DOUBLE MAP SUPPLEMENT: THE PACIFIC OCEAN'S FACE AND FLOOR (page 496)

VOL. 136, NO. 4 OCTOBER 1969

NATIONAL GEOGRAPHIC

SEE "THE MYSTERY OF ANIMAL BEHAVIOR," TUESDAY, OCTOBER 14, ON CBS TV (page 592A)

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

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Working with Egyptian physicists and archeologists, Dr. Alvarez has set up a detector in a chamber at the pyramid's base. If a secret room does exist, the rays (shown here as fiery streaks) would signal its presence by arriving in greater strength than those that passed through solid stone. So far—with about a third of the pyramid surveyed—Chephren remains elusive, but the technique has proven successful. Dr. Alvarez's detector, he reports, can "see" the pyramid's six-foot-thick limestone cap through 300 feet of solid rock.

As in so many other fields, a National Geographic Society grant helps make Dr. Alvarez's search possible. Invite your friends to join in supporting such exciting ventures by nominating them for membership on the form below.

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Hope we didn't shock you with our stern lecture, but we're sure you agree with our attitude. We want you to know that, in spite of the sad accident rate, we're doing all we can to keep *your* rates down. And that includes charging high rates for bad guys. You see, there is still some justice in the world. Our stern but fair agents are listed in the Yellow Pages.

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Two beautiful new ways to fly! Pan Am's® Boeing 747 Jet and the 1970 Thunderbird Special Brougham Two-Door Landau.

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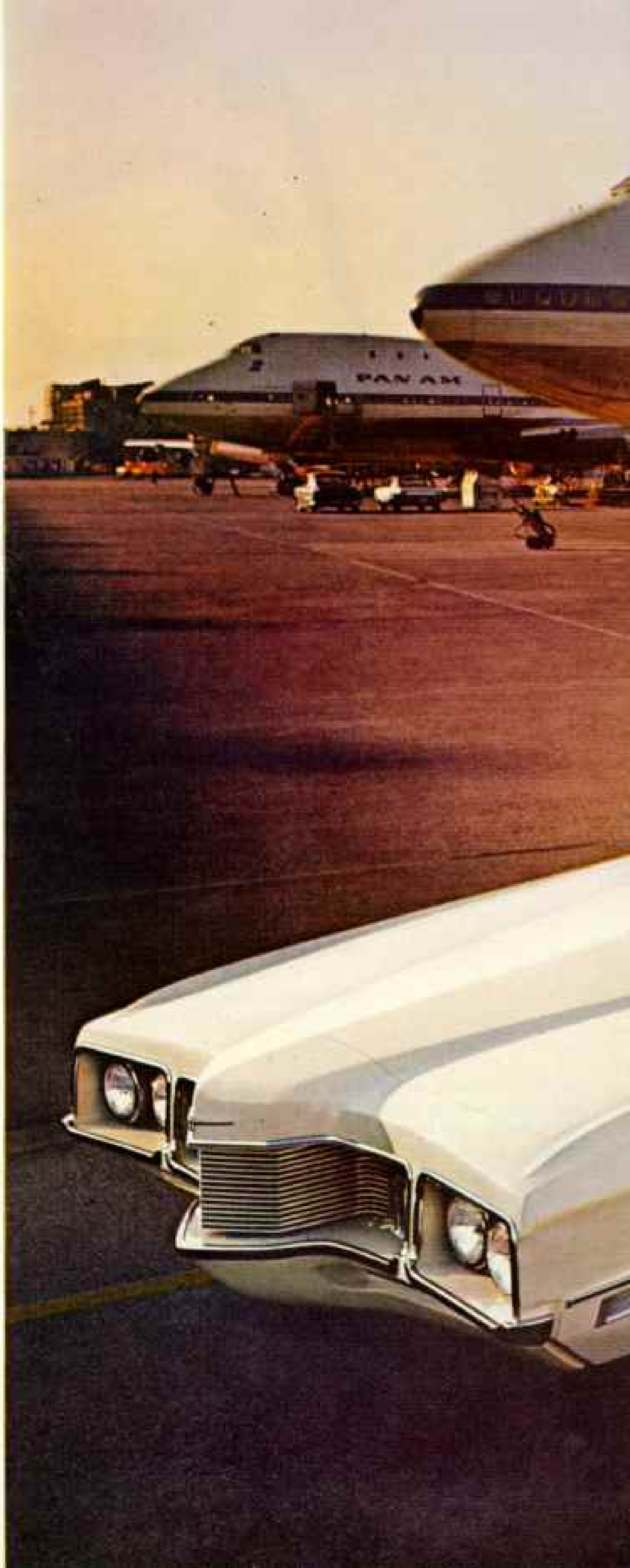


PAN AM

Mrs. Nugent Freeman's 10 year old KitchenAid dishwasher is still going strong, with no repairs. She lives in Nutley, New Jersey.

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GM

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The Natural Sound Speaker system is totally unique. It projects sound with a rippling motion, spreading tone evenly and equally.

Variable volume voice tabs. Two 61-key manuals. 25 pedals.

And you get it all for $2395.00.*

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And that's the start of real trouble. Speed isn't addictive, but the body builds up a tolerance. So he has to take more to get the same jolt. And more. And more. He often ends up shooting massive doses into his veins.

He has an abnormal feeling of power. Superiority. He can easily become violent and aggressive. If he gets in a car, look out.

In his confused state, he ignores his body's normal need for food, drink and sleep. So he's easy prey for pneumonia. He gets careless. And often winds up with hepatitis from a dirty needle.

But even if his body survives, his mind can be badly bent out of shape. It's not unusual for him to become paranoid and commit a violent crime. Perhaps kill.

Speed spreads death many ways.

If you know anyone who's thinking of experimenting with this stuff, we urge you to have a talk with him. If he's been on it a while, get him to a doctor.

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Metropolitan Life

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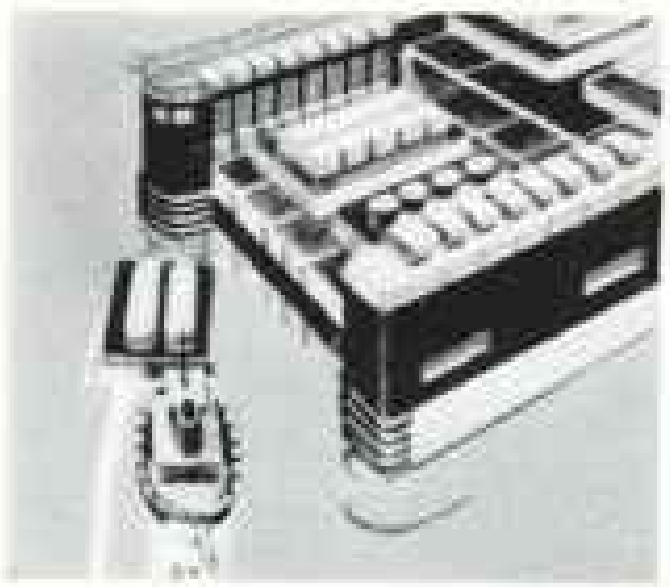

It's just one example of what technology can accomplish when it's handed a problem.

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GENERAL DYNAMICS

This bird sanctuary

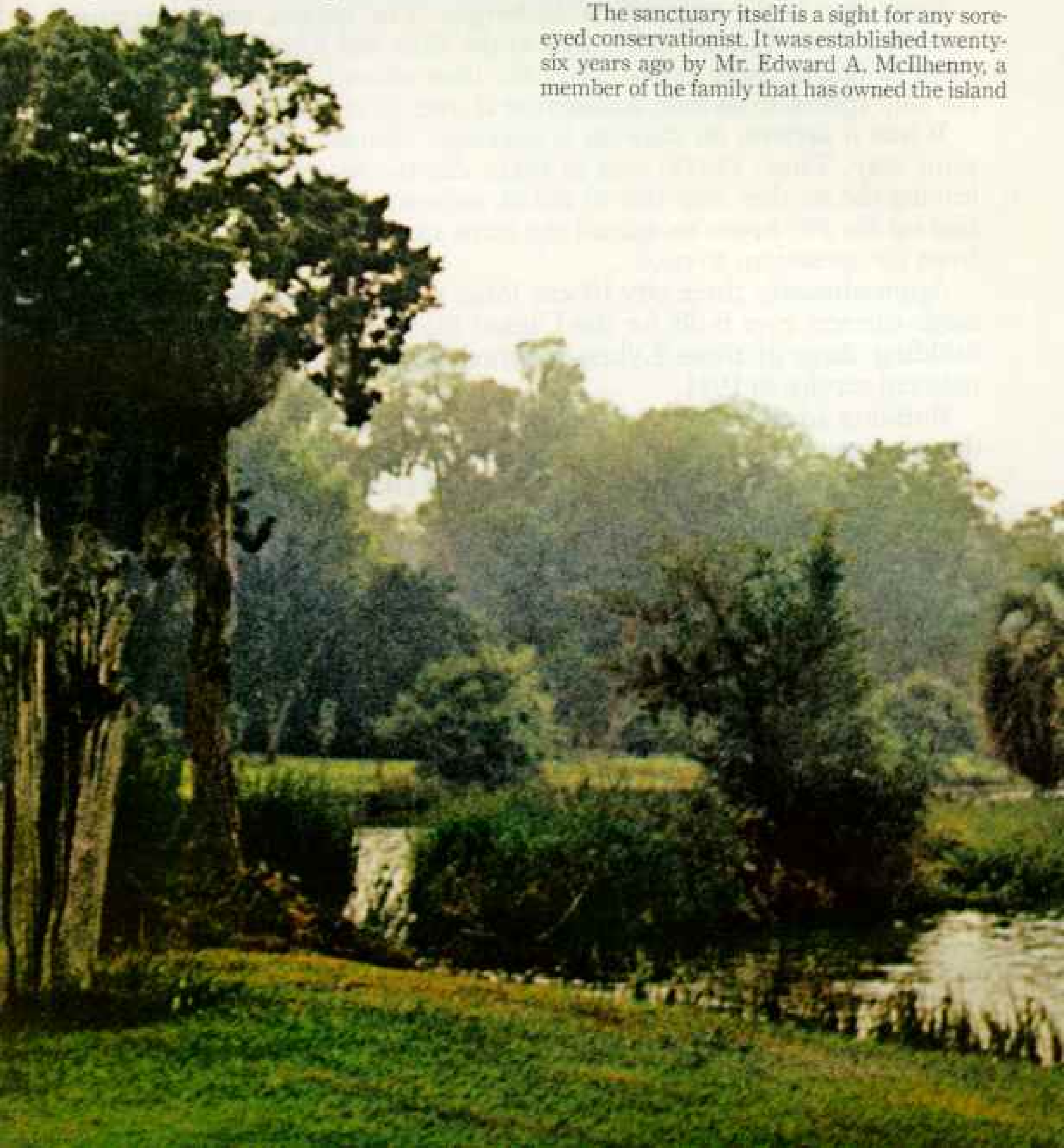
Imagine a tiny green hump of an island in a Louisiana swamp. Its total area is less than five square miles.

Put two hundred houses on it and seven hundred people. Add one of America's largest rock salt mines the Tabasco® sauce factory and over a hundred oil wells. And what have you got? Overcrowding?

Quite the opposite. Avery Island seems almost undiscovered. A place for the painter and the poet.

Its bird sanctuary sits in a 200-acre garden. Here you find irises from Siberia. Grapefruits from Cochin. Evergreens from Tibet. Bamboo from China. Lotuses from the Nile. Soap trees from India. Daisies from Africa's Mountains of the Moon. And the world's most complete collection of camellias.

The sanctuary itself is a sight for any sore-eyed conservationist. It was established twenty-six years ago by Mr. Edward A. McIlhenny, a member of the family that has owned the island



is an oil field.

for 152 years. It had one purpose. To save the snowy egret from extinction.

Known as Bird City, the sanctuary started with only seven egrets. Now, over 100,000 nest around its man-made lake every year. To see these alabaster birds sharing their Eden with herons, ducks, coots, swans, cormorants, turtles, deer and alligators is almost a primeval experience. It seems to put the clock back to the beginning.

And, wherever you wander on this peaceful island, you have to look hard to spot the oil wells. Many are hidden by grandfatherly oak trees bearded with Spanish moss. Others are screened by banks of azalea and rhododendron. To Jersey's affiliate, Humble Oil & Refining Company, this respect for environment is only right and proper.

The oil industry provides Louisiana with one-third of its total revenue. But even this contribution would be a poor excuse for defiling beauty or disturbing wildlife.

Amen say the egrets.

Standard Oil Company
(New Jersey)

GM

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Cadillac Motor Car Division

October 1969

NATIONAL GEOGRAPHIC

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In the Wake of Darwin's *Beagle*

By ALAN VILLIERS

Photographs by JAMES L. STANFIELD
National Geographic Photographer

THE WIND SHRIEKED and snow squalls swept violently across the sullen waters of the Strait of Magellan. Stinging snow sought my face and eyes. I leaned on the wind, turning to leeward the better to breathe. How easy it would be, I thought, to die from exposure in this freezing, storm-torn region.

Until Chile built Fort Bulnes in 1843, high above Port Famine (pages 456-7), this whole grim area had been left largely to its storms. So it had been when Charles Darwin, naturalist in H.M.S. *Beagle*, first came to the strait in 1834. He climbed Mount Tarn, south of Port Famine, while the *Beagle* lay at anchor there. He'd had to

MARINE IGUANAS *still roam what Charles Darwin called "the strange Cyclopean scene" of the Galapagos Islands—a momentous stop on his globe-girdling voyage of 1831-36.*

PAINTINGS BY GEORGE RICHMOND, 1840 (ABOVE) AND MARK RICHARD MYERS (C) N.G.S.

"The voyage of the Beagle *has been by far the most important event in my life . . . yet it depended . . . on such a trifle as the shape of my nose."*

When Britain's Charles Darwin (above) applied for the post of naturalist for a charting survey by H.M.S. *Beagle*, Capt. Robert Fitz Roy—a dabbler in phrenology—nearly rejected him because his nose suggested a lack of "energy and determination." With few candidates for the nonpaying job, Fitz Roy finally accepted the wealthy 22-year-old amateur, whose passion for collecting everything from pebbles to birds' eggs was to find extraordinary fulfillment on the nearly five-year-long voyage.

The young landlubber endured agonies of seasickness, as when the little ship fought high seas off Cape Horn (left). Yet he amassed and catalogued a huge collection of fossil and living specimens. Their subtle similarities of structure seemed to him to cry out for some explanation other than the common notion that all species had been simultaneously created in their present form. He was to labor a lifetime fitting together the myriad pieces of such an explanation—his world-shaking theory of evolution.

land by ship's boat and fight his way the nearly 2,700 feet upward, with a few companions.

The name Port Famine reflects the fate of a short-lived Spanish colony here in the 1580's. Of 300 settlers, starvation spared only one. Nearly 250 years later Darwin wrote of the place, "I never saw a more cheerless prospect," and the Indians "came and plagued us."

No Indians plagued us, for only a handful remain. We had come by car from Punta Arenas that morning, three of us in the wake of Darwin's *Beagle*—my younger son Peter, NATIONAL GEOGRAPHIC photographer James L. Stanfield, and myself. None of us had been in the Strait of Magellan before.

We would all have preferred to come in some new *Beagle*, but time ruled that out. Darwin's sailing vessel took nearly five years to circle the globe—from 1831 to 1836 (map, pages 458-9). We had a year at most.

We planned to travel where Darwin went, above all in South America and the Galapagos Islands. Then we would follow the *Beagle* across the Pacific and Indian Oceans. To do all this in a year meant flying, of course.

Our mission was to retrace Darwin's journey to see what he saw so far as it still exists, to try now and then to get inside the tremendous thinking apparatus that was his brain.*

Naturalist Turned a Voyage Into an Epic

Because young Darwin was on board the *Beagle*, the journey became far more than the hydrographic survey that was its official mission. To some, it ranks as one of the epochal voyages of all time, perhaps equal in its impact on the human mind to the feats of Columbus and Magellan.

*Captain Villiers follows Darwin's travels and thought chiefly from the scientist's own works published in his lifetime: *The Voyage of the Beagle*, *The Origin of Species*, and *The Descent of Man*. In addition, he draws upon the *Autobiography of Charles Darwin, 1809-1882*, New York, Harcourt, Brace, 1959; *Charles Darwin and the Voyage of the Beagle*, New York, Philosophical Library, 1946; and *Charles Darwin's Diary of the Voyage of H.M.S. "Beagle,"* London, Cambridge University Press, 1933, all edited by Darwin's granddaughter Nora Barlow.

Until Darwin voyaged in the *Beagle*, he did not dispute the dogma that every species had come into being at the same instant (in the year 4004 B.C., according to 17th-century Archbishop James Ussher). Darwin had, in fact, studied for the clergy at Cambridge University. But he was to see things on the *Beagle*'s voyage that he could not reconcile with accepted beliefs.

The phenomena of nature that Darwin observed in the great natural laboratories of South America and the Galapagos sowed the seeds of his theory of evolution. The seeds lay germinating for almost a quarter of a century before Darwin finally published *The Origin of Species* in 1859.

The *Beagle* came to Magellan's strait from Montevideo, Uruguay. As the ship sailed the desolate passage, Darwin kept a lookout for Indians. At one point, two seamen from a Yankee sealer ran along the shingly beach, shouting to be taken off. The captain sent a boat, but the sailors got no lift. The *Beagle* was heading west around the world; the castaways wanted to get back to New England.

Our own party met one lone gaucho wrapped in a poncho, squat on his saddle. We passed shacks made of driftwood with iron roofs lashed down, looking as if Robinson Crusoe had but lately moved out.

On Mount Tarn, by some trick of light and shadow and the snow, I could imagine Darwin, six feet and slim, slight stoop accentuated by the need to lean into the wind as he struggled upward. Near the top, perhaps, he paused to tap at a piece of rock with his geologist's hammer, intent on deciphering all he could of the story of the ages (and of mankind) from this frigid, gale-lashed land.

When Darwin climbed here in 1834, he was 24 years old, a quiet, unknown young man (page 451). He found himself at this extremity of the New World because one of his Cambridge professors had recommended him when the *Beagle*'s aristocratic captain, Robert Fitz Roy, sought "some well-educated and scientific person" to collect "useful information" during the coming voyage.

Captain Fitz Roy's name (from the old French *fils roi*, or king's son) meant direct descent from a king through an illegitimate line. He traced his ancestry to Charles II and his mistress Barbara Villiers, Countess of Castlemaine. An unusual and able man, Fitz Roy had been given command of the *Beagle* in 1828, at the age of only 23, after its captain during a long earlier voyage had broken under the strain.

It was entirely Fitz Roy's idea to take a naturalist to sea with him. Room could be found for Darwin only by slinging a portable cot (a hammock with wooden sides) in the charthouse of the little bark, about as big as a modern harbor tug. Since the charthouse was right aft at the end of the poop, it was the worst place in the ship for anyone unused to the violent motion of so small a vessel—and Darwin suffered dreadfully from seasickness. Because it was impossible to eat in the crowded charthouse, the naturalist shared the captain's day cabin for meals.

There was little room for exercise on deck, either. Large boats, spare spars, guns on their carriages, cordage, and tackle crowded every inch. Below, *Beagle* was full of provisions, galley fuel, fresh water, and ammunition.

Somewhere, somehow, amid all this, 74 persons were jam-packed: a dozen officers, a troop of marines, 34 able seamen, 6 ship's boys, a surgeon and assistant, an artist (who soon left), Mr. Darwin's servant, and 3 South

"It was now the beginning of winter, and I never saw a more cheerless prospect."

As young Darwin sailed remote latitudes, homesickness often plucked at his heart. In Tierra del Fuego he found winter hard upon the land in June, at a time of year when his native Shropshire was rainbowed with flowers.

Author Alan Villiers and photographer James Stanfield, retracing the great naturalist's travels, visited the Tierra del Fuego region in August and found its landscape "piebald with snow," just as Darwin had described it.

This slingshot-toting Chilean lad of the Punta Arenas area strikes a far less menacing posture than the Fuegian Indians who unleashed a storm of arrows at the *Beagle* in 1834. Driven off by musket fire, they "shook their mantles in vain rage" before fleeing.

"No object intercepted the vanishing points of this long canal between the mountains."

Beagle Channel, discovered during the ship's earlier voyage of 1826-30, and the Darwin Mountains gather the liquid gold of a sunrise over Tierra del Fuego. Captain Fitz Roy named

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

the massif after the naturalist, who, with characteristic modesty, failed to record the fact in his journal. Beagle Channel's "magnificent scenery" rewarded Darwin after a terrific battering at Cape Horn. He wrote home: "I am quite astonished to find I can endure this life: if it was not for the strong and increasing pleasure from Nat. History I never could."

KODACHROME © N.G.S.

"Miserable, degraded savages. . . . the Fuegians twice came and plagued us."

Fort Bulnes, overlooking the Strait of Magellan, had not yet been built when the *Beagle* arrived in 1834. Fierce Indians, now virtually extinct, shared the region's desolation with what seemed to Darwin "an endless succession of gales." Not until 1843 did Chile build the fort to establish its claim to the region. This reconstruction of the original stockade stands near Port Famine, where starvation wracked a short-lived Spanish settlement in the 1580's.

"A nice, modest, reserved young girl. . . ."

Darwin's description of Fuegia Basket, an 11-year-old Indian aboard the *Beagle*, might well apply to Nancy Zarricueta of Puerto Williams on Navarino Island.

On his previous voyage, Fitz Roy had taken several Fuegian hostages, transporting them to England and overseeing their education. He hoped to resettle them in their native land, and thus help to civilize the unruly tribes. To his dismay, the subjects of his experiment soon reverted to their primitive ways.

American Indian passengers. These last were natives of the Tierra del Fuego region, brought away by the *Beagle* on her earlier voyage.

The Indians were York Minster, a large and somewhat surly member of the Alacaluf tribe, aged 28, and two young Yahgans, likable Jemmy Button, from Navarino Island, 16, and Fuegia Basket, a bright, pert little miss, 11 years old. After seizing them as hostages for a stolen ship's boat, Captain Fitz Roy had taken his responsibilities toward them seriously. In England he had York and Jemmy instructed in gardening and carpentry. They all learned English and, he believed, the rudiments of Christianity and civilization. The captain hoped that all three might on their return make a beginning toward a better life for their fellow Indians.

Winter Flight to the "Land of Fire"

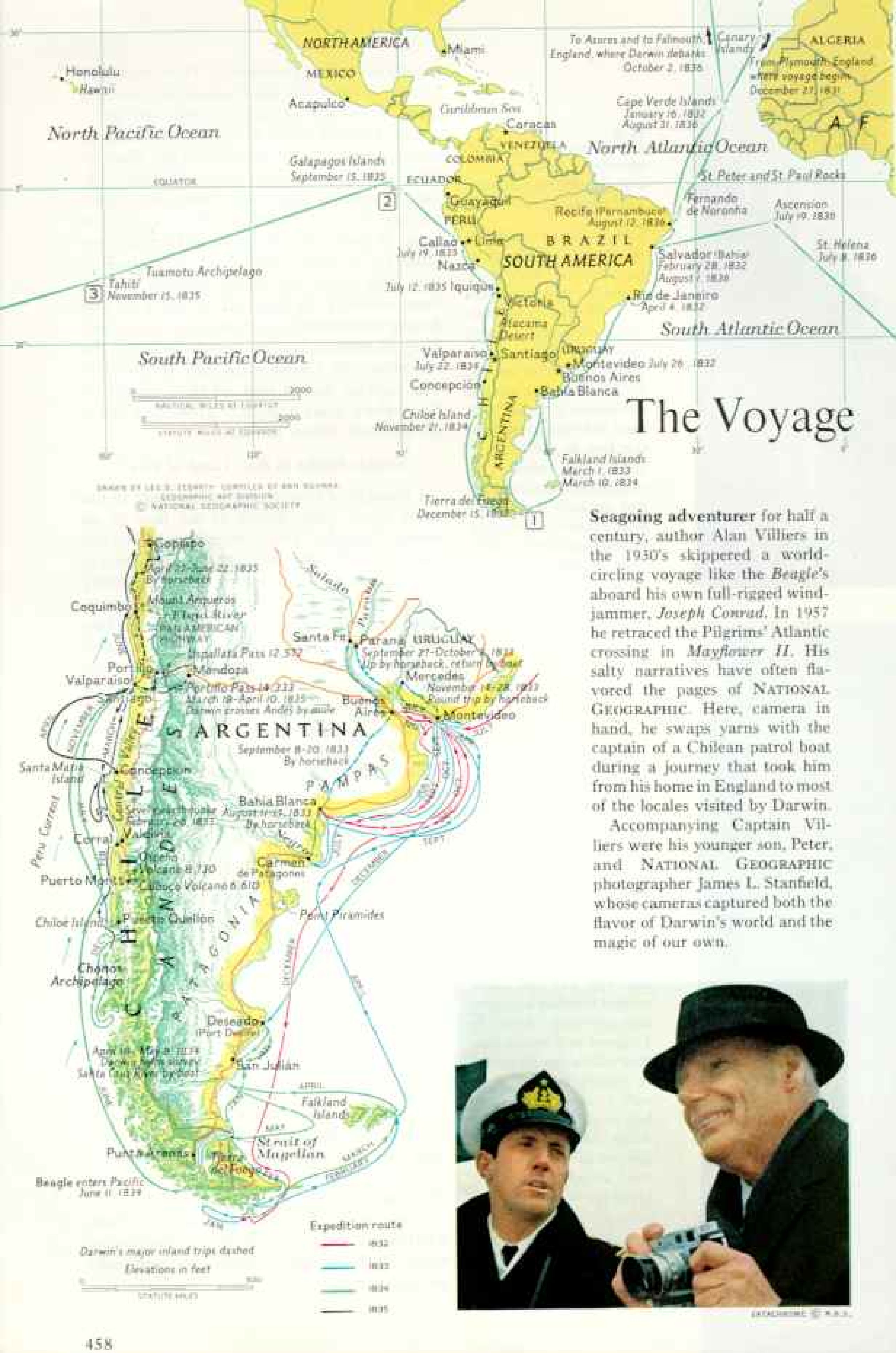
I thought of this strange assemblage in the wind-blown little *Beagle* as we flew in an elderly Douglas DC-3 from Punta Arenas toward the Beagle Channel and an airstrip at the Puerto Williams naval base on Chile's Navarino Island. It was August—winter in these latitudes—and below us the mountains of Tierra del Fuego (literally, land of fire) shone white and beautiful. But where were the Indian fires for which Magellan named this cold place? We saw no sign even of smoke.

There were few aids to aerial navigation for the DC-3; a nonchalant young Chilean pilot flew us in by eye. His passengers, besides the three of us, were Chilean naval seamen, plus Patrick Furniss from Punta Arenas, who runs a Navarino sheep ranch, and Tony Cambiaso from Valparaiso, flying down to take a look at commercial fishing possibilities.

Around us, high cloud builds up. The pilot banks and slides past mountaintops, over frozen lakes and black forests. The insides of the windows begin to frost. The clouds rise; so does the DC-3, leaping and bouncing, trying to dodge them (for she is not fitted with de-icing equipment). We disconsolate modern mariners sit grimly in our seat belts. What would Darwin think of this? The aircraft has not robbed this area of its dangers. Darwin was probably better off in the *Beagle*.

Suddenly the clouds roll open. The pilot slips into the gap. "The Murray Channel!" says Tony. "There's Wulaia!" The cove where the *Beagle* landed Jemmy Button!

I peer down. I see no township or village. The black waters froth white with the driving wind. The black land whitened by snow looks savagely cold.



The Voyage

Seagoing adventurer for half a century, author Alan Villiers in the 1930's skippered a world-circling voyage like the *Beagle's* aboard his own full-rigged windjammer, *Joseph Conrad*. In 1957 he retraced the Pilgrims' Atlantic crossing in *Mayflower II*. His salty narratives have often flavored the pages of NATIONAL GEOGRAPHIC. Here, camera in hand, he swaps yarns with the captain of a Chilean patrol boat during a journey that took him from his home in England to most of the locales visited by Darwin.

Accompanying Captain Villiers were his younger son, Peter, and NATIONAL GEOGRAPHIC photographer James L. Stanfield, whose cameras captured both the flavor of Darwin's world and the magic of our own.

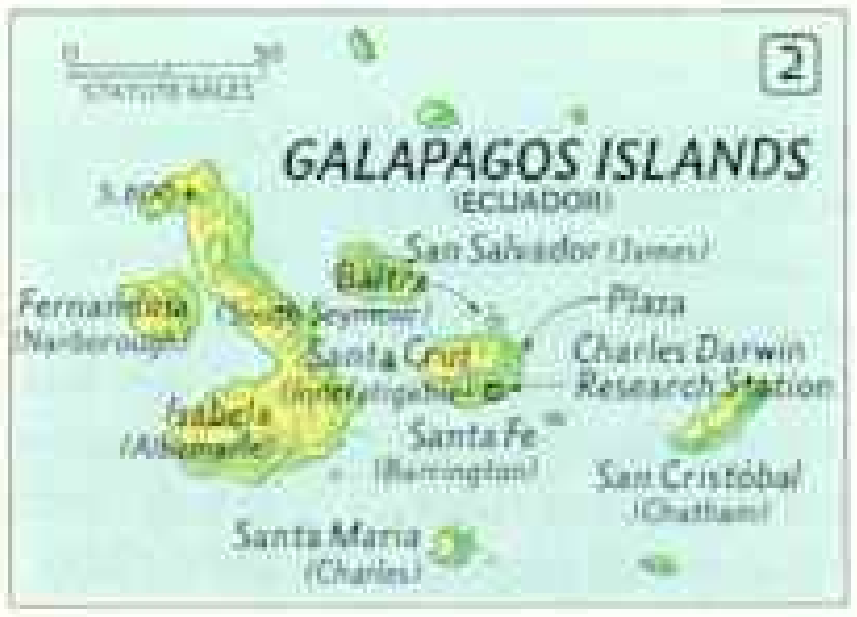
of the *Beagle*

WORLD-WANDERING *Beagle*, commissioned to gather hydrographic data for the British Admiralty, focused chiefly on the southeast and southwest coasts of South America (left).

While the ship pursued its task, Darwin often disembarked for weeks or months at a time. When living aboard, he studied marine life, pored over books, and worked on his diary and notebooks—portions of which he reshaped into the classic *Voyage of the Beagle*. Wherever he went, his perceptive eye scanned the jumble of nature's phenomena and seized on that which gave meaning to the rest. Not limited by any specialty, he became a self-taught expert in geology, botany, zoology, and paleontology. The study of human nature—whether seen in the behavior of a savage tribesman or glimpsed in the recesses of his own heart—also came within his purview.

In Tierra del Fuego (inset, below left) Darwin marveled that the Fuegian Indians had chosen to live in what he considered "one of the most inhospitable countries within the limits of the globe." Yet, he acknowledged, they managed to "enjoy a sufficient share of happiness . . . to render life worth having." He concluded that nature and the force of habit had "fitted the Fuegian to the climate and the productions of his miserable country."

In the Galapagos (below), Darwin's scientific curiosity was sharply prodded by the great variety of birds and animals in a remote place where "within a period, geologically recent, the unbroken ocean was here spread out. Hence . . . we seem to be brought somewhat near to that great fact—that mystery of mysteries—the first appearance of new beings on this earth."



Another mystery Darwin tackled was the origin of coral atolls. He pondered the relationship between precipitous volcanic islands like Tahiti (below) and the relatively flat, lagoon-enclosing islets called atolls. From observations in South America he already knew that sections of the earth can rise or fall thousands of feet over great spans of time.

Applying this knowledge to atolls, he put forth a new explanation of their origin. Islands that once jutted above the surface, he theorized, began to sink long ago—perhaps a foot a century. As they did so, coral with equal slowness built up in a circle around the subsiding islands, growing most abundantly on the outer rims because there the waves brought the coral-building polyps the most nourishment.

The great English geologist Sir Charles Lyell is said to have danced in ecstasy upon hearing this explanation. Had Darwin contributed nothing else, his name would have been permanently inscribed in the annals of science.

"The gauchos are . . . perfect riders. The idea of being thrown . . . never enters their head."

On his inland explorations, Darwin often rode with cowboys of the pampas, like these Uruguayan gauchos, matching his skill on horseback with

"In many parts," wrote Darwin, "magnificent glaciers extend from the mountainside to the water's edge." He thought it "scarcely possible to imagine any thing more beautiful." I find it hard to share his enthusiasm.

Now the pilot banks sharply, slips off height, straightens up; and there is the frozen runway of Puerto Williams's snow-covered airport. A blizzard roars across the field as we touch down, very smoothly. A low black cloud comes in to land too, as fast as we do.

I found myself looking around for the likes of Jemmy Button, York Minster, and other Indians. There were many Fuegians in Darwin's time. "Scarcely protected from . . . this tempestuous climate," he noted, "[they] sleep on the wet ground, coiled up like animals." Most astonishing to him was the sight of a young Fuegian woman, suckling a recently born child, who came alongside the *Beagle* in a canoe "and remained there out of mere curiosity, whilst the sleet fell and thawed on her naked bosom, and on the skin of her naked baby!"

AUDUBON PRINT BY JAMES J. STANFIELD © N.G.S.

theirs. Once, trying to hurl stone-and-thong *bolas*, he accidentally entangled the legs of his own horse. "The Gauchos roared with laughter," Darwin noted in his journal; "they cried out that they had seen every sort of animal caught, but had never before seen a man caught by himself."

How could human beings accept a life of such hardship, survive in such a place, on a diet of shellfish, sea-bird eggs, seal meat, and whale blubber? Darwin wondered just how far man might be removed from the animal.

This disturbing reflection so persisted that, almost four decades later, in 1871, he ended his *Descent of Man* with these words: "The main conclusion . . . namely, that man is descended from some lowly organized form, will, I regret to think, be highly distasteful to many. But there can hardly be a doubt that we are descended from barbarians. The astonishment which I felt on first seeing a party of Fuegians on a wild and broken shore will never be forgotten by me, for the reflection at once rushed into my mind—such were our ancestors. These men were absolutely naked and bedaubed with paint, their long hair was tangled, their mouths frothed with excitement, and their expression was wild, startled, and distrustful. . . .

"Man may be excused for feeling some pride at having risen, though not through his own

exertions, to the very summit of the organic scale. . . . We must, however, acknowledge, as it seems to me, that man with all his noble qualities . . . with his god-like intellect . . . Man still bears in his bodily frame the indelible stamp of his lowly origin."

Well-meant Efforts Come to Nought

I looked in vain for those people who had so impressed Darwin. None was to be seen. But it was not the climate that had killed them.

"When the *Beagle* was here, there were hundreds of these Indians," Patrick Furniss told me. "Darwin thought the Yahgans had a language of only about a hundred words. We know now their vocabulary totaled 32,000 words. Europeans underrated the Yahgans. They were good hunters who used bows and arrows, and slings like David's, too."

Darwin was to be depressed because York Minster proved an utter failure as a convert, and Jemmy Button no better. In little more than a year after the *Beagle* returned Jemmy to his people (in January 1833), he had reverted to his original state. When the *Beagle* returned to Navarino Island in March 1834, Darwin reported that Jemmy was "now a thin haggard savage, with long disordered hair, and naked, except for a bit of a blanket round his waist. . . . We had left him plump, fat, clean and well dressed; I never saw so complete and grievous a change."

Jemmy recounted that York Minster, who had married Fuegia Basket, had persuaded Jemmy and his mother to accompany them on a journey. One night as Jemmy and his mother slept, York and Fuegia Basket stole all they possessed.

Years later, York was killed in revenge for a murder he had committed, and in 1859 Jemmy, who had seemed such a good Christian, led a massacre of local missionaries.

"Measles, tuberculosis, the upset of their hunting grounds, and the destruction of their way of life finished the Yahgans," Patrick Furniss said. "There were some 3,000 in the 1830's. By the 1920's they were only 50 or so."

Patrick told me that the nearest to a full-

KODACHROME © N.G.S.

"*Cheerfulness, good nature and a 'stout heart'. . . .*"

Faces of a Brazilian woodcutter (above) and two children of Salvador, Brazil (right), glow with the bright light of humanity that Darwin saw shining through skins of every hue.

When, early in the voyage, Captain Fitz Roy praised the institution of slavery, Darwin made no bones of the fact that he "abominated" it. The tempestuous Fitz Roy's anger flared, and he nearly forced Darwin to leave the ship.

Darwin related in his journal the story of a runaway slave who had leaped to her death rather than be recaptured. "In a Roman matron this would have been called the noble love of freedom: in a poor negress it is [called] mere brutal obstinacy."

blooded Yahgan left on Navarino Island was probably a septuagenarian known as Filipe Alvarez. To call on him, we stumbled along a rough, snowy path to a tiny settlement beside the beautiful Beagle Channel (pages 454-5).

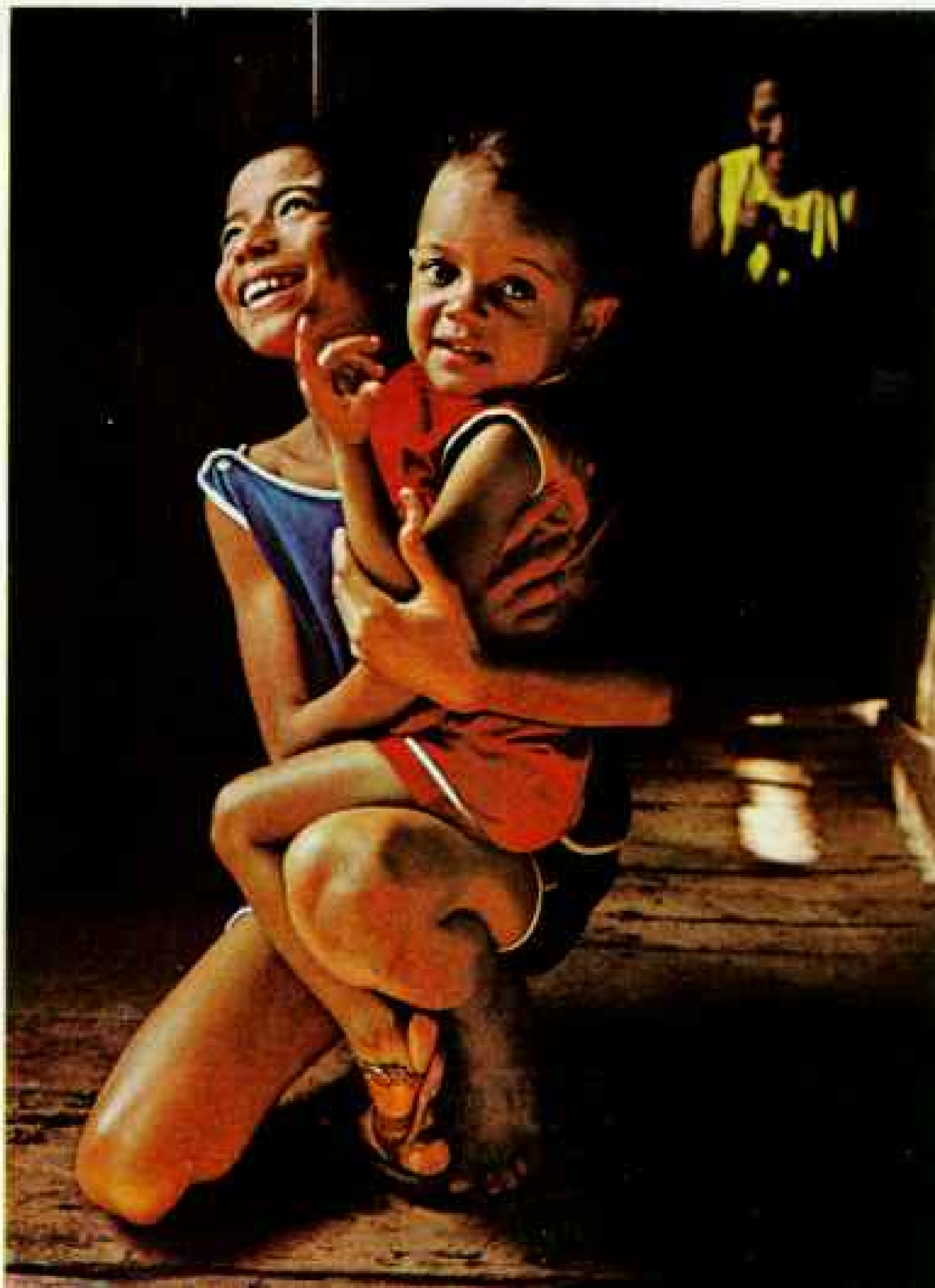
"Perhaps twenty Indians survive on Navarino; all are of mixed blood," the naval base dentist, Dr. Gaston Retamal, said. The older ones live mainly on welfare; the younger work on the naval base or keep sheep.

"How are you?" said Filipe in English. He lit a cigarette and resumed his stone-faced contemplation. A coal stove kept the wood-walled room comfortably warm. Plain but adequate furnishings included a sewing machine. On one wall, incongruously, was a garish print of a toreador fighting a large bull. Having perhaps exhausted his English vocabulary, Filipe just sat there in the big chair, silent, stolid.

Charts Still Rely on *Beagle*'s Data

The Beagle Channel, which had been discovered during the ship's earlier voyage, lies between the mountainous southern coast of the island of Tierra del Fuego and the jumble of Chilean islands that end at Cape Horn itself. Vessels using it may avoid rounding the cape.

We made part of the passage in the Chilean PT boat



"A peculiar and rather fantastic style of architecture."

Salvador, Brazil, still preserves the colonial atmosphere that so enchanted Darwin. Here, brimming with

eagerness and wonder, he first stepped on South American soil. The city, with its grand view of All Saints Bay, deeply impressed him. "But," he said, "these beauties are as nothing compared to the Vegetation."

"The land is one great wild, untidy, luxuriant hothouse, made by Nature for herself. . . ."

Thus Darwin described the overpowering reality of the tropical jungle near Salvador. Travelers today must venture farther inland to find virgin rain forest, like this preserve at Chacara Suissa plantation. "Delight itself," he wrote, ". . . is a weak term to express the feelings of a naturalist who, for the first time, has wandered by himself in a Brazilian forest." At each step some new wonder, such as the St. Andrew's Cross spider (below), rooted him to the spot and, after a few moments of contemplation, was harvested for his collection. "The number of spiders, in proportion to other insects," he noted, "is here compared with England very much larger. . . . Every path in the forest is barricaded with the strong yellow web of a species. . . ."

SPIDER (INCLUDING FOLLOWING PAGES) BY JAMES L. STANFIELD © N.G.S.

Quidora. Rushing through the black waters beneath the frowning mountains, at speeds in excess of 30 knots, was eerie. Squalls lashed the granite mountaintops with malignant intensity. The only change came when one of the sudden squalls called williwaws roared down a mountainside to blast the ship from above. This was even worse, for it seemed to be trying to blow the ship down into the water.

I noticed the navigator using charts based on British Admiralty data credited to Captain Fitz Roy. Several anchorages and harbors were still shown according to the *Beagle*'s original surveys.

Wasp Hunts With a Hound's Skill

In that somber, cold, and windy purgatory, it was difficult to recall that, only a few weeks earlier, we had enjoyed the beautiful beaches, lush tropic forests, and sunny delights of Brazil, which Darwin called a "great wild, untidy and luxuriant hothouse." The *Beagle* had surveyed the coasts of Brazil, Uruguay, and Argentina for nine months in 1832. After an excursion to Tierra del Fuego, she returned north for seven more months in 1833. During both periods Darwin explored ashore, making discovery after discovery.

For weeks at a time he trekked on horseback, through the forests of Brazil and over the wide pampas of the Argentine, living with gauchos, roughing it with his saddle for a pillow and sheepskin saddle blanket for a bed.

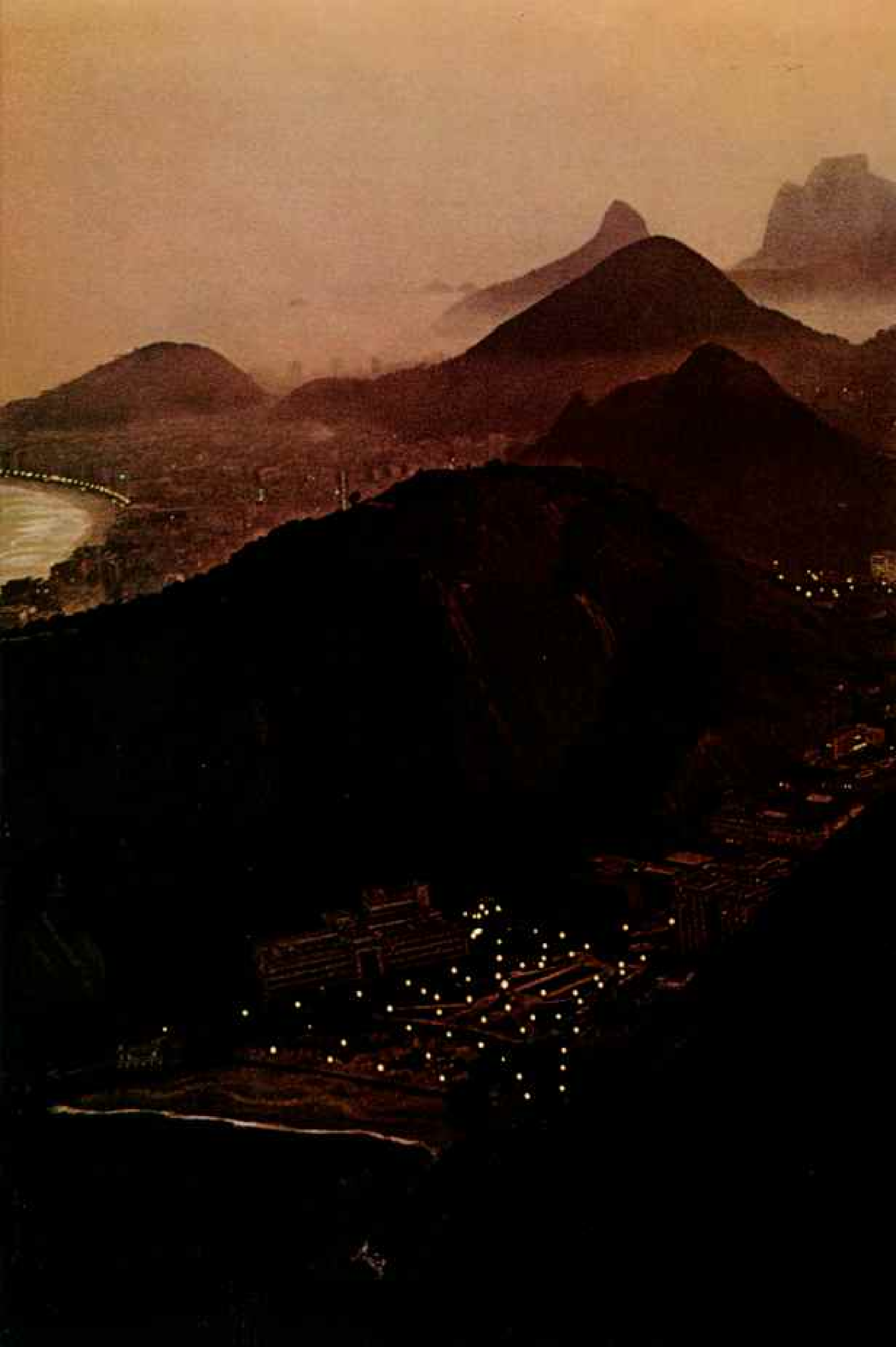
It had been more difficult for us to find the lush forests and the gauchos. In the great Brazilian bay off the city of Salvador (maps then called it Bahia), Darwin remarked on the noise of insects "so loud, that it may be heard even in a vessel anchored several hundred yards from the shore." He had to walk only a few feet from the landing place to find himself in a wonderful forest.

Today one must go inland to find virgin forest such as delighted Darwin (opposite). Salvador still stands on a "noble bay" where the white-sailed *canoas* and *lanchãos* slip silent in the evening air across the waters, but it is also now a great

(Continued on page 473)

"One of those splendid views . . . so common on every side of Rio. . . . every form, every shade, so completely surpasses in magnificence all that the European has ever beheld."

For 10 weeks in 1832, while the *Beagle* surveyed off the Brazilian coast, Darwin lived in a cottage on Botafogo Bay at Rio de Janeiro. Around him rose Rio's fantastically humped landscape, weathered granitic domes protruding from a seaside plain. Atop Corcovado, or Hunchback, Mountain (center), a 130-foot statue of Christ the Redeemer today spreads its arms in blessing over a city of 4,000,000. A cable car from Urca Hill (foreground) ascends at dusk to Sugar Loaf, from which the photograph was made. Here, "in these fertile climates, teeming with life," the young naturalist found the perfect environment on which to hone his scientific skills. His brilliant, methodical mind ranged from broad observations on geology to highly specific studies of the forms and habits of such creatures as flatworms and fireflies.



"An El Dorado to a geologist...."

On Argentina's Patagonian coast, stratified cliffs like those of Point Pirámides (right) told Darwin of uncounted eons of past time. Rich in fossils of extinct species, they pointed to a vastly older age for the earth than most estimates of the day. The idea of such mind-boggling spans of time would become a pillar of his later theories on the immensely slow transformation of one species into another.

Seals lounge beneath these testaments of prehistory. "The number of seals... was quite astonishing," Darwin wrote of such a herd. "... they appeared to be of a loving disposition."

THIS PAGE FOLDS OUT

modern city with a population of more than 860,000 (pages 464-5).*

In April 1832 the *Beagle* dropped Darwin at Rio de Janeiro. While living ashore for more than two months in a cottage on Botafogo Bay, he noticed "certain wasp-like insects" that built cells of clay for their larvae in corners of verandas and then stuffed these "full of half-dead spiders and caterpillars, which they seem wonderfully to know how to sting" so that they stayed paralyzed but alive until the larvae hatched and ate them.

A fight between one of these wasps and a spider "of the genus Lycosa" caught his keen eye. The spider was larger and armed with fierce swift jaws, but had no chance. It got away once, already partly paralyzed, to hide inside a thick tuft of grass. Back came the wasp to carry out "as regular a hunt as ever hound did after fox." Such observations of the struggle for existence, the survival of the fittest, would contribute in later years to Darwin's theory of evolution.

Strange Bones Fascinate "the Flycatcher"

Darwin's cottage stood "close beneath the well-known mountain of the Corcovado," but just where we could not discover. Part of the Botafogo foreshore has been filled in for apartment houses, traffic races round the bay, a road and a cog railway climb to the top of Corcovado, and not far away cable cars swing up Sugar Loaf (pages 468-70).

"It was delicious to sit quietly in the garden" at Botafogo, wrote Darwin, "and watch the evening pass into night," to the accompaniment of a group of small frogs "of the genus Hyla" sitting on blades of grass and sending forth "a pleasing chirp." Crickets shrilled pleasantly. "Every evening after dark this great concert commenced; and often have I sat listening to it. . . ."

Fortunate Darwin! The "concert" we heard was far different—a cacophony of traffic.

The *Beagle* left Rio for Montevideo in July 1832, and Darwin spent almost six months exploring ashore. The ship returned to Montevideo again in April 1833, after her first surveying expedition to Tierra del Fuego, and on this second anchorage off the Uruguayan capital, Darwin had many more months ashore.

If Brazil had held much to fascinate him, he found the pampas of Argentina a gold mine—a source of huge fossil bones of enormous long-extinct animals. He dug them from the clay or pried them from riverside cliffs and kept them aboard the *Beagle* until he could ship them to England.

Bones of the mastodon, toxodon, mylodon, megatherium, macrauchenia—mammals gone from the life of the earth for thousands, even millions of years, yet some of them strangely similar to existing beasts—he found and pondered over (following page).

"Apparent rubbish," his shipmates called these elderly, very odd bones whose fascinating story was lost on them. Whatever was their "Flycatcher," as they called Darwin, up to? They saw merely the strange pastime of a quiet young man indulging himself harmlessly. They had but one complaint.

"He brought more rubbish and dirt aboard than any 10 men," said the irate executive officer as the enormous fossil head of a toxodon, a beast as large as a hippopotamus, bumped across the clean hammock nettings and got sand on one of the brass guns.

Darwin had been raised on the orthodox idea that every species of animal, existing or extinct, had been created separately and simultaneously. Yet some of these fossils, he considered, belonged to animals too large to have been accommodated in the Ark—like the stout, heavy-hoofed toxodon or the oddly shaped macrauchenia, which had the neck of a camel and the trunk of an elephant. He sensed the kinship of these extinct monsters with living forms—and this, too, made him question the accepted dogma.

El Naturalista Rides With the Gauchos

He braved all dangers in quest of knowledge, journeying hundreds of miles with a few gauchos. He traveled from the mouth of the Rio Negro north to Bahia Blanca, and thence another 400 miles to Buenos Aires, sleeping under the stars, eating whatever game the gauchos could bag.

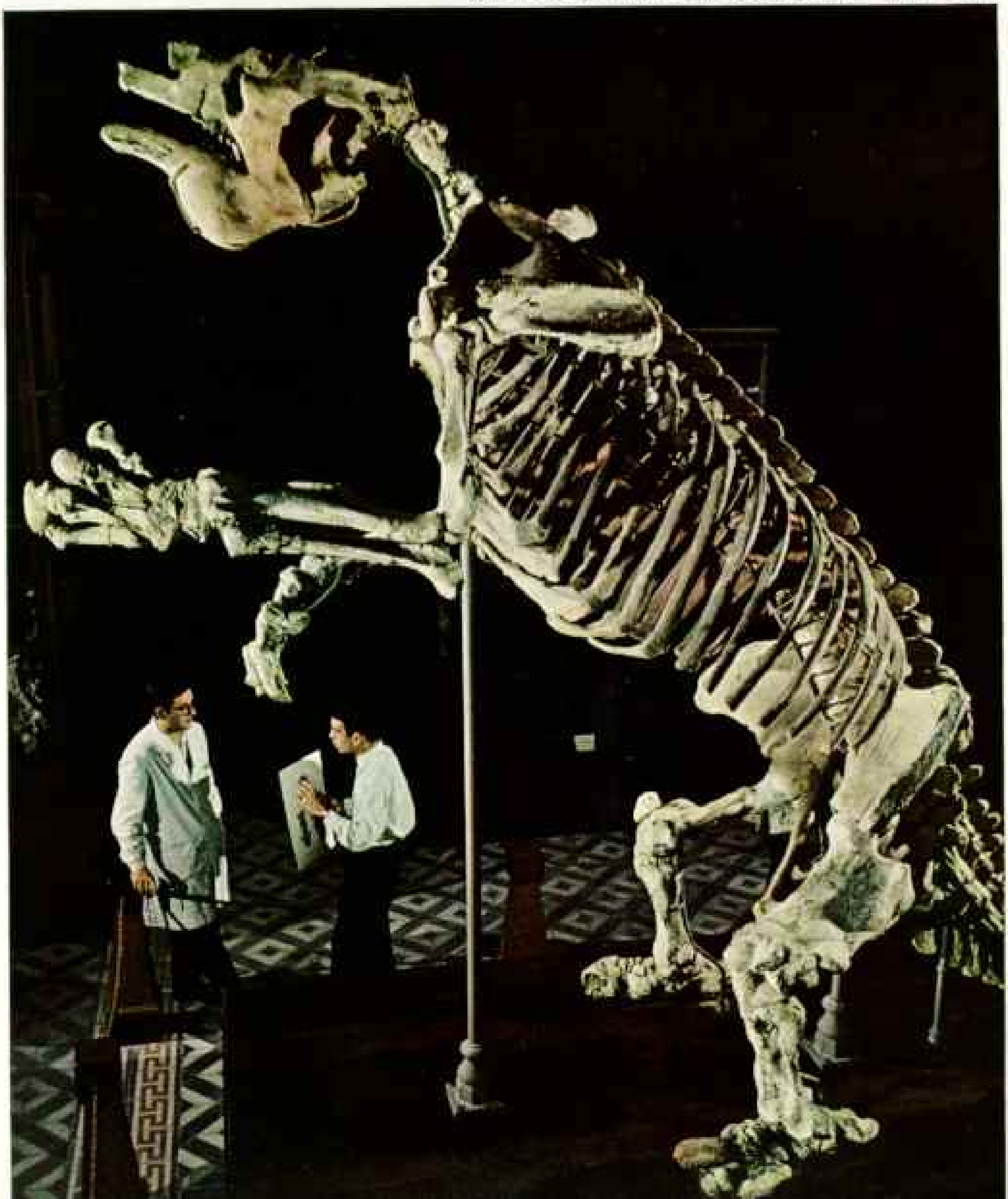
Armed with a passport describing him as *"El Naturalista Don Carlos Darwin,"* he wandered happily in a country often torn by revolution, and where colonists sought to exterminate resentful Indians and the Indians fought back. From Buenos Aires he rode horseback 300 miles northwest over dangerous roads to Santa Fe, on an arm of the Paraná, returning by boat downriver. Jaguars roamed the banks; voracious mosquitoes plagued the waters and lowlands. Darwin exposed a hand deliberately to these, the better

*See "Brazil *Ohal*" by Peter T. White, NATIONAL GEOGRAPHIC, September 1962.

"The whole area . . . is one wide sepulchre of . . . extinct gigantic quadrupeds."

In Argentina Darwin found fossils of extinct species, like the megatherium below, in the same deposits as still-existing species, such as the *Chlamys* scallop at left. This ruled out the widely held theory—devised to explain extinct forms—that great catastrophes periodically wipe out all life on earth. If this were so, he reasoned, the scallops, too, would be extinct; rather, the giant quadrupeds had died out, while the scallops continued to flourish.

MUSEO DE LA PLATA, ARGENTINA (SKULL); ROCKWORKS BY JAMES L. STANFIELD © N.G.S.



to study them while fifty or so gorged themselves on his blood.

Wandering in the Argentine, he found fossil bones and a tooth of an odd animal, unmistakably a horse millions of years old. But there were no horses in South America or North America when the Spaniards came. Why had this earlier species died out? Had the European horse, stemming from some common ancestor back through dim eons of time, been better developed—evolved—to survive in the struggle for existence?

The Flycatcher mulled over these things. In the Brazilian forests and in the Argentine, he had found the ideal research laboratory. Aboard the *Beagle*, moving upon the waters in harmony with sea and sky, he spent these formative years under conditions perfect for thoroughly worked-over thought. The ship and her voyage gave him his real education.

650 Miles of Astonishing Glaciers

On June 11, 1834, the *Beagle* beat to windward out of the Strait of Magellan and entered the Pacific. She made the 1,200-nautical-mile passage to Valparaíso by the end of July, remaining there until November. Then the ship returned south, to spend nearly three months charting the coast of Chiloé Island and the labyrinth of Chile's Chonos Archipelago.*

"Tremendous and astonishing glaciers" stood at the head of almost every arm of the sea for 650 miles northward of Tierra del Fuego, Darwin later recalled. Masses of ice frequently broke from them with a sound "like the broadside of a man-of-war." Such icefalls set up turbulent seas that dashed against the cliffs and beaches.

In February 1835, at Valdivia on the coast of Chile, Darwin felt an earthquake. It seemed mild to him; Darwin wrote he had no difficulty in standing upright. But he chanced to be out of town in an open wood; in town the houses were violently shaken.

At Concepción, 200 miles farther north, the earthquake had been severe: "...the most awful yet interesting spectacle I ever beheld," Darwin recorded when he reached there. He noted numerous fragments of rock with "marine productions adhering to them, [which] must recently have been lying in deep water" and were now flung up high on the beach.

"The most remarkable effect of this earthquake was the permanent elevation of the land..." the *Beagle's* naturalist recorded. "At the island of S. Maria (about thirty miles distant)...Captain Fitz Roy found beds of putrid mussel-shells *still adhering to the rocks* ten feet above high-water mark: the inhabitants had formerly dived at low-water spring-tides for these shells."

The earthquake Darwin experienced at Valdivia was no isolated instance. "Valdivia has been destroyed only four times by quakes," our cab driver there said, as if the record were not too bad. He then added, as if this were reasonable, too, "And our rain averages only 100 inches a year."

In March 1835 Darwin crossed the Andes from Santiago, Chile, to Mendoza in Argentina by way of Portillo Pass, returning by the Uspallata (map, page 458). His companions were two Chilean guides, his transport 10 mules. The journey across the Andes and back took 24 days.

"Our manner of traveling was delightfully independent," he wrote. "In the inhabited parts we bought a little firewood, hired pasture for the animals, and bivouacked in the corner of the same field with them. Carrying an iron pot, we cooked and ate our supper under a cloudless sky, and knew no trouble." He noted the excellent qualities of the Chilean mountain mule, a hard-working, much enduring hybrid, in which, Darwin wrote, "art has here outdone nature."

Mountaintop Sea Shells Teach a Lesson

His observations, as he rode along, convinced him that the Andes had "been slowly upheaved in mass," for he saw fossil sea shells even at 14,000 feet. The sight of petrified coastal trees high on the Argentine side he found astonishing. He knew that there he stood on "the spot where a cluster of fine trees once waved their branches on the shores of the Atlantic," though that ocean was now far across the pampas, 700 miles away.

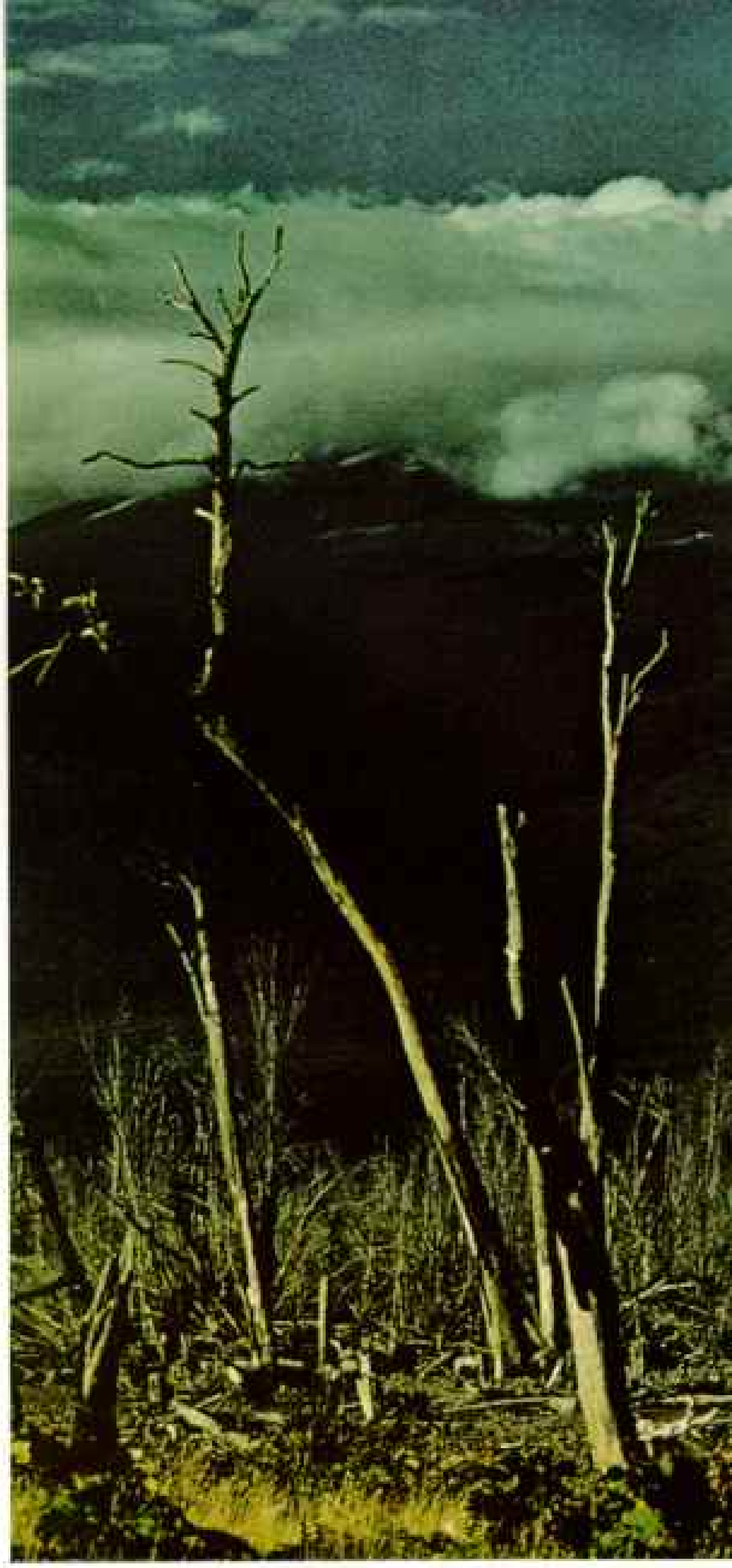
"I now beheld the bed of that ocean, forming a chain of mountains more than seven thousand feet in height." Realizing the tremendous force and changes that had been at work in the great Andes, he reflected that "nothing, not even the wind that blows, is so unstable as the level of the crust of this earth." Such geologic observations caused him to ponder the validity of a 6,000-year-old earth.

Darwin was pleased with his excursion, though it left his blood infected from the bites of "the great black bug of the Pampas," which

*See "Chile, the Long and Narrow Land," by Kip Ross, NATIONAL GEOGRAPHIC, February 1960.

"This most beautiful mountain, formed like a perfect cone and white with snow...."

Chile's 8,730-foot Osorno Volcano spouted "volumes of smoke" when Darwin saw it in 1834. It last erupted in 1960. Skeletal trees died in the 1961 eruption of nearby Calbuco Volcano. Jolted by an earthquake at Valdivia, Darwin marveled at these cataclysms which convulse the earth and suddenly erase or shatter the fossil record of past ages.



he called *"Benchuca,* a species of Reduvius," a loathsome blood-sucker about an inch long. For the rest of his life Darwin was an invalid, for the great black bug is the principal carrier of Chagas' disease, a lasting, debilitating ailment akin to African sleeping sickness.

Like Darwin we traveled into the Andes, but by car on a modern highway. At today's Chilean village of Portillo there is a world-famous ski area. The slopes along which Darwin's mules picked their sure-footed way now offer chair lifts and ski trails.

Wrong Season for Mule Trains

We asked the porter at the Gran Hotel Portillo where we might hire mules. He looked dubious. No mules—not there.

Then he smiled. Find Silverio Vega, he said.

Silverio Vega? Who was he? The last Chilean mule-train leader, of course. He lived high in the Cordillera.

In search of this last *arriero,* off we all went one bright morning in September. Soon we were bumping along mountain roads.

We inquire at every country shack and homestead: Has anyone seen Silverio? Why, yes, they all have—this we learn at a little settlement called Farellones. Silverio passed this way with the Little Tree four hours before, 20 minutes ago, 2 hours, 8 hours. Time sense is not well developed in these parts.

What is this Little Tree? Silverio's name, I know, means "woodsman"; but what would an arriero be doing with trees? Soon there are no trees to be seen anyway. Then suddenly, over a ridge a thousand feet above, comes a minute figure in black on a white horse.

"The Little Tree!" shouts our local guide. "And there is the mule! Look, halfway down!"

I am at a loss to know whether the Little Tree is the horse or Silverio. It is the horse, I discover, for it plants its hoofs firmly on the mountainside like trees.

Silverio shouts a greeting. Down he comes, a smiling little man in a great poncho, sombrero, and large silver spurs.

Yes, said Silverio, he could still arrange a mule train. But not in winter or spring; not January, either, for then the rivers run too high and dangerous; nor in March, for then sudden storms brew in the mountains. February would be best. He could provide three muleteers, a cook, and 12 mules, including a *madrina,* or godmother mule—a sort of boss animal which, as Darwin pointed out, the other mules "like good children, follow." All provisions would have to be carried, of course, and the party would sleep in the open.

It sounded fascinating, and we regretted that the season was wrong to try an excursion on the mules. But it was good to know that,

given time enough, one might still travel in Darwin's manner.

Back from his Andean journeys, Darwin met the *Beagle* briefly at Valparaíso on April 23, 1835, and returned promptly ashore to travel overland through central Chile to Copiapó, to rejoin the ship there. He had to travel the hard way, camping in the open. For us there was the Pan American Highway, a fine road along Chile's coast.

From this great highway, side roads, rough but passable, still service important mining districts in the interior. Darwin visited a silver mine called Arqueros. Looking for it, we enter the valley of the Elqui River, inland from Coquimbo in Chile—the valley of 12,000 goats, our guide calls it—and there we find both silver and copper mines.

Darwin saw miners climbing vertical ladders out of the shafts with incredible loads—200 pounds and more—on their shoulders. The mine we visited, the Sociedad Minera Talcuna, had a crude mechanical hoist. Several hundred persons live in the village. Merry-eyed little children play in white pinafores, while their mothers boil the wash over open fires. The sun is pleasantly warming in the pure blue sky.

Crossing the Atacama Desert farther to the north, from Iquique some 50 miles to the

nitrate workings at Victoria, we met a young man who had something of the Darwin spirit himself. He was trudging along beside the road, bound south, he said in Spanish, hoping to make Tierra del Fuego.

He was a cheerful youth more than six feet in height, black bearded, sun browned. He had on a heavy sheepskin jacket and carried his possessions in a large knapsack. We thought him a hitchhiking Chilean university student, or perhaps Peruvian.

Suddenly my son spoke to me in English, with a slight Australian accent.

"Hey, are you fellows Aussies?" shouted our "Chilean" student, astonished.

Modern-day Wanderer for Science

He was a New Zealander—John Dowd, student at the University of Auckland, reading geology and biology. He was taking five years off to learn something from a voyage of his own around the world, as Darwin had done. He had walked from Vancouver, in Canada, and intended to reach Tierra del Fuego, then swing north, cross the Caribbean by kayak to Miami, and continue from there. What a life!

We heard of him again, many months afterward. He had kept to his tough program. He had reached Tierra del Fuego, strode north again, picked up his kayak at Caracas, and got across the Caribbean, too.

As for Charles Darwin, in July 1835 the *Beagle* took him north from the nitrate port of Iquique to Callao, the port of Lima, where the bark stayed six weeks. A revolution spoiled the visit to Peru, and Darwin saw little of the country and less of the inhabitants. In September the little ship sailed out of Callao, at last bound across the Pacific.

As she sailed outward on the balmy trade winds, Darwin reflected on his South American experiences—the sublime Brazilian forests; primitive man in Tierra del Fuego; earthquakes and their lessons; shells from the floor of the sea 14,000 feet high in the Andes; both the diversities and the curious similarities in birds and beasts and creeping things, insects, fishes, and plants; and the provocative fossil bones of the pampas. Darwin was groping toward his theory.

The *Beagle*'s next stop was the Galapagos, that strange group of volcanic islands and rocks 600 miles out in the Pacific, west of Ecuador (pages 488-9).* There he observed such oddities among birds and beasts as caused him for the first time to reflect (and to record in his notebooks) that the apparent facts of life he observed in the Galapagos "*would undermine the stability of species.*"

In other words, Darwin was to conclude, "no living thing was created ready-made." Development in nature, he theorized, must be by evolution. Henceforth, his search for the "grand scheme, common to the present and past ages, on which organized beings have been created" was to be along these lines.

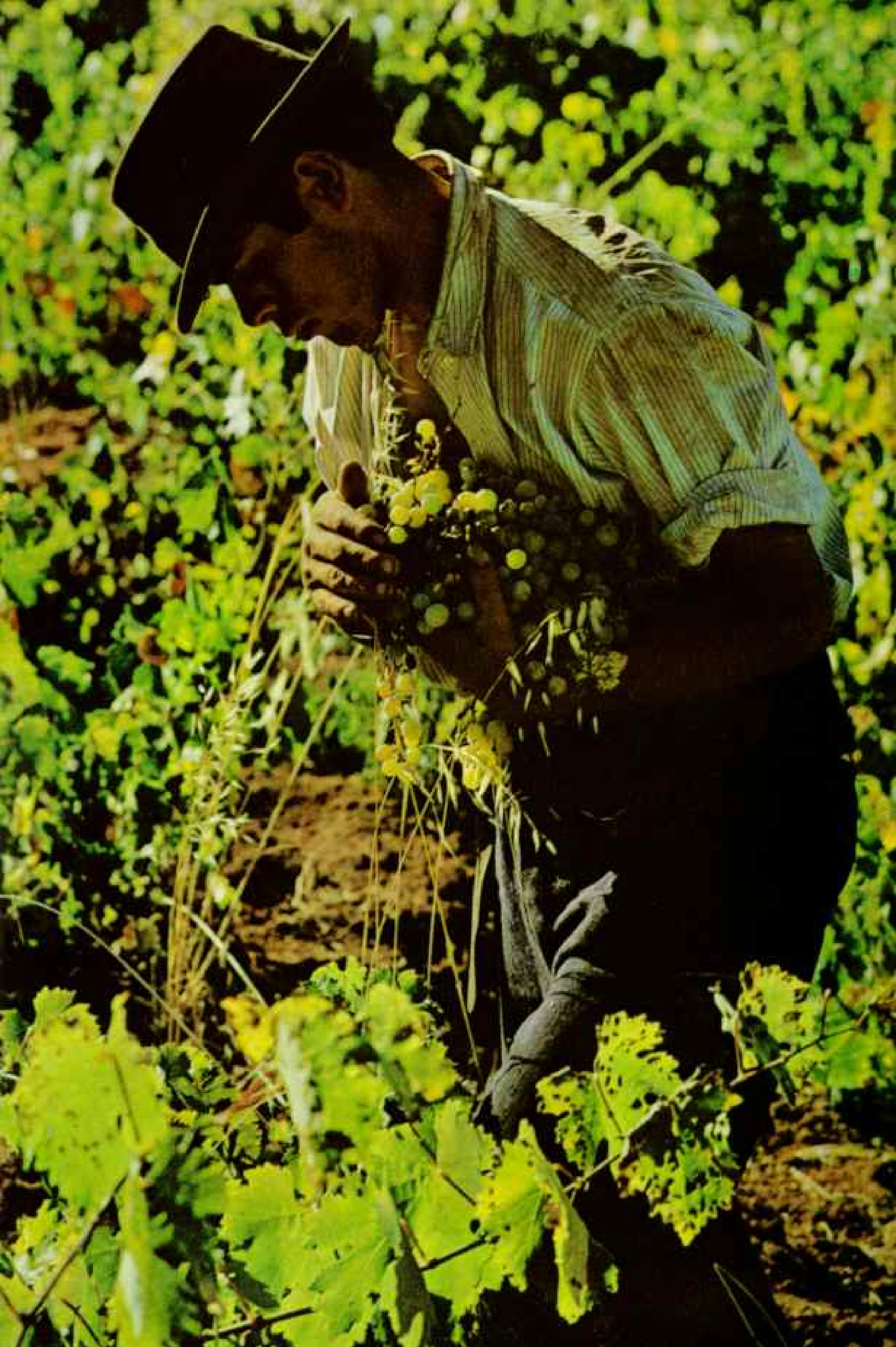
H.M.S. *Beagle* was far from the first ship to sail to the Galapagos. Almost from their discovery by the Spaniards in 1535, these odd islands were noted as a haven for hungry ships' crews. They came for tortoise meat,

*See "The Galapagos, Eerie Cradle of New Species," by Roger Tory Peterson, GEOGRAPHIC, April 1967.

"*The orchards produce an overflowing abundance of peaches, figs, and grapes.*"

A bee (left) sucks up the sugary juice of a grape in a vineyard at Puerto Quellón, Chile. Grape picker (right) reaps bunches of the fruit, bound for wine presses that produce the fine light vintages for which Chile is noted.

Darwin, observing the fertility of Chile's Central Valley, commented: "With all these advantages, the inhabitants of the country ought to be much more prosperous than they are." Though absorbed in the natural history of the lands he visited, he never overlooked, or failed to sympathize with, the plight of people gripped by poverty.



and they carried tortoises away by the hundreds because, in those days of salt provisions, the tortoise had the estimable quality of remaining alive for months with neither food nor water—the ideal fresh meat.

The *Beagle* carried away her share of tortoises. But Captain Fitz Roy was not really interested in the wildlife of the Galapagos. Curious differences among birds of the various islands—though all of a general similarity—proved to him only the "Infinite Wisdom by which each created thing is adapted to the place for which it was intended."

Predators Endanger Island Wildlife

The *Beagle* stayed in the group only five weeks in 1835, but for Darwin it was the most profitable period of the whole voyage.

We reached the Galapagos by four-engined Ecuadorian military aircraft from Guayaquil. Our companions included 20 tourists of eight nationalities. We landed smoothly on Baltra Island and transferred into a small motorship that had been a landing craft for assault troops in World War II. (I had commanded a squadron of 36 of them in those days.)

My son and I settled into our twin-berth cabin for a tour of the islands. We landed first on Santa Cruz to visit the Charles Darwin Research Station there. It was established largely because several islands are losing their unique wildlife.

"Predators brought by man and ships have done the damage," Roger Perry, the station's

KODACHROMES BY JAMES L. STANFIELD © N.G.S.

"How ugly Miss sounds after Signorita."

Despite his imperfect spelling of *señorita*, Darwin had no difficulty translating the meaning of a Latin beauty's shy, dark-eyed glance. Yet science was his first love. In a letter home, he noted that an acquaintance was traveling to Santiago, Chile, to "admire the beauties of Nature, in the form of Signoritas, whilst I hope to admire them among the Andes."

Modern Santiago vibrates to Latin rhythms at an Independence Day celebration (above). Beyond traffic on Plaza Baquedano (left) rise the Andes as Darwin saw them: ". . . bright with the evening sun."

British director, told us. "Pigs, dogs, and rats attack young tortoises. Goats destroy vegetation. House cats gone wild hunt birds and young iguanas." To establish the tortoise again on some of the denuded islands, the babies are hatched and protected at the station through their early years.

But the predators still flourish. Today there are dangers at times even for men. Recently two researchers on Albemarle Island were attacked by a dog pack. The men were unarmed and kept the dogs off only by hurling stones and branches. Fortunately help came in time. Now there is a blitz on wild dogs.

The 13 species of Darwin's finches in the Galapagos have different types of beaks, to cope with the kind of food each finds. We saw many flitting happily around trees and undergrowth. One species of finch uses a tool to poke insects out of holes in trees. Since its beak is not long enough to get into deep crevices, it breaks off a cactus spine and goes to work—one of the rare instances of an animal's making deliberate use of a tool (page 489).*

This is something Darwin missed, but he missed little else. In his *Voyage of the Beagle*, noting the divergence of the finches on

*Baroness Jane Van Lawick-Goodall told of tool use by animals in "Tool-using Bird: The Egyptian Vulture," May 1968 GEOGRAPHIC; "My Life Among Wild Chimpanzees," August 1963, and "New Discoveries Among Africa's Chimpanzees," December 1965.

"We found a solitary man . . . whose sole employment was hunting guanacos."

Wielding a guitar instead of a weapon, a ranger (below) takes time out from his duties: watching over alpacas (below right) in a preserve near Nazca, Peru. Darwin encountered innumerable wild guanacos, also cousins of the llama and the camel, on his overland forays. He called such creatures "the South American representative of the camel of the East." In Patagonia he found bones of a macrauchenia, a larger, extinct creature with a camel-like neck, which prodded his early thinking on evolution.

The apple being savored by a Peruvian Indian child (right) is still a luxury on the desolate coast of Peru, where the *Beagle* arrived in 1835. "The whole is utterly desert," Darwin wrote, ". . . every necessary comes from a distance."

different islands, he came very close to formulating the theory of the origin of species that he was to publish a quarter of a century after his visit. "Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends."

On our cruise around the Galapagos, we were accompanied by Edgar Pots, who once lived in the islands, and Carl Angermeyer, an artist and former seaman who settled on Santa Cruz Island in 1937. We were glad they came along, for many of the Galapagos animals are so perfectly camouflaged that they are difficult to see. The marine iguana, a solemn, shore-dwelling creature (page 449) that dives for algae on the sea bottom, and his dry-land counterpart, have only to stand still to blend perfectly with their background.

On Plaza Island Carl mesmerized a large marine iguana for us—a miniature dragon three feet long. Carl took it in the crook of one arm, where it lay peacefully, like a remarkably ugly baby. He stared it in the eye and made gentle passes over it for a minute or two in mesmeric fashion. After some moments Carl put it back on its rock, whereupon it snapped out of the trance and ambled away.

Crab Picks Ticks From Lizard's Skin

We must have seen at least a hundred iguanas at Plaza, both marine and land types. A large colony of noisy seals slithered over rocks made glass smooth by their endless passage. Scarlet crabs scurried across scarred black stones. In a quiet corner I noticed one picking ticks off a marine iguana, which rolled its eyes in contentment. On top of its head, Carl told me, this amazing animal—the only marine lizard in the world—has a rudimentary third eye, covered by skin.

High overhead, some large birds flew past

on crimson wings—the Galapagos flamingos, the only ones of their kind in the Pacific. Blue-footed boobies flew just offshore, barely high enough to see beneath the sea's surface. Suddenly they would retract their wings and dive straight down at a fish. None missed.

In an arm of the Peru Current, sweeping north from the Antarctic, fish thrive in vast schools around the islands. No wonder the local cormorant—one of the largest known—has evolved into a flightless bird with stubby wings that serve merely to balance its big body as it waddles to the water for yet another meal. It is all too easy—no need to fly!

One day I saw some familiar birds—little black-and-white creatures with tiny wings that sailors call Mother Carey's chickens, minute petrels that flutter over the raging sea down near Cape Horn. Always in the wildest storms flocks of them are there, paying no attention to the gale, skimming at zero altitude, going efficiently about their feeding, their fluttering feet seeming to dance on the sea. Many times in those grim waters they have brought encouragement to gale-blown seamen, including myself. If these fragile little birds could live, why so could we—and did.

Darwin Explores an Island Paradise

From the Galapagos to Tahiti is about 3,600 nautical miles. H.M.S. *Beagle*, sailing on October 20, 1835, made it in 25 days, for the southeast trade wind blew fresh the whole way. The passage lay through the Tuamotu atolls, and Captain Fitz Roy gave Darwin a good look at these "most curious rings of coral land, just rising above the water's edge. . . ." Darwin wondered how they avoided destruction "by the all powerful and never-tiring waves of that great sea, miscalled the Pacific."

The *Beagle* did not stop until Matavai Bay in Tahiti, close to the present port of Papeete. "As the clouds rolled past, the wildest and most precipitous peaks showed themselves," Darwin wrote. Characteristically, he resolved forthwith to go exploring.

Off he set toward the interior with two Tahitian guides. He tramped along the valley of Tia-auru (now Tuaura), down which a river flowed into the sea near Point Venus. The island was so mountainous that the only way in was by such valleys. Soon he was plodding along between thousand-foot precipices through "a mountain gorge far more magnificent than anything which I had ever before beheld."

The trip took two and a half days and involved some "very dangerous" rock-climbing and ledge-clinging. If one abyss were not "partly concealed by the overhanging ferns and lilies, my head would have turned giddy and nothing could have induced me to have attempted it," Darwin wrote.

The *Beagle* stayed 11 days at Tahiti. The party visited Papeete, paid their respects to Queen Pomare, and received her on board.

Tahiti Meets the Age of the Atom

We flew to Tahiti by large jet aircraft. Close by Papeete now, at Faaa, is a long runway where the big jets roar in and out from Acapulco, Los Angeles, Sydney, Honolulu, Auckland. Today the five-mile coastal strip between Faaa and Papeete, the capital, is largely built up. Traffic jams are a Papeete problem, morning, noon, and evening.

Cargo liners crowded the wharves, discharging stores, equipment, and materials for the French nuclear station nearby. The city and its environs reminded us of an armed camp. Could we still find Darwin's tracks here?

Tahiti's sawtooth peaks, rising to 7,352-foot Orohena, stand as bold, beautiful, and glorious as ever.* The Tuaura still flows into the Pacific not far from Point Venus.

Attempts to follow this river inland led us into quarries, private gardens, homesteads. We found narrow roads. They led to military reservations with signs warning PROCEED NO FARTHER or KEEP OUT. So we struggled back on foot into the valley once more.

It rained and rained. Raincoats, large

*See "Tahiti, 'Finest Island in the World,'" by Lula Marden, NATIONAL GEOGRAPHIC, July 1962.

"I was suddenly struck with horror at . . . eating one of the favourite dishes of the country. . . . It turned out to be Puma."

The meat of the puma, or cougar, no longer challenges appetites in South America, but formidable chains of sausages sell briskly at markets like this one in Guayaquil, Ecuador. South of here, in September 1835, the *Beagle* veered west to the Galapagos, and Darwin left the continent that for three and a half years had served him as an immense natural laboratory.

plantain leaves held overhead, or even umbrellas made no difference. Soon the mountain streams began to rush like torrents.

I doubt we would ever have seen much of the Tuaura Valley if we had not met John R. Reasin—a short, wiry man, strong-faced, aged 66, with thick gray-white hair—once of Baltimore. He and his wife Purea have a beautiful property called Rorue that clings atop a ridge 1,500 feet above the valley. Rainbows form for their delight above hibiscus, poinsettia, and orchids in the garden.

As we yarn with John at his fabulous homestead, Orohena rears imperiously over our shoulders. Point Venus and Matavai Bay look like beautiful maps of themselves, with Moorea's astonishing island skyline rising beyond, and the white-frothed flash of sea breaking on its barrier reef in the morning sun.

Far off I can imagine I see a little ship ghostly under gossamer sails—the shade of the *Beagle* with Charles Darwin aboard. He liked Tahiti. So did we (pages 490-91).

After Tahiti, the *Beagle*'s orders were to continue around the world, taking longitude readings as she went—in New Zealand, Australia, the Cocos (Keeling) Islands, and Mauritius (map, page 459).

Yankee Whalers Met in New Zealand

The *Beagle* arrived at New Zealand's Bay of Islands on December 21, 1835, and sailed again on December 30. Several Yankee whalers lay at anchor there; otherwise only an occasional Maori canoe broke the quiet of the harbor.

There were already a British resident and a mission in the area when the *Beagle* arrived. Not many years later, Captain Fitz Roy was to return as Governor of New Zealand, after many of the Maori chieftains ceded their territories to Queen Victoria by treaty in 1840.

EXTENSIONS © NATIONAL GEOGRAPHIC SOCIETY

"*That great sea,*
miscalled the Pacific."

Balsa-log fishing craft take advantage of one of the Pacific's gentler moods as they skim homeward toward the coast of Ecuador. Crossing the vast reaches of the Pacific, the sea-weary Darwin fretted at the prospect of thousands of miles of stormy ocean. "Heaven protect & fortify my poor Stomach," he wrote to one of his sisters.

With those of the ship's 22 chronometers that still worked satisfactorily, Fitz Roy took precise positions for the area. Darwin visited mission stations and made excursions through rough terrain. The Maoris, he thought, compared unfavorably with the Tahitians.

But when I asked after the Maoris 133 years later, I found that the 200,000 in New Zealand are now all literate, all nominally Christian, have been electing their own members of Parliament for the past 97 years, and have a strong sense of community.*

At the Bay of Islands, I based myself in a motel in the pretty beachside town of Paihia, within sight of the holiday center of Russell across the bay. This is the new name for Kororareka, the settlement Darwin knew.

The little harbor under the hills was full of fishing launches for hire. We visited the church at Russell, which was a-building when the *Beagle* was there. The list of subscribers, preserved in the local museum, includes "Captain Fitz Roy, Mr. Charles Darwin, and the Officers of H.M.S. *Beagle*," who gave £15.

From New Zealand the *Beagle* set all sail, and in 14 days made Sydney, Australia.

"We're studying Charles Darwin," said the pretty Australian schoolgirl happily, belting away with her geological hammer near Mount Victoria in New South Wales. Like Darwin on the same spot, the pupils of Sydney's Burwood Girls' High School were collecting fossils from the ancient rock.

Darwin "hired a man and two horses to take me to Bathurst. . . . to gain a general idea of the appearance of the country." He was 12 days on the round-trip journey. He tried kangaroo hunting at the sheep station of Wallerawang, but saw not even "a wild dog."

The aborigines he met "appeared far from being such utterly degraded beings as they have usually been represented." They threw spears for him, using a cap for a target, and had no trouble piercing the cap at 30 yards, "like an arrow from the bow of a practised archer." They were wonderful trackers too, but they would not "cultivate the ground, or build houses and remain stationary."

Darwin saw the strange little platypuses "diving and playing about the surface of the water, but showed so little of their bodies, that they might easily have been mistaken for water-rats. . . . a most extraordinary animal." He never seemed, however, to have related this mammal that lays eggs to his theory of the slow development of species. A living fossil—with a bill and webbed feet like a duck, a cock's spurs, a beaver's tail, and an otter's fur—the platypus is the descendant of a link between reptiles and mammals that appeared 200 million years ago.†

Today Wallerawang is still there, but its

*See "New Zealand: Gift of the Sea," by Maurice Shadbolt, NATIONAL GEOGRAPHIC, April 1962.

†See in NATIONAL GEOGRAPHIC: "Australia's Patchwork Creature, the Platypus," by Charles H. Holmes, August 1939; and "Strange Animals of Australia," by David Fleay, September 1963.

"The natural history of these islands is eminently curious. . . ."

Swallow-tailed gulls hunt on lava cliffs of Plaza Island in the Galapagos archipelago, 600 miles off Ecuador. "Nothing could be less inviting," Darwin remarked. But he was to find the volcanic outposts of unsurpassed scientific interest.

platypuses are gone and so are its full-blooded aborigines. When Europeans settled New South Wales in 1788, the aboriginal population of Australia was around 300,000. Today there are fewer than 200 full-bloods in New South Wales and only six in Victoria.*

In January 1836 the *Beagle* sailed on to beautiful Tasmania, where the indefatigable young scientist climbed rugged Mount Wellington. Darwin found the mountain tangled with trees and undergrowth. We followed a smooth motor road up its slopes. Tall TV masts top the summit, 4,165 feet up.

A few months before our visit a disastrous bush fire had blackened trees and burned out houses on the lower slopes, often leaving nothing but front steps or gaunt brick chimneys. Now ferns and rough grass were already carpeting the lower mountainside, and flowers were blooming again. But no birds sang, nor did we see as much as a kangaroo rat or a hungry wallaby.

"All gone," said old Ted Braithwaite, our guide. "They took an awful beating—us too." He pointed to a valley. "Fifty-three people died there. The flames were 200 feet high. Only a miraculous change of wind saved us."

Tasmania was beautiful, the anchorage at

*The author surveyed his native Australia in the September 1963 NATIONAL GEOGRAPHIC. The aborigines were also described in Captain Villiers's "'The Alice' in Australia's Wonderland," February 1966.

ROSCHROME BY ALAN ROOT © N.G.S.

"The archipelago is a little world within itself."

A tool-using Galapagos woodpecker finch, *Camarhynchus pallidus* (above), probes for a grub with a cactus spine. Darwin was surprised to find 13 distinct species of finches among the islands of the archipelago. He also noted different subspecies of the giant *Geochelone elephantopus* tortoise (below) on different islands.

Could nature, he wondered, have been so profligate as to create each form separately? Or—and here was the germ of his later theories on evolution—had there originally been but one variety of each, "which had been . . . modified for different ends?"

ROSCHROME AND EKTACHROME (BELOW) BY JAMES L. STANFIELD © N.G.S.

"In every respect we were delighted with Tahiti . . . the Queen of the Islands."

Whether in the form of a feathery cascade (left) or diamondlike droplets on a sun-lacquered surfboard, water seems to partake of some special enchantment in Tahiti. The people of the island, Darwin noted, "have the dexterity of amphibious animals in water." The *Beagle*, en route from the Galapagos to New Zealand, paused here for 11 days in November 1835.

BOOMERANGS BY JAMES L. STANFIELD © N.G.S.

Hobart ideal. But when the *Beagle* sailed on February 17, 1836, Darwin suffered agonies of seasickness from the long westerly swell. From Hobart to King George Sound, near the southwestern extremity of Australia, was more than 1,500 nautical miles.

Of King George Sound, Darwin wrote, "We staid there eight days; and we did not during our voyage pass a more dull and uninteresting time." He was tired, and just how sick he didn't know.

Actually, he was quite fortunate at King George Sound (where the city of Albany now stands). He saw a "corrobery" of the White Cockatoo and King George aborigines. A corroboree is a tribal celebration, alive with myth and history, staged by men known now to be in no sense Stone Age savages.

"A most rude, barbarous scene, and to our ideas, without any sort of meaning . . . hideous harmony . . . a perfect display of a festival amongst the lowest barbarians," was Darwin's summary.

Lowest barbarians? Those White Cockatoos were not a tribe but part of a tribe that deliberately included also Black Crows, to prevent the damaging effects of inbreeding.

As Mr. Frank Gare, Commissioner of Native Welfare in Western Australia, told me, the full-blooded aborigine "is a superb bushman and a natural gentleman, peaceful, quiet, unable even to lie, for he has neither need nor understanding of such subterfuges."

The aborigine here survives as an Australian worker. Commissioner Gare, whose receptionist was a pleasant aboriginal teenager, told me that all aborigines will shortly attain the same rights and privileges as other

Australians. Western Australia has nearly 10,000 full-blooded aborigines, more than half in the tropic north where many are iron miners, irrigation workers, stockmen—Australian cowboys.

After the call at King George Sound, Darwin still had six months of ordeal by sea ahead. The route lay across the Indian Ocean by way of the Cocos Islands, Mauritius, and the Cape of Good Hope. Thence the *Beagle* would sail through the South Atlantic to call at St. Helena and Ascension and again to touch Brazil to recheck her earlier observations. The final lap would be via the Cape Verde Islands and the Azores.

At Cocos in the Indian Ocean, in an 11-day visit, Darwin found evidence for a theory about the formation of coral atolls that has been confirmed by modern studies. This contribution alone (even if *The Origin of Species*

"At last we anchored within Sydney cove...." Sunday sailors ride the wind-tossed chop of Sydney Harbour, where the *Beagle* anchored in January 1836. "There never was a ship so

had not also come out of the voyage) would have brought him enduring fame.

Formed by countless millions of tiny polyps, the coral atolls were surrounded by almost unfathomable depths. The polyp could flourish only in the upper layers of the sea, no farther down than 20 or 30 fathoms. Yet the reefs they built often rose from tremendous depths. How could this be?

Darwin reasoned that the reefs hadn't risen; they had sunk. The volcanic upthrusts on which the reefs first formed had subsided. It was the same instability of the earth's crust that he had seen demonstrated so clearly in the Andes. As the mountaintops on which the polyp colonies lived slowly sank, the myriad coral skeletons sank with them. More and ever more lived and died on top of them, steadily renewing the atoll.

The *Beagle*, after 10 days at Mauritius,

full of homesick heroes," Darwin wrote, still many months from home. His English pride swelled when he reached prosperous Australia. "This is really a wonderful Colony: ancient Rome, in her Imperial grandeur, would not have been ashamed of such an offspring."

sailed on for the Cape of Good Hope, arriving late in May 1836. We reached Cape Town by air. I could no longer recognize the docks I had last seen from my sailing ship *Joseph Conrad* in 1935. Darwin and I would be equally lost in the great sunlit city that has risen beneath Table Mountain.

Darwin's Harvest: Knowledge

From the cape, the *Beagle* ran her roundabout race for home, via Brazil. At long last, in August 1836, she spread her storm-bleached sails to the wind off Pernambuco—known today as Recife—and pointed her long jib boom for England. Darwin's record of journey's end states simply:

"On the 2nd of October we made the shores of England; and at Falmouth I left the *Beagle*, having lived on board the good little vessel nearly five years."

As he closed *The Voyage of the Beagle*, Darwin reflected that, to go upon circumnavigations, a person should possess a "decided taste for some branch of knowledge.... It is necessary to look forward to a harvest... when some fruit will be reaped, some good effected."

He knew what his harvest was to be. Within a few years he had married a beautiful cousin and, not long afterward, settled at Down House near Orpington in Kent—only 12 miles as the raven flies from the Tower of London, but even today still amid the loveliness of rural Kent. Here, for the following 40 years, restrained by his own diffidence and harassed by increasing illness, he worked over his theories. It was 23 years after the *Beagle* voyage before his famous *The Origin of Species* was published, and another 12 before *The Descent of Man* followed.

Darwin's study at Down House is much as he left it that day in 1882 when his research and his life came to an end. Something of the tall, quiet thinker, who was to be given honored burial in Westminster Abbey, still pervades the room. His hard armchair, with the board across the arms on which he wrote, still waits for him. His old single-lens microscope stands on a window ledge (opposite).

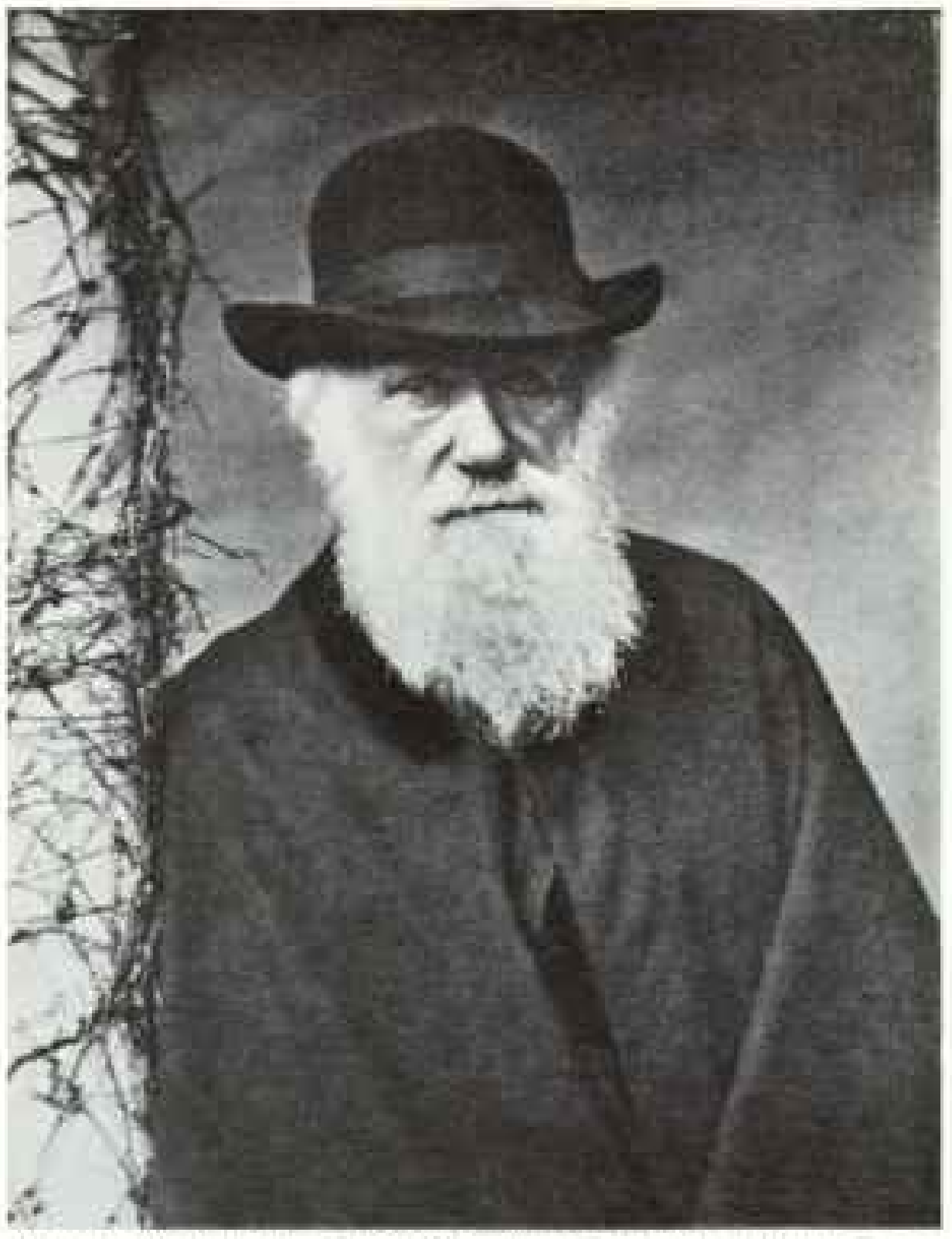
From a life-size canvas in the drawing room, a bearded Darwin gazes down benignly. The sweep of the deep-set eyes seems to take in much—reaching to the outermost ends of this fantastic world, which his life's work, he hoped, would help his fellow men better to understand. THE END

"My name ought to last for a few years."

Darwin never again traveled far from home or family after the *Beagle* anchored in England on October 2, 1836. His voyages henceforth would be inner ones in search of what he called the "grand scheme...on which organized beings have been created."

Weakened by illness, he worked with Olympian patience sorting out and fitting together the innumerable pieces of nature's gigantic puzzle. Nearly a quarter of a century passed before, in 1859, he stunned the world with his conclusions on evolution in the ponderously titled *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life.*

Today, in his carefully preserved study at Down House, Kent, his microscope (left) still stands with its lens focused on a slide, as if the bearded sage (right) has just stepped out to exclaim to his wife about some new discovery and will momentarily return.



COURTESY ROYAL COLLEGE OF SURGEONS; KODACHROME (LEFT) BY JAMES L. STANFIELD © N.G.S.

Face and Floor of the "Peaceful Sea"

And God said, Let the waters under the heaven be gathered together unto one place, and let the dry land appear: and it was so. GENESIS 1:9

LARGEST OF ALL THE OCEANS, so vast that it could swallow all the continents, so deep that scientists call its lowest reaches the "hadal zone," from Hades, the nether world—this is the Pacific.

Here each new day is born along the zigzag of the Date Line. Here, too, just before tomorrow begins, is the spot where the first men to walk on the moon returned to earth.

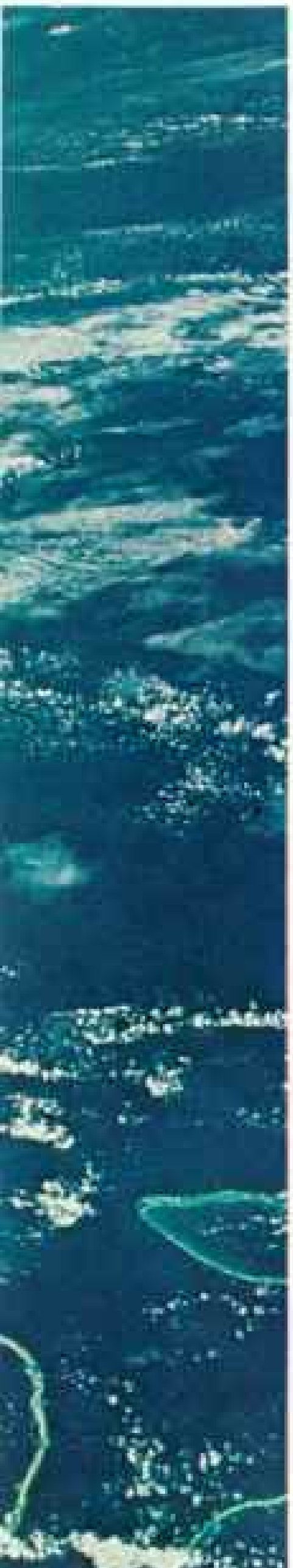
Mare Pacificum—peaceful sea—Magellan called it in 1521 after a serene and storm-free crossing to the Philippines. Yet hardly could a name be more misleading. For the Pacific is all too often swept by typhoons and seismic sea waves and jarred by earthquakes and volcanoes. A geologic teen-ager, it is youthful, restless, and still growing.

These attributes and more unfold on the National Geographic Society's latest map, a dual portrait of the Pacific—the ocean and the floor—enclosed as a special supplement to this issue.* One side spreads the sun-washed blue of the Pacific basin against a fitting background—60 percent of the earth's circumference. The other plumbs a crumple of underwater mountains and slashes to reveal a third of the earth's surface never seen by man—the 64 million square miles of the Pacific Ocean's floor.

Like the widely hailed map-paintings of the Indian and Atlantic Ocean floors which accompanied the October 1967 and June 1968 GEOGRAPHICS, the **Pacific Ocean Floor** presents a view of an entire ocean drained dry. Off the tan-tinted continents lie pale-blue coastal shelves, the sunken shorelines of ancestral beaches. Beyond the shelves lie the violet stretches of abyssal plains, great expanses of sediments—sand, volcanic ash, dust from meteors sleeting through the upper atmosphere, the minute shells of plankton, even the insoluble ear bones of whales. And beyond the abyssal plains lies the silent perpetual darkness of the great trenches: the Philippine, the Kuril, the Tonga, and the deepest of all, the Mariana, plunging nearly seven miles.

As were the Society's previous ocean-floor

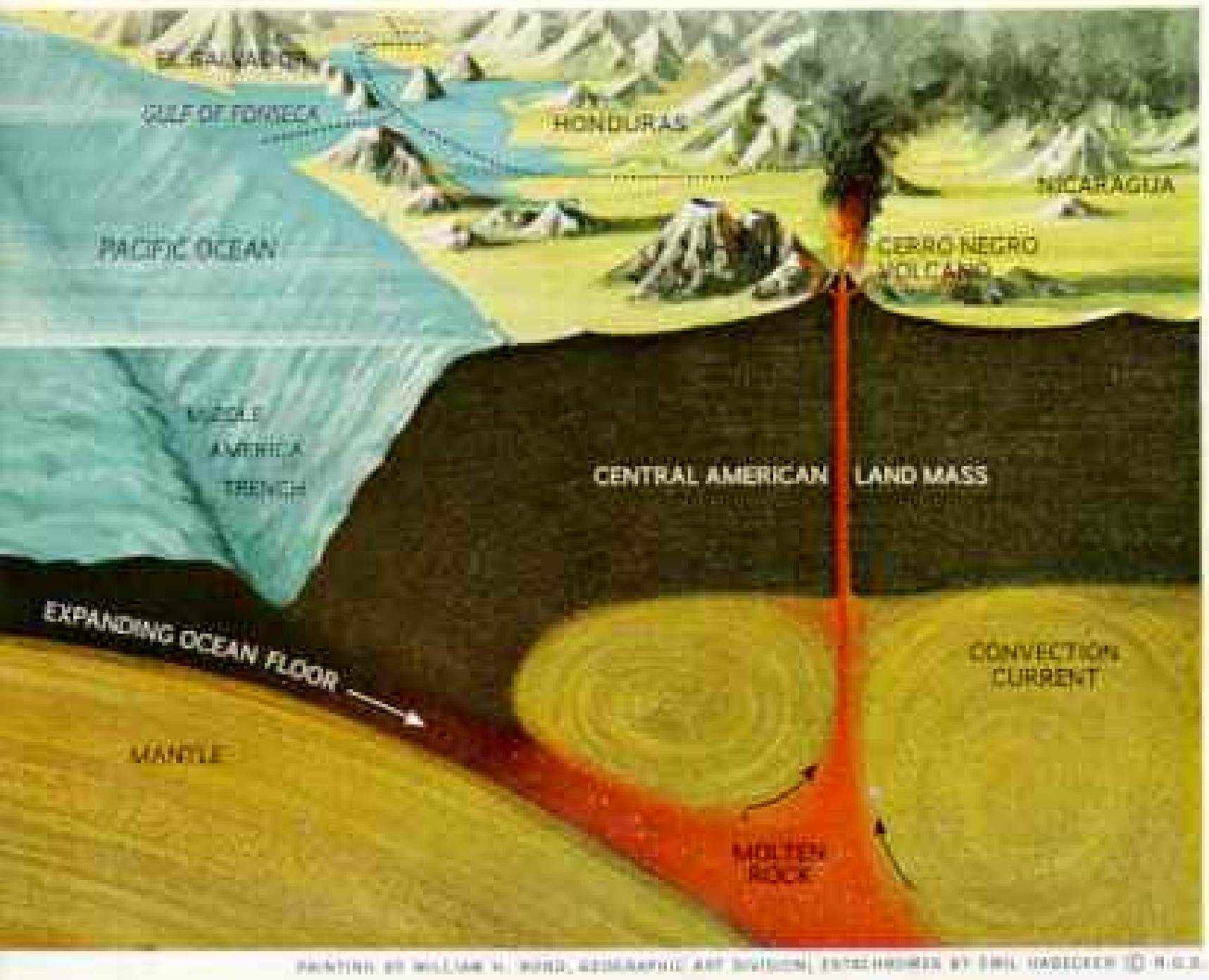
*Additional copies of the **Pacific Ocean-Pacific Ocean Floor**, and of earlier maps portraying the **Atlantic Ocean and Floor** and **Indian Ocean Floor**, may be ordered for $1.00 each, plus 10 cents postage, by writing Dept. 61, National Geographic Society, Washington, D. C. 20036.



EKTACHROME, NASA CAPT., REDISCHROME BY ROBERT SISSON © N.G.S.

Garlands of coral, atolls of the Tuamotu Archipelago seem to float on the curving Pacific. This photograph was taken from 120 miles in space by the crew of Apollo 7, Walter M. Schirra, Jr., Donn F. Eisele, and R. Walter Cunningham, during their 11-day orbital flight in October 1968.

Brilliant star in the Pacific's "ring of fire," Cerro Negro in Nicaragua explodes in 1968. A National Geographic grant helped Smithsonian volcanologist William G. Melson to study the eruption, its ninth since 1850. Two-thirds of the world's active volcanoes and 80 percent of its earthquakes occur on the Pacific's rim.



PAINTING BY WILLIAM H. BOND, GEOGRAPHIC ART DIVISION; ENGRAVINGS BY EMIL WEDDIGEN © N.G.S.

Spreading sea bed meets land, a deep trench forms, and volcanoes vent a subterranean caldron.

Geologists have found that the sea floor is expanding as new crustal rock steadily wells up along oceanic ridges. Some oceanographers believe that the great trenches rimming ocean basins, such as the 15,000-mile-long Pacific trench system, absorb the outward movement. As it collides with a continent, the expanding floor buckles like a scuffed rug, creating the trench. The collision compresses the edge of the continent, thrusting up mountains, and forces the thin ocean floor to dive beneath the thick continental crust. Subterranean friction adds heat to molten rock forcing its way upward through fissures to form volcanoes.

Eavesdropping on the ocean: A diver (right) works on an underwater sensor suspended below a buoy in the Pacific off San Diego. The complex buoy automatically monitors barometric pressure, air and water temperatures, and speed and direction of wind and ocean currents.

Scourge of the Pacific, the crown of thorns starfish *(Acanthaster planci)* devours coral-building polyps, jeopardizing some of the world's most prized reefs and the very existence of islands they surround and protect. The starfish, once rare, has become more prevalent in the last few years. Scientists are now trying to discover the reason for the population explosion. The predators are devastating Guam's coral fringe at the rate of half a mile a month and threaten Australia's Great Barrier Reef.

maps, this underwater portrait of the changing Pacific was painted by Austrian artist Heinrich C. Berann, on the basis of analysis of millions of depth soundings by geophysicists Dr. Bruce C. Heezen of Columbia University's Lamont-Doherty Geological Observatory and Miss Marie Tharp, now of the Naval Oceanographic Office. Careful extrapolation filled out their profile in remote areas not yet fully sounded by oceanographic ships.

Ridge Creates New Ocean Floor

Geologists think that most of the constant change in the Pacific's floor starts at the East Pacific Ridge, a primal crack in the earth's crust. On the Berann painting, the ridge cleaves northeastward from the South Seas for 9,000 miles before it slips out of sight beneath the North American land mass.

Molten rock from inside the earth wells up through the crack and presses outward, fracturing the flanks in a crosshatching of fissures and pushing the existing floor ahead of it (diagram, left). Says Dr. Heezen, "The west side of the ridge, with so much open space in front of it, is advancing 4 to 4½ inches a year in places, which makes it the youngest and fastest-growing part of earth's crust."

What's more, oceanographers believe, as the floor expanded northwestward across the Pacific, it passed over volcanic jets that pushed up islands, one after the other; then the moving floor carried them along, as if on a conveyor belt, until they were strung out in chains. The Hawaiian Islands are the newest product of this geologic assembly line.

With the decisiveness of an exclamation point, the island of Hawaii assumes its full stance as the tallest mountain on earth, rising more than 33,000 feet from sea floor to the peak of Mauna Kea—three-quarters of a mile more than the height of Mount Everest.

Hawaii and other chains—the Society, Caroline, and Marshall Islands—all have atolls as well, those necklaces of pinkish-white coral set in a tropical sea (page 496). Charles Darwin discovered their secret on his renowned voyage, retraced by Alan Villiers in this issue (see "In the Wake of Darwin's *Beagle*," page 449). They were coral crowns, Darwin postulated, which had grown around subsiding islands that eventually disappeared, leaving the atoll and its inner lagoon. In 1952, U. S. Atomic Energy Commission engineers confirmed his theory by drilling 4,208 feet down through the coral at Eniwetok, in the Marshalls, and hitting volcanic rock—the sunken island Darwin said would be there.

Some submarine mountains never reach the surface. The **Pacific Ocean** map on the opposite side of the sheet marks their locations with the term "seamount"; a companion word, "tablemount," indicates ancient drowned islands whose tops were flattened by prehistoric surf. Oceanographers apply the term "guyot" (pronounced ghee-yo) to these distinctive table-topped seamounts, discovered in World War II by U. S. scientist Harry H. Hess and named for Swiss-American geologist Arnold H. Guyot (1807-84).

To see the Pacific from its surface to its depths, fold one side of the double map over the other so that the same areas can be compared. With both sides drawn on the same projection and scale, the viewer obtains a virtual three-dimensional view.

In a single sweep, measuring 14,375 miles along the Equator, the maps show four continents, 45 nations, 22 seas, and myriad islands. They include such World War II battlegrounds as Guadalcanal in the Solomons; Tarawa in the Gilberts; the Midways, east of the Date Line; Okinawa in the Ryukyus; and Leyte in the Philippines, where—25 years ago this month—the late Gen. Douglas MacArthur redeemed his vibrant pledge, "I shall return."

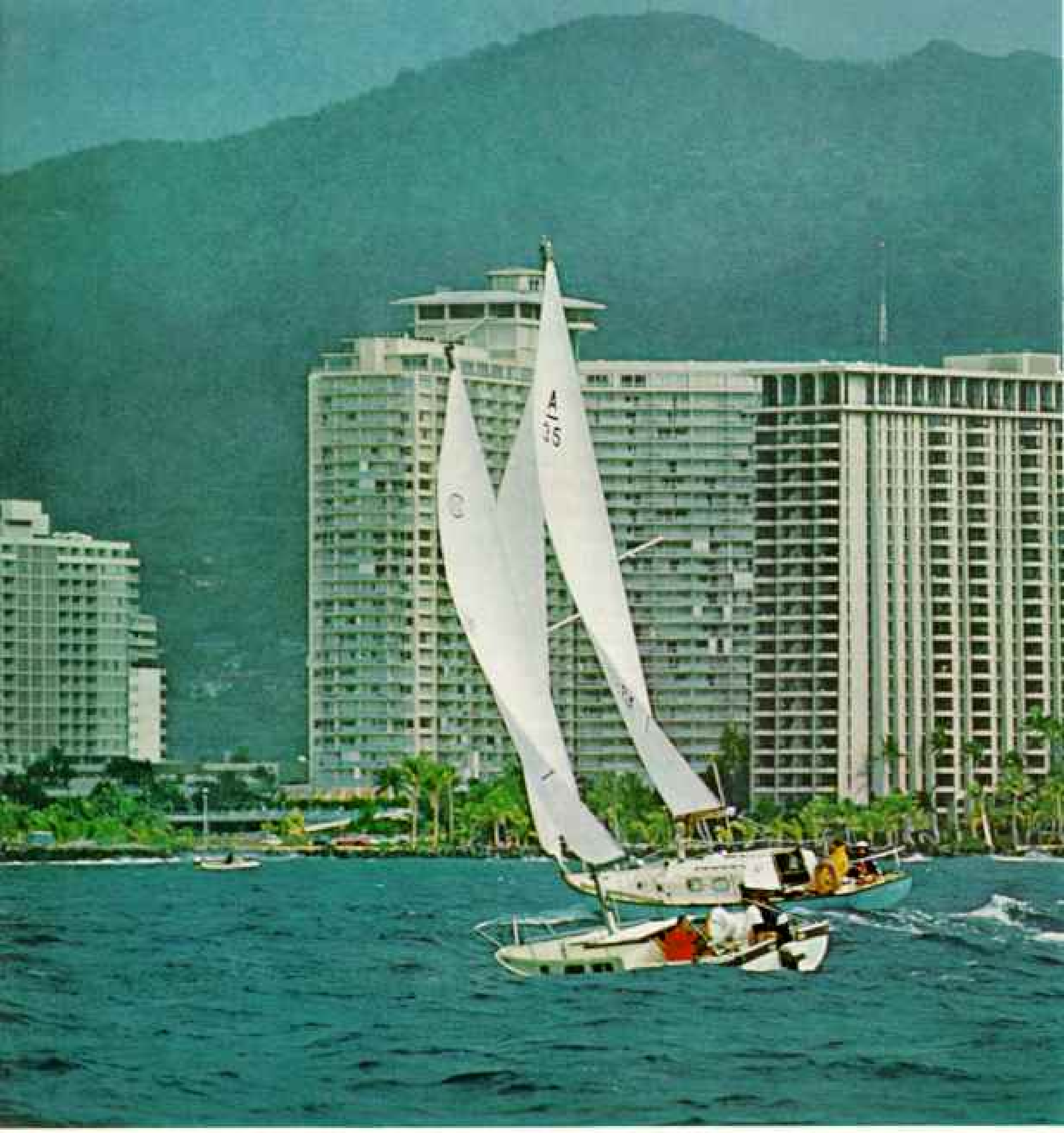
Conflict on Earth, Conquest of Space

Amid this mosaic of cartographic greens, yellows, and pinks lurk the somber hues of today's headlines: the Ussuri River, flash point on the eastern frontier between the Soviet Union and China . . . North Korea, captor of the reconnaissance ship U.S.S. *Pueblo* . . . the painful bamboo sliver of Viet Nam.

An innovation on National Geographic maps, recording the true advent of the Space Age, appears in the lower center, between Honolulu and the Samoan Islands. The red outlines of three descending capsules with billowing parachutes show the splashdown sites of Apollo 11—the historic 1969 moon-landing flight—and its preliminary lunar-orbiting missions, Apollos 8 and 10.

Incidentally, this is the Society's first map supplement to be printed on high-speed rotary presses using continuous rolls of paper. To do that for 6,600,000 maps required a running ribbon of paper 25 inches wide and 2,800 miles long—enough to span the United States from the Atlantic to Magellan's great peaceful sea.

THE END



Look What's

By JIM BECKER

Illustrations by National Geographic Photographer BATES LITTLEHALES

"HOW'S THE WEATHER out there?" asked a friend in New York when we spoke some months ago by long-distance telephone. I glanced out the window of my apartment in downtown Honolulu.

"Beautiful blue sky, nice warm sun as usual," I said. "How is it there?"

"A typical New York day for this time of year," he replied.

"Oh?" I said. "What time of year is it?" My friend was startled, but I had honestly forgotten.

High tide of prosperity washes over Honolulu, where record numbers of visitors and new residents trigger a construction and business boom. Here, riding the trade winds, sloops race past two towers of the Hilton Hawaiian Village, center and right, and the Ilikai Hotel in Waikiki.

Yet grace and beauty of bygone times remain. With bodies swaying, hula dancers tell with their hands a tale of life and love. For rhythm they click castanet-like *ili-ili*.

Happened to Honolulu!

The more I think about Honolulu, the more significant the incident becomes. The climate in this city, which I know well as a newspaper columnist and as an on-and-off resident for nearly 20 years, surely must have been designed for paradise. No recorded temperature downtown has ever exceeded 88° F. or dropped below 56°. But climate is one of the few things untouched by change in the epochal decade since Hawaii became the 50th State.*

In 10 years, statehood and the jet airliner have transformed the Hawaiian capital from a picturesque Pacific crossroads to something approaching an outpost of Southern California. A tourist searching a postcard rack for a typical Honolulu scene might as accurately select one showing cranes flinging up new buildings as one of palms swaying in the

*See "Hawaii, U.S.A.," by Frederick Simpich, Jr., NATIONAL GEOGRAPHIC, July 1960.

balmy breeze. And he might hear the *wham!* of pile drivers as frequently as happy rhythms strummed on ukuleles.

Honolulu today is a boomtown. Its population is growing 3 percent annually—more than double the national rate. In 1968 the value of new construction approached $415,000,000.

So many visitors surge into Honolulu—more than 1,200,000 in 1968—that tourism has become its second largest enterprise. Only the Federal Government pumps more money into the economy, principally from large military installations.

City Limits Span 1,350 Miles

Honolulu means "sheltered haven," an apt description of the snug, reef-girt anchorage on the southern coast of Oahu first surveyed in 1796 by William Broughton, a British Navy captain. However, Honolulu can mean a great deal more, for it covers a vast area.

During Hawaii's 59 years as a territory of the United States, city governments, as separate from county ones, were never established. Therefore, there are only four local governments in the state. One of these is the city-county government of Honolulu, whose jurisdiction includes all 608 square miles of Oahu, and a score of smaller islands, stretching as far as 1,350 miles to the west.*

These islands, a string of coral dots uninhabited except for Tern and Kure where the Coast Guard has navigation stations, make Honolulu technically the most far-flung city in the world.

Thus I can write of Honolulu as a city of pineapple and sugar-cane fields, placid lagoons, suburbs, lonely islands, mountains rising as high as 4,000 feet, and forests and valleys so little touched that it was possible to film, within an hour's drive of City Hall, most of the movie *Hawaii*, which depicts island life in the 19th century.

*See "Honolulu, Mid-Ocean Capital," by Frederick Simpich, Jr., NATIONAL GEOGRAPHIC, May 1954.

Easy island style pervades Ala Moana Center, where shaded walkways, piped music, palms, and pools bright with goldfish, locally called Japanese carp, enhance shopping hours. Its 155 stores make this one of the world's largest retail complexes. Cash registers sing as customers buy everything from Philippine handicrafts and Swiss cheeses to Hawaiian play clothes (page 514).

Here faces reflect the heritage of a rich blend of many peoples: Hawaiians, Japanese, Chinese, Filipinos, and *haoles*, or Caucasians. Intermarriage among these groups contributes to a notable lack of prejudice.

Hawaii's setting, the Makaha Valley, has since succumbed to development. "We finished the movie just in time," Julie Andrews, the film's leading lady, told me on a recent return to the scene. "If we made it on the same spot today, we'd have to contend with two 18-hole golf courses and a 200-room hotel that seem to have sprung up as soon as we left."

To most people, however, Honolulu means a 20-mile-long urbanized strip of Oahu's southern plain, between Pearl Harbor and Koko Head, with fingers reaching into the Koolau Range (map, pages 506-7). This area encompasses modern downtown Honolulu, with concrete towers rising twenty stories and more, the playground of Waikiki, and such fast-expanding residential areas as Hawaii-Kai near Koko Head. This last was created by the late industrialist Henry J. Kaiser, who lived in a pink mansion on the shore.

Whether you apply the narrow or broad definition of Honolulu's size, the city is the mainspring of Hawaii. The developed southern coast of Oahu contains nearly half the state's 808,000 people. The entire island, third largest in the Hawaiian chain, is the home of 80 percent of them. Appropriately, Oahu means "the gathering place."

Lately it has been gathering more and more *haoles*, or Caucasians. An estimated 38,000 moved to Hawaii from the United States mainland in 1968, most to settle in Honolulu. This is part of a continuing migration that has grown steadily in recent years.

Blessings for a first-born son: In the Izumo Taisha Mission, a Shinto bishop prays that a young citizen of the 50th State will enjoy good health, education, and a long and prosperous life. Like many of the city's Japanese Buddhists, the child's parents seek Shinto blessings on happy occasions.

Varied Strains Blend Smoothly

Honolulu's population has long been a melange of people, cultures, and languages. It is a rare Miss Hawaii, for example, whose ancestry does not include at least half a dozen racial strains. A third of all marriages in the state are interracial.

This results in a merry mixture of offspring and attitudes. Not long ago at a Honolulu high school, I heard a girl with distinctly Chinese features say to a schoolmate, "Guess what. I'm Jewish. I just found out."

"How do you know?"

"My mother told me."

"How Jewish are you?"

"I don't know. I forgot to ask."

I asked and discovered the girl had a Hawaiian-Chinese father and a mother who combined Chinese, Irish, and Jewish ancestry.

Chinese were imported to work in the sugar fields beginning in 1852. In all, more than 46,000 came, and some stayed to work their way off the plantations and into urban life. Japanese and Portuguese began arriving in large numbers in the 1880's to work in the fields. In this century about 125,000 Filipinos were brought in, along with Koreans, Spaniards,

and Puerto Ricans, to take their turn on the sugar and pineapple plantations.

So smooth a mixture was the resulting population that when the late Governor Samuel King was asked how Hawaii coped with the problem of minorities, he replied, "The secret of Hawaii's racial harmony is that we're all in the minority."

Hawaii's population at that time, the late 1950's, was roughly described as a third Caucasian, a third Japanese, and a third "everybody else," including Hawaiians, part-Hawaiians, Chinese, Koreans, Filipinos, and a smattering of others.

In Honolulu today, Caucasians and Japanese are about equal, each constituting 28 percent of the total. But the haoles, who are migrating in great numbers from the mainland, should become the largest segment within a few years. More come from California than from any other state.

"Why is Honolulu such an attractive new frontier?" I asked George Sowers, who moved here from St. Louis three years ago with his wife and daughter.

"The climate, for one thing," he said. "I'm 44, and the older you get, the less beautiful snow becomes—especially when you have to shovel it. Then there was racial tension back there, and all the violence. I couldn't see any end to it. One day I read an ad in the paper that said the Navy needed civil engineers in Honolulu, and I jumped at it. This is home now."

Comforts Balance High Costs

His wife Peggy added, "We love it here. Of course, we can't afford to buy a house—the prices are murder. So are rents. They say Honolulu living costs are 20 percent higher than on the mainland."

But there are compensations. "We don't need any heat and we don't buy winter clothing," Mrs. Sowers said. "We dress casually; George wears a suit about twice a year." She added emphatically, "And if it does cost more here, it's worth it."

According to one U. S. Bureau of Labor Statistics survey, Honolulu is the most expensive city in the United States. Middle-income families require $10,902 a year to make ends meet—almost a thousand dollars more than in runner-up New York City, and nearly three thousand more than in Austin, Texas, the least expensive city in the bureau's study.

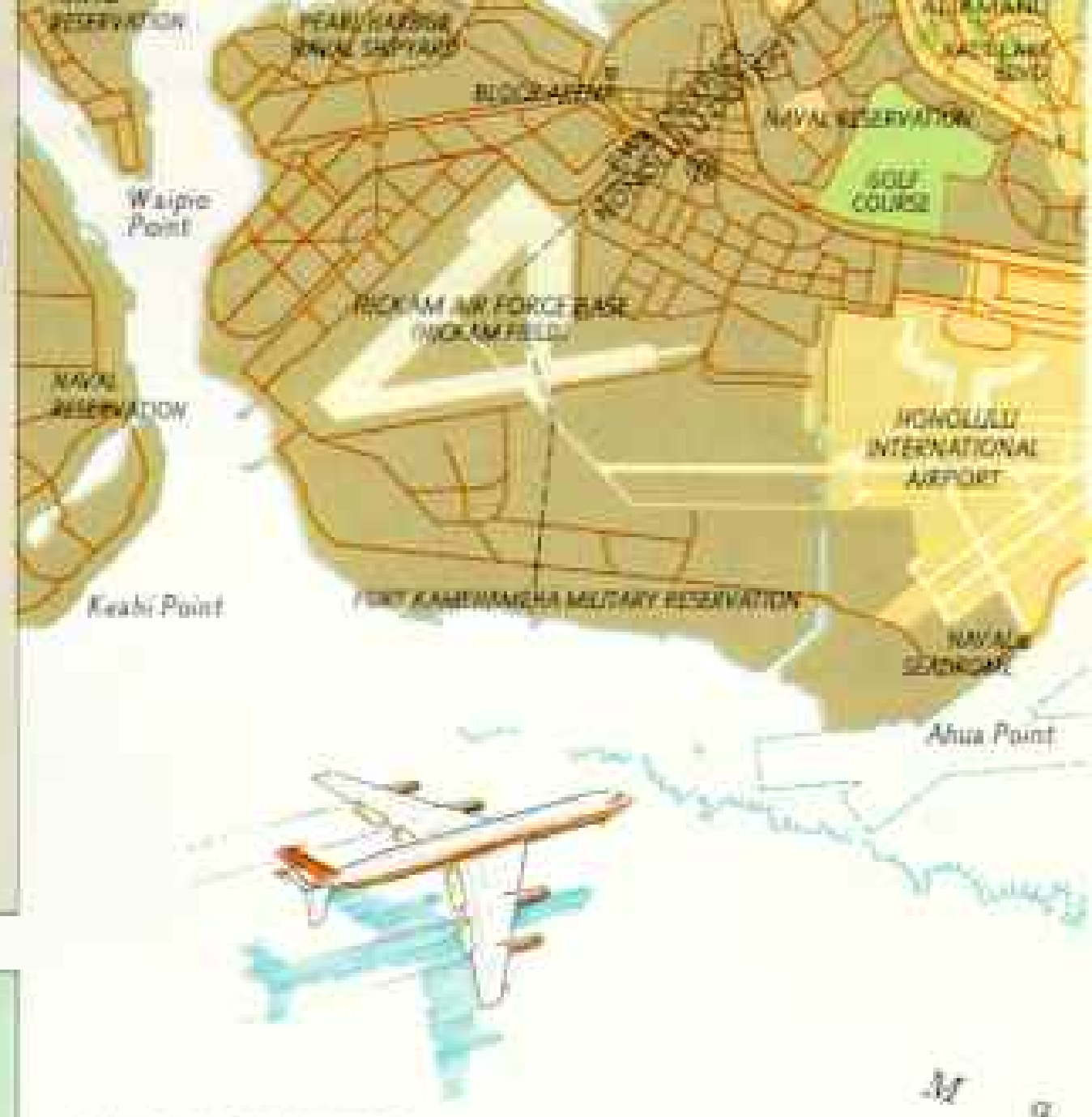
Practically everything islanders use, from peanut butter to color television sets, must be shipped 2,500 miles from the mainland, which explains part of the high cost of living. But a Honolulu newspaper recently did some comparison shopping and discovered pineapple juice, grown and canned in Hawaii, selling more cheaply in Maryland. Macadamia nuts

"You scrub my back, I'll scrub yours." Young cousins Adrien Miyake, left, and Japanese-Caucasian Winston Gample take turns soaking in the family *furo*. Their great-grandfather arrived before the turn of the century with the flood of Japanese who came to work the sugar fields.

Honolulu

THE "SHELTERED HAVEN" of the Hawaiians became a popular port of call for sailing ships in the 19th century and a strategic military outpost after the annexation of the islands by the United States in 1898. The Japanese attack on Pearl Harbor on December 7, 1941, plunged the U.S. into World War II. Now the capital of the 50th State, Honolulu is a boomtown of office towers, resort hotels, and sprawling suburbs. Its population grows 3 percent a year, including some 38,000 new residents from the mainland. Waikiki's sand and surf attract a growing tourist trade.

POPULATION: 650,000. By percentages: Caucasians, 28; Japanese, 28; Hawaiians and part-Hawaiians, 18; Filipinos, 7; Chinese, 6; others, 13. **ECONOMY:** United States Government installations make largest contribution, followed by tourism, sugar, pineapples. **CLIMATE:** Pleasant and equable; downtown recorded extremes, a low of 56° and a high of 88° F.



"**The gathering place,**" as Oahu means in English, saw its first arrivals more than 1,000 years ago when Polynesian seafarers sailed here in double canoes. In 1820 Yankee missionaries came to convert the Hawaiians to Christianity and to preserve the island language in writing. Some of the New Englanders' descendants stayed, helping to lay the cornerstone for today's prosperity with sugar and pineapple plantations.

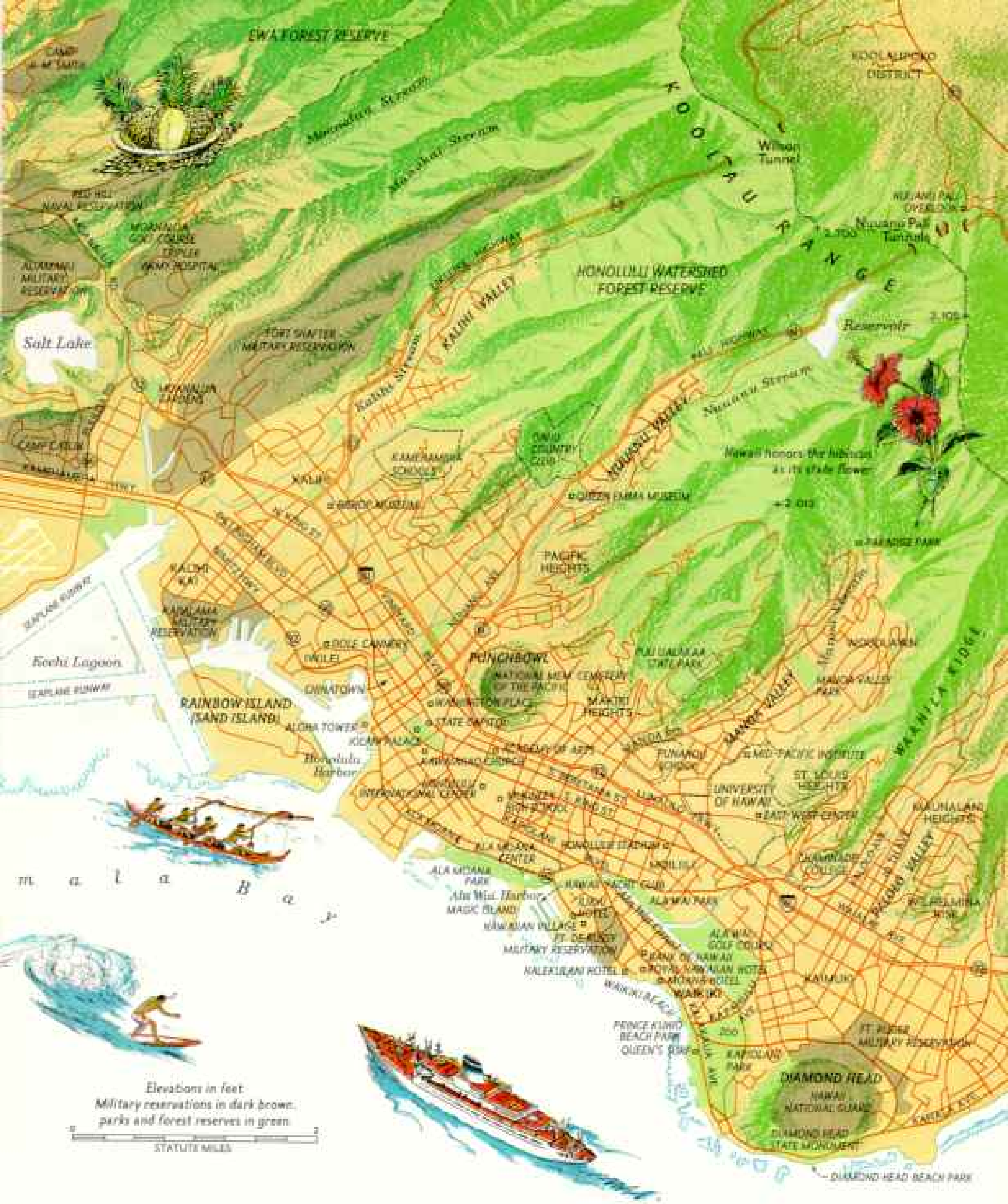
—a delicacy also grown and packed in Hawaii—were 93 cents in San Francisco and 94 cents for the same size jar in Honolulu.

The high cost of living notwithstanding, mainlanders continue to pour in. And the effect of the influx has been profound.

"We learn from these new people," former Mayor Neal S. Blaisdell, a native Honolulan who retired last fall after nearly 14 years in office, remarked to me. "Our kids pick up that haole get-up-and-go." Blaisdell himself is Hawaiian-Scotch-Irish; for a time he was a professional baseball pitcher on the mainland.

"Look at our kids today—lively, bright, talk your arm off," he added. "When I was a kid, you couldn't get a Hawaiian or an Oriental kid to open his mouth—including me."

I saw the difference myself when I returned recently to McKinley High School to keep a speaking engagement. I had spoken at the



same school 17 years before. On that occasion my audience, largely Oriental, was so shy and polite that I thought I had lulled them to sleep. After my last talk, on Viet Nam, I was nearly knocked down by students rushing to the platform to debate with me.

Their elders have changed, too, as I found when I poked through Chinatown in downtown Honolulu, one of the last of the old ethnic neighborhoods left, and itself greatly reduced in size by urban renewal. Dozens of blocks have been leveled to make room for middle-income housing.

In a noodle factory on the ground floor of a tipsy old wooden frame building, a dozen Chinese men in crisp white aprons and undershirts were patting up clouds of flour dust. At the same time they were vigorously debating —in English—the possible outcome of the weekend football game.

At the Sun Yee Hing meat market, amid dried octopus, Portuguese sausage, and raw fish for the Japanese dish called *sashimi*, I found the day's special: "Good lean stew beef."

A theater down the street was playing a Chinese-language picture entitled *Battle of Inchon*. A sidewalk poster proclaimed: "Filmed in Korea with a cast of Koreans, Chinese, and Marines."

A few blocks away stands a huge Buddhist temple, with a Japanese-language school attached, and a meeting room for the Young Buddhist Association, which arranges youth functions similar to those of the YMCA. And freshly relocated on a new street carved out of the lanes of old Chinatown is a Chinese-oriented Buddhist temple, where I found a busload of visiting school children.

"We've become a regular stop for sightseeing tours," a friendly temple member explained. "In fact, last Chinese New Year's a tourist couple noticed that our members left token offerings of food and drink. They insisted on leaving a case of Coke and a package of hot-dog buns."

The new patterns of life in Honolulu are well illustrated at McKinley High, once known as "Tokyo High" because so many Oriental families sent their children there, while many Caucasian children attended private schools.

"We don't keep records by race," principal Ed Toma told me, "but judging from the last names of students, our Oriental enrollment is down to about 55 percent. Two of our last five student-body presidents were haole kids. And our basketball team this year has four."

Among the many prominent graduates of McKinley are both of Hawaii's present United States Senators, Republican Hiram L. Fong and Democrat Daniel K. Inouye. No other American high school can make that claim.

Big Five Built Island Commerce

Although Honolulu has developed such a case of mainland-style urban sprawl that the view from many a lookout point is a sea of shingled roofs, its downtown also has grown—but upward. Some buildings rise twenty stories or more. Two of the tallest house the largest banks and the quarters of lawyers, construction companies, and insurance firms.

Downtown Honolulu is the home of the storied Big Five—Castle & Cooke, Alexander & Baldwin, Theo. H. Davies, Amfac, and C. Brewer—which for many years dominated economic, political, and social life in the islands. Merchandising launched most of the firms; later they branched into such fields as shipping, pineapple and sugar production, real estate, banking, and land development.

Hawaii's Montana-born Governor John Burns, who was brought to Honolulu as an infant, points out that although Big Five firms continue to grow, expanded shipping and communications facilities and the arrival of mainland firms since World War II have loosened their hold on the islands' commerce.

"The Outdoor Circle may have more power than the Big Five these days," Burns added with a grin. He was referring to the group of energetic ladies—my wife among them—who have succeeded in saving trees from bulldozers, eliminating highway billboards, and keeping other outdoor advertising down to a moderate size.

Dillingham Corporation Makes It Big Six

Other firms are growing; one already has revenues larger than four of the Big Five. This is the Dillingham Corporation, which has diversified enterprises ranging from British Columbia and California to Australia and Southeast Asia, including much U. S. defense building in the Pacific.

A spectacular Dillingham achievement in Honolulu is the Ala Moana shopping center, built between downtown and Waikiki on salt marshes that were filled with coral dredged from the Pacific. It was one of the first such complexes ever constructed and still ranks among the world's largest (pages 502-3). Signs on its escalators urge barefoot shoppers to please use the stairs.

At times I have trouble finding a place for my car among Ala Moana's 7,800 parking spaces. Its 155 stores sold $127,000,000 worth of goods in 1968, nearly double the business done downtown. The center's 300-foot office tower, topped by a revolving restaurant, is Honolulu's second tallest building. The tallest, also developed by Dillingham, is a 340-foot apartment building nearby.

Honolulu's boom has propelled some citizens of modest means to spectacular heights in finance and business. One is Chinn Ho, graduate of McKinley High School and grandson of a Chinese rice farmer (page 526).

Ho, 65, told me he began work as an office boy in a Big Five bank and later entered the brokerage business. From his savings he bought land in various parts of Oahu. "Then local people started asking me to invest the

funds of their little *huis*," he said. A hui is an informal syndicate; its pooled funds may be $100 or $100,000 and more.

"During World War II, when people moved back to the mainland, I bought up a lot of land," he continued. "I was able to purchase some in Waikiki for 75 cents a square foot." When some beachfront property there reached $70 a square foot, a Honolulu newspaper tried to photograph 70 silver dollars laid out on a foot-square plot. They wouldn't fit.

Ho also bought much of the Makaha Valley, 25 miles northwest of Honolulu, and is turning it into a delightful residential and resort community that retains much of the area's natural charm and beauty.

Chinese have thrived in other businesses, as well as real estate. As a group, they have the highest annual income in Hawaii. Many Japanese have moved into the professions. Filipinos, the most recent to arrive, still are mainly concentrated in pineapple and sugar work.

Among Hawaiians some have done extremely well, but others have failed to adapt to the mainland-oriented cultural and economic patterns. "Hawaiian Homesteads," enclaves where state land —seldom of the highest value—is leased for a very low price to persons with at least 50 percent Hawaiian blood, are dotted about the city and the state.

A traditional trade for Hawaiians, who frequently grow to great size, is stevedoring. For it was the harbor that made Honolulu—and still nurtures all life in the city.

These days most of the ships calling at the port are freighters bringing the goods Honolulu requires, from automobiles to canned soup, and carrying away such home-grown products as sugar and pineapple. Even Christmas trees are among the nearly 10 million tons of cargo that enter and leave the port annually. Oddly enough, Hawaii exports about 10,000 each year—Norfolk pines grown on island

Luau fit for the kings of old: A 170-pound pig lies trussed for roasting. Cooks fill the carcass with hot lava rocks, then lower it into an *imu*, or underground oven, also lined with rocks. Four hours later guests at Queen's Surf, a restaurant in Waikiki, dine on the steaming pork, butterfish wrapped in ti leaves, chicken with taro leaves, and poi. Henry Kamakawiwoole, left, and Wilfred Keale are Hawaiian, a term reserved for descendants of the islands' original inhabitants. Approximately 300,000 lived in Hawaii when Capt. James Cook arrived in 1778; today those of pure blood number less than 10,000.

tree farms. But most Honolulu residents still prefer firs imported from the mainland.

Not many years ago—before jet service was introduced—the harbor catered to much of the tourist trade. As many as five liners might be tied up in port at the same time. Brown-skinned boys dived for coins beside them. On the pier the Royal Hawaiian Band played "Aloha Oe"—fast and lively when a ship came in, slowly and sadly when it departed. Now, most visitors come by air, but the traditional dockside welcome still awaits an increasing number of cruise ships that stop at least briefly at Honolulu each month.

The 10-story Aloha Tower, at the end of the pier where many passenger ships dock, was once the city's tallest structure. Recently I rode the elevator to an observation room at the top, where crowds of tourists used to watch a man regulate harbor traffic, much like a controller in an airport tower. He and I were alone. I tried to imagine how the harbor looked in earlier days, when all who reached the islands had to come by ship.

A Polynesian village, a handful of huts on the plain known as Kou, existed on the waterfront even before the explorer James Cook discovered the Hawaiian Islands and named them the Sandwich Islands for the Earl of Sandwich. Captain Cook saw Oahu from a

Essence of Hawaii, distilled in song and dance, launches the 1969 session of the State's 76-member Legislature last February 19. Girls from each of the major islands dance traditional hulas. Families join representatives at flower-decked desks of koa, a native hardwood.

The festive ceremony occurred in the airy new capitol (right), where House and Senate met for the first time this year. The cone-shaped roof suggests Hawaii's volcanic origin. After landscaping is completed, a pool will encircle the $25,500,000 structure.

distance a year before he was slain by natives on the island of Hawaii in 1779. But the reef opening leading to Honolulu's safe anchorage was not discovered until 1794.

Word of that anchorage spread among mariners at the beginning of the 19th century and shaped Honolulu's destiny as a Pacific crossroads. Ships put in to trade, to buy Hawaii's fragrant sandalwood, and to find both provisions and pleasure among the uninhibited islanders. By the time the first missionaries arrived in 1820, the budding port was thriving.

Even the Russians, then owners of Alaska, tried to found a colony here. Russian ships arrived in 1815-16, and their crews built a blockhouse which has long since disappeared. They also constructed a now-crumbled fort on the island of Kauai. Encouraged by American traders, the Hawaiians expelled the Russians a year later.

At mid-century so many whaling vessels were sometimes moored in Honolulu Harbor that a man could walk their decks for half a mile without getting his feet wet. Rough-and-ready crewmen frequently clashed with the stern missionaries, who were determined to protect the islanders from abuse and sin.

Sugar Paved Way for American Rule

Honolulu gradually became the commercial capital of the islands and, in 1845, the political capital moved there from the island of Maui. In this period, Hawaii was ruled as a constitutional monarchy by the successors of Kamehameha I, who had made the islands one kingdom before his death in 1819.

The last of the Kamehamehas died in 1872 when American interests in Hawaii—especially in sugar—were growing, stirring sentiment for annexation to the United States.

Matters came to a head in 1893: Queen Liliuokalani was deposed and replaced by a republican government headed by Sanford B. Dole. Royalist attempts to restore the monarchy failed, and in 1895 the Queen was convicted of treason and briefly confined to Iolani Palace. She received a full pardon the following year. In 1898, at the behest of Dole's government and President William McKinley, Congress accepted annexation, and two years later Hawaii was constituted a territory of the United States.

Honolulu still preserves symbols of her past: One of the frame houses that were prefabricated for the missionaries in New England and shipped around the Horn in sections; Iolani Palace, which housed Hawaii's government until a new capitol was completed this year (page 511); and treasures of the Kamehamehas in the Bishop Museum.

"Hill of Sacrifice." Thus translates *Puowaina*, Hawaiian name for the Punchbowl, site of the National Memorial Cemetery of the Pacific. Some 21,000 graves lie sheltered within the crater of the extinct volcano. For Memorial Day, Boy Scouts decorate each marker with flower leis made by school children and flags contributed by the U. S. Army.

Of Hawaii's men in uniform during World War II, about half were of Japanese ancestry. Many of them, excluded in the early days of the war, flocked to serve their country when the opportunity came in 1943.

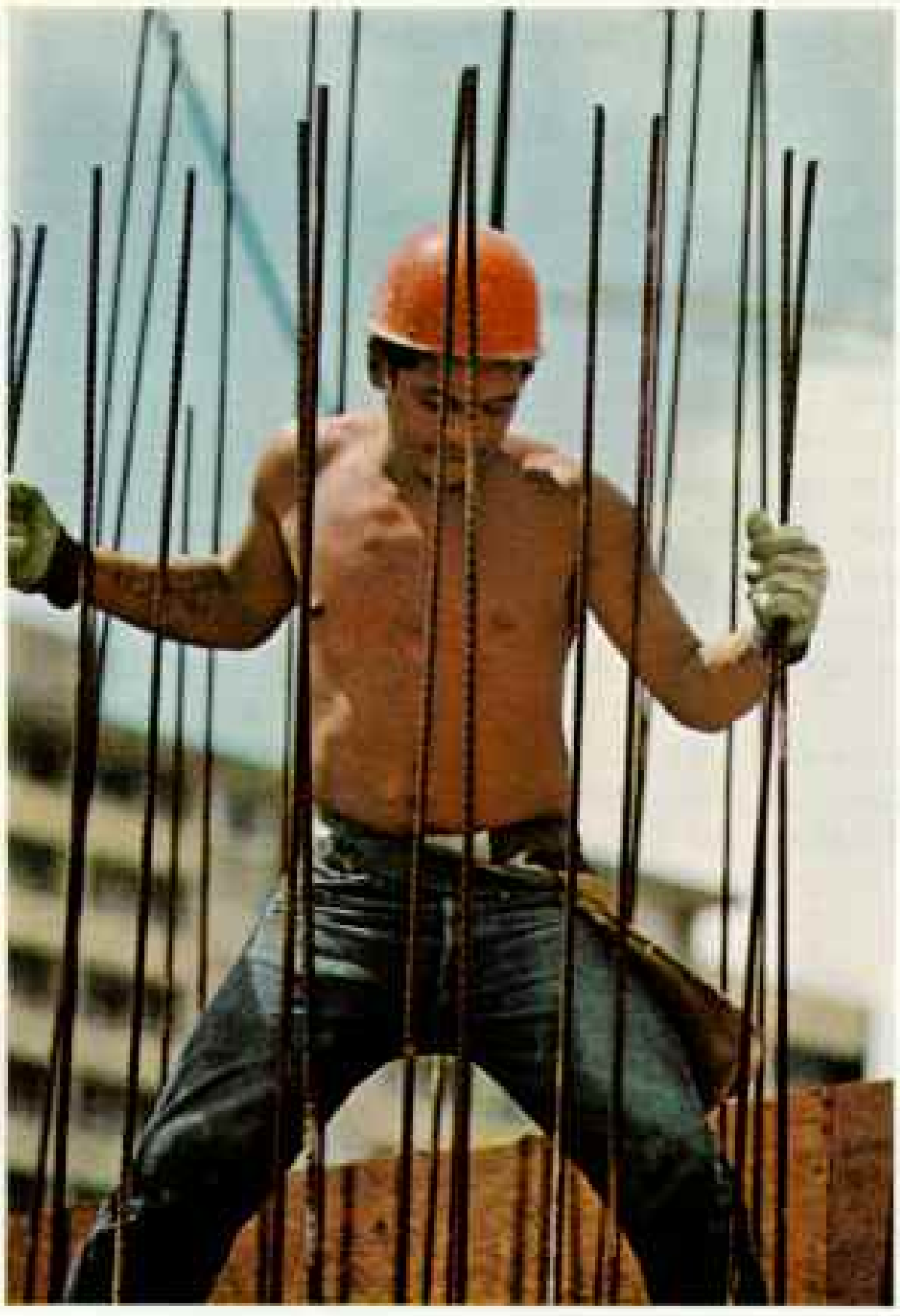
The museum has sponsored much research into the islands' past. Archeological excavations of early occupation sites have revealed that by A.D. 1000 all the major Hawaiian islands were inhabited by Polynesians; the first ones had probably come from the Marquesas Islands in eastern Polynesia about A.D. 750. Voyagers arriving from Tahiti around the 13th century strongly influenced the culture and introduced new kinds of plants and animals. This was the last big migration until modern times. The islands slipped into a period of isolation from which they did not emerge until Captain Cook's arrival.

Today's migration affects all of Honolulu but, from the tourist standpoint, focuses on the curving strip of glittering sand called Waikiki Beach (pages 518-19).

The strand is about a mile long, a third of it controlled by the Sheraton Corporation, which owns the famous Royal Hawaiian and Moana Hotels and operates five others. With Leonard L. Gorrell, Sheraton Hawaii president and general manager, I looked out upon the beach. Bronzing bodies crowded the sand; occupants have an average of 44 square feet at Waikiki, compared to 57 at Coney Island in August. The waves were dotted with surfers on their boards.

"To be honest, it isn't a big beach and never was," Mr. Gorrell said. "It's certainly inadequate to handle the demands that will be made upon it. But we have plans to cut down on erosion and enlarge the area."

The beach's limitations have not affected its popularity. In 1967 the number of tourists



Muscle counts as a worker aligns steel reinforcing rods, a common sight in a city bustling with construction activity. Yet housing remains in short supply and may cost twice as much as on the mainland. The high cost of living reflects the expense of shipping most goods from the West Coast, 2,500 miles away.

Golden cylinders of pineapple, peeled and cored by machines in the Dole Company cannery, slide past women who inspect and trim the fruit. Hawaiian fields, which produce 40 percent of the world's pineapples, earned $127,600,000 last year. Only sugar, with a $199,000,000 annual gross, outranked the fruit as an agricultural money-maker.

Bright colors and bold patterns capture the lighthearted spirit of a city that revels in flowers the year round. Experimenting with blossom shapes, David Rochlen designs fabrics to be printed in Japan; he then creates sportswear that sells under the name Surf Line Hawaii, Ltd. Last year, Honolulu's garment makers shared a $30,000,000 market.

HIYACHIRONO (ABOVE) AND KISACHIRONES © NATIONAL GEOGRAPHIC SOCIETY

attracted to Hawaii, most of them by Waikiki, increased by a phenomenal 40 percent, topping the million mark for the first time. In 1968 it went up another 20 percent. Figures for the first months of 1969 indicate that tourism will rise again by 20 percent this year. In 1968, Waikiki hotels enjoyed an occupancy rate of nearly 90 percent—the envy of the hotel world.

"We have a glamour name," Mr. Gorrell went on. "This is probably the best-known beach in the world."

Miami Beach might dispute that, but there is no disputing what tourism has done for the economy. The annual crop of visitors now earns Hawaii more money than its traditional sugar and pineapple harvests combined. "We figure that visitors spent $460,000,000 in 1968," Mr. Gorrell said, "about 80 percent of that in Honolulu, and mostly in Waikiki."

There is a royal precedent for holidaying on Waikiki. It was known as the "King's Grove" when Mark Twain visited it in 1866, gathering material for his *Letters from the Sandwich Islands*. Twain wrote: "The King's flag was flying from the roof of one of the cottages, and His Majesty was probably within. He owns the whole concern thereabouts, and passes his time there frequently, on sultry days 'laying off.'"

Hotels Creep Toward Diamond Head

No hotel intruded until 1901, when the wooden Moana was built. Considerably altered, it is still in business. It was joined in 1917 by the Halekulani and in 1927 by the Moorish-style Royal Hawaiian, favored by presidents, kings, and famous entertainers.

When I first came to Honolulu 20 years ago, the Royal was the most prominent landmark on the beach. Looking down from Diamond Head recently, I had difficulty locating it among the concrete towers erected in Honolulu's frantic hotel boom (page 528).

The tide of visitors has risen steadily since World War II. Spurred today by jet service and round-trip economy fares of about $200 from the West Coast, tourist traffic is expected to reach three million a year by 1975.

With real estate prices soaring in Waikiki, even the lower slopes of 761-foot-high Diamond Head were recently threatened with a clutch of hostelries up to ten stories high. A public outcry, marked by thousands of "Save Diamond Head" bumper stickers, resulted in a City Council vote last June to purchase the contested land for park purposes.

Meanwhile, three multistory hotels along Waikiki's main street are scheduled to open early next year. "I've seen a rendering of what Waikiki will look like when we are through," a local businessman told me. "A solid wall of concrete."

I asked Mr. Gorrell where it will all end.

"You hear about the point of diminishing returns, 'concrete jungles,' and all that," he answered. "But I think the people who worry about those things are working from a fallacious premise. Tourism is absolutely the best industry for any area that can attract it."

Men and Money Already a Problem

Nevertheless, there are concerns about the growth. Where will the money come from? Honolulu's Mayor Frank F. Fasi, originally from Connecticut, has proposed a tourist tax as one answer. Where will new workers come from? Honolulu's unemployment rate already stands below 3 percent.

One who raises these questions is Honolulu-born Lieutenant Governor Tom Gill, whose father, a New York architect, came to Hawaii as a tourist. When his ship stopped briefly at Honolulu in 1898, the senior Mr. Gill got off—and never got back on.

"We get estimates that we will need 20,000 or even 30,000 new hotel rooms by 1975," Lieutenant Governor Gill commented. "We get other estimates that we will need 30,000 or even 50,000 workers to man them. If we have to import labor, and if the imported worker has a family, this leads to an estimate of around two-thirds of a billion dollars needed for new housing, community facilities, roads, schools, and so on."

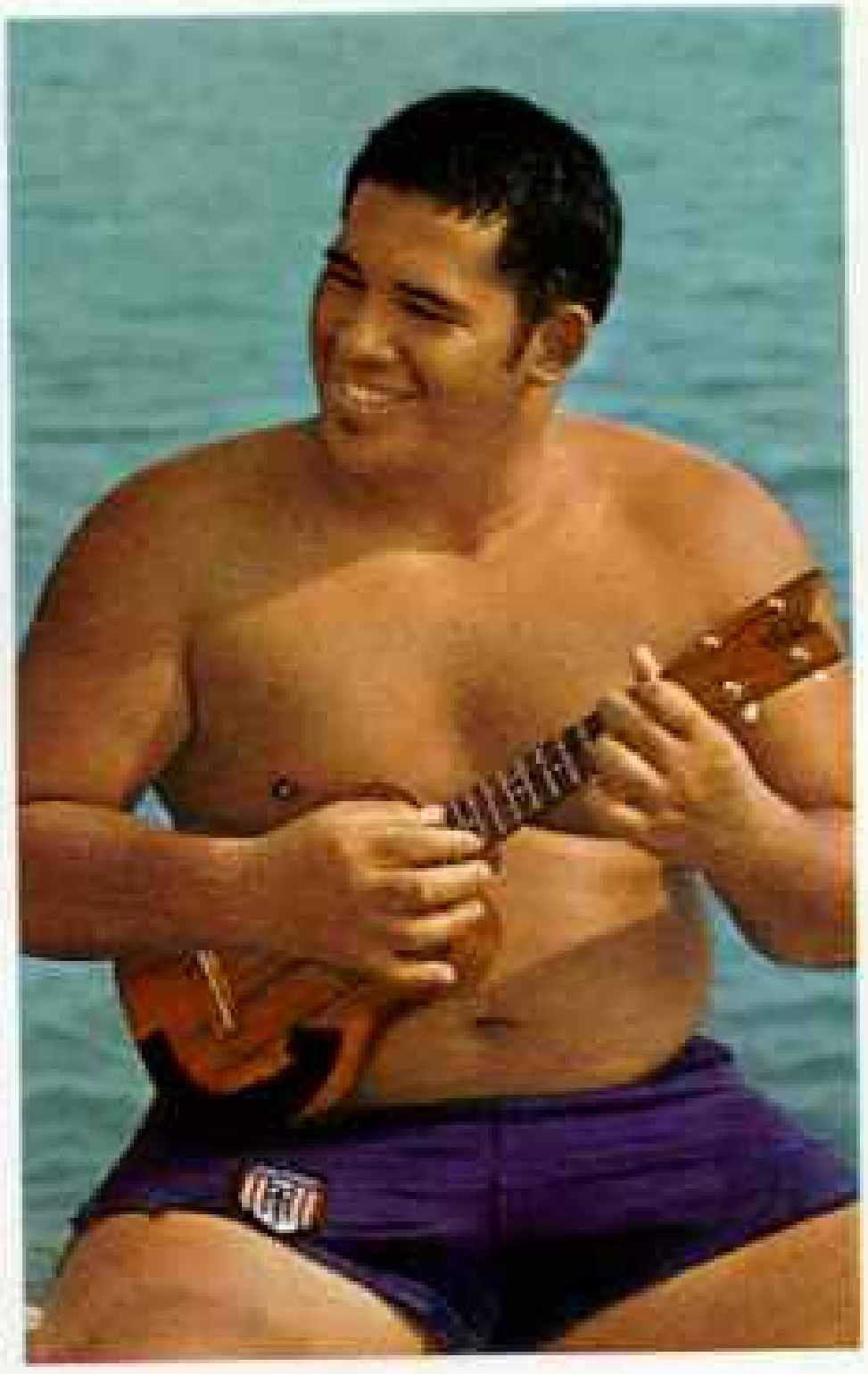
Mr. Gill walked to the windows and looked out over Iolani Palace, fronted by a double row of palms, and Kawaiahao Church, built of coral blocks by the missionaries in 1842. With its steeple and peaked roof, it would be in character on a greensward in a New England town. Beyond, the sea was a ribbon of blue.

"Happily, nature has put a boundary on our mistakes," Mr. Gill said. "Most of our hills are too steep to subdivide, and our ocean is too deep to fill. We're going to have to work out a way of life with what we have, and with the newcomers who are coming here to live. And with tourism, which can make us or ruin our way of life."

(Continued on page 522)

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY

"Memory imprisoned on a chain," poet Don Blanding called a flower lei. In Kapiolani Park, Rufina Lee strings a fragrant necklace of plumeria, or frangipani, fresh from her yard, on Lei Day, May 1. The poet suggested the holiday, first observed in 1928. These garlands of blossoms are the tokens of aloha, that warm Hawaiian word for love, friendship, best wishes, welcome, and farewell. At airport or ship dock *malihinis*, newcomers to the islands, often find themselves smothered in ginger, carnations, orchids, *pikake* (jasmine), gardenias, and plumeria.



Waikiki and young people go together! Ukulele-playing Honolulan Mark Borden takes time out from the Job Corps center at Koko Head, where he trains to operate heavy construction equipment. Sun-bronzed blonde (below) rolls up her beach mat at day's end.

Dowager Queen of Honolulu's hotels, the coral-pink Royal Hawaiian shared Waikiki Beach only with the Moana and Halekulani in the late 1920's. Now, as skyscrapers encroach, the Royal raises her own 16-story addition at right. Crumbling sea wall a quarter mile away from it appears close by in this telephoto view.

Hawaiian monarchs chose Waikiki for their feasts, swimming, and surfing. Last year more than 1,200,000 tourists came to Honolulu, many of them just to visit the famed beach.

At night people flock to restaurants and night clubs. Television and recording star Don Ho (right), whose songs range from old Hawaiian to contemporary, invites a member of the audience to share the spotlight at Duke Kahanamoku's, a night spot named for the late Olympic swimming champion.

EKTACHROME (BELOW) AND KODACHROMES BY BATES LITTLEHALES; KODACHROME (FOLLOWING PAGES) BY ROBERT B. GOODMAN © N.G.S.

On an awesome roller coaster, a surfer faces the ultimate challenge —the winter waves at Sunset Beach on the north shore of Oahu. After catching the swell at its crest, he dropped down the sheer face and here prepares to ride the curl. But he tumbled in the white water—a wipe out. Surf spawned by north Pacific storms gives the daring few a 30-to-60-second, 30-mile-an-hour thrill on the highest ridable waves in the world—as tall as 30 feet.

Where is he? There he is! We're together. After flying in from Colorado, Mrs. Thomas Bujakowski waits anxiously (left) at Fort De Russey for her husband, an Army captain due from South Viet Nam for a five-day rest-and-recuperation leave. Joy fills her face when she sees him. She flies into his arms, tossing a lei that just misses being a ringer. Their poignant reunion is but one among many; each month 10,000 battle-weary men arrive for "R and R" in Honolulu.

Even the University of Hawaii, at its campus between shoulders of the Koolau Range, has tourism on its mind. As befits a university a mile north of Waikiki with a view of the surf, it offers many courses related to hotel management and the travel industry.

Keeping pace with the growth of Honolulu, the university develops new programs and facilities there for some 22,000 students. Its East-West Center works toward the fusion of Asian and American cultures.

"Any building more than twenty years old is considered hallowed," remarked President Emeritus Gregg M. Sinclair, a Minnesotan who joined the faculty in 1928. That was 21 years after the university was established to teach agriculture and the mechanical arts.

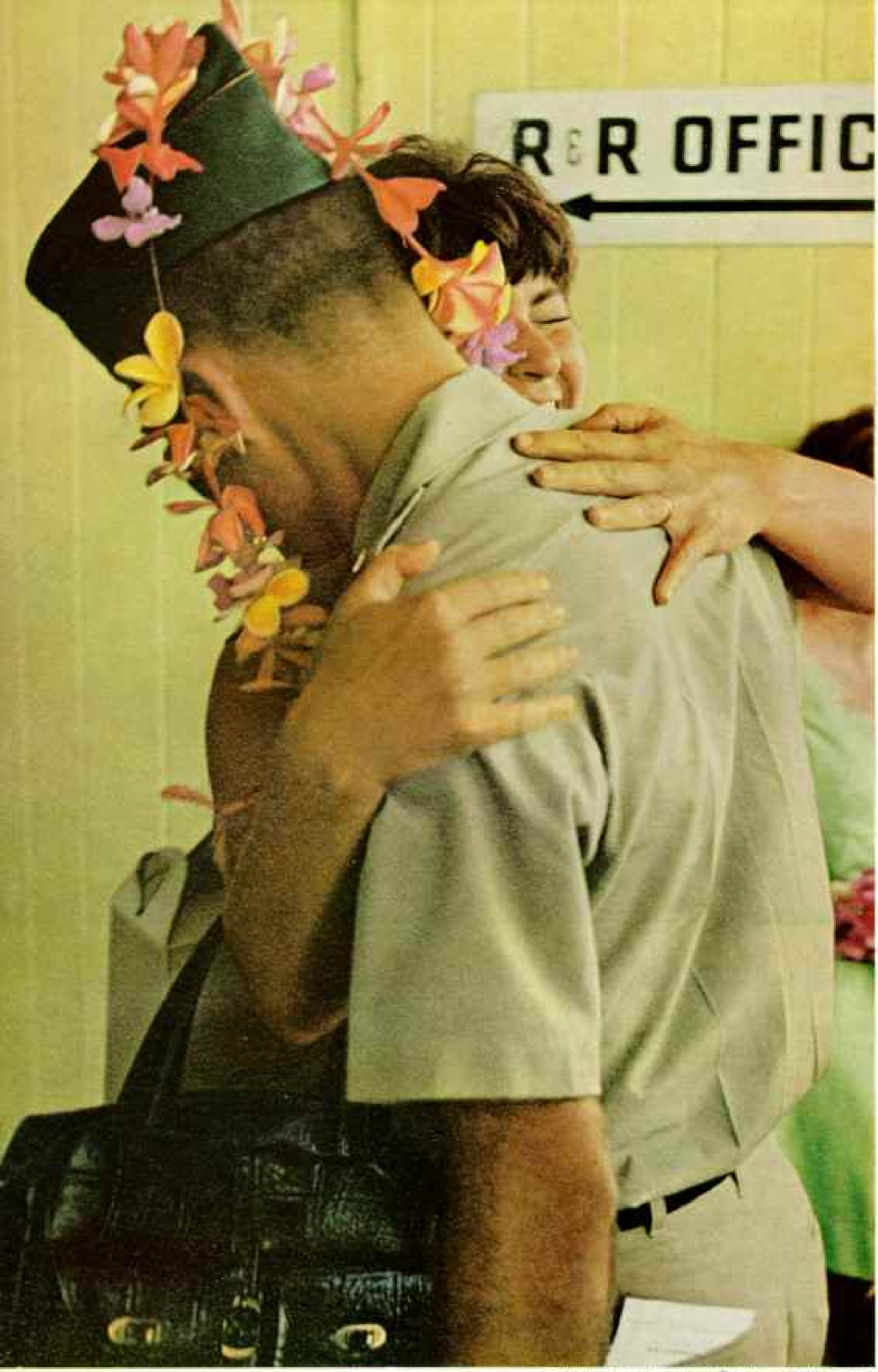
"There are more professors in the English department now than we had on the entire faculty when I came," he said. "The university is doing things we could only talk about in my first years." He cited courses in oceanography and art, and a thriving cultural curriculum, particularly outstanding in drama.

I sat in on a class in hotel management. The students were preparing a formal dinner with $4-a-pound beefsteak, champagne, and two dinner wines. As we disposed of the repast—worth an "A" on anyone's grading scale—I remarked that this seemed to be a splendid way to go to college.

"Not always," a student responded. "Yesterday we had to eat cherries jubilee at 8:30 in the morning."

So many students earn money during the summer at the huge Dole pineapple canning factory in the downtown section that it is said, "Half of Honolulu went to college at the cannery."

Dole, owned by the biggest of the Big Five, Castle & Cooke, employs 1,100 women on each shift at the peak of the canning season (pages 514–15). It is the city's largest single employer, counting temporary help.



EXTRACHROMES BY KATES LITTLEHALES © NATIONAL GEOGRAPHIC SOCIETY

At the Dole plant, fruit picked in the morning may be canned by nightfall. Pines, as they are called, are trucked from the fields to make their way through a series of sorting, chopping, slicing, and juice-making machines. After slices are finally packed into cans by hand, only a few wisps of fuzz remain unused. Even the rind has value; it goes into cattle feed.

On the packing line I met Katherine Nagafuchi, one of Honolulu's many working wives. "I put two daughters through business college with the money I made here," she told me. "Most of the wives in my neighborhood work to make ends meet. The schools make special arrangements to keep our kids until we can pick them up at four or five o'clock."

Agriculture workers in Hawaii are the highest paid in the world, and strongly organized. Field hands on sugar plantations earn at least $2.19 an hour, but mechanization of field and factory operations has been intense.

"We use only about a sixth as many men as we did thirty years ago," Soichi Yonemori told me at the Kahuku sugar plantation on the northern tip of Oahu. No hand-cutting of cane takes place in the fields. When the cane is ripe, the sea-green fields are burned, filling the air with billowing black smoke and the smell of braised sugar. The fire removes the leaves, leaving the stalks, protected by their high sap content. Then bulldozers scoop the stalks into piles to be trucked to the mills.*

Many workers displaced by mechanization

*The pineapple and sugar industries were described by Frederick Simpich, Jr., in "Because It Rains on Hawaii," NATIONAL GEOGRAPHIC, November 1949.

have moved into hotel and construction work, where they are more than welcome.

The largest enterprise in Honolulu continues to be the Federal Government, with enormous military and naval bases, 50,000 servicemen, and an equal number of dependents. The Government fueled Hawaii's economy to the extent of nearly $900,000,000 last year, most of it spent on Oahu.

Air Attack Took Tragic Toll

With Pearl Harbor and Hickam Field on her western flank, and Schofield Barracks 18 miles northwest, Honolulu was a strategic bastion well before the morning of December 7, 1941, when Japanese bombers found eight battleships, the backbone of the Pacific Fleet, in Pearl Harbor (map, page 506). Like sitting ducks, seven were berthed in a row.

Five of them were sunk or beached. Thirteen other ships sank or were damaged; 188 planes were destroyed. Among some 2,400 persons killed were at least 57 civilians who perished when the attack spilled into downtown Honolulu.

When the battleship *Arizona* settled into the mud, she took more than a thousand men with her. On the memorial built over her protruding superstructure, Mr. Robert W. Hart lectures to an average of 850 visitors a day.

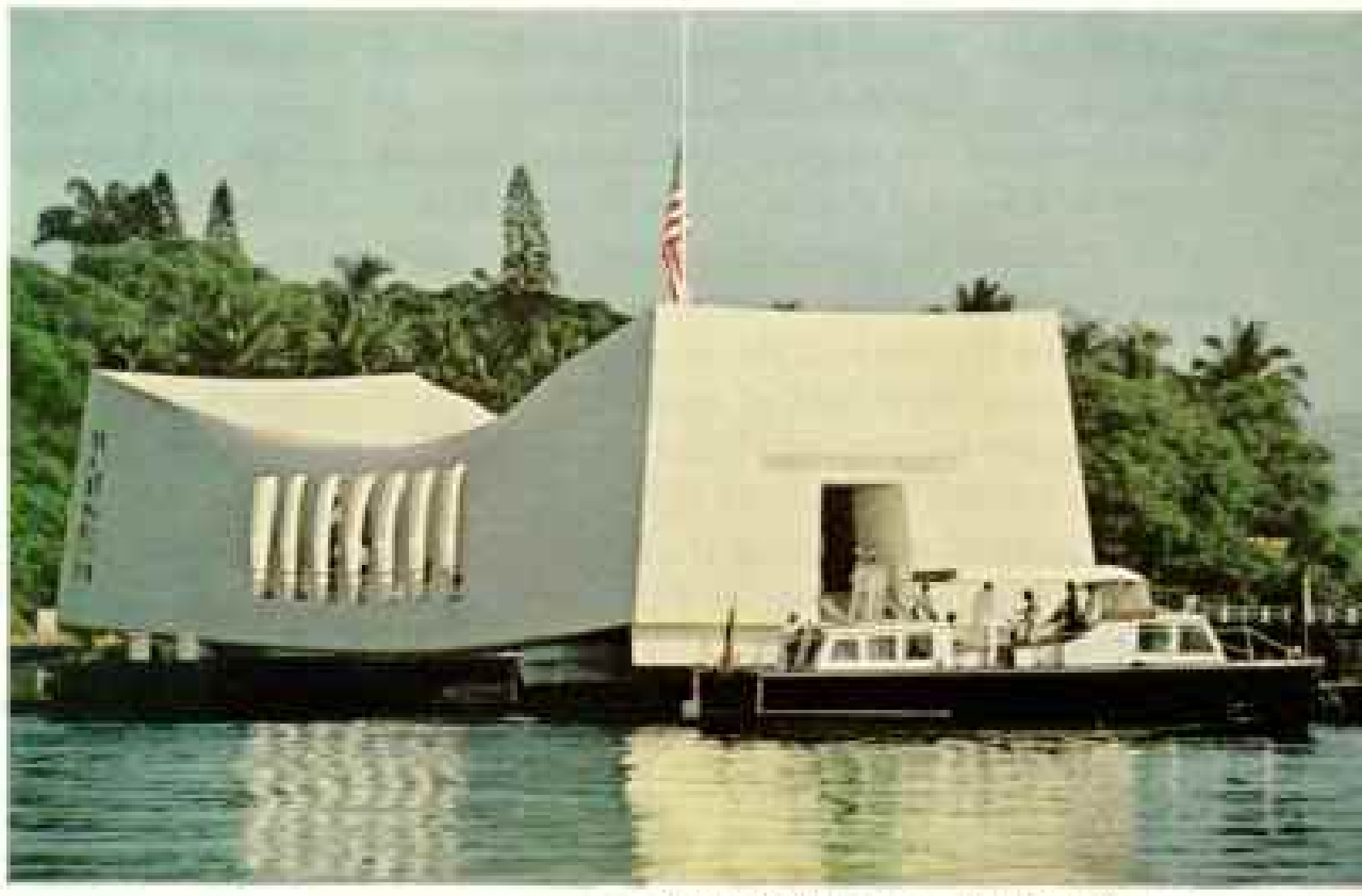
Many tourists ask if the Japanese had exact knowledge of American ship dispositions.

"No," replies Mr. Hart. "In fact, they thought at least one of the American carriers, which were at sea, would be in the harbor."

Did spies ashore help guide the planes? "No. From the air, Pearl Harbor is the most visible landmark on the island, and hard to miss."

"**A terrific explosion** on the forecastle, apparently from the bomb penetrating the magazine. . . . the ship blew up and caught fire. . . . she was a mass of flames . . . . the bodies of the dead were thick." Thus survivors from the U.S.S. *Arizona* (above) remember the Japanese air attack of December 7, 1941. For more than a thousand crewmen, the wreckage became a tomb.

Today a simple shrine supported on pilings above the *Arizona*'s shattered hull (right) honors all who died at Pearl Harbor. Naval officers pay their respects last Memorial Day.



U. S. NAVY; KODACHROME BY GATES LITTLEMALES © N.G.S.

Island success story: Grandson of a Chinese immigrant farmer, Chinn Ho plays an influential role in Hawaii's business life. His investment company built the Ilikai, one of the world's largest hotel-condominiums (page 500), and a new resort community at Makaha. Here, in the Ilikai's penthouse, he wears a brightly patterned shirt on Aloha Friday, the weekday when everyone is encouraged to dress in island style.

Many Chinese came as plantation laborers. Saving their money, they became landowners and merchants. Today, Chinese comprise only 6 percent of the population.

Fast-paced change overtakes Kalakaua Avenue in Waikiki. A revolving restaurant tops the 21-story Waikiki Business Plaza. The pineapple inspired the shape of windows on the Bank of Hawaii, distant left. The frantic pace of Honolulu's building boom has caught up with the Liberty House department store, right. Photographed only a few months ago, it has already been partially torn down; soon it will occupy the first floor of a new skyscraper hotel to be built on the site.

KODACHROME © N.G.S.

Why hasn't the *Arizona* been raised? "We sent divers down in 1947 to see about bringing her up, but their cutting torches touched off gases inside the hull. Two divers were killed in the explosion. It was decided to leave her on the bottom."

Pearl Harbor is still a bustling naval base, with a busy off-duty program of entertainment and sports for the men, centered around Bloch Arena, which by a quirk of fate was dedicated on December 6, 1941, with a "battle of bands." The winner was the band from the *Arizona*.

Sports and entertainment in Honolulu today demonstrate an easy mixture of Eastern and Western cultural currents. At Honolulu Stadium during the baseball season, many spectators eat hot dogs. But others eat *saimin*, a sort of Oriental chicken-noodle concoction, with chopsticks. Saimin, served in a cardboard bowl, sells for 35 cents at the stadium. It contains Japanese-style noodles in a clump, plus Chinese-style bits of meat.

"We must be the only baseball team in the country buying chopsticks by the box," Jack Quinn, general manager of the Hawaii Islanders, told me. Honolulu, he says, is the most sports-minded city he has ever been in.

"We led the Pacific Coast League in attendance in 1968," he said, "and in 1963 we led all of the U. S. minor leagues. If we ever win the pennant, we might attract more people than some of the major-league teams."

The Hula Bowl, Honolulu's contribution to midwinter football, is always a sellout, and even local high-school games may attract a capacity 25,000 fans.

An 11-million-dollar theater-convention hall complex, the Honolulu International Center, provides an elegant home for other entertainment, ranging from ballet to basketball. Honolulu is proud of its symphony orchestra, which has a budget of $600,000. In addition to subscription and youth concerts, it offers a winter opera season of six performances.

Such achievements prompted former Mayor Neal Blaisdell to declare, "This city is exciting. We jumped from a sleepy little place out in the Pacific practically into the 21st century. We're good, and we're going to get better."

Honolulans long felt they had an uphill struggle to convince fellow Americans that they speak English, pay taxes, send their children to school, and have rush-hour traffic. Almost everyone has a story about the misconceptions other Americans have about the islands. Mine concerns a New York producer who gave permission to the lively Honolulu Community Theater to present his play while it was still on Broadway—and was incensed to learn it was being performed in English.

Now some *kamaainas*—long-term residents—fear that, with the rapid development of Honolulu and the flood of new residents and

Jewel of Honolulu, Diamond Head thrusts its rugged slopes above the city. State owned, the extinct volcano holds National Guard and Federal Aviation Administration facilities in its crater; beyond, to the northwest, stretch Waikiki and Honolulu Harbor. Across the Ala Wai Canal the

city skirts a golf course and reaches into the rain-washed Koolau Range. Cries of "Save Diamond Head" resounded when high-rise buildings threatened to creep up its lower slopes. Last June the City Council voted to purchase residential property at far left for eventual use as parkland.

tourists, the celebrated "aloha" spirit of the islands has been over-commercialized, if not buried. "Aloha" is the word Hawaiians use to say hello and goodbye, and to express an assortment of emotions. It symbolizes the hospitality and graceful style of life for which the islands have long been known.

As the pace of life has increased, and with many more people to be hospitable to, there have been distortions of the old ways. Some leis hung round the necks of new arrivals lack the fragrance of the tropics, for they are made of plastic. It costs more to say aloha with flowers now.* At a recent luau I attended, the traditional poi—the starchy dish made from taro root—was served in paper cups.

One of the persons concerned about such changes is ex-Mayor Blaisdell, who is 66, healthy, sports-minded, music-loving, open-armed, and in many ways epitomizes the city he governed so long. It pains him to hear what passes now for island music, he told me.

Still, Mr. Blaisdell is confident the aloha spirit will survive. "People make the aloha spirit," he said, "and I don't think they'll lose it. The Chinese always conquered their conquerors. We do the same thing here."

I think I agree with him.

Sometimes it takes a newcomer to remind us kamaainas how exceedingly beautiful Honolulu's setting is. A tourist did me this favor as we both looked down on the city from the 500-foot-high volcanic cone of the Punchbowl (pages 512-13).

The man handed me his camera and asked me to take not one but two pictures of him-

*See "The Flowers That Say 'Aloha,'" by Deena Clark, NATIONAL GEOGRAPHIC, January 1967.

self and his wife: one with the ocean as a backdrop, another against the mountains. "I just can't believe the colors," he said.

He was right. I looked beyond the city to the ocean, shading from pastel green along the shore to the deepest blue, with feathers of white where the surf plunged over the reef. Behind us stretched the Koolau Range, tinted purple and a dozen shades of green, colors Gauguin used in his paintings of Tahiti. As many times as I had seen the view, I was enchanted all over again.

So far, pile drivers and cement mixers have spared this view, but they have practically eliminated the little grass hut which Americans long associated with Hawaii. I know of one, however—on the northeast side of Oahu. It is the boyhood home of Kekoa David Kaapu, Honolulu's urban renewal coordinator.

His full name, by the way, is Kekoalauliionapalihauliuliokekoolau David Kaapuawaokamehameha. His first name refers to a tree that grows on the steep cliffs of the mountains behind Honolulu, and his last name means "cup bearer to King Kamehameha." City Hall colleagues call him Dave.

"I slept in this house until I went away to college in 1954," Mr. Kaapu said as we entered the waist-high opening in the thatch. He explained that his father, who is descended from Hawaiian *alii*, or chiefs, wished to rear his children as nearly as possible in the life style of his ancestors.

"He thought it was a good way. We didn't wear many clothes around the place. My sister and I climbed the trees for coconuts and fished in the ponds, and played in the mud of the taro patches."

But even in Mr. Kaapu's boyhood, that was an unusual way for Honolulans to live, and the neighbors were upset.

"They formed a delegation and called on my father," he told me. "They said they were sure my sister and I would come to no good end. Years later, when my sister had become a college teacher and I had graduated from Harvard, they came back to apologize."

Mr. Kaapu's parents have since moved into a gadget-filled house behind the grass one; it is easier to manage now that both are in their 70's. Mr. Kaapu's own two children are being reared in a suburban split-level home.

Such is the evolution of Honolulu.

Mr. Kaapu suggested a cool drink, and, taking up a long pole, knocked two coconuts from a tree. With a machete he chopped off one end of each and gouged a hole through the white meat. I raised one to my mouth and drank.

The pale liquid tasted fresh, untamed, and invigorating.

"It's only like that when it's right off the tree," Mr. Kaapu said. "That's one thing they can never change in Honolulu." THE END

Synchronized stars, two false killer whales *(Pseudorca crassidens)* leap a rope in opposite directions in Whaler's Cove at Sea Life Park; hand signals from their trainers sent them flying. Visitors to the 20-acre preserve can also peer through glass at a cross section of coral reef inhabited by some 2,000 marine creatures, and watch porpoises cavort in the 850-seat Ocean Science Theatre. Such shows, attracting half a million spectators annually, help finance sea-life studies by the affiliated Oceanic Institute.

ADVENTURES WITH SOUTH AFRICA'S

BLACK EAGLES

By JEANNE COWDEN

Photographs by the author and ARTHUR BOWLAND

"*LOOK OUT!*" At Arthur Bowland's warning, I instinctively ducked and waited for the familiar sound of wind whistling through feathers, the electrifying scream of an attacking eagle, and the blur of a black projectile hurtling past my head.

Month after month we had clambered over this cliffside, high on an 8,000-foot spur of South Africa's Drakensberg Range, to observe a family of three black eagles. And time after time, the mother eagle had attacked, as if trying to knock me over the precipice. Once, diving steeply from the sky, she raked the back of my sweater with her outstretched talons, ripping it from waist to neck. Fortunately she barely grazed my skin (following pages).

Nevertheless, I had always returned to watch—first with fascination, then with tender affection—the eaglet in her nest.

Now, from the ledge below, Arthur pointed to a wild confusion of wings and feathers plummeting toward us. Although I had approached the rocky shelf which held her eyrie, the mother eagle had momentarily put me out of her mind while a jackal buzzard challenged her for possession of a hyrax—a mammal the size of a rabbit.

Locked in savage conflict, these two giants—an eagle with a seven-foot wingspan, a buzzard with a five-foot span—tumbled toward the plateau 200 feet below. As they hurtled past, I saw talon

Attack!

Dive-bombed by a screaming eagle at the very edge of a cliff face, author Cowden ducks to avoid the bird's sharp talons (left). The scene was often repeated during the five months she and photographer Bowland studied a family of African black eagles (Aquila verreauxi) high in South Africa's Drakensberg Range. Calculating the angle of a bird's assault, she usually was able to roll out of harm's way (right). Despite attacks, Miss Cowden developed a strong affection for the parents and their single chick. She named him Temujin, boyhood name of Genghis Khan – the "Rider of Heaven."

REDACHROMES BY ARTHUR BOWLAND © N.G.S.

claw at punishing talon and heard angry hisses from beaks that lashed and tore. At the last moment, they disengaged and soared up to the clouds again.

I looked at the nest. "He's gone!" I yelled to Arthur. Apparently frightened by the battle, the eaglet had attempted flight.

Then I saw him. Against the rock face, the young bird's speckled body floundered and bumped, his wings flapping inexpertly as he fought for balance. It was useless. The wind, always strong on this mountain, blew his flailing body into a crevice far away.

I knew I had to find the eaglet. Only three months old, he would be easy prey for buzzards before dark, or jackals or wildcats afterward. "I'm going after him," I shouted.

"No!" Arthur protested. He pointed to menacing saffron clouds in the afternoon sky. "There's snow coming up. And if that's not enough, the old girl will tear you to bits."

It would have been as easy to abandon a member of my family. On my many weekend trips to the mountain from my home in Durban, I had watched him evolve from tiny chick to proud young eagle—and my affection for him grew with each visit.

It had been 4½ months earlier, at the end of May, that Arthur and I saw two eggs in the nest. In July, at winter's height, we observed the puny scrap of life which hatched from one. A grotesque, ungainly head wobbled on a spindly neck. I named him then: Temujin, the boyhood name of Genghis Khan, who was known as the "Rider of Heaven." It seemed appropriate for a young black eagle.

I watched him lose his down and acquire feathers. He amused me as he preened them with his beak, then sat back like a small boy smugly hoping his mother would look behind his clean ears.

He learned to recognize my whistle when I came close—as I did many times while the adult eagles were away. And he grew fat on the rabbits and guinea fowl we brought.

Majestic Birds Match Mountain Realm

This encounter actually had begun long before Temujin hatched. Newspaper photographer Arthur Bowland had set out to photograph the black eagles (also called Verreaux's eagles) that wheel over Natal Province and the Drakensberg at the border of South Africa and Lesotho (map, page 538).* I went along because I am happiest in the mountains, and when I am watching birds.

As we approached the mountain on our first trip, the barely discernible track probed a mist-shrouded grove. Then the trees were gone, and with them the track. We continued on foot, climbing past immense boulders. Our packs were heavy. The cold air cut our lungs. Eventually we reached a plateau flooded with the golden grass of winter. Its shadowy places harbored pockets of snow. Above us soared the massive slab of rock which bore the eyrie.

The morning sun showed a fit place for black eagles. Glinting on their snowy mantles, the light raced from mountain to mountain in vast sweeping strokes. In these remote peaks, which rise above 11,000 feet, the eagles reflect the characteristics of their surroundings. Aloof and relentless, they live by hunting and killing, by mastery of the sky, by strength and expert vision, and by their wits.

As we battled up a steep, snow-filled gully toward the top of the mountain, a gigantic shadow swept over us, filling the air with raucous screeching. From that day, the gully was our point of contact

*For other accounts of eagles, see "Sharing the Lives of Wild Golden Eagles," by John Craighead, NATIONAL GEOGRAPHIC, September 1967, and "Eye to Eye With Eagles," by Frederick Kent Truslow, January 1961.

A hit!

With terrifying speed, the female (opposite) swoops toward the author. "I was knocked sprawling," she recalls, "and felt my sweater torn from waist to shoulder as claws raked my back" (below). Fortunately the scratches were light.

The female is bigger and more aggressive than her mate, though coloration is identical. Her average wingspan slightly surpasses that of the American bald eagle and rivals that of the golden eagle. Bold hunters, black eagles live by their mastery of the sky. Natural enemies are few, but fire and drought may diminish favorite prey, the rabbit-size hyrax. Sheep farmers sometimes shoot the birds, believing they kill lambs, and herdsmen capture the chicks for food.

KODACHROMES BY JEANNE CEMBER AND ARTHUR BOWLAND (BELOW). © N.G.S.

TWIN EGGS lie in the three-foot-high nest of sticks and green branches, perched 200 feet up on a sheer rock face (page 540).

ONE CHICK HATCHES. Had there been two, the stronger would probably have killed its nest mate or starved it in the competition for food.

FOUR WEEKS: Beak hooks noticeably. Talons lengthen but remain weak.

FIVE WEEKS: Eyes become hooded; Temujin flexes his talons as a boy might try his muscles.

Eaglet's album

Family life for a pair of eagles begins with courtship—a spectacular aerial display of swooping dives. During the six to seven weeks of incubation, the male spells his mate at the nest so she can find food for herself. For about six weeks after the eggs hatch, he takes over hunting duties for the entire family.

TWO WEEKS: Plump and alert, the chick Temujin feeds on shreds of meat mixed by his mother with bones and fur for roughage.

THREE WEEKS: Gentle mother uses her knife-sharp beak to feed her woolly offspring and nuzzle his scrawny neck.

SIX WEEKS: Beak, talons, and head grow more adultlike. Feathers push through fluff. Wobbling erect, he tries to stand on unsteady legs.

SEVEN WEEKS: Temujin wears an identification tag on his left leg—put there by the author to aid study of black eagle travels.

PHOTOGRAPHS BY JEANNE COWDEN (UPPER RIGHT, LEFT CENTER, AND BELOW) AND ARTHUR DOWLAND © N.G.S.

EIGHT WEEKS: The eaglet does his own butchering. Brownish plumage will darken over 4½ years, until he is as black as his parents.

TWELVE WEEKS: Though adult in appearance, Temujin keeps to the nest. He will not venture to fly until his fourth month.

with the eagles. The sky unfailingly showed two black specks as we began the final ascent. And as we climbed, always the female came in to attack.

"You two women had better sort things out," Arthur said. I was her usual target; Arthur discouraged her by shouting or waving a stick. I learned to guess the probable angle of her attack from the velocity and direction of the wind—and to duck, dodge, weave, and fling myself to the ground to avoid the big bird's talons (pages 532-3).

Black eagles are among the largest of all eagles, big enough to dispatch an antelope or a baboon by sweeping in behind an unsuspecting victim and knocking it from a ledge.

At first we offered food simply to entice the mother closer for photographs. But as our affection for the eagles grew, we brought up food so that, through the bitter winter, they would have at least one meal a week.

Initially, I put the carcass of a rabbit atop the escarpment and retreated. One day I stood only a few steps from the offered meal.

"No eagle will come so close," Arthur said.

The bird screamed and dived, but she would not approach the food. Then Arthur withdrew, and I saw her climbing high. "She's

DOMAIN of the African black eagle extends from South Africa into Egypt. Wild, broken highlands offer the space they must have to survive.

Lost

Eaglet's princely profile hides the terror of a premature fall from the nest while his mother fought with a jackal buzzard. Blown far from the nest, threatened by swooping buzzards, Temujin faced almost certain death.

"Three months of knowing him were not going to end here," said the author, who vowed to search until she found him.

coming in!" I shouted. The eagle hunched her wings and dropped. Suddenly I wondered: Was I her target, or was the rabbit? I would not know until the last instant.

The rabbit! She seized it and sped half a mile to the "butcher block," where the eagles always beheaded and gutted their food before taking it to the nest.

Although the mother eagle continued to accept food from me, she remained adamantly an eagle. If she lowered her defenses—and her pride—while taking the handout, it was done with superb arrogance.

I observed her closely many times. Missing primary feathers and a shoulder singed in a mountain fire testified to her part in guarding and feeding her family. I could not guess her age (the normal life span does not exceed 20 years), but she was obviously older than her sleek and well-groomed mate.

Eagles remain paired until one dies; he was almost certainly not her first mate. Like all male black eagles, he was somewhat smaller than the female.

While she brooded the two eggs in the nest, a three-foot-high pile of sticks and brush, he chased the vultures and other large birds that occasionally flew over the eyrie. He rarely

AUDACHROME BY JEANNE COWAN © N.G.S.

attacked us; perhaps that was woman's work.

In the nest, the second egg disappeared. Even if it had hatched, nature usually decrees that only one eaglet survive. The stronger chick kills the weaker or, getting most of the food, starves it to death.

Arthur and I set up a blind on a ledge near the nest (below). From there, when Temujin was only a few days old, we watched mesmerized as the mother eagle flew in with a hyrax and began to feed him shreds of meat.

In motherly fashion, she would also preen his neck feathers, and sometimes would tidy the nest, rearranging the branches and removing old bones and fur.

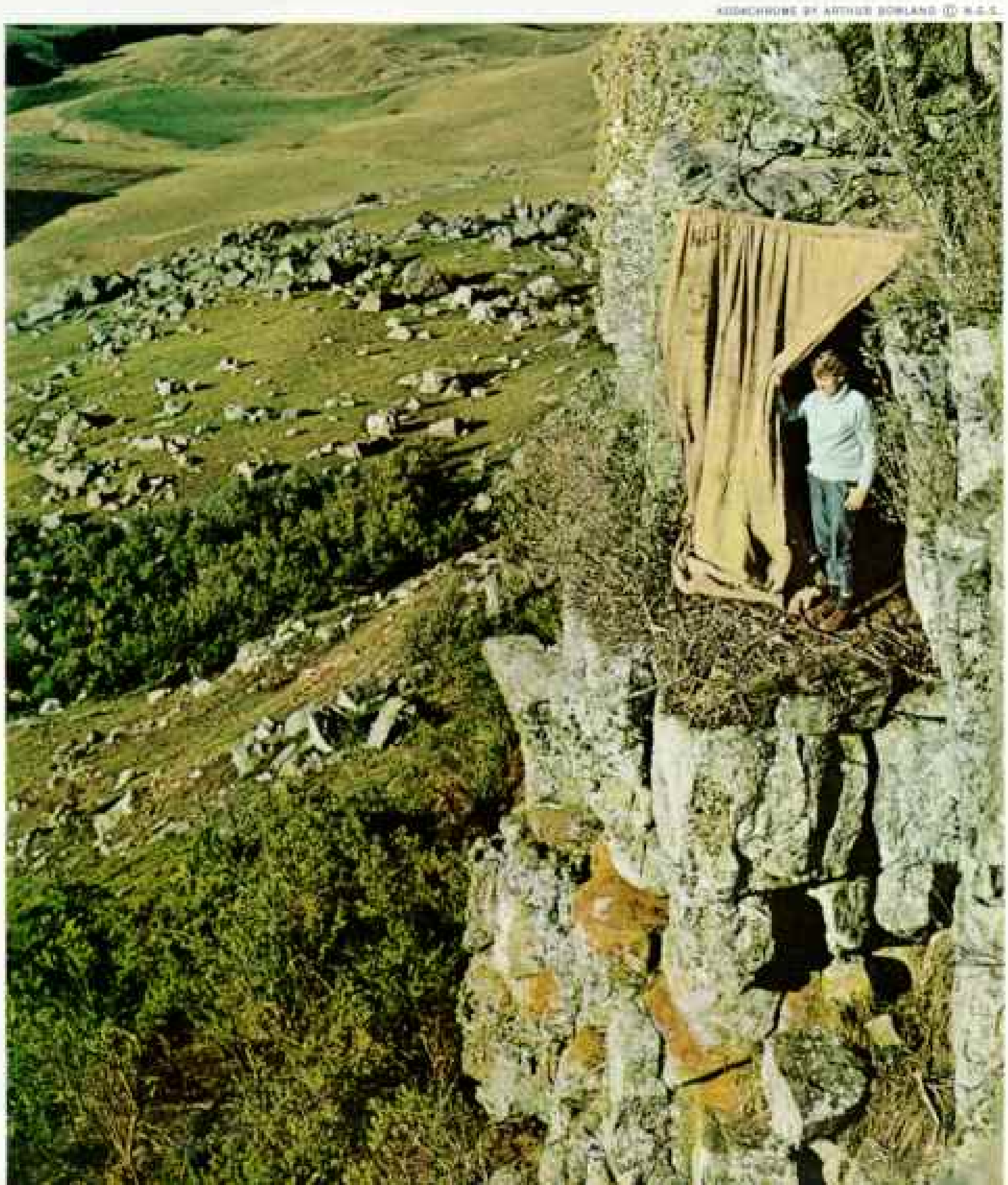
The eaglet grew. His eyes were now hooded; his beak developed a prominent hook. Becoming aware of his talons, he flexed them often.

Temujin was three months old when spring burst from the branches and pushed up through the naked earth. Small flowers carpeted the veld, and icicles melted on the rock face. He was fully feathered now, although it would be 4½ years before he acquired the distinctive black-and-white plumage of his parents.

He flapped his wings, voraciously gulped his food, and strutted in the nest. But he ignored the beguiling attempts of his mother to get him airborne. Intuitively he seemed to know, "Not yet."

Now, as I watched him being blown out of sight, precipitated into flight by the terror of the battle between his mother and the buzzard, I felt an overpowering responsibility for him. Hastily I pulled myself up the rope to the top of the escarpment; already the sun was low in the ominous sky.

The wind seemed to shake the mountain. Sometimes, as I struggled against it among



Found

In a raging wind the author fought her way over a mountainside to the downed Temujin. Again frightened by the buzzards, the eaglet leaped up and was blown away, "flung against rocks and tossed by savage gusts." Two miles from the nest she found him a second time. His legs tied (below), Temujin submitted quietly to being carried back to the nest.

After months of watching the eagle family from a blind of sacking (left) ten feet above the nest, the author felt that the eaglet grew accustomed to her presence. But the parents never accepted her; they attacked when she brought their youngster home, a trip that required her to climb to the top of the cliff and then drop by rope down to the nest—"a swaying nightmare."

PHOTOGRAPHED BY ARTHUR ROWLAND (ABOVE) AND JEANNE LONDON © N.G.S.

Two weeks later, called aloft by his parents, Temujin soars near the cliff on inexperienced wings (right). Later he gained the skill that makes the black eagle one of the most graceful of flyers.

the boulders and crevices, I thought I saw Temujin, but it was only a branch blown aloft.

I searched for an hour. Finally, as I clung to tufts of grass and looked over a rim, I saw a quick movement—the flick of a tawny eye. How small he looked against the towering mountainside! I edged down, whistling to him. His body heaved from the buffeting he had endured. Yet he watched me unafraid (pages 538-9).

But just as I reached to pick him up, a pair of buzzards appeared over the rim. Frightened again, he leaped into the air. Caught by the wind, once more he was hurled down the mountain, out of sight.

I tried to follow; so did the buzzards. Momentarily they turned on me, but then they sought out Temujin. Circling over him, they unwittingly guided me to his hiding place.

When I reached it, I lifted him firmly and tied his legs, ignoring the swooping buzzards. Arthur joined me. Hurrying against the approaching night, we started back to the nest—two miles distant—with our acquiescent cargo wrapped in my sweater.

Atop the escarpment we were greeted with the strident ingratitude of Temujin's parents. "Take it easy!" I shouted as they dived at me. "I've brought your baby."

Two weeks later I watched him fly. He rose and stretched, extended each perfect wing in turn, then stood quite still. His parents soared high across the sky, calling to him. He looked up; then, with breathtaking suddenness, he was airborne (page 541).

He was inexpert, but the rapture of movement and the wind in his wings seemed to intoxicate him. He rolled and spiraled in the updrafts, then plummeted in youthful abandon. The two fiercely protective parents flew beside him.

There was little reason for me to return to the eyrie now. For the three eagles, the nest receded in importance as they roamed farther afield.

But we did go back to take a rabbit. Where should I put it? I wondered as we watched the eagles, high above. Then I knew. I held the carcass aloft in my hand.

The mother eagle circled near, veered off, and circled near again, watching me. Then she climbed almost out of sight—and dived. Again I wondered, would she go for the rabbit? Or me? Her unerring talons snatched the offering as she winged past (above). Then, climbing, she gave a triumphant turn of her old head.

Men who have studied birds say an adult wild eagle's behavior is not likely to change from ferocity to friendship. Yet I like to think that parting look was a sign that a tenuous current of understanding had passed between us.

I watched them fly off, three eagles weaving their splendid poetry against the Drakensberg clouds—wild, remote, magnificent.

THE END

Dive!

"The female eagle would soar into the air," said Miss Cowden, "until she was hardly visible. Then she would fold her wings and hurtle toward earth until it seemed she must hit it. At the last moment the wings would unfold (opposite) and her momentum in the tight arc that followed would send her once again toward the heights."

AQUACARMES BY ARTHUR ROWLAND © N.G.S.

In dubious truce, the female swoops in to snatch a dead rabbit from the author (above), who admits it may have been more an act of expediency in a time of food scarcity than a sign of friendship. "She took the food with insolent triumph," Miss Cowden recalls, "remaining every inch an untamable bird of prey."

JOURNEY INTO THE

THE GREAT CURVES of the Seine beckoned me on through the hedgerowed fields of Normandy, veiled with apple blossoms, towered with stone churches, pastured with grazing cows and powerful Percheron horses. The soft fragrance of May greeted me as I drove inland from the French coast on my quest for the springtime of our civilization.

Then suddenly, as I rounded a bend, I spied Château Gaillard, Richard the Lionheart's castle! It was a wonder in its day. It still is.

"If its walls were made of solid iron," sneered France's King Philip, "yet would I take them."

"By the throat of God!" roared England's King Richard. "If its walls were made of butter, yet would I hold them."

I climbed those ramparts, stood where Richard had stood, and recalled his feats in France, and against the chivalrous Saladin in Palestine. In my youth my pulse had quickened to tales of Robin Hood, Ivanhoe, Roland, King Arthur's knights, Richard the Lionheart. The very names rang with chivalry.

AGE OF CHIVALRY

By Melville Bell Grosvenor, LL.D., Sc.D.
Editor-in-Chief and Chairman of the Board
National Geographic Society

Indeed, I never lost my enchantment with the Age of Chivalry. I have climbed castle ruins steeped in Arthurian legend at Tintagel, on the craggy coast of Cornwall; sought out Robin Hood's Sherwood Forest in Nottinghamshire; trudged the Pyrenees where Charlemagne's vassal Roland fell in epic battle.

I have explored castles on the Rhine, Crusader citadels in the Holy Land, and walked the walls of the French fortress town of Carcassonne (pages 548-9). And now, from the ramparts of Richard's castle, I gazed down the corridor of history that flowed

Bold warrior and valiant steed thunder down the lists in the Joust of the Saracen, a re-enactment of a medieval tournament staged twice a year in Arezzo, Italy. Courtly knights and their ladies, audacious kings, saintly monks, and sagacious merchants fill *The Age of Chivalry*, the National Geographic Society's new book on an era called "dark" that lent light to the future.

PAINTING IN THE LOUVRE, PHOTOGRAPH FROM GIRAUDON

New world of commerce spawned the moneylender, here portrayed in 1514 by Flemish artist Quentin Massys. As goods from the Orient flowed to Europe, merchants thrived, tradesmen built great guildhalls, and the middle class emerged.

Grotesque mask in Marksburg Castle, Germany, was used for torture. Jailers often heated such devices until they glowed before clamping them on traitors' faces.

Majestic Chartres Cathedral soars in silhouette as the sun sinks over the French countryside. Of the Middle Ages, French novelist Victor Hugo wrote: "... whoever was born a poet became an architect. ... mankind has thought of nothing important that it has not written in stone."

beneath its walls. Snub-nosed barges plying the peaceful Seine became Viking dragon ships bent on plunder. Settling on the land they ravaged, those Northmen gave their name to Normandy and became the Normans who conquered England.

I had threaded the streets of their capital, Rouen. From the cathedral enshrining Richard's heart, I had strolled under the venerable one-armed clock to the marketplace where Joan of Arc was burned at the stake.

I shuddered at her fate. But then I remembered the glory she had brought France, this farm girl clad in knight's armor, who won a coronation at Reims for Charles VII through her shining victory at Orléans.

I thought of Joan, and Richard, and Roland, and Lancelot and Guinevere, when I began to plan a book on the Age of Chivalry with Merle Severy and his brilliant Book Service team. Here was our opportunity to bring to life a resplendent pageant of valiant knights and fair ladies, tourneys, codes of chivalry, heroic quests undertaken for sacred vows.

Knights Were Heroes on Horseback

"Chivalry?" said Mr. Severy. "Basically it has to do with the horse. Oats as well as oaths."

Of course! "Chivalry" comes from *chevalerie*, derived from *cheval*, French for horse.

"Without his horse the knight was lost. Remember Richard III's cry in Shakespeare: 'My kingdom for a horse!' Those Percherons you saw were no accident," Mr. Severy continued. "Europe's horses had to be bred to a size and strength to carry all that armor.

"Before stirrups were introduced from the East, a cavalryman clung to his beast as best he could. They welded horse, warrior, and lance into a powerful weapon.

"So . . . no stirrups, no knight," I mused. "But a war horse and armor must have cost a pretty penny."

"Right. Worth about twenty oxen—the plow teams of ten or more peasant families. Add to that the cost of a remount and equipping a squire. The cavalryman, the knight, had to be an aristocrat."

"So you must develop a feudal system to support such knights," I offered. "A lord grants lands to his retainers in return for their military service. Mounted knight and manor go together. Which means we should explore the organization of the manor. . . ."

"And how food production was affected by the introduction of the horse collar, which magnified Europe's horsepower four or five times," chimed in John Putman, project editor. "The old hitch around his neck choked a horse every time he pulled hard at the plow."

Our Book Service crew was getting excited. Voice after voice added suggestions.

"But the feudal pyramid, built on the basis of one man—*an homme*—giving homage to another, couldn't stand without the concept of fealty. This stemmed from the bond between a warrior chief and his companions in the Germanic tribes that overran the Roman Empire in the fourth and fifth centuries."

Then came the Goths who sacked Rome, the Vandals whose wanton destruction created the word vandalism, and the Germanic deities who live on in our days—Tiw (Tuesday), Woden (Wednesday), Thunor (Thursday), and Frig (Friday).

"For all their valor the knights were a destructive lot. To keep baronial feuds from ripping Europe apart, the church urged hot-blooded nobles to give up fighting during Lent and on weekends. They consecrated

Viking's voyage to Valhalla sometimes included the burning of a longship as a funeral pyre. Scotland's Shetland Islanders, in memory of Norse forebears, fire a dragon-headed galley at the Up Helly Aa festival, celebrating the end of Yuletide in late January.

Vast double bulwark encircles Carcassonne, France, the ideal of a medieval city. Rome first fortified the height in the first century B.C. Visigoths built on the Roman ruins 500 years later; portions of their construction can still be seen in some of the citadel's fifty towers. The 12th and 13th

AERIAL PHOTOGRAPH ON KODACHROME BY JONATHAN S. BLAIR © N.G.S.

centuries saw the completion of the bastion. The city today reflects the meticulous efforts of French architect Eugène Emmanuel Viollet-le-Duc, who in the 19th century restored the crumbling battlements. "I do not know . . ." he wrote, "a subject of study so interesting, a more picturesque site."

these supercharged horsemen to nobler endeavors—fighting infidels."

The Crusades! We'd follow Crusaders to the Holy Land, and pilgrims trekking to shrines such as Santiago de Compostela in Spain. We'd trace the rise of Christianity from the catacombs of pagan Rome, see Constantine founding a new Rome in the East—Constantinople. We'd observe silent monks in somber cloisters at Citeaux and hear choirs in the cathedral at Chartres (page 546).

"Let's show the glorious stained glass," volunteered Charles Hyman, art director, "and explain visually how medieval artisans built Notre Dame in Paris."

"Without Mohammed, no Crusades," observed Anne Kobor, illustrations editor.

Surely we'd show the surging vigor of Islam and the many contributions its culture made to medieval civilization—arts and sciences, scholarship as well as spices.

"And Arabian steeds," Mr. Severy said.

Golden Age Leaves a Lasting Imprint

The resurgence of trade sparked the growth of towns, the rise of guilds, banking, the parleying that led to parliaments, and the learning that gave us the universities of Bologna, Paris, Oxford, Heidelberg. While today's campus turmoil dinned in our ears, we would savor the brawling life at infant universities, where many of the scholars pursued serious studies, but others attended mainly to tipple, riot, and wench.

We'd see shrewd merchants building gilded empires of trade. Wealth of the Hanseatic League that linked cities from London to Lübeck on the Baltic to Novgorod in Russia produced a sunset glow of chivalry at Bruges, a canal-laced Flemish city I find enchanting.

Jousts served to channel warlike passions into courtly display. Associated with them was the chivalric ideal of romantic love that put woman on a pedestal, worshiped from afar by knights who broke lances in her honor.

As armor grew heavier, the knight's role as warrior grew lighter. The noble *gendarme* (man-at-arms) had scorned as infants the peasants who fought on foot. When this infantry came of age and could hole the knight's breastplate with a musket ball, he paraded his gleaming armor more for prestige than protection. Our chevalier had become a courtier, sometimes cavalier in his treatment of lesser mortals, but ever chivalrous and courteous to the damsels he courted.

Professor Kenneth M. Setton of the Institute for Advanced Study in Princeton, New Jersey, joined us as principal author and consultant. Other scholars penned sprightly essays: Norman P. Zacour, University of Toronto; Urban T. Holmes, University of North Carolina; T. S. R. Boase, Oxford University; Paul Murray Kendall, Ohio University.

MUSÉE CONDÉ, CHANTILLY, GIRAUDON

National Geographic writers and photographers traveled through the medieval world—Canterbury, Cluny, Cologne, Cracow, Constantinople, and from Norman Sicily to Hanseatic Norway, Mont St. Michel to Mecca.

At long last the labors of creating *The Age of Chivalry* were over. The other day Mr. Severy and I paused to leaf through the finished book, feeling the contented glow that comes from achieving what we had envisioned. We examined the stunning 16-page foldout—the complete Bayeux Tapestry in color, with William the Conqueror's mounts splashing ashore, his knights riding to victory over the unmounted Saxons at Hastings.

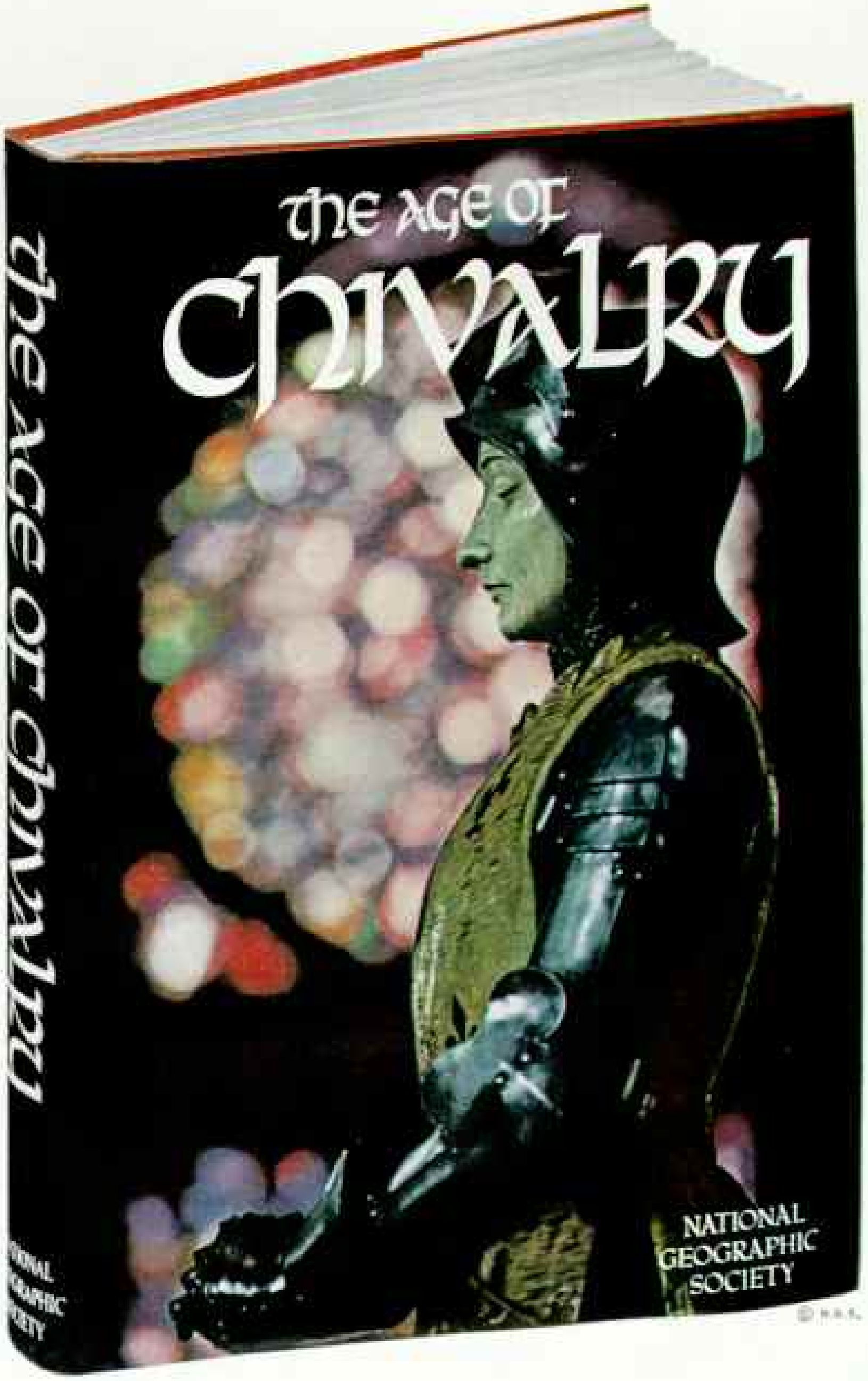
I asked Mr. Severy why he was grinning.

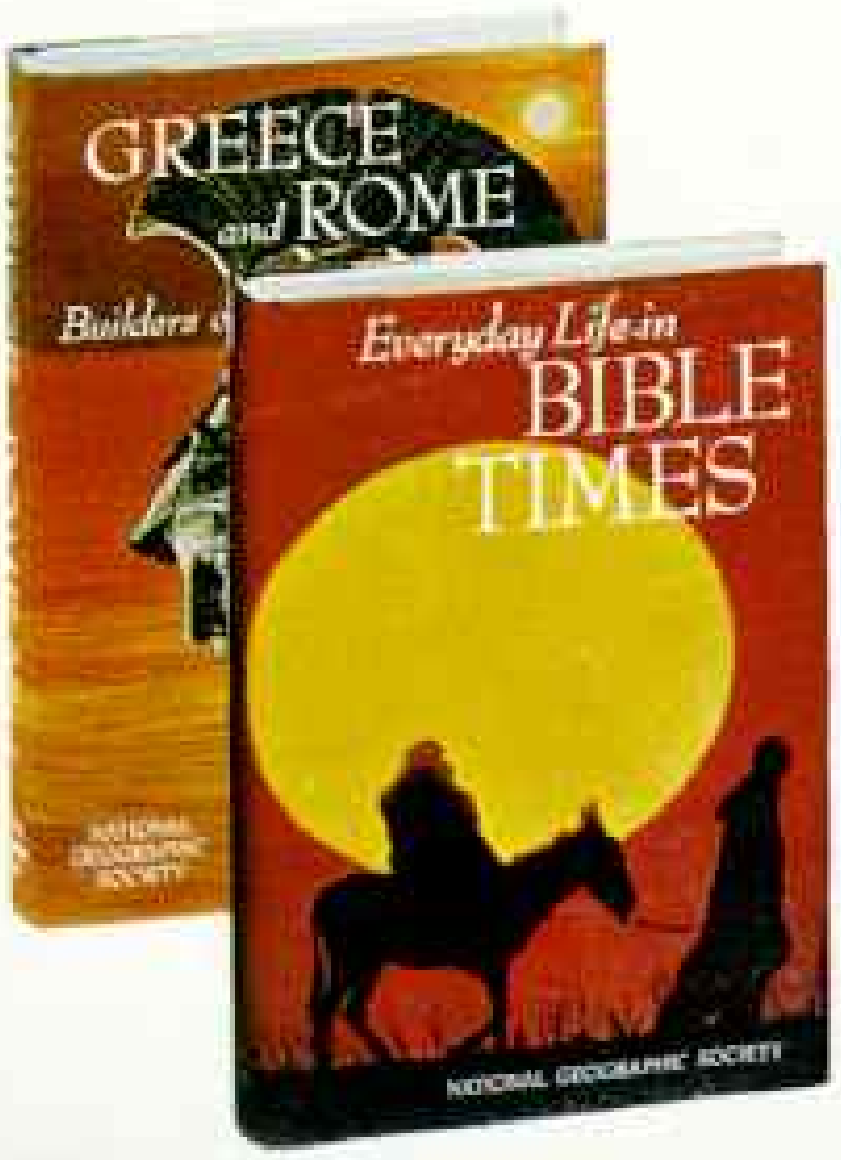
"As you can see," he replied, "basically it all has to do with the horse."

The horse—and heroes, and handsome ladies, and more than ten hundred years of thrilling history. * * *

Joyful trumpets lead a cavalcade of nobles and ladies celebrating spring with a ride through the woods beneath tower-studded Riom, France (left). This 15th-century scene represents the month of May in the Duc de Berry's Book of Hours, an illustrated calendar with prayers and Psalms, signs of the zodiac, and charts of the moon's phases.

Noblemen such as the Duc de Berry, reputedly the wealthiest man in France, indulged themselves with opulent banquets, grand balls, and lavish hunts, despite the turmoil in the kingdom. Prolonged war with England and internal conflicts so disrupted France that from 1422 to 1429 the new King Charles VII remained powerless. Then one of chivalry's last great soldiers—a young girl—led the royal troops to victory over the English. Joan of Arc, whose statue stands in the Cathedral at Reims (right), won Charles his throne and lost her life in martyrdom.





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Southern California's Trial by Mud and Water

By NATHANIEL T. KENNEY

Photographs by BRUCE DALE

Both National Geographic Staff

SOUTHERN CALIFORNIA is still with us, despite the home-grown prophets of doom who predicted it would slide into the Pacific Ocean by Easter. But for a while it appeared nip and tuck.

Last winter the heaviest rains in recorded meteorological history deluged the new American Mecca, triggering landslides, floods, and general havoc. More than a hundred people drowned, were buried in their homes by waves of mud, or lost their lives in storm-related accidents. The works of man and land itself suffered an estimated billion dollars in damage—and insurance covered almost none of it.

Meanwhile, in the high country east of the

TWO AGAINST THE TIDE: *Patrick Harney, left, and neighbor Fred Nicholson struggle to divert a river of mud from Harney's house behind them. Already the torrent engulfs other homes on Rainbow Drive in suburban Glendora, amid the foothills rimming Los Angeles. The nightmare struck last winter, when record downpours deluged Southern California, and mountains flowed like water.*

KODACHROME (ABOVE) AND EKTACHROME BY THOMAS A. DEFEO © N.G.S.

ONLY AT HIS PERIL does man tamper with nature's delicate balance, or ignore her erratic ways.

In Southern California last winter, torrential rains turned fire-denuded land into a Niagara of mud, taking more than a hundred lives and wreaking havoc in areas where men had built precariously on steep hillsides. In the northern Midwest, a frozen time bomb set off by the warming breath of spring brought flood and destruction to parts of five states. New tools for weather forecasting helped avert widespread disaster, but where man let down his guard, nature thrust with wounding speed.

Man versus nature

To examine these catastrophes, NATIONAL GEOGRAPHIC dispatched two teams of writers and photographers. Nathaniel T. Kenney and Bruce Dale portray California's suffocating mudslides in the accompanying article. Peter T. White (below, second from right) began his coverage of the Midwestern floods with photographer Thomas A. DeFeo at first warning of record snow packs. Here he joins Gen. George A. Lincoln, Director of the Office of Emergency Preparedness (holding map), on a damage-assessing flight. Mr. White's article, including a report on hardest-hit Minot, North Dakota (above), begins on page 574.—THE EDITOR

Soldiers in a losing battle stack sandbags against rising water and mud on Glendora's Glencoe Heights Drive. A sign, posted by neighborhood bachelors who call themselves the Royal Guard, bespeaks the community's pluck. Seconds later a mighty surge swept away the

coastal plains, record snows caused death-dealing avalanches and yet more property damage. As in the Midwest, spring thaws later produced further floods in the lowlands.

Much of the catastrophe I witnessed myself, especially in the steeply tilted canyons ringing midtown Los Angeles. Chiefly I sought to learn its causes, and whether anything can be done to prevent a recurrence.

Within an hour of landing in Los Angeles, I heard a proposed solution. One of those robed and bearded soothsayers you're bound to meet eventually in the Los Angeles area was haranguing passers-by on Hollywood's Sunset Boulevard.

"Shape up, sinners!" he shouted. "Make your peace with mother nature or she'll wash you into the Pacific!"

Next day, when I met Dr. Martin L. Stout, associate professor of geology from California State College at Los Angeles and a leading engineering geologist, I quoted the street-corner prophet with some amusement.

"He's more right than he realizes," said

KODACHROMES BY BRUCE DALE © N.G.S.

barricade. Fires last fall in the surrounding San Gabriel Mountains set the stage for disaster by denuding slopes, reducing their capacity to absorb water. Then the skies opened—44 inches of rain fell in 42 days—to trigger a succession of floods, mud and gravel flows, and slides.

Dr. Stout. "The Southern California environment is hostile and tricky, and it has been ever since the coast rose from the sea.

"Violent floods, landslides, erosion, the brush fires that help cause them—all are natural processes, responding remorselessly to a pattern of feast-or-famine rains. The very earth we tread out here is young and geologically unstable, prone to dramatic movement without any help from us.

"And the corner preacher is right again when he says our transgressions of natural laws have speeded and intensified these primeval forces. Frantically building a megalopolis, we've heedlessly altered the land, with little thought for nature.

"Meanwhile, the population has increased so drastically that some people inevitably are getting in the way of natural changes in the environment." *

The summer before had seemed a normal one, with its smidgen of rain and the famed

*See "California, The Golden Magnet," by William Graves, NATIONAL GEOGRAPHIC, May 1966.

southland sun shining day after pleasant day. On the hills and mountains the thick chaparral dried into explosive tinder, as always, and upwards of 100,000 acres burned.

"In our area we answered more than 6,000 alarms in grass and brush during the last high-fire season," said Chief Engineer Keith E. Klinger of the Los Angeles County Fire Department.

"It was a record, but as the population increases, we have to expect this. Each year more people go into the hills, and wherever you have people, you have the danger of fire."

A rule of thumb applies to any Southern California watershed: Flood follows fire.

"Burn a hill, and it loses nearly all its capacity to soak up even a normal rain," explained Supervisor William T. Dresser of the big Angeles National Forest overlooking Los Angeles. "The water rushes right off,

Strain of his ordeal reflects in the face of Patrick Harney, bone-weary after a night of fending off freshets of mud. Ultimately, he and a band of volunteers saved his house from the fate of a neighbor's (right).

Ruin reigns in the kitchen of the John R. Caufield home on Glencoe Heights Drive. A high-school volunteer inspects litter borne in on a sticky flow that rose above the level of the stove, upper right; a heat register at left trickles ooze from the living room, which filled with mud.

One of Glendora's hardest-hit families, the Caufields abandoned their $55,000 home as a total loss. Cruelly, another slide destroyed furniture they had stored for safekeeping in a neighbor's garage. Insurance covered nothing; most home underwriters refuse the risks of slide country.

tearing the slopes to bits as it goes, and it ends as certain flood in the lowlands."

At summer's end the rains began, but precipitation records show them as average. Then, in the middle of January, a record-breaking storm rolled in from the Pacific.

"Normal West Coast rains fall from storms originating off Alaska," said Anselmo Lewis, Angeles National Forest district ranger. "The one that started all the trouble here came from the Pacific near Hawaii. Moreover, it was hidden behind a minor disturbance just ahead of it, and caught us napping."

"No, we didn't predict its onset well," said George Kalstrom, meteorologist in charge of the Weather Bureau's Los Angeles Forecast Office. "Once it started, though, we were accurate to the end. Satellite photographs helped.

"If not unique, it was an unusual storm. We felt its effects for nine days, during which we

measured rainfall never equaled during any like period on record."

Immediately the surface mud and gravel, already well soaked, washed from the slopes, smashing into hillside homes through doors and windows and trapping people in their beds. In their lower reaches, outrageously swollen rivers choked themselves with debris and rampaged out of their courses.

After flood came landslide—to be expected in view of the area's geology. Formed by deposits on the bed of an ancient sea, the subterranean earth consists of many layers, some of them clay or other slippery material.

Over the centuries, movements of the earth that characterize this highly active earthquake zone have tilted and fractured the layers into a jumble. The mid-January rains penetrated to normally dry sloping layers and loosened their bonds. Also, the sheer weight of water soaking the upper soils may have been partly responsible; in any event, sliding began at once and in some places will continue.

Foothill Cities Suffered Most

The February rains that followed the tropical deluge came from normal North Pacific storms. However, stations reported rainfall as much as 800 percent above normal. It rained frequently, with occasional clear periods, from mid-January until Sunday, March 2. By that time Los Angeles had received a record 25 inches of rain—almost twice the yearly average—with the wet season still not over.

In the Los Angeles Basin, a sluggishly drained coastal plain ringed by mountains, nearly 100 cities occupy land once devoted to agriculture. A score of these cities nestle in the foothills. As they grow, they push ever farther up the slopes and into the canyons that drain the San Gabriel Mountains (map, page 566). The flat land of the basin yearly grows scarcer and more expensive. And a house with a view is fashionable, even if it must be pegged to the hillside by stilts.

Glendora, population 32,050, is a typical foothill city, an attractive, self-contained community replacing the fragrant trees of large citrus groves. Although the city suffered no fatalities, it counted 160 homes badly damaged and five destroyed or stricken beyond repair.

Glendora's experience, it seemed to me, was the entire Southern California catastrophe in microcosm. And the personal disaster of Lorin Rimer, who owned a $45,000 rambler on Glendora's moderately steep Rainbow Drive, typified the experiences of hundreds.

"Mrs. Rimer and I came here from Punxsutawney, Pennsylvania, in 1947," he said, "and bought a house on a nice hillside. Then last summer the slopes behind us burned—for

Anything may help. A neighbor adds a mailbox to a dike protecting the home of Glendora Police Sgt. William H. Hayes, Jr. Though the gravelly stream fast erodes the barricade, rains slackened just in time to save Sergeant Hayes's home—already inundated three times. During this onslaught, the sergeant watched helplessly from across the street, trapped there by the sudden cascade when he went to rouse a neighbor.

the first time in half a century, I was told.

"The neighborhood realized the danger; we held block meetings to make plans; we stocked up with shovels and sandbags. The canyon above Rainbow Drive has no flood-control works.

"The first heavy rain came on Sunday, January 19. On Monday so much mud and water was coming out of the canyon into the street that many of us stayed home to sandbag and shovel muck.

"By Tuesday the torrent was carrying coarse gravel and boulders. We fought it all day and into the night, then went to bed thinking we had things under control.

"Early Wednesday a cloudburst woke us up. By the time I reached the window, the lawn was gone. A neighbor was clinging to the low eaves of our house. The current ripped off his boots, but he made it to high ground.

Escape Hazard: A "Hot" Window Frame

"By now our house was an island. A window let go, letting in a wall of water and gravel. We knew the muck would be up to the ceiling in a few minutes. Our front door was blocked, so I told my wife to get out through a window, fast.

"When she touched the sill, she was knocked right back inside. A short circuit in the house

wiring had charged the metal window frame.

"'I can't do it!' she shouted.

"'You'll have to,' I said. 'Otherwise we'll be buried alive.'

"On the third try she went out, and I went through behind her. I was so keyed up that I barely felt the electricity.

"The water swept us maybe a hundred yards before we could crawl to a house on a high lawn. I couldn't understand why I was unable to stand up. Then I discovered my pajamas were filled with heavy gravel. My legs were cut and bleeding. But we were safe."

Nightmare on the Freeway

The experience of Edward R. Jennings of Fullerton contained a peculiarly modern element of nightmare. Mr. Jennings was driving on the Pomona Freeway when an unseen force seized his car and carried it sideways onto the median strip! The cliff above the highway had collapsed (page 568).

"I hadn't seen the landslide come down, and I felt as though I were in a boat being tossed about in a storm," Mr. Jennings told me.

Then there was the Soledad Canyon incident, a Hollywood terror movie come alive. It centered on Ralph D. Helfer's ranch on the Santa Clara River. Africa, U.S.A., as Mr. Helfer calls his place, rents exotic animals to makers of movies and TV films. You may have seen some of them: the tiger in the Esso commercial; the Ford Motor Company cougar.

The Santa Clara inundated Africa, U.S.A., and many of Mr. Helfer's great carnivores were free in the night to roam the countryside, where possibly 10,000 people live within a 15-mile radius. One can imagine the panic had the Helfer neighbors known the facts. But they didn't, for all communications with the ranch were out.

Actually, there was little danger.

"When the water reached the cages," Mr. Helfer said, "we tranquilized what untamed animals we had. Unfortunately, we lost a dozen—lions, tigers, a jaguar—when a dam burst before we could carry them out.

"After we'd attended to this sad business, we turned to the rescue of our gentle animals.

Mud took the wheel of this driverless station wagon, sweeping it a quarter of a mile and smashing it into a garage. A volunteer worker checks damage to the auto.

Mired in muck, a bicycle awaits rescue from the quagmire that choked Glendora.

Children's treasures clutter John Caufield's roof, tossed there out of the way of the mudslide. As an epitaph to the mud's grim work, a book at lower left displays the title *Lost Worlds*. Ladder offers the family an escape to the roof—a vantage point that a volunteer has reached by walking up eave-high debris on the other side of the house.

mostly lions and tigers. These have been patiently tamed with kindness alone and are about as savage as well-bred Great Danes.

"The river by now had made an island of their cage area. We reached it by forming a human chain. We opened the cage doors and called the animals to follow us.

"Then came the only beautiful thing in our catastrophe. Together the men and the wonderful animals struggled to save each other. The men provided the leadership, the animals the power to overcome the current while the men clung to their fur. All were saved.

"In the noise and confusion the animals waited patiently while we made makeshift quarters for them. Certainly they could have run away, but they didn't. They wanted to be near their human friends."

Children Die in Their Beds

Of human tragedies none so moved me as the deaths of little children where they had most reason to feel secure—in their own homes, in their beds. An avalanche of mud that damaged no other house in the block thus suffocated two tots in Highland Park (opposite), while a slide in Topanga Canyon killed two other children and their mother as well.

As pure spectacle, I saw nothing that matched the tumble of a house from atop a Castellamore cliff onto Route 101, the heavily traveled Pacific Coast Highway, near Sunset Boulevard (map, page 566).

In Santa Ana, near Disneyland, ingenuity saved several blocks of houses along Santiago Creek. When the swollen stream threatened to cut the lots from beneath the homes, city officials bought hundreds of junked automobiles, then called on the United States Marines.

Out of the sky swooped a huge Marine Corps helicopter, bringing car after car as an eagle carries a rabbit (page 569). Five thousand volunteer workers gathered in Santa Ana, risking their lives to help position the wrecks in the breached banks, to shovel, and to fill sandbags.

"The workers included people of all ages and stations in life," said Assistant City Manager G. David Tayco, himself about to drop from exhaustion when I saw him. "Most of them are young people, some from Watts, the black ghetto in Los Angeles. You're not likely to hear me criticizing our youth from now on."

In the plush Hollywood Hills, homes of affluent Angelenos slid down vertiginous slopes as though on rollers. Chunks of Gould Avenue cascaded into Laurel Canyon, leaving nine houses precariously perched over the abyss. Authorities ordered them abandoned.

In the Santa Monica Mountains, Twentieth Century-Fox's set for Charlton Heston's film *Planet of the Apes* became a tangle of flood-twisted wreckage.

Driving through the stricken countryside north of Los Angeles, I found no community that had not sustained visible damage. At Ventura the river burst into the yacht marina from the land side, filling the harbor with silt and wrecking most of the wharves. A hundred boats were buried or swept to sea, and two hundred others suffered damage.

Santa Barbara, Carpinteria, and Montecito took savage beatings. Roily water inundated ranches in Ventura, Santa Barbara, and San Luis Obispo counties, destroying $30,000,000 worth of oranges, lemons, flowers, sugar beets, vegetables—and a mushroom farm.

A few people, a very few, left the area permanently. Television cameras caught one small automobile caravan leaving Los Angeles with residents who had had enough. On each day of their journey east they passed, statistics say, between 600 and 800 people happily headed westward for new lives in the southland!

Defenses Paid For Themselves

And what will be done to make these new lives safe ones?

"In the main, improve and expand what's already been accomplished," said Brig. Gen. William M. Glasgow of the U. S. Army Corps of Engineers. He is division engineer in charge of operations in the Pacific Southwest.

"People are usually surprised, especially after a winter like this one, to learn what big steps Southern California has already

(Continued on page 569)

Nearly buried alive, Mrs. John Gonzales lies pinned beneath the rubble of her home. "My babies are in the front room," she screamed as neighbor Jerry Hand arrived to help. After three hours, rescuers uncovered the lifeless bodies of Joe Gonzales, 2 years old, and Steve, 10 months. Disaster struck when rains loosened a wedge of hillside behind houses lining El Paso Drive in the Highland Park area of Los Angeles. Hurtling down, the slide singled out the Gonzales home and slammed it onto the street.

STAFF PHOTOGRAPHER, LOS ANGELES TIMES

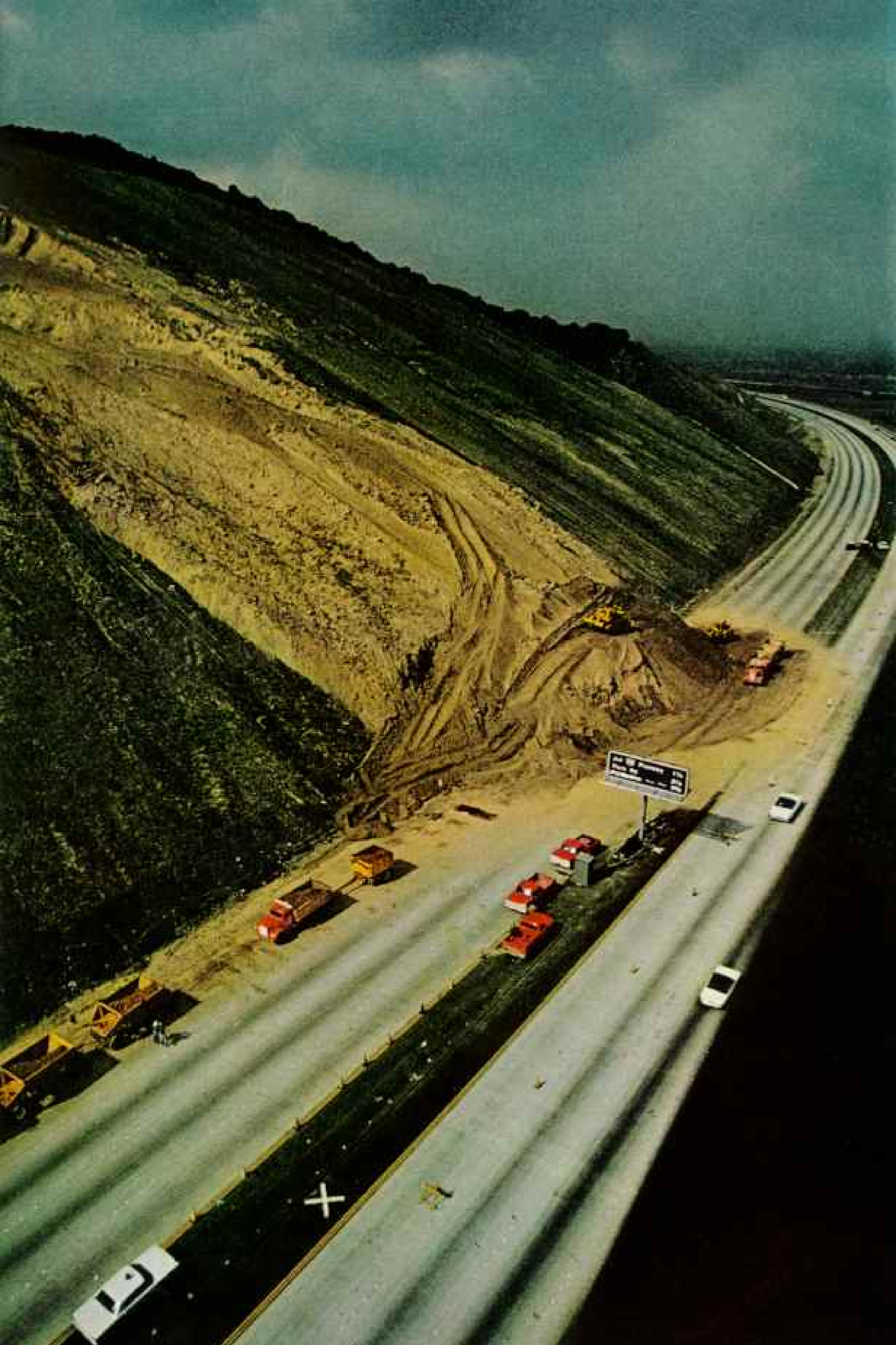
Where men met mud

ITS LONG SIEGE ENDED, Rainbow Drive in Glendora slowly digs out beneath a sparkling sun (opposite). Rumpled foothills of the San Gabriels, stripped by fire and gouged by rains, wall canyons that spewed devastation with every cloudburst.

Glendora suffered the worst onslaught on January 22, when torrential rains funneled a wall of water, mud, and debris into Rainbow Drive (photo key at left). The roaring flood shot past Ralph Johnson's house and hurled itself at the home of the Lorin Rimers, who barely escaped through a window (text, pages 560-63). On down Rainbow Drive it swept, leaving few homes untouched.

In scores of other Glendoras (below), mud and water brought havoc and heartbreak. The final toll: 101 lives lost, a billion dollars in property damage, 15,000 persons evacuated. Heartwarmingly, wherever misfortune threatened, friends and strangers flocked to help.

As the rains spent their wrath, a scourge struck from the sea. An oil well in Santa Barbara Channel sprang a leak, gushing hundreds of thousands of gallons of oil to smear beaches and destroy wildlife.



A mountain moves: Heavy equipment gnaws at a mammoth slide blocking eastbound traffic on the Pomona Freeway, normally one of Los Angeles's most frenetic arteries. Rains seeping through the soil lubricated a layer of clay, triggering the avalanche in the San Gabriel Valley. More than 200,000 cubic yards of earth clogged the highway. One horrified driver felt the shifting mass lift his speeding auto and carry it onto the median, but he escaped unscathed (text, page 563). Grading and terracing the slope may prevent future slides.

Wrecks to the rescue! As floodwaters rage down usually dry Santiago Creek in Santa Ana, a U. S. Marine Corps helicopter airlifts junked autos to shore up banks that might crumble under homes.

EKTACHROME (ABOVE) BY CHARLES O'REAR; KODACHROME BY J. R. STEWART © N.G.S.

taken to tame floods and slides.

"In the Los Angeles Basin, for example, the lower San Gabriel and Los Angeles Rivers burst their banks in 1938, causing heavy damage and loss of life. Both rivers have now been brought under control. Last winter they gave almost no trouble—and the rainfall was double what it had been in 1938.

"The Los Angeles County Flood Control District was established as long ago as 1915, after a bad flood the year before. The Federal Government began aiding such local groups on a major scale in 1936. Since that time, 1.3 billion dollars in federal and local funds has been spent in Southern California for flood control.

"Were the results worth it? Well, we believe the present system saved 1.5 billion in damages that didn't occur, meaning that every dam and dike more than paid for itself.

"The big problem is building adequate defenses before more people arrive and get clobbered. The Santa Clara River, for example, has flooded for centuries, but it didn't make much difference until the recent population explosion in the valley.

"This winter the river really hurt a lot of folks. Now, while the control agencies are busy working to tame the Santa Clara, it's a good bet that some other valley will fill up with people overnight and take a beating before we can get to it."

To defend against rains, the triggers of flood, you must know the worst you can expect, based on measurements made over many years. Few of Southern California's rainfall records go back more than sixty years, and the recent rains, as the newspapers put it, were "hundred-year rains." Thus flood defenses planned to cope with the worst rains on record were not quite enough. In the future they will be designed to a higher standard.

Scientists Chart Earth's Hidden Flaws

Earth scientists have done much for Southern California, and will do a lot more. I talked again with my geologist friend Martin Stout.

"Out here the ground structures are so jumbled we must have a detailed underground map of every piece of land we use," he said. "Seismologists chart earthquake-causing faults; soil and earth scientists map unstable surface soils; foresters select appropriate vegetation for cover.

"Geologists like myself also inspect and map the deeper strata. And I mean 'inspect.' We sink borings and even go down into some of them. Air photos often show things you can't see on the ground, and we use them regularly."

With better knowledge of the environment have come sound building laws and fire regulations—probably the best in the Nation, says Dr. Stout. In 1952 Los Angeles passed a city ordinance prohibiting construction on dangerously steep slopes, on uncompacted fill, or on known unstable areas. Surrounding counties have since passed similar codes. The city's effective "green hills" statute, requiring scientific landscaping and dry-season irrigation of the ground cover, went on the books in 1961.

"Last winter proved the worth of the city regulations," said Martin Stout. "Few structures built to their grading specifications sustained more than minor damage."

Among the regulations specifically aimed at preventing the classic fire-flood sequence is a ban on smoking (even in automobiles) in critical foothill areas during the dry season.

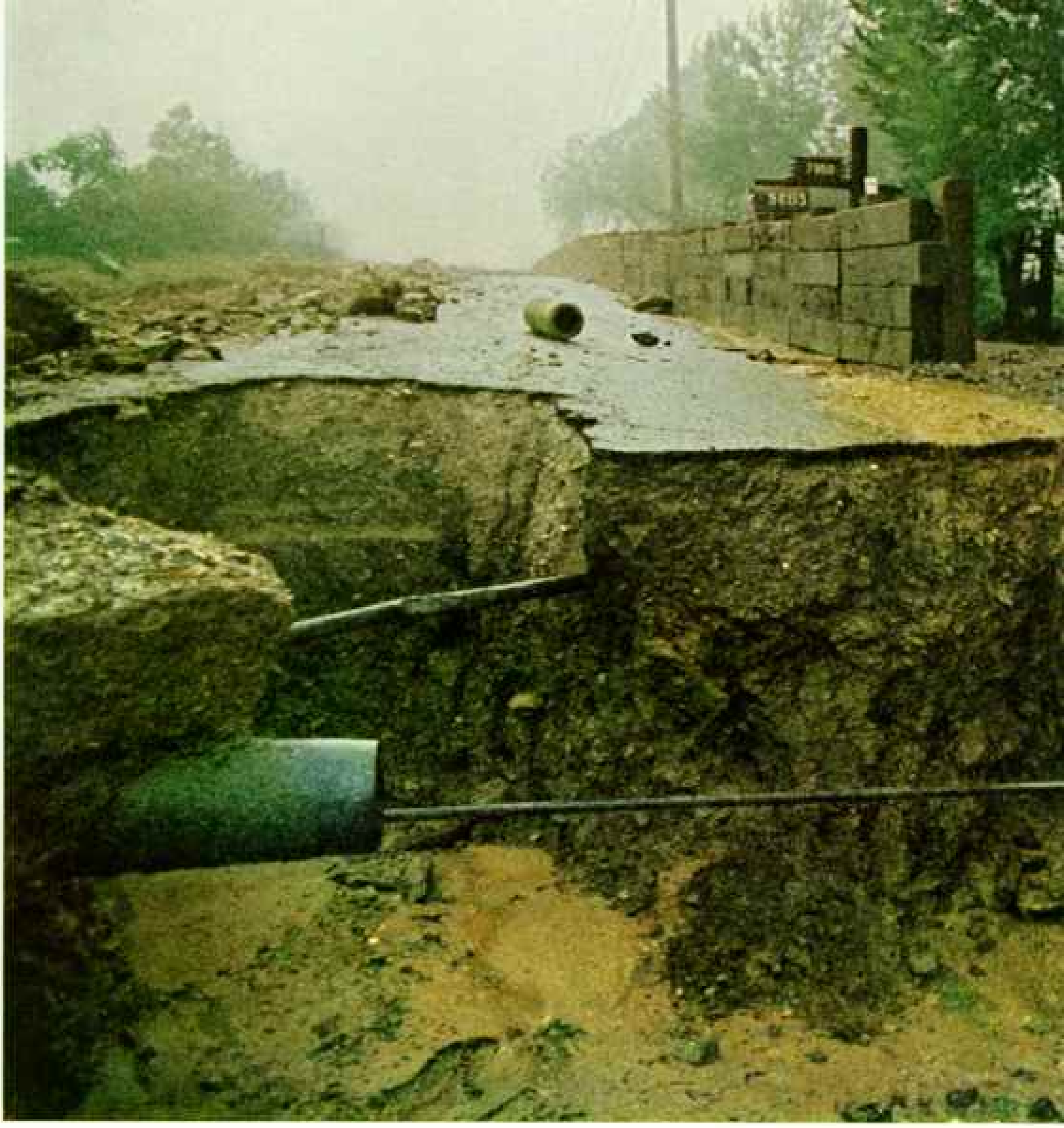
A $10,000,000 Repair Job

In the southland, virtually all major watersheds are in four national forests. The agency charged with caring for these natural flood defenses is the U. S. Forest Service. Actually, "forest" is a misnomer for the scrub-covered foothills, although timber clothes the high country farther east. Originally established solely to preserve the delicate watershed, the forests now play host to increasing millions of vacationists; rangers counted 19,000,000 individual visits in 1968.

A lesson learned: Picturesquely sited homes at left, built before Los Angeles stiffened its building codes, cling to slide-prone slopes in the Santa Monica Mountains. To protect Mount Olympus in Hollywood, right, developers graded slopes and moated lots with storm drains. Sites near the summit sell for as much as $85,000.

Fathoming the ways of water, a graduate student experiments with sedimentation at California Institute of Technology in Pasadena. Paired sonar prongs profile the shifting bed. Findings could help engineers curb Southern California's rampaging erosion.

BOOMERANG (ABOVE) AND EXTINCTIONS BY BRUCE DALE © N.G.S.



Dead end: An ever-deepening washout cleaves Glencoe Heights Drive as rains still pelt Glendora. Gas pipes stretch like bared tendons beside a sheared irrigation pipe. Barricade of railroad ties thrown up by Detro H. Sells eventually succumbed to floods, and slides piled 10 feet of debris against his

"This season visitor wear and tear will be the least of our problems," I heard Angeles Forest Supervisor Bill Dresser tell the Los Angeles County Watershed Commission. "We've lost so many bridges, roads, and trails that people simply won't be able to get in. We think it will take all summer and the better part of $10,000,000 to put us back into the recreation business."

When the streams leave the national forest, they become the responsibility of local district flood-control organizations. Their debris basins cleanse the water of silt; their holding dams store it until it is safe to release in controlled amounts. After this the streams cross the coastal plains in sturdy concrete channels built, like other major flood defenses in the southland, by the U. S. Army Corps of Engineers but turned over, with a few exceptions, to the local authorities for operation and maintenance.

Water Is Short Despite Floods

In the plains the flow is swelled by heavy runoff from the roofs and streets of the urban areas. Thus augmented, the rivers head for the sea, most of them still in artificial channels of heavy concrete.

EKTACHROME BY BRUCE DALE © N.G.S.

house, right. Unlike his next-door neighbors the Caufields (pages 558-9), Mr. Sells was able to restore his home. Now, with other Southern Californian communities, Glendora plans to strengthen its defenses of storm drains, debris basins, and dams so that its nightmare may never be repeated.

"Do we now sit back and watch them go?" said Stanley Steenbock of the Los Angeles County Flood Control District. "No. Whatever it looked like this winter, Southern California has a water shortage because of its dry summers. We import 60 percent of our water at high cost from across the mountains.

"So we catch all the local water we can in reservoirs and turn it onto 26 'spreading grounds,' where it seeps into natural underground storage basins. From these it can be pumped up as necessary."

When the floods ended, I returned East. While writing this article, I telephoned my friend Lorin Rimer to confirm several details.

"How are you making out?" I asked in the course of the conversation.

"Fine, fine," said Mr. Rimer. "What with all the flood deductions, it was almost fun paying income taxes. And my real estate business has never been better."

"But what about your house?"

"Oh, that," said Mr. Rimer. "That's past history. It's still up there under the mud. We bought a new place."

"In Glendora?" I wanted to know.

"Where else?" said Mr. Rimer. "Finest place on earth." * * *

Satellites Gave Warning of Midwest Floods

By PETER T. WHITE
National Geographic Staff

Photographs by
THOMAS A. DEFEO

NOT SINCE NOAH have people had such authoritative warning of high waters to come. So said William E. Hiatt, the United States Weather Bureau's Associate Director for hydrology—the science of the behavior of water.

He and his colleagues had been working with unprecedented tools to enhance flood forecasting. Pictures beamed to earth from cameras orbiting in satellites showed the January snow cover across the northern Midwest (page 578). It looked extraordinarily extensive in Minnesota and the Dakotas. Observers on the ground, some ferried to remote or snowbound places by helicopters, sampled the depth and quality of the snow pack. It was as much as four feet thick, three times thicker than in normal years; by late February its moisture content was extremely high, the equivalent of six to ten inches of water—and it covered thousands of square miles.

All this information trickled into a computer at the Weather Bureau's River Forecasting Center in Kansas City for electronic comparison with data from the past. Out flowed the predictions: Near-record water levels in any event. But in case of rain, or more snow, in March—or steadily warm weather and hence a quick melt in April—flood records would be topped.

Along the rivers of the northern Midwest scores of towns lacked permanent dikes. People shuddered.

Town becomes a lake as rescuers salvage a family's belongings in Minot, North Dakota. The deluge struck last spring when melting snows overflowed riverbanks and threatened devastating floods across the northern Midwest. Unprecedented success in anticipating high waters and building defenses against them saved most communities. But Minot staggered under a direct hit.

KODACHROME © N.G.S.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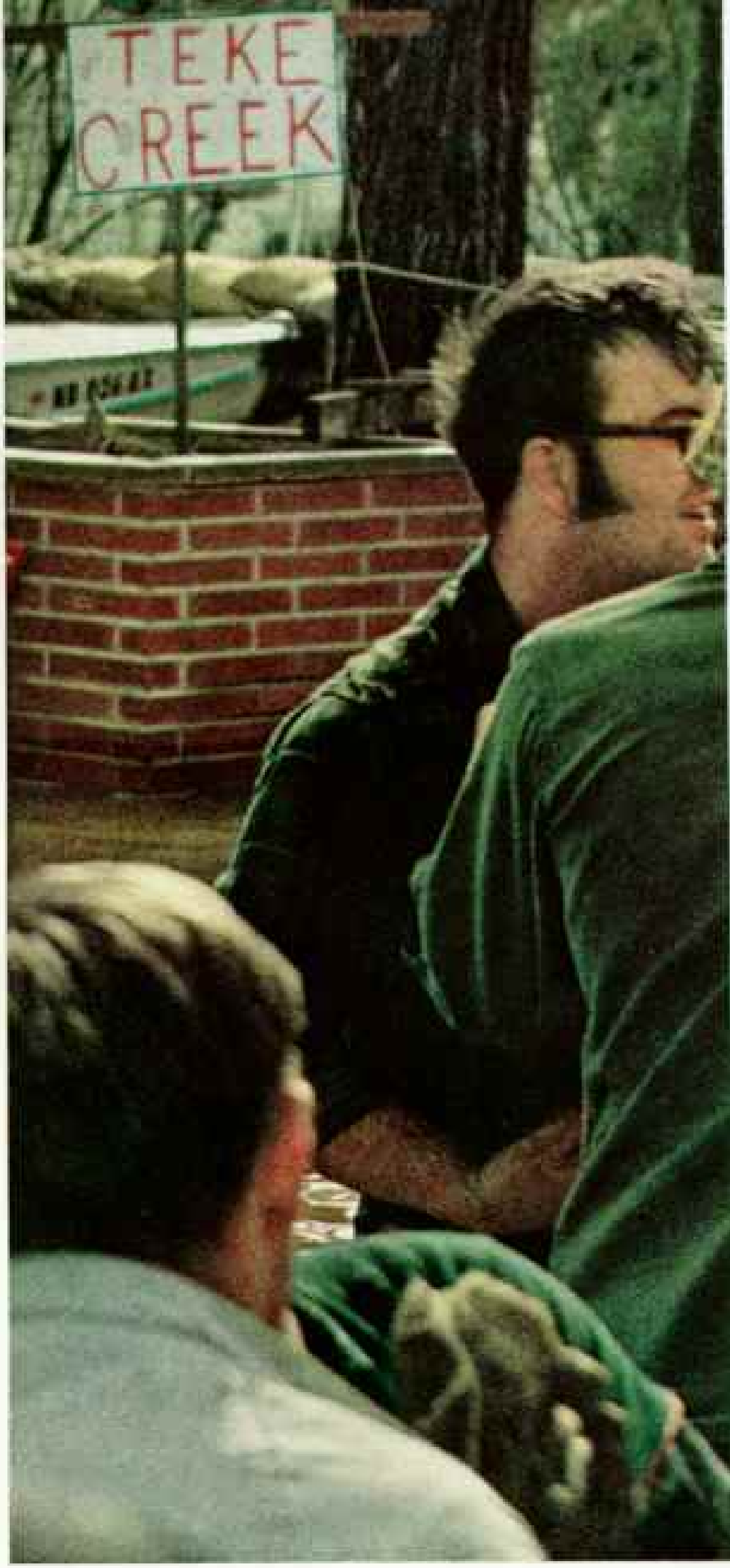


LEFTCHROME (ABOVE) AND RIGHTCHROME © W.E.B.

Weary old and exuberant young react to the threat of calamity. An invalid at the Lutheran Home for the Aged in Mankato, Minnesota, clutches her possessions during evacuation. Warned against the rampaging Minnesota River, Mankato threw up levees that kept most of the city dry.

Spirits undampened, members of "Teke"—Tau Kappa Epsilon fraternity—at Minot State College form a human chain in a futile effort to sandbag their house against the rising Souris, or Mouse, River, cheerfully dubbed "Teke Creek." Tragically, flood warnings did not cover the Mouse and its tributaries. On Easter morning the river spilled over its banks and eventually drove more than a third of the city's 33,000 people from their homes.

They remembered 1951, 1952, and especially 1965 when floods killed 16 persons and caused $180,000,000 worth of destruction. Could this year be worse?

For many weeks I witnessed the response to the great flood threat of 1969, an unprecedented outpouring of energy and skill launched by the President of the United States. He called it Operation Foresight. For the first time, federal disaster aid was committed *before* the waters began to rise—flood-fighting experts and pumps, millions of bags to be filled with sand, millions of dollars for the hire of earthmoving equipment.

I saw many a triumph of foresight, and of ingenuity, backbreaking work, and sheer luck. But for one city there was no warning. And so I also came to know the shock of totally unexpected calamity; and with it the havoc that the silent pressure of water can bring, to men's houses and to men's hearts. As a clergyman told me amid 3,000 flooded homes in Minot, North Dakota:

"To many people their house has become a part of themselves. To lose it is like losing a husband or a wife."

At my first stop, in Minnesota, I found the March air icy and the flood-fighting pace brisk. North Mankato (population 7,000) nestles in the great bend where the Minnesota River

turns 90 degrees northwest to meet the Mississippi at Minneapolis-St. Paul (map, next page). Along this bend runs U. S. Route 169, and atop its two northbound lanes a dike was rising—38 feet wide at the base and three and a half miles long (pages 584-5).

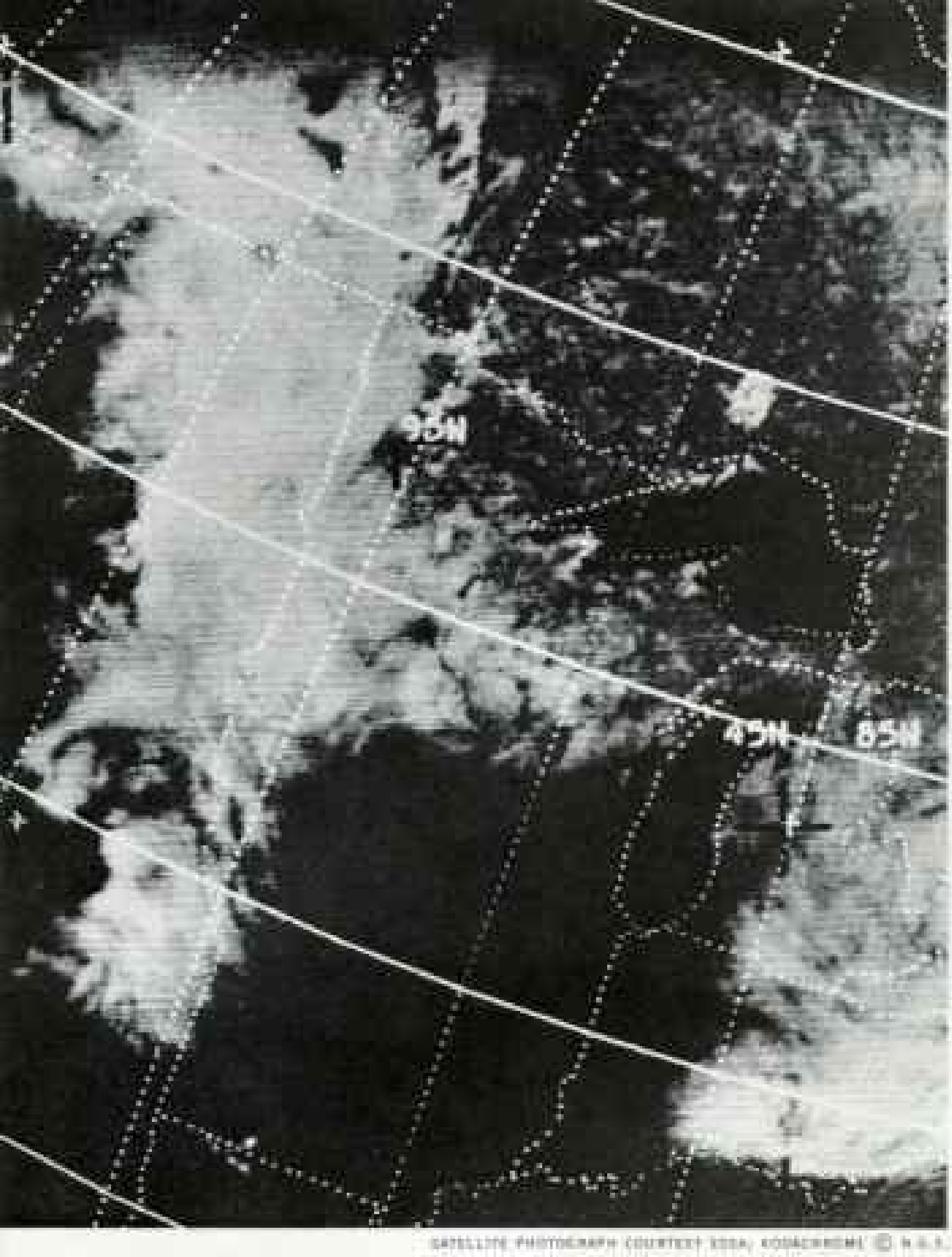
"Fat" Clay Makes a Good Dike

Trucks dumped piles of blue-gray clay; bulldozers and graders spread it in six-inch layers; rollers packed it down. The pace never let up, or the noise.

I stepped up close to a supervisor, a civilian with the U. S. Army Corps of Engineers. "Good fat clay," he shouted. Why fat? "Not much sand and plenty of moisture, so it'll compact well. The more compaction, the better it'll hold. Watch out!"

A yellow monster roared by on nine-foot wheels, bringing eighty tons of clay at one clip. That was one of the scrapers. They scraped clay from a hillside, spread it, and roared back for more, all without stopping.

Six out of seven North Mankatoans live in the flood plain, and despite that fat dike everybody seemed to have a precise plan for evacuation. A lady on Belgrade Avenue told me hers. "My son-in-law and his friends will come with a truck and bring up the freezer and the washer from the basement. I'll go stay



SATELLITE PHOTOGRAPH COURTESY ESSA; KODACHROME © N.G.S.

Warming from the sky: A blanket of snow lies ominously over the northern Midwest in a picture beamed to earth on March 21 by weather satellite ESSA 7. The solid white mass behind wispy clouds spreads heaviest in the Dakotas and Minnesota (above). Comparison of daily satellite pictures warned of the melt that unleashed last spring's onslaught.

Preflood patrol deploys from a U. S. Army helicopter on a South Dakota plain to measure snow depth and water content. Such surveys by the Weather Bureau, an agency of the Environmental Science Services Administration, gave early warning that record-high river levels were to come. Federal, state, and local governments last winter launched emergency preparations in a mammoth campaign called Operation Foresight. Even local gravediggers cooperated by reporting frost lines, important in predicting how quickly snow melt would run off fields

with him, but my grandchildren are afraid of my dog, so the dog will stay on a farm."

Her suitcase was packed; her TV set and her sewing machine were in the attic. High on a bookshelf sat her home-canned peaches and sauerkraut. In 1951, when the dikes had collapsed, her preserves were swamped in the basement, and she subsequently had to throw them out. "The health people said they might be contaminated."

Store and Bank Rely on Plastic

The proprietor of the Ben Franklin Store surveyed his zippers and batteries, notebooks and candy. "I have 4,000 different items," he said, "and I don't want them to get mixed up. So I bought 4,000 plastic bags." Outside, two trucks stood ready. Volunteers would help him pack up.

The Valley National Bank prepared to move out files and cash, but what about the safe-deposit boxes? The president took me into the vault and pointed to a gigantic sheet of polyethylene. "We'll put them on that, bring up the sides, and tie it on top." We computed the size of that package—24 feet by 12 feet by 6, very possibly a record for a plastic bag in the Midwest.

In the municipal building, police headquarters brimmed with rubber overshoes and flashlights, sent by Civil Defense from Minneapolis. "For the dike patrol," said the chief of police. "We're signing up volunteers."

The city administrator masterminding the defensive build-up told me that the dike wouldn't be something to sleep behind but a platform to fight from. Day and night the patrols would watch for danger signals. Such as?

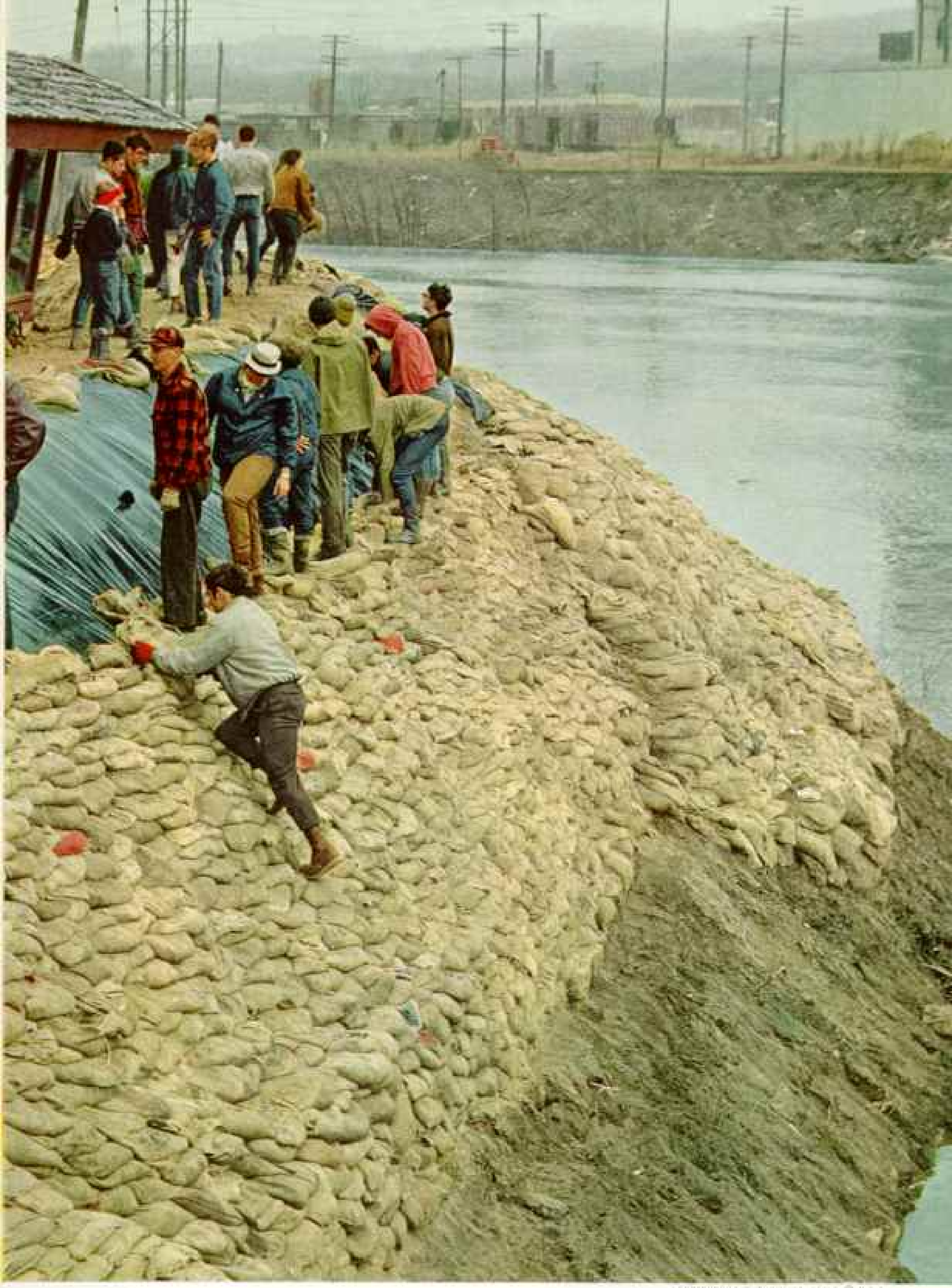
Sand boils! Water that has seeped under the dike and bubbles up behind it (page 587). "Then you have to move fast. With sandbags. Please excuse me." He moved off fast, in his blue radio car.

Volunteers were needed right away near the Main Street Bridge, where the river, rushing around the bend with increased velocity, would soon be scouring the dike. Hence a stretch of the dike was to be protected with polyethylene, held down by a revetment of 20,000 sandbags (following pages). Filling these made for a hectic afternoon, with many broken fingernails and several breaks for hot coffee from the Red Cross.

"As usual, the ones who work hardest are the kids," said a math teacher from the junior high. The local college president thought this was a wonderful thing for students. "They look for a reason for being—and you never learn who you are as surely as when you're filling sandbags." I teamed up with a tireless eighth-grader who said, "Anything's better than school."

On the other side of the bridge, in the city of Mankato (population 37,000), trees and

Forewarned, forearmed: A battlement climbs toward the eaves of the Century Club Restaurant in North Mankato to stave off the rising Minnesota River. Sandbags anchor sheets of polyethylene plastic to prevent scouring by currents. Most of the workers are teen-agers—



PHOTOGRAPHS BY THOMAS A. HEINZ © N.G.S.

a proportion often repeated in other threatened communities. As part of Operation Foresight, the U. S. Army Corps of Engineers distributed more than four million bags in the northern Midwest. Arm-weary local volunteers filled and manhandled them into place.

High-water prophet Joseph Strub, Jr., meteorologist in charge of the Weather Bureau Forecast Office in Minneapolis, sifts field reports of snow depths, ground saturation, rainfall, frost, and temperatures. Working with data from the bureau's computer center in Kansas City, Missouri, Mr. Strub made forecasts that gave most communities precise warning of when and at what level high waters would strike.

Backing up the front line, a Salvation Army worker brings food to dikers at LeHillier, a community of 1,000 next to Mankato. Floods ravaged LeHillier in 1965; this time its dikes held.

War against water

"**More charges!**" orders Army Engineer Fran Mertes. Secured by a safety line, he planted explosives to dislodge ice jamming the Blue Earth River near Mankato. Waters backing up could have broken loose in a torrent. His blasting succeeded.

Grim reading: Ariend Denzel logs a Minnesota River gauge at LeHillier. Numbers show elevations higher than 700 feet above sea level. The gauge here indicates water at 768.6 feet, 18.6 feet above the river's flood stage of 750 feet at this location.

As part of Operation Foresight, Mr. Mertes (right) explains how to floodproof buildings at a meeting of business leaders arranged by the Mankato Chamber of Commerce.

brush on the steep riverbank had been cut down and burned. Trucks now dumped craggy chunks of limestone. These went thumping down the slope; as they settled they lined the slope in a jagged jumble called riprap (page 587).

"That's the armor we need here where the scouring will be worst," explained an Army Engineer. "Just inside the embankment runs a main sanitary sewer. Imagine—if the river breaks into that big pipe, it will force itself into the sewer system. Then every house sitting lower than the river crest will get the flood piped right in, through the plumbing."

No wonder people looked preoccupied. A young housewife told me she never had headaches before, but now she had one every day. "All you think about and hear about is what the radio says, how high the river is now." For many, the worst of a flood can be the waiting.

Only two days earlier the gauge at the Main Street Bridge read seven feet. Now it was 15. Flood stage—when the river rises above its normal banks—would be 19. In 1965 it went to 29.07, and a Mankato dike gave way. Present predictions ranged up to 32.

That rapid eight-foot rise had not yet reflected a big runoff from the Minnesota River's drainage area which, upstream of Mankato, amounts to 14,900 square miles. Most of the tributaries up there—the Cottonwood, the Lac qui Parle, the Pomme de Terre—were still frozen over.

The rise had come chiefly from the Blue Earth River, which joins the Minnesota just above Mankato. The more Blue Earth water drained now the better—there'd be that much less to worry about later. But now a great wedge of ice jammed the Blue Earth. Behind it had accumulated a four-mile-long mass of ice and debris.

Warm Air Holds a Knife-sharp Threat

"When the weather warms," said an Army Engineer, "the pressure behind that ice jam will rise. It could break suddenly." That could mean a surge, carrying splintered ice that could cut the dikes like knives.

What to do? Blast it, said the Engineers. Would I like to help?

We cut a hole through the ice and lowered an improvised charge: a dynamite stick surrounded by a mixture of ammonium nitrate and fuel oil—all that in a plastic bag, weighed

REDACTIONS (UPPER'S LOWER LEFT) BY U. LOUIS MAZZATENTA, CHINCHIRIMAS (ABOVE AND OPPOSITE UPPER LEFT) AND RIGGINGHOUSE BY THOMAS A. SERVED © N.G.S.

Moving a hillside to tame a river: Hungry scrapers gulp huge loads of earth to build up a North Mankato dike. The region's rich blue-gray clay proved ideal for making watertight levees.

Ramparts rise atop a highway to protect North Mankato; trucks shuttle more clay

down with a brick. The explosion would have the force of 10 dynamite sticks.

We linked such charges by the dozen and spliced delaying devices between them, so that they would go off successively, a fraction of a second apart. This would produce a wave action under the ice, lifting and cracking.

Whoom! Bits of ice sailed 250 feet into the air. Great fissures appeared in the ice. Success! The first ice island detached itself and began drifting downstream. The Blue Earth would unjam gently.

On the night of April 9 word came from South Dakota that a very important dike was eroding fast. This dike, on the Big Sioux River, protected a meat-packing plant that provided 2,500 jobs—a livelihood for one out of every eight wage earners in the city of Sioux Falls. The plant had closed because of the flood danger, and there was fear that if it were badly damaged it might not open again.

When I arrived on April 10, I learned that attempts to reinforce the dike had been abandoned at 3 a.m. By dawn that dike was still there, though I could see a 100-foot stretch washing away, bit by bit, into the rushing, foaming river. Two-thirds of the dike's original width was gone.

from a nearby "borrow pit." Completed in nine frantic days, the massive levee measured 38 feet across at the base and stretched for 3½ miles atop the northbound lane of U. S. 169. When crisis came, the barrier successfully held back the swollen Minnesota River (out of picture, at left).

"I say we can still save it," insisted a contractor. "Let's give it another try."

Exertions redoubled. National Guardsmen rushed up truckloads of dirt and rock, hour after hour. A daring young man on a bulldozer pushed it all into position—rock down the face of the dike; earth behind it, to make up for lost width. A police captain said the water might break through any moment. The young man bulldozed on, into the night.

But the river tore away the rocks almost as soon as they were placed. Would all this sweat go for nothing?

The contractor improvised a last-ditch defense: old automobile bodies, secured with cables, weighed down by concrete beams normally used for building bridges. And the dike held at last—a monument to dauntlessness.

Federal Office Gives Emergency Help

President Nixon had entrusted Operation Foresight to George A. Lincoln—the Director of his Office of Emergency Preparedness, or O.E.P.—a retired general whose main task is to make sure that the Federal Government can continue to function after a nuclear attack. Now General Lincoln flew in from Washington to see how the flood fight was going. I

joined his official party for a flight along the Big Sioux.

General Lincoln lit his pipe, looked down, and then looked at his map (page 555). Notations on the map showed him how much federal money he was spending to supplement local efforts in the soggy towns below:

Sioux Falls, levees, $121,333 . . . Brookings, levee around sewage plant, $11,099 . . . Watertown, to clear channel, $21,000.

"This is the finest sort of investment," said General Lincoln. "In terms of damage prevented it pays off at five or ten or fifteen to one. But you really can't measure in dollars what it means to people."

Said Maj. Gen. Frederick J. Clarke, newly designated Chief of the Army Engineers, "People have done at least twice as much as I thought they'd be able to do."

Frank Farrar, the Governor of South Dakota, was silent during much of the flight. Once he turned to me and said, "Did you see the little dikes put up by farmers? And then they burst? It's tragic."

The monotonous blanket of snow was gone from the northern Midwest. As seen from the air, the endless prairie had resumed much of its familiar geometry: an endless pattern of squared-off fields, now brown, with colorful little insets—white house, red barn, silvery silo. The April sun drew silvery flashes from the water in huge potholes, in straight drainage ditches, in winding streams.

How winding all those streams and rivers really were one could only infer—their banks, outlined by double lines of trees, snaked inside wide bands of water.

What masses of water! Some 3,700 linear miles of Midwestern rivers were over their banks simultaneously, many carrying twice the volume that had set previous records. The Red River of the North formed a 160-mile-long lake, in places eight to twelve miles across. In much of the Midwest, 1969 would go down as one of the floods of the century.

Yet the experts agreed that the damage—though serious to the people affected—would be, on the whole, gratifyingly moderate.

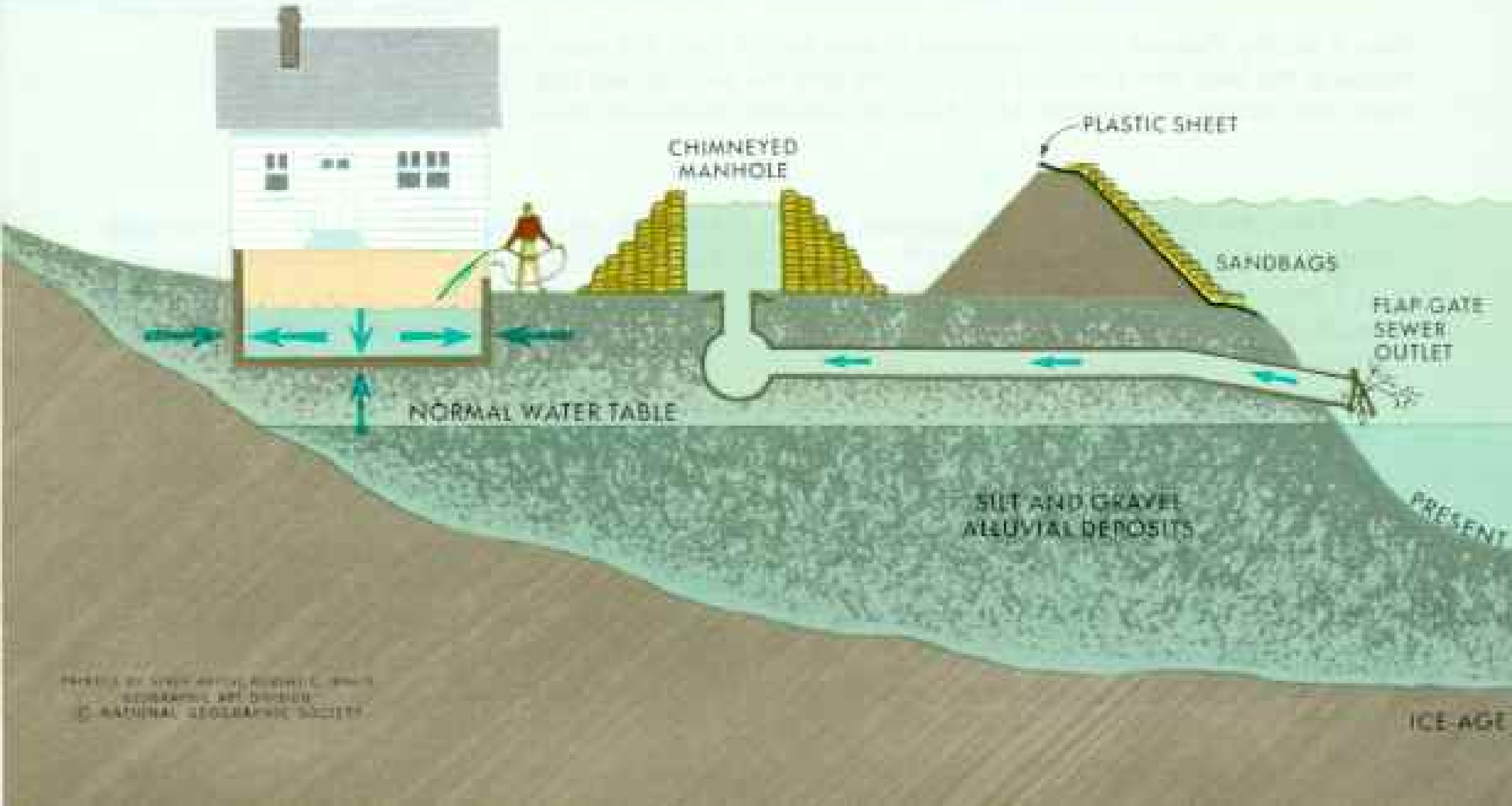
The Mouse Strikes Without Warning

Most hurt in South Dakota was North Sioux City—45 families flooded out when the Big Sioux hit. In Minnesota, the Red River of the North hit Moorhead: 50 houses damaged. There were anxious moments in many places, including Mankato, but all major dike systems were holding remarkably well.

The experts cited a string of favorable circumstances: Little rain in March, and alternatingly warm and freezing weather that kept the runoff from coming all at once; the timely aid to hundreds of communities, and the spirit and skill of the few that had decided to go it alone; above all, the incisive warnings from the Weather Bureau.

Then the Mouse hit Minot.

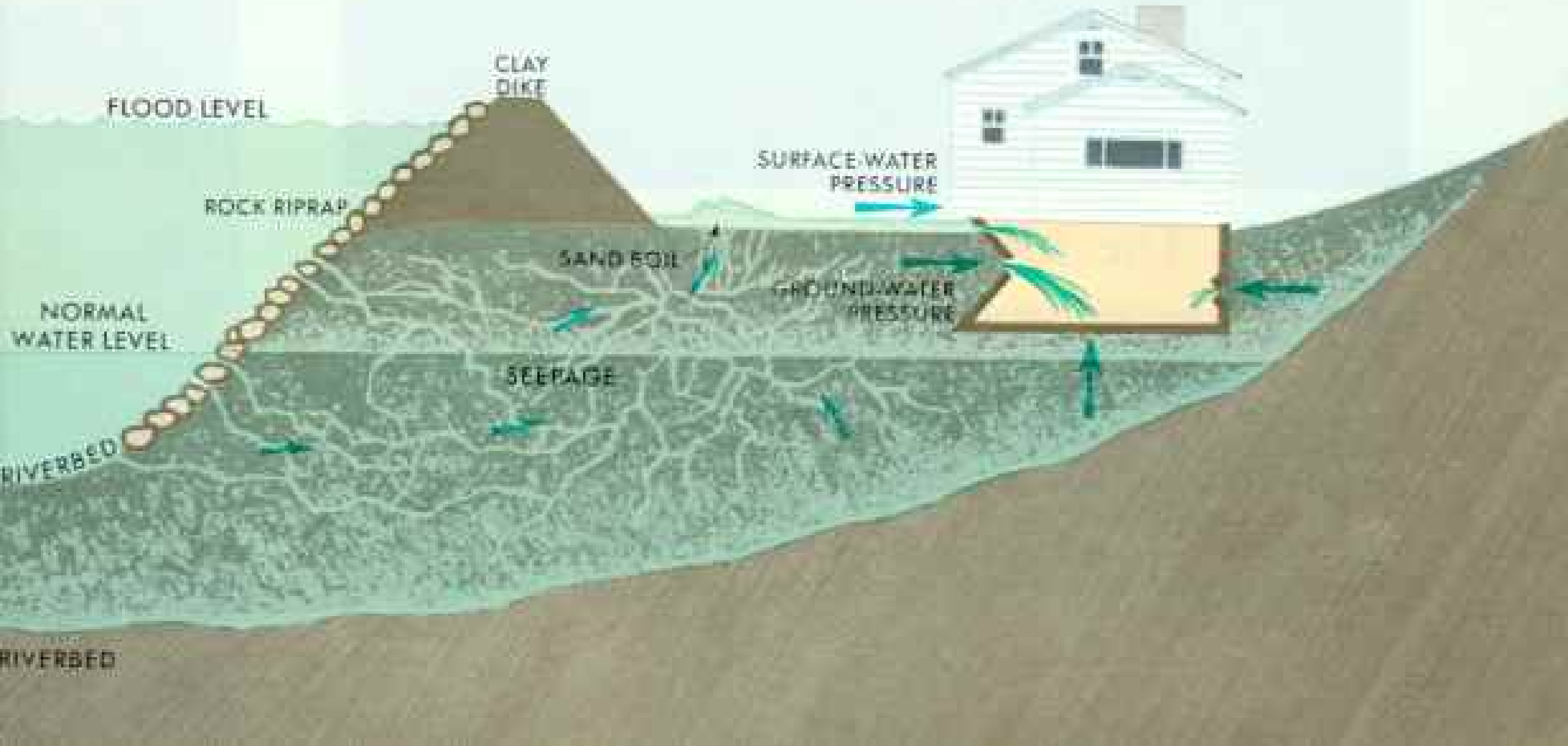
MULTIPLE THREATS call for elaborate safeguards. In this cross section, a clay dike wears plastic sheeting anchored with sandbags to keep the river within its banks; across the stream, rock chunks, called riprap, prevent currents from eroding critical points. But water seeps beneath the dike and builds pressure that collapses basement walls and bubbles up in a sand boil, right. Countering the pressure, a flood-wise homeowner at



Midnight crisis grips Mankato volunteers as water backing along a storm sewer erupts from behind the main dike, threatening inundation from within. A surveyor determines the height to which these high-schoolers must raise a chimney dike (diagram, lower left). In a blur of motion, left, a lad tosses one of 10,000 sandbags used in turning back the attack.

left fills his basement with water. A dike, shaped like a chimney, holds in water that gushes up from a sewer after debris jams open its flap gate. A similar dike could have contained the sand boil.

The river bed, carved by glacial melt and then partially filled over the centuries with loose deposits of sand and gravel, resembles those of most of the streams involved in last spring's Midwest floods.



It hit 2 schools, 15 churches, 212 businesses, and the dwellings of 11,864 people. It came as a surprise, the city manager told me, "An absolute surprise."

How could this have happened to a city of 33,000—the trading center for a third of North Dakota? I would have to find out about that later; now the watchword was evacuation. One crest of the Mouse River had struck, another was coming and would be higher. This was the time to get people and property out of the way, fast (pages 574-5).

I remember a white-haired widow. She stood on her second floor, where helpful neighbors had deposited a hundred things from downstairs. Now a boat was at her door, and she was told to hurry.

She tried to think of what to take along. But how could she find anything, in this waist-high tangle of clothes and rolled-up carpeting and kitchenware? She couldn't even find her cat. She kept saying, "Here Goldie, sweetheart, here. . . ."

Most of the moving out proceeded in trucks —supplied by movers, by farmers, by the National Guard—each with a team of assorted helpers. The American Red Cross, which directed this operation, later called it "the biggest mass movement of furniture we were ever involved in."

Family Piano Saved From Mice

My team included a National Guard driver, two officers from the nearby base of the Strategic Air Command, and a Minot State College freshman named Ken. Ken's mother finally caught up with him—he had been away from home three days, snatching sleep in the armory and eating sandwiches at the Salvation Army. Ken persuaded his mother to go away.

We lifted and lugged people's things to storage in an empty grain elevator and in private garages up on safe high ground. It certainly was a weighty business—kitchen range, hot-water tank, boxes full of NATIONAL GEOGRAPHICS. A lady said please don't take the piano to the grain elevator. "They have mice. I don't want mice in our piano." The piano went to a hotel.

KODACHROMES © N.G.S.

The Mouse attacks Minot

WILL IT HOLD? Anxiety tenses the face of Clayton Locken as the second crest of the Mouse River threatens his home in Minot's Westwood Addition. After the river's first unexpected crest had come and gone, only lightly damaging the development, Locken and 16 neighbors hired a contractor to build a private dike similar to the one around five of the homes at right. Taking no chances, a family stashes possessions on a roof, foreground. Eight nerve-racking days after this picture was made, showing the Mouse meandering within its tree-lined banks, the river again boiled out and challenged the oval defenses. Some barricaded homes, Locken's among them, stayed dry. But luck ran out on these (right and next pages).

Military police directed traffic, so that the trucks taking out furniture would not interfere with trucks bringing in clay. Army Engineers supervised dike building around schools and sewage-pumping stations that could yet be saved. The main north-south thoroughfare was hurriedly built up some seven feet, so that the additional water, soon to come down the middle of Minot, would not cut the city in half.

There was no time to build dikes for general protection—homeowners were on their own. If you were lucky enough to catch a contractor, you might get a private dike built around your house. Neighbors could chip in for a joint dike. Didn't it make sense to put up $1,000 in order to prevent damage that might cost eight times as much to repair? Yes, but if one's dike didn't hold, that would be just another $1,000 down the Mouse. Many took the gamble (below and next page).

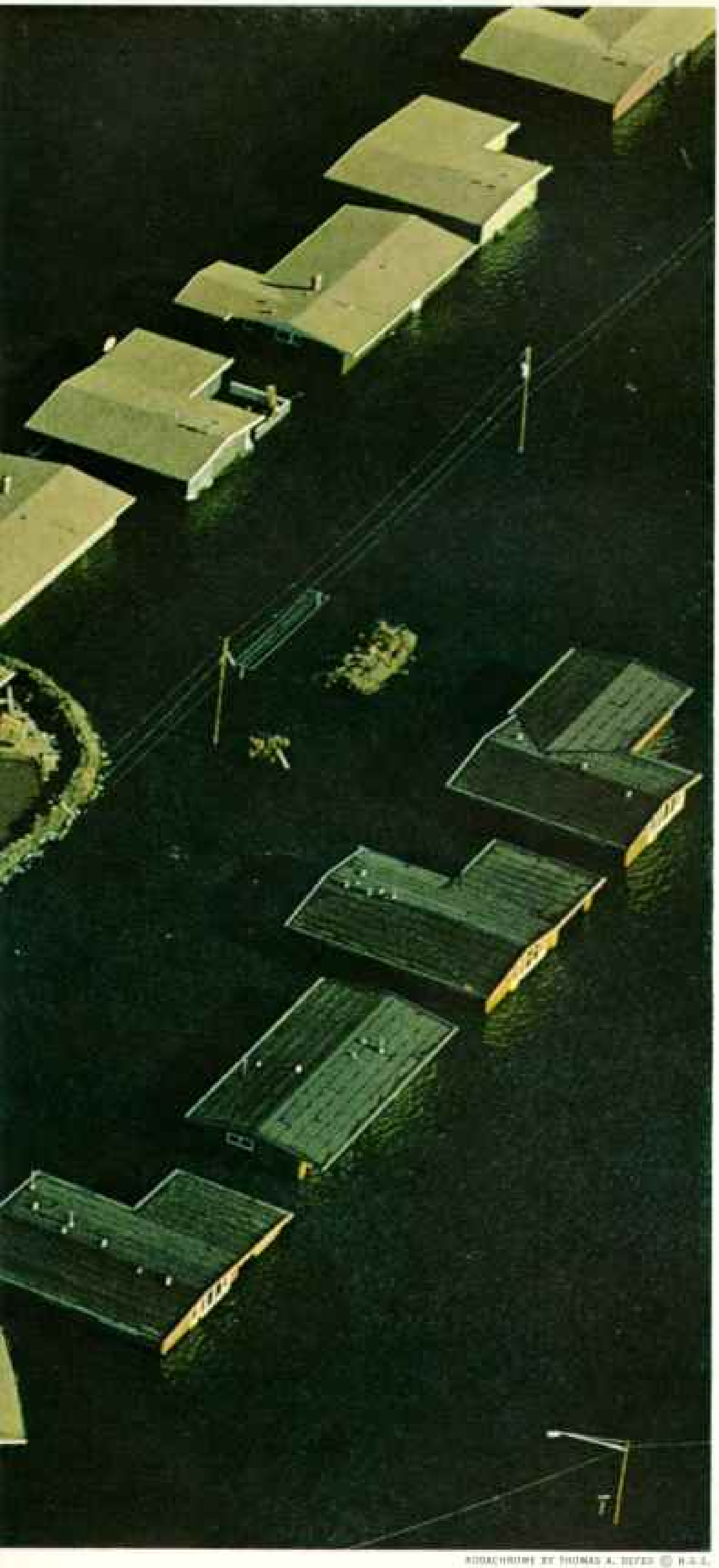
And then a silence fell on a third of the city, and the water rose and rose, as if indeed all the fountains of the deep had burst forth.

To enter the deserted areas one needed a pass from the police. Bright orange punts of the U. S. Coast Guard, sent from St. Louis, putted down the watery streets and across watery backyards. They carried policemen watching for looters.

I drifted in a canoe through Country Club Acres in the western suburbs all the way east through the zoo, over the flooded State Fair grounds, into a drowned junkyard. Back in the heart of the city I tied up before the place where Charles Pratt had lived with his wife and four children.

The Pratts had moved out in a rush, taking nothing with them. That was before the utility lines were shut off. Pressure from the flood waters caved in a concrete basement wall and cracked a gas pipe. The house filled with gas. There was a spark—from the refrigerator motor, or from a short circuit caused by the water? The house exploded, its roof landing on the roof next door. It burned for 23 hours. Out of the black rubble stuck a cast-iron frame with a set of blackened piano strings.

I sloshed about in the zoo, in water up to within an inch of the tops of my hip waders.



PHOTOGRAPHS BY THOMAS A. DEWEY © N.G.S.

Peacocks huddled on a roof. Two prairie dogs were left on a rock; hundreds had swum away, to the prairie. Many animals had been trucked to safety, but Emma the emu was dead. The zookeeper blamed the shock of evacuation.

I returned to the great silence at night, floating past houses at window level, coming close to windows and shining my flashlight into the empty rooms; empty, that is, except for water up to the light switches. One house wasn't quite that empty. In it floated an easy chair, reclining in the water. It was eerie.

I switched off my flashlight and sat quietly. The stars and the great mirror of the water made for a dim glow. The dark outlines of the houses blended with those of the massive trees and became a part of nature, too. The drowned city no longer seemed eerie. It was enchanted.

Something moved. I switched on my light and caught two little red eyes. It was a beaver, swimming past the corner of First Avenue and 8th Street, Northwest.

How had nature contrived to play Minot such a trick?

The Mouse River, as North Dakotans call it, flows from Canada. There it got most of the water that hit Minot. (Canadian maps, and some U.S. maps also, give it the French name for mouse—Souris.) Seven miles above Minot the

Defeat of a dike: "Water gushed in so fast there was nothing to do but get out," said a homeowner. The dike held, but water pushed through soft soil around a sewer pipe and burst into the enclosure. An island across the street fares better. Gaps in the nearer dike were cut to let water out as the flood receded.

Mouse is joined by the Des Lacs River, and that's where this year's troubles began.

The Des Lacs lies almost entirely within the United States, in a portion of northernmost North Dakota which was one of the few Midwestern areas *not* covered by the Weather Bureau's River and Flood Forecasting Service. After all, the Mouse hadn't given any real trouble for 42 years, and the bureau must watch its budget.

Thus no Mouse or Des Lacs data went into the computer. Temperatures in the Des Lacs Valley rose uncommonly fast; the melt was rapid; and not until six days after the Des Lacs water made the Mouse rise so unexpectedly in Minot did the discouraging word come from Canada: All gauges up there had drowned out—watch out! That second crest would be a whopper.

The Gnawing Mouse Ignored No Longer

Worst of all, Minot was blissfully unprepared psychologically. When the heavy snow fell last winter, everyone in Minnesota worried about floods right away, but in Minot people were delighted. They raced about happily in their new snowmobiles. And they looked forward to a verdant summer, to watering their lawns again without restrictions. Recent summers had been terribly dry.

True, Army Engineers at a public meeting had spoken of drastic inundations possibly to come. But that was four years ago. Nobody thought this would be the year. Now, as the waters rose so inexorably, the Weather Bureau promised to stretch its warning network across all North Dakota. Opposition to the Army Engineers' plans for reservoir-building had all but evaporated. Minot had become the most flood-minded city in the United States.

The largest congregation in town, First Lutheran, held services high and dry in the Empire movie theater. Father Paul Koutoukas of St. Mary's Greek Orthodox Church had moved to a Roman Catholic rectory, to Father Francis McKanna's of St. Leo's. Thousands of evacuees stayed with relatives or friends; 300 had asked the Red Cross for shelter. But a Red Cross expert thought that soon he would need trailers for hundreds more. How long can a large family in a small house put up another large family?

The flood in Minot stayed up 36 days.

New experts came, to survey the damage. The U. S. Department of Health, Education, and Welfare would pay for cleaning up the schools, the Office of Emergency Preparedness for fixing cracked streets and sewers. It would take months.

I watched people trickling back, starting their cleanup. A man was tearing the siding off his house, to let the insulation dry out. His neighbor absentmindedly raked the lawn; each blade of grass was gummy and gray. A woman rubbed down a garage with a detergent labeled Super Cheer.

How could they be so calm, amid the caved-in basements, the hardwood floors turned gray and crumpled a foot high? Perhaps post-flood anguish acts like the destructive force of the flood itself—less like the blow of a hammer, more like the squeeze of a vise. No man died in the Minot flood, but more than one was hospitalized with nervous exhaustion.

People whose private dikes had held were cheerful enough. But what about their dikeless neighbors—wondering if it was true that those dikes had probably meant extra water for them? True, said an Army Engineer. Any structure impeding the flow of water will raise the water level. A five-house dike might raise the level nearby a couple of inches; a number of such dikes could make it a foot. One couldn't tell without detailed analysis.

I looked closely at the houses, at the yellowish-brown smudge lines that showed how high the water had come. On quite a few it had inched just above the first floor.

I looked at the Engineers' table of figures labeled Residential Flood Damage: $15,000 house, water in basement up to first floor—$2,160. Same house, water two inches above first floor—$3,940, a difference of $1,780.

In a $30,000 house, those two inches made a difference of $4,150.

Minot Surmounts Its Third Disaster

A well-off couple with a waterlogged house said too bad this mess had to come just now. They'd have to postpone their trip to Africa to see their son in the Peace Corps.

But what about the retired railroad worker, with his house his only asset, his pension checks his only income? He was eligible for an inexpensive Government loan, to patch up the house. But how could he ever pay back?

I paid a farewell visit to a flooded-out pastor. The people of Minot, he said, are a strong people. They surmounted the great depression and the great drought. They would now surmount the great flood.

I could only say Amen. THE END

WATCH "THE MYSTERY OF ANIMAL BEHAVIOR" ON MOST OF THESE CBS TELEVISION STATIONS

(Canadian and some U. S. stations may schedule the program on another date. Check your newspaper.)

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Dothan WTVY (4)
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Mobile WKRG-TV (5)
Montgomery WCOV-TV (20)

ALASKA
Anchorage KTVA (11)
Fairbanks KTVF (11)
Sitka KIFW-TV (13)

ARIZONA
Phoenix KOOL-TV (10)
Tucson KOLD-TV (13)
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Atlanta WAGA-TV (5)
Augusta WRDW-TV (12)
Columbus WRBL-TV (3)
Macon WMAZ-TV (13)
Savannah WTOC-TV (11)

HAWAII
Honolulu KGMB-TV (9)
Wailuku KMAU-TV (3)

IDAHO
Boise KBOI-TV (2)
Idaho Falls KID-TV (3)
Lewiston KLEW-TV (3)
Twin Falls KMVT (11)

ILLINOIS
Champaign WCIA (3)
Chicago WBBM-TV (2)
Peoria WMBD-TV (31)
Quincy KHQA-TV (7)
Rockford WCEE-TV (23)
Rock Island WHBF-TV (4)

INDIANA
Evansville WEHT (25)
Fort Wayne WANE-TV (15)
Indianapolis WISH-TV (8)
Lafayette WLFI-TV (18)
South Bend WSBT-TV (22)
Terre Haute WTHI-TV (10)

IOWA
Cedar Rapids WMT-TV (2)
Des Moines KRNT-TV (8)
Mason City KGLO-TV (3)
Sioux City KMEG (14)

KANSAS
Ensign KTVC (6)
Goodland KLOE-TV (10)
Hays KAYS-TV (7)
Topeka WIBW-TV (13)
Wichita KTVH (12)

KENTUCKY
Lexington WLEX-TV (27)
Louisville WHAS-TV (11)

LOUISIANA
Baton Rouge WAFB-TV (9)
Lafayette KLFY-TV (10)
Monroe KNOE-TV (8)
New Orleans WWL-TV (4)
Shreveport KSLA-TV (12)

MAINE
Bangor WABI-TV (5)
Portland WGAN-TV (13)
Presque Isle WAGM-TV (8)

MARYLAND
Baltimore WJZ-TV (2)
Salisbury WBOC-TV (16)

MASSACHUSETTS
Boston WHDH-TV (5)

MICHIGAN
Cadillac WWTV (9)
Detroit WJBK-TV (2)
Kalamazoo WKZO-TV (3)
Lansing WJIM-TV (6)
Marquette WLUC-TV (6)
Saginaw WNEM-TV (25)

MINNESOTA
Duluth KDAL-TV (3)
Mankato KEYC-TV (12)
Minneapolis WCCO-TV (4)

MISSISSIPPI
Columbus WCBI-TV (4)
Jackson WJTV (12)
Meridian WTOK-TV (11)

MISSOURI
Cape Girardeau KFVS-TV (12)
Jefferson City KRCG-TV (13)
Joplin KODE-TV (16)
Kansas City KCMO-TV (5)
St. Louis KMOX-TV (4)
Springfield KYTV-TV (10)

MONTANA
Billings KOOK-TV (2)
Butte KXLF-TV (4)
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Las Vegas KLAS-TV (8)
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Cleveland WJW-TV (8)
Columbus WBNS-TV (10)
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Sayre KVII-TV (8)
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Medford KOBI (5)
Portland KOIN-TV (6)

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Erie WICU (12)
Harrisburg WHP-TV (21)
Johnstown WARD-TV (56)
Lebanon WLYH-TV (15)
Philadelphia WCAU-TV (10)
Pittsburgh KDKA-TV (2)
Scranton WDAU-TV (22)
York WSBA-TV (43)

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Providence WPRI-TV (12)

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Rapid City KOTA-TV (3)
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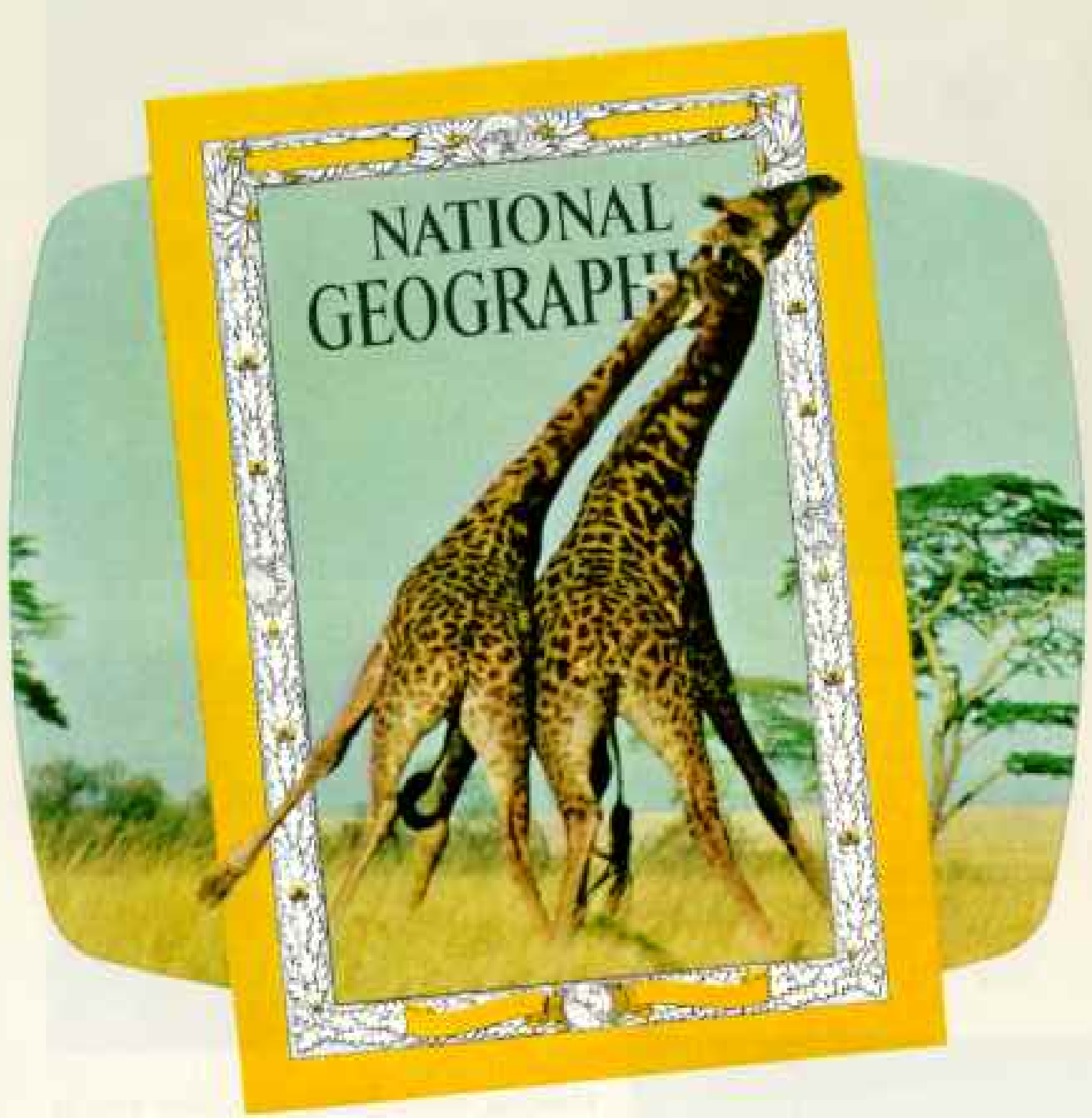
*See neighboring states

IN RITUAL BATTLE, BULL GIRAFFES OF AFRICA'S SERENGETI PLAIN BUMP HEADS AND NECKS. PAINTING BY GEORGE B. SCHALLER © N.G.S.



The Mystery of Animal Behavior

SEE IT IN COLOR, TUESDAY, OCTOBER 14

HIGHLIGHTS BY ROBERT CAMPBELL (ABOVE), IRVIN DE VORE (CENTER), AND ROBERT F. SISSON © N.G.S.

Stuffed leopard, animated by a car's windshield-wiper motor, is set out on the plains of East Africa by Heinz Sielmann as he prepares to film the aggressive behavior of a troop of baboons. The dominant members of the troop attacked, screaming a signal to the other baboons to close in. A less assertive male (right) disguises his fear of their common enemy with a yawn.

592B

Floating on its back, a sea otter uses its chest as a table while dining on octopus in calm waters off the Alaskan coast. Sometimes the animal becomes a tool user, breaking the shell of a clam by banging it on a stone borne on its breast.

Tear out this page and keep it near your television set as a reminder

Window on the amazing ways of wildlife

A FAT AND FURRY sea otter floats in frigid Alaskan waters, cracking a clam on a stone which it clutches to its chest as an anvil. Heinz Sielmann is there.

Bighorn rams in the Canadian Rockies clash head on in thunderous rivalry for a harem of ewes; Heinz Sielmann is on hand. A pair of kangaroos spar in the Australian bush—again, Heinz Sielmann films the fight.

In his widely acclaimed career as a student of nature's wonders, Sielmann has captured a world of extraordinary rituals on motion-picture film. You can glimpse this world on Tuesday evening, October 14, when the National Geographic Society presents "The Mystery of Animal Behavior," the first in its 1969-1970 series of color TV documentaries.

At the renowned Max Planck Institute of Behavioral Physiology in Germany, with which he is associated, Sielmann and his cameras offer rare insights into the protective instincts of a parent: A mouth-breeding fish that shelters her eggs in her mouth, from spawning until they hatch. And you will watch this master photographer's ingenious preparations to film a woodpecker feeding its offspring inside their dark tree-trunk nest.

"The Mystery of Animal Behavior," narrated by Joseph Campanella, is produced by the National Geographic Society in association with Metromedia Producers Corporation (MPC). Sponsors are Crest Toothpaste and Timex Watches.

Racing their shadows, a polar bear and her cubs lumber across pack ice near Shishmaref, Alaska. As Sielmann and Eskimo assistants photographed a mother bear on a beach, she charged, scattering the crew.

HIGHLIGHTS BY JOHN J. BURNS © N.G.S.

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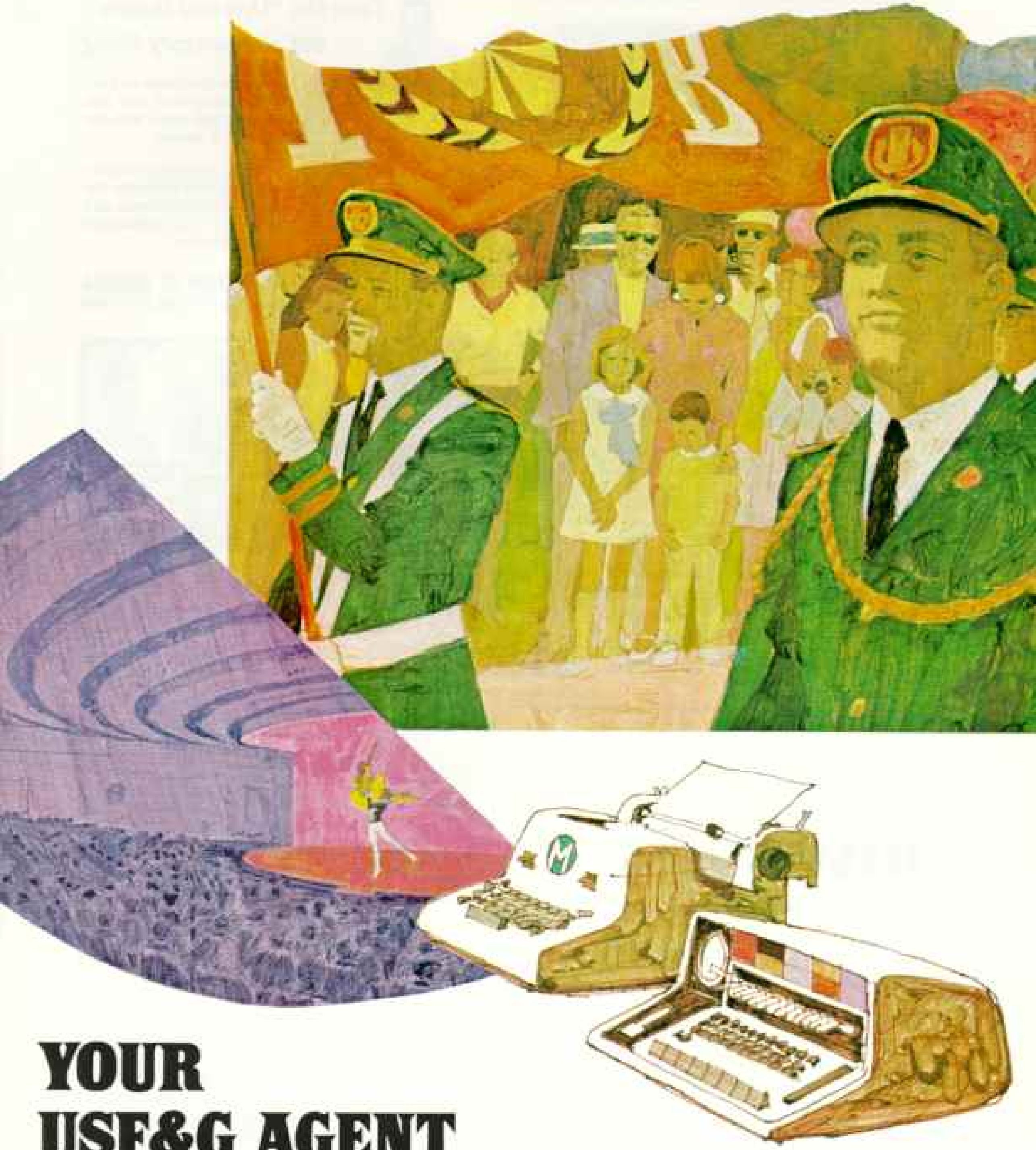

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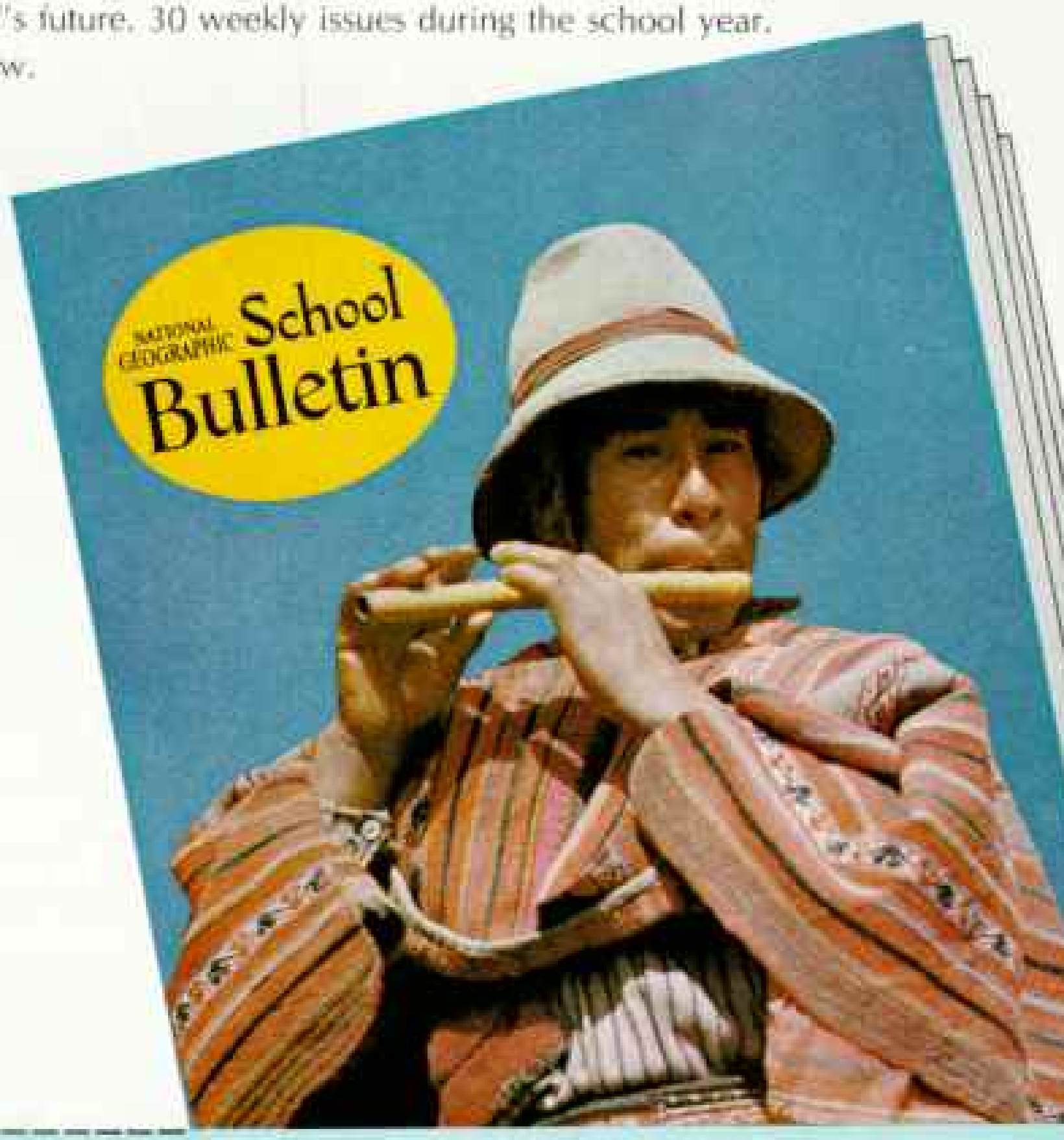

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