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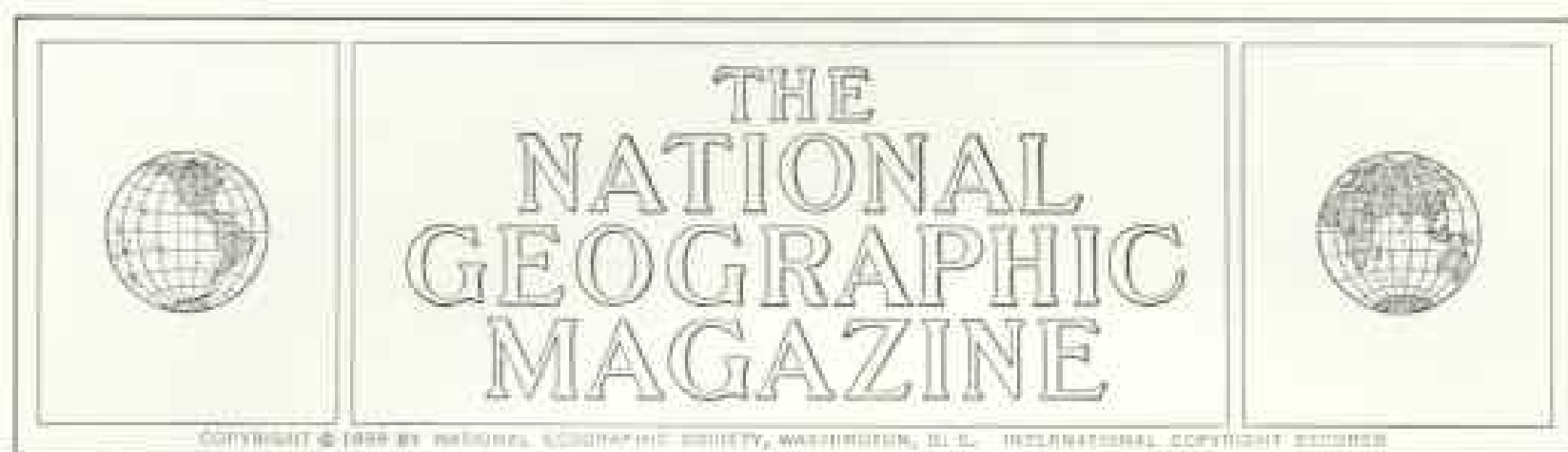
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*Islands drowsing in the sun track flaming rockets
down the Atlantic Missile Range, a Space Age proving ground.*

Cape Canaveral's 6,000-mile Shooting Gallery

By ALLAN C. FISHER, JR., Assistant Editor

*With photographs by LUIS MARDEN and THOMAS NEBBIA
National Geographic Staff*

RISING from the distant edge of night, the thin pencil of flame arched past the North Star and headed southeast. Then, quite suddenly, the heavens exerted their magic. Behind the racing flame shimmered an enormous tail of light, pearly, opalescent, for brief moments tinged faintly with green, a luminous veil miles long across the darkness and the stars.

East of my vantage point on Grand Bahama Island the cometlike tail streaked behind billowy clouds, lighting them eerily, only to reappear with undiminished brilliance. Yet its light seemed a delicate wraith of a thing, as weirdly beautiful as an aurora or the zodiacal light. Far to the southeast, a storm front extinguished the sight, and my companions and I turned away, feeling like men who had dreamed in color while yet awake.

An intercontinental rocket, the huge Atlas, touched off that spectacular display. Vaulting into space from Cape Canaveral, Florida, just over the horizon, the missile hurtled past

Grand Bahama at 15,000 miles an hour en route to its death plunge off distant Ascension Island in the South Atlantic. Atlas's high, scorching passage through remnants of air built a wake, like that of a ship sailing a phosphorescent sea.

Ascension, 5,000 miles from Cape Canaveral, anchors the Atlantic Missile Range, a Space Age proving ground stretching across a quarter of the globe. Along the unique flyway lie island tracking stations where technicians, intent at powerful cameras, antenna consoles, and banks of electronic gear, record missile performance (map, page 434).

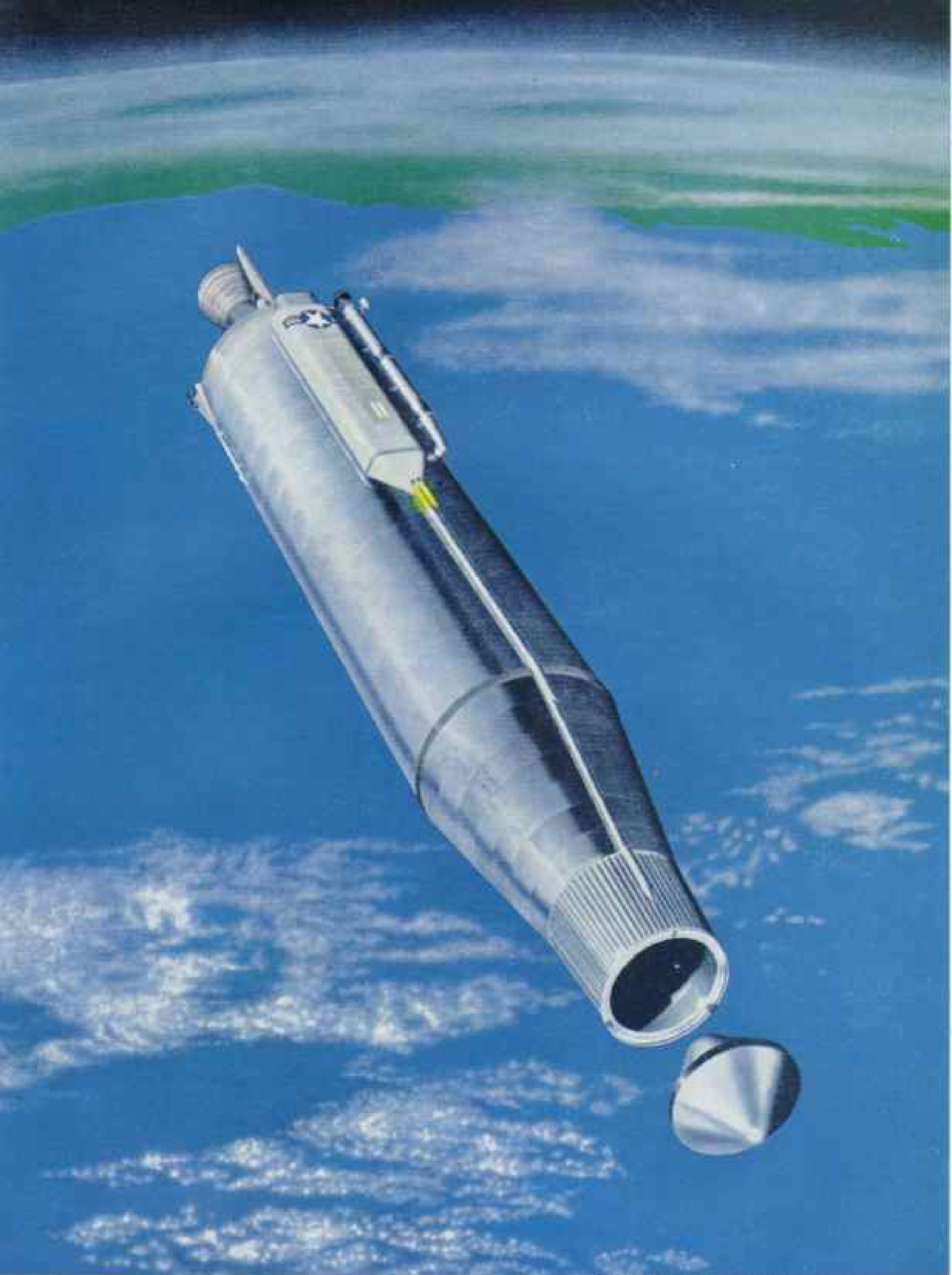
Grand Bahama is the first of 11 islands in the tracking chain. Musing in the soft subtropic night, I pictured Atlas's 6,000-mile journey down range: past the other Bahamas, dark smudges on the face of the sea... past the sleeping West Indies... high above the featureless Atlantic... and, finally, to a flaming, meteoric fall beyond terminal Ascension.

National Geographic photographer Tom



Ocean-spanning Atlas Ares Into Space
on a 30-minute, 6,000-mile Flight
From Cape Canaveral, Florida

Seconds ago the Air Force's intercontinental missile exhausted its fuel. Now, speeding 15,000 miles an hour, the spent engine sheds its nose cone some 200 miles above the Atlantic. Small braking rockets flaring on Atlas's decapitated



body aid separation; in this near vacuum no wind brushes back the flames. A few thousand yards apart at journey's end, the cone and its trailing "tankage" will plunge seaward beyond Ascension Island like blazing meteors. But only the cone,

PRINTED BY NATIONAL GEOGRAPHIC ARTIST GILBERT H. THREYER © N. G. S.
which carries data-recording instruments and their radio voice, will survive the torch of air friction. Storied subtropic isles—Grand Bahama, Great Abaco, Andros, New Providence, and Eleuthera—lie off Florida in this artist's conception.

Nebbia and I toured that island missile empire from its beginning to end, the only outsiders who have been privileged to do so. Luis Marden, a National Geographic veteran, accompanied us over most of the range. We spent three months at the task and logged a combined total of more than 40,000 wearying miles. At Cape Canaveral, officially Station No. 1, the all-important first link in the tracking chain, we saw a dozen missiles blast off in raging cataracts of flame.

The pyrotechnics above Grand Bahama, however, had been completely unexpected, an unusual display that typified for us the alien strangeness of space. Only a few rockets fired at night grow a tail, so to speak, and the cause of the phenomenon, though under study, remains mysterious.

Some scientists believe a ballistic missile may trigger a release of energy in the electrically charged ionosphere—provided condi-

tions 200 miles up and more happen to be just right. These experts theorize that the extreme speed and heat of an Atlas, for example, may strip electrons from vagrant air particles, causing the violated atoms to emit visible light.

Other scientists think the glowing wake may consist of a thin fog of exhaust gases, but they are at a loss to explain why some rockets and not others should create the effect.

Few Men Witness Glowing Wakes

Only men on the northernmost isles ever see the diaphanous tails of light, which cannot be viewed from Cape Canaveral and vanish when the rockets exhaust their fuel, usually off San Salvador. Most missilemen have never witnessed the sight or even heard of it.

Atlas's swift passage from Florida would last only 30 minutes, but I knew it had been carefully planned for months and had involved the work of 2,500 men in prelaunch preparations, firing, and tracking. Yet Cape Canaveral shoots many missiles of various kinds each month, and the complex teamwork has become routine.

The range's 18,000 workers subject that last and greatest frontier, space, to day-and-night assault. They strive, primarily, to perfect weapons, but these are men who believe that attaining the stars, one day, is not so wild a dream. So, with far-ranging probes, satellites,

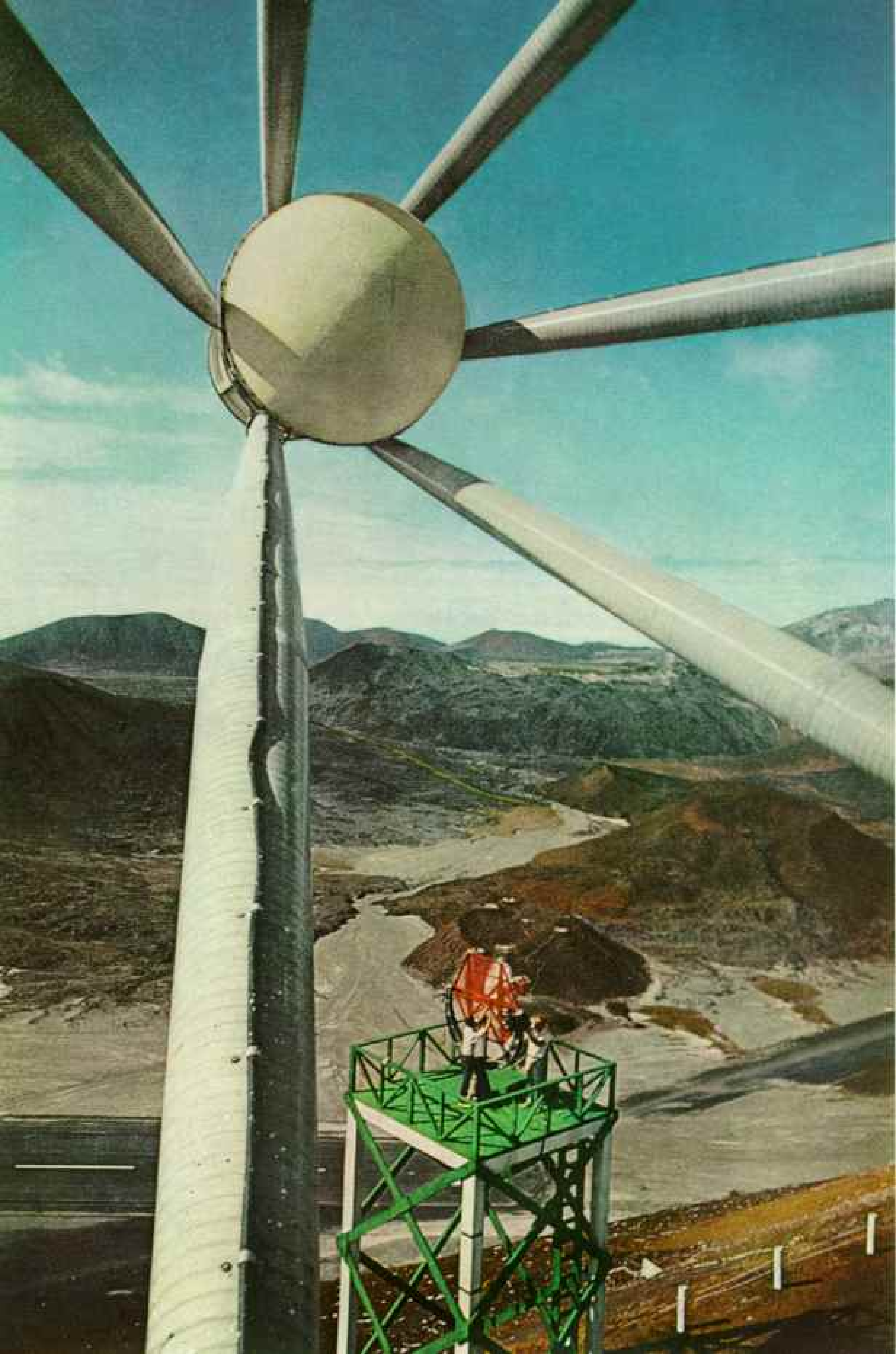
Bulbous Eye in Metal Spider Web Follows Missiles Homing Near Ascension

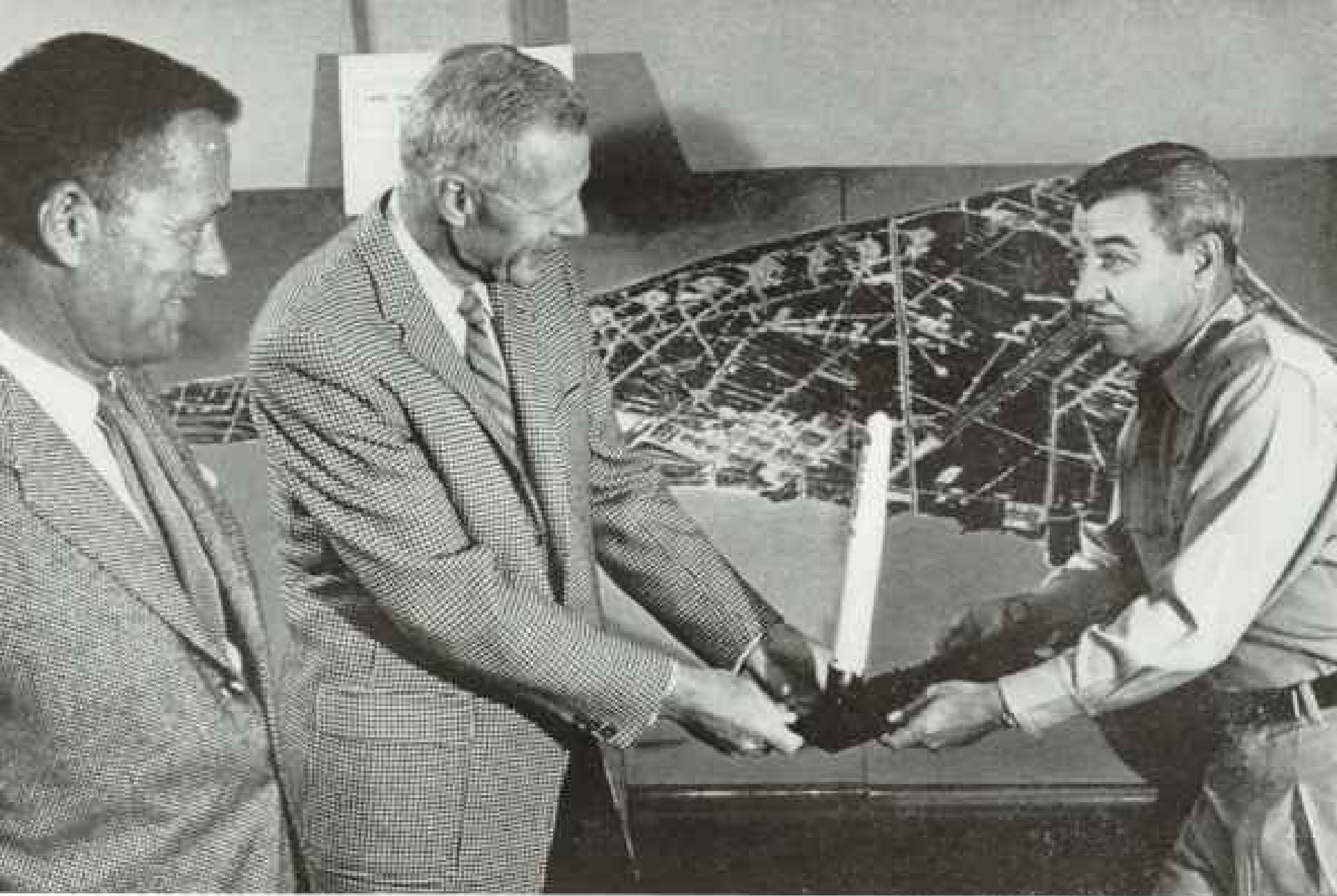
Giant arms support the sphere, an instrument package, before the face of a disk-shaped antenna 60 feet in diameter. Waiting 5,000 miles from Cape Canaveral, the antenna starts gathering Atlas's radio signal when the missile is still hundreds of miles distant. Instruments in the eyelike sphere break down the signal into many separate frequencies, each describing some phase of the rocket's performance. Trackers record the information, which is known as telemetry data.

Men on the tower check a smaller telemetry antenna overlooking Ascension Island's airstrip, ash-heap hills, and cinder cones (page 458). Bleak Ascension anchors the Atlantic Missile Range's chain of island tracking stations.

Identical 60-foot antenna shows its bizarre profile on Antigua, Station 9.1 in the tracking chain. Three of these powerful instruments, including one at Cape Canaveral, cover the length of the range. Each stands more than seven stories high.







NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS BERRY

A Three-man Team From Air Force and Industry Runs the Missile Range

To date the Nation has invested \$500,000,000 in building and equipping the tracking system, which employs 18,000 workers. Pan American World Airways operates it under Air Force contract, and RCA Service Company records signals from the racing rockets. Maj. Gen. Donald N. Yates, the range's commander, accepts a Thor model from his principal aides, Kenneth M. McLaren, RCA vice president (center), and Richard S. Mitchell, Pan American vice president. Relief map shows Cape Canaveral.

rocket-riding monkeys, and other experiments, they also pursue the goals of peace.

Like Caesar's Gaul, the Atlantic Missile Range can be divided into three parts: a 15,000-acre testing and firing reservation carved from Cape Canaveral's scrubby brush; an administrative headquarters at crowded Patrick Air Force Base, 18 miles south of the launching sites; and the down-range stations on drowsy isles. Working together, one and inseparable, they comprise the largest and most important installation of its kind in the Free World.

Maj. Gen. Donald N. Yates of the Air Force, the range's commander, often refers to his charge as "a \$500,000,000 shooting gallery." This figure represents capital investment only; operating costs for fiscal year 1959 reached a whopping \$130,000,000.

But a shooting gallery that stretches between continents requires unusual services, many of them expensive. The range operates its own regularly scheduled, interisland airline and flies specially instrumented aircraft on

missile-tracking missions. The combined fleet totals 41 planes. General Yates also commands a navy—11 ocean-going tracking vessels, plus several smaller ships used in missile recovery and supply missions (page 467).

Traveling teachers, a chaplain, even an island-hopping barber, serve the various stations. The range has its own excellent medical corps and its own motion-picture service. Wisely, I believe, it spends \$100,000 a year on film rentals. Each station gives nightly shows in an outdoor theater, an essential morale builder at the lonely outposts.

Cape Transformed in a Decade

Imagine, for a moment, a desolate expanse of sand and snarled brush that juts out into the Atlantic like a bent elbow. Alligators bask in its swamps, snakes infest its undergrowth, birds of many species wing its air-lanes, and hordes of voracious mosquitoes drone in its thickets. Of human habitation, however, there are but few signs—a venerable lighthouse and several forlorn old houses.

That would be Cape Canaveral a decade ago.

Now visualize the Cape today, as I saw it from a low-flying aircraft. Along the ocean front, like robots in file, stand huge towers of skeletal steel—the missile gantries, or service towers. I count 15 major ones, each with its own concrete launching pad and, near by, a blockhouse for the launching crew. Many of these shelters, made of reinforced steel and concrete, look like massive igloos.

Gazing inland I see a broad ribbon—an air-strip—and beyond it a community of enormous buildings—missile assembly and check-out hangars. Here, there, seemingly everywhere, I glimpse smaller structures: bizarre, dome-shaped beehives housing tracking instruments, and squat buildings topped by strange-looking antennas. Paved roads, veins through the brush, connect the sites.

In the language of the military, a specialized tongue known as Pentagonese, the Air Force

has "cognizance" (supervision) of this Space Age laboratory and all its many dependencies. But a private company, Pan American World Airways, operates the range for the Air Force. A subcontractor, RCA Service Company, a division of Radio Corporation of America, provides technical know-how and the skilled "bird watchers," or missile trackers.

Instruments Track Rocket's Every Move

A ballistic rocket is one of man's most complex creations. Its electronics system alone may contain 37,000 items; these, plus several hundred thousand other parts, must function perfectly. If they do not, engineers must determine where the failure occurred.

RCA's bird watchers supply a host of clues to the mystery. Their complex precision instruments yield such information as missile temperatures, pressures, course, velocity, altitude—often more than 16,000 individual read-

Helen Mann Feeds Mathematical Data to an Electronic Brain

Mrs. Mann, employed by RCA, once confounded television's "What's My Line?" panelists, who failed to guess her occupation. Holder of two degrees in physics, she helps prepare complicated test data for analysis by computers. Here she issues instructions to FLAC (Florida Automatic Computer) at Patrick Air Force Base.

NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS BERRIE





STUDIOS (PROVE) AND ASSOCIATES © N.Y.

Tension generated by a countdown reflects in the faces of men monitoring blockhouse instruments.

Pioneer IV Blasts Off on a Voyage Past the Moon

On March 5, 1959, this four-stage rocket roared up from Canaveral with a 13.4-pound satellite in its nose. Forty-one hours later the payload passed within 37,000 miles of the moon, then swung into orbit around the sun, where it may endure as long as the solar system. The moon was neither full nor visible at take-off time. Luis Marden photographed moon and rocket separately, creating symbolic double exposures on the same film. Billows of smoke at lift-off (below) characterize Army's

428 Jupiter, *Pioneer IV*'s first stage. Turbine exhaust (opposite) spews flame from the rocket's side.





ings for each minute of a 15-minute flight.

This intensive scrutiny begins before the rocket lifts from its pad. Consider, for example, one of the launchings I witnessed, that of a two-stage Thor Able designed, not as a weapon, but as a tool for long-range tests of missile nose cones.

Dismal clouds covered the Cape that night, and rain pelted me in gusts as I stood near a roadblock. T-time, the scheduled moment of firing, had been delayed more than an hour by range safety officers, who require a certain minimum ceiling of visibility for each test. But the countdown had gone well, and the rocket stood poised and ready for its journey past Ascension.

Minutes later the elements relented, a big hole opened in the overcast, and the Thor first stage, gushing incredible fire, pushed its burden up, up, up, while the lightning of its engine reflected blindingly from the surrounding clouds. I had witnessed other successful launchings, but, as always, the beauty and perfection of the sight moved me deeply and sent my imagination soaring.

Seconds before first-stage ignition, remotely operated cameras on the firing pad began taking pictures at a rate of more than 1,000 frames per second. As the rocket fled, cameras elsewhere on the Cape established its position to an accuracy of a few inches. Theodolites, accurate to 30 feet at ranges up to 15 miles, also eyed the sprinting missile.

Electronic Brain Computes Position

Big radars, powerful enough to follow the flight of a baseball 88 miles away, locked on to Thor Able. An intricate electronic device picked up its radio tracking beacon and fed it to a computer, which disgorged 10 position reports per second. Meanwhile, another radio signal provided telemetry data, a continuous stream of information on conditions inside Thor Able, where instruments monitored 175 separate functions.

Resurgent clouds soon covered the hole in the ceiling, but I knew Grand Bahama Island had joined the tracking. Successively, other islands would take over the job.

Guidance systems "program" all test missiles down range. The celebrated moon rockets, however, take a different trajectory. A special antenna at Mayagüez, Puerto Rico, is the only instrument on the range that tracks the payload (page 446).

An earlier article introduced NATIONAL

GEOGRAPHIC readers to these probes of deep space.*

At that time complete success could not be reported, but more recently, on March 3, 1959, *Pioneer IV* blasted off on a trip past the moon and into orbit around the sun (pages 428-9).

Luis Marden and I saw that historic launching. Later, during star-filled nights in the islands, Luis would shake his fist at those distant beacons, Mars and Venus, and exclaim jubilantly, "We'll get you both, you rascals!" Venus and Mars definitely are on the space probe agenda. The optimum time for a probe of Mars is October, 1960, and for Venus, January, 1961.

Be Careful of That Word "Failure"!

Sometimes the island trackers wait patiently for rockets, only to learn, after long "holds" in the countdown, that technical difficulties forced a cancellation. At other times they get word that their quarry met a flaming death above the Cape. Headline readers interpret the missile's destruction as a complete failure for the test—a natural, but mistaken, impression. In explanation, I can cite a revealing incident from my own experience.

Again I am at a roadblock. Less than half a mile away stands an Atlas, its golden flanks gleaming in the sun, oxygen vapor pluming from its sides. Suddenly flame stabs from its tail and waxes with furious energy. Ponderously the rocket moves upward. Almost immediately, however, while still climbing, it drifts to the south, where only five miles away houses begin. Fire blossoms along the missile's sides, engulfs it, and someone shouts, "She's coming down!"

An explosion, triggered by a radio signal from the range safety officer, rends the mortally stricken creature and fills a huge area of the sky with debris. Hastily, impatient at my fumbling fingers, I shoot pictures, take one last look at the flaming wreckage, now arcing nearer, and dive beneath a truck. Photographer Nebbia, true to the traditions of his profession, remains at his post, but our lanky escort, Capt. Thomas H. Burlison, joins me.

"Would you move over a bit, please?" he asks with drawing-room politeness. "I can't quite get under."

Luckily a strong wind carries the rain of

* See "Reaching for the Moon," by Allan C. Fisher, Jr., NATIONAL GEOGRAPHIC, February, 1959.



NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS HEDDIE

Cape Canaveral Yields Tools of a Vanished Indian Tribe

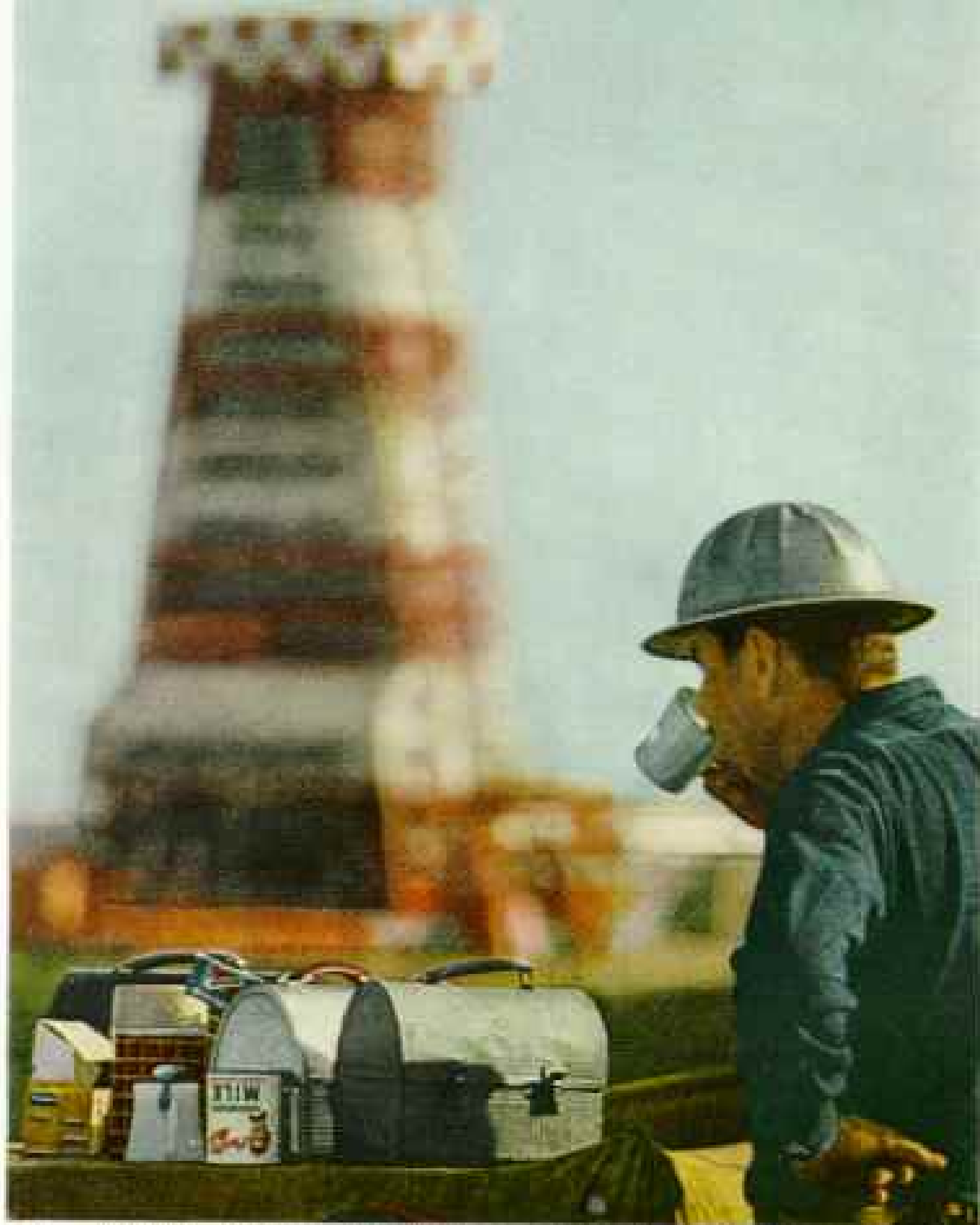
Bulldozers that cleared rocket firing sites unearthed abundant evidence of Cape Canaveral's early residents. Marvin H. Sears, a captain in the Cape's security police and an amateur archeologist, picked up hundreds of pre-Columbian artifacts from the disturbed earth. With his wife and daughters, he examines part of his collection. Many of his prizes are shell instruments for cutting meat, scraping skins, and opening clams and oysters. Others include bone awls, spear points, and stone arrowheads.

wreckage far down the road. There it touches off a number of brush fires, spectacular but soon extinguished.

This test happened to be one in a series of puzzling Atlas mishaps immediately after take-off. But a minute study of pictures made by the automatic pad cameras revealed a flaw. A complete test failure? Not from a missileman's point of view. It told him what he wanted to know.

The lesson is even more pointed in other instances. General Yates, who combats the "failure" impression with the zeal of an evangelist, explains:

"Actually, many successful tests terminate in so-called failures, either by design or accident. We may deliberately push a missile beyond tolerances for the purpose of determining the failure limit. Or perhaps some flaw terminates a test, yet we get 95 percent

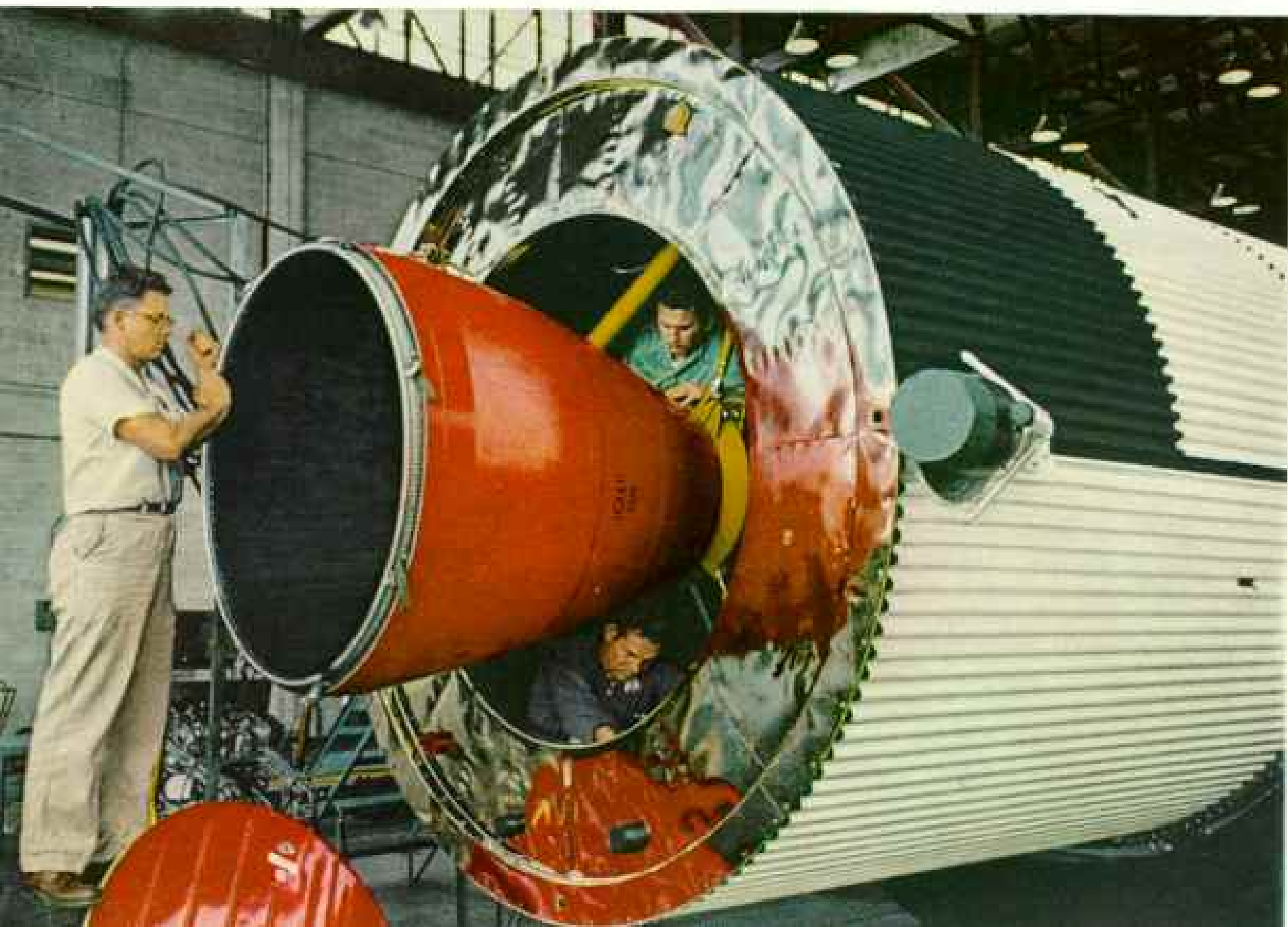


Missileland, Too, Has Its Coffee Breaks

This man, who works on the Titan project at Cape Canaveral, sips coffee near a candy-striped Atlas gantry.

Technicians adjust a red shield that protects the bell-like rocket nozzle of a Jupiter undergoing checkout procedures in the hangar. Delicate tubes hidden beneath the shield encircle the nozzle. Fuel, acting as a coolant, circulates through the tubes before entering the combustion chamber; otherwise temperatures exceeding 5,000° F. would melt the nozzle. A heat-reflecting, gold-plated flange encircles the casing.

432 PHOTOGRAPHS BY THOMAS HERRIN (LEFT) AND LEO WARTEN, NATIONAL GEOGRAPHIC STAFF © N.G.S.



of the telemetry information sought. We regard the test as 95 percent successful."

Sometimes, however, internal performance data does not reveal the cause of missile death, requiring an autopsy of the remains. When debris falls off the Cape, a wiry swash-buckler named Louis Berger sends ships to fish it out for examination. Crews may trawl for wreckage or raise it with the help of divers. Berger's men are proud of a better than 90 percent record of success in recovering vital pieces desired by engineers.

Salvagers Memorize Missile Parts

Often the divers work in water too murky to see, so they must learn to recognize various missile parts by touch. Vernon Nealey, strapping young salvage master, takes the men to hangars, where they examine missiles, feel, heft, and memorize many parts. During one such session an engineer exclaimed with mock indignation, "We haven't even flown this bird, and you blasted undertakers are measuring it for a coffin!"

"Undertakers" the salvage men have been known as ever since, but they accept the title proudly. Evidence they brought to the surface revealed why the first lunar probe exploded and why the Vanguard failed repeatedly in early attempts to launch a satellite. Their work also has resulted in vitally important modifications to other missiles.

Sharks and foul weather plague the undertakers, but a more bizarre hazard ages Cape firemen when they recover missile debris from the brush. Fires set by showering fragments, such as those from the Atlas, drive dozens of rattlesnakes into the open. Booted firemen fight two battles, one against flames, the other against scorched, angry snakes.

Wildlife Still Claims the Cape

Despite Canaveral's metamorphosis, other wildlife remains in residence. Workers often see rabbits and armadillos. Occasionally someone sights a wary bobcat. Gulls, vultures, hawks, and pelicans still abound. For the past four years Florida members of the National Audubon Society have scored record 24-hour bird counts from stations just outside the Cape's south gate.

Several times, immediately following night missile shots, I have seen flocks of killdeers circling about in the searchlight beams, crying distractedly. But they won't leave. Even a few alligators cling to their old habitat.

Last year members of an Atlas launch crew found a 10-foot gator sunning itself in the entrance to their blockhouse. No one dared go in until those reptile specialists, the firemen, lassoed the intruder and carted it off for release in the near-by Banana River.

Much of the missilemen's enthusiasm for their work, their feeling of identity with a stirring future, rubs off on the private citizens of Cocoa Beach. This booming small town, Missileland's unofficial capital, lies between the launching area and Patrick Air Force Base. Along "Motel Row" spacecraft in glaring neon advertise such spots as the Vanguard, Polaris, Sea Missile, and Satellite. At another popular hostelry, the Starlite, one may dine spacioously, let us say, while gazing at large murals of the solar system, the moon, and Mars, all eerily illuminated by ultraviolet light.

I soon learned to affect a blasé air when merchants and barbers spoke knowingly of such things as "meco" (main engine cut-off) and "veco" (vernier engine cut-off). But, when a waiter used the word "clunge," I appealed to friends for a translation. It's slang for an impressive but crowded array of electronic equipment—"a real rat's nest."

Pan American Puts Experience to Work

Visitors to Missileland often think it curious that a commercial air carrier, Pan American, should operate testing facilities for intercontinental weapons. The overwhelming atmosphere of "wild black yonder" exploration and conquest makes it seem even more curious, visitors observe. I confessed a similar reaction to Richard S. Mitchell, vice president in charge of Pan American's Guided Missiles Range Division.

"We're often asked why we got into this," he said. "But we have many years experience operating stations in remote areas. You may recall that we opened up the Pacific to air travel with stations at Guam and Wake.

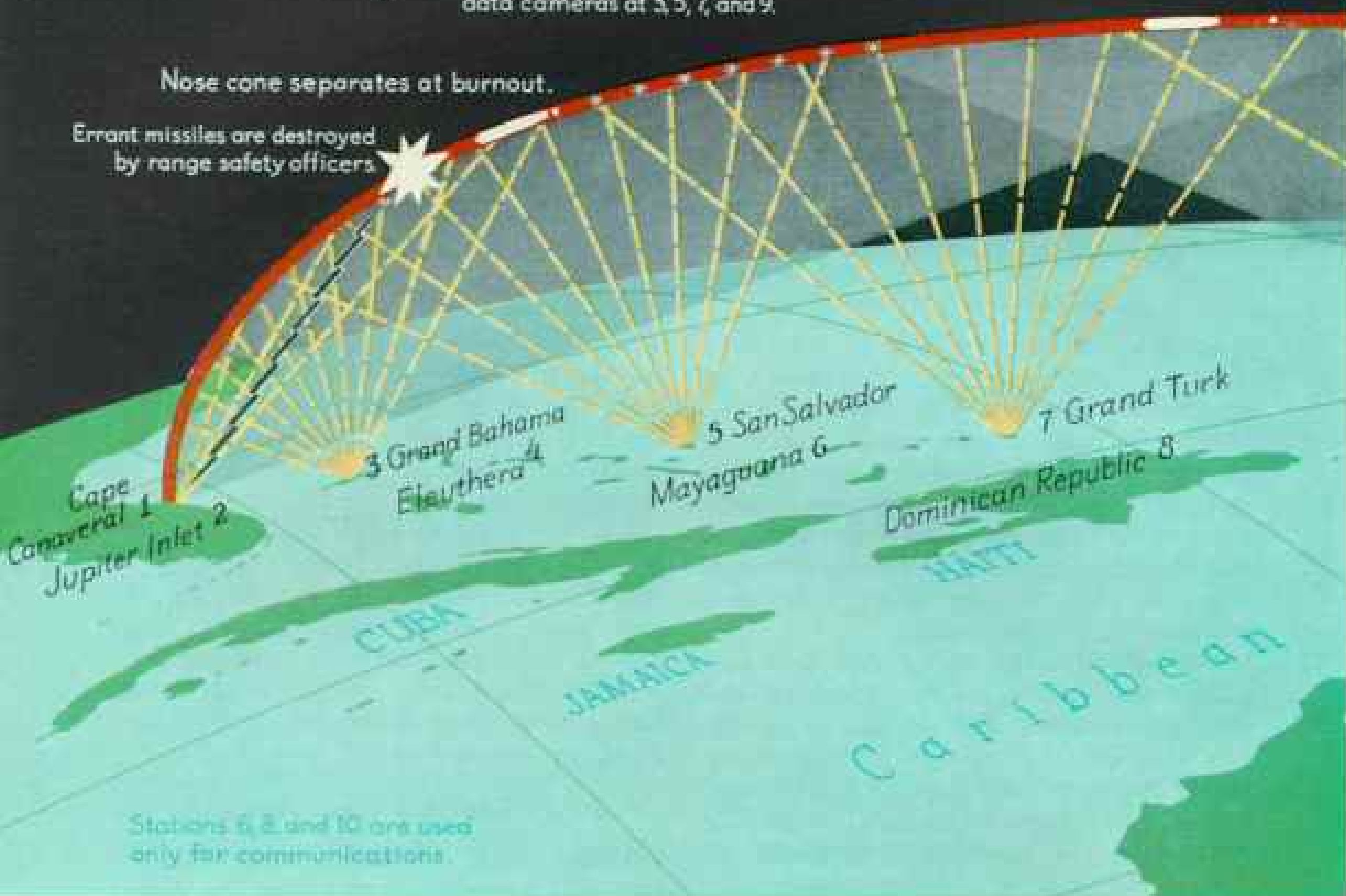
"Also, this work puts us in the vanguard of new techniques that eventually will be used by the airlines. For example, we understand missile properties and instrumentation. It's not too dreamy to think in terms of boost-glide transports; in other words, of liners that would take off and arch into space under rocket power, then glide to their destinations."

Kenneth M. McLaren, the vice president who directs range affairs for RCA Service

Blinking missile lights are photographed against star background by precision data cameras at 3, 5, 7, and 9.

Nose cone separates at burnout.

Errant missiles are destroyed by range safety officers.



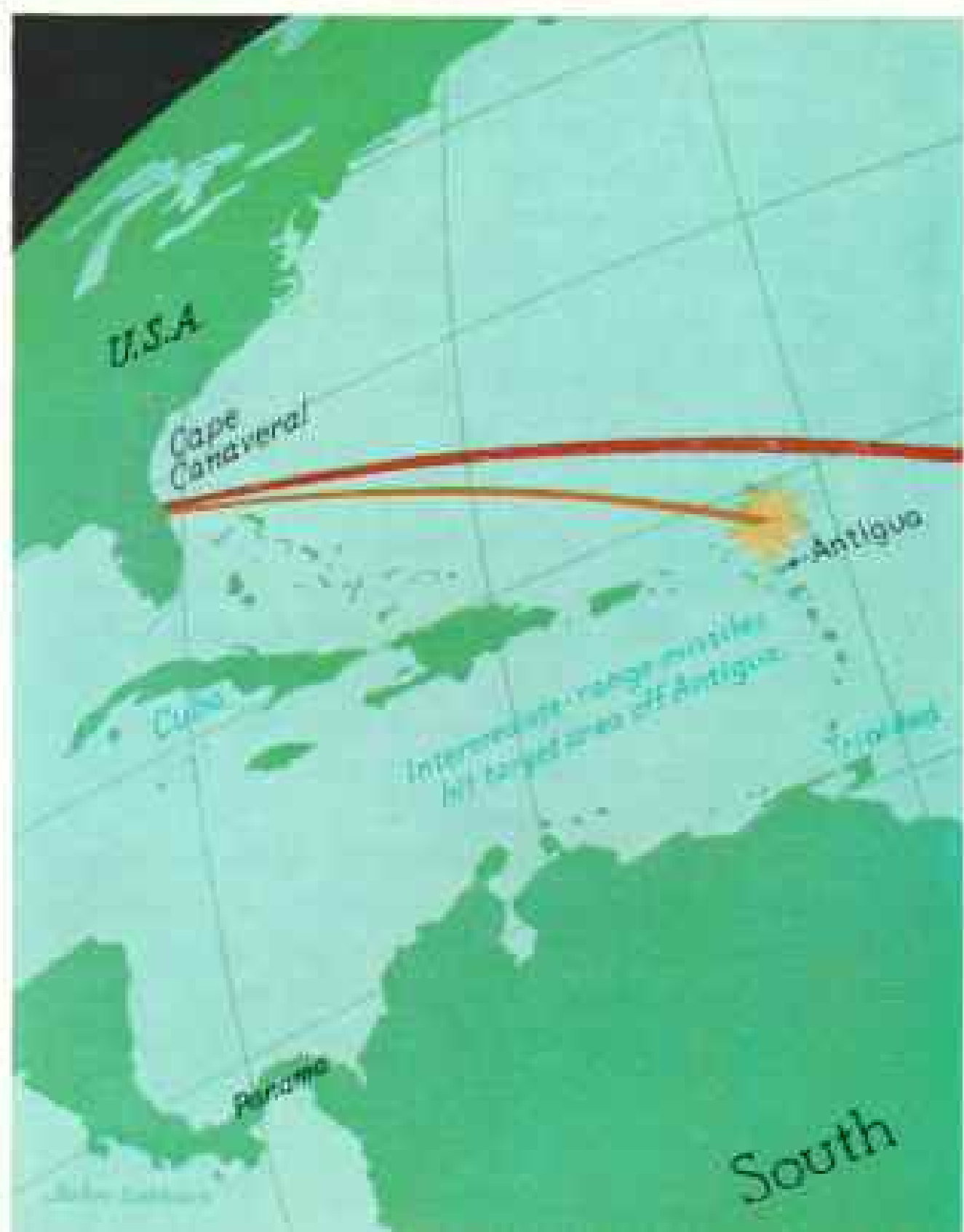
Atlantic Missile Range Spans a Quarter of the Globe

No other area in the world, experts have said, seems so well designed by nature for long-range missile testing. Open reaches of sea guarantee safety against mishaps. Sites in the Dominican Republic and on islands owned by British Commonwealth nations, Brazil, and the United States assure good tracking. A 15-minute flight may yield a quarter-million readings.

As a missile roars up from Canaveral, a complex electronic system picks up its tracking beam, plots its course, and predicts its impact point up to 5,000 miles away with lines moving on screens before the eyes of the range safety officer. If the rocket veers off course, the officer presses a button, a radio command flashes up, and the missile explodes.

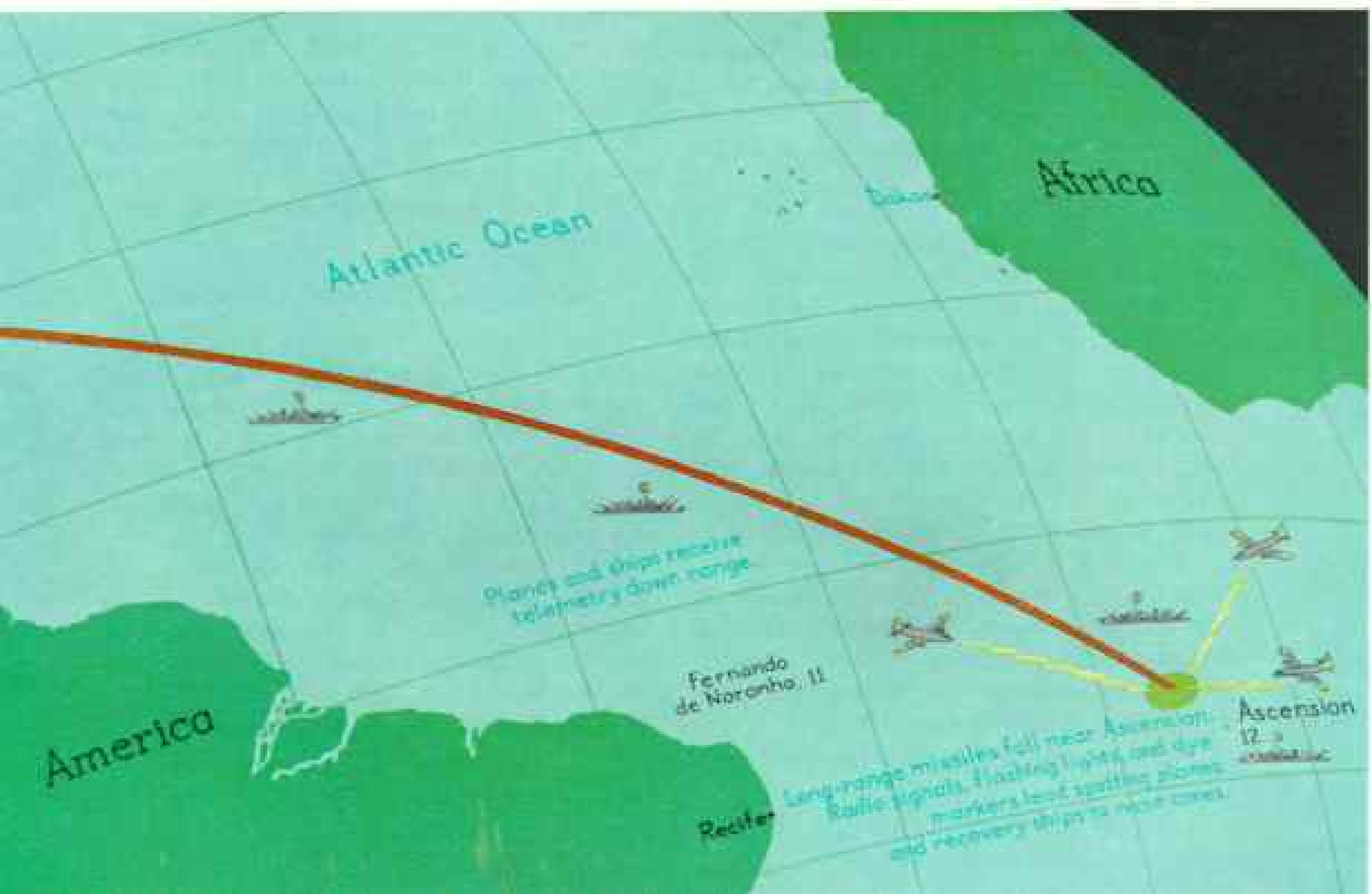
Diagram of the range's northern third (above) shows an Atlas in flight above the main tracking systems.

Ships and aircraft crammed with electronic gear fill gaps in the range's southern sector and at times extend coverage beyond Ascension.



Radar (yellow lines) tracks missiles and provides trajectory data.

Huge telemetry antennas at Canaveral, Antigua, and Ascension bracket entire range (blue shading), follow missiles automatically, and collect performance data.



Company, pointed out that the amiable partnership of two experienced contractors offers several advantages to the military services, which share use of the range.

"It relieves the military of a lot of business and administrative headaches and the need for putting uniformed men in jobs that can be handled by civilians," he said. "If you did use military men, you would have to ask yourself, 'Can I train them and keep them long enough?'"

Of the range's 18,000 workers, Pan American employs 4,900 and RCA 3,100. Most of the remaining personnel work for missile makers and other contractors or hold Civil Service ratings, but the Air Force assigns 1,800 of its men to supervisory and support jobs. As Mr. Mitchell puts it, "Pan American doesn't 'run' the range; we do exactly what the Air Force tells us to do."

Like newly hired employees assigned to the islands, the National Geographic team bared arms for numerous inoculations, studied rules and regulations for down-range conduct, and sat through orientation briefings covering the entire chain.

Three Bases Have Limited Jobs

Two stations, Mayaguana and St. Lucia, are on stand-by status, and a third, in the Dominican Republic, has but 12 employees. These stations serve as communication relay points but otherwise are unneeded because of changes in tracking requirements. Population of the other bases varies from 98 at Eleuthera to more than 200 at Grand Bahama and at Ascension, busiest points on the range.

An Air Force officer commands each station, though he is usually the only military man there. His principal duty, liaison with local authorities, often requires the tact of a diplomat and the astuteness of a Philadelphia lawyer; additionally, if on an island not a part of the British Commonwealth, he must speak the local language fluently. The Air Force hand-picks these men with great care.

At times the commanders, all career veterans, feel like doddering grandfathers in the company of bouncy RCA employees, whose average age-down range is 28.6 years. Most of these employees learned a technical specialty during military service, then received additional training from their company. Base managers and other Pan American workers, who speak of their diverse du-

ties as "housekeeping," usually are older men, many with stateside families.

Employees of both companies must volunteer for island duty, and Pan American's large medical department, headed by Dr. Laurent P. LaRoche, screens them.

"To get away from one's wife is not considered a good reason for applying," Dr. LaRoche told me dryly, "although it is sometimes given in response to a question on our application forms. A quick stake is the big incentive."

Bonus and Tax Rebate Lure Workers

All but the Air Force commanders get a substantial monthly bonus over base salaries: 40 percent at the two most distant outposts, Fernando de Noronha and Ascension, and 30 percent elsewhere. Each man receives free room, board, and medical care, and Uncle Sam gives him an income tax refund if he remains out of the United States for 510 days during an 18-month period. Thanks to these inducements, employee turnover in the islands is not much greater than the normal rate on the mainland.

Trackers at Grand Bahama station, which lies only 180 miles from Cape Canaveral, delight in the climate but not in the island's terrain. Almost as flat as the sea, the rocky soil supports a green maze of thin pine trees, prickly undergrowth, and poisonwood, the latter a plant whose virulent touch makes poison ivy seem like balm. An American firm, Owens-Illinois Glass Company, reaps the pine to make paper containers, and rutted logging roads cut geometric patterns through the tangle. The isolated range base was carved from a woods on Grand Bahama's southern side.

Grand Bahama Tracks All Missiles

Cape Canaveral's proximity guarantees plenty of work for personnel. Target drones hunted down by Bomarcs, for example, and some other missiles do not go very far down range, but Station No. 3 "sees" them all. Much of its equipment and instrumentation is standard for all stations.

Twin radars locked on the Atlas that staged the magnificent show above Grand Bahama, described earlier. A compact computer, housed in air-conditioned comfort beneath the rooftop radars, accepted their tracking data and fed split-second position reports to

(Continued on page 445)

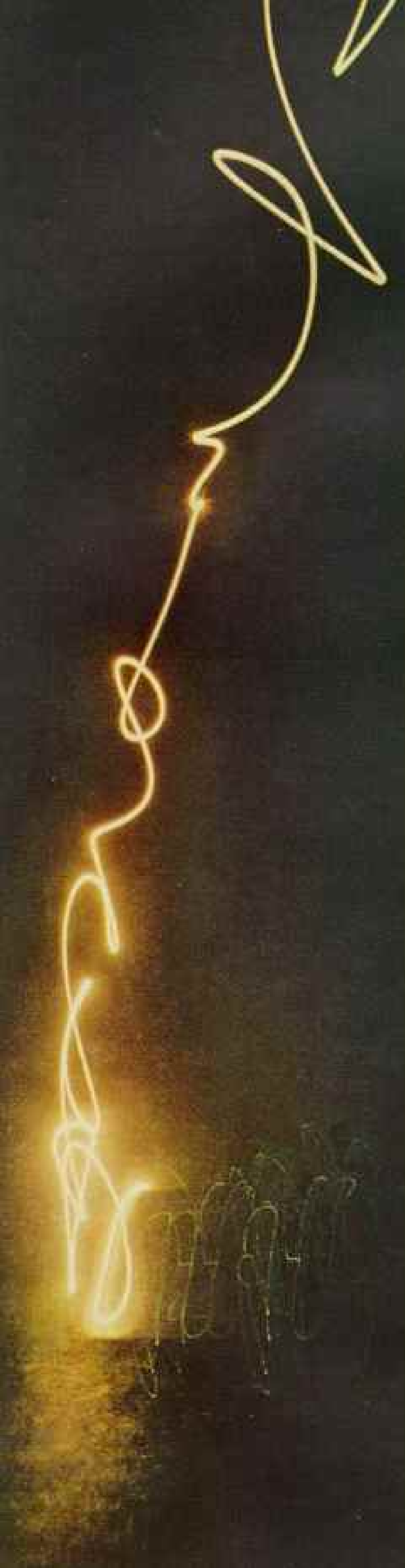
Bundled up, Roy Merrow of the Thor Able project wears a heavy flight jacket and a wool scarf around his plastic safety helmet. His telephone communicates with other workers on an 11-story gantry at Cape Canaveral, where winter temperatures sometimes skid to the frost zone.

Pioneer IV Space Probe Exhales Chill Plumes of Oxygen

In the last hours of the countdown, *Pioneer's* launch crew pumped tons of liquid oxygen into the Jupiter first stage. This oxidizer, mixing with a derivative of kerosene, powered the booster rocket. Solid fuels propelled three later stages and sent the instrumented payload into orbit around the sun (page 428).

Until T-time, the moment of firing, Jupiter vents evaporating oxygen to relieve internal pressure. Striking air, the cold gaseous oxygen forms heavy clouds of vapor.





A rocket seemingly gone mad ties knots in its fiery track. Braced on the deck of a rolling ship, photographer Marden opened his camera shutter as a Jupiter took off from Cape Canaveral. The missile rose on course, but camera motion played tricks in this Kodachrome time exposure. Seen from 2½ miles at sea, gantry towers trace thin loops of light at the lower right.

Intercontinental Titan blasts its launching pad with raging flame during a successful short-range test. This 90-foot Air Force rocket, larger and newer than Atlas, is designed to vault 6,300 miles. Liquid fuel powers its two stages.

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HEAT-SENSITIVE AND © NATIONAL GEOGRAPHIC SOCIETY



Navy's solid-fuel Polaris leaves a smoky wake as it streaks into a flawless Florida sky. Specially designed atomic submarines now being built will patrol the seas with Polaris, an intermediate-range missile that can be launched under water.

Atlas spews fire taking off November 28, 1958, on its first full-range flight of more than 6,000 miles. Other long-range rockets have two or more stages that fire in sequence. Atlas carries a main engine and a twin-chambered booster engine but only one fuel tank, enabling power plants to fire simultaneously and eliminating risk of ignition failure by a second stage miles above earth.

BOACORNE (RIGHT) AND OTHER PHOTOGRAPHS BY LUIS BARROW © W.E.B.

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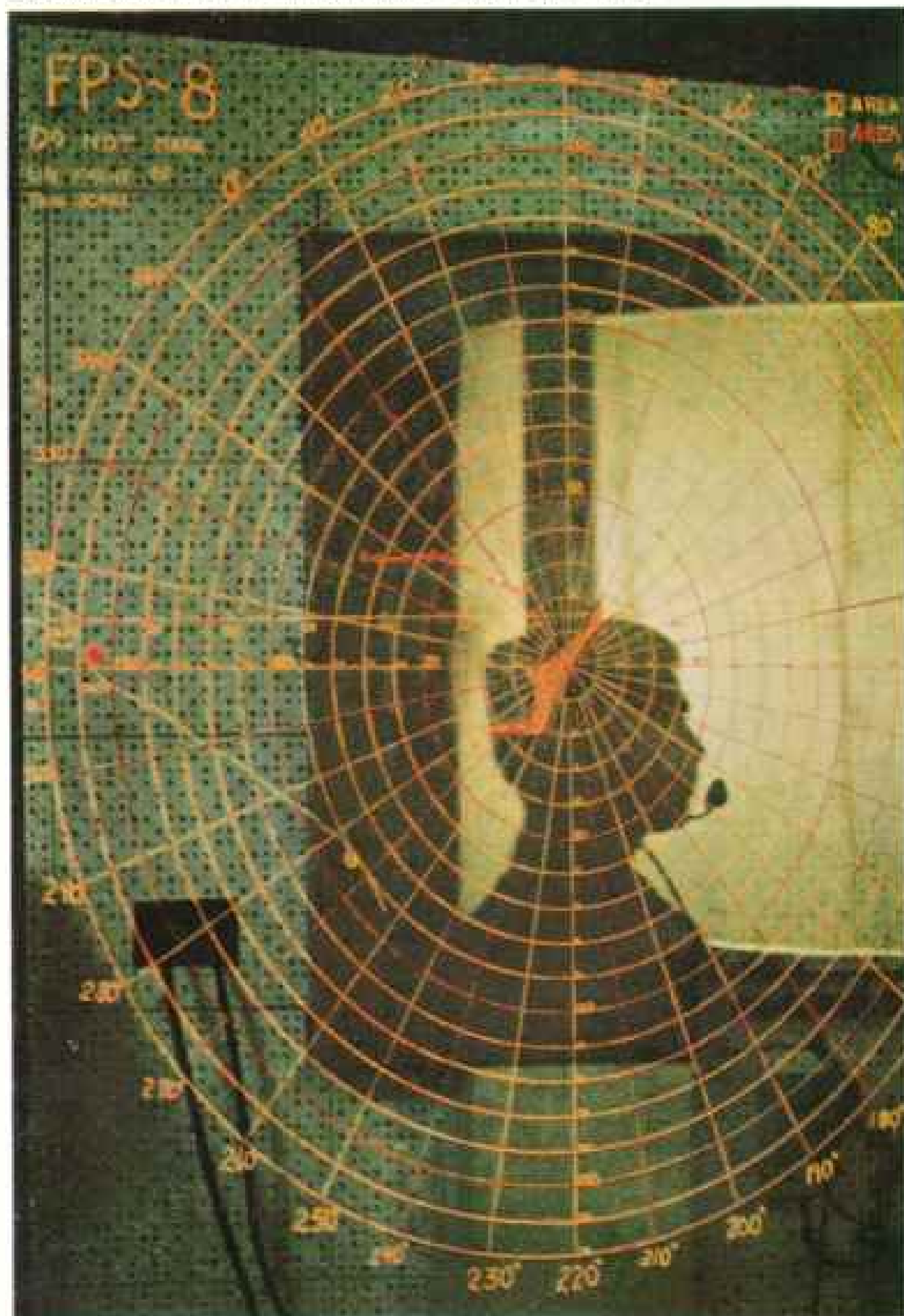


Goggled Diver in 90 Feet of Water Clutches a Submarine Cable, the Missile Range's Lifeline

Stations as far away as Mayagüez, Puerto Rico, share this submarine link with Cape Canaveral. Over the "pipe," as range personnel call it, flow voice and teletype messages and electrical impulses that translate into missile performance data. Now 1,300 miles long, the cable is being extended an additional 500 miles to Antigua.

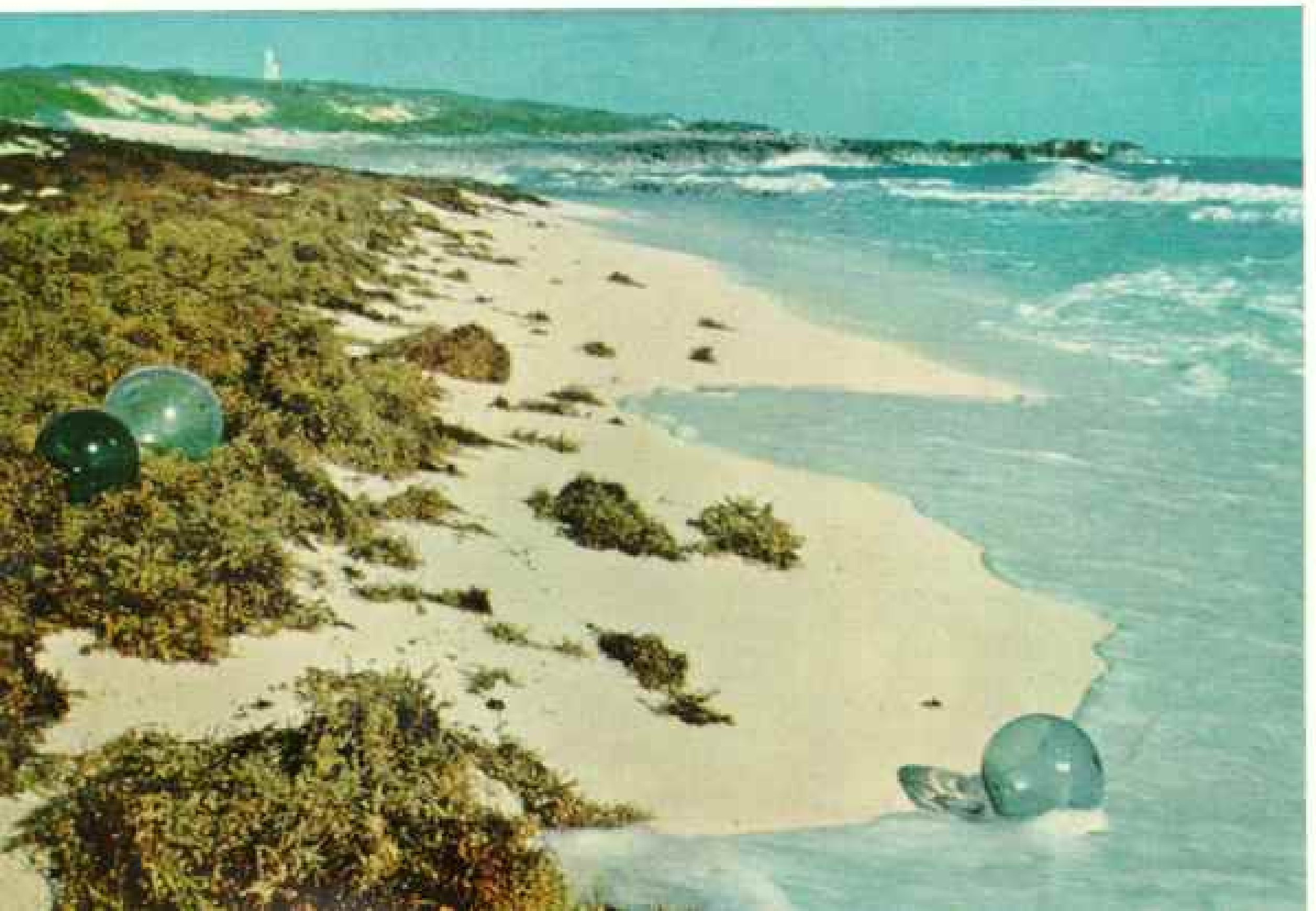
Here the cable leaves San Salvador. Not far away it snakes over a 300-foot cliff to a drowned ledge, then plunges 3,000 feet to the ocean floor. Russ Howard, president of the Water Wrigglers, San Salvador's diving club, hovers above a coral head. Bucket-shaped orange object is a sponge.

ARCADE PHOTO (BELOW) AND BUDACHROME (LOWER LEFT) BY THOMAS HERRIS AND BUDACHROME (UPPER LEFT) BY LUIS WARDEN, NATIONAL GEOGRAPHIC SOCIETY © N.G.S.



Huge telescopic camera on San Salvador takes motion pictures of missiles and satellites arching through space. The lens-and-mirror system, called ROTI (Recording Optical Tracking Instrument), gives the camera a focal length of 500 inches. ROTI can read letters four inches high at a distance of eight miles.

Transparent chart at Grand Bahama plots radar-detected ships and aircraft. Areas surrounding the island must be cleared before missiles are fired from Canaveral. The grid reflects the operator, microphone at his lips. Red line at center traces an approaching plane.





Grand Turk Sleeps in a Turquoise Sea

This island, which has but one village, extracts salt from sea water by evaporation. The U. S. base lies to the left of the large salt pan at the near end.

Glass balls, bedded in sargassum weed on San Salvador, drifted from Portugal, where fishermen used them as net floats. Prevailing winds and currents that wafted them also influenced Columbus's first landfall, believed by many to be San Salvador. Distant monument honors him; the *Chicago Herald* erected it in 1891.

Wives may join missile-tracking husbands on some of the islands. David Donaldson, RCA manager at Grand Bahama, and his wife live in this beachside trailer. Here she talks to Stan Monfette, who, with Donaldson, owns the light plane. They frequently fly it to Miami.

EDUCATION BY THOMAS KEEFE
LEFT AND BELOW AND LOTS BEHIND,
NATIONAL GEOGRAPHIC STAFF © N. G. S.

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plotting boards, where automatic pens traced Atlas's course. At other sites sensitive helical spirals of telemetry antennas tuned in the missile as it narrated its own performance. On tiny near-by isles cameras with powerful lenses photographed its tail flame against a backdrop of stars, whose known locations helped in pinpointing Atlas's position.

Some of the information flowed instantaneously back to Florida on the range's submarine cable, which links stations as far south as Mayagüez and carries a time signal that synchronizes their instruments (page 440). Tapes and graphs made a permanent record of thousands of readings. Aircraft whisked this raw data, together with records and photographs from other stations, back to Patrick. There the Technical Laboratory, after analyzing the information with the aid of huge computers, issued a test report almost as thick as a big city telephone directory.

Hobbies Occupy Idle Hours

During off-duty hours the men at Grand Bahama, as elsewhere, can swap yarns in a pleasant club built with their own money, shoot pool, war at ping-pong, or play outdoor sports with equipment provided by Pan American. Yet time often weighs upon a man, and his capacity to resist boredom, supervisors told me, may depend upon his hobbies.

Ken Waltz, RCA communications manager at Grand Bahama, heads a group that builds and launches model rockets. Unluckily, I visited the island between shots, but Ken showed me part of a beautifully fabricated casing for his next creation. Stuffed with solid propellants, such as zinc and sulphur, the models erupt with a gratifying racket and often climb thousands of feet.

A young technician, giving a hammy imitation of a German rocket scientist, confided to me in a stage whisper: "Vee call ziss leader of ours Doktor Kenneth von Waltz. Der Cape fires rockets at us; vee fire der rockets back, ja!"

Waltz, who has worked on the range more than five years, also collects "thunderbolts," artifacts of greenish stone that the island's

prehistoric Indians used as club heads and scrapers. Made of basaltic rock, they are unlike all other stones on the island; migrant hunters or war parties probably brought them from South America. Waltz barterers for these trophies with island inhabitants—"locals" in range parlance—and he took me along on one such expedition.

We jeeped ages, it seemed, through sand, brush, and narrow trails that might have given pause to a goat, arriving finally at the cabin of kindly old "One-armed Joe." Joe, who had lost a bout with a shark in his youth, gave Ken several of the stones, then told me with a wrinkled grin how they got their name.

"Lightning it hit pine trees, go down in ground and form stones—t'underbolts. They come to surface zactly seven years later; we pick them up."

This pleasant fable, I later found, is universal in the islands, where many such celts are discovered.

Grand Bahama does contain one recreational oasis, the plush Grand Bahama Club, a hotel some 40 jolting miles from the base. Veterans, inventing a fiction for young single workers, occasionally spread a rumor that the "Nassau Nurses Association" or the "Florida Secretaries League" is convening at the hotel. The prank always works with some of the newer youngsters, who expectantly beeline for the hotel as soon as duties permit. Pretty girls do vacation there, enough of them to keep hope springing eternally in the base's lonely hearts.

Family Life Difficult at Bases

Some married men live with their families in trailers near the base (page 443). But Edward J. Jones, Pan American manager, told me that neither his firm nor RCA gives any help to men who want to bring wives and children. Indeed, the companies discourage the men from taking families to San Salvador, where conditions are primitive, and forbid families at remote Fernando de Noronha and Ascension. Housing, medical care, and schooling for dependents prove troublesome—and then there is the problem of babies.

Missile Families Call Eleuthera the Country Club of the Range

Green and fertile, with long stretches of gleaming beach, the island supports luxury hotels, an exclusive golf club developed by wealthy Americans, and many attractive private homes. Twenty-one missile-tracking families now live on Eleuthera. This group picnics at sunset beneath a casuarina tree near the United States base.



Nylon dome transparent to radio waves houses an ultrasensitive receiving antenna at Mayaguez. The antenna tracked *Pioneer IV* 104,000 miles toward the moon.

Within the dome, air pressure supports the girderless structure as it would a balloon. Men enter through an airlock.

The 10-foot dish gathers radio signals that yield position and performance data. Unique on the range, the instrument is operated by the National Aeronautics and Space Administration as part of its worldwide probe-tracking network.

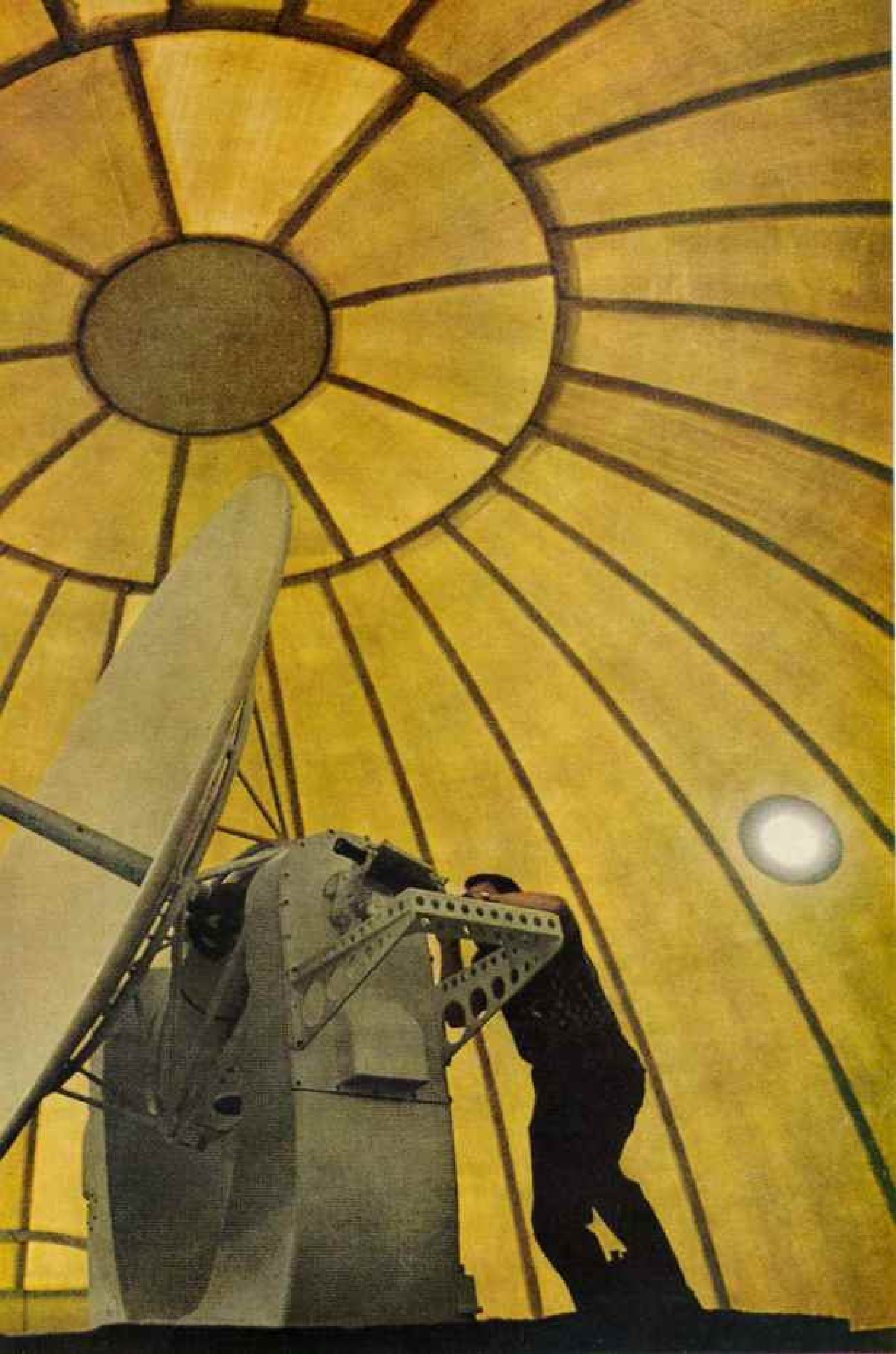
Sighting a target through a porthole, the technician aligns the antenna's optical and electronic axes; he leaves the device unattended while it is operating.

Youth is accented down range. Raleigh Tremain, Jr., works at Mayaguez.



SENER ANSICHTSREI BY THOMAS REEDER (1959)





Jane Donaldson and her husband, RCA instrumentation manager at Grand Bahama, once had to bundle a prematurely expectant wife aboard their private plane and race the stork to Miami. They landed in the early morning, only to be held up by a customs inspector, who thought their blanket-swathed cargo looked suspicious.

"Those forms of yours always ask where people were born," snorted Jane. "Well, you're going to know precisely where that lady's baby was born if you don't let us go."

Visibly shaken, the inspector hastily released them, and they beat the stork to the hospital.

Eleuthera, Station No. 4, contrasts sharply with Grand Bahama, both in beauty and in conveniences for families (page 444). Seldom have I seen an island so lovely. It is now experiencing a resort boom that, the British confidently expect, will make it "a second Nassau." * A retired Broadway actor, Craig Kelly, built French Leave, a luxury hotel; Arthur Vining Davis, Miami multimillionaire, backed the posh Rock Sound Club; Juan Trippe, Pan American's boss, headed a group that recently bought an exclusive golfing resort at Cotton Bay.

With money pouring into the island, lots facing the blue-green sea now sell for \$95 to \$200 a front foot.

Base Commander Creates Good Will

The base itself stands on a breeze-swept knoll overlooking the sea. It was established to track jet-powered Matador and Snark missiles; now, with the range emphasizing ballistic rockets, such as the Atlas, it is not very busy, although a new missile test program soon will increase its responsibilities.

Capt. Robert H. Reynolds, the commander, a gregarious soul, roams the island in his spare hours, visiting, chatting, making friends for his colleagues and his country. Roads near the base need repair? He will ask the Air

Force to authorize help. St. Patrick's Anglican Church is raising funds for a parish hall? Yes, it's okay to use the base's big recreation room for a charity dance. You fellows are building a chicken coop? Well, we have some big packing crates we can't use.

I spent one of the most pleasant hours of my trip swapping tall yarns in the back room of a country store with Reynolds and George Thompson, mayor of Gregory Town. George, a man of flashing wit, likes Reynolds, and he helps the base at every opportunity. Celebrities visiting Cotton Bay frequently drop by the back room to enjoy the cracker-barrel philosopher's colorful speech and irrepressible good spirits.

"Man, we redden the sky!" George laughed. In more serious vein he told me: "A man needs two things, freedom and happiness. If you've got them, what more do you need? Come back and stay awhile. We'll share them with you."

Time Stands Still on San Salvador

At San Salvador a marked contrast in islands again occurs. Except for the base and a single town, San Salvador remains virtually as undeveloped as when Columbus's three little vessels hove into view and joyously welcomed it as their first landfall.

Actually, some authorities—a small minority—credit that honor to one of the Caicos Islands, and men at the base debate the question endlessly. Their little newspaper, the *San Fly*, not given to crusades, says "presumably" it was San Salvador.

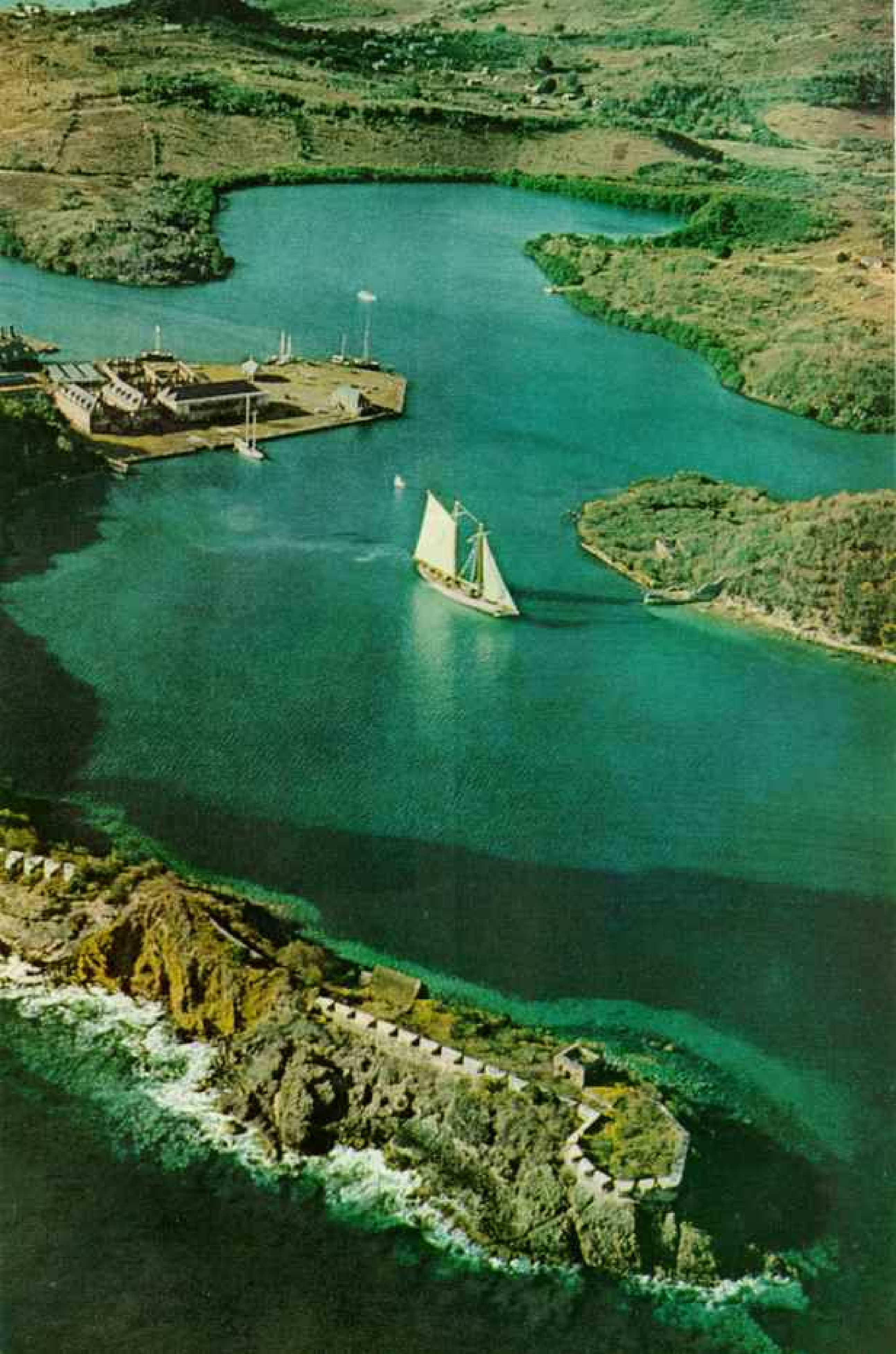
Three relatively small monuments, widely dispersed, yet each claiming to be the spot where Columbus landed, stand on the island's shores. The crew of a visiting yacht erected one, and a Chicago newspaper another (page 442). The third, a handsome white cross, is the handiwork of a group led by a New

* See "The Bahamas, Isles of the Blue-green Sea," by Carleton Mitchell, NATIONAL GEOGRAPHIC, February, 1958.

Antigua's Historic English Harbour Sheltered Horatio Nelson's Warships

For more than a century and a half British men-of-war used this landlocked finger of water as hurricane shelter, dockyard, and principal naval station for the Leeward Islands. Here, in 1784, came 26-year-old Captain Nelson for a three-year tour of duty. On near-by Nevis he wed a comely widow, Mrs. Nisbet, who was given in marriage by Nelson's comrade, William Henry, the sailor prince who became King William IV.

Restored, English Harbour now serves as a yacht basin. Men from Antigua's tracking station visit the site, rent boats, and explore its storied waters. The 134-foot schooner *Te Vega* sails toward the harbor entrance at old Fort Berkeley (foreground).

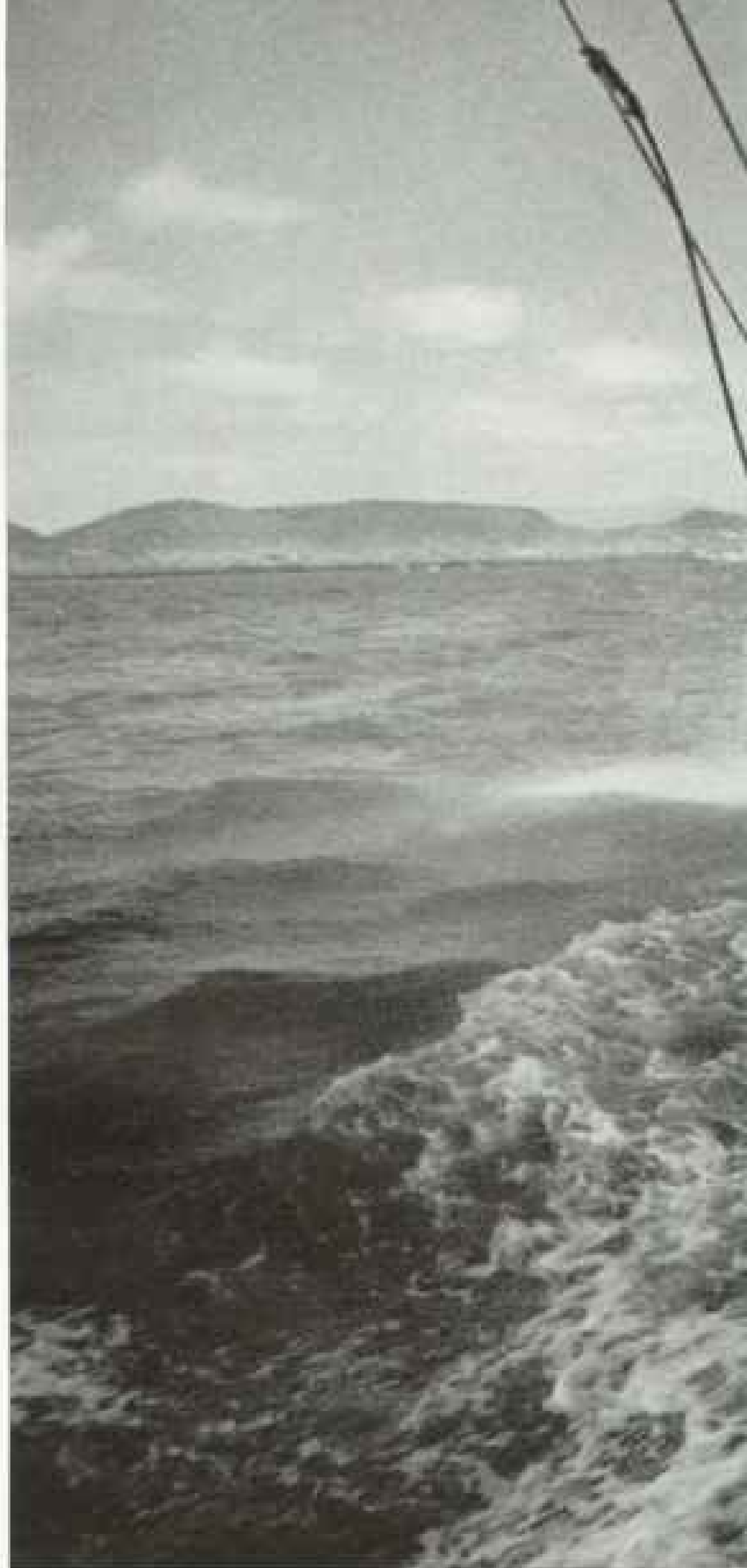


Missilemen Brace on the Heeling Deck of a Schooner off Puerto Rico

Feet against the lee rail, Sunday sailors enjoy a family outing aboard the 60-foot stay-sail schooner *Fairwind*, here driving close-hauled. Mrs. Henry Milstrey, wife of *Fairwind's* owner, is the mother of a missile tracker formerly stationed at Mayagüez.

The sun scintillates in the camera lens as *Fairwind* cleaves a sparkling sea.

NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS HERRIN



Yorker, Mrs. Seymour Wolper, who maintains a home on San Salvador.

Reaching the monuments by jeep, with Capt. Roy Lefstad, challenged both spine and nerves, as did the uphill trip to stone ruins where, local legend maintains, once lived buccaneer John Watling. John, who began his career as an able-bodied seaman, thought his captain should observe the Sabbath, so he incited a mutiny and clapped the skipper in irons. After leading the crew in devout prayers, he sailed happily off under the Jolly Roger.

Boredom strikes quickly on San Salvador. To combat it, many of the men sign up for schooling under one of their Pan American colleagues, Adolph C. Risko, a remarkably versatile University of Chicago graduate. He



conducts evening classes in college algebra, analytical geometry, German, Russian, symbolic logic, modern mathematical group theory, and physics.

At San Salvador, as at other stations, the men look forward to work-connected instruction by visiting teachers: RCA's Technical Training Office employs 16 of these traveling pedagogues. I met one of them, Joseph Shoebert, at Grand Turk, where he lectured to a packed house on astronomy and its relation to the optical tracking of satellites. Pan American also sends men down range occasionally to give management training courses.

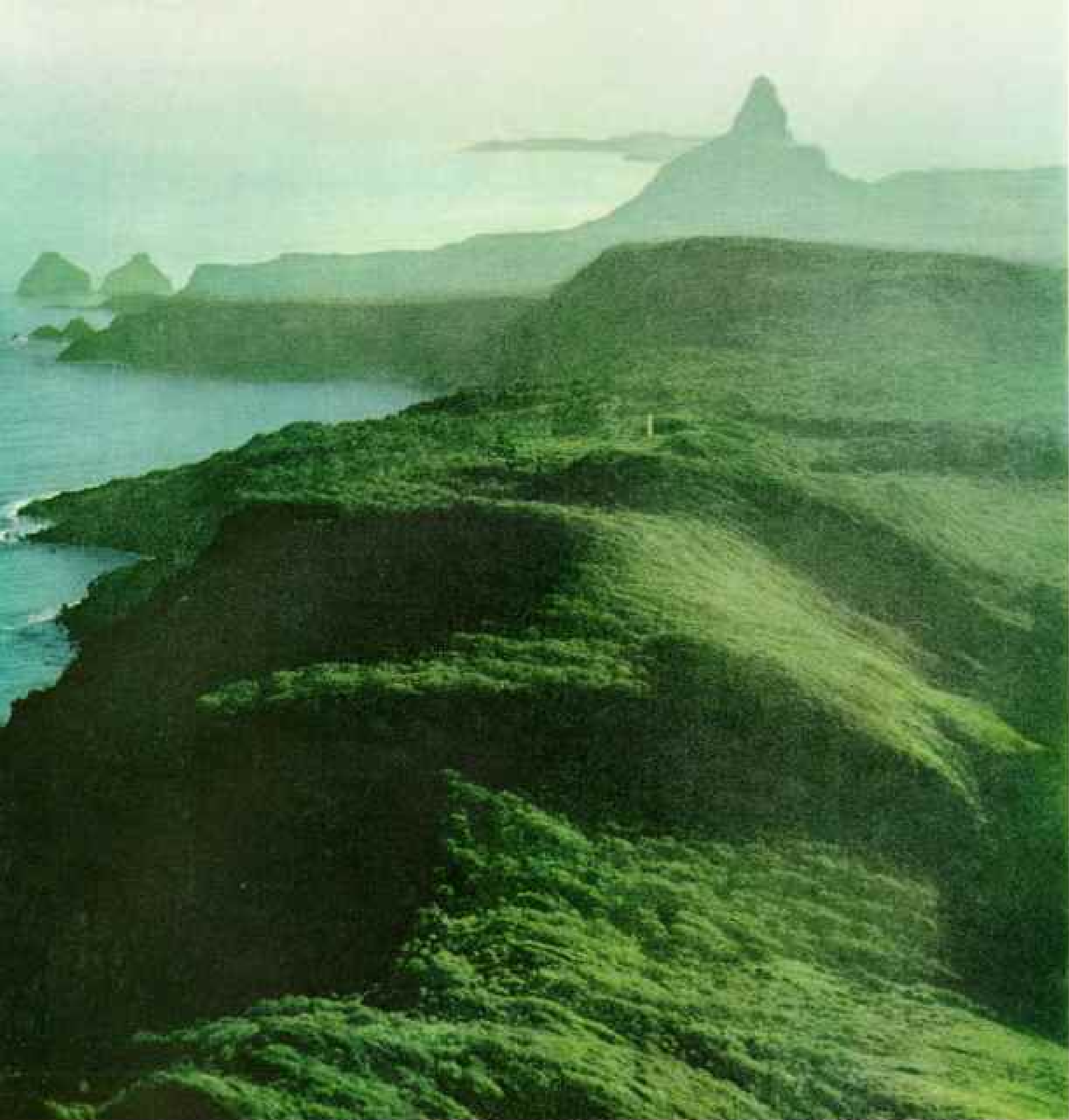
Both companies assist employees in planning correspondence school courses. If an RCA man takes a subject that will help in

his work—and passes it—his company foots the bill. Similarly, it pays tuition for employees on the mainland who enroll at colleges for spare-time study. Approximately 580 RCA men have signed up at correspondence schools and 780 at colleges.

Grand Turk Slumbers in the Sun

On San Salvador I had noticed many workers who seemed withdrawn and introspective, and the same thing proved true on sun-bleached Grand Turk (page 443). It, too, has but one town and offers little after-hours diversion. Islanders wrest a precarious living from the sea by reclaiming its salt and by fishing; they also raise a little livestock.

Grand Turk's missilemen, however, count



PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS NEBBIA © N. G. S.

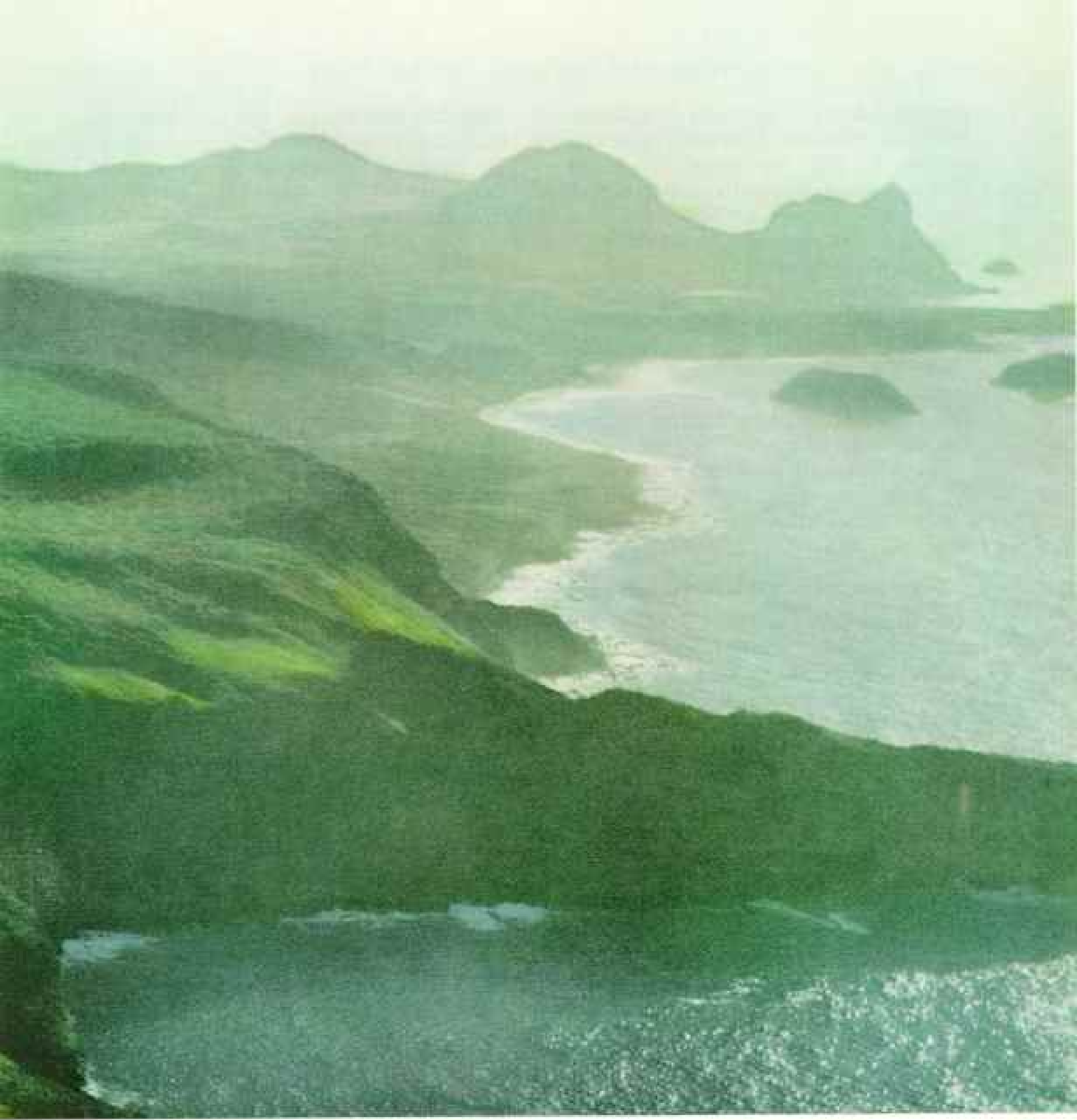
Morning Sun Burns the Mist From Emerald Fernando de Noronha

This lovely Brazilian island, lying 340 miles northeast of Recife, has long been closed to casual visitors. Until 1942 authorities used it as a penal colony. Today Brazilian armed forces garrison the isle and cooperate closely with United States missile trackers. The author, who visited Fernando de Noronha with photographer Nebbia by special permission, thought it "a place of dreamlike beauty."

In the distance rises the island's "little Sugar Loaf," a 1,053-foot spire. Officially it is known merely as Pico (peak). At its foot lies the United States base (page 454). White lighthouse in center stands in lonely isolation on a verdant hill.

Majestic seascape off Fernando de Noronha fails to distract range employees preparing telemetry equipment to track a missile.

Technician Fred Teague examines the antenna's helical coils, and RCA engineer John Anderson telephones to men at a near-by post.



themselves lucky to have near by a number of Britishers, who man the island's cable station. Geoffrey C. Guy, the British commissioner, likes Americans, frequently entertains them at parties with his own nationals, and is on a friendly first-name basis with the station commander, Capt. Sheril D. Huff.

"We borrowed a lot of vaccine and needles from the base to combat a typhoid epidemic," the commissioner told me appreciatively. "Since then we have carried out a full-scale vaccination campaign and have improved the water system and made certain, of course, that the water is safe."

The islanders depend upon trapped rainfall. To a lesser extent, so does the base, but it also has a distillation plant that converts sea water to fresh.

Parish Spans Fifth of the Globe

On Grand Turk I met perhaps the best liked man on the range, the Reverend Joseph Keiper, traveling chaplain. Joe, as he is known to many, logs 125,000 miles each year island-hopping from Grand Bahama to Ascension. "I guess I have the longest parish in the world, 5,200 miles," he said.

Stocky, balding, clad for comfort in T shirt, shorts, and sneakers, he looked more like a missileman than what he really is, a dedicated Methodist minister, and the trusted confidant of lonely men. Mr. Keiper spends about a week at each base, where he holds nondenominational services and, if the island lacks a Catholic church, arranges visits by priests. Much of his time is spent counseling men who bring him problems.

"They have a need for understanding," he said, "without criticism and expressions of sympathy. Don't get the idea many of the men are troubled, but, of the ones who come to me, most are running away from something. I try to convince them that they are probably carrying the problem with them and must face it.

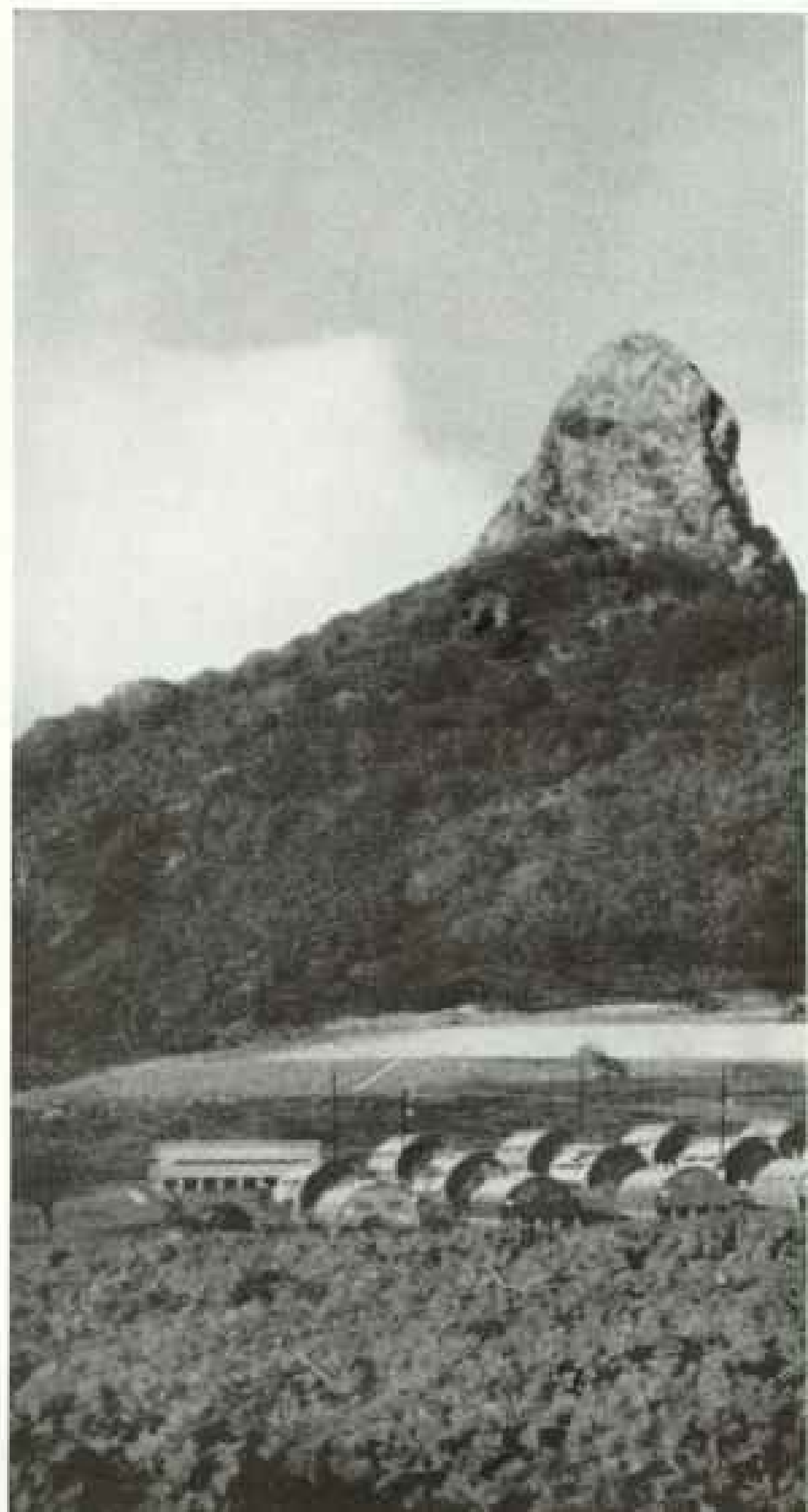
"If a man tells me his marriage is in jeopardy, I advise him that his marriage is more

important than any job. Pan American always backs me up on this and will send me to visit the family of the man on the mainland, if I think that will help. No, I never tell the company the name of the family involved, and no one ever asks.

"When I took this job, Pan American officials, quite literally, gave me but one instruction: 'Go down there and do what the Lord tells you to do.' That's the approach we have taken, and I really feel I was led into this work."

Another well-liked personality is young Dick Langley, the traveling barber, who serves the range as far south as Grand Turk. Beyond that point the men shear one another or wait until they can visit a barber. While getting a rapid but skillful haircut, I asked Dick how he got his job.

"I used to work in Florida and ran into a



Fernando de Noronha's Peak Lifts Its Granite Head Above the U. S. Base

Comfortably furnished quonset huts house personnel, whose tracking sites lie elsewhere. Paved area behind the base traps rainfall. Distillation units provide additional fresh water, which is stored in the hillside tanks. The Brazilian farmer inspects his crop.

couple of guys from Grand Turk who told me the job was open. I applied and got it the same day. I guess it wasn't very hard to get," he added thoughtfully.

Dick spends three or four days at each base, then returns to Florida briefly before beginning the round again. He could have used a haircut himself. But, when I suggested one of his friends might clip him, he replied scornfully: "I've seen some of the work of these guys, and I don't want to carry any of it back to the States."

Wisely, both Pan American and RCA give their employees generous leave time. Each man can take several week-long special leaves each year, plus 30 days' vacation. Rather than endanger his income tax rebate by returning to the United States, he may ride a range airliner to Ciudad Trujillo, capital of the Dominican Republic, where he enjoys special rates at

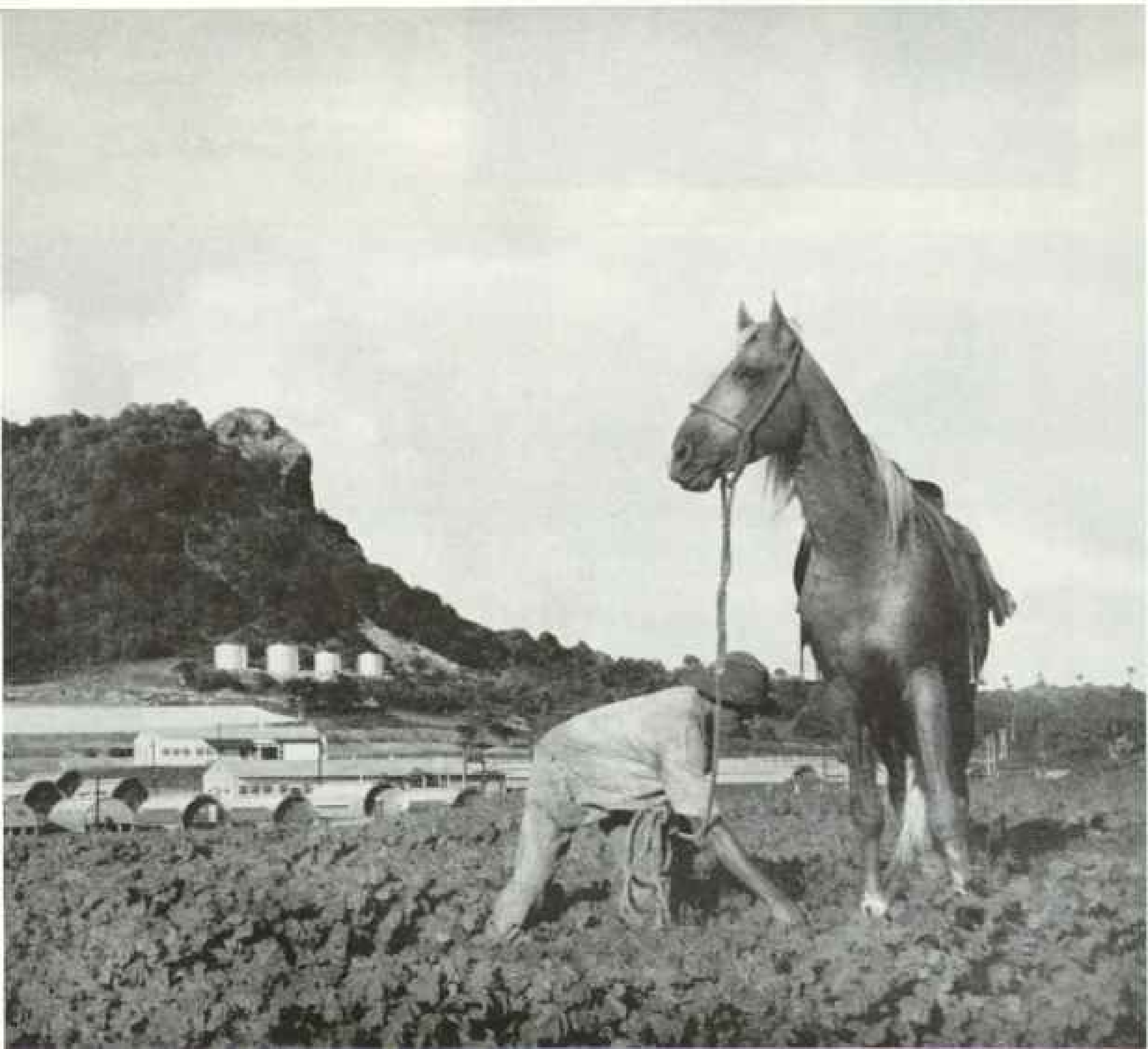
luxurious hotels owned by Pan American and can take his pick of restaurants, clubs, and sightseeing tours in a large modern city.

The range station in the Dominican Republic lies near the Atlantic at Sabana de la Mar, 50 miles northeast of Ciudad Trujillo. Not very active now, it serves only as a cable station and communications link. On the shore of beautiful Samaná Bay, near by, Columbus's men skirmished briefly with Indians in the *Batalla de las Flechas* (Battle of the Arrows).

Wedding Bells Ring for 19 Men

In one respect the Dominican station is most active. Since it was established, 19 employees have married dark-eyed local señoritas. A number of these couples gave a barbecue in our honor and proudly displayed plump babies in carriages and strollers.

At the time of our visit, Maj. Byron J.





Leashed Balloon Strains to Probe the Stratosphere

Twice daily each range station sends aloft radiosondes, small instrument packages that transmit data on barometric pressure, temperature, and humidity. These atmospheric variables determine the amount of refraction, or bending, undergone by radio beams from missiles.

Since trajectories are computed from the beams, engineers use weather reports to determine the degree of refraction, an essential correction factor in their calculations. The reports also aid Air Force weather forecasters.

Technician Bill Freese, on Fernando de Noronha, holds a balloon that will ascend some 100,000 feet.

Off-duty technicians fish for snappers and groupers from a wave-lashed ledge at Fernando de Noronha.

Range employees here enjoy some of the world's finest fishing.

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ESSENCERONS (ARREVE) AND ARRECHONE BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS REESE © N.G.S.



Greene commanded the station and also held the job of Air Force liaison officer in Ciudad Trujillo, where he had an office. Greene met every range airliner, shepherded hundreds of men through customs each month, served as their adviser and translator, and maintained a close and cordial relationship with Dominican officials. Both the Americans and their hosts often referred to him as "the ambassador without portfolio."

Greene, happily, represents a type one meets with increasing frequency in the services: a specialist, well schooled in languages, who smooths relationships for the United States military in a non-English-speaking country.

Station 9 in Puerto Rico, our next stop, commanded a magnificent view of verdant slopes and distant sea from a hilltop outside Mayagüez. The only island station on United States soil, it rates as one of the choicer assignments among married men, who can maintain families in comfort in the city below. The range calls its commuting married men "brown-baggers," for frequently they bring their lunches in brown paper bags. On some weekends families may dine in the base cafeteria. Food at each station is so good and so plentiful that it balloons many a waistline.

Bachelors find Mayagüez, a quiet, home-loving city that clings to Spanish ways, a little sedate; cosmopolitan San Juan, the capital, becomes their mecca.

Blazing Missiles Fall off Antigua

For weeks our group had eagerly anticipated the island of Antigua. Off its shores intermediate-range Thors and Jupiters flash back into the atmosphere like meteors, while their vital data capsules and nose cones, also blazing brilliantly, hurtle toward the sea for recovery by ships. With luck we might see from Antigua a missile's final dramatic, friction-tortured plunge—something no other journalists had witnessed, the Air Force told us.

We had been well briefed on what to expect. The spent rocket slams into the air like a bullet into a well of feathers, and friction consumes it. The nose cone, previously separated from the rocket, fares better. It bears a special coating designed to absorb heat and peel off in fiery streams, thus protecting the inner cone and its payload. A layer of ionized air grows around the projectile, however, disturbing radio transmission from its instruments. For some tests engineers encase the instruments in a protective plastic ball.

Ejected from the cone, the ball, or data capsule, falls separately.

The prospect that we might capture a missile entry on film seemed to intrigue Antigua's base, and many men offered advice and help. Fortunately the schedule called for a night Thor shot in three days. Luckily, too, a tracking vessel, the *Sword Knot*, lay briefly at Antigua. Tom Nebbia sailed on her, hoping to shoot the Thor from a ringside seat. Since *Sword Knot* might remain weeks at sea, Luis Marden and I decided to remain on the island and chance seeing the show from there.

We found the perfect vantage point: a tower overlooking the base's high-gain telemetry antenna, a giant steel skeleton resembling a radio telescope. The Thor would streak through the sky just to the right of the antenna, trackers assured us.

Cameras Wait in Vain for Thor

Then fortune turned capricious. On the scheduled night Luis and I huddled hours atop the wind-swept tower, only to have the shot canceled. Two nights later we resumed our post: showers plagued us, delay followed delay, and once more the shot was "scrubbed." This time, however, it would not be rescheduled for five days.

But no enforced stay on Antigua seems irksome. Like Eleuthera, it is a lovely, smiling place with sun-washed beaches, luxury hotels (six already built, eight more planned), and flower-fringed homes. On Exchange Bay lies the exclusive Mill Reef Club; there, in a 1,400-acre private domain, members have built 42 spacious homes. The club's roster reads like *Who's Who*, listing such men as poet-playwright Archibald MacLeish, publisher John Cowles, Pittsburgh's Paul Mellon, and Philip Reed of General Electric.

English Harbour, hallowed by association with Great Britain's premier naval hero, Horatio Nelson, reigns as the island's No. 1 tourist attraction (page 449). Its recently restored buildings, locally known as "Nelson's Dockyard," include a museum. Among its treasures I spotted one of those mysterious "thunderbolts." A card identified it as a Carib Indian adz and appended this observation, attributed to an unnamed early historian, about the cannibalistic Caribs:

"They have tasted of all the nations which frequented them, and affirm that the French are the most delicate, and the Spaniards the hardest of digestion."



Georgetown Thrusts a Foot Into the Sea
From Its Cinder Heap, Ascension Island

Ages ago volcanic fires spewed torrents of molten rock and glowing ash above the surface of the South Atlantic to create Ascension, one of the most barren, isolated spots on earth. Here United



PHOTOGRAPH BY NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS REESIA © N. G. S.

States engineers track nose cones plunging into the sea. The road to their main tracking site snakes up Cross Hill, the ancient cinder cone in center. Clouds bathe distant 2,817-foot Green

Mountain, the only spot that receives enough moisture to support vegetation (page 462). British residents of Georgetown operate a transatlantic relay station for Cable and Wireless, Ltd. 459



Since the subtle French cuisine is universally esteemed, and its tenderizing effect upon the anatomy can be readily imagined, I thought the Caribs' conclusion most perceptive. Ian G. Turbott, Antigua's administrator, had been guiding me about, and he agreed—but we could not imagine why the Caribs should be any more critical of a Spaniard than, let us say, an Englishman or a Portuguese.

On the night of the rescheduled shot, Luis Marden and I once more climbed the tower. Our spirits, however, were far lower than our vantage point. *Sword Knot*, with Tom Nebbia aboard, had been ordered back to her home port at Trinidad, and another ship

had taken her place. Moreover, an unremitting wind endangered our own prospects, blowing so fiercely that we had to lash trembling cameras and tripods to steel girders.

But periodically the high-gain antenna crew shouted to us that the countdown went well. Then came word, "She's off!"

Nervously we counted the minutes. When a dozen had ticked away, we gazed fixedly, expectantly, to the right of the handle of the Big Dipper. For long moments only the stars stared back. Then, at a spot where there had been nothing but blackness, a light flashed on, growing immediately into a racing, brilliant meteor.

Luis Marden's remarkable photograph on



NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS HERRIN

page 464 captures that man-made falling star; yet, because of the necessary time exposure, it could not record all that the eye saw. Briefly, fleetingly, I glimpsed three separate streaks of light, one less vivid than the others, all arcing downward in the same trajectory. Then they seemed to coalesce into a single stream of fire that vanished abruptly, low on the horizon. Presumably, experts later told me, I had seen rocket, data capsule, and cone, and the capsule had been the fainter light.

Viewed close up from tracking aircraft, these night displays are blinding in their brilliance. Maj. M. E. Griffith, Thor Able project officer, told me of one that occurred

Road Through Chaos: a Vulcan's Dump Broils in the Sun on Ascension

This jeep track near Comfortless Cove cuts through gritty clinkers spewed during an ancient eruption. Men who explore the grim jumble afoot soon find their shoes slashed by the rocks' razor edges. Even the slightest cut sustained in a fall proves troublesome, for embedded cinders make healing difficult. Bald, humpbacked cones line the horizon.

so suddenly, and with such intense light, he thought for a moment a crewman had fired a flashbulb in the cockpit. Occasionally someone gets a fleeting look at a missile's daylight plunge. Vernon Nealey, salvage master of the "undertakers," saw from a plane a tremendous geyser raised by the cone of a Redstone. To the north great clouds of steam, visible for 20 miles, erupted when the rocket, not entirely consumed, also plummeted into the sea.

Jupiter Dies Above Recovery Ship

Crews of recovery ships, who have an unobstructed sweep of the horizon, often get the best view. Capt. Edwin S. Church, skipper of the *Sword Knot*, described one instance when the view seemed too good.

"It was a Jupiter," he recalled, "and it looked like a very bright comet zooming directly toward us. That thing lit up the sea all around the ship, and I thought it was going to come right down our stack."

Actually the cone hit 10 miles away, zeroing in perfectly on its target area. But a sonic boom hurtled down from the outraged air and struck the ship like a thunderclap.

Pan American's Marine Department directs *Sword Knot* and other tracking ships from bases at Trinidad, in the West Indies, and Recife, Brazil. Suwannee Steamship Company, a Florida firm, operates most of the vessels. In addition, the Army converted an old Liberty freighter into a floating station, and Navy ships sometimes assist in recovery operations.

We had now reached that point on the range which trackers call "the water gap." The next active station, on Fernando de Noronha off the bulge of Brazil, lay more than 2,400 miles from Antigua. We would reach it circuitously, however, flying by Military Air Transport Service from Trinidad to Recife, thence to the island. Everyone cheerfully assured me that the flight to Recife alone would last 11 nonstop hours, since MATS follows the South American



coast and skirts the vast Amazon jungle.

But Fernando de Noronha lured us as compellingly as did Antigua, though for a different reason: it had an intriguing reputation as an isle of mystery. For many years Brazil's State of Pernambuco operated the island as a penal colony; later, until 1942, the Federal Government put it to the same use. More recently the Brazilian Air Force and Army had garrisoned Fernando de Noronha as a strategic outpost, and no journalist in modern times had visited it with official sanction.

Range Ships Sail Despite Strike

Earlier, General Yates had told me frankly that he doubted the Brazilians would permit our visit. But, through diplomatic channels, the National Geographic Society asked approval for its representatives, and it was graciously and speedily granted.

In Recife the Air Force stations another of its specialists in diplomacy, Maj. William F. Sandusky. When we arrived, he was preoccupied with the problem of getting Pan American tracking vessels out of port despite a dockyard strike that had made hundreds idle. Again I saw how the Air Force's carefully tended liaison with a host government pays dividends. Sandusky appealed to the Brazilian Army and Navy, and they eased the range ships out of their berths and shepherded them to sea in time for an important test.

Nothing I had read or been told prepared me adequately for the beauty of Fernando de Noronha. Viewed from the air, its majestic humps and spires, its green slopes and wave-lashed cliffs rose from the sea like an improbable dream (page 452). Despite its limited area, only 10 square miles, ruggedness and a serrated coast gave the island an arresting sweep and grandeur.

Still bemused by the air view, I was the last passenger to quit the plane after it landed. Yet, curiously, a number of men turned to stare at the door of the empty plane after greeting me, and expectant smiles

wreathed their faces. Finally one of them asked:

"Where's Louise?"

"Louise?"

"Yes, didn't she come with you?"

Completely bewildered, I explained that, while feminine companionship would have been delightful, only Tom Nebbia and Air Force officers had accompanied me. Luis Marden, scheduled to come, had been recalled to Washington for another assignment.

My questioner, suddenly crestfallen, offered an explanation which I received with hoots of laughter. A message had been sent the base listing our names. Apparently "Luis" had been garbled in transmission, emerging as "Louise."

Word of that message had flashed with rocket speed around the womanless base, touching off much speculation. Supervisors, however, worried about proper housing. They solved the problem by assigning "Louise" solitary quarters in the infirmary, and several stout fellows of good character drew the job of guarding her maidenly slumbers.

Luis Marden will not learn of his celebrity on Fernando de Noronha until he reads this article. I hope our friendship survives.

Peaks Guard Fernando's Coast

Viewed from the ground, the island seemed just as lovely as it did from the air. Its dominant feature, Pico, a precipitous 1,053-foot spire, stands like a sentinel on the north coast. Near its foot nestles the missile base, a group of comfortable quonset huts. United States Navy forces, who shared with Brazil the island's defense in World War II, planted an aircraft warning beacon atop Pico. Long ago it ceased to operate, and no one has attempted repairs. I could see why, for scaling the peak is a job for human flies.

Many smaller spires rise from the surf along the north coast, and hills of softer contour line the island's southern end. Between stands a central table, the Quixaba Plateau, which falls off abruptly to the island's single valley, site of the airstrip.

Water-trapping Concrete Paves a Hump on Ascension's Green Mountain

Peter Critchley (left), a former RAF fighter pilot, shares an idle hour with Air Force Capt. Edward Duch, commander of the United States base. Critchley, who manages a farm atop the island's summit, supplies Ascension's British subjects with fresh vegetables, milk, and meat. This lush Shangri-La taps moisture from clouds that frequently shroud the mountaintop. Rainfall from the catchment basin is piped down to dry and cindery Georgetown, which has no other source of fresh water.



**A Blazing Thor Streaks Antigua's Sky
Like a Meteor From a Shattered Planet**

Twelve minutes and 1,500 miles after its launching from Cape Canaveral, the missile dives seaward at 10,000 miles an hour. Photographer Marden waited 10 days to catch this spectacle, which



EGGALHREME © NATIONAL GEOGRAPHIC SOCIETY

lasted only 18 seconds. His multiple time exposure records Thor's incandescent trail, an estimated 150 miles from the island. In the tail of the track, the spent rocket bursts into flame.

Miles ahead, the nose cone slashes the night sky, but its light ebbs as a ribbon parachute brakes the fall. Powerful antenna at left, similar to a radio telescope, picks up the cone's signal.

It can truthfully be said of Fernando de Noronha that "every prospect pleases." I have seen the rocky coast of Maine and the seascapes of Nova Scotia and southern California, but none quite matches the beauty of this onetime prison isle.

Like most Edens, however, it has a flaw. Rainfall during the dry season, August to January, averages only four inches. Much of the year the low vegetation looks sear and brown, not the lush emerald green we remarked from the air. Authorities humanely permitted prisoners to bring families to the island, and several hundred of their descendants still farm the land, though lack of moisture restricts crops.

Governor Served With U. S. Troops

Brazil has placed in command of the island, as military governor, a staunch friend of the United States, Lt. Col. José Francisco Costa. Colonel Costa, who speaks excellent English, trained with U. S. forces during World War II at Fort Sill, Oklahoma, and later fought in Italy under Gen. Mark Clark, as did many Brazilians.

Major Sandusky, whose liaison duties frequently bring him to the island, took us to call on the governor at his headquarters, a huge, cool building, gleaming white, that commands a hillside in the only village.

"Americans and Brazilians have gotten along very well on this island," the governor told me. "We are good companions, good friends. Mutual confidence—that's the important thing, that's what Major Sandusky and I work for."

The governor, we found, had a most attractive partner in his duties—Mrs. Costa. She administers social services, directs reforestation (the island once had many trees), and supervises restoration of an old fort built by the Portuguese in 1772.

Proudly the couple showed us the island's modern school, named for the governor and attended by 210 youngsters, and its spotlessly clean, well-equipped maternity clinic, where a woman pays a single chicken as the price for delivery of her child.

When, regretfully, we left the island, its

"mystery" had been dispelled, and young Tom Nebbia could say, and mean it: "It's too bad they no longer keep prisoners there; I'd like to sign up for a year's sentence."

Wholly different was our last stop. As our escort, Capt. Tom Burleson, pointed out, if one cannot go to the moon, "the next best place" is that dead caldron Ascension Island.

Volcanic Ascension, with its dark, brooding cinder cones, ancient lava flows in tortured shapes, and monstrous chunks of slag, all coated with gritty dust and cinders, does resemble the moon's ravaged face (page 460). It can also be likened to another celebrated world, infernal rather than celestial, as indicated by these names given some of the island's grimmer features: Devils Inkpot, Devils Ashpit, Devils Riding School, Deadmans Beach, and Comfortless Cove.

A Portuguese, João da Nova, discovered the isle in 1501 on Ascension Day, hence the name. Later voyagers treated it with understandable indifference, though occasionally they found it a fitting place to maroon some sinful sailor. When the British put Napoleon on St. Helena in 1815, they decided to occupy Ascension, lest it be used as the base for an attempt to free him. The indefatigable British have remained ever since, and today their community, Georgetown, maintains a vital transatlantic cable and radio station (page 458).

Limited Housing Plagues Base

Missile-tracking antennas, reached by giddy, serpentine roads, rise from the tops of several widely scattered cones. The main base, with its comfortable dormitories, cafeteria, and offices, lies a mile and a half from Georgetown. Built to accommodate 194 people, it had squeezed in 281 at the time of my visit, and supervisors were concerned, feeling that life on Ascension is difficult enough without crowding.

Except for a few plants near the dormitories, set out and carefully watered by the men, no green vegetation exists around the base, and the view of bald, scabrous hills and gullies inevitably dampens spirits. The island's remoteness and its lack of outside

A Missile Range Station Afloat, *Sword Knot* Awaits a Voice From Space

This converted freighter is one of a dozen vessels that fill in the range's gaps, extend its operations, and recover nose cones and data capsules. Ship's officers between guard rails in center take position sights. Red-shirted technician tests receiving antennas housed in the dome-shaped Fiberglas huts on *Sword Knot's* bridge deck.





NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS BERRIE

Sword Knot's Trackers Keep Intent Eyes on Banks of Telemetry Equipment

recreation, popularly known as "goofing-off facilities," also tend to create a certain mental jaundice.

Dr. N. H. Allen, the base's Iranian-born physician, works on morale problems in his role of medical-recreation director. Skilled medical technicians fill that post at each of the other bases, but Ascension, because of its remoteness, requires a physician.

"One troubled young fellow from South Carolina came to me recently," Dr. Allen recalled, "and confided that he missed trees. 'I just can't stand it without trees,' the boy said, and I had to send him home."

But, Dr. Allen emphasized, such incidents are not typical. Carefully selected, the men are physically and mentally well balanced. They serve on the island only six months and usually cure their blues with such diversions as the island offers.

The fishing, for example, is superb. At a

beach picnic I saw Air Force flyers pull dozens of groupers from the surf. Only one thing troubled these blithe young men: the possibility that hordes of sharp-toothed blackfish might attack their catches before they could be reeled in. The problem was solved by tossing into the surf fish entrails, which the blackfish devoured, ignoring the struggling groupers.

Fish Lost to Marauding Sharks

Boating parties take many game fish, such as wahoo, dolphin, and tuna. All too often, however, sharks tear the hooked fish. These marauders so infest one off-shore area that it has been named "Shark Alley."

Because of the many barracuda and sharks, British authorities forbid swimming, except in one protected cove.

But Americans enjoy Georgetown's golf course, locally acclaimed with pride as the

world's worst. Having seen it, I will not dispute its right to the title. The nine-hole layout, unblemished by so much as a single blade of grass, zigs about in a field of big clinkers, and its ashy fairways would be nightmare roughs anywhere else. I mistook the greens, made of sand, for sand traps, and the gritty traps looked as deep as craters.

A. R. Harrison, island magistrate and manager of the cable station, pointed out that the course does boast one advantage.

"You know the problem of divots—digging up the turf when you swing?" he asked. I confessed a deplorable familiarity with the problem. "Here no one has to give it a thought," Mr. Harrison beamed. "The problem is how to keep from breaking your club."

Though the base is short of vehicles, a group sometimes gets a truck or a jeep and drives in ever-ascending twists and turns to the mist-shrouded top of Green Mountain. There they find a compact farm, green and delightful, an almost unbelievable contrast to the rust-colored desolation below (page 462). The secret is moisture; Green Mountain draws it from the faithful cloud cover, making possible vegetable gardens, pasturage for livestock, and groves of sweet-smelling eucalyptus and other trees.

Cable and Wireless, Ltd., maintains the farm to feed its employees. The base sometimes buys surplus vegetables, but most of its excellent fare comes from the United States by plane and an occasional ship.

Alien Trees on Mountain's Summit

United States troops occupied Ascension during World War II and grew vegetables by hydroponics, the soilless culture of plants in chemically treated water.* But this method is difficult and uneconomic. Today there is little trace of the GI occupation.

One must hike to reach Green Mountain's actual summit, where a bamboo forest, its slender, close-packed trunks endlessly clattering against one another in the wind, awaits the sure-footed and the spry. The British Navy planted this alien but delightful forest many years ago, and it flourishes in the almost perpetual mist. Mr. Harrison and his wife, both tireless climbers, guided me to it at an apoplectic pace. Then, by holding out the lure of a cooling drink, they persuaded me to venture down a dizzying track to their lodge on a flank of the mountain.

Most of the men seldom get a chance to visit

Green Mountain's lush oasis, but they bear their surroundings stoically, even with humor. A group conversing in the club may suddenly stand and bellow in unison, "I hate this blasted island!" Then the men resume their talk, as if nothing had happened.

Many collect pin-up pictures of movie starlets and models. I had thought some of the wall displays on other islands sensational, but Ascension has no peer in this endeavor. One young bachelor ceremoniously intones, "Farewell, darling," to his favorite blond pin-up each time he leaves his room.

Specialists Arrive for Test Series

But the best antidote for loneliness and isolation is work, and Ascension gets plenty of it. There, at the end of the line, fall the elite of Cape Canaveral's missiles, the intercontinental rockets. Their terminal plunge is a supremely critical test for trackers, who must not only get performance data, but, frequently, must spot and retrieve the cone. These days the base often finds its regular personnel suddenly augmented by visiting scientists, engineers, technicians, and aircraft crews, sent to lend their talents during a series of critical tests.

One such test coincided with my visit. Canaveral had scheduled a Thor Able, and its vitally important cone of advanced design would contain experimental material. Three planes from the 6550th Operations Squadron, based at Patrick Air Force Base, stood by at Ascension to track it. Scientists of Avco Research Laboratory and Aerojet-General Corporation had joined the plane crews.

These two companies, together with Barnes Engineering Company, form a private industry team cooperating in Operation Gaslight, a study of missile entry problems. With special cameras and spectroscopic devices, the civilian contractors record the holocaust that envelops falling cones.

In the last split seconds of their plunge, these man-made meteors cannot be tracked by Ascension's instruments or those aboard ships. But designers want telemetry information right up to "splash," or impact; planes, with a downward view unimpeded by earth's curvature, obtain that data, as well as optical coverage.

* See, in the NATIONAL GEOGRAPHIC: "Ascension Island, an Engineering Victory," by Lt. Col. Frederick J. Clarke, May, 1944; and "Greens Grow for GIs on Soilless Ascension," by W. Robert Moore, August, 1945.



Mental tension seemed a tangible thing around the base on the day before the shot, and for a good reason. Ships had recovered cones off Antigua, but none fired long range had been retrieved off Ascension. Mysteriously the Atlantic swallowed them without trace.

Luis Marden, at the request of another contractor, General Electric's Missile and Space Vehicle Department, had photographed the underwater behavior of a cone dumped overboard from a ship (opposite). Diving repeatedly into the twilight depths with movie and still cameras, Luis recorded the cone's bobbing gyrations. His pictures showed that the movement was not too severe and that the strap tying cone and bag together definitely seemed strong enough. He also reported—and his pictures confirmed—that the strap was not snarled or chafed by the large ribbon parachute that each cone releases to brake a seaward plunge.

Puzzled designers could only surmise that, if the cone had been subjected to an actual atmospheric entry, its recovery aids might not have functioned. Perhaps the float's transmitter, which beeps out a "come-get-me" signal, could not survive the shock of air resistance, thereby handicapping searchers.

Dye Marker Aids Cone Recovery

Long before daybreak I heard the tracking aircraft rev up on the airstrip below my quarters, and I wished each one good hunting as it roared overhead. Tom Nebbia and I turned out just before dawn, hoping to see the entry from a tracking site. But, stare though we would at the slowly reddening horizon, nothing flamed in the blank vault. The missile had entered far away, visible only to electronic eyes.

Seemingly endless hours of waiting followed. Then word flashed about the base, "It's found!" None of the searchers had picked up radio signals from the cone's float, but an Avco man in one of the planes had spotted a dye marker just as hope began to wane. All floats emit dye, but it is ex-

tremely hard to find in the immensity of the Atlantic.

For three hours aircraft orbited the tell-tale discoloration; then ships reached the scene and picked up the heat-blackened cone.

When the planes returned, their crews had been 12 stressful hours in the air and should have been exhausted. But seldom have I seen a more jubilant group of men. In conversations they relived each moment, and a party in their honor at the club continued until early the next morning.

Recently missilemen have fished out other cones off Ascension, for recovery techniques have been improved; yet, among the men who were there at the time, no subsequent success could approach the thrill and the gratification of that first lucky find.

Mercury Astronauts Will Use Range

With the privilege of a comparative elder, I excused myself from the merrymaking and took a solitary stroll under the stars. In the clear, ocean-fresh air they blazed with an almost unwinking brilliance, and my thoughts, as well as my eyes, lifted toward them.

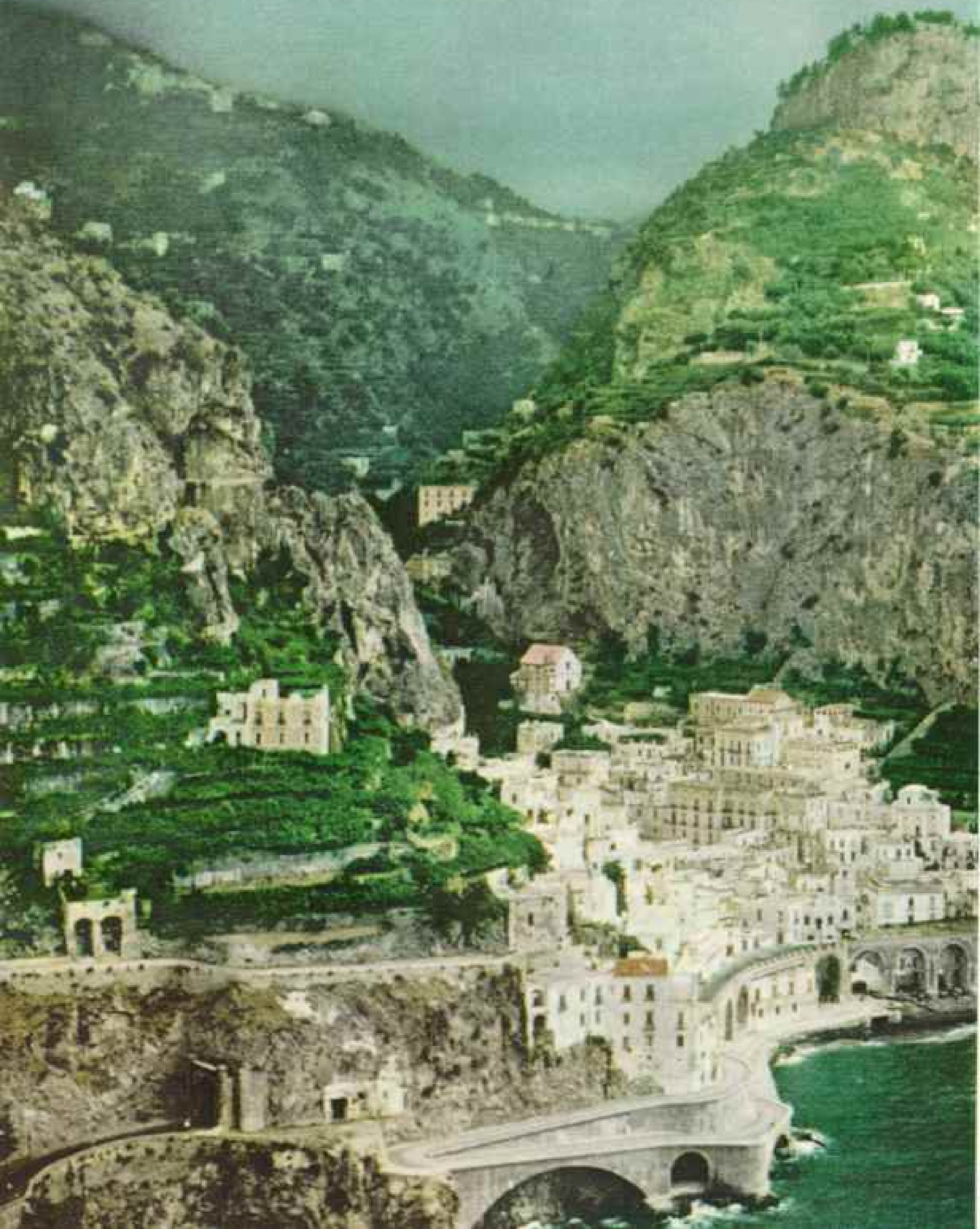
In a sense, that expression of a people's faith and will, Cape Canaveral, and the many isles we had trod might be termed stepping-stones toward those distant stars. Man has a rendezvous in space, and historians of a later age will say that he took some of his first modest strides from the range we had traversed. As early as next year, for example, one of the Project Mercury astronauts, a man instead of a monkey, may ride a capsule down range. By 1961 a rocket fired from Canaveral may carry an astronaut into orbit around the earth.

The moon, the planets, and eventually that strange dimension, time itself, will yield to the challenge of man's mind and heart. But a certain enthusiast must remain a yearning on-looker while early pioneers in increasing number go out to meet their high destiny. Sadly, I dwelt upon the thought that I had been born 20 years too soon.

Fish Men Salvage a 600-pound Nose Cone Bobbing Beneath the Sea

As it strikes water, the cone releases a self-inflating nylon float (upper). Fluorescent dye stains the waves, and the float's waterproof radio, topped by a small antenna, beeps out a signal to searchers. Suspended from the bag by a nylon strap (lower), the cone dangles 40 feet below the surface. Shroud lines of its ribbon parachute, which serves as a brake during atmospheric entry, stream in the current. Diver attaches a cable for hoisting the cone. High-visibility spiral stripes aided underwater observations during this test of recovery techniques off Grand Bahama.

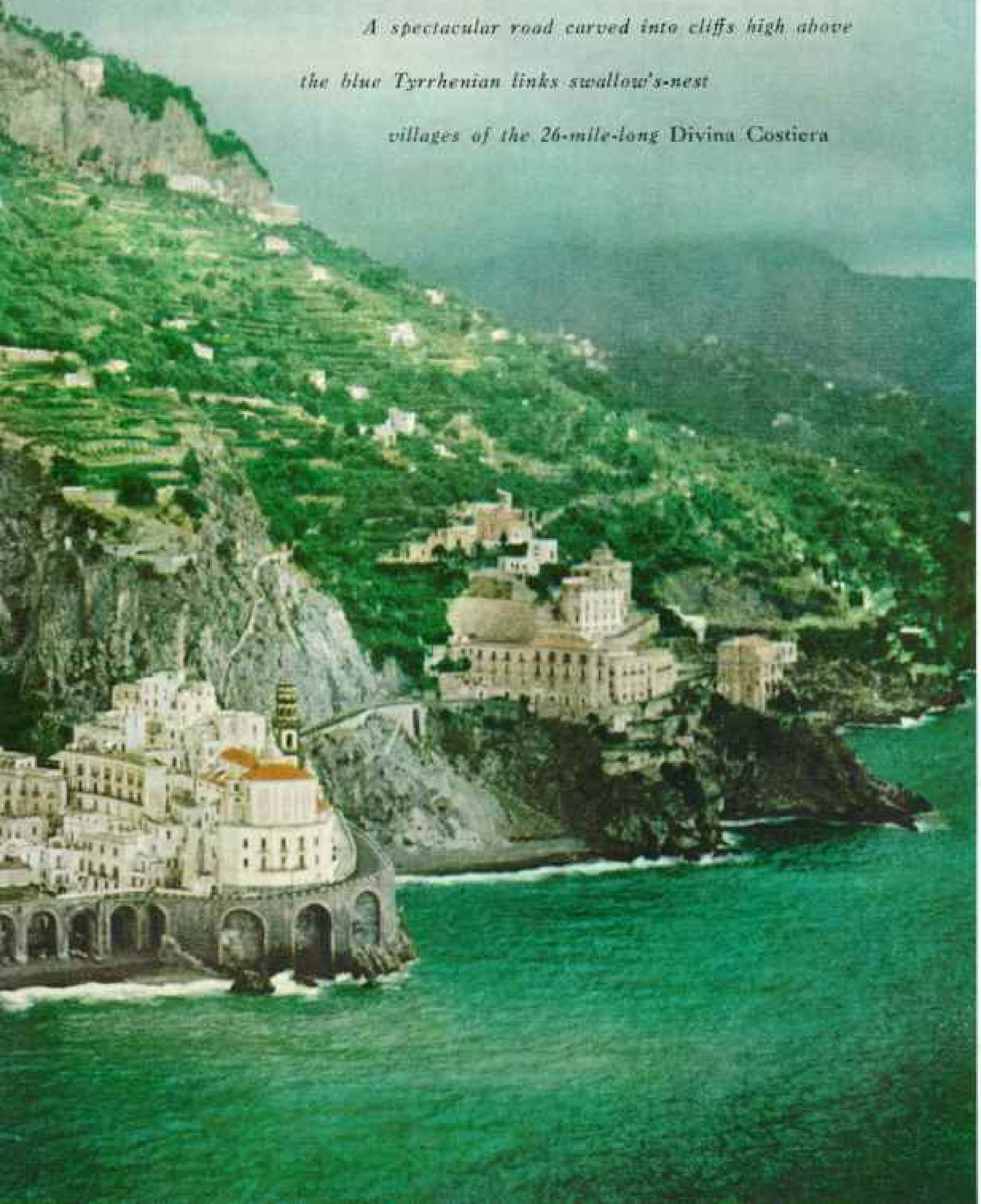
Amalfi



Article and photographs by LUIS MARDEN

ITALY'S DIVINE COAST

*A spectacular road curved into cliffs high above
the blue Tyrrhenian links swallow's-nest
villages of the 26-mile-long Divina Costiera*



◀ Glistening white Atrani, a suburb of Amalfi, lies clasped between sea and mountain. Ravello, high on its rocky promontory, perches above terraced gardens heavy with the fragrance of lemon blossoms. Only steep paths reach most of the hamlets clinging to the mountainside. By day the roar of motorcars echoes from the rock-walled ravines of the Amalfi Drive. At night the musical cries of fishermen putting to sea in lamplighted boats break the stillness (page 488).

“THE DAY OF JUDGMENT, for the Amalfians who rise to Paradise, will be a day like any other.”

The man who wrote that was an Italian, but travelers from over the world echo him at sight of the *Divina Costiera*.

This stretch of mountainous coast, indented with deep blue bays, studded with white villages clinging like swifts' nests to steep cliffs, perfumed with the scent of lemon and orange blossoms, and traversed by a twisting road that hangs high above the cobalt Tyrrhenian, compresses more spectacular beauty into its score of miles, I believe, than any region of comparable area on earth.

I first came upon this concentration of earthly loveliness by road. I had come from Naples, past Pompeii, roofless and silent under the blue shoulder of Vesuvius, and, turning inland just before Sorrento, I had driven up on to the spine of the Sorrentine peninsula.

High walls shut off my view until I reached the hamlet at Colli di San Pietro. Behind me the ground fell gently to the orange groves of Sorrento, on the Gulf of Naples. Under my front wheels lay the hazy blue sweep of the Gulf of Salerno. Descending in reverse curves through groves of oak, ilex, and somber pines, the road dropped toward the Tyrrhenian Sea,

then fell vertiginously toward it, and I was on the Amalfi Drive (map, next page).

The celebrated road rarely descends to sea level, but follows the incredible windings of the coast at a height of one to seven hundred feet above the water (page 500). On my left the Lattari Mountains rose brown and bare against an unbelievably blue sky. Their rocky face was fissured with ravines down which vestigial streams found their way to the sea.

Sports Cars Prowl the Drive

Few pedestrians or donkeys walk the Drive today. Instead, the rock walls echo to the accelerating roar of the lovely products of Italy's motorcar makers. Elegant and intricate as Florentine jewels, the low-slung Lancias, Alfa-Romeos, and Ferraris shoot along the road, wrench round the curves in a shower of gravel, then snarl into the straightaways again.

My bigger but, compared with the thoroughbred Italian *vettura*, underpowered and underbraked car lumbered along gallantly, leaning and squealing on turns and grades hardly countenanced in Detroit.

At first the Drive skirted brown and arid slopes, but with each loop I saw more signs of cultivation. This precipitous coast holds little arable land, so the farmers cut terraces in the



Sunlight Glows Blue-green Through a Watery Opening in the Emerald Grotto

Divers on the Amalfi coast enjoy vistas as striking as those above water. This sea cave was discovered when unusually low water briefly revealed its underwater entrance (left). For years fishermen used it to store their nets and traps, entering through a man-made door on the landward side. Today boat-borne visitors glide across the cave's still waters.

Aqua-Lung diver swims past the grotto's hidden entrance.



rock face (page 484). Grids of chestnut saplings support grapevines and the fruit-laden branches of lemon trees. Whitewashed square houses with domed roofs give a peculiarly Arabic look to the scene.

The Italians are a people used to living with beauty; yet since the earliest times their poets have paid tribute to Amalfi.

In the 14th century Giovanni Boccaccio wrote: "It is thought that the seacoast from Reggio to Gaeta is almost the most delightful part of Italy; in which very near Salerno there is a littoral that looks down on the sea, which the inhabitants call the Coast of Amalfi, full of small cities, of gardens, and of fountains. . . ."

We can forgive Boccaccio the qualifying words "it is thought" and "almost"; he was after all a Florentine from the north.

Positano's Beauty Catches the Breath

At the entrance to one curve I drew off the road, looked over the railed edge, and was struck full in the heart by Positano. The rock dropped sheer to a clear green cove of the sea. On the opposite shore the white and pastel houses of Positano rose tier after tier from a tiny beach, on which fishing boats lay like strokes of multicolored paint. The houses flowed over a headland thrust into the quiet sea. High above the town rose a sienna mountain. Offshore, to balance the composition, lay the Galli islets, a legendary home of the Sirens.

It was too good, a stage set for some performance not yet begun. But it was real, and alive. Across the water came the staccato clatter of wooden clogs as the Positanesi went up and down the stone flights of stairs that serve for streets in their vertical town. Cocks crowed, a dog barked, a bell clanged, and a lateen-sailed fishing boat came round the headland.

To go down into the town of Positano, you leave the main Amalfi Drive, descending in hairpin turns so tight that it is almost impossible to get an American car round them on one try. At the height of the tourist season, traffic flows one-way down into the town from the Naples side and out again at the other end, toward Salerno.

A small triangular square, a sort of landing on the flights of stone steps leading down to the sea, is the center of life. Here are the post office and the bus stop, the shops and the cafes, and the worst traffic tangle in Positano when cars, buses, and horse-drawn fiacres converge all at once on the small piazza that was never designed for anything motor-driven.

From the piazza I took leave of the world



Gulf of Naples

Amalfi: Sea, Sun, and Mountains; the Poet's "Perfumed Garden"

Generations of writers and painters have celebrated these few miles on the Gulf of Salerno. Once a powerful maritime republic with a navy of 120-oar galleys, the *Costiera di Amalfi* today is a string of villages, vineyards, and lemon groves set against a backdrop of unsurpassed beauty. The Amalfi Drive, which dramatically overhangs the Tyrrhenian Sea, runs from Colli di San Pietro to Vietri sul Mare. Leaving the Drive at Vietri, the Salerno-Naples road skirts Pompeii and Vesuvius.



©N.G.S. Victor J. Kelley

of wheels. Ramps and stairs, some so narrow you can touch both sides with your outstretched hands, lead down to the beach. Houses in a geometric jumble of planes and angles cut into the narrow band of blue sky overhead.

In Italy it seems that nature and man cannot make an artistic mistake. The mountains are the right shape, the trees are in precisely the correct position, man's structures fall into place gracefully, their colors blend, and everything forms a harmonious whole.

I arrived in Positano in the spring, and the trickle of tourists had not become the steady stream that flows all summer long. Local people still outnumbered the visitors.

I walked past a shoemaker's shop that displayed for the tourists leather-soled sandals of fifty patterns.

Over a carpenter's shop a small oil lamp flickered before a glassed-in shrine housing a figure of the Virgin. Under it an inscription



Gulf of Salerno

read: "Passers-by! As you walk through this street, raise your eyes and salute Mary."

Beneath the shrine carpenters shaped a rudder for a fishing boat. Their plane made a pleasant *snick* as it shaved a long wooden curl, releasing the fragrance of freshly cut wood, the smell of the good craftsmanship that is still cherished on the Amalfi coast.

Fishermen Angle for Tourists

Positano, like most of the other towns of the littoral, was once a village of fishermen. Today, though the fishing boats still set out at dusk, few are manned by townspeople. The town has become a watering place, and most of the inhabitants cater to vacationists. The fishermen take people sightseeing, and many of the young men and girls work in hotels.

I lived at the Albergo Le Sirenuse, ancestral home of the Marquess Paolo Sersale, a handsome bachelor who is Positano's mayor. The Sirenuse, like most Positano residences of any

size, falls on several levels. The hotel is furnished with 18th-century pieces in the elegance that comes so naturally to Italians. The floors are tile, a specialty of the region.

All along the Amalfi coast ceramists make some of the most beautiful tiles I have ever seen. Some makers copy the ancient mosaics of Pompeii, others specialize in marine and floral patterns of their own design, but all are virtuosos in clay (page 494).

Positano has something for everyone, including the lotus-eaters. As it becomes fashionable, the town attracts more and more of the conventionally unconventional set, who circulate from watering place to watering place round Europe and the world, greeting each other with delighted little cries as their trails cross.

English tourists, coming south to seek the sun, are usually the first to arrive in spring. As the season draws into summer, the English give way to a peaceful invasion of seri-



**Pen Shells, Giant Bivalves,
Emerge from the Sea**

Though pens resemble mussels, they are not eaten in this area. Amalfi boatmen sometimes bring up the shells to sell as souvenirs. Seaweed and sponge sheathe the exterior with camouflaging growth. Silver-gray nacre coats the lustrous inner shell.

Free diver floats weightlessly above pens standing upright on the ocean floor. Hairlike filaments, called byssuses, anchor *Pinna nobilis* to the bottom. Southern Italians used to weave the silklike threads into ceremonial gloves for their bishops.



ous Germans in Volkswagens and Mercedes-Benzes. As the days grow into the truly hot weather of midsummer, whole families from Naples, with running, shouting children, come to town. After Bastille Day the French, great devotees of *le camping*, swoop down from the north in Citroëns and Renaults and set up tents on the beaches (page 496).

With autumn, some of the quiet-seeking English return, the little orchestra in the Buca di Bacco—Bacchus's Cave—gives way to recorded music, and the town's few genuine fishermen again mend their nets in peace on the beach.

One eats well in Italy. In the south the specialty is *pasta* in its many forms, especially the classic dish, *spaghetti alle vongole*—with clam sauce (page 507). But that American phrase, the "spaghetti dinner," is meaningless here. Pasta is merely the preliminary to a meal. After a heaping plate of spaghetti, the waiter asks, "Now what would you like to eat?" Most of these coast folk are lean and hard-bellied, yet they consume an astonishing amount of food.

Southern Italians love "fruits of the sea," shellfish, and the delicately flavored fish from the limpid waters of the Mediterranean. There are a few practicing fishermen left in Positano, and one of them, Nicola Grassi, promised to show me how to make a real *zuppa di pesce*, very like the bouillabaisse of Marseille. The Italians say they invented

the French dish, and, in fact, the term for it in the local dialect is *a' vulle e' bascio*, meaning the same as the French word—to simmer, or boil "low" over a slow fire.

I met Nicola one morning shortly after dawn on the shingle beach. He rowed his high-stemmed boat in the Mediterranean fashion, standing and facing forward, and when he came alongside the mole, he showed me a colorful collection of sea creatures—grotesque scorpionfish, stargazers with periscope eyes turned heavenward, octopus, squid, shrimp, and clams (page 486).

A Soup Fit for Heaven

At the Covo dei Saraceni—the Saracens' Hideout—they prepared Nicola's catch, cooking it in a pan with water and olive oil, parsley, garlic, and tomato sauce, then served it over croutons made from good crusty Italian bread. When we tasted it Nicola exclaimed, "Eternal Father, what a soup!"

"*Signore mio*," Nicola went on, "I know the sea, inch by inch. Mornings, the people who like to smell dawn air and fresh fish come down to the beach to see me. But when I am gone—*finito tutto*—all is finished. There will be no more fishermen in Positano. Nowadays tourists come first. That's the way the town authorities want it."

Amalfi fishermen use purse nets to surround schools of small fish they attract with petroleum lamps. They also stretch gill nets for larger prey, but Nicola told me he no longer "extends" his nets close to shore.

"If I do, one fine day instead of catching a fish, I catch a man." Nicola referred to the extremely popular sport of free diving. Every season there are more and more goggle fishermen, men who swim under the sea with a spear gun to shoot fish in their own element. The sport was born in the clear waters of Italy more than thirty years ago.

One day I found out graphically what Nicola meant. I was swimming in the blue—and surprisingly cold—sea some thirty feet below the surface, when I noticed that although I kept kicking my rubber foot fins I was not making much headway. Gently I came to a stop. I looked up through the restricted window of the diving mask, and to

Too small for jewelry, these seed pearls were found off Positano. The author, who dived in vain for oyster pearls in the Pacific, was surprised to discover 14 gems in the Mediterranean's lowly pen shells (opposite).

ERRIC BISHOP, NATURAL GEOGRAPHICAL SOCIETY



my horror saw a pale grid of netting rising like a fence before me. I had swum into a gill net, which had entangled itself round the valve and air tank on my back. Fortunately I had plenty of air. As carefully and slowly as I could, I untangled mesh after mesh from the apparatus.

It was slow work, but at last I was free and swam back toward the shore. Had I been short of air, I could have slashed my way free with my knife, but I had plenty of time and did not want to destroy the fisherman's means of livelihood.

Dolphins Chase Anchovies Into Nets

Nicola told me that dolphins—porpoises—are the fisherman's friend.

"They help all fishermen," he said. "When we catch little ones in our nets, we always let them go, but first we mark them by cutting off a bit of fin. Then we can recognize them later when we see them playing round our boats.

"There is one we call Little Peter—we generally sight him about three miles out—and whenever we see him, we know fishing will be good, because he and his friends herd the fish straight into our nets. I don't know if they do it on purpose, I only know the good ones always help us.

"Not all of them are good to us. There is one pair, husband and wife; when we spot them, we clap our hands to our heads—Blood of the Madonna, they eat everything, including the nets! The good ones, when they have eaten some of our anchovies, herd the rest of the school in our direction."

With two fishermen, Onorato and Pietro, I sailed along the coast near Positano. We took a run out to the small rocky islets offshore, the Galli. Today the islands belong to choreographer Léonide Massine, one of a growing colony of artists who live in Positano for several months of the year.

"Those islands," said Onorato, "used to be surrounded by solid banks of fish. I don't know what's happened to them."

The fish of the Mediterranean have been harassed night and day, season in and out, since the earliest recorded times, and it is a wonder to me that there are any left at all.

Yet fishermen usually make good hauls. There are times, though, when many return with a pitifully small catch.

Onorato and Pietro specialized in fishing for squid. They told me of the excitement among fishermen when word spreads that the black squid have arrived offshore. Like other varieties, black squid are caught at night.

"Each time a star appears, it seems one of them comes to the surface. Ah, but the black squid make the women wear black, Signor Luigi. When they appear, we are certain of catching 20, 50, 80 pounds; so we go out regardless of the weather. It takes three hours to reach the grounds and three to return. In that time the weather can turn bad, and so when the black squid rise, some of us do not come back."

The lore of the winds, handed down from classical times, is safe in the hands of sea-knowing men like Pietro and Onorato. They told me how they divide the circle of the horizon into eight sections, with a name for the wind that comes from each direction.

Beware the *Libeccio*, an Evil Wind

"The *tramontana* (across the mountain) is ferocious; it blows from the north. Then, counting clockwise, comes the *grecale*, a good wind. After that, the *levante*; it almost always is safe. Next the *scirocco* that blows from Africa, almost invariably bad. Then, *mezzogiorno*, also bad, same as the *scirocco*.

"Now comes the *libeccio*, the worst of all. When it comes down, the sea is heavier and has a longer scend than with the *scirocco*. After that, the *ponente*; it's good, and you can go with it. Then the *maestrale* from the northwest is beautiful, we always can put in a good day's work with fine weather when it blows.

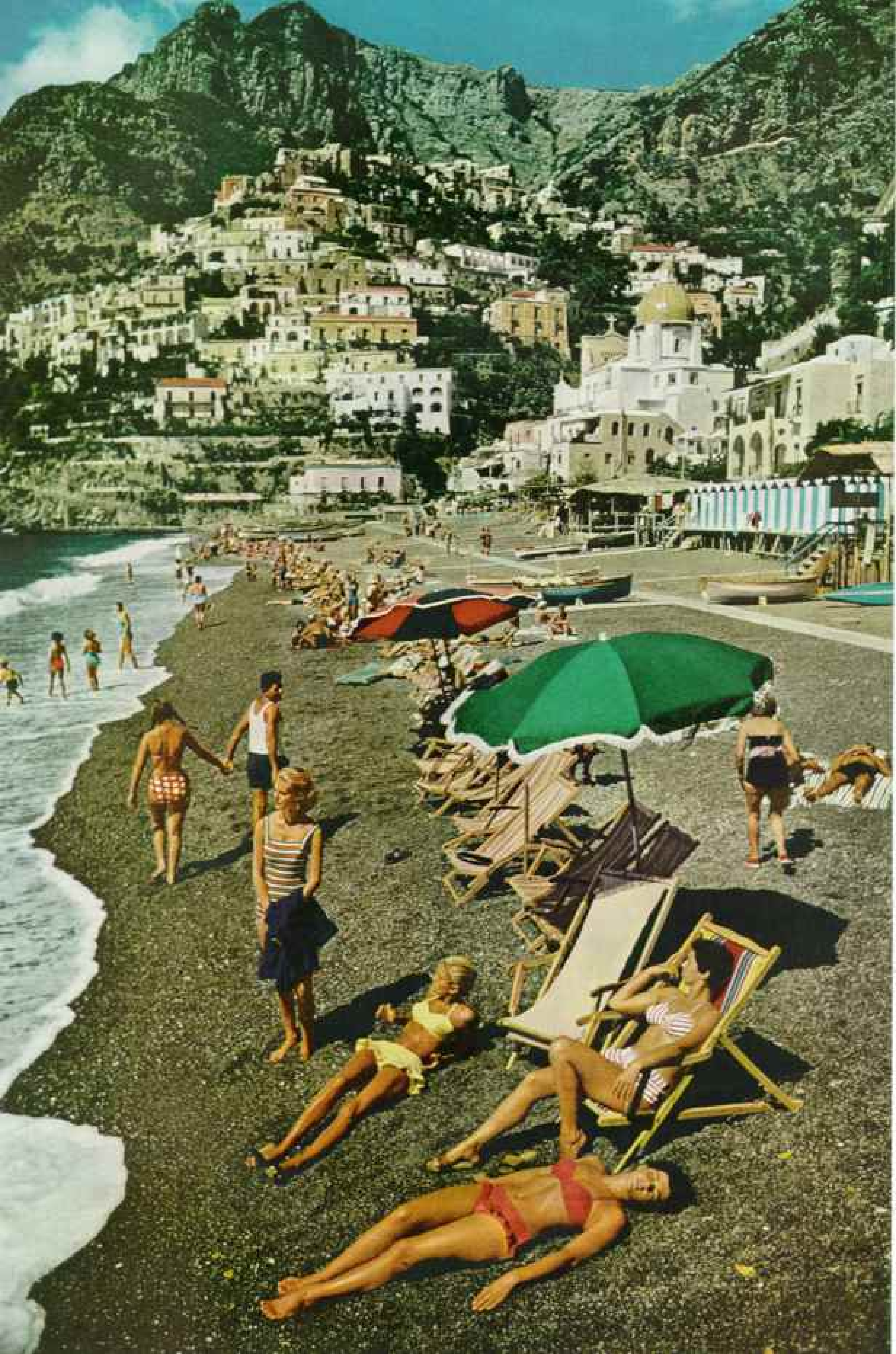
"These winds move with the clock. Beginning at three in the afternoon, the *maestrale* blows until nine or ten at night. From midnight until ten in the morning, there is the *levante*. From eleven in the morning until three in the afternoon, the wind shifts to the opposite quarter, blowing from *ponente*."

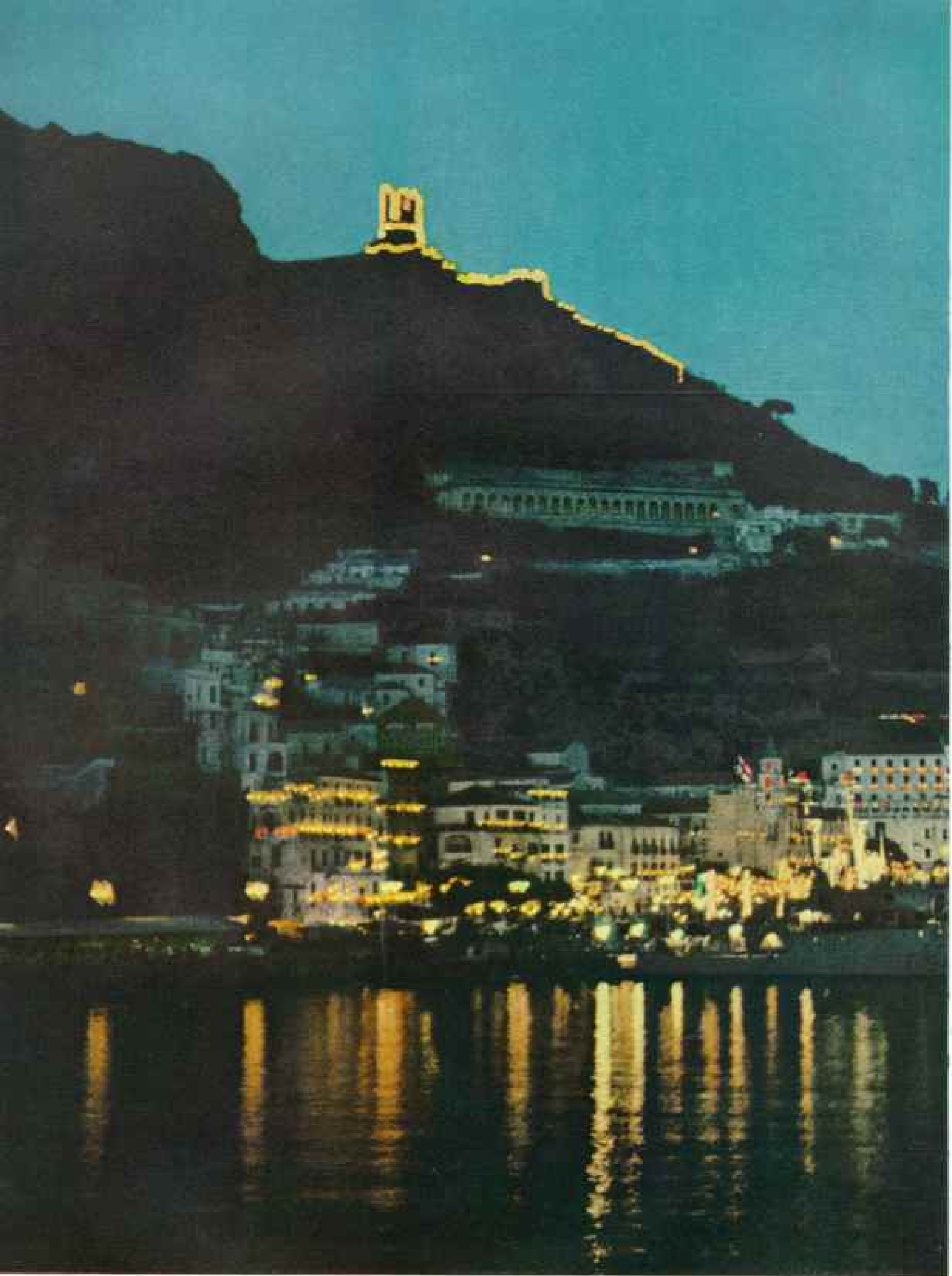
I was interested to find how closely these men live with the rose of the winds, because

(Continued on page 489)

Happy With Their Little Corner of the Earth, Bathers Bronze in the Sun

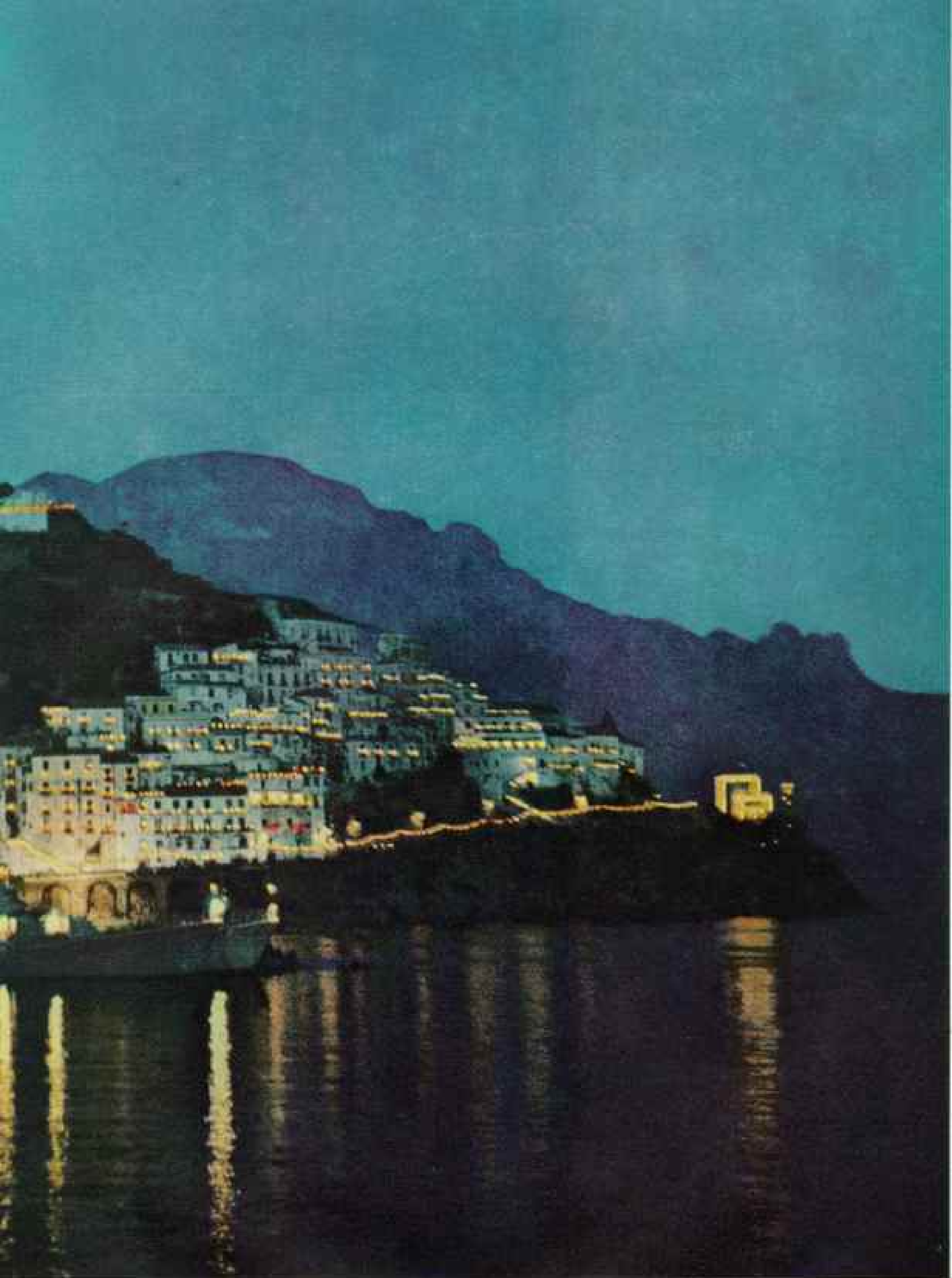
Positano attracts painters, writers, and holidaymakers who come simply to enjoy the *dolce far niente*—sweet do-nothing—of this favored coast. Here, in summer, fishermen have dragged their boats high up on the strand to leave room for vacationists. During the rest of the year they peacefully mend nets on the nearly deserted shore.





Ablaze With Lights, Amalfi Gives Thanks to Patron St. Andrew, Her Protector

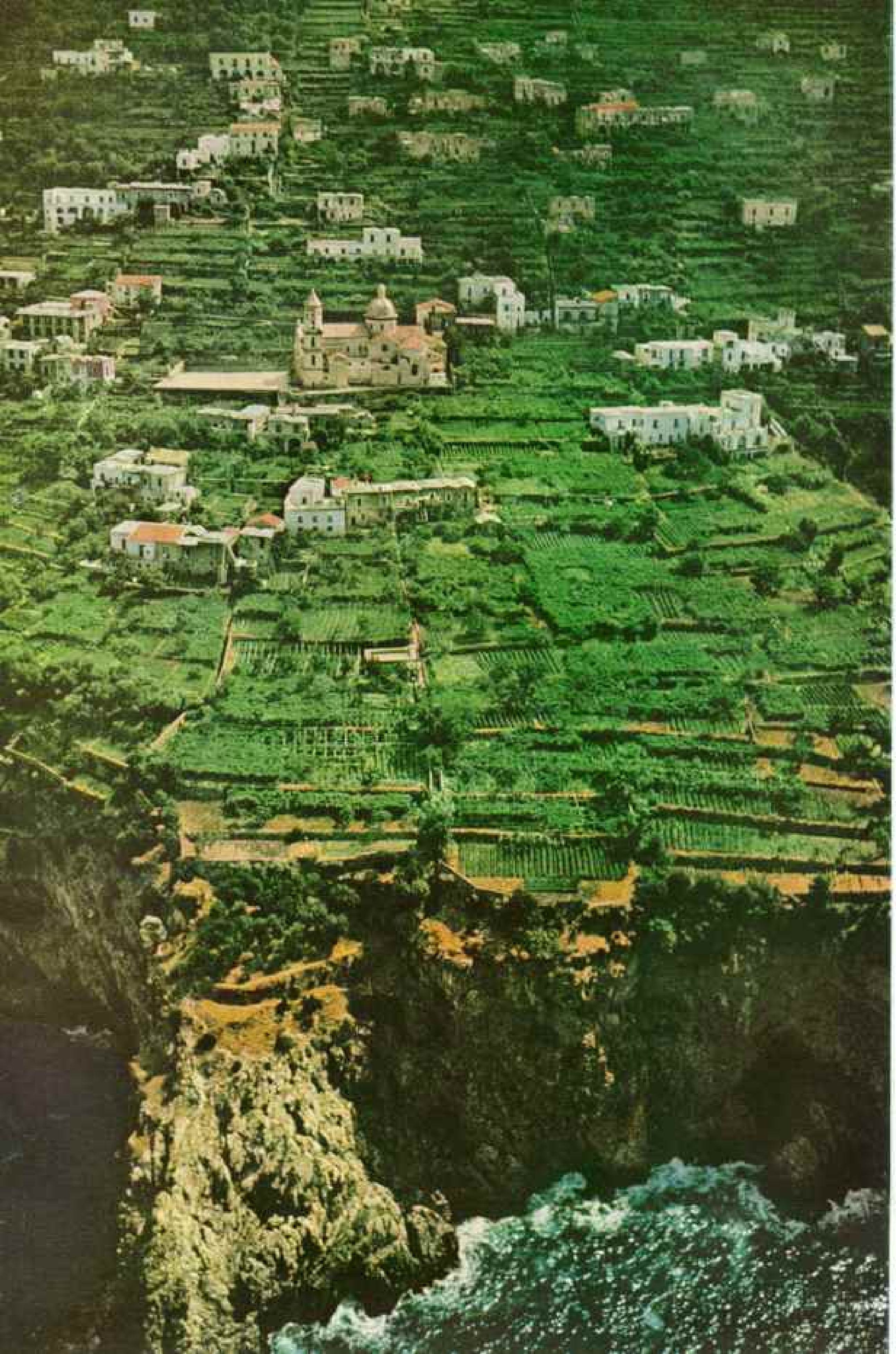
A line of light follows a ridge to the ruined Ziro tower, where Amalfians once kept watch for Moslem corsairs. Square tower at far right shines

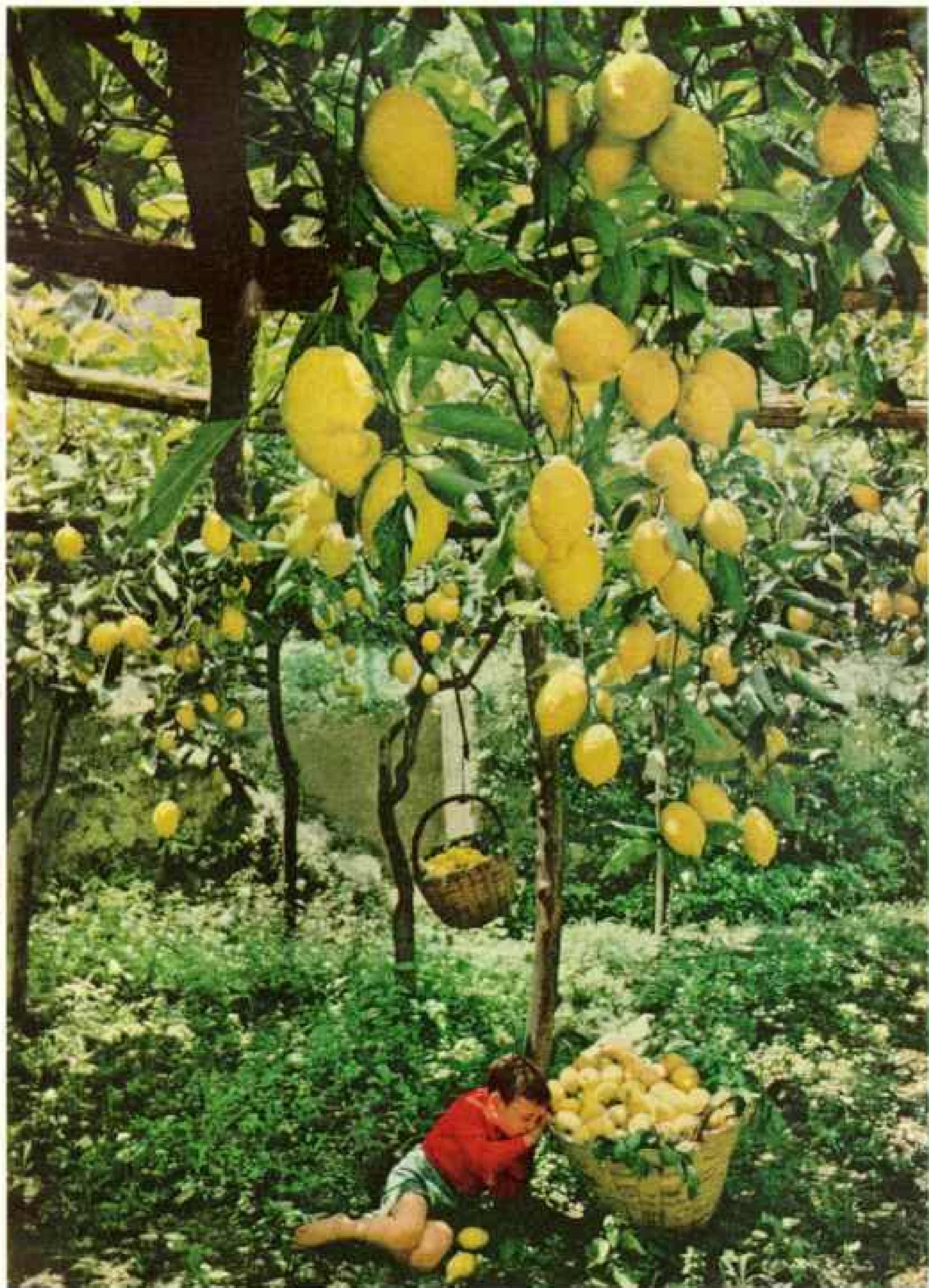


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as if with warning fires that burned when the foe was sighted. When the pirate Barbarossa threatened the coast in 1544, a sudden tempest cap-

sized most of his ships. Lighting their homes on June 27, the anniversary, Amalfians pay homage to St. Andrew for their deliverance.





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Sweet-scented Lemons Lean on Chestnut Pergolas

Lemons of the Divine Coast are so sweet that they are sometimes sliced and eaten as salad. Sagging branches must be supported because Amalfi's lemon trees bear so abundantly. The boy naps beside a basket heaped with the golden harvest.

Domed church of Vettica Maggiore stands in a green-and-gold mosaic of lemon groves and grape arbors. Emigrants from the village now settled in the United States paid for the church's tiled plaza. Excellent wines are made from grapes grown on the terraced slopes.



Amalfians Say They Gave the Mariner's Compass to the World

Though the magnetic needle was known to the Chinese, the nautical compass supposedly took on its modern form when seafaring Amalfians about the year 1300 added a movable card marked with the rose of the winds. Thereafter Amalfi became known as the Magnetic City and bore a winged compass in its coat of arms. These fishermen study an old dry-card compass preserved in the Town Hall.

Portrait of relish: he caught his own dinner. Fisherman Grassi rubs his hands in anticipation of a Lucullan feast in Positano. He eats *zuppa di pesce*, a southern Italian dish like the bouillabaisse of Marseille, which Italians say they originated.

Fish soup in the raw lies on the beach. Curious sea creatures, bizarre in shape but succulent to the taste, go into the *zuppa di pesce*. They include scorpionfish, stargazers (the fish with upturned eyes), squid, octopus, shrimp, and gurnard.







Amalfi (and when I say Amalfi I mean the whole coast, from Colli di San Pietro almost to Salerno) claims to have given the sailors of the world the mariner's compass.

More than a thousand years ago, Amalfi, which legend says began as an obscure Roman colony in the 4th century, became a republic. Her merchant ships sailed the Mediterranean world, and her enterprising merchants grew rich and built opulent palaces and villas, some of which still survive.

"Like the Needle Turning to Its Star"

About the year 1300, a native son took the magnetic needle, which had been known to mariners for some time, possibly as a simple magnetized pointer floating in a bowl of water, fixed it to a card on which he drew the rose of the winds, suspended the card on a pivot, and the modern nautical compass was born. Tradition ascribes it to one Flavio Gioia, whose birthplace is disputed between the towns of Positano and Amalfi. Careful research says that Gioia never existed, but many works on the history of navigation are willing to give Amalfi the credit for the elaboration of the magnetic needle (page 486).

Scattered references to the simple needle had occurred in Chinese writings for a century before the event, but most allusions to the magic pointer are found in Italian literature. The poet Dante refers to it in his *Paradiso*. In the 12th Canto he says:

*"...like the needle turning to its star
Straightway to that voice I hearkened."*

The Romance languages have always used the magnetic needle as a symbol of constancy. A Spaniard says to his sweetheart: "You are my North."

With Onorato and Pietro I made many boating excursions under the towering cliffs of the coast. High above hang white villas, dazzling in the sun, on terraces bright with scarlet flowers. One villa is built around a tower that is said to have been the grist mill of one Arienzo, freedman of the Emperor Tiberius (page 496). The emperor feared poisoning and would eat no bread but that made from flour ground at Arienzo's mill.

On headlands all along the coast stand

stone towers. From them lookouts once kept watch for the sails of the Saracens who harassed the coast in the Middle Ages. Some are in ruins, but others have been made over into delightful villas.

The sea has hollowed out many caves in the cliffs of the Amalfi coast. A few have black arched entrances big enough to admit a good-sized boat. Once we rowed through one archway, traversed a gallery echoing with the plangent slap of the sea, and emerged some distance away through another opening.

One small cave, just big enough for two people, is floored with a rarity in these parts, a perfect miniature sand beach. It is called La Grotta degli Innamorati, the Cave of the Lovers, and is almost never without its occupants in the summer season.

After a night's work, Positano fishermen haul their boats up onto the beach. To drag them high up on the shingle beyond reach of the sea, the men place rollers under the heavy boats, then pull them up by means of a portable wooden capstan.

The boats, brilliant in fresh coats of orange, yellow, and green, bore names like *Santa Rosa*, *San Giorgio*, *Santa Maria Pulce*, and *Delfino*. My favorite was one labeled in English *Baby No. 97*.

Time literally stands still in Positano. When I was there, the clock in the campanile always read 7:12 (page 509).

The Madonna Touched a Mountain

High above Positano stands the little village of Montepertuso (Hole Mountain). The houses, set among groves of olive and filbert trees and terraced vineyards, grasp at footholds on the steep flanks of the mountains. Beside the town a deep ravine plunges to the sea. Across the ravine looms a sheer brown shoulder of rock. Punched so cleanly through it that it seems artificial, a natural arch in the rock lets through a semicircle of improbable blue sky.

On the second of July the townspeople celebrate the festival of their patroness, Santa Maria delle Grazie, and re-enact the piercing of the mountain, the miraculous result, they say, of a contest between the Holy Virgin and the devil.

Fishing Lamps Cast Pools of Warm Light in the Blue Twilight

Boatmen, putting to sea at dusk, search all night for anchovies. Attracted by light, the fish gather under the lamps; then men surround the school with nets. Light-and-shadow effects of scenes like this help to explain why Italy is a nation of painters.

The devil challenged the Virgin to compete for the souls of the people of Montepertuso. They would go to the one who could pierce the living rock of the mountain. With a bar of iron, the devil succeeded only in making a partial perforation. In a fit of rage he turned himself into a serpent and fled down the mountain, leaving his wavy tracks cut into the rock. The tracks are still there; I have seen them.

The Madonna then placed her finger against the mountain, pressed gently, and glided effortlessly through the solid rock, leaving the great arched opening through which the piercing zenithal blue of the Italian sky shines today. Descending into the village, the Madonna said, "Here I shall make my home."

On the eve of the Madonna's festival, I climbed the switchback trail to Montepertuso. The sun had set, and the sea took on a strange lilac hue in the afterglow. I leaned on a cherry-wood walking stick, while bands of pilgrims, carrying baskets and chattering like magpies, walked past me.

In the little square of the village I stood beside the church door and watched the procession form. Near by stood an important personage in Italian festivals, the fireworks expert, who held a long bundle of withe-tailed rockets. Every few minutes he touched one off, lighting the fuse with a glowing cigar end. The rocket swept into the sky with a rush, and exploded high in the fading light with an ear-shattering bang.

Where Policemen Have Tender Hearts

On each side of the church door stood a tall *carabiniere* in gala uniform, resplendent in red-plumed cocked hat, white gloves, and sword. These national police are noted for their impartial and emotionless carrying out of duty. Always sent to a post far from their birthplace, so that they may dispense justice "without fear or favor," they are considered impassive figures of rigid discipline.

Yet as I watched, I saw proof that the Italians, as someone has said, are all heart. Each time a rocket soared into the sky and exploded with a shaking detonation, a young shepherd dog standing near the church door trembled violently. After this had happened twice, one of the expressionless *carabinieri* bent over and held his white-gloved hands over the little dog's ears. He did this each time a rocket went up.

The Italian kindness to animals extends even to the relatively faceless creatures of the

barnyard. When a friend of mine went to buy a chicken from a woman who had come down from the heights into Positano one day, the woman, who carried the fowl cradled in her arms, began caressing it and tearfully kissed it goodbye, crying "Addio! addio!" My friend thrust the money into her hands and fled—without the chicken.

Candles Light a Miracle

From a flat rooftop I watched the re-enactment of the miracle. The sky had been clear and bright with stars, but at a quarter to ten, when the pageant was about to begin, clouds spilled over the pierced mountain. Watching from our side of the ravine, we could see candles flaring as dim smears of light through the veil of fog. Fourteen blows of an iron crowbar clanged out as the devil attempted to pierce

As if the stars had fallen on the sea,



the mountain; then the sweet immature voices of a girls' choir chanting a litany drifted across to us, through the fog.

In the intervals of silence, we distinctly heard the voice of the director, stumbling about in the cloud-shrouded darkness exclaiming, "Misery! What's happened to the devil?" A brilliant white light blossomed on the mountain, and through a hole in the cloud we could see the Madonna, outlined in pyrotechnic flares, robes billowing in the night wind, emerge from the natural arch. Then the cloud closed in and we saw no more, until the night exploded in a fountain of colored fire.

A maestro from Naples put on the fireworks display at Montepertuso. Out of the glowing mist, parabolas of fire ascended into the clear upper sky and burst in dazzling color—blue,

green, gold, and red. As the stars arched outward from the central rocket casing, each exploded in turn and made its own miniature constellation of fire.

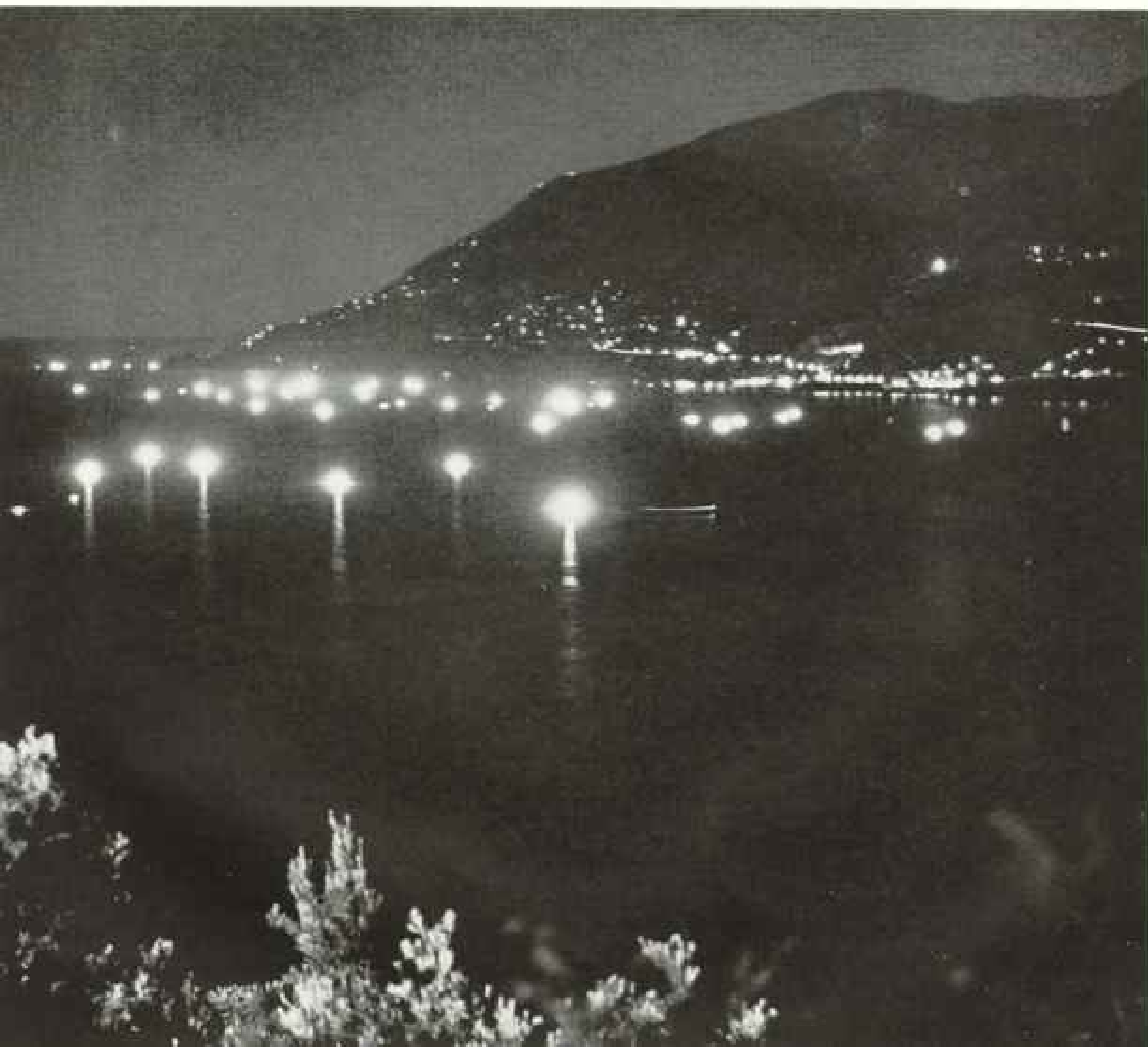
Long after midnight I descended the narrow trail toward Positano. I carried a lantern, like many of the other pilgrims, and the night was pleasant with the sound of voices and the swaying circles of light moving down the trail.

Shining Lights Attract Anchovies

On a rock outcropping at a turn in the path, I sat down to rest. Below me, a trapezoid of fishing lamps moved imperceptibly shoreward, a fallen constellation of Pegasus moving through a dark and liquid firmament.

I had gone out with the fishermen, and in my mind's eye I could see the anchovies, darting black silhouettes just beyond the emerald

lights of the fishing fleet gleam beneath headlands of the Amalfi coast.





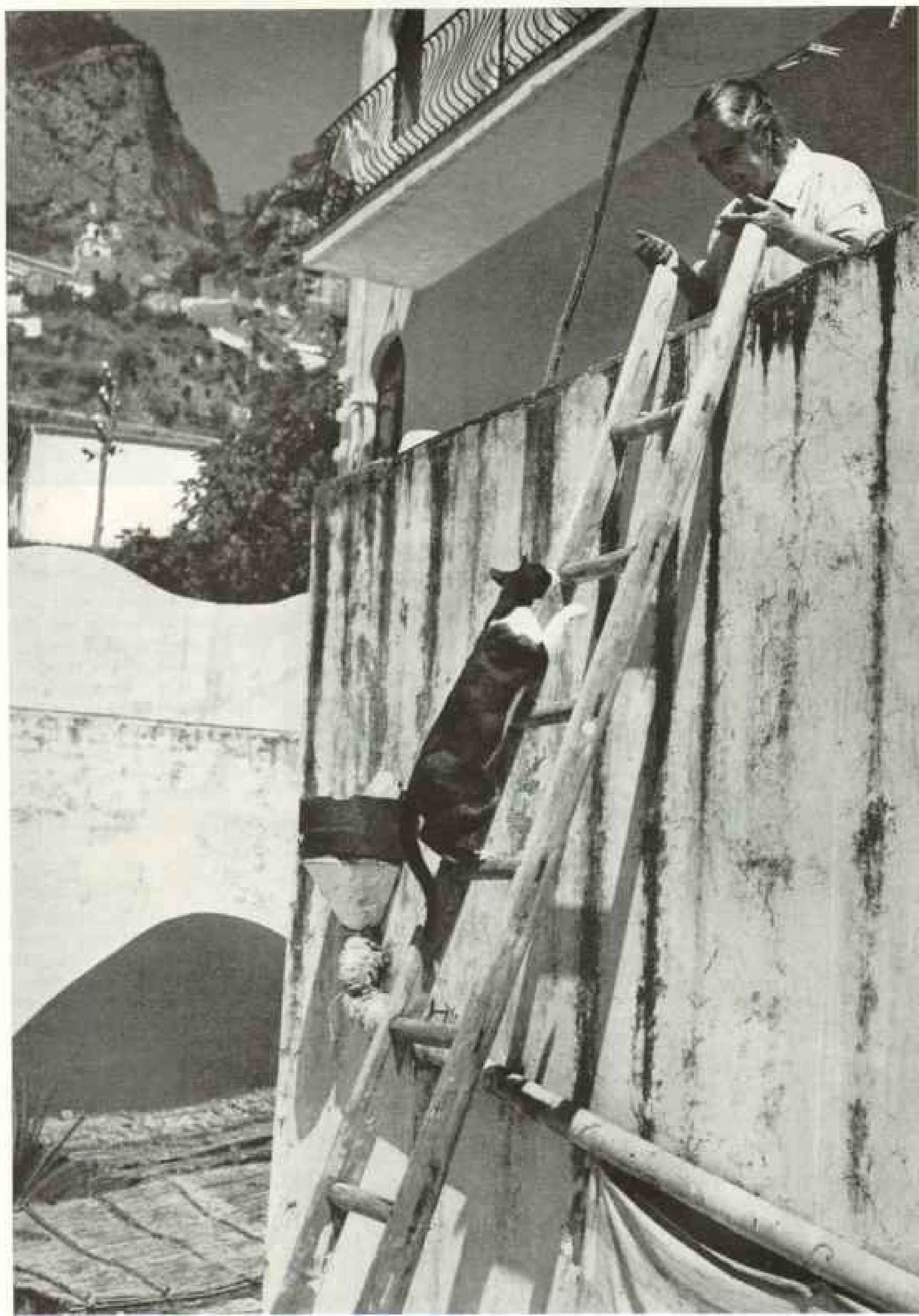
Positano Girls Make Pillow Lace Under the Sharp Eyes of Sister Agnes

Operated by nuns to keep a dying art alive, this school turns out lace handkerchiefs and other delicate articles. The students, whose bobbins fly with a noise like the chirping of sparrows, weave threads around pins stuck into the cylindrical cushions.

In Vertical Positano, Even the Cats Learn to Climb

Flights of stone steps serve as streets in towns built on the Amalfi cliffs. Houses rise one above the other like the apartments of Pueblo Indians in the American Southwest. This cat, named Titino, takes the short way home by climbing a ladder his mistress lets down from her balcony. To go out, he uses the town's stone steps.

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Greengrocer Carves Wood Beside the Fruit He Sells

Antonio Aronne, a self-taught artist working under the steps of the Cathedral of Ravello, sculptures chestnut-wood panels in high relief. Many travelers have taken his carvings home to distant lands. Here Aronne works on a panel depicting the Seven Deadly Sins, which he copied from a marble in a Ravello villa.

Painting on tile, a ceramic artist in Vietri sul Mare copies a page from the NATIONAL GEOGRAPHIC. He works on a panel of six closely fitted tiles, which he will fire and glaze separately, then reassemble to form the completed picture.

In this view, angelfish hover around the ship's bell of *Thistle-gorm*, a freighter sunk in World War II—an underwater scene photographed by the author for page 181 of the February, 1956, GEOGRAPHIC. Today the tiles form a tabletop in Mr. Marden's home.

circle of light, turning to flashing silver streaks as they swam under the glare, whirling round and round in an ecstasy of abandon to the dazzling intoxication of the light, until the net, closing round them, drew them up and ended the dance of death.

I could hear the faint ghost of the fishermen's cries drifting up in the still night. I thought of Izaak Walton's Biblical advice to all fishermen: "Study to be quiet." I suppose that the fish in these parts, being Italian, do not mind a little conversation.

Juggernauts Drive a Corkscrew Road

Beyond Positano toward Salerno, the Amalfi Drive begins in earnest. The turns are sharper, the coast more precipitous, and round every bend scenes of surpassing beauty unfold. Frequently as I drove, the high-pitched yelping horn of a bus echoed from the ravines, warning of the approach of fifty-foot-long red juggernauts, driven with consummate skill by nerveless youths.

One driver, Aniello Cinque, told me there are several curves impossible to negotiate without backing and filling three or four times. I marveled that these 57-passenger monsters could get round the tight spots at all. One Z-shaped curve crosses a short bridge over a torrent; the bus drivers call it the Requiem Eternum, and it is not to be taken lightly by the fainthearted.

"I usually run into at least one foreigner a day who is afraid to go around some curves," said Aniello. "If it is a little car, there's no problem. Only the other day we met a French lady in a small Renault. When I asked her to back up, she said, 'I can't; it's broken.' So some of the passengers helped me to pick up the car and move it to one side. Sometimes, I have to get down and drive a car round for some of the timid ones."

A local man became a hero on the Drive during the German occupation in World War II. A truckload of German troops came roaring down the Drive one morning and ground to a stop at a hairpin bend. The driver, high in his cab, could not see his wheels; so he called to a peasant who was tilling his vineyard close by to direct his backing and filling. The Italian farmer waved and called, "You're all right, keep coming back; that's it, back . . . back . . . back . . ." and waved the lorry, soldiers, weapons, and all, right over the cliff into the sea.

At the crest of a long slope a mass of color

caught my eye. A flowerfall of roses and carnations, brilliant red and pink against a deep-blue sky, cascaded over a high wall. When I stopped the car, a gray-haired woman looked over the wall and invited me to come up.

In the sweet-scented garden she offered me a glass of white wine, and we talked a while. When I identified myself, she cried, "And how is your president?" Dr. Melville Bell Grosvenor had visited the garden the year before while on a tour of Italy, and had sent the Signora Talamo color photographs of her garden. She ran to get them and showed them to me proudly. "Hundreds of autoists stop here and make pictures every spring," she said, "but Dr. Grosvenor is the first person ever to send me a picture, though many have promised."

Several days later I was watching men pile up chestnut saplings beside a bend in the road. From high on the mountainside the woodcutters sent the poles down by an overhead cable.

At the height at which the men were working, the peeled poles looked like pale straws floating in the wind. As they descended slowly, they grew into blanched asparagus stalks, then became poles about 10 feet long as they came to the end of the cable and fell with a clatter on the ground.

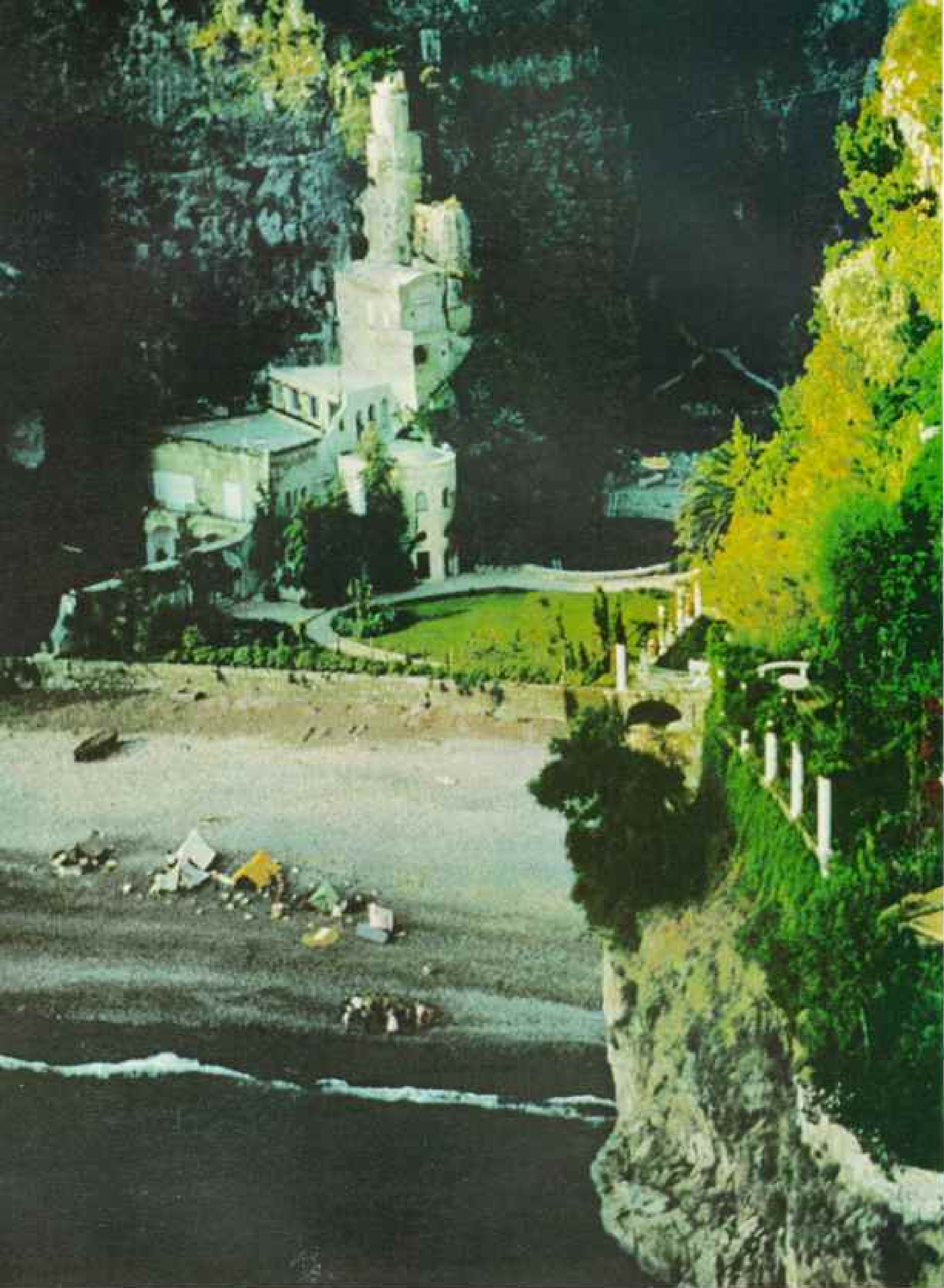
As I watched, a ringing voice from the heights cried in English, "Hel-lo dah-ling!" I peered up and saw a kerchiefed figure waving vigorously. It was the Signora Talamo of the flower garden, working energetically with the woodcutters at the age of 59.

Toddy Bear That Went to Sea

A mass of oleanders overhangs the village of Vettica Maggiore, below the Drive on the seaward side. Here I walked down seemingly endless flights of steps to the marina at Praiano to watch the fishermen drag their boats up the ramp after a night's work. To the high stem of one boat was tied a bleached, slant-eyed Teddy bear. "I found him swimming out to sea from Positano," the owner said.

A boat beating into the wind offshore seemed to heel over excessively. When it came closer, I saw it was only the slant of the lateen sail's cockbilled yard.

About halfway between Positano and Amalfi there lies hidden below the Drive the Emerald Grotto. The Grotta di Smeraldo was discovered when an exceptionally low sea



White Villas Among Terraced Gardens
Gleam Against Positano's Rock Face

Whitewashed walls and hollow, vaulted ceilings keep the houses cool in the hot Italian summer. Towered villa at left originally was a Roman



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mill; tradition says it ground wheat for Emperor Tiberius's bread. A stream that powered the mill cascades down the terraces into a swimming pool.

Tents at water's edge belong to French vacationists, who are protected by an Italian law that says no landholder may control the beach.

in the nearly tideless Mediterranean revealed the underwater entrance. Amalfians enlarged a small opening on the landward side, and the cave was opened to visitors in 1934. A steep flight of stairs leads down to the cave, but I took an elevator that descends through a shaft in the rock.

After the glare of sunlight outside, I could see nothing when I first entered. When my eyes adjusted to the semidarkness, I saw that I stood on a concrete embankment beside a pool of dark water (page 475). In the distance shone a faint blue glow. I felt like Dante, standing with Virgil on the brink of Inferno.

A cheerful voice called from the gloom, as a flat-bottomed boat slid in to the pier. Slowly boatman Andrea rowed me over the still pool. From the high, vaulted ceiling, yellow-brown stalactites hung down to the water; some even penetrated the surface mirror, baffling me until Andrea explained that the cave, together with the whole Amalfi coast, had slowly subsided through millenniums of time, until the tips of some stalactites were well below sea level.

Against the seaward wall a patch of luminous water glowed intense electric blue-green, where sunlight, penetrating the seaward opening below the surface, refracted through the limpid water. Our faces shone a ghostly blue, and when Andrea struck his oar on the water, glistening droplets like liquid aquamarines spattered the surface.

Exploring the Grotto Floor

I returned many times to the weird beauty of the grotto, and one day I slipped below the surface with an Aqua-Lung on my back (page 474). I lighted my way at first with a waterproof flashlight, but as I swam toward the sunken opening, the glare grew so bright that I switched off the light. Near the opening to the sea I passed a solid column of limestone formed by a stalagmite that had grown upward to join tips with a stalactite. Beyond, the sand floor shelved sharply, and at a depth of 30 feet I swam into the open sunlit sea.

Above me the underwater entrance arched to within 15 feet of the surface.

The seabed, covered with undulating brown seaweed, sloped gently, and then dropped off in deep rocky valleys. Here and there on the bottom, at a depth of 50 feet, oval shells a foot high stood upright (page 478).

If the moon had an atmosphere to soften the harsh black and white of sunlight and shadow, I am convinced it would look like the bottom of the Mediterranean, where steep crags and peaks rise from glowing blue depths, and a jagged lunar landscape melts into the luminous haze of distance.

Swimmers who know only the tepid surface waters of this inland sea would be surprised to find how cold the Mediterranean can be at depth. At 50 feet it begins to grow cold; at 100, the diver swims through liquid ice. American divers used to swimming in the cold California Current would feel at home here.

Amalfi Policeman Quotes Dante

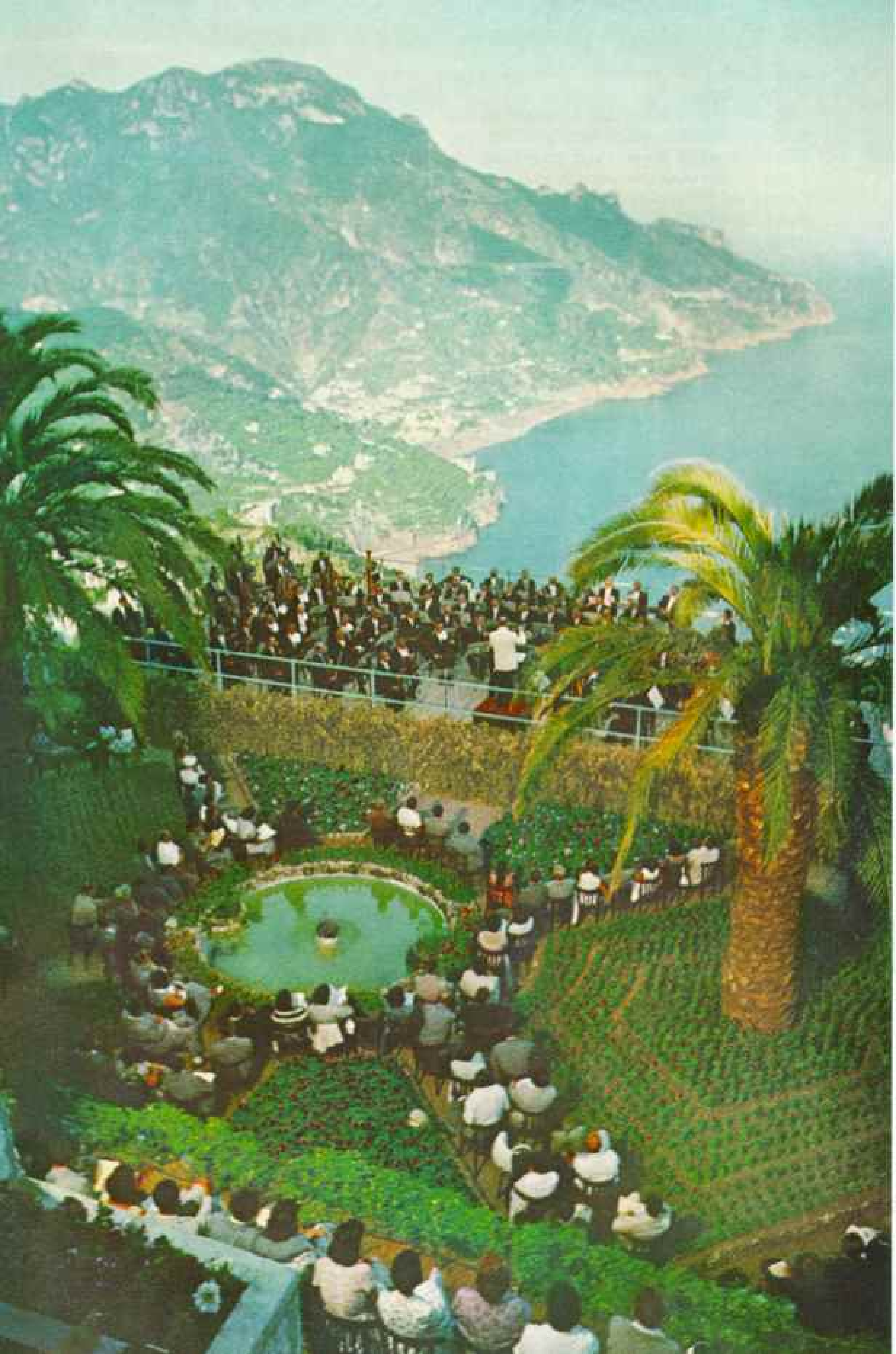
It is not far from the grotto to Amalfi; more hairpin turns, several striking vistas, and then a sloping dark tunnel through the rock and, at the far end, Amalfi. The Drive makes one of its rare descents to sea level at the parent town of the coast; just beyond the tunnel it debouches on a square jammed with carriages, parked cars, Amalfians, and visitors strolling about in the incomparable air and sunlight.

On my many visits to Amalfi, I became fast friends with the town policeman, who quoted Dante to me at every opportunity. This is not so unusual in Italy; the Italians live with the literary giants who formed their language; they belong to all and are not the property of a few scholars.

"I have relatives in Calabria," the policeman told me. "About 50 years ago we had a good depth of water right up to the shore, and big ships could still come in here. We had a lively trade with southern Italy. Our people used to sail there to sell pasta. Some left the ships and settled, mainly to open up

A Symphony in the Sky Plays Wagner in a Garden Loved by the Composer

Richard Wagner visited Ravello in 1880. When he saw the garden of Villa Rufolo hanging more than a thousand feet above the Gulf of Salerno, he exclaimed: "Klingsor's magic garden is found!" and ordered his painter to sketch the scene for the production of *Parsifal*. In commemoration of the momentous visit, the people of Ravello each summer bring a world-renowned orchestra to play in the garden. Visitors gather from all parts of Europe and the Americas to hear four concerts. The musicians' platform, specially built for the occasion, overhangs the village of Minori far below.



small home pasta factories. Calabria is full of Amalfians."

In the year 1899 a big landslide carried most of Amalfi's waterfront into the sea, filling the small harbor and preventing the access of deepwater vessels. Another similar disaster in 1924 caused widespread damage along the coast. Now only small vessels tie up at Amalfi's mole.

In the Middle Ages the venturesome sons of this coast sailed in their home-built vessels all over the Mediterranean and founded several colonies.

Amalfi was born "between the sunset of the Western Roman Empire and the dawn of the Eastern." The Chronicle of Amalfi states that a band of Roman patricians, fleeing the invasions of the barbarian hordes, set sail toward Constantinople, but contrary winds and tempests forced them on to the rugged southern coast.

Nobles Find a Haven From Pirates

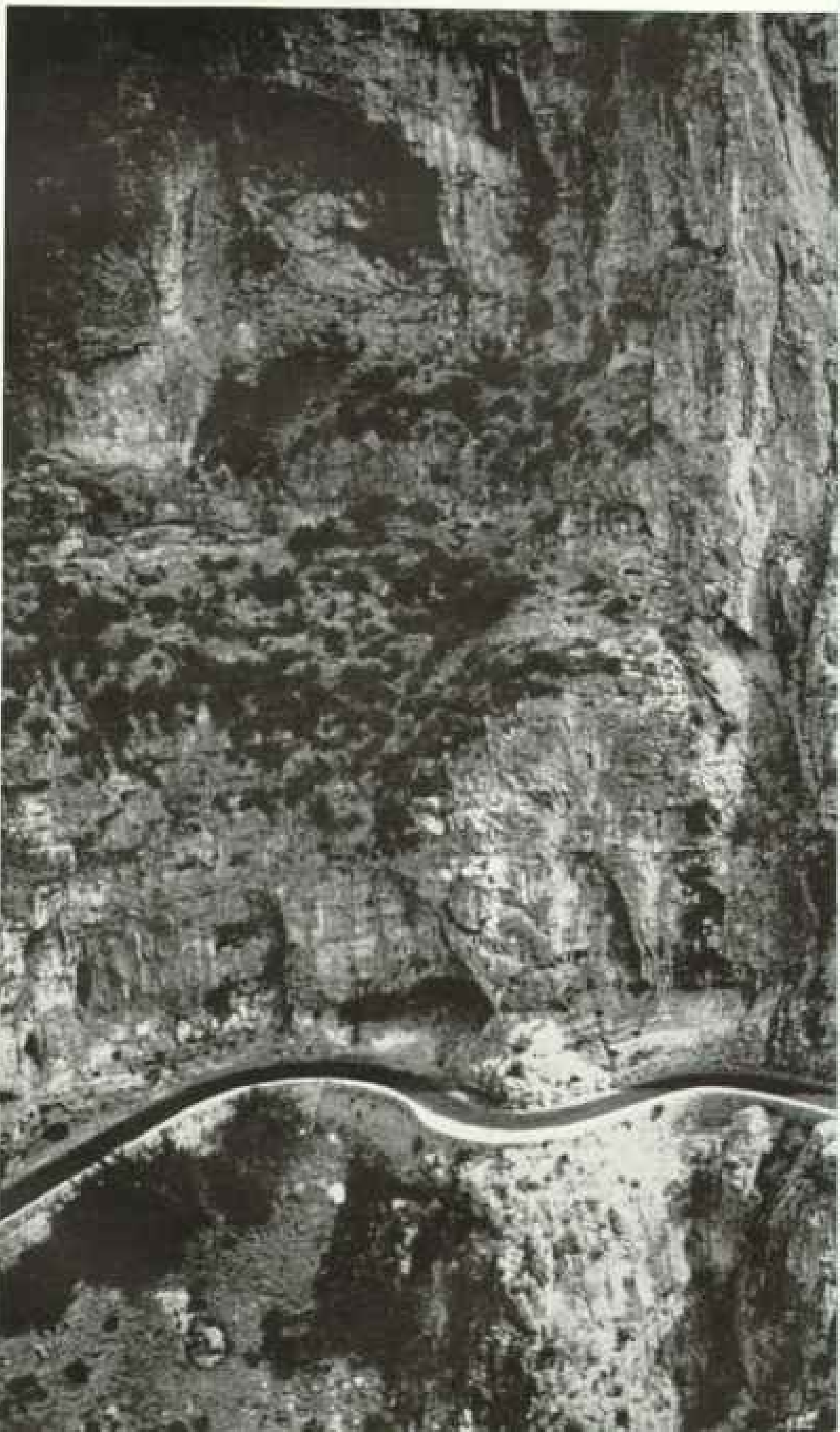
On the banks of a river called Melfe they founded a town, and they became known as Melfitani. Barbarians and pirates harassed

Amalfi Drive Cuts Into Living Rock High Above the Sea

A triumph of engineering, the road loops round headlands and swings inland to follow deep coves. For almost its entire length, the Drive overlooks blue water 100 to 700 feet below, disclosing vistas of incomparable beauty at nearly every turn.

Small Italian automobiles negotiate the curves with ease, but large American cars barely squeeze around the tighter loops. To negotiate some hairpin turns, the big bus in center has to back and fill several times.

This craggy shore graphically illustrates the shortage of arable land that compels most Amalfians to look to the sea for a living. More than a thousand years ago their forefathers organized a maritime republic, whose sea power lasted for centuries (page 504).



them constantly; so they fled again, this time to the impregnable natural defenses of the Lattari Mountains, where later they founded the town now known as Amalfi.

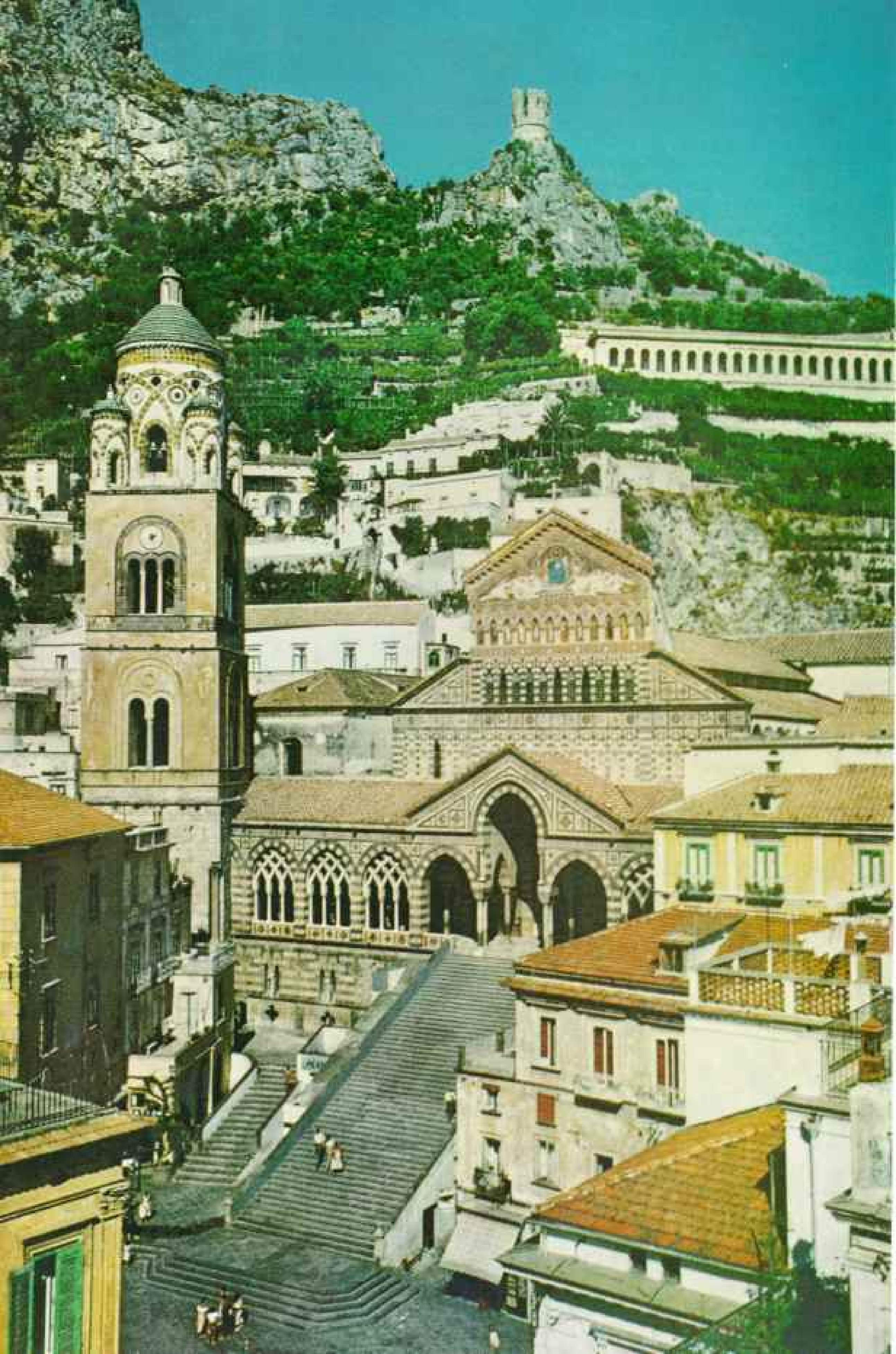
Through the centuries Amalfi grew constantly richer, building an unrivaled military and merchant navy. She was included in the Byzantine Empire until she declared herself an independent republic in the 9th century, thus becoming one of the four maritime republics of Italy. Of the other republics—Genoa, Pisa, and Venice—Pisa became a mortal enemy.

A Baghdad merchant wrote in 972 that Amalfi was "the most prosperous city of Longobardia, the most noble . . . the most enterprising, and most opulent."

In the 14th century Boccaccio could still call the Amalfians "as rich and stirring in the matter of trade as any in the world."

Amalfi, from the experience of its sailors and traders, formulated in the Middle Ages a code of maritime laws that regulated the seafaring commerce of that region for centuries. The republic even coined its own money in silver and gold and, some time before





the 13th century, founded a local industry that still exists—papermaking.

At the height of her power the town had more than 50,000 inhabitants. Today she does not hold a tenth that number, but most of medieval Amalfi lies beneath the sea. Terrible landslides and tidal waves have eroded the waterfront until less than half is left of the original foreshore.

When the Sea Swallowed Amalfi

The most cataclysmic of these catastrophes was the result of a storm of unimagined fury that struck on November 24, 1343. The poet Petrarch was in Naples at the time and has left us a vivid description of the tempest in his *Epistolae*. At Amalfi a tidal wave swallowed up all the port works of the city, walls, palaces, and monuments, and destroyed part of the arsenal and all the ships in port, cutting off the lifeblood of the republic.

I swam over the seabed but saw no signs of an engulfed city. Doubtless what ruins may be left are buried under tons of rubble.

What remains of Amalfi today is a maze of winding passages and narrow streets, some so arched that they resemble corridors in a monastery. When I emerged from a dark tunneled passage into the blinding light reflected from whitewashed walls, the glare was so intense that I had to close my eyes.

I stood one day in the square at the foot of the tall flight of steps leading up to the Cathedral of Amalfi (opposite). In the pediment above the arched entrance a magnificent mosaic in colored stone winked gold, blue, and red in the evening light.

It was June 27, and the Amalfians were celebrating a feast in honor of their patron, St. Andrew the Apostle (page 482). The procession emerged from the cathedral and passed slowly down the steep staircase, carrying an umbrella-shaped canopy in the red and yellow colors of the old Kingdom of Naples. A banner read: "St. Andrew the Apostle—The miracle that occurred in defense of Amalfi against the famous corsair Ariadno Barbarossa on the 27th June 1544."

On that date warnings that the fleet of the Moslem corsair was approaching reached

Amalfi. The greatly outnumbered Amalfian ships sailed to defend their homeland, when suddenly, out of a clear sky, a terrible storm struck the enemy ships, destroying most of them. Amalfians attributed the miraculous intervention to their patron.

Another banner carried amid flickering wax tapers said:

"The Committee expresses publicly its gratitude to the Society of Saint Andrew of New Haven, Connecticut, and to all the Amalfians resident in the Americas who have generously contributed to the fireworks of the procession."

Amalfi's largest colony in the United States lives in New Haven. Regularly the emigrants come to visit the old country. The returned native sons are easy to spot among the local people and the casually dressed tourists. They wear bold-patterned sports jackets and bright ties, and speak dialect Italian with an American accent.

Some come home to find a wife to take back to the United States; others loudly cry, "Where can you find air like this?" and either settle down to stay or take the next ship back to America.

Amalfi's Serenity Inspired Ibsen

The tranquillity, sun, and solitude of Amalfi have always attracted writers looking for the Great Good Place, as H. G. Wells termed it, in which to work. The Sitwells came here, and before them Henrik Ibsen. The Norwegian playwright lived in the Hotel Luna, overlooking the sea on the edge of Amalfi. Originally the Luna was a monastery, probably founded by St. Francis of Assisi himself in 1222. Here Ibsen wrote *A Doll's House*.

Amalfi squeezes into the mouth of a ravine called the Valle dei Molini. When I followed the narrowing ravine away from the sea, I walked beside a wall overlooking a small stream. On the banks of the Canneto stand the old paper mills. Water power still turns the thumping and whirring machinery in these small manufactories. Today the mills make only a heavy gray machine-made paper which is used mainly for wrapping, but I was presented with a small volume printed on an

Amalfi's Cathedral Has Stood on This Site More Than a Thousand Years

Little remains of the original church, which today is a cathedral dedicated to St. Andrew, the town's patron saint. Beginning with an enlargement in 987, the church has been rebuilt various times. Restorers erected this façade after the old front collapsed in 1861. Medieval sentinels stood invasion watches in the ruined tower on the crag.



Lateen-sail Fishing Boat Tucks Into a Hidden Haven

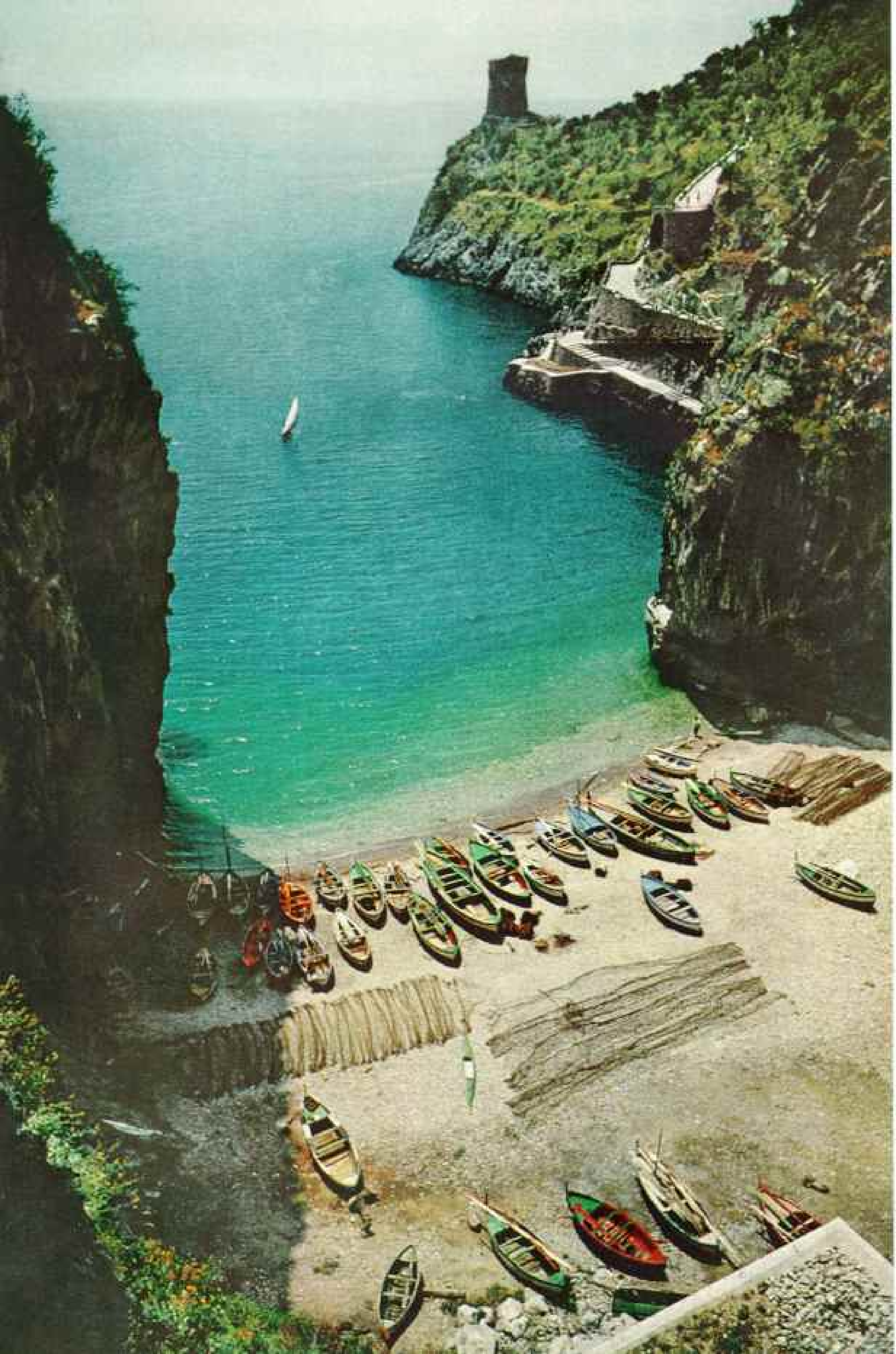
After a night's fishing, boats lie on the Marina di Praia, and nets dry in the sun. Ruined watchtower on the point served as a lookout post for Saracen invaders. Other turrets dotting the Amalfi coast have been made over into villas.

Robed in Gold, the Doge of Amalfi Puts to Sea

Once a year Amalfi competes in a rowing regatta with Pisa, Genoa, and Venice, the three other maritime republics of Italy. Before the race the doge walks in procession but does not enter the boat. Here, at home, he enacts a scene from the days of the republic. A page carries his golden crown.

Barge of the republic, with its winged-horse figurehead, glides over an oily sea.





excellent handlaid paper made in these ancient works.

Beside the stream stand pergolas heavy with dark green foliage, through which the golden yellow of the famous lemons of Amalfi glints in the sun (page 485). These delicately scented lemons are almost as big as grapefruit. A half dozen of them I tossed in the back of my car, filling the whole vehicle with a pleasantly astringent perfume.

Road Turns Its Back on the Sea

Beyond Amalfi the road climbs above the sea again and resumes its twisting and looping. At Minori the Drive comes down to sea level once more. Just beyond, at Maiori, the road was cut in 1954 by a heavy landslide that took many lives and caused uncalculated damage in Minori, Maiori, Tramonti, Cava de' Tirreni, and even Salerno.

On the other side of the sandy alluvium the Drive climbs again to one of the most bizarre points of the coast, the Capo d'Orso, Cape of the Bear. Here twisted dark-green rock strata, crowned with stunted and gnarled pines, resemble the landscape in the background of some primitive Italian painting. From the highest point of the cape there is a superb view backward toward Amalfi.

The Drive plunges far inland round a deep valley glossy with the green of lemon groves and vineyards, then climbs steeply out again to the edge of the sea. On headlands below, solitary ruined towers keep watch for a vanished enemy.

At Vietri sul Mare, a few miles beyond the Cape of the Bear, the Amalfi Drive proper ends. From here the coast road runs docilely downhill into the flat plain of Salerno, and here the traveler who traverses the Drive in one day turns inland, and, having had a glimpse of Paradise, rejoins the main road to Pompeii, Naples, and the everyday world.

Set back from the sea, high above Amalfi, on a rocky promontory like a gigantic petrified ship anchored in the sky, stands Ravello (page 472). To reach it, I left the Amalfi Drive at Castiglione, just beyond Amalfi, and struck inland. Here there are turns and grades that make the Drive seem almost sedate. The road follows a high-walled, narrow valley far inland, before doubling back upon itself to climb to the top of Ravello's rock.

Ravello, high above the streaming traffic of the Drive, cool in the mountain air, stands in the quiet of other centuries. Under sough-

ing poplar trees in the cathedral square, three old women in black conversed in whispers. Solid-looking citizens sat at little red cafe tables on one corner of the square and greeted one another with a raise of the hat and the old Latin *salve!* Gently over all lay the murmur of silence.

Ravello was the seat of a powerful medieval family, the Rufoli, and the ruins of the villa built by them still stand. It was to a Rufolo that Boccaccio referred in one of the *novelle* of the *Decameron*. The garden of the Villa Rufolo, with its formal geometric beds and terraces on several levels, is still meticulously kept. The oldest part of the ruins dates from the 13th century.

To Ravello came Richard Wagner in 1880, seeking inspiration for his *Parsifal*. When he saw the exquisite Rufolo garden hanging above the sea, he exclaimed: "*Klingsors Zauber-garten ist gefunden!*"—"Klingsor's magic garden is found!" and ordered his artist to make sketches on the spot for the set of the opera. Nothing could have done more honor to the Italians, a nation of music lovers, and each year a series of Wagnerian symphony concerts is given in the Rufolo garden to commemorate the historic event.

Ravello Remembers D. H. Lawrence

Wagner was not the only artist who sought and found peace in Ravello. The novelist D. H. Lawrence came here several times and stayed at an inn called today the Albergo Rufolo. From the terrace of this hotel I saw what is perhaps the most strikingly beautiful view of the whole Amalfi coast: the sweep of the Gulf of Salerno, the white towns of Minori and Maiori, and the terraced mountains falling in stiff folds into the blue Tyrrhenian.

A plaque on the wall of the Rufolo reads: "The celebrated English author sojourned here in 1926, finding inspiration for his famous novel *Lady Chatterley's Lover*."

"Meditating on the terrace of this hotel, he added this reflection:

*Lost to a world in which I crave no part
I sit alone and commune with my heart,
Pleased with my little corner of the earth
Glad that I came and not sorry to depart"*

In Ravello I met the three brothers Caruso, and thanked them personally, especially Pio the oenologist, for the bottles of good wine bearing their label that I had drunk during my stay on the Amalfi coast. The brothers make



Tomatoes Hang to Dry Under a Sun-warmed Roof

Tomato paste, basis of spaghetti sauce and much other Italian cookery, is made by pressing the partly dried tomatoes through a sieve. The paste is then put up in jars.

Spaghetti alle vongole (with clam sauce) is a specialty of the entire Naples area. Sometimes mussels are used instead of clams.

This man washes down his *pasta* with a rosé wine produced at Furore, a small fishing village close to Conca dei Marini, where he lunches.



white, rosé, and red wine, and they say that their family originated the rosé in 1896. They told me none had been made or bottled anywhere in Italy before that date. The skins of dark grapes give red wines their color; by removing the skins before fermentation is completed, the lovely pomegranate-colored rosé results.

When I drank my first bottle of Gran Caruso, the waiter said: "They say this wine makes one sing." It can.

Villa Perches 1,200 Feet Above the Sea

Far out on the spur of rock that overlooks Castiglione and the sea stands a villa constructed in recent times but of ancient materials and style. The Villa Cimbrone was built in 1905 by Lord Grimthorpe, the nephew of the designer of London's Big Ben.

Conversing one day with a waiter, Lord Grimthorpe learned that the land at the crest of Ravello's Gibraltar was for sale. "If you will be my factotum, I'll buy it," said his lordship. For the next six years the English lord and the Italian ex-waiter, working together without plans or architect, built one of the handsomest villas in Italy. Gathering ancient pieces from demolitions, they built the villa and filled it with works of art.

The Villa Cimbrone stands on the summit of the rock of Ravello that thrusts like the bow of a ship into the blue Italian sky. The villa's formal gardens run the length of the long promontory. Under somber cypresses and poplars stand bronzes of Roman gods. At the point of the promontory the ashes of Lord Grimthorpe lie under a statue of Bacchus.

At the extreme "bow" of rock, a belvedere like the bridge of a ship commands the most dramatic view. Far below cars seem to crawl along the edge of the white-scalloped indigo sea. Beneath my feet, swallows dived and darted, and under them the vineyards and lemon groves lay in green geometric patterns against the brown earth.

With Gino and Paolo Caruso I attended a Wagnerian concert in the garden of the Villa Rufolo. For the 100-man Munich Symphony brought from Germany for the series of four concerts, a platform had been built out over space from the edge of the lowest terrace.

The audience sat on chairs set on the paths of the lower garden, on the steps leading up to our level, and on grandstands erected for the occasion (page 499).

The concerts began nearly at sunset, with the red glow of the fading sun shining on the white towns a thousand feet below. In the center of the lower garden, immediately in front of the orchestra, stood a circular fountain. At fortissimo passages of tympani and brass, a startled shoal of goldfish in the fountain would make a sudden sortie from under a rockery and dash round the pool.

Never was a setting more dramatic, but the music and the voices of the soloists were all but lost in the immensity of sky and sea. The sound was absorbed by the blue void behind the orchestra, and some of the grandeur of Wagner's most stirring passages drained off the precipice into the beauty of the Divine Coast.

When the concerts were finished and the musicians, cars, and crowds had departed, I walked one day at dusk down the avenue of cypresses to the belvedere of Villa Cimbrone.

A rising crescent moon, orange-yellow like a slice of Paestum melon, hung over the violet sea. As the evening darkened, the planet Mars appeared under the moon, ruddy at first, then paling to salmon as it rose. Beneath it, like a lambent reflection, quivered the pale salmon flame of a squid fisherman—two planets Mars, one hanging motionless in the sky, the other trembling below it on the dark breast of the sea.

Stars on the Night Sea

Round the headland of Atrani, the brilliant white lights of the anchovy fishermen came, a fluid village of lights. Overhead, the stars rivaled the lamps in brilliance. I thought of the story a friend had told me the day before. On the train near Sorrento he had met an old woman who had just returned from the United States. She had spent 20 years in New York and was now coming home to the Divina Costiera. Why, asked my friend, after living so long in New York, was she now coming back to Amalfi?

"Because," said the old lady, "in New York the stars are so far away."

Candles Flicker at Day's End as Positano Girls Walk in Procession

After winding down steep staircases, the Corpus Christi procession pauses on the embarkation mole. Small girls in bridelike first-communion dresses wait for others to catch up. When the author was here, the church-tower clock always pointed to 7:12.





Unsung Beauties of Hawaii's Coral Reefs

Article and photographs by
PAUL A. ZAHL, Ph.D.
National Geographic Senior Staff

MY WIFE peered into the collecting bucket at a motionless lump of ugly tissue the size of a walnut. "What on earth is that?" she asked.

"A nudibranch," I answered. "It's one of the sea's most gorgeous creations!"

She looked at me with lifted brows and peered again into the bucket. As if in response,

the amorphous lump suddenly unfurled itself, revealing brilliant reds and yellows. Then, with slow, undulating movements, it left the bottom; curving, banking, gliding, it flew through the water like a hibiscus petal caught in a gentle breeze.

The "petal" was in fact a shell-less mollusk—a sea slug, technically known as a nudibranch, meaning "naked gill." The names may suggest ugliness; yet few living things rival sea slugs for color and grace of motion.

My wife Eda and I were watching sea slugs under ideal conditions. To study a bright sampling of marine life, we had come to a Hawaiian setting as colorful as any creature we might photograph. Much of the time we had a complete island virtually to ourselves.

Properly, our isle was called Mokuoloe; but visitors who come to Kaneohe Bay to view its coral reefs know it better as Coconut Island. A mere 15 miles from Honolulu—close enough to Oahu's shore to rest in the



Coconut Island Lagoons Hold a Treasure Trove of Tropic Sea Creatures

Caressed by trade winds, this coral-fringed garden spot sits in the warm shallows of Kaneohe Bay off Hawaii's Oahu Island. Downtown Honolulu, capital of the new 30th State, lies but 30 minutes away by launch and car.

A philanthropic group that purchased the verdant island in 1948 made available a section to the University of Hawaii for a marine laboratory. Biologists from all parts of the world call here to study the sea life.

As a guest of the laboratory, the author came to Coconut Island to observe and photograph the vivid nudibranchs, or sea slugs, and other animals that swarm its pools.

Like a flower in the sea, a Pacific nudibranch glides through the water. Removed from the tide pool, this five-inch beauty called flying carpet collapses into a shapeless blob of tissue. Scientists know it as *Hexabranchus*, meaning "six gills."



evening shadows of the Koolau Range—18-acre Coconut Island sits in warm bay waters (map, page 519). More than 2,500 marine species thrive in Kaneohe Bay and the adjacent sea. This marine variety attracts scientists from all the world, and Coconut Island is the home of a famous marine laboratory of the University of Hawaii. At the invitation of Dr. Robert W. Hiatt, Dean of the Graduate School, we were staying in a pleasant cabin maintained by the laboratory.

Slugs Mimic Their Surroundings

In our quest for nudibranch specimens, we first turned to the bay's waters. Our guide was the laboratory's director, Hank Banner, more formally known as Dr. A. H. Banner, Professor of Zoology at the University of Hawaii. With us went Mrs. Banner and the four Banner children, ranging in age from 6 to 13. Our goal lay near one of the bay's

reefs where, according to Hank, we might find a type of orange-colored coral called *Dendrophyllia* (opposite). Among its polyps often lives a sea slug of matching color.

Browsing and feeding in miniature forests of tide-pool algae, amid swarms of stinging jellyfish, on the undersides of seaweed fronds, on coral branchings, mud flats, or submarine banks, in sand shallows, and even in the pitching waters of the high seas, these fancy cousins of land snails are found in every sea. Yet so effective is the mimicry of many of them, so harmoniously do they blend into their chosen backgrounds, that they often go unseen unless painstakingly sought.

Nudibranchs come in many sizes, from a quarter of an inch long to eight inches. They have shells for only a short period early in life. As they mature, all trace of the shell is lost.

So fragile are these fairyland creatures that museums of natural history cannot exhibit

Bottom-browsing Nudibranchs Show Horned Tentacles and Plumelike Gills

Sea slugs, unlike their cousins the land snails, have lost their shells. "To appreciate their full beauty," says the author, "one must observe them in motion." When danger threatens, *Glossodoris* draws in the delicate gill filaments which give the sea slug its scientific name, nudibranch, or "naked gill."

ALL ILLUSTRATIONS BY PAUL R. ZANK. NATIONAL GEOGRAPHIC STAFF © N-G. I.





Hunters Comb the Coral for Camouflaged Slugs

Pacific nudibranchs that live and feed among coral branchings often display colors matching their environment. Only the keen-eyed can detect them.

Dr. A. H. Banner, Professor of Zoology at the University of Hawaii, and his family scan the shallows of Kaneohe Bay. Shoes protect their feet from razor-sharp coral. Mountains of Oahu loom in the distance.

Golden petal-like tentacles of *Dendrophyllia*, one of the few brightly colored corals found in Hawaiian waters, reach out to seize food and carry it to the mouth slits. Early in life these tubelike polyps, magnified four times, begin to build limestone castles atop their ancestors' skeletons. Ultimately they too become cemented into the rock-hard mass.



Sinister-looking Crab Clutches Poison-laden Weapons in His Fists

"Like a prizefighter armed with rattlesnakes instead of gloves," the author describes the boxer crab, *Lybia tessellata*.

This dime-sized crab, enlarged eight times, carries a live stinging anemone in each front claw. The anemones' poison-injecting cells are more deadly, on a miniature scale, than any rattler's fangs.

When an enemy approaches, the crab puts up his venomous "gloves" as a threat. The wise foe retires in a hurry. A reckless one is likely to be stung to death and eaten—shared by *Lybia* and the captive anemones.



them effectively. In a bottle a sea slug becomes a shapeless mass, rendered almost colorless by the preservative.

Professor Banner and his four youngsters donned face masks and flippers and began to dive. They had no luck. Before the rising tide forced us off the reef, we secured half a dozen lumps of the orange-colored coral—but not a single matching sea slug. We would have to seek elsewhere, in the placid lagoon and shallows of Coconut Island itself.

Island Busy From 8 to 5

Into this lagoon each weekday morning came a launch loaded with researchers and technicians who lived on the mainland of Oahu. As soon as these workers stepped ashore, the quiet, palm-shaded laboratory buildings began to hum. A research group sponsored by the Atomic Energy Commission studied radioactive substances in the tissues of

fish and other marine life. A team from Princeton University gathered specimens of bioluminescent marine life—animals that glow like fireflies in the night sea (page 516). Other scientists were recording the blood types in tuna, classifying Pacific shrimps, and studying the physiology and distribution of corals, mollusks, and plankton.

With impressive dedication these scientists set about their respective researches—stopping only in time to board the 5 p.m. launch back to the mainland. Then gone in an instant was the bustling age of science. Nature's own wonderful serenity settled back on Coconut Island and enveloped the little lagoon. During most of our stay we were the laboratory's sole on-island residents.

Under the spell of this castaway regime, we soon discovered that certain mud flats on the far side of the lagoon were alive with various species of sea slugs. Sand shallows and tide



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pools outside the lagoon became our happy hunting grounds for additional species. Before long our sea-water tanks held dozens of little crawlers. Like pieces of color-splotted plastic—orange, carmine, azure, green—they took possession of the aquariums.

Sea Slugs Annex Deadly Weapons

Some—those belonging to the aeolid family of sea slugs—we had found in the rocky crevices of tide pools, feeding voraciously on tiny coelenterates: anemones, hydroids, and corals. This part of their menu gives the slugs an almost melodramatic character, for they have appropriated, quite unintentionally, certain deadly weapons belonging to their prey.

It must be explained that coelenterates are equipped with stinging cells known as nematocysts. On a microscale, these make booby traps seem like playthings. Whenever a foreign body brushes against these treacherous

cells, the contact triggers a barrage of tiny hypodermic tubes—suggesting a broadside of harpoons shot from a whaling vessel. The hypodermics sink into the victim, each injecting a droplet of virulent poison. Thus do hydroids secure their diet of tiny floating "sea babies," or zooplankton.*

But the poisonous nematocysts seem to work no hardship on sea slugs. The slugs eat and thrive on the venom-armed coelenterates; by some unexplained process they can digest the poison balls without exploding them.

Now the nematocysts adorn the sea slugs, as lethal here as they were in the coelenterates' armory. But whether the new owners actually use the stolen weapons is still not known.

For years zoologists were mystified by the presence of nematocysts in sea slugs, for these structures normally occur only in coelenter-

* See "Strange Babies of the Sea," by Hilary B. Moore, NATIONAL GEOGRAPHIC, July, 1952.

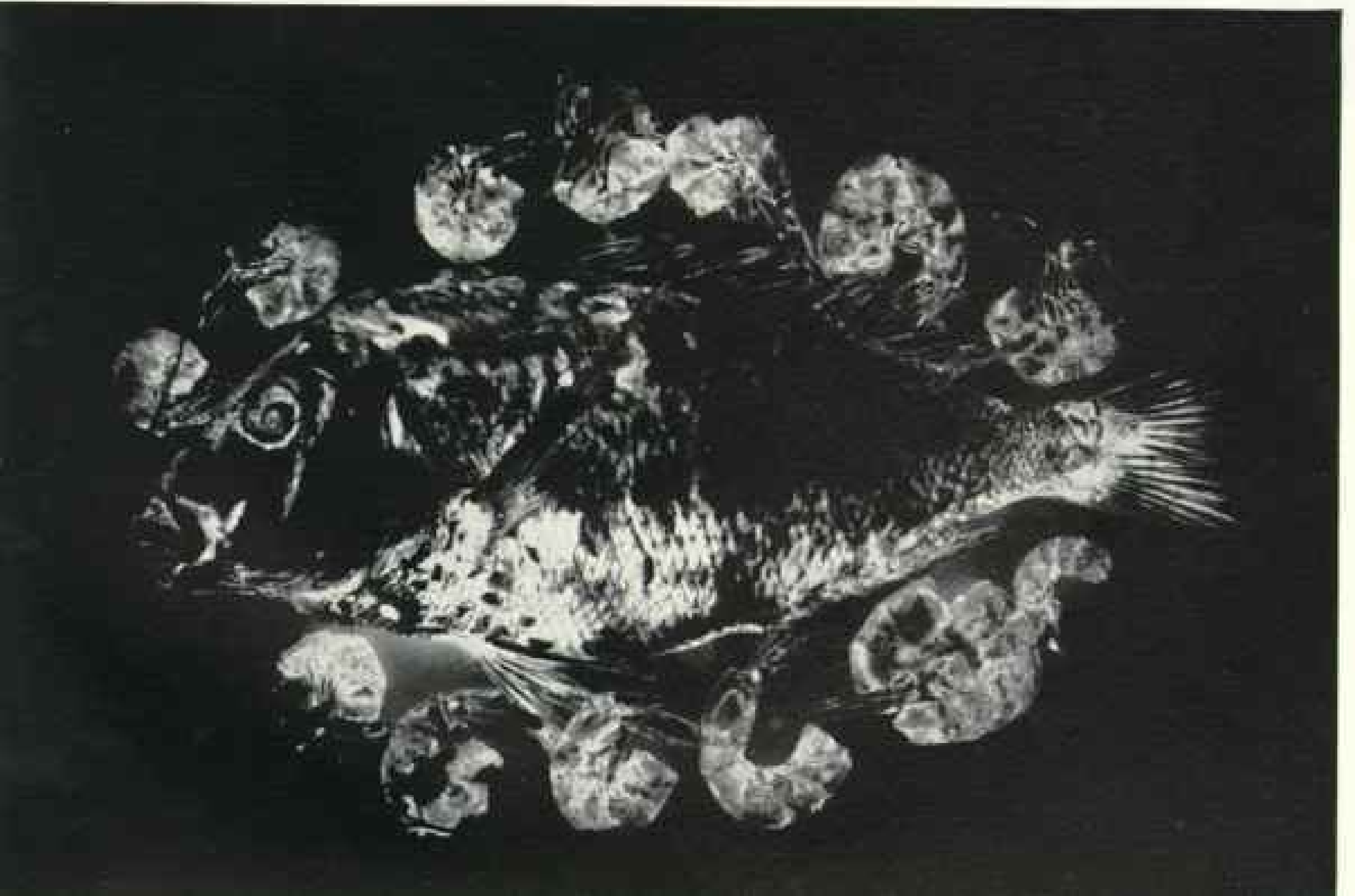


FRANK H. JOHNSON

Switch Off the Lights and This Seafood Platter Casts a Ghostly Glow

Self-lighting occurs in many marine animals, as well as in fireflies and other land dwellers. Luminous bacteria growing on this porgy and shrimp produce an eerie, cold light. Prof. Frank H. Johnson, who studied the phenomenon known as bioluminescence on Coconut Island, photographed the platter in normal light (above). Moments later, when he repeated the shot in his darkroom, the seafood provided its own light.

516



ates. Finally, observations of the sea slug's eating habits solved the mystery.

A sea denizen known to appropriate coelenterate weapons in yet another fashion is a crab, *Lybia tessellata* (page 514).

One day I was visiting Charles Cutress, a graduate student of zoology at the University of Hawaii, in his laboratory. "How do you like that fellow?" he asked, pointing to a crab with a body about the diameter of a ten-cent piece sitting in a bowl of sea water.

"I thought you were working on anemones," I said.

"I am," replied Cutress. "Look what that crab is holding in its 'fists.'"

In each of its two front claws the crab carried a live pea-sized *Triactis producta*—an anemone species armed with deadly poison-injecting cells. In response to a pencil that Cutress moved its way, the crab quickly lifted its venomous living weapons.

A gruesome parallel, and yet an apt one, would be for a prizefighter, instead of wearing boxing gloves, to hold in each hand a cluster of rattlesnakes to which he but not his opponent was immune.

Among the launch-load of other researchers on Coconut Island were Professor and Mrs. F. H. Johnson of Princeton University. Theirs was one of the sea's most intriguing problems—bioluminescence, or the production of light by living organisms. All of us have seen the glowing wake of a ship at night or the flicker of fireflies on a summer evening.*

Measuring the Faint Lights of the Sea

The Johnsons were concerned with measuring the amount, duration, and other characteristics of light produced by the variety of luminescent sea animals found here. Their workroom boasted a complicated array of electronic equipment so sensitive that it could measure light intensities far below those detectable by the human eye.

At low tide the Johnsons would often wade off into the shallows on collecting trips and bring back buckets of sea organisms to ob-

* See, in the NATIONAL GEOGRAPHIC: "Hatchetfish, Torchbearers of the Deep," May, 1958; "Night Life in the Gulf Stream," March, 1954; "Fishing in the Whirlpool of Charybdis," November, 1953, all by Paul A. Zahl; and "Torchbearers of the Twilight," by Frederick G. Vosburgh, May, 1951.

Sealed in a Coral Cell, This Tiny Crab Serves a Lifetime Sentence

Soon after hatching, this female crab, called *Hapuloarcinus*, settled among branches of coral. The living polyps, constantly drawing dissolved calcium from the sea, gradually built a house of limestone around the little crab, dooming her to a life of solitary confinement. Sea water, flowing in through pores in the chamber's walls, brought plankton upon which the prisoner fed.

At mating time, scientists believe, the free-roving male fertilized the female shortly before the coral entombed her. Baby crabs escape from the cell through the tiny pores, the females destined to dwell in similar coral tombs.

A section of the coral (*Pocillopora*) has been chipped away to show the inmate.



ALL PHOTOGRAPHS BY PAUL A. ZAHL, NATIONAL GEOGRAPHIC STAFF © N. G. S.



**One Less Danger to Divers:
a Spotted Moray Eel,
"Rattlesnake of the Reef"**

"Moray eels proved real pests while we were collecting reef fishes," reports the author. "Every time we turned over a piece of coral, likely as not a couple of them would shoot out."

Sometimes eight feet long and as thick as a man's arm, morays carry no venom, but their strong, sharp teeth can inflict severe wounds.

Skin diver Vernon E. Brock, Director of the Hawaiian Bureau of Commercial Fisheries, shot this spotted eel with an underwater spear gun. Several years ago he nearly lost an arm in the jaws of a larger attacker.

Mr. Brock made his plastic contour-fitted mask. Fish-net floats bob on the surface behind him.

Voracious morays lurk beside their rock cave in the Waikiki Aquarium. Gaping mouths inhale water for respiration.





Opalescent waters of the 50th State—at the edge of the vast Indo-West-Pacific faunal area—teem with 2,500 marine species. The author photographed many of them around Mokuoloe, or Coconut Island.



serve in the darkroom. Sometimes they would bring back masses of coral which Mrs. Johnson, with a hammer and chisel, would dissect in search of light-giving creatures that live in the coral's labyrinths.

"Would you like to do some dissecting, too?" Mrs. Johnson asked me one day. I had noticed some peculiar lumps, or galls, on several coral branches, and had wanted a chance to look inside.

Lying snugly in the hollow center of the first gall I cracked was a tiny crab. I opened others, and in each found either a living *Hapalocarcinus* crab—always a female—or the corpse of one.

Bizarre as it may seem, every female of the species deliberately allows herself to be surrounded by a wall of limestone formed by the thousands of pinhead-sized polyps comprising the coral colony.

These polyps are constantly drawing dissolved calcium from sea water and depositing it in the form of calcium carbonate, or limestone. Each crab vault, though porous, is absolutely escape-proof and must eventually become the occupant's tomb (page 517).

I placed a crab and her partly opened chamber in running sea water and watched. Although fully capable of crawling, she refused to budge. She had no doubt become so accustomed to her prison that she had lost all longing for freedom.

These strange dependencies of the deep—crabs and captive anemones, coral and captive crabs—emphasized the drama of life in these waters and its fascination for researchers. The mid-Pacific here is of special importance

Slate-pencil sea urchins, plucked from a submerged reef, suggest shellbursts. Blunt spines make them less dangerous than their smaller, more prickly cousins. Eda Zahl, the author's wife, deposits her find on a wharf at Coconut Island.

to marine biologists, for the Hawaiian Islands are situated on the outer edge of the most teeming faunal area of oceandom.

If you were to place on the Philippine Islands the hub of a wheel so large that its rim would rest on the Hawaiian archipelago to the east and as far as the Indian Ocean to the west, the region so covered would roughly comprise what zoologists refer to on their charts as the Indo-West-Pacific faunal area (above). The figurative concept of a wheel is apt, for lines of evolution and distribution



among marine species in this vast area seem to have radiated outward like spokes from a central hub.

For example, there is practically no difference between certain species of cardinal fish found in the Red Sea, on the western rim of this imaginary wheel, and those found in Hawaiian waters. But there is little overlapping of fauna between Hawaii and the coast of California.

We had seen many of the inhabitants of Hawaiian waters at the aquarium in Waikiki and at the Honolulu fish market, as well as in the shallows around Coconut Island. But since we were also concerned with creatures swimming free in open water, we arranged a trip aboard the *Makua*, a war-surplus vessel converted to scientific use by Hawaii's Fish and Game Division. About a mile off the north shore of Oahu, we anchored over a deep reef.

Several of our companions aboard began putting on their diving togs and swinging into Aqua-Lungs. Others maneuvered a heavy 5-gallon tin close to the edge of the deck.

Vernon E. Brock (page 518), leader of the expedition and Director of the Fish and Game Division at the time, was among the

first in the water. He reached up for us to hand him the tin. Carefully he pushed away from the *Makua*. Then, giving his goggles a final adjustment and his mouthpiece a few testing bites, he upended and, with flippers briefly exposed, dived with his strange cargo into the cerulean depths.

Fish Poison Aids Scientific Census

Choppiness of the water and its inky color hid the operation from view, but we knew that about 40 feet below us the sea bottom dropped off steeply, forming a submarine cliff with a vertical face and caverns inhabited by an infinite assortment of sea creatures. To collect some of these underwater cliff dwellers was the expedition's aim.

Just as land biologists study specimens from various geographical regions to learn about distribution and animal interrelationships, so marine biologists must now and then sample the sea. From the abundance and diversity of species at chosen spots, a biologist can deduce much about the state of life in the ocean at large. Such data can be of economic import as well as scientific value.

Nets, trawls, and seines are classic devices

(Continued on page 525)



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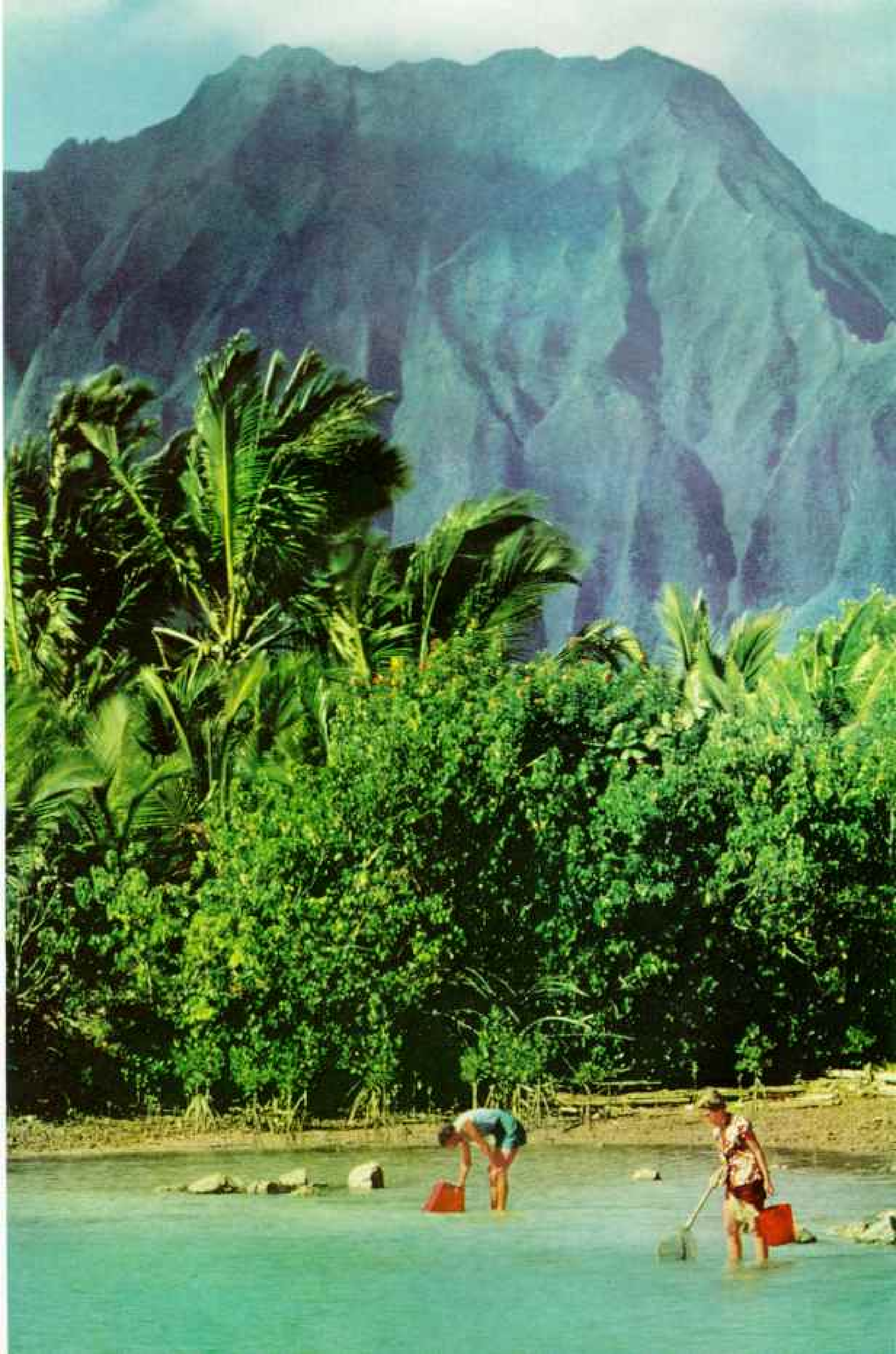
Wading the Shallows, Collectors Search for the Sea's Oddities

Racing clouds shadow the face of the Koolau Range, a 2,500-foot-high volcanic barrier on the east coast of Oahu that towers above Kaneohe Bay.

Equipped with net, bucket, and viewing glass, Dora Banner (left) and Eda Zahl turn their backs on the scenic beauty and concentrate on the elusive sea slug.

Streamlined nudibranch senses a dinner among the rocks and swoops bottomward to devour it. *Glossodoris lineolata* is shown twice life-size.

Some carnivorous nudibranchs feast on tiny coelenterates—anemones, hydroids, and jellyfish. The coelenterates are equipped with thousands of nematocysts, saclike venom-laden stinging cells that explode on contact. The sea slugs can digest these poison balls without triggering them, and the nematocysts then become lodged in the nudibranchs' bodies.





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Like a bouquet of butterfly wings, a sea slug flutters its appendages. Few nudibranchs exceed an inch in length, though some Pacific giants reach eight inches. *Cyerce nigra* appears natural size. This nudibranch and the one below live on Australia's Great Barrier Reef, world's largest coral structure, where Dr. Zahl collected them in 1955.

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**Old Man of the Sea
Sports Handle-bar Horns
and a Walrus Mustache**

A garden of tubes, called cerata, drapes the back of *Aeolidiella* (enlarged four times). Food passes through stomach ducts into the tubes, which function like a liver. They also serve as a means of defense. When disturbed, the slug humps up like a hedgehog and hides its head. If touched, it can discard the bristling cerata as a lizard sheds its tail.



Flame-tipped horns and gills identify *Glossodoris festiva*, shown five times life-size. Horns are sense organs. Gills, the nudibranch's breathing tissues, absorb oxygen from the water and expel carbon dioxide.



for the capture of marine animals. But because a certain number of free swimmers can always elude such devices, samplings of sea life taken in this manner are often incomplete. Today biologists have an additional collecting tool, one new yet old—rotenone.

This substance, found in the root of derris and other plants, has been used for fish poisoning by the Indians of Central and South America for centuries. The chemical, deadly to fish, is harmless to man when swimming in water tainted with it. Divers may even dispense with goggles. Rotenone can be used effectively not only in inland waters but at sea and among tide pools as well.

The technique is to release the poison in the area of interest, then merely wait. As the rotenone diffuses through the water, fish are painlessly suffocated and will float to the surface to be scooped up.

When the poison is used well below the surface, the fish may be collected by a diver with a hand net. The use of rotenone is, of course, legal only under authorized circumstances for scientific research.

In addition to leader Brock and the ship's crew, we had with us on the research vessel that day Dr. William A. Gosline, Professor of Zoology at the University of Hawaii, and a number of university graduate students and assistants. At least half a dozen of the party were experienced Aqua-Lung divers familiar with Hawaiian waters.

Data, Ocean-fresh and on the Spot

The plan for the day called for Brock to open the can of rotenone at a depth of about 70 feet and, as the toxic paste seeped out, to hold his position while other divers combed the area, netting any dazed sea creatures.

Large, swift-swimming oceanic fishes would escape the poison cloud, but smaller individuals close to the coral cliff would be easy victims. Eda and I were hopeful that the haul might also include some deepwater sea slugs, not nearly so well known as their cousins of the shallow lagoons.

An examination table was improvised on the *Makua's* stern deck, where a trained ichthyologist sat ready to record all relevant data before dropping the specimens into bottles

of preservative. For our sea slugs, we had provided bottles of sea water. Several student assistants in swimming trunks and face masks stood ready on the deck to spot and retrieve whatever floating victims the divers missed.

They did not have long to wait. Brock had been down no more than ten minutes when we saw on the dark-blue surface of the sea, not far from the ship, a bright-yellow surgeonfish about the size of a tea saucer lying flat and pitching in the waves.

Tropic Sea Gives Up Its Bounty

One of the deck men dived into the water and quickly netted the fish. In the meantime another saucer of yellow appeared on the surface, and another. The swimmer soon had his dip net loaded.

But, we were beginning to wonder, what about the divers below?

An answer came when Edith Hunter, a skilled Aqua-Lung diver, suddenly broke surface not far from the *Makua's* sea stairs. We could see that her clear plastic collecting bag was bulging with dozens of small specimens of every hue. Then in succession the other divers popped up, similarly laden. Last came Brock himself, also bearing a collecting bag heavy with sea beauties.

Heaped on the examination table, the specimens shone in the tropical sun—yellow surgeons, red squirrels, azure wrasses, rose lizards, black-and-white eels, and a host of other fishes as bizarrely shaped as they were colored, all yielding their lives so that man's knowledge of these mid-Pacific waters could be extended. And we were elated to discover a number of dazed but live sea slugs in the glittering collection.

That evening Eda and I were taken ashore to our car. With our day's catch of slugs safely stowed away, we drove the scenic 30 miles along the east coast of Oahu to catch the motor launch for our laboratory base on Coconut Island.

This was our last collecting trip in Hawaiian waters. We had work to do with the camera, to record on film a fragile beauty that no specimen bottle could preserve—the living colors of the nudibranch.

Sea Slug in Quest of Food Explores a Sharp Bed of Coral

Fringed nudibranch (*Pteracolidia semperi*, seven times life-size) crawls atop the bleached limestone skeleton of a *Dendrophyllia* coral. Most nudibranchs deposit their jellylike eggs on seaweed fronds or coral branchings.



*After four years and \$250,000,000
of Operation Deep Freeze,
the naval officer in charge sums up*

What We've Accomplished in Antarctica

By Rear Adm. GEORGE J. DUFEK, USN

Commander U. S. Naval Support Force,
Antarctica during the
International Geophysical Year

I HAD ON my waffle-weave underwear, three pairs of socks, heavy pants, and my parka, and I had the plane's controls from the copilot's seat. The engines were purring sweetly. A short way ahead was the edge of the icy lid that tops the southern continent. Above, the stars shone in a black-velvet sky; below, the ocean glistened in the golden reflection of the October moon.

My steward handed up a paper cup of hot coffee and lighted my cigarette. In the warm cockpit, suffused by the aroma of coffee and smoke, and wrapped around outside by darkness and stars, I grew pleasantly relaxed and reflective.

It seemed a shade unreal that we were headed back for another season in the Antarctic, that this would be my last trip as commander of Navy activities at the bottom

Splendor and mystery draw men ever deeper into rugged Antarctica. The stark beauty of the Horlick Mountains confronts this member of the 1958-59 Byrd Station traverse party. To reach the nearest peak, he faces a five-mile hike across a treacherous, icy surface. Hidden crevasses necessitate his safety line and ice ax. November's evening sun reflects gems of light from the wind-polished glacier.

of the world, that during four years we had peopled Antarctica with so many ships and planes and bases and technicians and scientists that our invasion had an aura of permanence.

As if to convince myself of the reality, my mind suggested a review of those long years of effort. I was, it appeared, about to witness a mental motion picture.

However, better to have someone flying the plane who was not daydreaming. I turned over the controls to Lt. Comdr. Hank Hanson and drifted back into the cabin of the heavily loaded Douglas Skymaster. Then my private movie was postponed.

Crisis Above the Pacific

Our radioman announced: "We have just heard by voice radio that one of our R4D's is in trouble. One of her two engines cut out en route from Honolulu to Canton Island. She'll run out of gas 10 minutes short of Canton. They're jettisoning all unnecessary gear."

"At least they'll have warm water to crash-land in," said Comdr. Jack Mirabito, our Antarctic weather expert. "Nothing like the cold water we'd hit down here if our engines should give out."

Our thoughts flickered from the plight of the men in the R4D to the dread peril that always accompanies planes flying from New Zealand to Antarctica. (The United States is the only nation in the world that flies aircraft regularly down to the icebound continent.) We don't care to think about a forced landing in the freezing water. In ordinary clothing, it means death in about 10 minutes. We could live an hour if we had frogmen rubber immersion suits. But why prolong it?

Presently our radioman came back with good news.

The R4D had squeaked into Canton on one engine, without enough gasoline even to taxi to the parking area. Everything on board except people and the equipment vital to flight had been thrown out to lighten the burden on the one remaining engine.

But no lives were lost, and that was the important thing.

I closed my eyes with relief and thought back to how all this flying to the Antarctic had started.

In 1950 geophysical scientists began to speculate on the values of an international study of the nature of the earth and its environment. Since the last such study in 1932, called the Second Polar Year, there had been almost explosive development of new research equipment for tapping the secrets of earth, oceans, air, and space.

That part of our earth with which man has direct contact is really no higher or deeper, by analogy, than a coat of paint over a classroom globe. Our deepest penetration in the earth's crust, an oil well not quite five miles deep, is only a pinprick in this theoretical coat of paint. Our breathable atmosphere is only as thick as a second coat of paint.

But by 1950 we had new tools to find out what goes on in and beyond these layers. We could reach below them toward the earth's core and above them toward the planets. Thus was born the program that came to be called the International Geophysical Year.

Our aircraft's four engines throbbed onward into the night.

U. S. Spearheads Antarctic Invasion

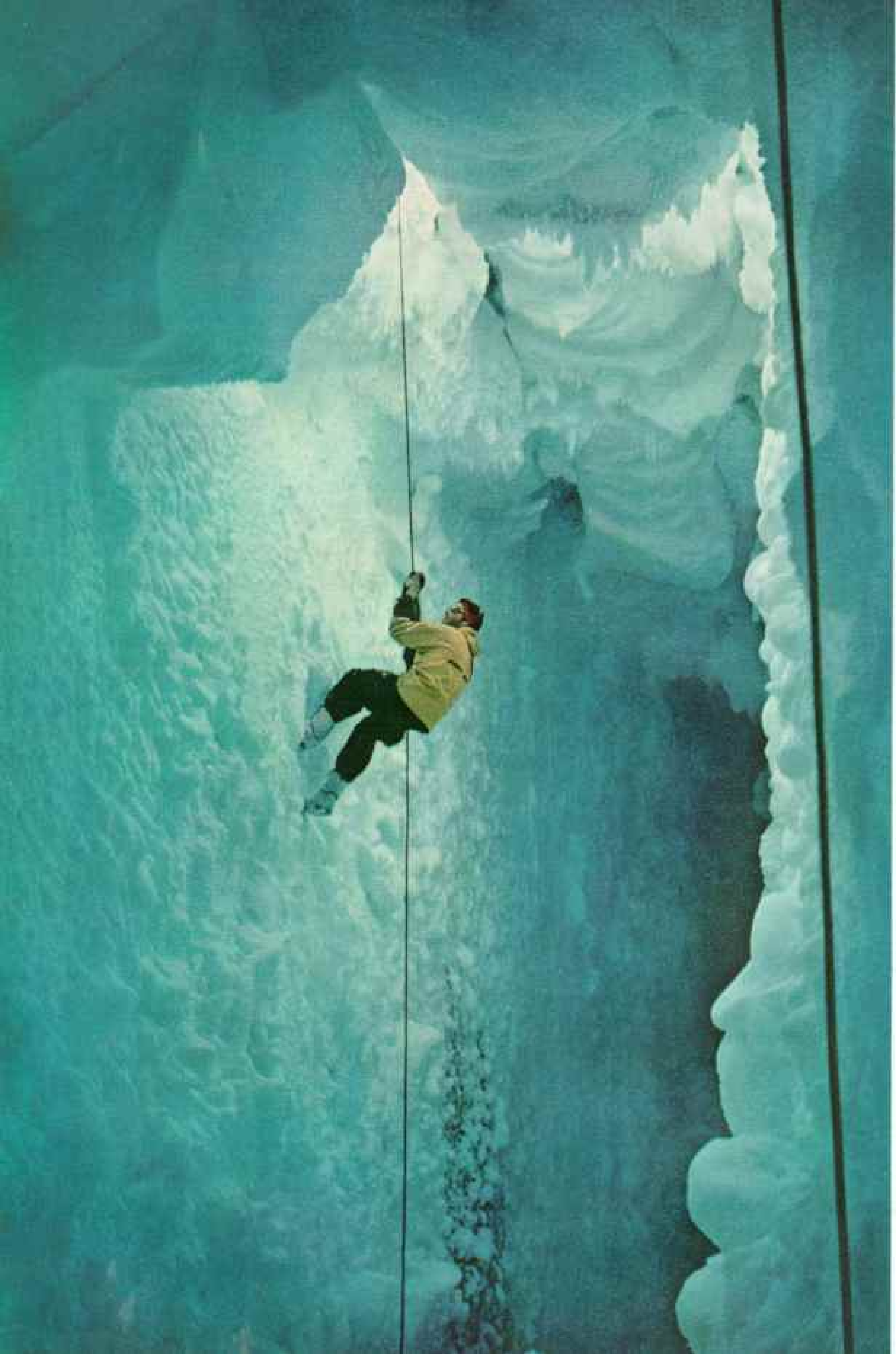
I looked out at the stars and tried to imagine the quantities of money, men, and machines marshaled by the 66 countries participating in the IGY. I really had no idea. I knew a large portion of it had been channeled by 11 countries into the Antarctic. And of those probing Antarctica's ice and seas and rock and air, the United States had mounted the most ambitious program—an effort amounting to about \$250,000,000.

Only two percent of that was required for the scientific studies as such. We had to spend some \$245,000,000 just to set science up in business on the inhospitable ice.

It had fallen to me to direct the ships and planes and military personnel who were assigned by President Eisenhower to settle our

Fairyland Blue of a Crevasse Pervades a Geologist's Icebox Laboratory

Where islands anchor the Ross Ice Shelf, pressures fold, twist, and shear the ice into miniature mountain ranges. Scientists study the ice shelf's tortured areas for clues to stresses that may shape large segments of the earth's crust in similar fashion. This man hauls himself out of a 70-foot crevasse used as a scientific workshop at Camp Michigan, 37 miles from Little America. Crystal pendants frost the ceiling. Power cable at right lights an under-ice laboratory.





DAVID L. BOYER, NATIONAL GEOGRAPHIC ARMY

The author: Rear Adm. George J. Dufek's Antarctic service began in 1939 under Admiral Byrd. In 1956 he led a plane crew of seven in the first landing at the South Pole. Last February Dufek received the National Geographic Society's Hubbard Medal as commander of the U. S. Navy's 1955-59 Operation Deep Freeze "for outstanding service to science in exploring vast South Polar regions and establishing scientific stations for the International Geophysical Year."

scientists in Antarctica. Dr. Laurence M. Gould, President of Carleton College, had been appointed to guide the research program. Now that our stations are established, they appear to be there to stay. The United States has proposed a treaty to preserve the continent for scientific research.

So it was for the sake of science that I came to be on this airplane and bound once again for the bottom of the world.

Much had happened in the past four years. In two summer seasons of assault tactics, using ships and planes and over-snow tractors, we had built six main IGY stations. Four were scattered about the water's edge of this continent that is nearly twice as big as Australia. The other two were deep in the awesome ex-

pense of the interior, one at the exact geographical South Pole.*

For three years now—because the International Geophysical Year was actually 18 months long, and because much of the research has been extended for at least one extra year—the scientists at these bases have been spinning around with the revolving earth in the darkness of the Antarctic night and the 24-hour sunshine of the Antarctic day. Some of their instruments are trained on geophysical phenomena in the air above them. Others are probing the secrets of thousands of years of weather salted away like tree rings in the ice below (pages 532, 536, 549, and 554).

We did not put our scientists there without hardship. Nor did we do it without tragedy. Ten men of our military support forces had died in accidents. This very night, with the R4D at Canton, we had come close to adding to that number. As the sun rose in the eastern sky, illuminating the white mantle of the Admiralty Range, I hoped those ten fatalities would be the last.

Welcome Party Suffers Frostbite

Commander Hanson broke into my reverie to say we should be landing in 20 minutes. We tightened our seat belts, and Hank brought her in smoothly on the ice runway at McMurdo Sound—12 hours and 45 minutes after taking off from Invercargill, New Zealand.

A large group was on the parking ramp to meet us. This was their first contact with the outside world in seven months. It meant new faces, fresh vegetables, and *mail!* We were greeted warmly by the officers and men headed by Capt. Eugene "Pat" Maher, Commander, U. S. Antarctic Support Activities.

As I stepped off the ladder, I was saluted by six hooded Navy men detailed as side boys. Their whiskers were covered with frost. I shook hands with all as I passed down the line.

Then I noticed telltale white spots on the noses and cheeks of some. Frostbite. "Cover it up," I said, "and get inside soon."

We embarked in vehicles and raced for the camp three miles away. The temperature was 28° below zero, wind 15 knots. The snow road to our main supply base was straight and smooth.

The mail was rushed to the post office and distributed rapidly. Station Commander Ed Ludeman declared a holiday.

We rolled up to our quarters to stow our

* Dr. Paul A. Siple has written two vivid accounts of life at the South Pole for the NATIONAL GEOGRAPHIC, July, 1957, and April, 1958.

gear. "What would you like to do first?" asked Commander Ludeman.

"Nothing," I replied. "Let the men have a chance to read their mail. I'll take a walk around the base."

After a cup of hot coffee, I started for a stroll. Ludeman and Comdr. Roger Witherell fell in with me.

"I wanted you to read your mail," I said.

"We've waited seven months for it," replied Ludeman. "We can wait a few more hours."

I knew then that they were proud of the work accomplished during the winter night and wanted to show it off. What a change had taken place! They could well be proud.

McMurdo Shows a New Face

Electric overhead cables had replaced the underground lines that bulldozers sometimes cut and that used to break down because of freezing and thawing. Living quarters were much improved. The library, once jammed in the noisy administration center, now had its own building, a peaceful place to read and to write letters.

A small pool table looked very popular in a new building designated as an enlisted men's club. Men sat contentedly around tables drinking beer and soft drinks.

I talked to Tom Wentworth who was dispensing drinks over the bar. Perhaps I should say I listened to him:

"Yes, sir, this club's the best thing that ever happened to this base. The men have a feeling they are on liberty when they come here. A man can get away from his work and his barracks and relax.

"Every once in a while we have a jamboree. The chaplain has gotten up a hillbilly band. Everybody else sings. You don't have to sing good, just loud.

"On quiet days like this, the men like records. I play the machine back here. I know the men and what they like. You can usually tell where a fellow is from or what kind of guy he is by the music he likes. Care for a beer, admiral?"

"Not just now, thanks," I replied. "I'll stroll around the base some more."

Every building I visited showed improvement. I turned to Ludeman and Witherell and said, "You and your men have done a tremendous job during the winter. Now go read your mail. I'll join you later."

I threw my parka hood over my head, leaned forward against the wind, and walked along the main street toward my quarters.

After a hot shower and change of clothing,

I joined Ludeman and Witherell in the mess hall for the evening meal. Comdr. Herb Whitney, our Antarctic engineering and construction officer, joined us over coffee, and we discussed the possible use of nuclear power plants at our bases.

Of all cargo delivered at the South Pole, 62 percent was diesel fuel. Originally costing 14 cents a gallon, it came to \$3.60 by the time Globemasters had dropped it by parachute at the Pole. This made a total of a quarter of a million dollars just to heat and power one Antarctic base!

The U. S. Army, Commander Whitney reported, was working on nuclear plants that were just what the doctor ordered, and we could get them by 1961. At an estimated cost of \$3,000,000 each, they would pay for themselves in 20 years' time.

I feel certain that the benefits of the controlled atom will be felt in Antarctica in the very near future.*

We picked up our platters and returned them to the scullery.

"Do you want to see the movies tonight?" Ludeman asked me.

"No thanks, Ed," I replied. "It's been a full day. I think I'll turn in."

My room in the "Wheelhouse" had a small desk in one corner, a locker in the other, and a soft rug on the floor. I got into clean pajamas, climbed between crisp white sheets on an inner-spring mattress, stretched out, adjusted the electric blanket, and turned on the reading lamp.

The early explorers would never have believed this. I thought, as I opened a book about Scott slogging to the South Pole.

Supply Planes Wing Toward the Pole

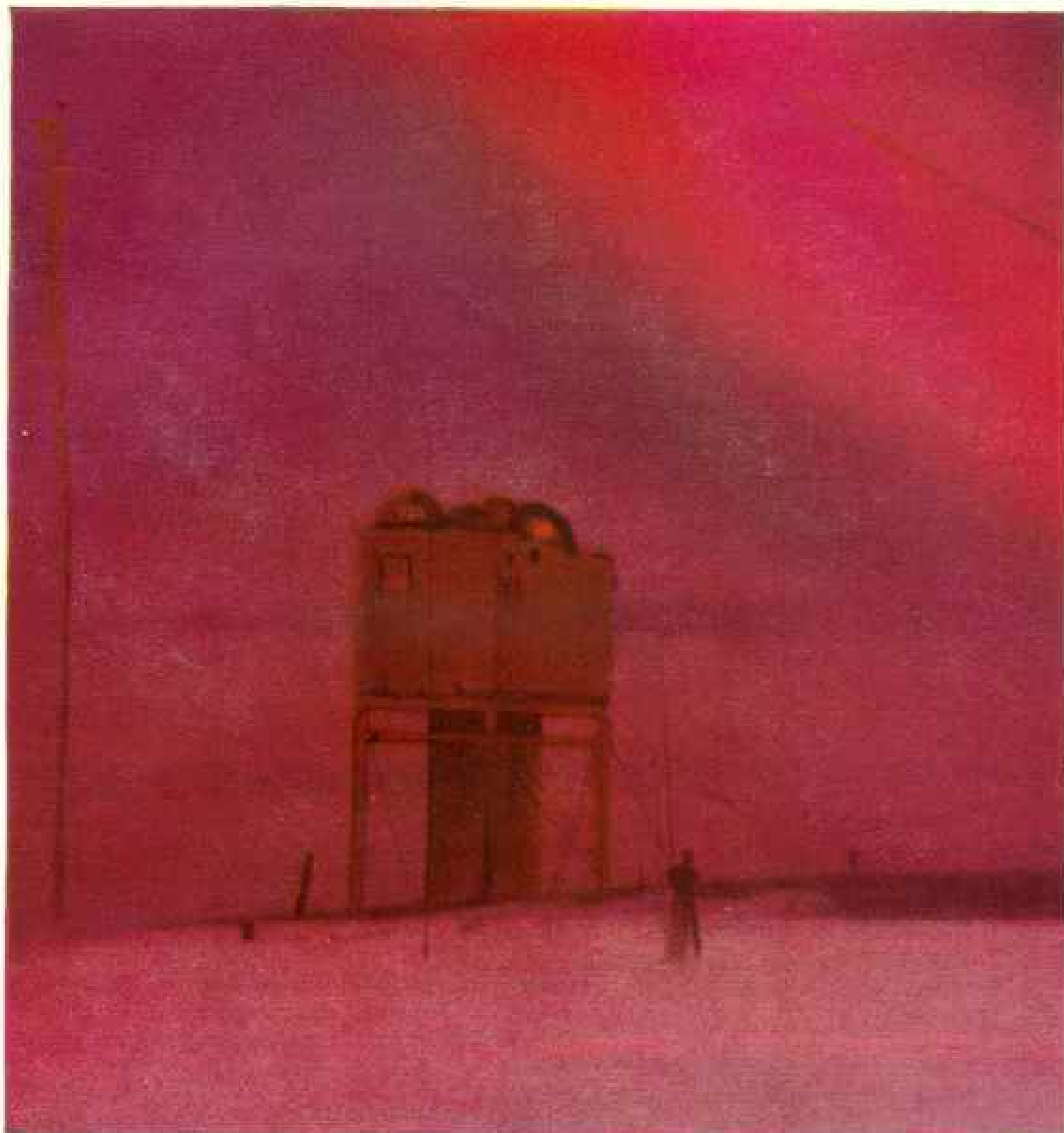
Within a few days our Air Force Globemasters arrived from New Zealand. Commanding them was Lt. Col. C. J. Ellen. He and his lads had been here before. They had dropped 749 tons of equipment by parachute when we built the South Pole base two years before. Now they were back to drop 451 tons of supplies at the Pole and 522 tons at Byrd Station in the heart of Marie Byrd Land.

"Twelve hours' crew rest, then off for the first Pole drop," C. J. announced as we sipped coffee together. "Like to come along?"

I would.

Next morning, with C. J. at the controls, we took off. Within two hours we were in the soup—thick clouds—with mountains to

* See "You and the Obedient Atom," by Allan C. Fisher, Jr., NATIONAL GEOGRAPHIC, September, 1958.



BOOTHUMES BY DAVID S. BUYER, NATIONAL GEOGRAPHIC STAFF (BELOW) AND EDWARD A. BRADLEY © N.G.S.





Aurora Australis Burns the Polar Sky; Snow Appears Too Hot to Touch

Norsemen, gaping at similar displays by the aurora borealis, concluded that Valkyries rode the heavens. Other men speculated that polar glaciers, by their sheer immensity, spouted flames, or that icecaps reflected the sun's rays.

Science has eliminated the superstition and much of the conjecture. Men of the IGY recorded simultaneous northern and southern displays and linked them to storms on the sun. They believe the solar flare-ups kick into space the charged particles that may create the Van Allen radiation belts above the earth. Overflow radiation near the auroral zones around the geomagnetic poles apparently seeps into the atmosphere, and man marvels at the resulting auroras.

A display as vividly red as this is rare. Here, on a midwinter noon, it illuminates the aurora observation tower at Ellsworth Station. Prevailing gales bowed the mast antenna at right.

Mirage at McMurdo Sound Spreads Lake and Islands Across Empty Ice

Similar illusions have plagued Antarctic explorers since Lt. Charles Wilkes took a U. S. naval squadron 1,500 miles along the coast in 1840 and charted land that later expeditions failed to find.

Whether in desert or across water or ice, the visual hoaxes may waver and beckon wherever sharp temperature variations lie near the surface.

Cold, dense pockets of atmosphere in Antarctica bend light rays like a prism or reflect them like a mirror. Observers have reported seeing mountains upside down in the sky and pressure ridges magnified until they appeared to be mountains.

This mirage, shimmering below the Royal Society Range, paints a sweep of McMurdo Sound ice with a lake that has no more reality than visions of oases seen by parched travelers in the desert.



the right and left of us. We put on oxygen masks and climbed to 19,000 feet.

Over the polar plateau we broke into the clear and came down to 11,000 feet, less than 2,000 above the station. Dr. Vernon Houk and Maj. Palle Mogensen came in on the radio from the ground. Their men were thrilled to see something from the outside world after a long winter's isolation.

I went back to watch the parachute drop. The cargo doors opened, and a frigid blast of air filled the plane. Then the countdown—four, three, two, one! Chutes away! Ton after ton spilled down the ramp to be caught by billowing colored parachutes, red for mail, yellow for food, green for fuel.

I saw a red parachute, in the grip of the wind, dragged miles from the drop zone. An orange "weasel" chased after it across the snow. Mail from home. It would mean much to those men who had not seen their loved ones for a year.

That night from McMurdo I sent a message to the Pole:

"Very happy to open this season's operations. We all hope you enjoyed receiving your mail."

"Dear Admiral Dufek," came the reply from young Dr. Houk. "Thank you very much for the try. Not one of us received a personal letter. It was all philatelic mail. Respectfully from all of us."

I investigated. It was true: Our plane had carried mail from stamp collectors who wanted the South Pole postmark. The men's personal letters had been on the Globemaster ahead of us, forced to turn back with engine trouble. Colonel Ellen delivered it next day.

Blizzard Catches Four Planes in the Air

C. J. reminded me of a professional boxer. He alternated left and right jabs. When weather was bad at the Pole, he sent flights to Byrd Station, and vice versa, nearly always keeping four planes in the air. He had a deadline to meet, and he drove himself more than any pilot in his squadron. All those tons had to be dropped before warm weather broke up the ice runway. Our airstrip might even drift out to sea.

Four Globemasters were in the air October 9 when a blizzard came screaming into McMurdo with winds up to 40 knots. Swirling snow reduced visibility to 10 feet.

Colonel Ellen and I, in operations center, watched the weather instruments, then stared

out the window into the blowing whiteness. Hours passed and conditions became worse—gusts up to 53 knots at right angles to the runway, skies socked in up to 10,000 feet.

We began to think, hesitantly, of our emergency ice landing strip 400 miles north at Cape Hallett (map, page 542). We had never used it before. It lay in a canyon, and reports were that a pilot would have only one try.

An hour before our Globemasters were due back, I radioed orders to Lt. Comdr. Bob Epperly, flying an R4D from New Zealand, to put down at Hallett. He certainly couldn't land at McMurdo.

Epperly landed safely at Hallett and reported the emergency ice runway in good condition. This was encouraging, but an R4D was no 75-ton Globemaster. And night was coming on.

Tension Mounts as Fuel Dwindles

The four Globemasters arrived over McMurdo on instruments and circled at 1,000-foot intervals. Our blizzard refused to abate, and the lines of tension on the faces of officers and men in Operations deepened. I could imagine what must be going through the minds of the men "upstairs."

Colonel Ellen ordered Capt. Leland "Chief" Bearskin, in one of the planes, to try a radar approach. Bearskin came in over the strip only 150 feet above sea level. He could see nothing, and he went back up to altitude.

There were two choices. Either the planes could be diverted to the emergency strip at Hallett, or they could land blind on radar.

I cringed inwardly at the thought of their landing blind with that howling cross wind. At least two of them, I thought, and perhaps three or four, might be splattered all over the ice of McMurdo Sound. We would not be able even to reach them in this weather.

It was up to C. J. to make the decision.

At 7:23 p.m. he ordered Bearskin to proceed to Hallett. "Roger, and out," came from Bearskin. Word to the others followed, and "Roger, and out," crackled successively through the storm.

But the danger was still with us. It would be dark when the planes arrived at Hallett. No radar, no floodlights, just the strip marked by a row of empty black fuel drums—and beyond them, mountains on either side.

Presently, information began flowing in from Hallett. Weather was improving. Lt. Commander Epperly had placed his R4D on



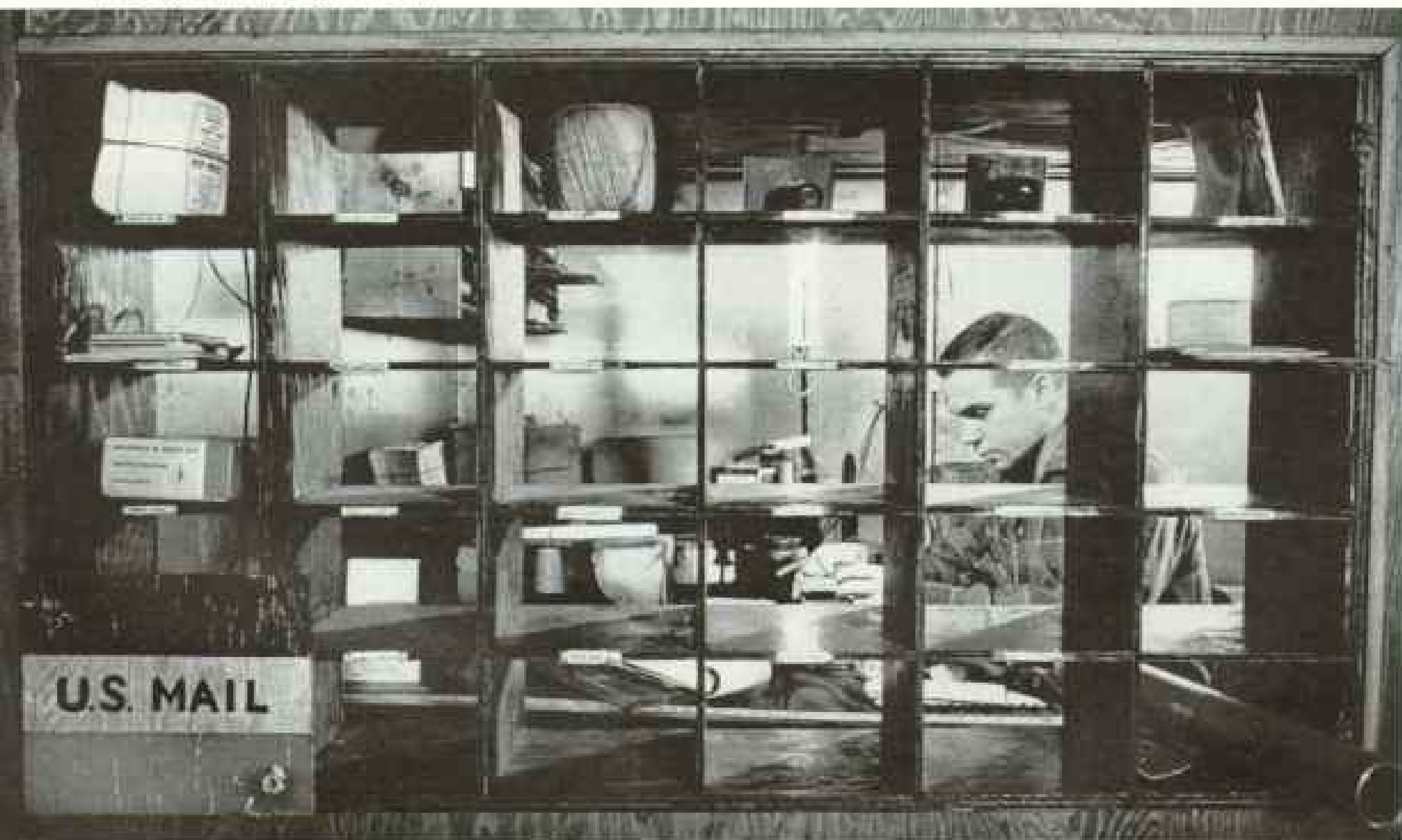
FRED BAYLING

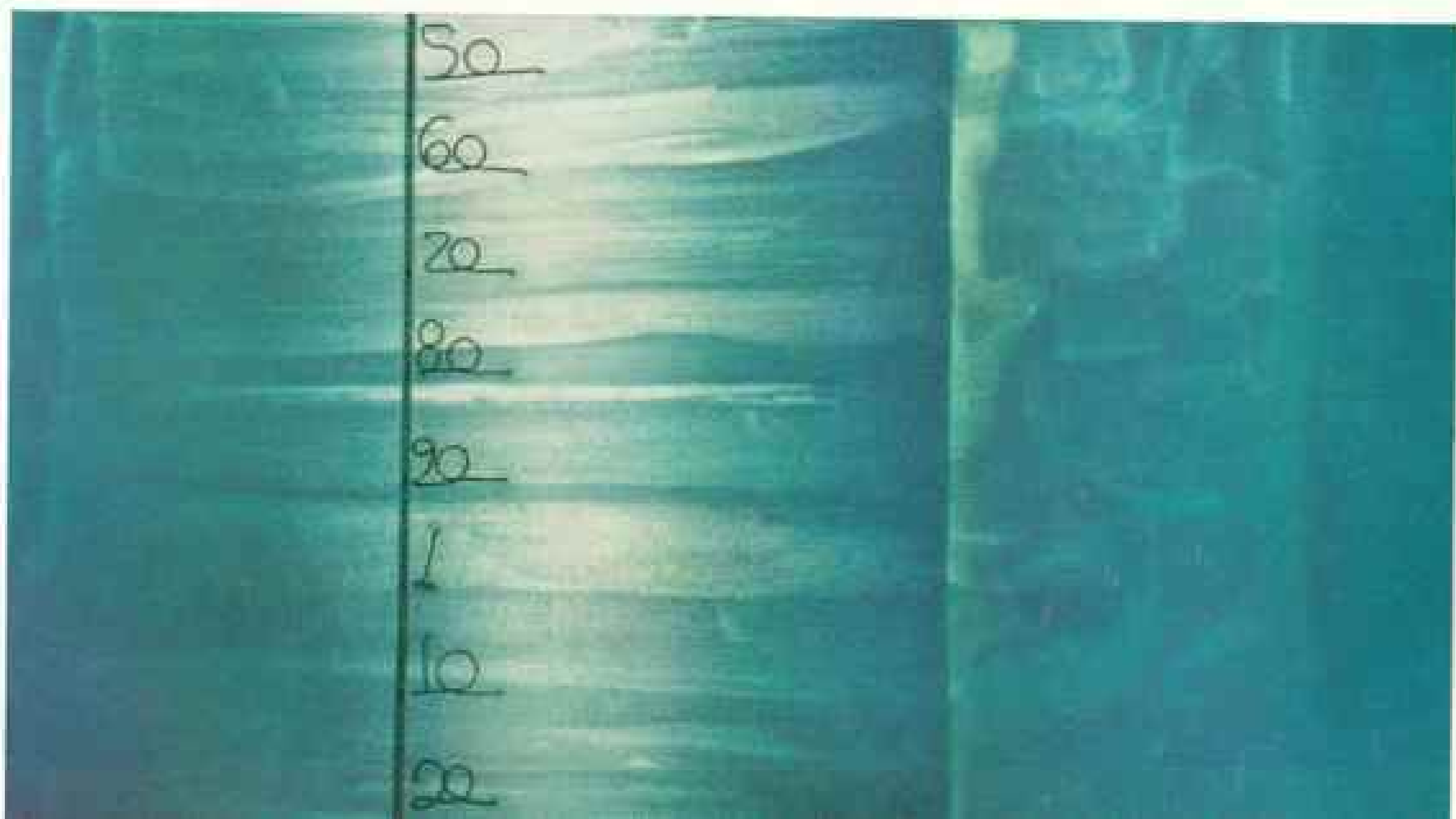
Two guitars and a mandolin enliven a Byrd Station party celebrating the arrival of a supply-laden tractor train. Recreation included hi-fi, judo, movies, table tennis, and weight lifting.

DAVID S. BOTEZ, NATIONAL GEOGRAPHIC STAFF

Pigeonholes in Byrd Station post office seldom collected letters. Mail from home was too precious to languish; the boxes became catchalls for cameras, twine, and other odds and ends.

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the left edge of the approach to the runway. His landing gear lights were pointed down the strip, and his navigation lights were blinking on and off. All vehicles from Hallett Station were lined up with their headlights playing on the ice.

Captain Bearskin in No. 958 and Lt. Tedd Bishop in No. 980 were circling overhead. Bearskin directed Bishop to go in first. Bishop was one of the youngest pilots in the squadron, and Bearskin wanted him to have the advantage of the waning light in the sky.

Then there was no more talk. We waited while Bishop made his approach.

The radio finally broke the silence. "Touchdown. No sweat. I could see the barrels very clearly."

I turned to C. J. and asked, "Is that young Bishop talking?"

"Yes, it is," he said.

"He's as cool as a cucumber," I remarked.

"He's a North Carolina boy," replied Colonel Ellen, who happens to come from North Carolina himself.

"Nine five eight on the ground," came from Captain Bearskin.

Capt. Wally Malone in No. 982 came in next. He landed and reported, "No strain."

Then came No. 983, Capt. John Flatness. "All planes landed." The time was 9:58 p.m.

Logistics reports started pouring in. All Globemasters had less than an hour's fuel in their tanks. I recalled a remark made by one of the maintenance men on the strip: "We always put in every pound of gas allowed; we top off with 500 pounds for the guys' wives, and another 500 pounds apiece for two kids."

This was a night they had needed it. It was a wonderful thing to know that we really had an alternate airfield in the Antarctic. That same night, nevertheless, I sent a dis-

patch to Adm. Arleigh Burke, Chief of Naval Operations, and Adm. Jerauld Wright, Commander in Chief of the Atlantic Fleet, my immediate superior. I reported the situation as it occurred and urged again that we build a land runway. Too many of our aircraft have cracked up in landing on the perilous ice.

Only seven days after the emergency landings, Antarctica reached out with icy fingers to snatch the lives of six flyers just 35 miles from Hallett.

Colonel Ellen and I rushed again to Operations when we heard that Globemaster 1017, en route south from New Zealand, had not radioed in on schedule, and that Captain Malone, flying north, had reported hearing a faint "Mayday! Mayday!"—the international distress call.

Then came news that chilled us to the bone: "Globemaster 1017 crashed on side of hill approximately 1,500 feet altitude. Six dead, seven survivors."

Disaster Demands Swift Action

I looked at Colonel Ellen. Not a muscle of his face moved, but the blood drained from his usually ruddy complexion. I knew what was in his mind. He was living with those men on that desolate, snow-covered mountainside—bewildered, suffering shock, cold, slowly and painfully patching each other's wounds and counting the dead.

When a plane goes down in the Antarctic, we spare no effort. Two weasels started off over the ice from Hallett. Five airplanes with survival gear, doctors, and medical supplies converged on the area.

But when one weasel was damaged and the other blocked by an ice cliff 100 feet high, we could think of only one way to effect the ground rescue. Never had I dispatched a

Firing a Frothy Blast, a Seismologist Probes the Icecap's Heart

Recorders measure the velocity of sound waves traveling through the ice. This member of the 1958-59 Byrd Station party which explored 1,104 miles in an 87-day trek sets off a small dynamite charge. Snow showers him as he kneels by a Fiberglas "banana" sled. Larger explosions required him to stay well back. Scientists touched off a major blast 100 miles east of Byrd Station and got an echo from bedrock 14,200 feet down and 3,400 feet below sea level—the thickest ice yet measured anywhere.

Blue light filters through a lens of ice. Byrd Station scientists dug a 10-foot pit into the icecap and drilled a parallel hole close by. Focusing a powerful light into the smaller hole, they stood in the pit and photographed the effect. Summer's layers of compacted snow show light stripes; winter's denser layers, dark. Vertical lines at right mark a groove where snow was removed for study. A centimeter scale drawn on the photograph aids analysis. By such means scientists find clues to climate in ages past.

Yawning Chasm Halts Sno-Cat and Sledges

To cross treacherous crevasse belts where snow bridges often make the danger invisible, motorized explorers get out and scout afoot. Sometimes the labyrinths compel them to retreat and seek a safer route. Such a maneuver calls for turning around, frequently in restricted space, and skirting sheer walls of ice in the heavy tractors.

This Sno-Cat leads the 1958-59 traverse from Ellsworth Station. Expedition members sledged inland from the Weddell Sea atop ice filling a below-sea-level trench knifing deep into the continent. Some scientists suspect the trough cuts Antarctica in two.

Here a small crevasse, found far inland, stopped the Ellsworth party only momentarily during its 69-day, 1,250-mile trek. The chasm's width pinched down rapidly to about two feet, affording a safe crossing. The explorers regarded its 30- to 40-foot depth as relatively shallow. Peering into other crevasses, they failed to see bottom, lost in shadow hundreds of feet below.





RESEARCHER BY EDWARD A. BRADLEY © NATIONAL GEOGRAPHIC SOCIETY



A Crevasse Crumbles, and Plop Goes the Weasel

Antarctica continues to confound the electronic and mechanical gadgets that men pit against it. A simple welding job may require hours of pre-heating and gradual cooling. Rubber- or plastic-covered cables chill to metallic hardness. And pan-borne crevasse detectors do not always work, as this listing weasel testifies.

On a trial run, the crew deliberately pushed their detection rig onto a crevasse field near Ellsworth Station and promptly got stuck. Here other vehicles stand by for the tow-out.



FRED BARLIND

Cross section of a stone tree, encased in a lighter-colored cliff face, shows growth rings formed when the tree was living wood.

Fossil-bearing Shale and Petrified Wood Prove Antarctica Was Green Eons Ago

Pine, swamp palm, laurel, fig, beech, sequoia, and huge fern once thrived here. Shale bears imprints of leaves like those of the araucaria, a tall, majestic evergreen that grows today in Brazil, Chile, and the South Sea islands.

Field geologists can read the story of Antarctica's verdant age wherever the wind sweeps a mountain flank or a valley free of snow, from Palmer Peninsula to the Queen Maud Range, within 300 miles of the Pole. They face a harder task, however, in explaining the continent's change to a land of perpetual ice.

One theory contends that when the world was young, South Africa, Australia, India, South America, and Antarctica comprised a single land mass, but gradually drifted apart. Another hypothesis holds that ages ago the world's axis tilted, relocating the geographic poles.

A rare look into the past rewarded members of the 1958-59 traverse party from Byrd Station. Climbing a small peak in the Horlick Mountains, an eastward extension of the Queen Maud Range, they found the shale-paved shelf and the tree turned to stone.

Other findings (opposite) included two bits of coal in center and, clockwise from upper right, the imprint of a twig on sandstone; shale bearing the faint impression of two eucalyptuslike leaves; a cross section of wood; a piece of multicolored wood; and a dark strip of wood sandwiched between slabs of sandstone.

helicopter on such a dangerous mission.

I asked Lt. Comdr. Edgar Potter, the helicopter pilot, and Lt. Comdr. Frank Dandrea, pilot of a small Otter plane for escort, how they felt about flying 400 miles into reported bad weather.

"We're warmed up and ready to take off," said Potter. "We've been standing by waiting for you to call us."

Twenty-six hours after the crash, Potter had delivered the injured into the hands of seven doctors and medical corpsmen who had created an emergency hospital at Hallett.

All seven survivors were in shock, and only two had been able to stay on their feet. Yet somehow they had managed to crank out "Mayday!" on a hand radio and to crawl into the severed tail section of the shattered plane, where they gained some warmth by burning cargo lumber soaked in gasoline.

McMurdo Welcomes Soviet Visitors

We were not the only Antarticans flying early this 1958-59 season. Soviet scientists across the icecap were planning an over-snow traverse toward the South Pole and wanted to survey the route by air. Our American scientist living with the Russians at Mirny, Morton Rubin, radioed to me. Could they visit us at

McMurdo and borrow 1,500 gallons of gasoline for the return flight?

They could and did, landing on our strip after flying over our station at the South Pole. It was a fine flight, 14 hours long.

Mr. Pavel Astapenko, the Russian meteorologist who had spent the winter at Little America, printed us a sign for the welcoming. When the twin-engined Ilyushin landed, we guided it to a parking spot with a jeep labeled "Follow Me" in Russian.

At dinner in the mess hall, Soviet chief scientist I. E. Tolstikov asked, "How many people eat in this one dining room?"

"During our busy season now," I replied, "more than 350—Air Force and Navy flight crews, summer construction people, observers, and newspaper correspondents."

"How many newspaper correspondents?"

"Eighteen," I replied, after a mental count.

"Why so many?"

"To tell our story to the American people. Our taxpayers want to know how their money is being spent."

"Ah."

Scientists' quarters at the Soviet base were much more luxurious than ours, with wallpaper and overstuffed sofas. When their leader saw my quarters, he grunted, "Like a stateroom in a destroyer."

After a tour of the base and a press conference, we cleared the decks for a party. Most of our guests took coffee, and a few drank a little beer. This was certainly not the roisterous Russian drinking we had heard about.

The visitors were generous with gifts. Our men received Russian perfume, cigarettes, and picture cards of Moscow and rural Russia.

The piece de resistance was a 25-pound salmon, caught in the Volga River and presented to me. I thought it must be the most widely traveled frozen fish in the world.

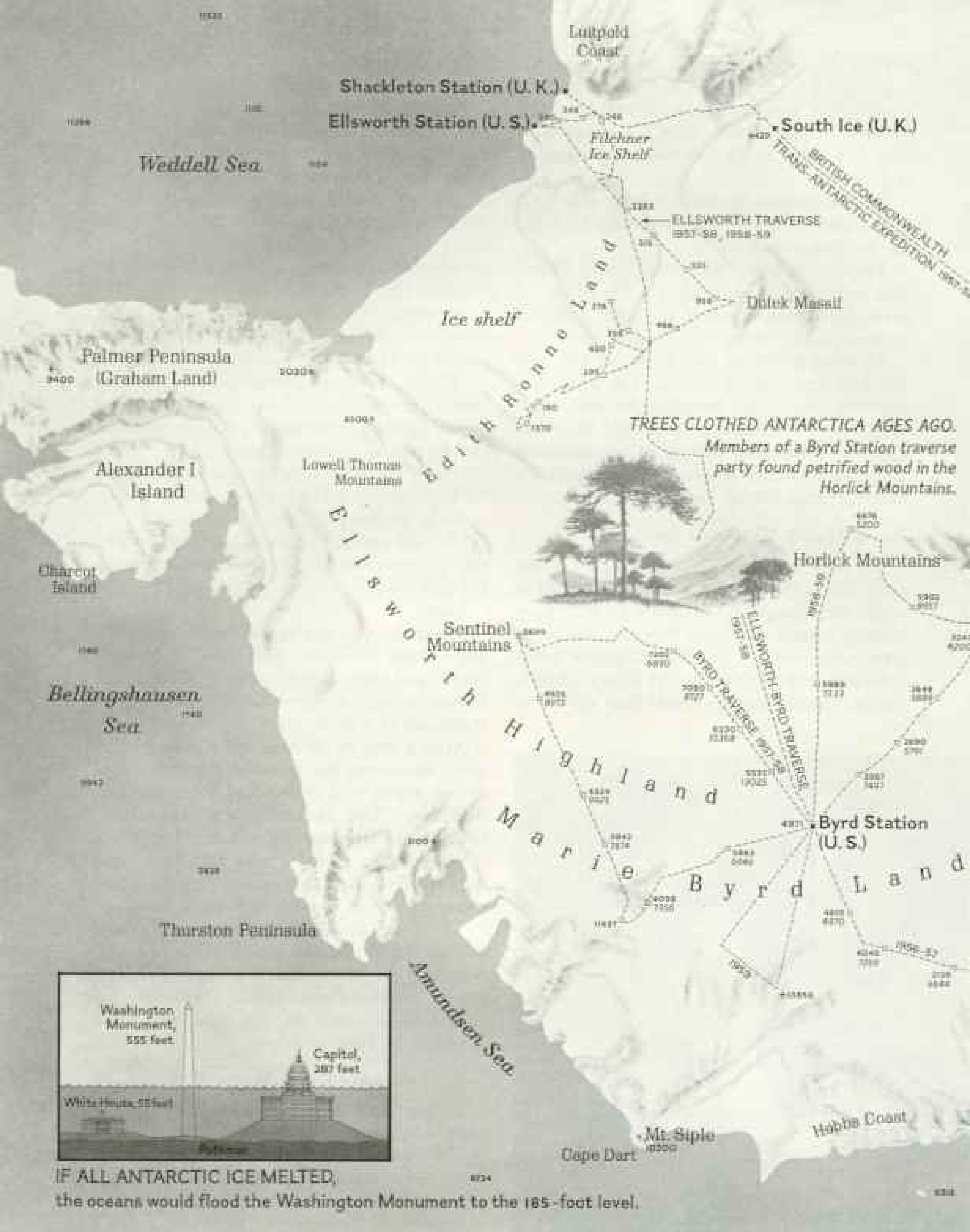
Our guests took off the next day for a direct flight back to Mirny.

Newcomers Get a Warm Welcome

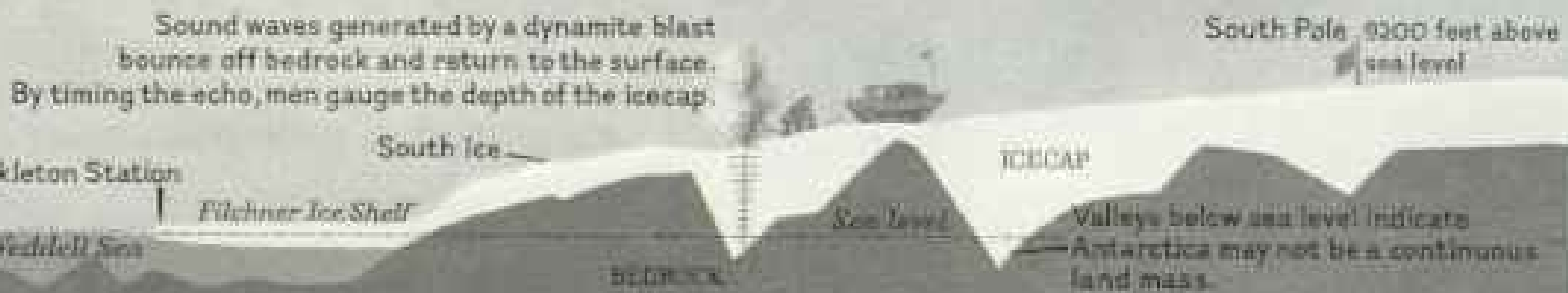
Meanwhile U. S. planes from New Zealand were landing new wintering-over personnel. Spirits of officers and men who had spent the long winter night at our stations rose sharply as they eagerly explained their duties and equipment to their reliefs. They were anxious to shed their heavy clothing, feel the warmth of milder climates on their bodies, see flowers and green grass and the faces of pretty girls.

No other experience can be compared to the thrill of the first day in civilization after months of isolation in the polar regions.





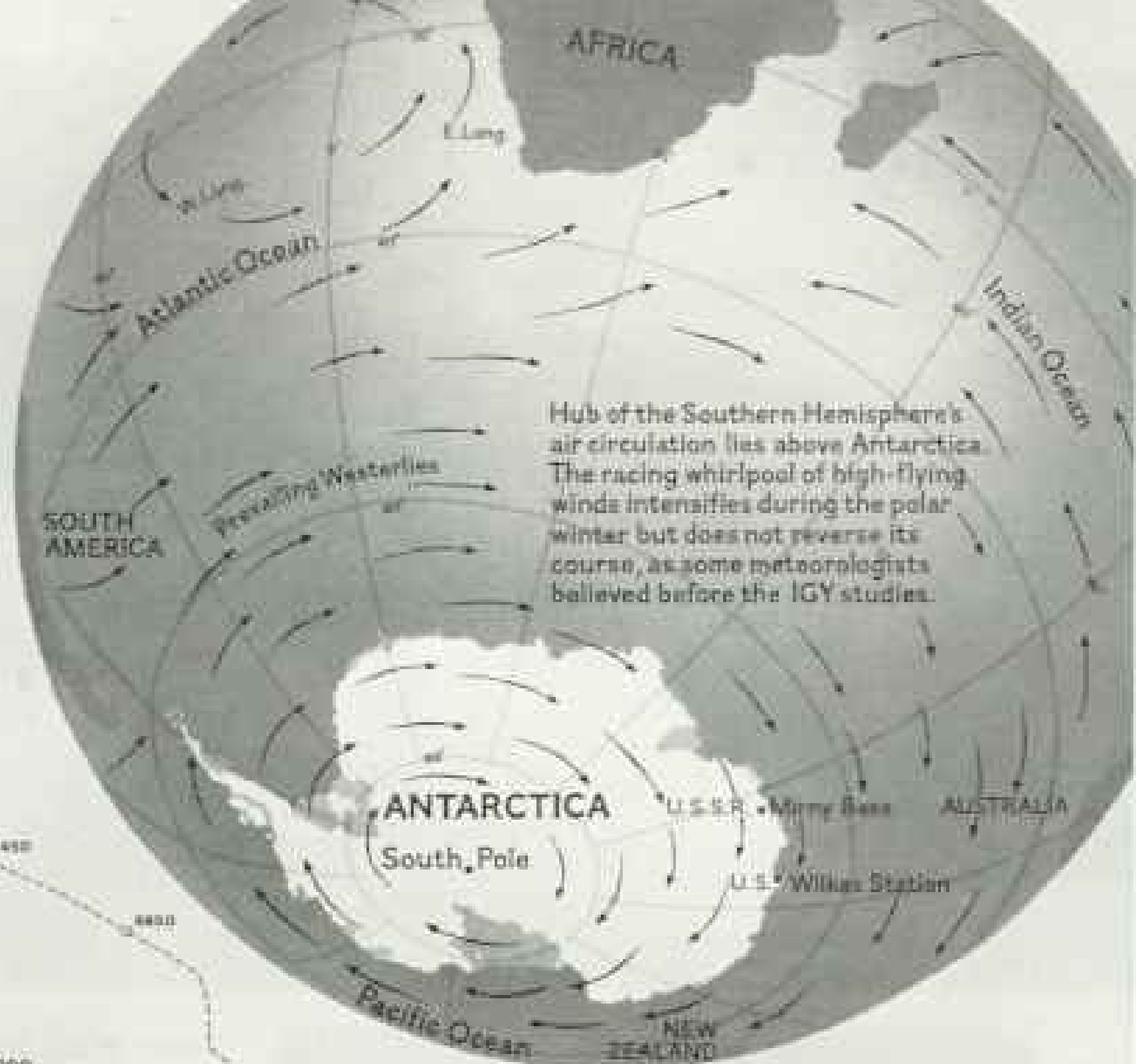
CROSS SECTION ALONG ROUTE OF BRITISH COMMONWEALTH TRANS-ANTARCTIC



Globemasters deliver fuel to Antarctic bases. South Pole Station's annual fuel bill is a quarter of a million dollars.



8300
Polar
South Pole 9200
Plateau
Amundsen-Scott Station (U.S.)
Established 1956



EXPEDITION, NOVEMBER, 1957 TO MARCH, 1958 Based on expedition's seismic soundings

* Fuchs' party of 12 trekked 2,158 miles across the icecap.





TRACY L. FERGUSON, UNIVERSITY OF ALASKA

Polar Wind Sculptures a Rock Whale, and Dry Cold Mummifies a Seal

Erosion works overtime, but aridity thwarts decay in ice-free Taylor Glacier Dry Valley, near McMurdo Sound (pages 546-7). The sandblasted granite boulder above lies in the gravel of a moraine. Last year scientists found 52 stiff and leathery seals and one penguin, all apparently very old, in Taylor Valley's natural cold storage locker.



Among the new arrivals at McMurdo were Comdr. William A. Lewiston, who was to relieve Captain Maher as skipper of all our bases, and Dr. T. O. Jones, the new Antarctic science program director. They brought new plans for the post-IGY period.

For reasons of economy, among others, Little America would be closed, though left ready for survivors of accidents or for reopening later. Ellsworth Station on the Weddell Sea would be loaned to Argentine scientists, and Wilkes Station on the Budd Coast to Australia, for a continued science program called the International Geophysical Cooperation.

Under the U. S. National Science Foundation, research at our remaining stations would carry on as before but with somewhat different objectives.

"Until now," Dr. Jones explained, "we have mainly studied the ice itself, the contour of the ground below, a bit of the ocean, the weather, earth's magnetic field, the upper air, and the ionosphere where radio signals are reflected and aurora and air glow are observed."

In alliance with more than a thousand IGY stations around the world, a comprehensive picture of Antarctic weather was emerging. Antarctica is no longer a missing link in long-range world weather forecasting.

"Plans call now for a shift in emphasis," Dr. Jones said. "New kinds of scientists will be making special maps, analyzing rock structure, checking further into the lives of the fish, the birds, the seals. We expect physiologists to look deeper, too, into the functioning of men's bodies in this cold environment."

Medical researchers from Johns Hopkins University already have visited our isolated stations in the belief that these lonely outposts are an ideal place to pursue and identify viruses that cause the common cold. Amazingly enough, no one has colds at these stations during the winter night; but the men promptly catch them as soon as outsiders arrive. They catch colds, in fact, when the first mail is delivered by parachute.

Scientists Assess a Long Winter's Work

As soon as we could arrange transportation, Dr. Jones made a tour of all our scientific stations. With him went other scientific leaders, members of the IGY team, including Rear Adm. Lloyd V. Berkner, who studied the ionosphere here with Admiral Byrd in 1928 and who is now President of Associated Universities of New York; Dr. Harry Wexler, chief U. S. Antarctic scientist; and Canada's Dr. J. Tuzo Wilson, President of the International Union of Geodesy and Geophysics.

They wanted to hear firsthand reports from the scientists who had been working there through the long winter months. These preliminary reports would indicate, to some extent, what the "net profit" on our quarter-billion-dollar investment was going to be. Yet they were, at best, only an indication, for the results of 18 months of work by scores of experts cannot be appraised in a few days or adequately summarized in a few words.

The news the science leaders gathered included the following:

About weather—

The hub of the main circulation center of air in the Southern Hemisphere lies over the Antarctic. High aloft, winds driven by the intense cooling of the polar atmosphere during winter race in a huge whirlpool. When the sun returns, the atmosphere warms, and the whirlpool weakens. Intense storms occur; it is possible that the atmospheric disturbances

associated with these storms are felt across the Equator and affect weather in the Northern Hemisphere.

About ice—

There is a great deal more ice than previously calculated—6,600,000 cubic miles of it, enough to cover the United States from Maine to California more than two miles deep.

The ice, if melted, would raise the level of the oceans sufficiently to submerge the White House and to put a third of the Washington Monument under water.

A record of 1,000 years of Antarctic snowfall is being deciphered in cores of ice brought up by oil-well-drilling methods from depths reaching 1,000 feet. The cores, packed in plastic tubes five feet long, went by ship and special truck in refrigerated compartments to an Army laboratory in Wilmette, Illinois, for study of weather and pollen records written into the striated ice.

About magnetism—

The earth's magnetic field is not so stable as once thought. It is probably affected by other magnetic fields in space.

About auroral displays—

It was conclusively proved that the aurora, the result of bursts of radiation from the sun reacting in earth's magnetic field, occurs simultaneously in both hemispheres (page 533). Understanding the physics of auroral processes may make it possible to predict periods of activity and their effect on communications. Air-glow studies revealed the presence of lithium in the upper atmosphere, possibly a result of high-altitude atomic tests by the United States in August, 1958.

About the shape and structure of the continent itself—

Large areas of ice-free land exist in Antarctica. Once thought to be a continuous land mass, the continent now appears to be a complex of islands and folded mountain chains in the Weddell Sea and Marie Byrd Land quadrants, and on the opposite half a vast, stable shield or plateau. A deep trough, running from the Ross Sea to the Weddell Sea, and not yet pinpointed by seismic soundings, separates the two parts of the continent. Whether the trough is deep enough to make it an arm of the sea beneath the ice remains to be determined; best opinion to date opposes the theory that a below-sea-level valley actually splits the continent there.

About flora and fauna—

Plants—blue-green algae and lichens—grow



Canada Glacier: a Wall of Ice 150 Feet High

Frozen tongues thrusting into Taylor Valley create a natural laboratory for scientists. Erosion, evaporation, and summer's melt have kept mile-wide Canada Glacier at a standstill for half a century. Thaw water grooves its face.

Lake Bonney, a paradox in frozen Antarctica, mirrors the Kukri Hills, part of a wall barring the icecap from Taylor Valley. Bare earth describes the climate: arid.

A lily pad of ice clings to the bottom of a small lake near McMurdo. Solid in winter, the pool melts from the top in summer. Algae, one of the area's few living things, cover the slopes. A visitor tries an icy foot bath.





in partly ice-free lakes in Antarctic valleys (page 546); how they developed there is a mystery.

Continuing the intensive study of penguins, two enterprising scientists even determined that in the below-freezing temperatures of the Antarctic, nesting Adélie penguins keep their eggs at an average hatching temperature of 92.7° F. They learned this by ingeniously fitting a tiny radio transmitter inside an egg and monitoring the temperature signals sent out.

Perhaps you find it difficult, as I do, to evaluate such findings in terms of everyday practicality. I indicated as much to Admiral Berkner.

"Well," he admitted, "it is a little difficult to see how it matters, for example, that there are 6,600,000 cubic miles of ice down here, instead of 3,240,000 as we formerly estimated. Yet that is a critical figure for studying the delicate balance of the heat and water regimen of the earth. Science may one day use such figures to tell us extremely practical and valuable things about the earth's future.

"When you consider," said the admiral, "that in 35 years, at the rate we are going, there will be twice as many people alive as there are today, you realize that science must come up with solutions for thousands of new problems. What we have been learning in Antarctica is the raw material for some of these solutions."

This is a hard problem, evaluating Antarctica and its ice. I remember my first reaction to this vast and lonely land. I was sailing with Adm. Richard E. Byrd to the Antarctic 20 years ago. I was a mere lieutenant, and he was the most famous Antarctic explorer of our time, the man chiefly responsible for the continued interest of the United States in the polar continent.

Admiral Byrd, a slender, arrow-straight, handsome man, stood at my side that day in 1939 on the sailing ship *Bear*. We looked in silence at the ice surrounding us.

Then the admiral said, "Well, George, what do you think of it?"

I shall never forget my reply, or the admiral's response to it. I said, "Well, admiral, it's a lot of ice. But what good is it?"

Admiral Byrd turned on his heel and walked

away. He didn't speak to me for two weeks. There was a man with faith. He believed that all that ice had significance for the future. Gradually I learned to feel that he was right.*

I believe the Antarctic will play a very important role in the coming Space Age. The South Pole is on a platform—the Antarctic continent—and remains stationary as all other points on the earth's surface move from west to east with the earth's rotation. Thus a satellite in a polar orbit could be observed from the South Pole every time it passed around the earth—at present speeds of 18,000 miles per hour, about every 90 minutes.

Such satellites, when eventually manned, could be controlled better from the South Pole than from any other spot on the earth's land surface. By "controlled" I mean given instructions for the pilot to break out of orbit and land.

Antarctic as an Air Hub of the Future

In this era of fantastic, ever-increasing speeds we must not neglect to consider the future importance of remote areas of the earth. Amundsen and Scott less than half a century ago spent more than a year from the time they left Europe until they reached the South Pole. After the establishment of our U. S. Antarctic bases during the International Geophysical Year, we could land at the South Pole by aircraft within five days after departure from San Francisco.

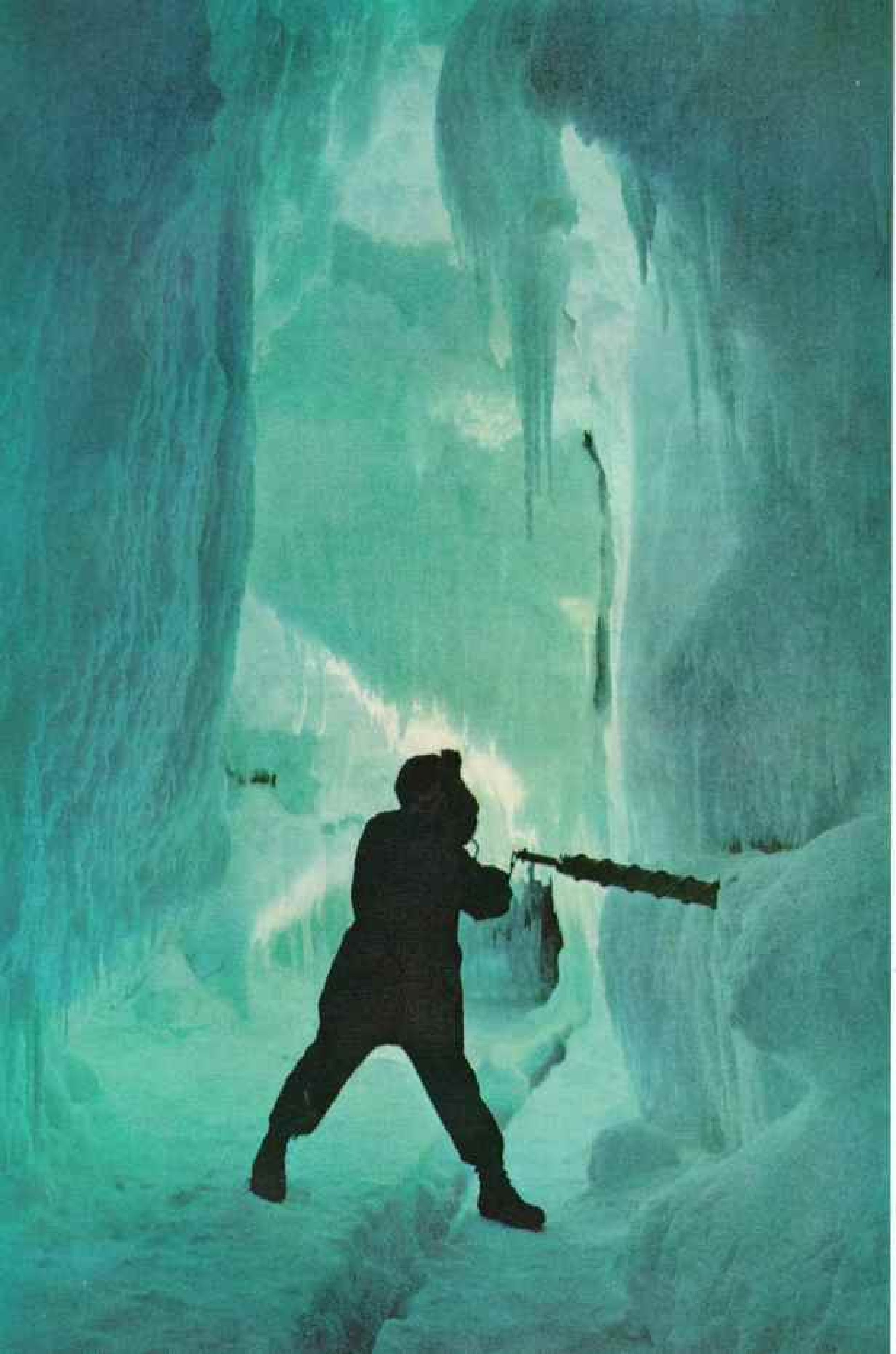
It has long been a dream of mine to build a runway on solid ground in the Antarctic, equipped with all the facilities of a modern airport in the United States. With such an airport we could fly planes in and out of the Antarctic twelve months of the year.

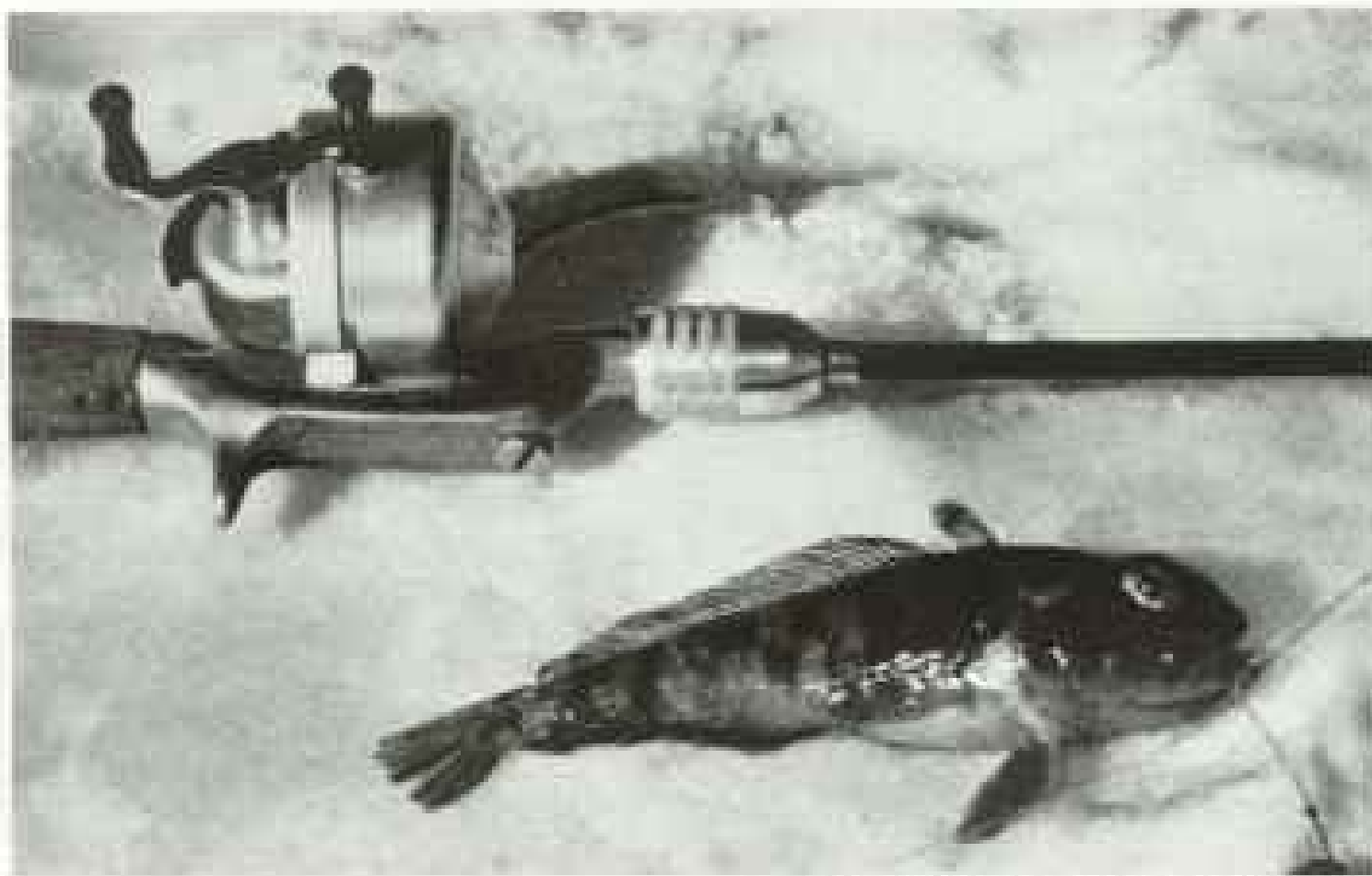
Furthermore, this could open the era of trans-Antarctic flights between Australia and New Zealand, South America, and Africa, just as today many U. S.-Europe planes fly great-circle routes across the Arctic. The demand for such shortened routes will come with growth of population, development of re-

* Beginning with his pioneer flights in the Arctic, including his 1926 flight over the North Pole, and during his many expeditions to Antarctica, Admiral Byrd reported his achievements in the *NATIONAL GEOGRAPHIC*. See *Cumulative Index, 1899-1958*.

Unlocking Frozen Climate, an Ice Corer Drills Into a Turquoise Grotto

The extracted core's trapped air, pollen, and dust will shed light on past weather. Some specimens contain volcanic ash that discloses ancient eruptions. Ceaseless cold preserves snows that fell many centuries ago. This man works in an icicle-draped crevasse in the Ross Ice Shelf near Little America.





SCOTT J. DUPER AND FRED CARLING (UNIDENTIFIED)

Fish-catching Penguins Study a Rival's Ways

Biologist John Reseck, Jr., fishes through McMurdo Sound's ice with seal-meat bait. The catch (left) belongs to the family *Nototheniidae*, and is nicknamed the Antarctic cod.

Some 128 species of fish inhabit Antarctic waters. Their trademark: large heads, small bodies. One family has colorless blood.

sources, and expansion of industries in the Southern Hemisphere.

Today if you wish to fly from the southern tip of South America to New Zealand, you have to go north to Los Angeles, California, across to Honolulu, down through the Fiji Islands, and south to New Zealand—a distance of 14,000 miles. By the Antarctic route the distance is 5,400 miles, a saving of 8,600 miles. I predict that within a few years commercial airlines will be flying the Antarctic routes as they are now flying the Arctic.

At present, aviation in the Antarctic depends upon smoothed snow runways for ski planes, open water for sea planes, and hard ice runways for land planes. None of these can be used enough months of the year to develop the continent effectively. We must have a land runway.

In 1955 we thought we had found such a site at our McMurdo base on Ross Island. The Navy's Seabees went to work with their slipsticks and dynamite. Bitter defeat! Their explosives revealed that six feet of lava was resting on a glacier. Evidently old Mt. Erebus once had blown her top and vomited her insides upon the virgin ice of Ross Island. This was plainly no place for a permanent land runway.

My pilots searched and probed. It had to be a large flat area of land that could be supplied by ship. In all that vast territory they found the spot—Marble Point, on Cape Bernacchi. I wish I could give one pilot credit for it. Perhaps the most enthusiastic was Capt. William M. "Trigger" Hawkes, who from the beginning planned the first landing at the South Pole with me. At any rate, one look at it convinced me that this was the place.

It is on the mainland of Victoria Land, 45

miles across McMurdo Sound from our main base at Hut Point. We already have a 1,700-foot land strip there for small Otter aircraft on wheels. Sir Edmund Hillary and I made the first wheels-on-dirt landing in Antarctica on it in 1957. Some day an airstrip of at least 5,000 feet will be constructed there, and that will be a great day for Antarctica and the whole Southern Hemisphere.

The Antarctic, I believe, will go on being explored and exploited scientifically forever. In this sense the work will become routine.

Scientists tell me that they are having a harder time each year recruiting people to come to the Antarctic. The glamour has worn off. So, if the U. S. is to make its full contribution and obtain for itself the hidden things the Antarctic has to give us, our scientists must be willing to come more and more for science and less and less for fame and excitement.

Courageous Scientist Cheats Death

A fine example of the Antarctic field scientist is Albert P. Crary, 48-year-old geophysicist, who this year received the Navy's highest civilian award. He is a sturdy man, built like a middleweight boxer, but he speaks in a scholarly low voice. He reminds me very much of Sir Vivian Fuchs.*

When Crary returned to New Zealand last February, he had spent two continuous years in the Antarctic, served as scientific leader at Little America for three seasons, and made two major traverses, crawling over the frozen continent a total of 3,150 miles.

He had many close calls on these long tractor journeys, but perhaps the most unusual

* See "The Crossing of Antarctica," by Sir Vivian Fuchs, *NATIONAL GEOGRAPHIC*, January, 1959.



adventure in all Antarctic history befell him only five miles from base.

Bert Crary and Stephen Den Hartog, assistant glaciologist at Little America, were taking sea temperatures from the edge of the ice cliff in Kainan Bay. The ice cliff is the seaward front of an ice shelf a thousand feet thick floating on the ocean.

Then, for Crary, the bottom fell out of everything. With a thundering roar tons of ice and snow broke away like a giant trap door and tumbled him into icy Kainan Bay.

Den Hartog jumped back, and when the snow mist cleared, he saw Crary bobbing up and down with huge lumps of ice. In about a minute Crary managed to get up on a small ice floe, but the wind was offshore, carrying him seaward.

Den Hartog ran to his weasel and roared off to Little America. To Capt. Pat Maher he gasped out his story.

"Helicopter is out of commission," said Pat, as if talking to himself. "Call Kiel Field," he ordered. "Tell them to get the helicopter back in commission soon as possible. Send a rubber life raft to me immediately."

Bert Crary meanwhile was drifting farther away from the ice cliff. He didn't like the small ice floe he was sitting on. It rocked, and he feared he might slide off. He slipped

into the frigid waters and swam to a larger one a few yards away. It was better, but not much—about the size of a billiard table.

Crary's windbreaker trousers, tied at the ankles, had filled with water and were ballooned out. Laboriously he took off his gloves and with numbed fingers untied the knots. The body-warmed water spilled out over his half-frozen feet. Then he retied the strings.

Sitting on that ice floe is what saved Bert Crary. Ten minutes in those icy waters means death. His clothing and gloves froze, forming protection against the wind and providing an air layer warmed by body heat.

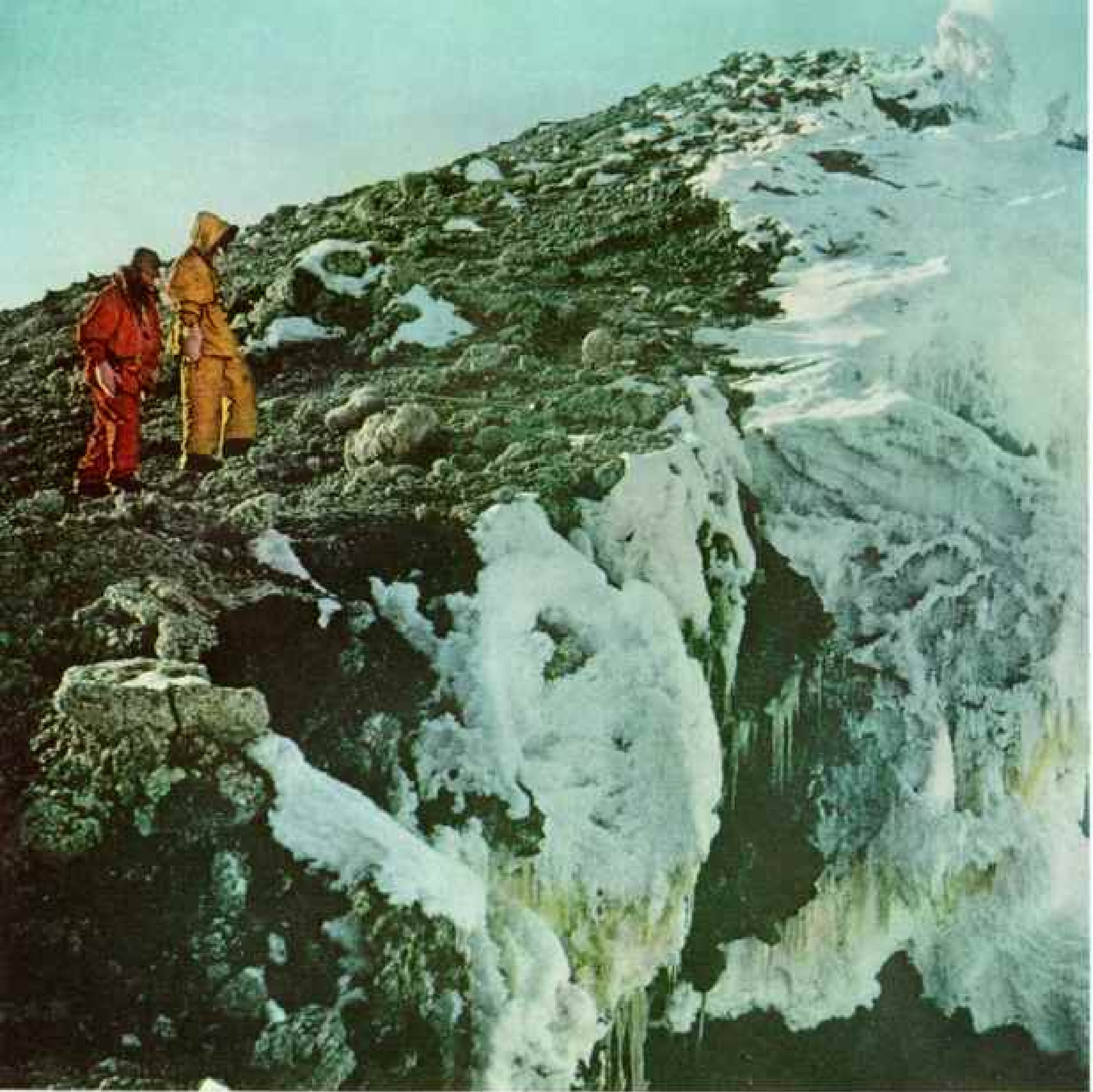
Back at base a Sno-Cat lumbered up with the rubber life raft and bad news: "Everyone is working full bore on the chopper, but it won't be ready for two hours."

"Have it join me when ready," ordered Pat.

Into the vehicle jumped Maher, Den Hartog, and Charles R. "Bucky" Wilson, another assistant glaciologist. At the edge of the 60-foot ice cliff the rubber life raft was inflated and lowered. Down the lines next went Maher and Wilson, then the paddles.

Indian style, they paddled toward Crary. When they bumped alongside his ice floe, Bert said, "Hello."

"Dr. Livingstone, I presume," replied Pat Maher.





New Zealanders Gaze Into the Open Maw of Erebus, a Steam Pit in an Ice Tub

Mount Erebus, Ross Island's 13,200-foot volcano, has fascinated explorers since 1841, when the James Ross expedition discovered its lofty cone belching steam from a fiery bowl.

Shackleton's 1908 expedition was the first to scale the volcano. In 1912 a climber from Scott's northern party fled an eruption of rocks and sulphurous clouds.

Leaning over Erebus's brink, the New Zealanders behold an awesome sight.

"The crater measured 2,000 by 1,500 feet," says John Harrison, the leader. "Walls that dropped sheer for 800 feet were festooned with efflorescences of ice and mineral. Jets of yellow-brown steam hissed from five pits in the floor of the crater, and rocks glowed red hot. We smelled sulphur and heard an incessant buzzing."

ESKADROWER BY JOHN HARRISON © NATIONAL GEOGRAPHIC SOCIETY



Manhauling a sledge as did Scott on his ill-fated trek to the Pole, the Erebus climbers emerged from murk into intense sunlight at 1,200 feet. They shed heavy garments as they sweated on up to 2,870 feet, where they made final camp. On the fifth day, using skis and finally crampons, they attained the 2½-mile-high summit.

To gain traction, one of these climbers thrusts bare arms into snow. The gear-laden sledge tows a mileage wheel.

An hour of exploring the crest severely taxed the New Zealanders, who had climbed too fast to accustom themselves to the altitude. Speeding their return to a more comfortable level, they made 5,000 feet of the descent on skis. Earlier climbers became human toboggans, casting themselves down the slopes and using ice axes as brakes.



Bert climbed into the raft and they headed back to their starting point. They couldn't make it; the wind forced them toward the high, sheer ice walls to the east.

There was a whirring noise; they looked up and saw the bright-orange helicopter, dangling a line. They strapped the rescue harness around Crary and gave the thumbs-up signal. Bert was jerked upwards and started spinning, first one way, then the other.

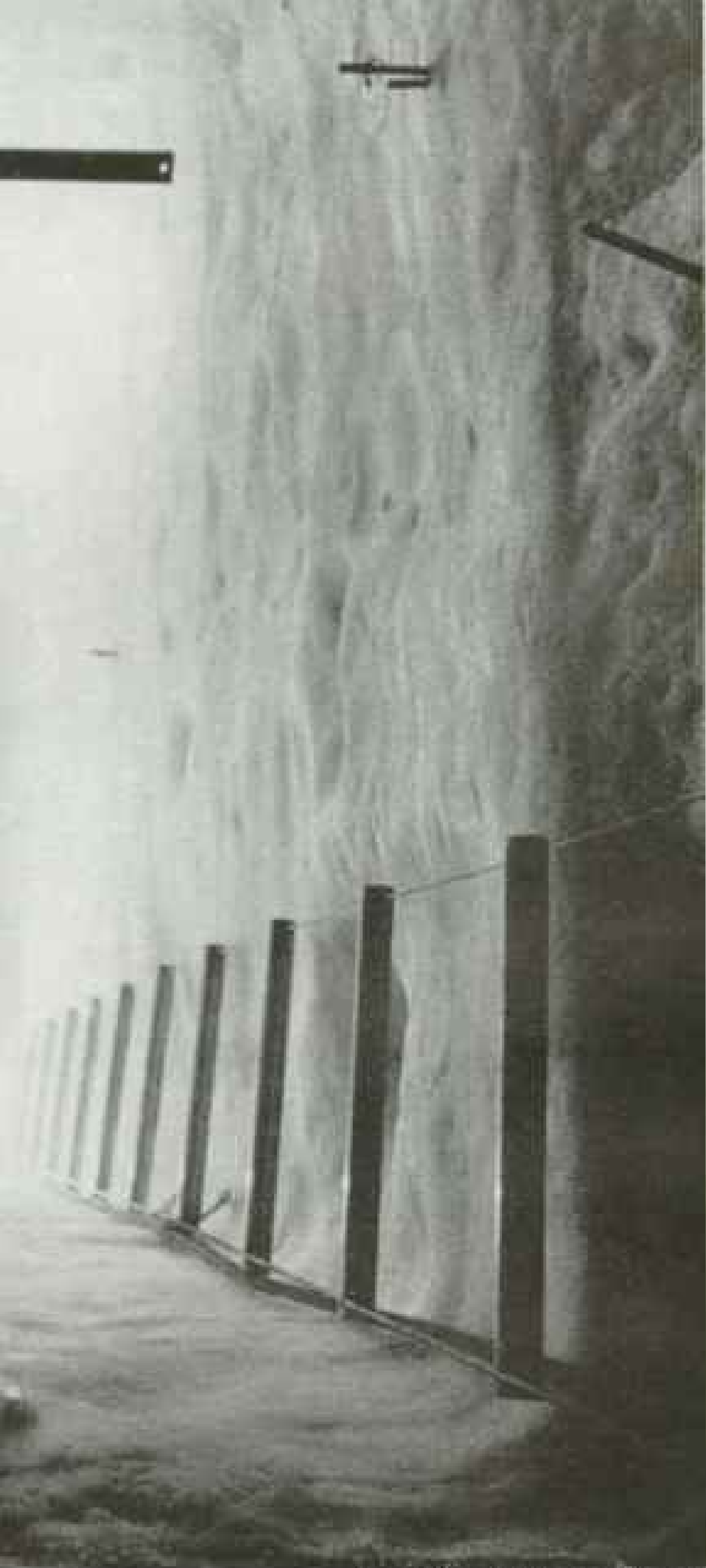
The mechanics had got the helicopter fixed and in the air in a little over two hours. They hadn't waited to repair the winch that raises and lowers the rescue gear. Instead they had grabbed a new line and secured the upper

end firmly inside the helicopter. The pilot, Lt. Comdr. Willard J. Franke, handled his chopper superbly. But the line was new with kinks in it. This caused Bert to spin back and forth in such a ridiculous manner.

The chopper hit a downdraft and lost 10 feet of altitude. So did Crary, except that he was only five feet above sea level to begin with. In a second the chopper gained altitude, and so did Crary—dripping like a wet cat.

"Looks like he's spitting ice cubes," Maher remarked to Wilson.

Bucky Wilson was lifted out next without incident. Pat Maher stayed with his ship till the last, and like Bert he got a dunking.



EDITH S. BOYER, NATIONAL GEOGRAPHIC STAFF

Looking Straight Down Into an Ice Pit: Glaciologist Climbs a Nylon Rope

Forces that rule the world's largest ice mass intrigue science. Americans at Byrd Station, who dug this 40-foot shaft to study compression, found the walls contracting a centimeter a month. In a related project, they drilled a record 1,013 feet down and recovered cores of ice that fell as snow about the time of Charlemagne's birth in 742.

This man, inching his way up a nylon line, applies a measuring stick to markers spaced at intervals in the walls.

two or three exceptions. I remember the day two airline stewardesses of Pan American World Airways arrived on the only commercial airplane ever to land in the Antarctic.

The girls, the Misses Ruth Kelly and Patricia Hepinstall, ravishing in furs, were being wined and dined in the McMurdo mess hall, where they were called upon to judge a beard-growing contest. But I noticed there were some men missing, and I walked around the base to see what they were doing.

It was a strange thing. They were sitting in their quarters, smoking and drinking coffee, Coca-Cola, and beer. I sat down and smoked with them. They didn't say much, but I could see they were resentful. None had gone to meet the plane. They had remained indoors when the girls drove up main street. Their reason: They wanted to be able to say that from the time they left civilization until they returned, they hadn't seen a woman!

Eventually women will come to the Antarctic. They will prod, probe, and climb with the rest of us. They will help us open the Antarctic, as the pioneering women of early America crossed our country to open the West. We really need them.

All I have to say is this: I don't want to be the Solomon to have to decide who is to be the *first* woman to reach the South Pole.

The Antarctic is a tourist paradise, and the day will come when the *GEOGRAPHIC* will be carrying ads like this: "Cruise to unspoiled Antarctica. See the comical penguins, the great Ross Ice Shelf, the steaming volcano Mt. Erebus, and icy mountains untouched by man. Visit Little America and the actual huts of Scott and Shackleton. Enjoy winter sports in an unsurpassed setting. Landing craft and sightseeing helicopters will whisk you quickly ashore. Warm staterooms, all meals aboard ship. Make your reservations now."

One of the most enjoyable and rewarding results of our operations in the Antarctic has

In sick bay the three were given the standard Navy treatment for exposure to cold. None caught so much as the sniffles.

The next day Mr. Albert P. Crary was busy making plans for his next traverse.

I remember a favorite story of Admiral Byrd's. He and one of his men were walking silently along the ice shelf. Suddenly Byrd asked, "What do you miss most down here?"

There was a pause. Then his companion replied: "Temptation."

I have always been against women in the Antarctic for the simple reason that during the construction period there was no place for them. So far, this has been a man's world with



Hovering helicopter picks up supplies on frozen Kainan Bay, where the icebreaker U.S.S. *Glacier* left them. Soon the machine will leap the Ross Shelf, in background, and deliver its cargo to *Little America V*, atop the ice shelf.

556

JATO bottles spurt flame as a Navy *Neptune* blasts aloft on summer's first flight from McMurdo Sound to the South Pole. Photographers hunch over cameras; crash trucks stand by. Passengers will replace men who wintered at the Pole.

PHOTOGRAPHS BY DAVID S. BEYER, NATIONAL GEOGRAPHIC STAFF © N.G.S.



been the cooperation between New Zealand and the United States. On one of my trips to Christchurch I gave a little speech on the subject, "The First Cruise Ship to the Antarctic." Both then and after my return to Antarctica I was bombarded with inquiries from many countries. In reply I have explained why this is entirely practicable.

For the past four years little if any pack ice has been seen in the Ross Sea between New Zealand and Antarctica in early February. Of course icebergs are always present, and the same care must be taken as in the North Atlantic. I suggest the employment of an ice pilot familiar with Antarctic waters.

It must be remembered that weather and ice conditions are sometimes unpredictable. No U. S. Navy icebreaker escort can be promised, but the law of the sea dictates assistance to any vessel in distress.

The ship will need no special winterization but of course must have a good heating system. Warm clothing will be required. For the past three years the average temperature ashore at our McMurdo base in late January and early February has been 24.1° F., with a high of 39 and a low of 9.2. The average wind has been 8.4 knots. At sea and on the ice the temperature is usually about 10 degrees colder.

At the time of year when Antarctica is most accessible, the snow surfaces are too icy for skiing, since the snow melts in December and early January, then refreezes. Ice skating, hiking, and mountain climbing are available, and a fair game of golf can be played on the snow or ice with a standard ball encased in a knitted cover of red yarn.

Men Carve Penguins for Tourists

The news of the tourist interest spread through our McMurdo base as men began receiving news clippings in mail from the outside world. Before I left, I noticed that some of our men were taking up a new hobby, one that would help occupy their time during the winter night. They were making souvenirs to sell to visitors and even had a price list: "Penguins carved from wood, painted black and white—\$1.50. Old whale teeth—10 cents each. Penguin feathers—5 cents. Old explorers' items—whatever the traffic will bear."

As a matter of fact, Argentine and Chilean ships already have taken tourists to the northernmost fingers of Antarctica.

Now that I am retiring from active duty,

turning my job over to Rear Adm. David M. Tyree and looking back across four years of Operation Deep Freeze, I find myself thinking what a grand experience it all was.

Parts of it were grim, to be sure. Losing men—and we lost 18 of them—was the hardest thing. But most of it was good.

When you work in a tough place like the Antarctic, you really find out what men are made of. Ours were some of the best.

One of the proofs of this came to me in a report prepared by Dr. John H. Rohrer and Capt. Charles S. Mullin of the Navy Medical Corps, who visited our bases as a psychiatric evaluation team.

Doctors Find Few Patients

Among all the men chosen to winter over at our stations last year, there was no case of pathological depression, no case of any suicidal gesture. Nostalgia for home was not a major problem, nor was boredom. The men did alleviate the dullness with drawn-out arguments but generated no real anger.

Almost any kind of emotionally mature man, the doctors concluded, can get along in the Antarctic. They cited the curious case of one who rarely spoke a word to anyone else. He was so antisocial he didn't sleep in the barracks but in his own workshop. He was a good worker, though. He didn't bother anybody, and he was considered a good shipmate.

Being a good worker seemed essential. No matter how charming a man's personality, if he was a slacker he was an outcast until he mended his ways.

While the tension of isolation and confinement did not bring on serious quarrels, Dr. Mullin and Dr. Rohrer found it could result in frequent headaches. Aspirin consumption by some of the men was phenomenal.

Race, religion, social background—these differences took a back seat in the Antarctic, the doctors discovered. What mattered was whether a man was a worker and a good fellow.

Well, we had lots of good fellows. In four years I knew and worked with hundreds of them. Many of them will go back to Antarctica. They will go because they want to, because there is something on that lonesome, awesome, beautiful, and treacherous ice that is as irresistible as it is indefinable.

Americans will be part of the Antarctic from now to eternity. I know I'll always be with them down there in spirit.

82 National Park Areas

THE ROCKY MOUNTAINS

Yellowstone
Grand Teton
Glacier
Rocky Mountain
Devils Tower
Theodore Roosevelt
Mount Rushmore
Wind Cave
Jewel Cave
Badlands

THE GREAT PLATEAU

Grand Canyon
Lake Mead
Zion
 Bryce Canyon
Cedar Breaks
Capitol Reef
Pinnacles
Natural Bridges
Arches
Black Canyon of the Gunnison
Colorado
Hinosaur
Lehman Caves
Timpanogas Cave
Craters of the Moon

THE SOUTHWEST

Carlsbad Caverns
Big Bend
White Sands
Saguaro
Organ Pipe Cactus
Chiricahua
Petrañed Forest
El Morro
Great Sand Dunes
Capulin Mountain
Chaco Canyon
Mesa Verde
Hovenweep
Aztec Ruins
Bandelier
Navajo
Canyon de Chelly
Sunset Crater
Walnut Canyon
Wupatki
Montezuma Castle
Tuzigoot
Casa Grande
Tonto
Gila Cliff Dwellings

THE GOLDEN WEST

Yosemite
Muir Woods
Devils Postpile
Pinnacles
Siyah
Kings Canyon
Death Valley
Joshua Tree

THE PACIFIC NORTHWEST

Olympic
Mount Rainier
Crater Lake
Olympic Caves
Lava Beds
Lassen Volcanic

THE EAST

Everglades
Great Smoky Mountains
Blue Ridge Parkway
Shenandoah
Cape Hatteras
Acadia
Mammoth Cave
Russell Cave
Pipestone
Effigy Mounds
Ocmulgee
Mound City Group
Isle Royale

ALASKA, HAWAII, VIRGIN IS.

Mount McKinley
Katmai
Glacier Bay
Hawaii
Virgin Islands



Symbol of the Nation,
a bald eagle surveys
his parkland domain.

Announcing The Society's Book of National Parks

By MELVILLE BELL GROSVENOR
President and Editor

FROM MAINE TO HAWAII, from the Virgin Islands to Alaska, record numbers of people are visiting America's wonderlands this year. National Park Service officials are now adding the totals. Perhaps your own family increased that count. Or perhaps, tempted by stories of enthusiastic friends, you promised yourself, "We're going there someday."

For those who have already discovered the parks and those about to—or those who prefer armchair travel—the National Geographic Society announces an extraordinary new book: *America's Wonderlands, The National Parks*.

This handsome volume, the most ambitious ever presented by The Society, combines guidebook, reference work, and color album in its 512 pages. It portrays by word, map, and lavish illustration—390 color pictures in all, the largest park collection yet published—the uncommon grandeurs of the 82 scenic areas at left.

"I am honored to have been a contributor," Conrad L. Wirth, Director of the National Park Service, told me recently. "In scope and beauty, this book is worthy of the parks themselves."

For one Geographic member-family, the Robert M. Langdons of Edgewater, Maryland, a look at an advance copy produced enough travel plans for a year. "During the Christmas holidays our family is going to Carlsbad Caverns and Big Bend," Mr. Langdon reports. "Next summer, Yellowstone, the Tetons, and other parks. For us, this is the right book at the right time."

History, of course, is full of stories of the right books at the right time. As a boy, Abe Lincoln pored over books by firelight. Thomas Alva Edison found paths for his genius the day he discovered the Detroit public library. Young Charles Darwin shipped aboard the *Beagle* after reading Humboldt's *Travels*.

Yosemite's Mirror Lake Wraps the Book in Color

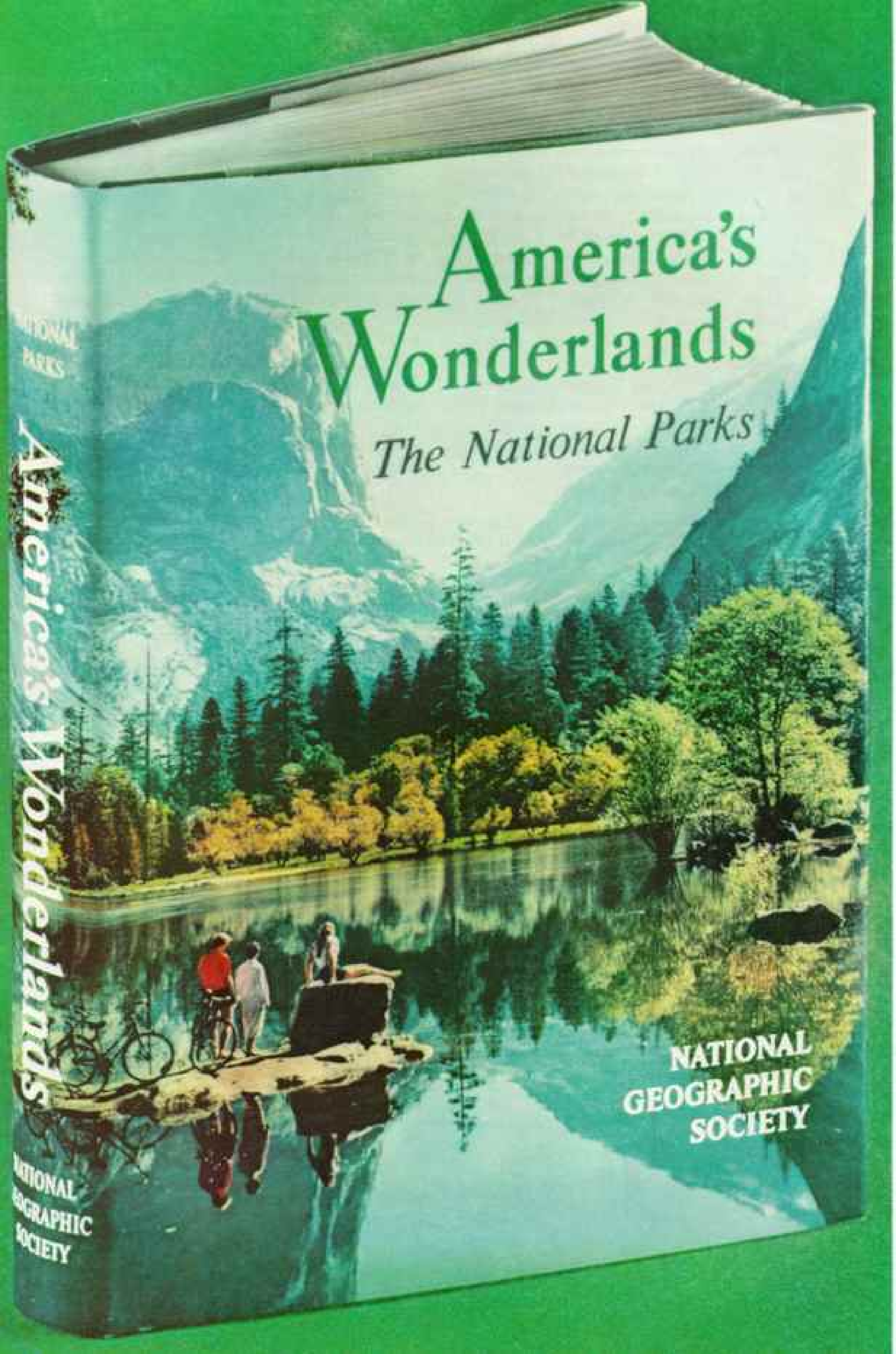
America's Wonderlands

The National Parks

NATIONAL
PARKS
America's
Wonderlands

NATIONAL
GEOGRAPHIC
SOCIETY

NATIONAL
GEOGRAPHIC
SOCIETY



No one can predict which spark will ignite a lifetime interest in nature and the outdoors. But the pages of *America's Wonderlands* offer a scope and style to whet curiosity.

Here are adventure stories for many an evening's enjoyment. A veteran of the white water takes readers down the rapids of Dinosaur National Monument. A mountain climber boosts the vicarious hiker to a breathless panorama of the Tetons. An archeologist shares his treasure hunts, uncovering artifacts of Mesa Verde cliff dwellers.

Park Director Wirth himself and scores of rangers, scientists, writers, artists, and photographers helped The Society make this book not only colorful, but reliable in its smallest detail. Park Service experts in each locale checked details of terrain and geology, new trails and roads, even the kinds of clothes needed in the different seasons.

Is your special interest wild flowers? Then a naturalist guides you to a rare blossom high in Olympic National Park. The flora of each park gets careful attention—from delicate moss to the towering General Sherman Tree.

Wildlife of all kinds abounds in the parks, and it animates the pages of *America's Wonderlands*. Nature tells its own story in action photographs and in natural-history paintings by Walter A. Weber. Leafing through the book, we see a snakebird gulping a fish. A coyote brings home food to its young. An alligator slides through the lush Everglades; a grizzly sniffs the chill, thin air of Mount McKinley.

Here, in compact form, are all the facts a family needs in planning a vacation. The book covers each park in its geographical context. Regional maps introduce each of the book's seven major sections. A large 10-color map of U. S. parks is tucked into a back-cover

Zion National Park, Utah, spreads a feast of grandeur for picnickers. In 512 pages, 420 in color, the National Geographic's book captures the lure of the parks.



pocket for easy reference. Advice on how to get to the parks by road, rail, and air assures the reader of saving time and money, many times the price of the book itself.

"We traveled within nine miles of one park and 30 miles of another . . . without knowing they were there," a Western member wrote not long ago. Most of us can sympathize; but with *America's Wonderlands* as our guide, we can avoid such disappointments. And when we get home again, we can return to its pages to recapture outdoor pleasures.

Book Lists a Drive-in Volcano

No matter how many times you have visited these parks, I am sure you will learn some surprising facts from the pages of *America's Wonderlands*. I know that I have. Would you care to visit a drive-in volcano? Or climb a mountain that is turning itself inside out? You will even read about spots within the 24-million-acre park system that have never been scientifically surveyed and mapped; even today you can find land never before trod by a paleface.

"I can't think of a better way to interest young people in geology," said Dr. Donald W. Fisher, State Paleontologist for New York. And, certainly, how can anyone think geology dull when he sees the rainbow spectrum in a piece of petrified wood or reads the biography of the Grand Canyon—a billion and a half years preserved in stone! A remarkable series of paintings traces the fiery origins of Crater Lake; another shows how ice carved Yosemite Valley. A depth map of Carlsbad Caverns prompted a noted speleologist to say, "For the first time I can orient myself in Carlsbad."

Members will want this volume for many reasons. You may take a proprietor's pride in the magnificent scenery. American citizens own these parks, and members of The Society have contributed in extraordinary ways to the park system: the first expedition to explore Carlsbad Caverns . . . the discovery of the Valley of Ten Thousand Smokes . . . the donation of a tract of towering trees in the Giant Forest of Sequoia . . . the recent gift of Russell Cave, Alabama.



NATIONAL GEOGRAPHIC PHOTOGRAPHER THOMAS J. ARBONOWSKI

Virginia in *America's Wonderlands* finds adventures that would have astonished Alice. Reading the book in her Edgewater, Maryland, home, the 11-year-old daughter of the Robert Langdons dreams of vacations in the national parks.

The Nation's parklands have been preserved for all to enjoy because America has always found, in the words of poet Sam Walter Foss, "men to match my mountains"—courageous fighters for conservation like John Muir, Stephen T. Mather, and Horace M. Albright; generous, public-spirited donors like John D. Rockefeller, Jr., and farsighted men in Congress and the White House who have helped make the U. S. system of national parks a model for all the world.

That highly literate outdoorsman, Theodore Roosevelt, once wrote, "... among those men whom I have known, the love of books and the love of outdoors, in their highest expressions, have usually gone hand in hand."

In that spirit, your Society is proud to offer its members *America's Wonderlands*.

Members are advised to reserve AMERICA'S WONDERLANDS, THE NATIONAL PARKS at the special prepublication price of \$9.95 to ensure obtaining a first edition. Enthusiastic early response indicates the first printing may be oversubscribed; requests will be filled in the order received. A bill will accompany the book. After publication the price will be \$11.50. Gold lettered, buckram-and-linen bound in two-toned green, 512 pages; 466 illustrations, 390 in color.

Write to National Geographic Society, Dept. 28, Washington 6, D. C.



*On the marshes of Dorset, among ruins mellowed by 900 years,
England's oldest swannery still tends its noble birds*

The Swans of Abbotsbury

By MICHAEL MOYNIHAN

Photographs by BARNET SAIDMAN

ONE OF Fred Lexster's proudest possessions is a framed certificate. It records that one night, in the BBC television studios in London, he defeated the panel of "What's My Line?"

He was rather shocked that the members of the panel failed to identify him as a swanherd, keeper of the Abbotsbury Swannery on the Dorset coast, the oldest institution of its kind in England and, probably, in the world. Fred's 700 charges, the largest assembly of mute swans in England, are heirs to a history that reaches back some nine centuries.

Recently I went to Abbotsbury and found among its stone cottages a road sign directing me to the swannery. There, just beyond the thatched gatehouse, I met Lexster, a thickset man of middle years, instantly likable. I asked him about his television appearance.

"A dim lot, that panel," he growled. "Why, I gave the show away with the miming!"

He repeated it for my benefit—an intricate manipulation of hands, the placing of an invisible something on an invisible other thing, then a sudden retreat. I had to admit myself to the ranks of the dimwits.

Tolerantly Fred explained that he had been pantomiming the marking of a newly hatched swan—a cygnet—with a knife nick on both tiny webs, the replacing of cygnet on nest, and then a quick getaway from the irate mother's slashing wing. The nicks would forever distinguish an Abbotsbury bird from all unmarked swans at large in England, long the property of the Crown.

"Come and see them for yourself," Fred in-

vited. We followed a path through a garden bright with flowers and bird song. Here the coastal hills of Dorset slope into the reedy verges of a sea lagoon called the Fleet. Beyond this inlet, pebbled Chesil Beach walls off a preserve of some 25 acres belonging to Lord Stavordale, where swans may live unfenced and undomesticated.

Nine hundred years ago, as now, across the brackish waters of the Fleet, myriad terns would have swooped above Chesil Beach. The abbot of the now-vanished Benedictine monastery that began the swannery would probably have asked how many cygnets were to spare for the roasting spits.

Mute Swan Makes Many Sounds

At present the swannery's 35,000 annual visitors feast only with the eye. It is something to reflect that spring after spring for hundreds of years has been heralded by the swans, gliding two by two from their winter feeding grounds five miles away.

Around us on the marsh we could count half a hundred ramshackle heaps of stick-and-reed nests built by the industrious swans. The air was clamorous with parental concern.

"Mute!" said Fred scornfully. "A mute swan can make at least eight different sounds."

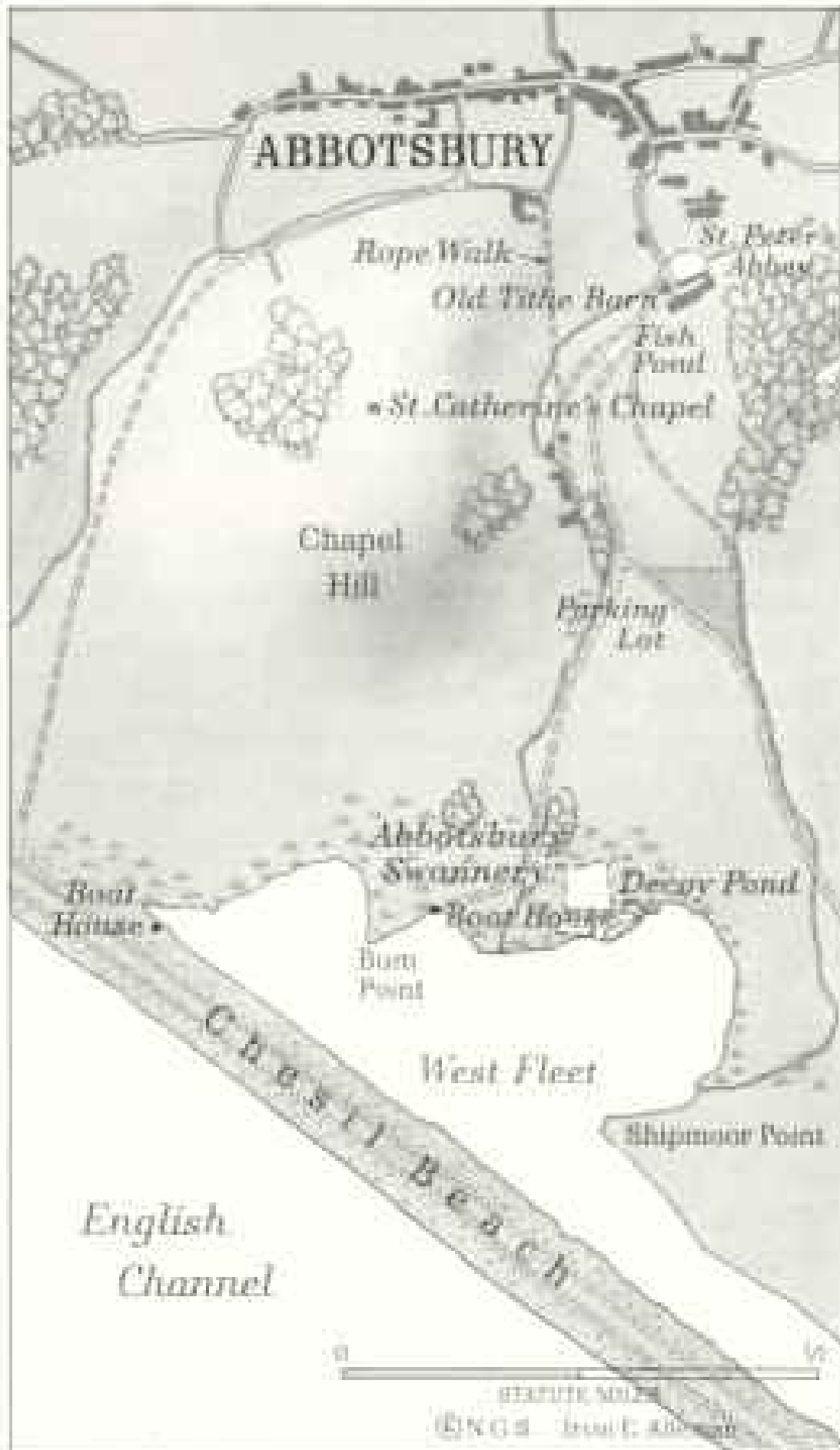
Therewith he mimicked a range from a twangy trumpeting to an alarm call (Fred transcribes it as "Herbert! Herbert!"), a defense call, and a cry of victory. I heard the way a pen, or female, summons her brood to venture into the wide, wet world; it sounds for all the world like a frisky puppy's bark.

Mute Swans Convoy a Downy Flotilla at Abbotsbury Refuge, England

Some 700 swans, England's largest community of its kind, inhabit this 25-acre preserve on the Dorset coast (map, next page). A pen, or female swan, here escorts her brood through a ditch near the nesting grounds. Her mate, known as a cob, swims rear-guard alert against marauding foxes, otters, and rats.



© N.G.B. / Irvin E. Allenman



Seven miles from Weymouth, the Abbotsbury Swannery occupies the reed beds of a Dorsetshire lagoon called the Fleet, once the haven of pirates and smugglers.

Chesil Beach, a 10-mile-long pebbled breakwater, shelters the lagoon from tides and English Channel storms that drove many a ship to its doom.

Calm waters of the Fleet mirror handsome birds that scour the bottom for food. Yearly the swans build reed nests and launch a fresh generation of cygnets.

And when my feet strayed over the invisible boundary each male, or cob, inscribes around his nest, I heard with some alarm the actual hissing and snorting that says as plainly as words, "Advance at your peril!" One blow from the knucklebones of those wings, I knew, might break a man's arm (pages 566-7).

Fred is a naturalist by birthright, and his language that of a salty philosopher. But like sages and poets of all eras, he sees in the life cycle of his swans a mystic reflection of man.

The mute swan (*Cygnus olor*), distinguished among his kind by arched neck, pinkish-orange bill, and black forehead knob, mates for life. Even when death parts the mates, widow or widower may still build a nest and sit there "like patience on a monument," keeping nothing but hope alive.

Cobs Guard Against Thieving Rats

Life begins at Abbotsbury with a clutch of from four to twelve gray-green eggs. The cob does his stint on the nest when the pen flies to East Fleet to feed and wash. But for the most part he stands belligerent guard. His chief enemy is the rat, creeping in the dark to devour unprotected eggs.

After five weeks the cygnets break from the eggs with a shrill peeping. Not long after hatching, they are coaxed to the water and out to that section of the Fleet where father, with a mighty beating of wings, has circled his claim.

In the open the swan parents are constantly on the alert, for their children are fair and delectable game for foxes, otters, and birds of prey. At night the cygnets sleep safely in the softest of feather beds. On signal, each clambers into the downy hollow between the pen's wings (opposite).

For some five months the fast-growing youngsters remain under the parental wing. Weighing about 20 pounds and by now able to fly, they are at their least attractive age. As dingy gray feathers are shed for white, the adolescent can admire his brightening reflec-

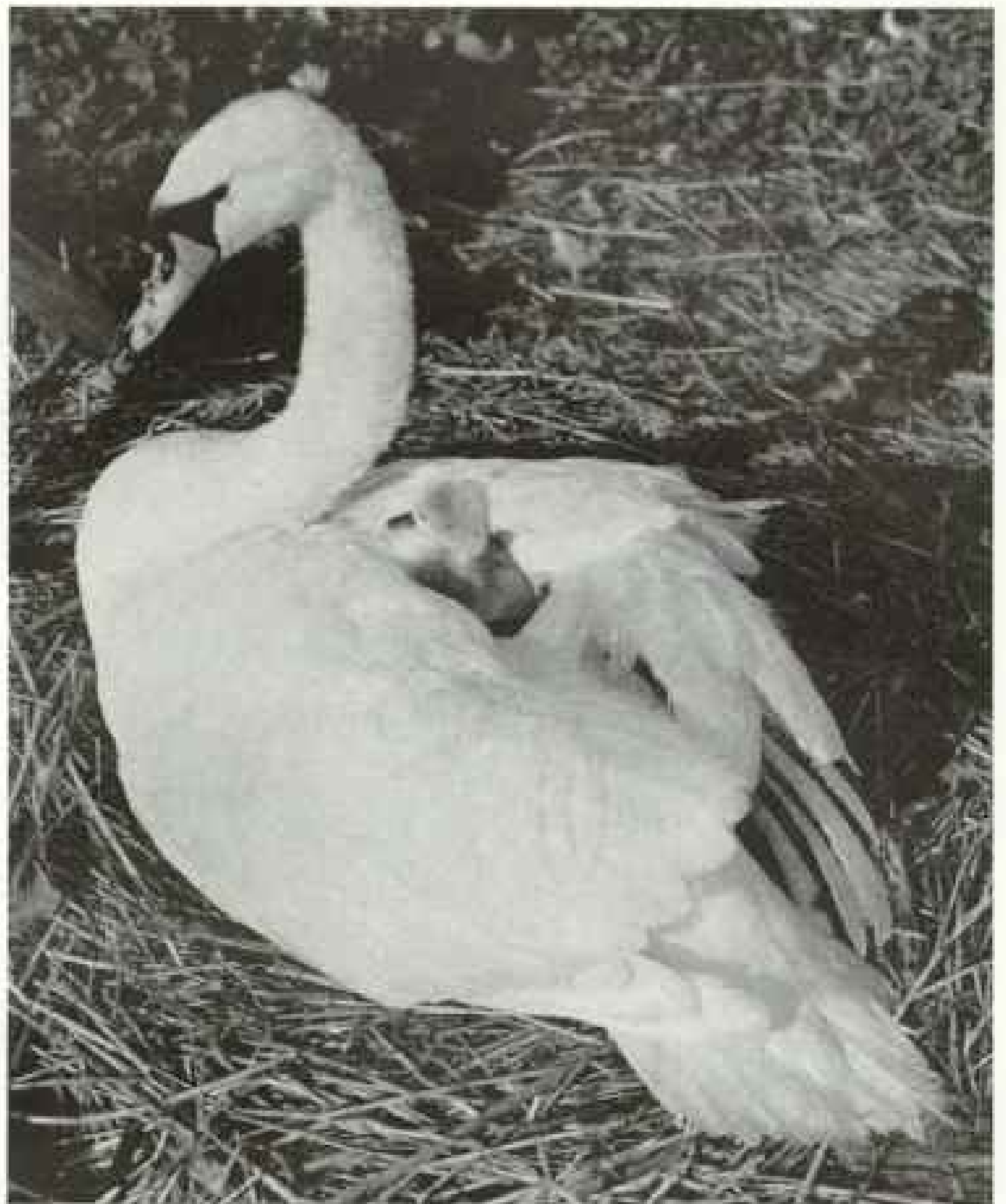
Mother Transports Baby Aircraft-carrier Style

Young swans sleep in the soft hollow between their mother's wings. If danger threatens, the pen converts bedroom to sanctuary, lifting her webbed foot as a stepladder for the cygnets scrambling aboard. This day-old passenger goes for a trial run.

Three out, one to go: A pen shelters her hours-old brood while turning the remaining egg. Clutches vary from four to twelve eggs. The young take five weeks to hatch, five months to fly. Adults choose a lifelong mate usually at two years of age and retire from parenthood around 30. Their age may equal man's proverbial threescore and ten.

This female displays the gracefully arched neck that helps to distinguish mutes from other swans.

565





tion in the inlet's waters. During the next two years the gray beak warms to orange, and the characteristic knob at the base of the beak becomes fully formed, smaller on the female than on the male (page 570).

Dancer Inspired by Abbotsbury Birds

It was to see the display of the mute swan that Anna Pavlova came to Abbotsbury 35 years ago. The great ballerina, whose dance, "The Death of the Swan," thrilled audiences the world over, became herself a fascinated spectator as a young pen and cob, on tiptoe at water's edge, arched their snow-white necks, beak to beak, into the shape of a heart and sank slowly with a quivering of wings.

"Are you able to tell individual swans apart?" I asked Fred.

"We can," he said, "though not so much by looks as by the way they behave. We even have names for two of the couples. Would you like to meet Tom and Bet?"

As we turned up toward the swannery garden, Fred told me about this pair. Tom and

Bet are keeping up a swan family tradition by rearing their young away from the communal nursery in the marsh. Instead, they choose a spot where a millstream sparkles among exotic tangles of pampas grass and hydrangea.

"It started when my uncle, Joe Gill, was a boy of 13," said Fred. "He helped raise an orphaned cygnet at the gatehouse."

That was 56 years ago. The cygnet grew to swanhood, and one spring day proudly escorted her cob and cygnets up the garden path. Succeeding generations have kept this residence in the family. How possessively, I discovered when Tom, bristling with belligerence, suddenly confronted us in the narrow path.

"That Tom," muttered Fred, who had no intention of making a detour. With his stout stick as shield, he drew quick lefts and rights from those slashing wings.

The blows were less powerful than Tom would have administered to a stranger, but Fred was careful to avoid that lethal knucklebone. Suddenly he clutched the right wing, moved behind, and bodily lifted the 30 pounds



Challenging the Swanherd, an Outraged Cob Cocks Wings for a Bone-smashing Blow

Every spring mating cobs carve Abbotsbury into dozens of private domains, each defending his territory against all comers, bird, beast, or human. Menacing hisses greet intruders, and flailing wings brandish knoblike knucklebones that can snap an arm or crumple a galvanized pail.

This irate male squares off against Fred Lexster, manager of the preserve, while pen and cygnets retire behind the lines. Mr. Lexster parries the lightning strokes with his staff and seizes the bird from the rear (below).

Outreaching man, a full-grown cob displays the nine-foot wingspread that enables mute swans to attain speeds up to 50 miles an hour. Largest of swans except the wild trumpeters of North America, adult mutes may tip the scales at 30 pounds.

Abbotsbury's tenants, unlike occasional wild swans that call at the refuge, migrate only five miles between East and West Fleet.

Mr. Lexster feels the powerful knucklebone on a wing's leading edge. The less belligerent pen sits quietly atop her nest of reeds and straw.

567





A Tiny Nick in the Web Brands a Newcomer

Swan-upping, or marking, began in England more than four centuries ago. Ownership of swans, once a royal monopoly, spread to court favorites and powerful guilds. The royal registry once contained some 900 swanmarks.

In 1541 Sir Giles Strangways leased the Abbotsbury swannery; Queen Elizabeth I later confirmed his heirs as sole owners. Today, as charges of Lord Stavordale, the stately birds attract 35,000 visitors yearly. A one-shilling (14-cent) admission fee helps cover costs of caring for the swans.

Using a knife, Mr. Lester painlessly brands Abbotsbury's own distinctive sign on each webbed foot of this cygnet.



Snowy Squadrons Pass in Dress Review

During their nine centuries at Abbotsbury the swans have survived both natural and man-made disasters.

Early records reveal that neglectful swanherds let high water overrun the nests and destroy the eggs. Bitter winters occasionally froze the Fleet, destroying feed grass. World War II turned the refuge into a testing ground for rockets and reduced the census to a record low.

These birds glide sedately past Fred Lexster.

Feathered bagpipe honks its indignation at the swanherd. To voice alarm or signal their young, mute swans, belying their name, can blare like a bugle or bark like a dog.

Wire cages in background house swans chosen for gentleness as foster parents of orphaned cygnets.

569





Among Swans, Only Mutes Wear the Fleshy Black Bulb on the Forehead

Gripping a captive by the neck, Mr. Lexster holds the powerful beak at a respectful distance. Lexsters and relatives have herded Abbotsbury swans almost 200 years.

of vigorously protesting Tom. It was the only time at Abbotsbury I saw a swan look other than impeccably dignified.

The other couple with Christian names were George and Margaret, who also sought seclusion. For years they nested in a lonely creek near an old duck decoy.

A Fighting Cob Takes Possession

Then Margaret died. But again the next spring George came up the Fleet to build a barren nest. He was not prepared for the young cob swimming in battle array around the reed beds.

The combat was short and fierce. Bruised and ruffled, George took flight from the creek where for many seasons all his offspring had been raised. But it was a fighting cob he left in possession—his own son!

It is not so bad for 30-year-old veterans like George, floating and dabbling and squabbling out there in the lagoon with a lordly eye on the up-and-coming. For 40 more springs he may watch the couples set sail for the reed beds, as he did proudly in his prime.

Then one day Fred will find a swan's white body in the reeds, resplendent even in death. He will dig a grave deep out of reach of raven and carrion crow—and ponder awhile.

We passed the monks' onetime fishpond, and Fred stopped to watch a pair of swans whose remote forebears, perhaps, had preferred this domain to the reed beds. And though I did not suggest it to him, my own thoughts turned to Tennyson's lines:

*Man comes and tills the field and lies
beneath,
And after many a summer dies the swan.*

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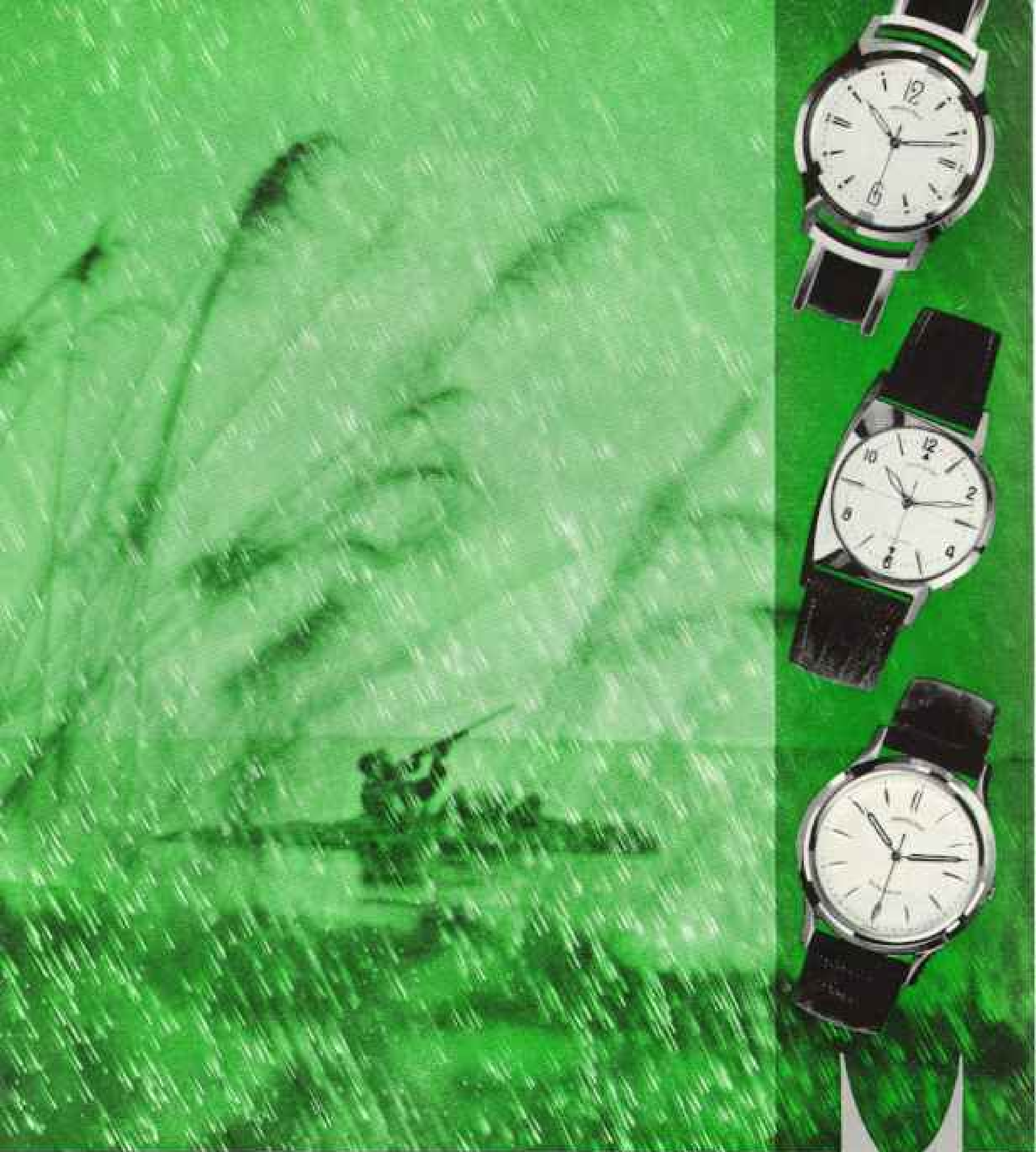
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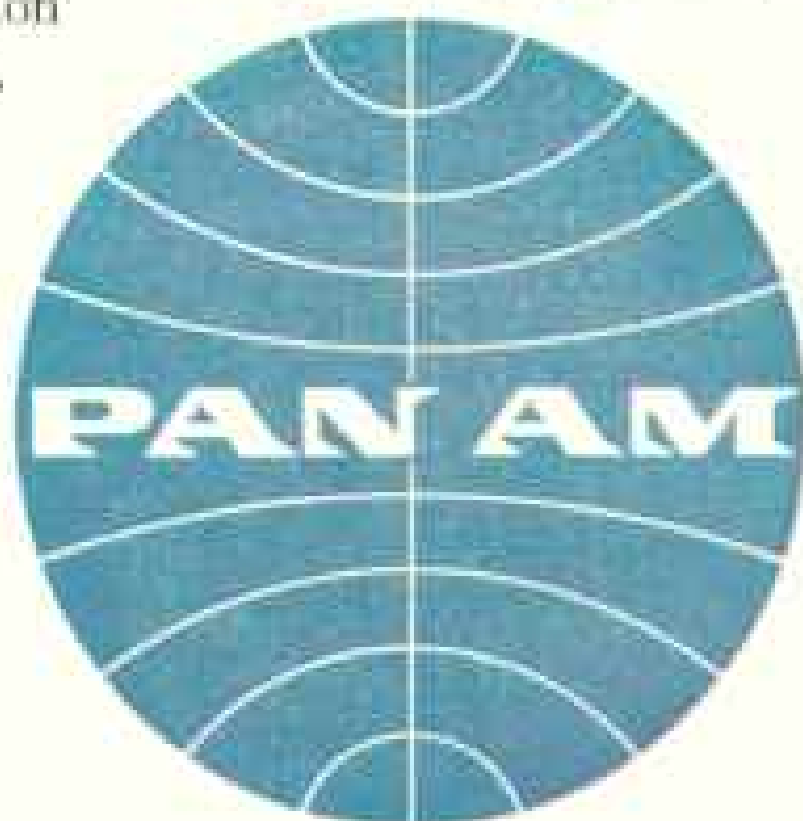
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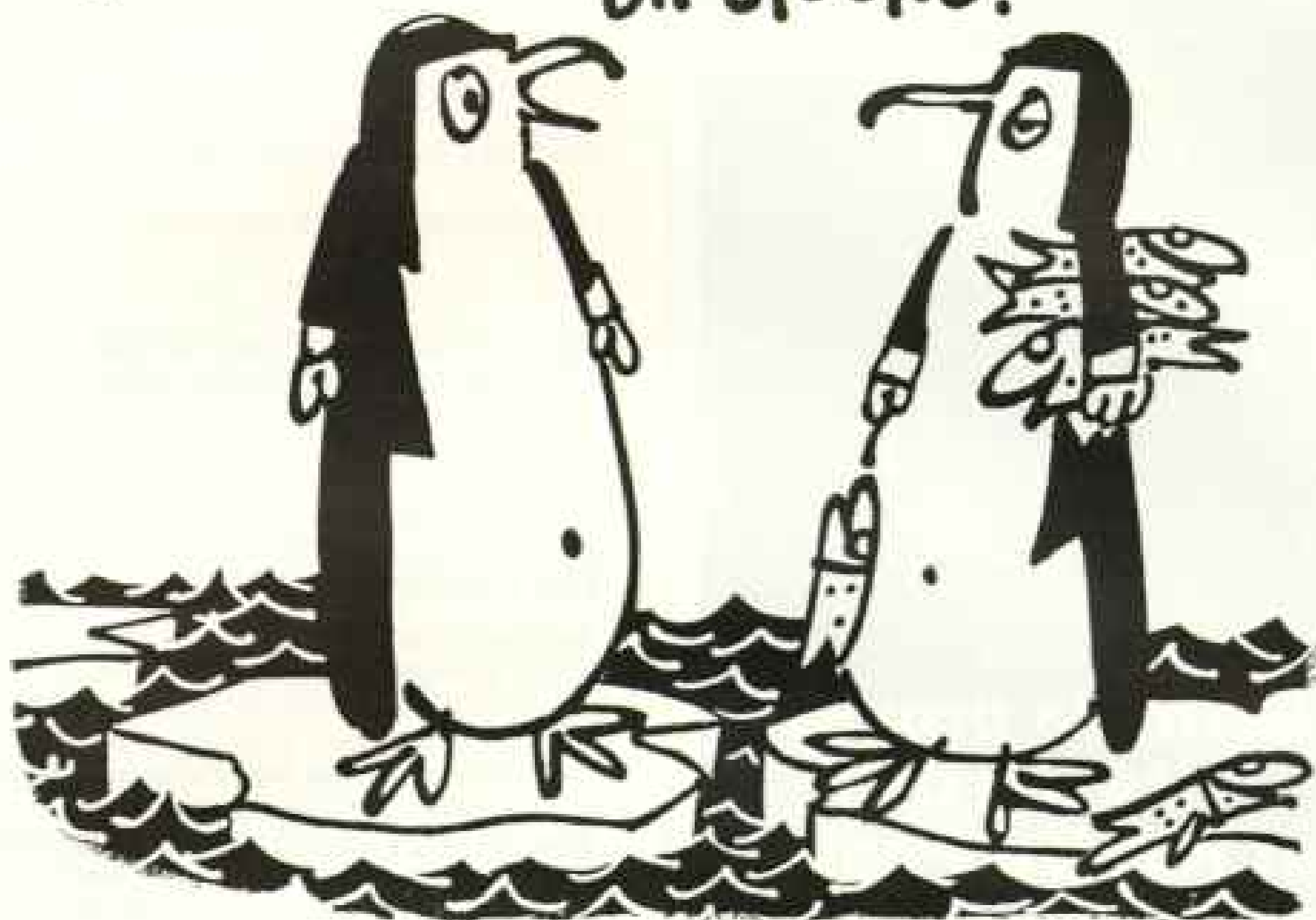
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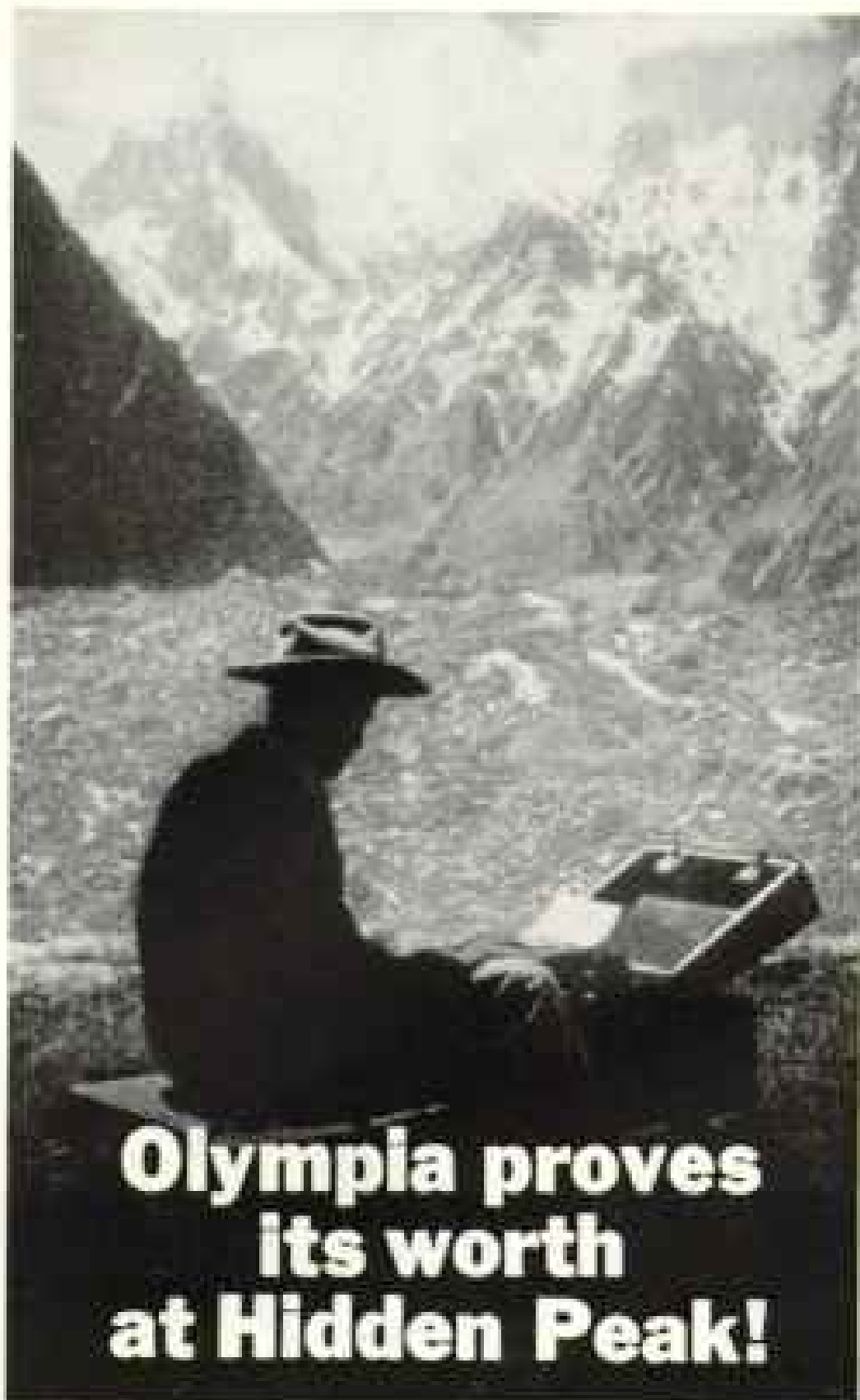
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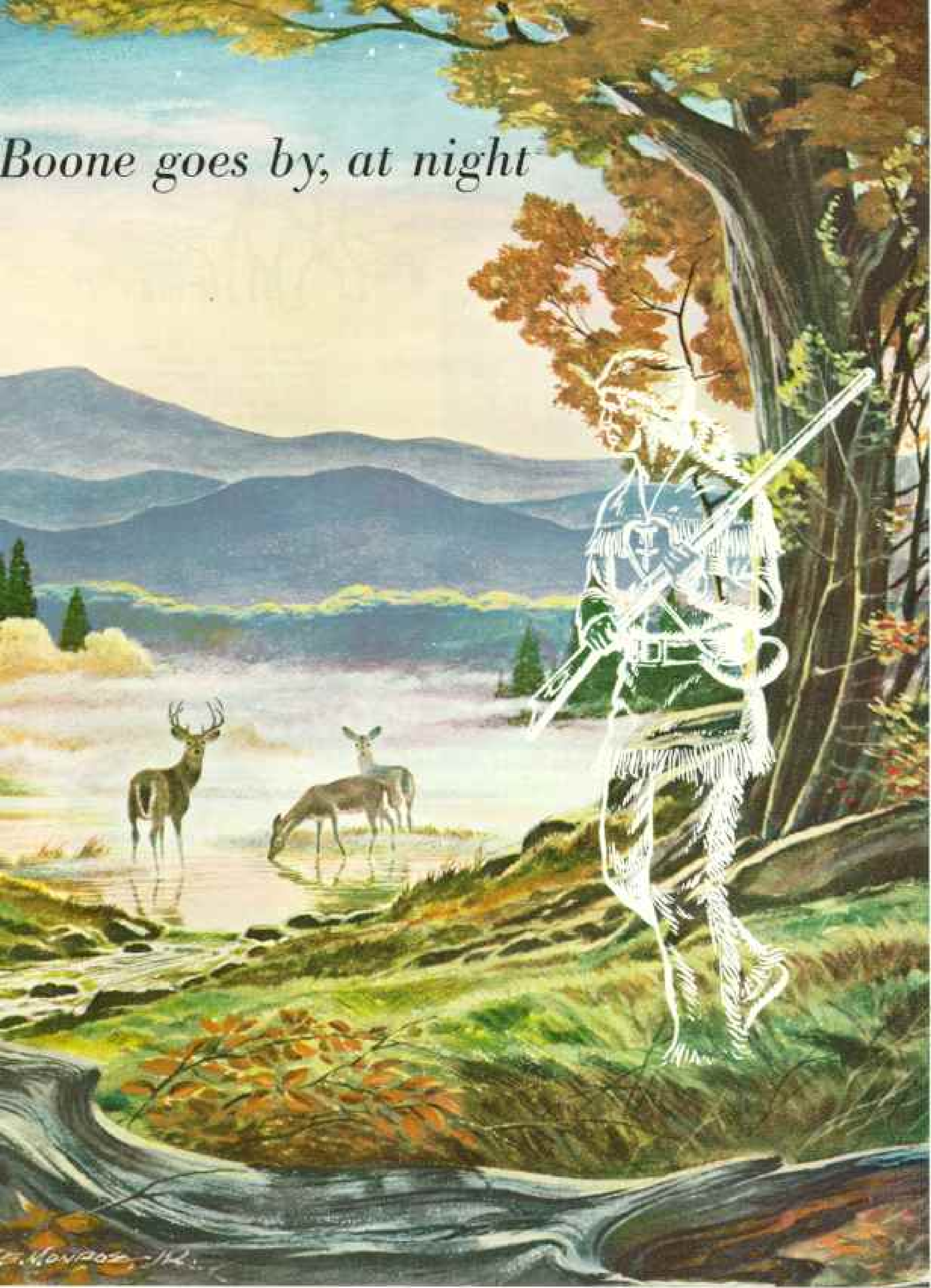
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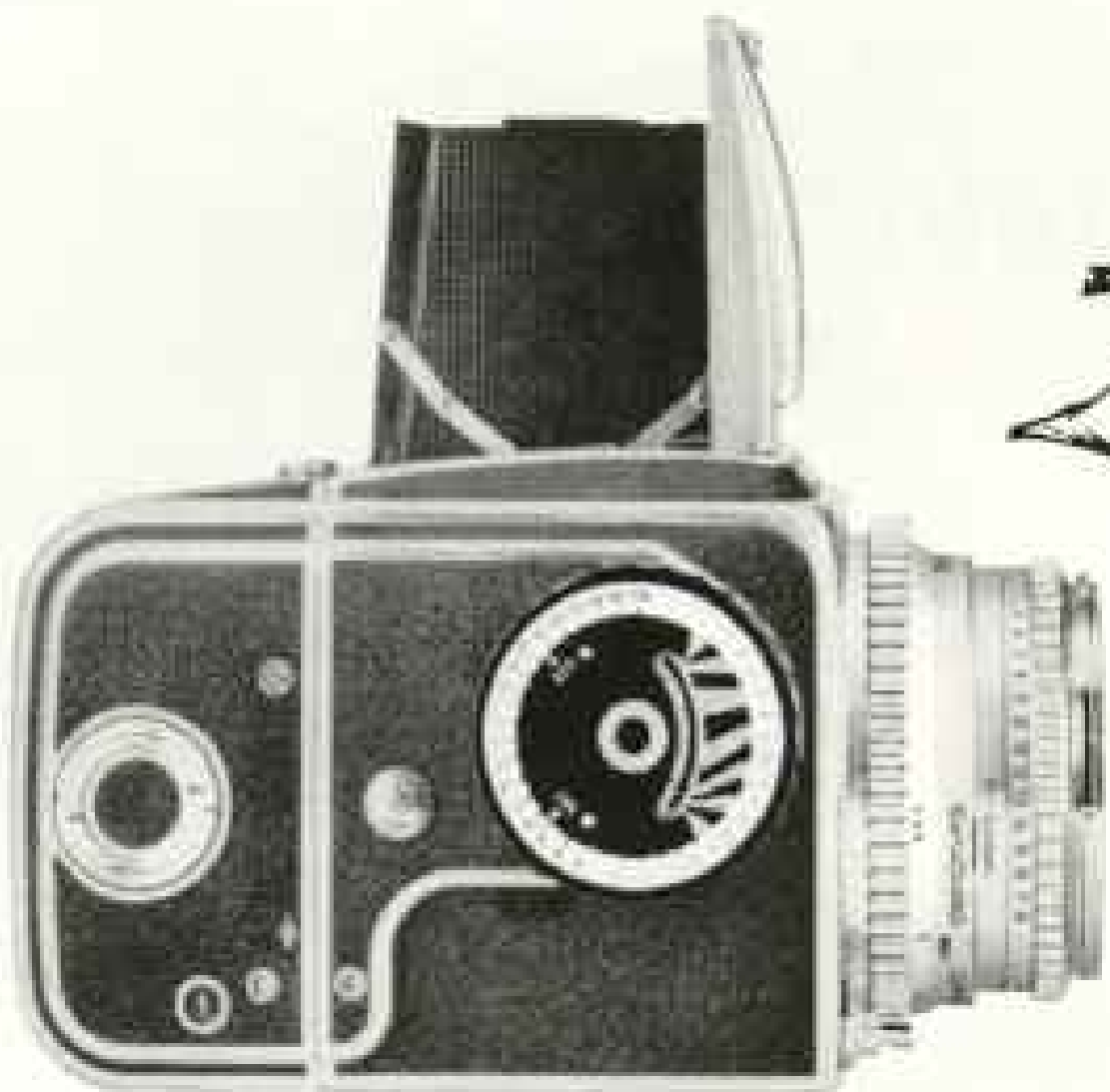
1. From "Daniel Boone" by Stephen Vincent Benet, Harcourt & Co., Inc.
2. From "Wild America" by Roger Tory Peterson and James Fisher, Houghton Mifflin Co. Publishers.



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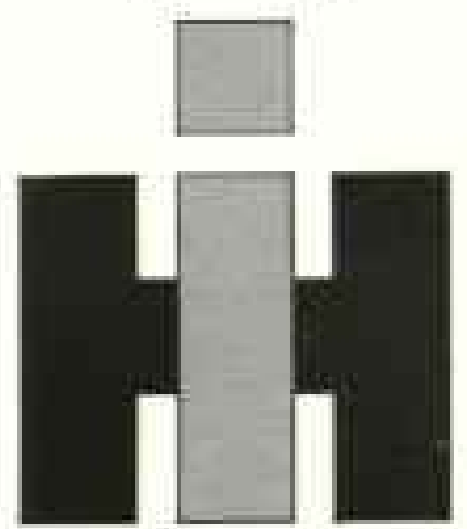
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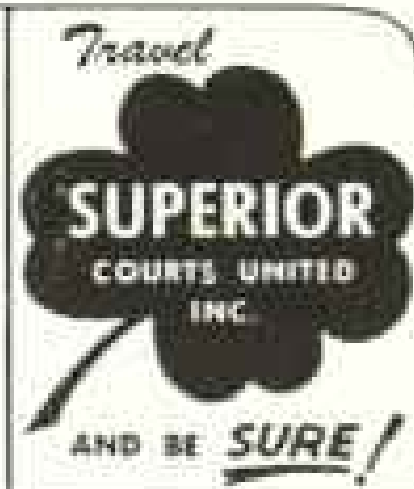
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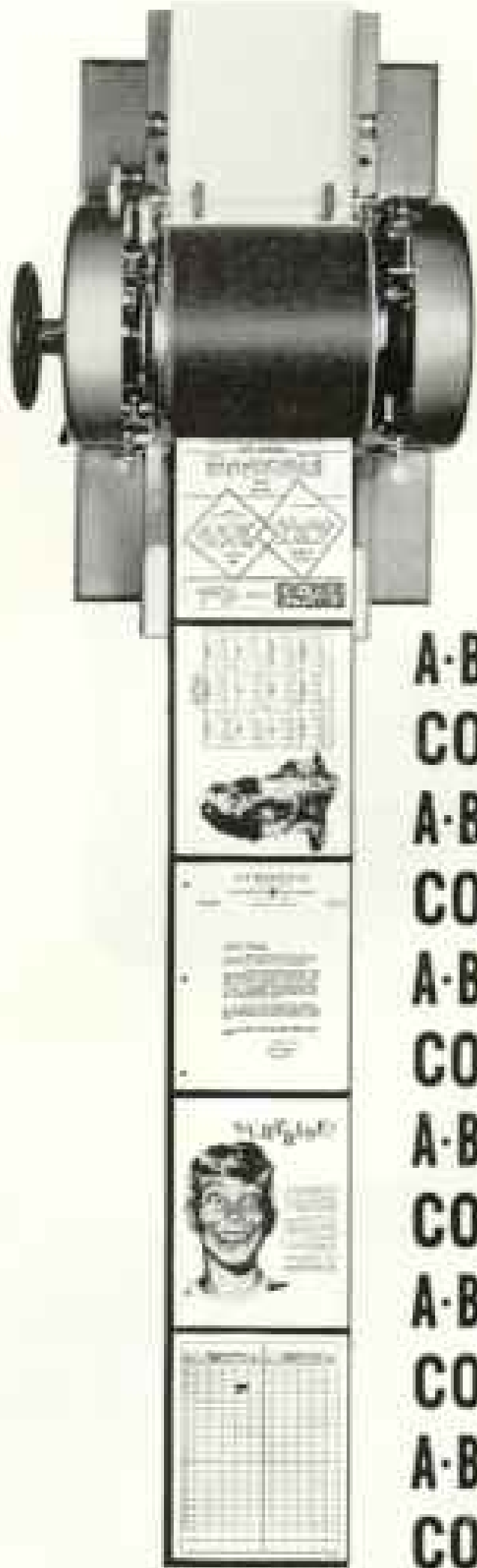
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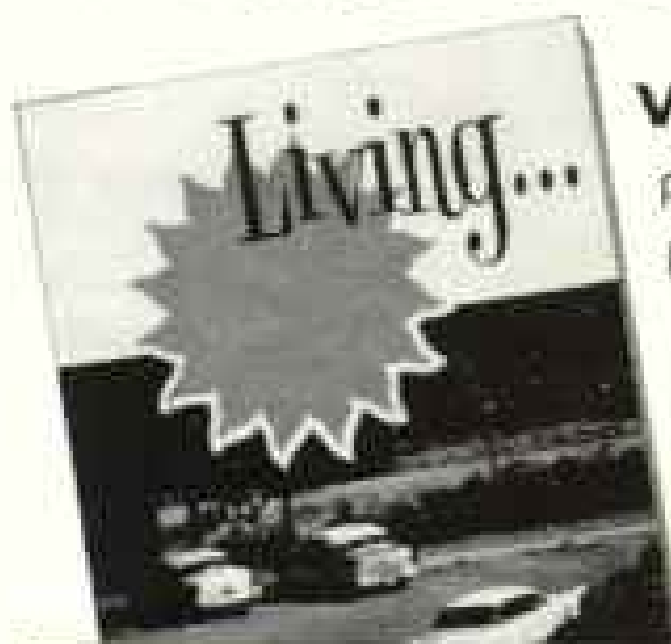
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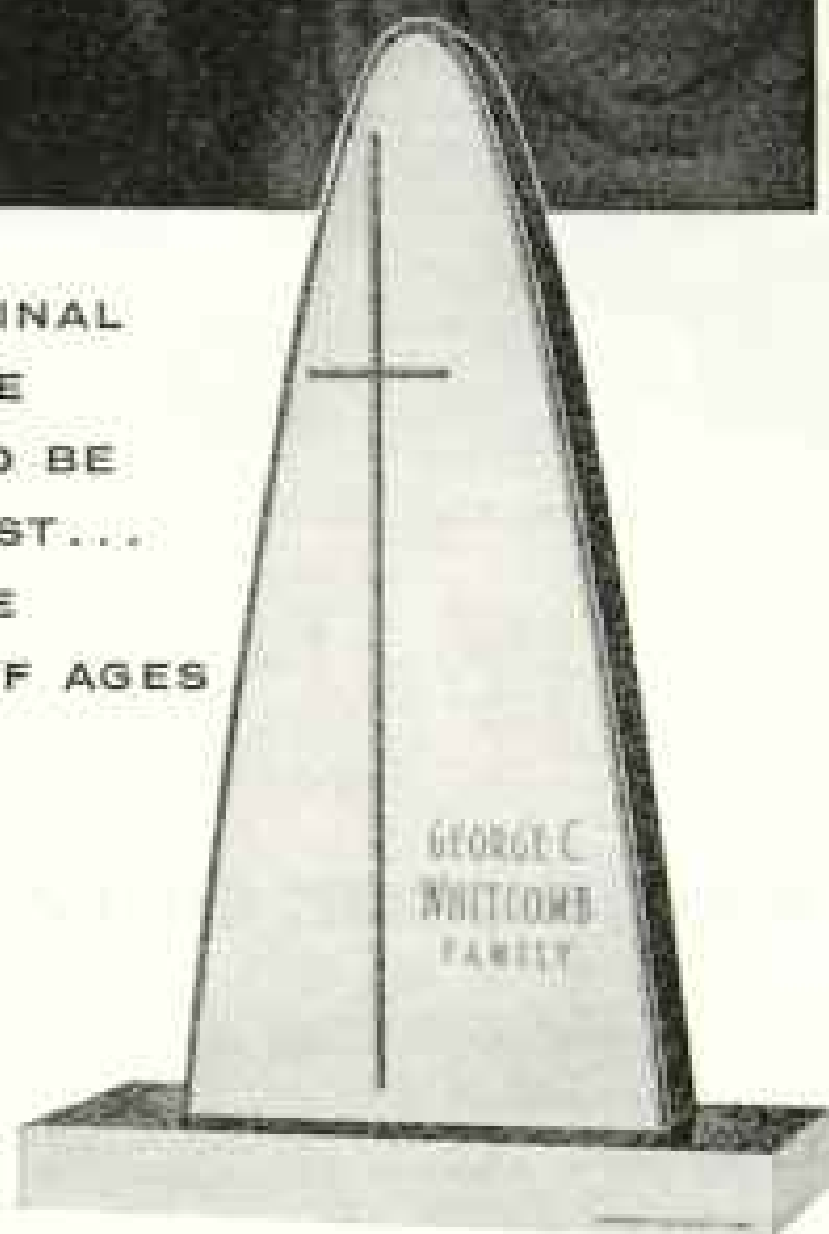
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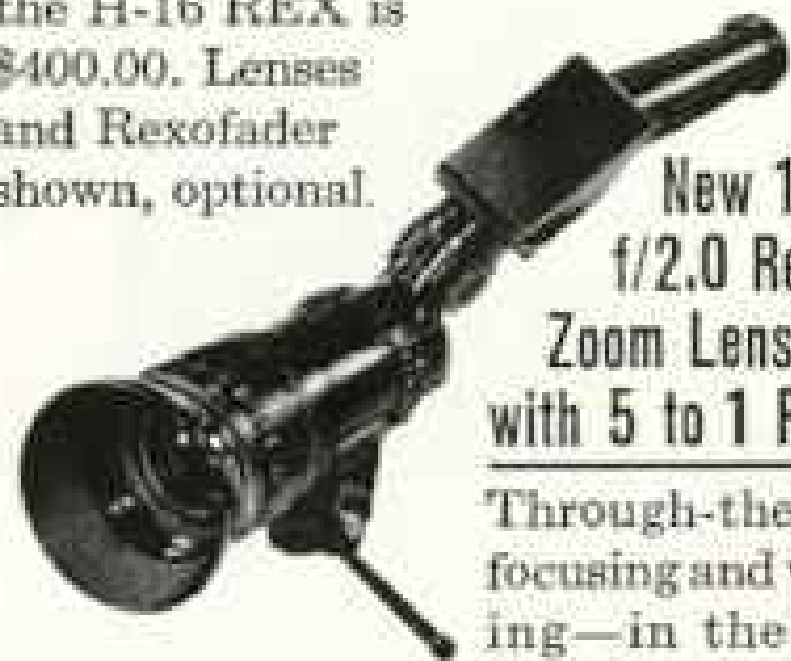


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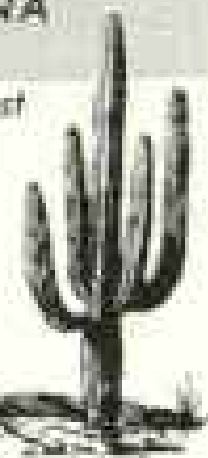
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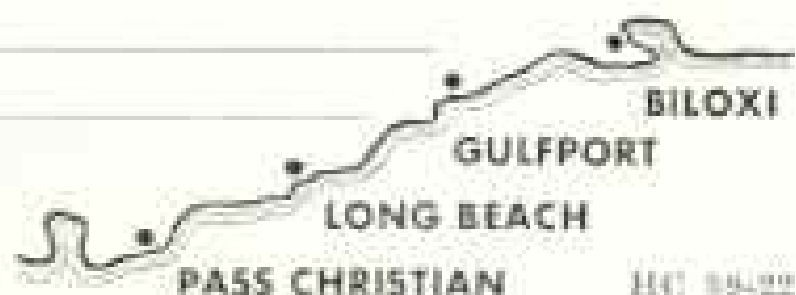
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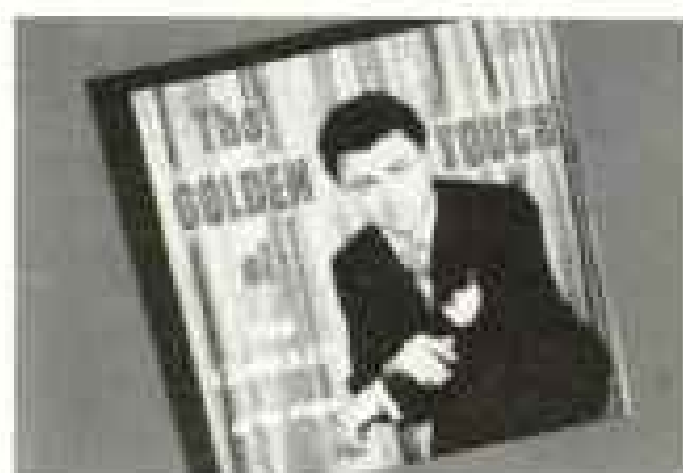
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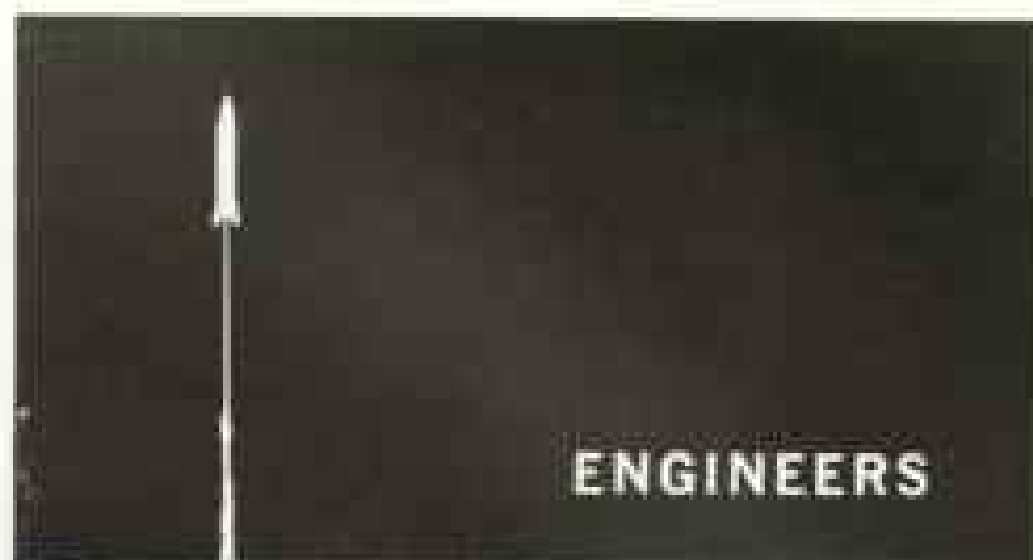
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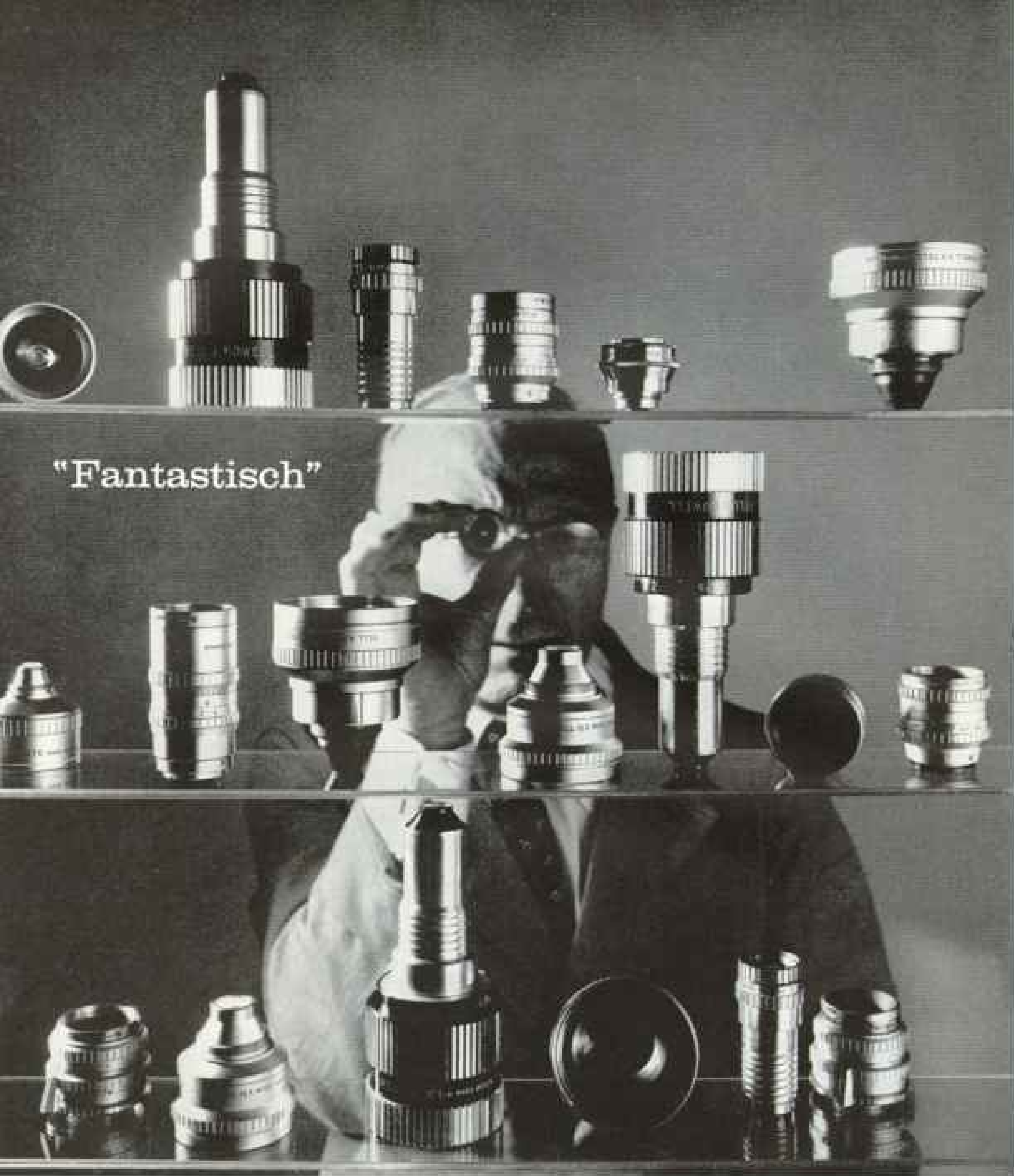
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