compatibility with all ghost-and-flare reducing SMC Takumar lenses.

Pentax — it stands for technological innovation. No wonder it's the world's best selling, most-loved fine 35mm SLR camera.

ES II

The worlds best selling fine camera

ASAHI PENTAX

No.1-Loved:Pentax

ASAHI OPTICAL EUROPE S.A., Freight Bldg., Brussels National Airport, 1930 Zaventem, BELGIUM
ASAHI OPTICAL EUROPE S.A., Hamburg Office, 2000 Hamburg 54 (Lokstedt), Grandweg 64, WEST GERMANY

BUSINESS TRANSPORTATION YOU CAN RELY UPON: BEECHCRAFT.

There probably aren't any records to prove it, but it's doubtful that anyone ever built a successful business by relying entirely upon others. Usually, there is someone who supplies the individual initiative and momentum to carry an enterprise forward.

Today, in this period of crucial business decisions, that individual could very well be considering the purchase of a Beechcraft.

And that, in itself, is a very significant form of initiative.

With the current energy situation, with widespread travel restrictions being urged on every mode of transportation, with increasing demands being placed upon business management's time...a Beechcraft becomes even more important.

A Beechcraft Baron 58 (like the one shown above) could easily become one of the few reasonable solutions to providing flexibility and dependability in business travel.

The Baron 58 swiftly transports up to 6 persons (or a ton of cargo) directly to destination at 230 mph.

And, with a nonstop range of well over 1,000 miles, the Baron 58 gives you tremendous operational flexibility...because most trips can be made without fueling stops en route.

Imaginative businessmen are recognizing more and more that a Beechcraft ...privately-owned and operated by an aggressive company...is the only way you can be sure of being where you need to be when you need to be there.

A successful business today must rely more and more upon its own transportation methods.

And a Beechcraft is business transportation you can rely upon with confidence.

Beechcraft

THIS IS NOT A COUPON!

It's sort of an un-coupon. If it isn't a crime to cut up a page in National Geographic, it ought to be!

However, we'd be delighted to send you full information about the Beechcraft Baron 58. Just write on your letterhead to Beech Aircraft Corporation, 9791 E. Central, Wichita, Kansas 67201, U.S.A. You'll be glad you did.