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# THE NATIONAL GEOGRAPHIC MAGAZINE



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VOL. 121, No. 5      MAY, 1962

## NEW GUINEA



**A**T A TIME when astronauts have orbited the earth and scientists plan conquests of the planets, one corner of the world still competes with space for men's imaginations.

New Guinea—the very name quickens the pulse.

Here, on an island flung across the tropical Pacific like a grotesque 1,500-mile-long bird, are mountain valleys and jungle pockets that await their first explorer. Here live people who never saw a wheel until it dropped to them from the skies on an airplane.

But the world changes, and soon it will be too late to see New Guinea in its pristine beauty. Suddenly this living museum of primitive man has burst into the news. Michael Rockefeller disappears tragically, and attention focuses on the island's almost unknown southwest coast. An old feud between Indonesians and Dutch flames anew. Control of New Guinea becomes an explosive political issue. The United Nations calls for independence for colonies and Trust Territories. Australia takes a new look at its wards in eastern New Guinea.

To bring to Society members a fresh portrait of this second largest island (after Greenland), Assistant Editor John Scofield traveled from the western tip of Netherlands territory to the idyllic South Seas atmosphere of eastern Papua.

Thanks to cooperation extended to NATIONAL GEOGRAPHIC by both Australian and Dutch authorities, Mr. Scofield was able to visit places that would otherwise have been nearly impossible to reach. His survey includes unique photographs of the largest tribal gathering ever to take place in the South Pacific (pages 618-627). He also brought back unforgettable glimpses of a community of head-hunters and cannibals of the little-known Casuarina Coast (pages 596-601). His are the first color photographs of these extraordinary people to appear in an American publication.

— The Editor.

# Netherlands New Guinea

*Whether the Indonesian or Dutch  
point of view eventually prevails,  
West Papua faces an uncertain future*

By JOHN SCOFIELD

*Photographs by the author*

THE OLD HEAD-HUNTER'S boldly carved face radiated strength and bravery. He was the kind, I thought, who would as surely have been a leader had he been born in New Jersey instead of in the tiny village of Amman Namgai, hidden away on New Guinea's swampy southwest coast.

As he sang his song of vengeance, he beat a savage rhythm on an hourglass-shaped drum on which a head of lizard skin had been glued with human blood.

Behind him, two carvers worked intently, shaping stylized human figures along an enormous log. These were memorials to villagers slain by raiding head-hunters from a nearby settlement.

I had come to Netherlands New Guinea's forbidding Asmat (map, page 586) on a survey that would carry me from one end of this adventure-packed island to the other. That morning the villagers of Atsj—it was they who had taken the heads in Amman Namgai—had greeted me with the traditional welcome of this seldom-visited coast. A fleet of war canoes skimmed the river around the patrol boat that had brought me, and the warriors beat a stirring rhythm on the sides of their fragile craft with ironwood paddles ornamented with cockatoo feathers (opposite).

I marveled, as I watched these moving spectacles, that such things could still exist in our workaday world. I had arrived in New Guinea at that fleeting moment when man's nightmare past lay within the grasp of the present. With the creation of a handful of wilderness airstrips, places had suddenly come into

Living exhibits in a museum of early man, plumed Asmat warriors sweep the Zuid Eilanden River in dugout canoes.

Long isolated by swamps, jungles, gorges, and mountains, many Papuans now face civilization for the first time. Pioneering teachers, doctors, missionaries, and government officers work to dispel the dark terrors of ignorance.

Head-hunters and cannibals until recently, these tribesmen stand to paddle craft so unstable that white men may tip over even when sitting. A bold Asmat wood carving like those sought by Michael Rockefeller on his ill-fated expedition ornaments the nearest canoe. Less than three weeks after this photograph was made at Atsj, Mr. Rockefeller disappeared while on his way to the same village.









When the Netherlands East Indies won freedom in 1949, the Dutch kept only western New Guinea of their once vast Pacific empire. Today Indonesians, who call this half of the island West Irian, consider it their nation's property. The Dutch want to help the natives progress to a point where they can determine their own future. Though undeveloped and almost roadless, Netherlands New Guinea has one of the Southern Hemisphere's largest airports at Biak, since 1960 a regular jet airliner stop between Amsterdam and Sydney.



## Netherlands New Guinea



### Arafura Sea



reach that few white men had glimpsed before me. And yet the impact of the 20th century had not been at work long enough to change the people deeply.

"The last head-hunting in the Asmat—real organized head-hunting—took place about five years ago," anthropologist David Eyde told me in Amman Namgai. "But the ceremonies connected with it still go on."

Around me the jungle-mantled ranges and sodden rain forests beckoned, guarding ways of life that had not changed in thousands of years. But time to see them was running out.

**T**HE SIGN said *Huis te koop*—"house for sale."

"There's the story of Netherlands New Guinea," my friend said, and shrugged.

I had known before I went there that this land of unexplored mountain fastnesses and steaming jungles was undeveloped and unpromising, that the Dutch were spending some \$30,000,000 a year and getting back only headaches. But I was unprepared for the stark pessimism that seemed a part of the very air I breathed.

The Dutch were discouraged; it was obvious everywhere I looked. Several thousand of the territory's 18,000 Europeans had already drifted away to Holland or Australia or, in the case of men who could not bear to leave their beloved tropics, to some other South Pacific isle. Hollandia, the capital—it is actually not much more than a village—wore a wistful, oddly deserted look, as if half its people were away at the beach.

"What is there here for us or for our children," asked the ones who were left, "when we will have to get out sooner or later?"

In fact, there isn't much for their children—or for the natives' children either. For, added to an uncertain political future, nature endowed the island capriciously, and the Dutch half came out second best. Here, for instance, was no rich gold strike like the stampede to Edie Creek that brought capital and men to Australian New Guinea in the 1920's.

"Why have the Dutch had so much difficulty?" I asked Dr. J. Victor de Bruijn one day in Hollandia. During World War II, de Bruijn's exploits behind the Japanese lines earned him the title of "Jungle Pimpernel." Today he serves as the Government's Adviser for Native Affairs. Few men know New Guinea so well—or love it so intensely.

"West New Guinea's soil is poor and its population thin," Dr. de Bruijn told me. "De-

velopment here was neglected—quite naturally, I think—in favor of the good soils, the more advanced people, and the mineral resources of Java and Sumatra.

"For a time we looked to oil as our economic salvation, but only one or two fields remain in production, and we expect them to dry up in a few years. There are deposits of copper and nickel, but hundreds of millions of dollars will be needed to develop them.

"It will be a long time," he admitted, "before western New Guinea can support itself."

Native-born Nicolaas Jouwe, representing Hollandia in the New Guinea Council, was even more emphatic. "Where does West Papua's economy stand? Nowhere! In my opinion we need at least 25 years before we can become economically self-sufficient."

If western New Guinea faces an uncertain future economically, Jouwe himself represents political progress, and here Netherlands New Guinea forges steadily ahead. Of the 28 members of the New Guinea Council, established in 1961 to rule jointly with Governor P. J. Platteel, 22 are Papuans, as natives of New Guinea are called. One Indonesian and five Dutchmen represent the minorities.

### Worthless Cane Brought Wealth to Others

Curiously, this island which has had so difficult a time developing a livelihood of its own has contributed much to the wealth of other lands.

My companion in Dutch New Guinea was Professor J. J. Ochse, an eminent tropical botanist who has spent many years in Southeast Asia. Since the war he has devoted himself to the search for plants that might aid botanists in their never-ending quest for disease-resistant varieties.

One day Professor Ochse showed me a lush strip of jungle barely an hour's drive from Hollandia. He pointed to a rank growth beside a shallow stream.

"Sugar cane," he said. "Useless commercially, but plants of this species have been taken to the United States, India, Java, and many other countries for use in developing disease-resistant, high-yielding varieties."\*

Despite their pessimism about the future, I found the Dutch making determined efforts to raise the educational level of their Papuan charges. In Hollandia's Kota Radja Junior Technical School I saw student mechanics

\*Dr. E. W. Brandes described his discovery of disease-resistant sugar cane species in New Guinea, and cautiously prophesied their future importance, in *NATIONAL GEOGRAPHIC*, September, 1959.





learning such basic skills as arithmetic and the construction of a septic tank. And I found a refreshing innovation in a Protestant mission classroom nearby: a room full of 10- and 12-year-old girls paired off, intently playing chess (page 590).

"Chess—how you say—stretches their minds," their teacher explained.

But I still find myself puzzled by the class of earnest young mechanics at Kota Radja, all gravely studying traffic problems created when a highway crosses a busy railway line. This in a land of fewer than two thousand private automobiles, of practically no paved roads, and with exactly six miles of narrow-gauge railway!

**W**ORLD WAR II, which swirled so furiously around this improbable land, was seldom mentioned. And, in fact, little remained to remind me of it. New towns have arisen from the rubble of old ones knocked flat by Japanese and Allied bombs, and landing strips and camps that once held whole divisions lie hidden in the jungle.

Rusting landing craft protrude gauntly from harbors here and there, and the hulks of a few Flying Fortresses sleep in the grass where great airbases once flourished. But Japanese and Hong Kong scrapyards have converted most of what was movable into baby buggies and chrome-plated eggbeaters.

Only on Hollandia's "Invasion Beach," where General Douglas MacArthur's forces came ashore one eventful morning in 1944, did I find what I had expected to see in so many places. In a mute line along the shore lie dozens of abandoned, rusted-out landing craft.

Homes mounted on stilts dot coral-crust-ed shallows off Japen Island. Fishermen-owners sell their catches in nearby Seroei, only town in Netherlands New Guinea not bombed into ruins during World War II.

#### Rusting Hulk of a Landing Craft Recalls the Invasion of Hollandia

Americans stormed the beach in April, 1944, but met little resistance. Within months Hollandia became a huge Allied staging area for the liberation of the Philippines. In October nearly 500 ships rendezvoused here. Linked by catwalks, they covered the harbor waters. Lights aglow at night, the armada suggested a city at sea.

But the city has lost its most prized memento of the wartime years.

I had been invited to lunch by Governor Platteel, and we were looking out over the city's picture-postcard harbor from his hill-top mansion. Below us, in place of the fleets of warships that had bristled there when General MacArthur's forces were gathering for the liberation of the Philippines, lay only a trio of graceful sailboats.

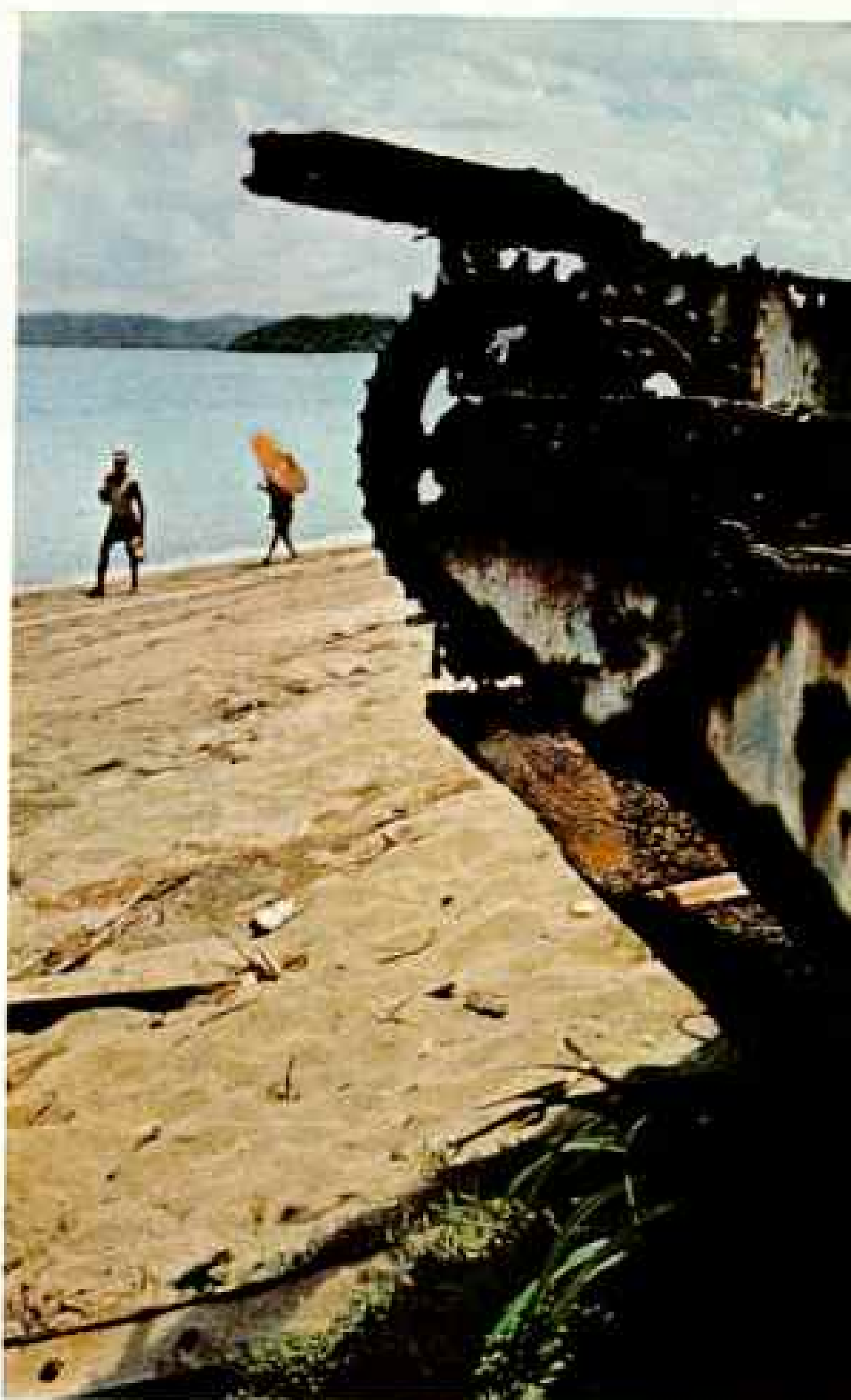
I complimented the Governor on his airy residence, with its clumps of flowering orchids and its magnificent view.

"Were you in New Guinea during the war?" he asked. I told him I had served in Europe.

"Then you wouldn't have noticed," he said. "This house is pleasant and modern, but my old one was more historic.

"Before this was built," he continued as we walked toward the dining room, "the Governor's residence was in General MacArthur's old home. It was there that he planned his return to the Philippines."

589





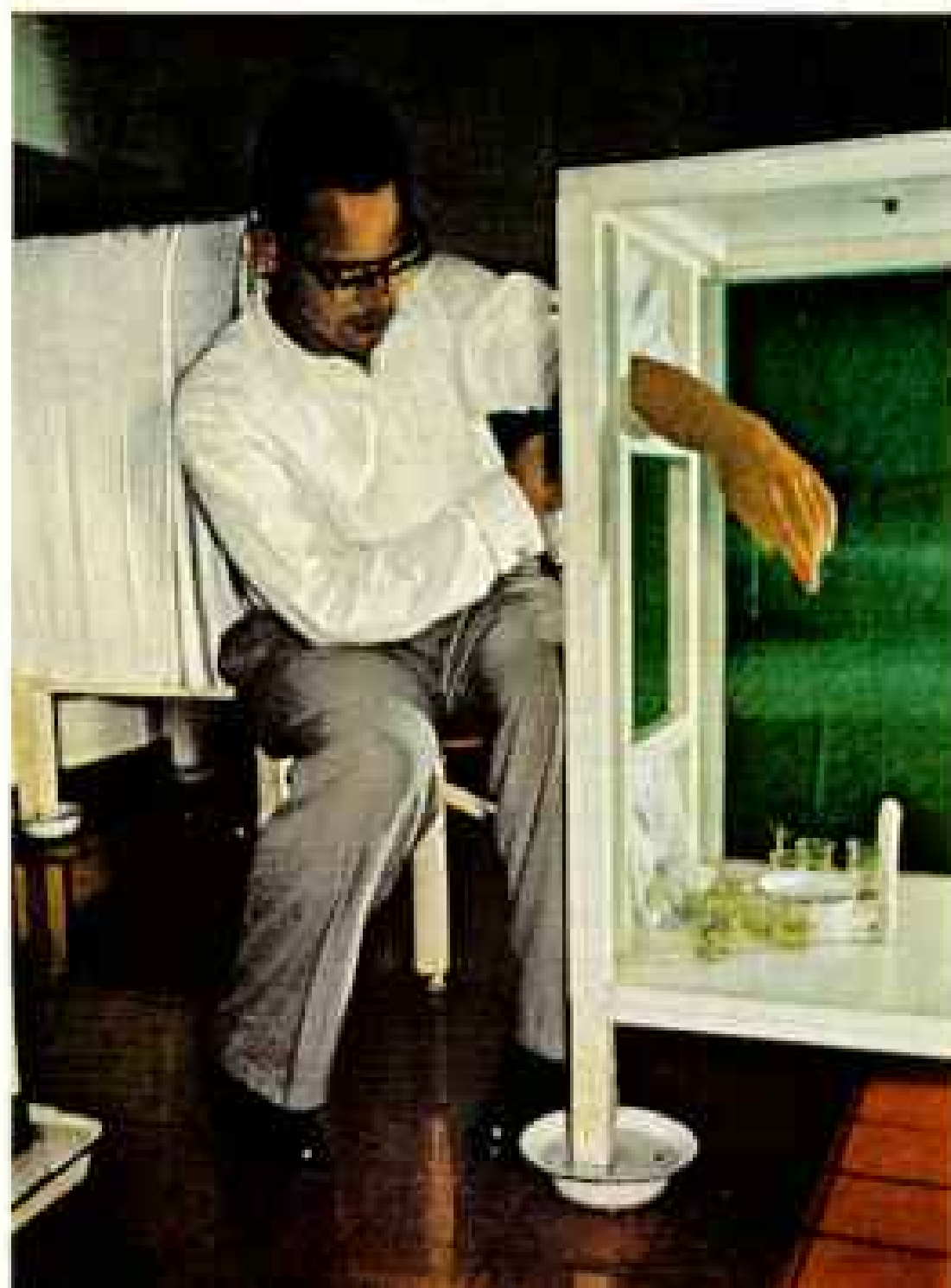
Mind-stretching game, chess absorbs students at a Protestant mission school in Hollandia. Co-operating with church-supported schools, Dutch officials set up educational standards and certify teachers.

Mosquitoes feed on blood from the arm of Dr. Joseph Meuwissen, who makes the sacrifice for science. Wire mesh confines carriers of filariae, parasites that may cause elephantiasis. The life cycle of *Culex fatigans* is under study at the Public Health Department's mosquito-borne-disease control center in Hollandia. Researchers wet down the tile floor to increase humidity and simulate the insect's breeding conditions.

OPINAY, paramount chief of the Baliem Valley's Wellese tribe, grinned knowingly, though he understood not a word we were saying. The potbellied gnome wore nothing in the chill of this 5,000-foot-high Netherlands New Guinea valley but a white shell necklace and the end of a gourd (page 592).

"I took Opinay to Hollandia with me a few months ago," District Officer Carel Schneider told me in English. "I thought it might broaden his outlook to see even this much of the outside world.

"Opinay took it all very calmly, including his first airplane ride. When we came back, he decided that the big town was all right, but he preferred it here. White people have fewer pigs—they represent wealth even more than they do food to the Baliem natives—and Hollandia's paramount chief





Linking felt bones of an imitation skeleton, student nurses at Central Hospital study for work in village clinics. A Dutch graduate nurse instructs these Papuan trainees.

School convenes in a tropical playground of swaying palms and warm waters. These preschoolers yearn to join classes at the church on Kaju Pulu, an island in Hollandia Harbor.

Netherlands New Guinea's future postal clerks learn telegraphy at a government training center in Hollandia.



AS BRITANNIA AND EDWARDS (RIGHT)  
 ALL BY JOHN SCOFFIELD, NATIONAL GEOGRAPHIC STAFF © N. G. S.

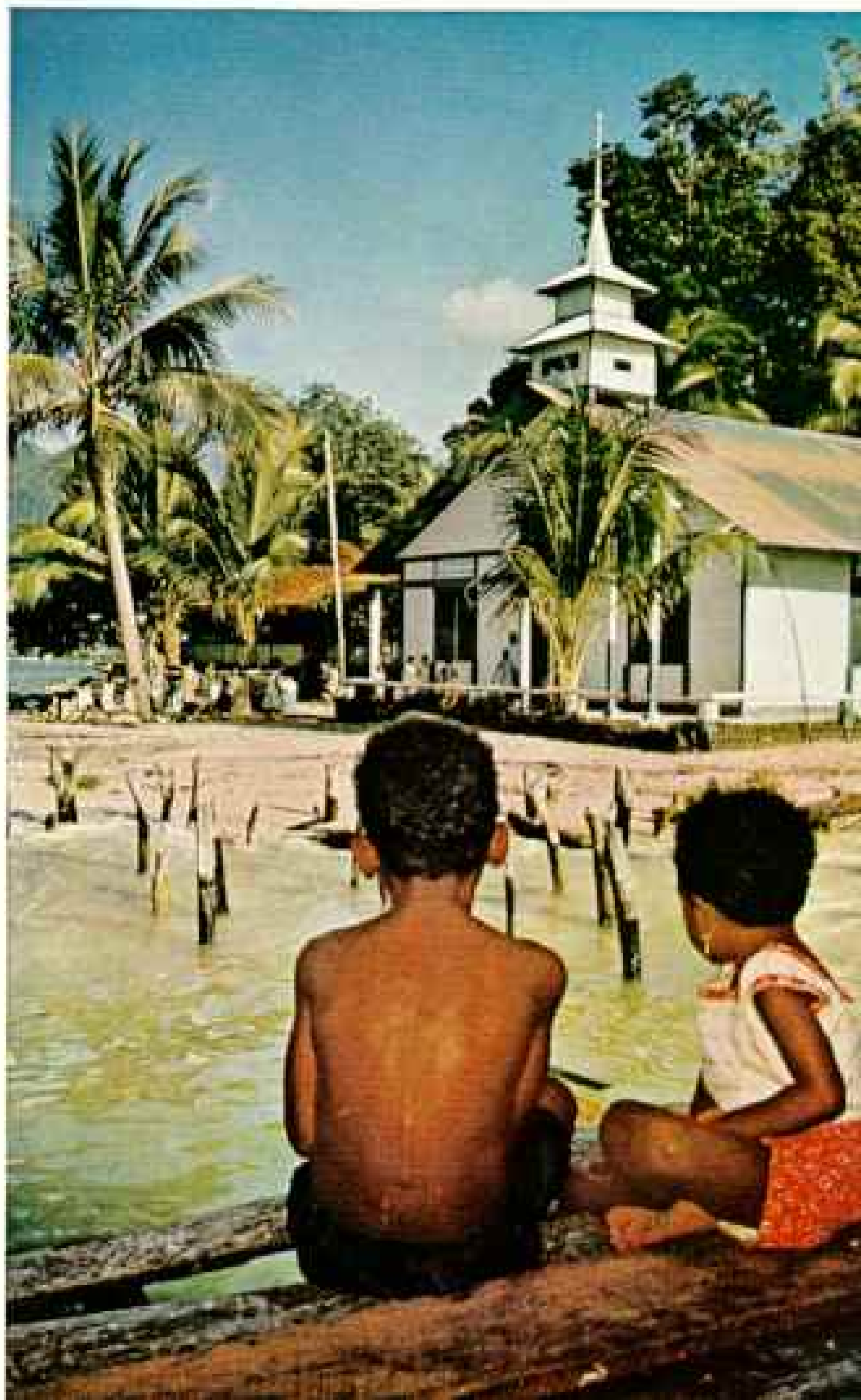
—he meant Governor Platteel—is permitted to have only one wife!"

This Stone Age valley in the shadow of the Snow Mountains became famous in May of 1945 with the crash there of a United States Army transport plane. Three passengers; one a woman, survived to be rescued weeks later in a dramatic glider operation.\*

While the survivors awaited help, the world's newspapers had a field day: "Incredible Shangri-La," crowed the front pages; "completely lost to the world. Hogs as big as donkeys. No white man has ever before set foot in the valley."

The bubble burst when the embarrassed papers learned that this was the "Grand Valley" discovered  
*(Continued on page 395)*

\*An account of this accident and subsequent rescue of survivors appeared in the December, 1945; NATIONAL GEOGRAPHIC.







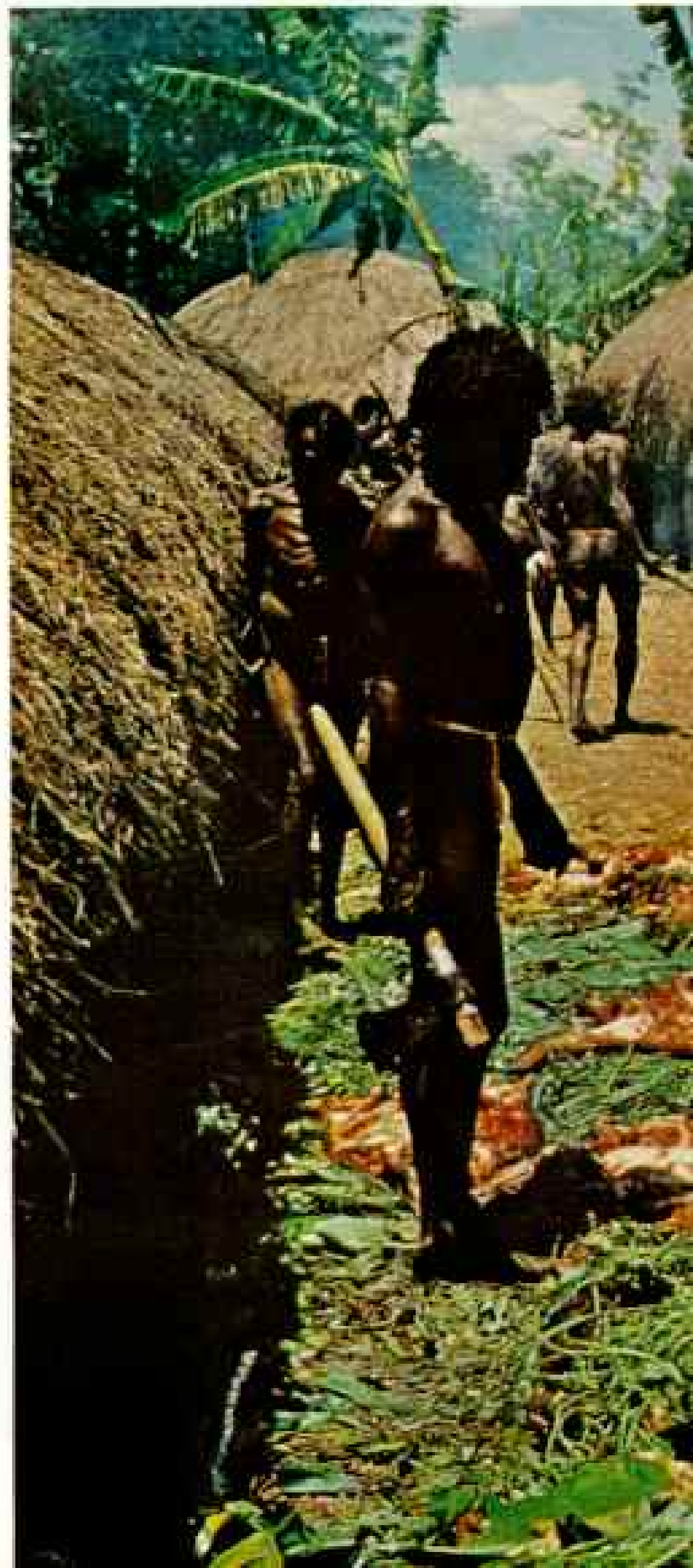
His pig stolen, Chief Opimay files a complaint with District Officer Carel Schneider, who uses the Papuan's bailer-shell necklace as a desk for note taking. A Baliem Valley man, the chief blackens his body with soot. Bark-fiber net covers his hair.

## Stone Age villagers

**T**UCKED in the folds of the Snow Mountains, the Baliem Valley and its 50,000 people remained hidden from the world until 1938. Today steel axes replace stone ones and patrol officers redress war-provoking grievances (left), but tribal life still lies locked in millenniums-old patterns.

In this fortified village, the time has arrived to marry the young girls who have come of age during the past two years. While brides primp for the ceremony in windowless thatched-roof homes, their

Ringtlets greased with pig fat and tipped with birds' flight quills frame the soot-adorned face of a jew's-harp player in the Baliem Valley. His instrument, a sliver of bamboo, emits a gentle twanging sound. A bank account of strung cowrie shells hangs from the musician's neck.



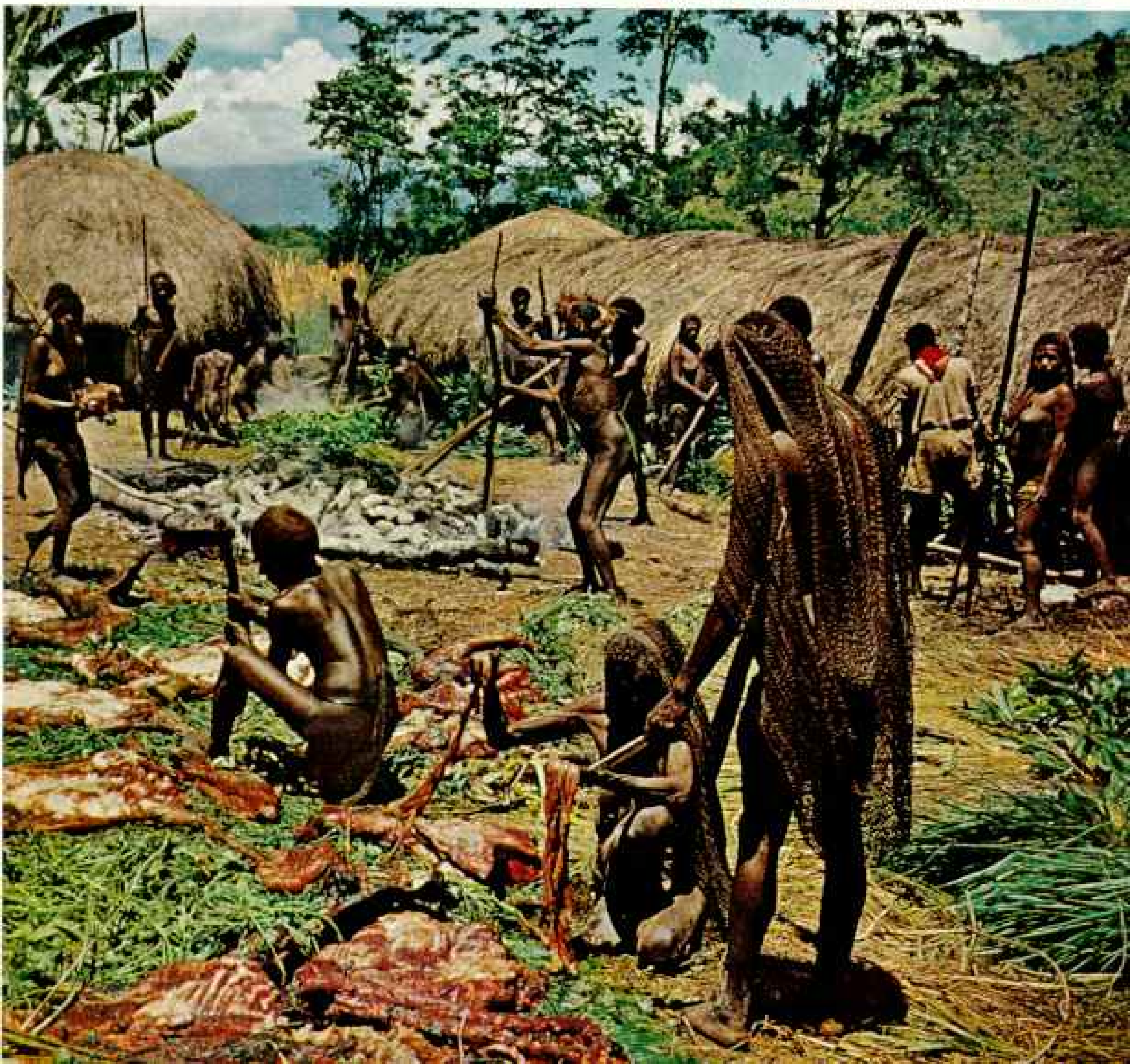
Elfin grin of an elder welcomes the author to a Baliem village. Despite chill in the Highlands, the oldster wears only head feathers and a curling gourd. Left hand shows missing finger joints that he chopped off in mourning when relatives died.

## cook a nuptial feast

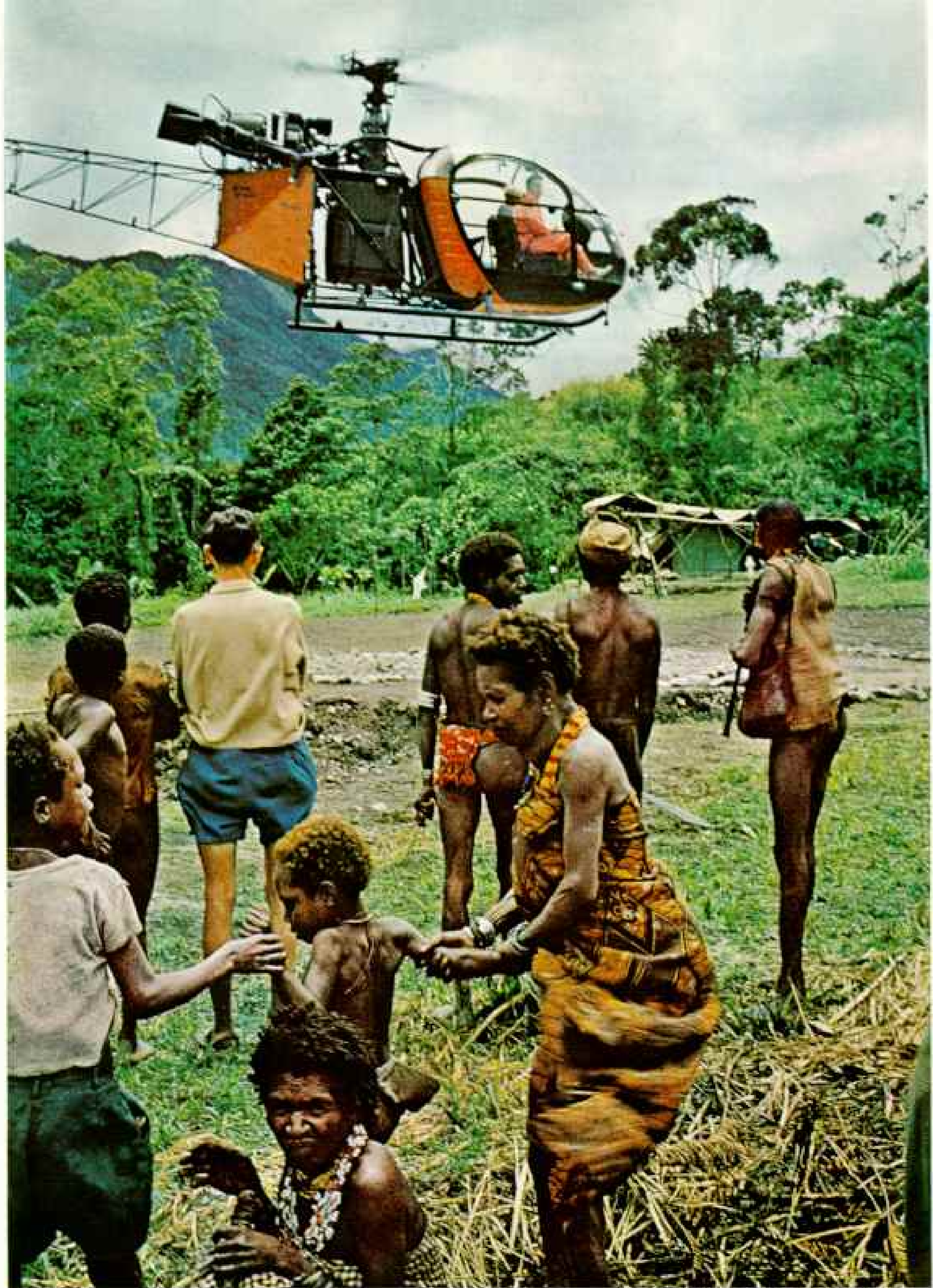
elders prepare a pig feast on the village common. Men in center split carcasses while others heat rocks that will be packed in a pit between layers of meat and foliage (extreme right). Women in foreground pick over entrails for edible bits that they will wash and share with everyone. At dusk the girls are wed, the steamed pork is unearthed, and the feasting begins. Because living pigs are valuable to these people as symbols of wealth, they seldom kill the animals except on festive occasions.



PHOTOGRAPHS BY JOHN SCOFFIELD, NATIONAL GEOGRAPHIC STAFF © N. G. S.







WOLFGANG W. © NATIONAL GEOGRAPHIC SOCIETY

### Helicopter-borne Scientists, Prospecting for Progress, Survey the Vogelkop

To aid the Netherlands in advancing west New Guinea, the European Economic Community set aside \$35,000,000 for development projects. Geologists, flying a French jet-powered craft, search for mineral wealth. Landing at a remote camp, they stir awe among Arfak Mountain men, fearful women and children scurry to safety.



and explored seven years earlier by a joint U. S.-Dutch expedition led by Richard Archbold of the American Museum of Natural History.\*

"It was perhaps fortunate," said a museum news release modestly, "that the survivors . . . found themselves in a locality in which the Archbold party had been able to make conditions reasonably safe. . . ."

The Baliem, as it came to be known, remains a Shangri-La of cloud-wreathed peaks and mountain people who stubbornly refuse to change their ways—outwardly at least.

While I was at Wamena, a tall, fuzz-bearded Dutch patrol officer—he looked not more than 18—showed up to report the conclusion of a peace treaty between two groups of the valley's die-hard Stone Age tribesmen. We shook hands and he disappeared before I could even be sure of his name.

He was one of that dedicated band of young men who, both here and in Australian New Guinea, lead possibly the most romantic careers left in today's world. Usually single and in their early twenties, they think nothing of walking for days through unknown country to extend government control over men who have never before seen an outsider.

District Officer Schneider accepted the news of the peace agreement matter-of-factly. The week before he had himself talked the last two major tribes still at war in the Baliem into making peace.

"Now we will start them road building," he said. "When we take war away—it's a very central thing in their culture—we have to give them something else to do."

#### Natives Find Safety on Roads

It seemed strange, building jeep roads in a valley almost without wheeled transport and linked to the outside world only by air. But the roads serve another purpose.

"They become neutral ground between tribes that used to kill one another on sight," Schneider said. "Once they have roads, the Baliem natives can safely walk to and from the valley's one town. They stay in the exact center," he added, "on the theory that it's the safest place."

Although there is progress against tribal warfare, individual killings are another matter. The young bloods of the Baliem still feel they must prove their manhood by killing someone. They do it from ambush, with bow and arrow or a long ironwood spear, and a

woman or child will do just as well as a man.

I was reminded of this often in Wamena, the emerging "capital" of Shangri-La, by the sight of a dozen tribal murderers, manacled in pairs, being marched off to do hard labor.

"The worst punishment you can inflict on these mountain people," Schneider told me, "is to take them away from their villages and their families. We hope the sight of these fellows will lead to more civilized ways of proving their bravery."

AS I WINGED BACK to the Baliem Valley on a charter flight from the southwest coast, missionary pilot Robert Johanson suddenly banked his little single-engine Cessna. We climbed toward a patch of blue that pierced the clouds shrouding majestic Wilhelmina Top. Then we were in the clear again, droning above a mass of jumbled mountains with, here and there, a village or a neat grid of drainage ditches where natives had planted sweet potatoes.

"Upper Lorentz River," Johanson shouted. "Some day we'll have a landing strip there." I raised my eyebrows—an easier way of asking a question than to compete with the noise of the engine.

"Plenty of people down there," he explained, "but I doubt any white man has ever gotten in. Country's too rough."

"How do you know?" I shouted.

"The natives occasionally come out to mission settlements. They tell of trails that hang on cliff faces, that kind of thing."

"Be a long time before civilization gets to them," I guessed aloud. Bob nodded and put the plane into a long glide toward the Wamena airstrip.

New Guinea, both Australian and Dutch, is dotted with these pockets of Stone Age men who remain uncontacted and unhelped because there are too few of them and their country is too rough to open up. Weeks after Johanson and I had flown back to the Baliem Valley, and hundreds of miles west of there, I heard of one approach to this problem. John van Bodegom, the Dutch Resident in Manokwari, told me the story.

"A few years ago on the Queen's Birthday, when the chiefs often come to town for a visit," he began, "I received a delegation of wiry little hill men from the Arfak Mountains.

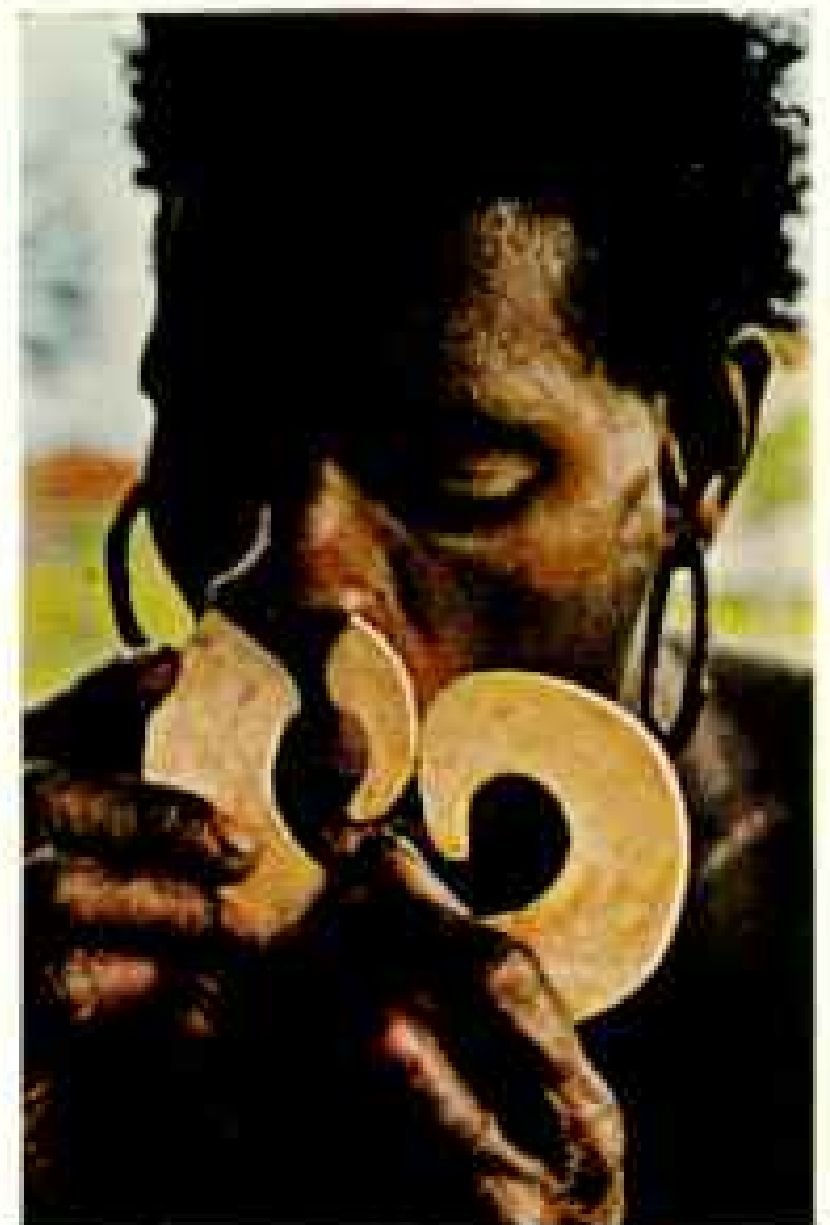
\*See "Unknown New Guinea," by Richard Archbold, NATIONAL GEOGRAPHIC, March, 1941.



### Warrior Wears Mother's Skull to Protect Him From Her Ghost

Head-hunters and cannibals of the wild Casuarina Coast live in a nightmare of fear. This man with war bow and arrows fights supernatural foes by displaying bones of the dead. A vertebra from his mother's body dangles from his neck. Woven armband holds a dagger of human bone. Pig-tusk armbands signify that he has taken two heads.

Mustache of cut shell worn in pierced septum adorns a warrior.



RODCHROWER © NATIONAL GEOGRAPHIC SOCIETY

They represented the Moiray, Hattam, and Meach clans—some of the sixteen or eighteen thousand people scattered over the Vogelkop [map, page 586].

"They wanted schools for their people, they told me, and doctors, and a way to sell their crops. In substance, they were serving notice on us: 'We don't want to remain savages any longer.'"

The Resident, who had long worried about this problem, quickly made a proposal.

"Now, look here," he said, re-enacting for me his conversation with the chiefs, "we can't do anything for you if you stay in your mountains. There simply aren't enough of us. But if you'll move your village down to the foothills, nearer to town, I promise to do everything in my power to help you."

"And what happened?" I asked.

"Why not look for yourself?" he said.

The next morning I jounced for two hours

over a rutted jeep road to Warmare settlement. What I saw there wasn't outwardly impressive—a scattering of houses raised on stilts and windowless in the mountain fashion, each surrounded by bananas and an untidy vegetable plot. But there was a school full of chattering Moiray children, a store to cater to the people's simple needs, and a clinic. Before, it had been a three-day walk from their mountain fastnesses just to ask for medical help, and another three days back—if there was anyone to go.

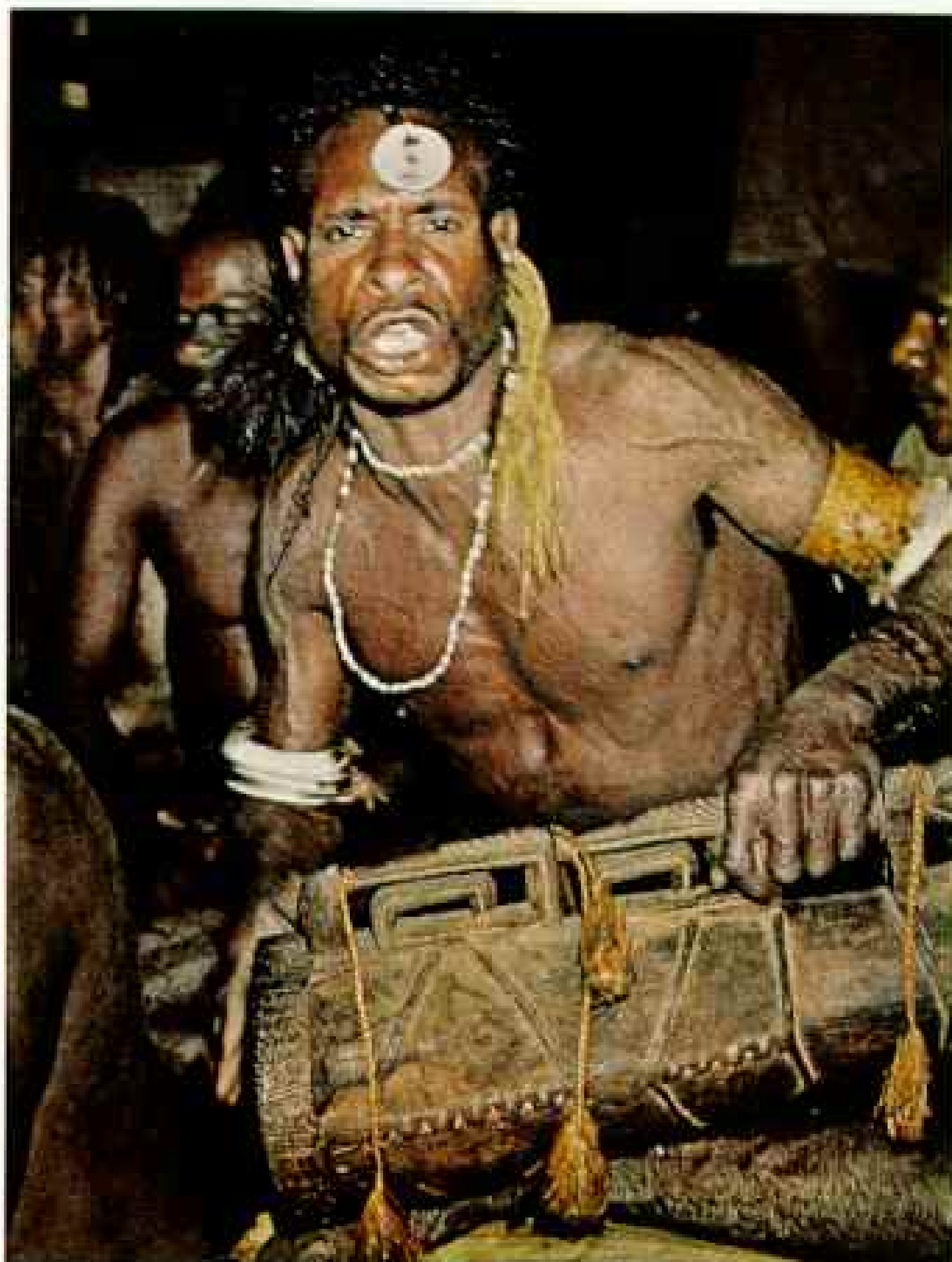
"Next year we hope to start with the Hattam people," the Resident told me when I saw him again that evening. "But you can't push them; they'll have to see how well the Moirays are making out before they'll leave their own mountains."

"You know, these people take nothing for granted," he said. "They know it will take time to create a new community down here,

### Owl-eyed, Beak-nosed Image Recalls the Creation of Man

Asmat people believe that a mythological hero once traveled their land and built men's clubhouses. He filled the halls with wooden figures and then brought them to life by beating a drum, thus peopling the region.

This 18-inch carving, made to decorate a men's house, belongs to a medical missionary at Piriapoen. Michael Rockefeller, son of the New York Governor, tried to buy the figure for New York City's Museum of Primitive Art.



Crying vengeance and drumming the point home, a head-hunter incites Otsjanep villagers to retaliation at a men's-house ceremony honoring warriors killed in raids. Others carve statues of the dead. Lizard-skin drumhead is glued on with human blood.

perhaps longer than their own lifetimes. But I told them this was not for them. They must do it for their children's sake.

"The rest of them are up there now, thinking it over. One of these days another delegation will come down, and then another, and another. . . ."

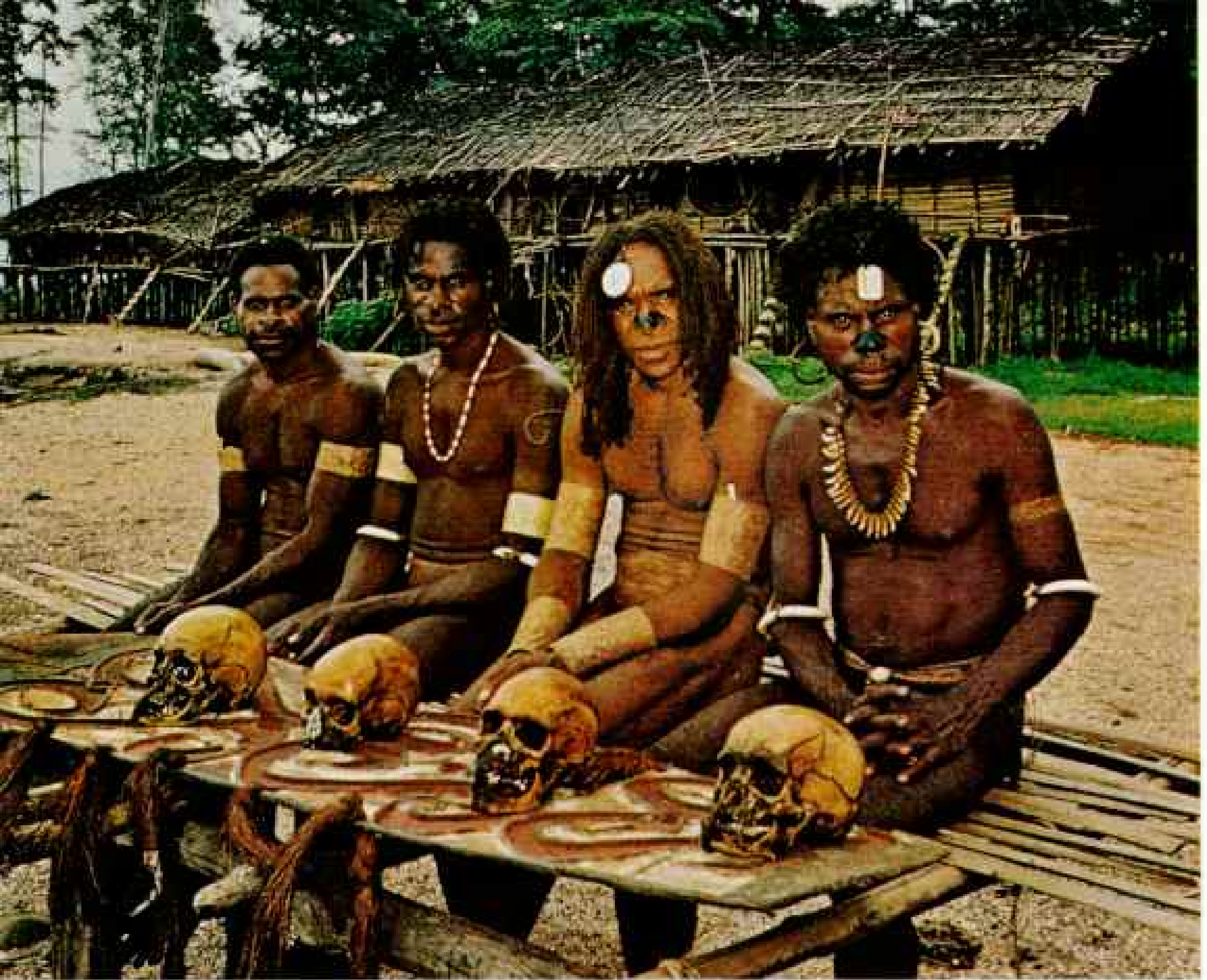
**LITTLE SEROEL**, on Japen Island (page 588), glows like a green jewel among the towns of west New Guinea; it alone slipped almost unscathed through the bombings of World War II. Seroeians showed me their arching avenue of rain trees—they made me think of enormously overgrown mimosas—and their square, where the red and orange jerseys of Papuan soccer players flashed vibrantly against an unimaginably green backdrop of jungle. The town lives by chocolate; miniature groves of cacao trees alternate with

houses on some of its unpaved streets, and while I was there the sickly odor of fermenting beans was never quite out of my nostrils.

It was in Seroei that I was most strongly reminded that western New Guinea was for 67 years administered as a part of the Netherlands East Indies. Island womenfolk are nearly all Christians—Seroei has long been a center of missionary activity—but they wear batik sarongs in the fashion of the Javanese and stroll their beautiful beaches in the shade of paper parasols. And in the government resthouse, the *pasanggrahan*, I dined sumptuously one morning on Javanese-style fried rice—*nasi goreng*—served with a searing red-pepper sauce and crisp wafers of rice flour.

In fact, everywhere I went in the north and west—the areas that had been longest in contact with Dutch traders and missionaries—this subtle flavor of Java lingered over homes and lanes. But I soon learned not to





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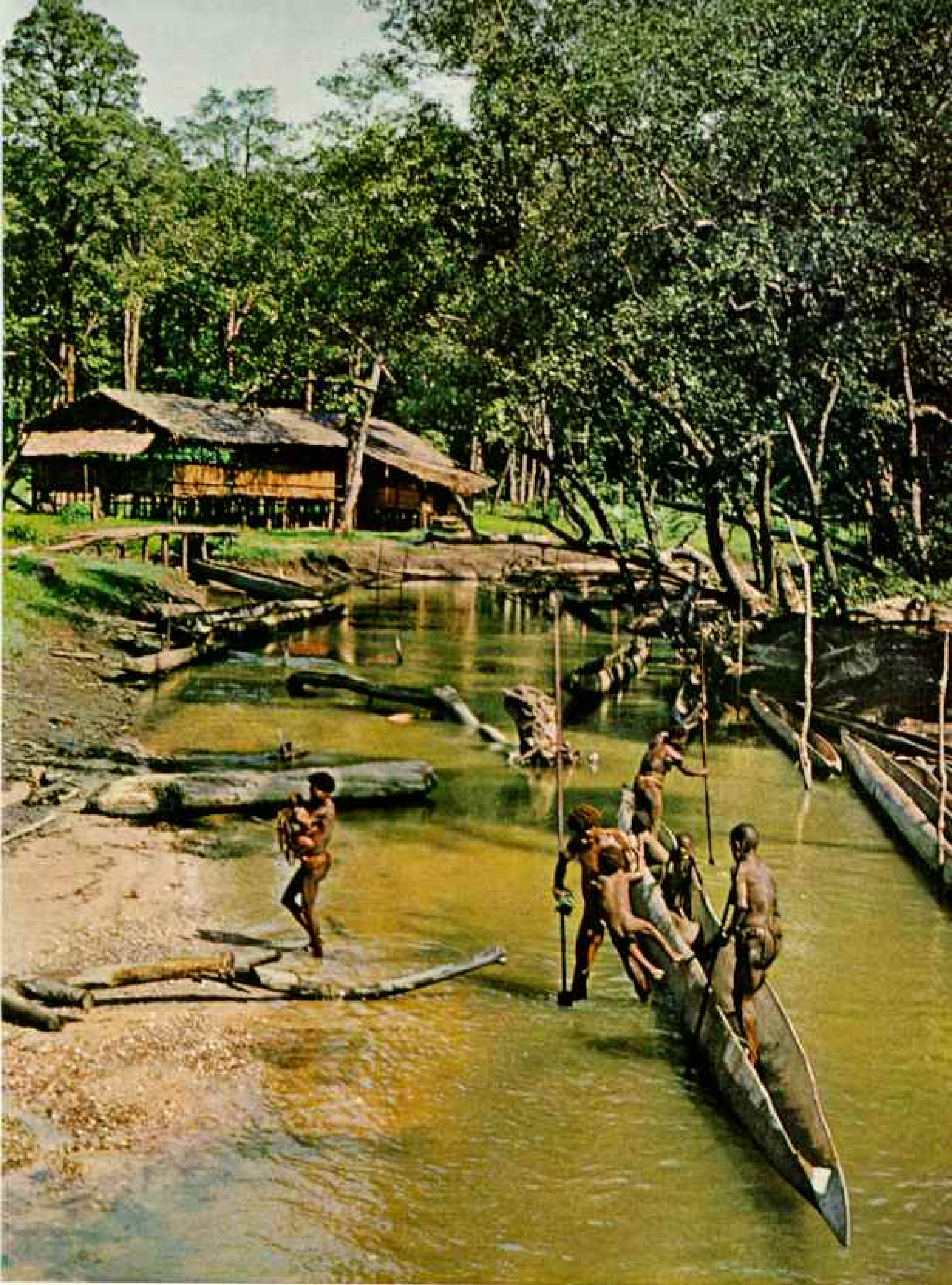
Ancestral skulls, ornamented with seeds, rest on a war shield before head-hunters at Piriapoen. The men sit on a wooden platform where bodies of the village dead are placed. Homes in background shelter one to half a dozen skulls each. Owners sleep with the relics, fondle them, and carry them on food-gathering expeditions. With such constant polishing, the bones acquire the sheen of old ivory. Reddish complexion (second from right), a natural skin color, occurs occasionally in New Guinea.



Baby sleeps beside forebear's skull as peacefully as he would beside a rattle.

Agile dog scrambles up a notched log to the porch of a home on stilts. Taking the same route, author Scofield found friendly tribesmen eager to steady him.





ALL PHOTOGRAPHS BY JOHN BOSTFIELD, NATIONAL GEOGRAPHIC STAFF (S. W. L.)

Enjoying the blessings of peace, a Casuarina Coast family returns to Pirimapoen in safety after visiting a neighboring village. Only a couple of years ago every traveler feared ambush and the loss of his head. Youngsters attend school in the building at left.





confuse these outward signs with deeper political allegiances.

Indonesia's President Soekarno has often implied that most Papuans of West Irian, as he calls Netherlands New Guinea, have Indonesian flags hidden in their homes, ready to be raised at a moment's notice. I mentioned this several times to educated Papuans in Hollandia and always received a shocked answer from them.

"Pro-Indonesian? Absolutely not!" was a typical reply. "Some of us may be anti-Dutch; but that means only that we want an independent west New Guinea."

A FEW HUNDRED miles south of Hollandia, with its political anxieties and its economic woes, live men who have never heard of either Indonesia or the Netherlands, and have not the slightest idea they are being fought for by powers a world apart.

In a little village of houses on stilts, I climbed a notched log that served as a stairway and ducked through the low opening that led inside. In the gloom, pierced only by a shaft of light from the doorway, I could make out three naked men.

All of them wore bone ornaments in their noses. One, his eyes heavy with sleep, rested





PHOTOGRAPH BY NATIONAL GEOGRAPHIC SOCIETY

his head on an object that glowed richly in the stream of sunlight. I realized with a start that it was a human skull, yellowed by handling until it gleamed like a Renaissance ivory.

The man said something that sounded like *mani wi*, and held up the skull so that I could see it. There was no lower jaw, and in the temple gaped a hole the size of a silver dollar.

I knew that "wi" means head to the natives of this remote area, and assumed that this was the skull of a man whose name had been Mani. Weeks later, from one of the few white men who had preceded me to this area, I learned how completely I had misunderstood.

### Skull of an Enemy Serves as the Pillow of a Contented Cannibal in Samoa

Tribal pride, manhood, art, and tradition are all based on taking heads, but the coming of white men has doomed the practice.

Absence of the lower jaw distinguishes this skull from ancestral relics. A hole battered in the temple permitted removal of the brains, which the killer ate. Armlets proclaim that he has taken a dozen heads.

The author was one of the few white men ever seen by this Papuan, whose village lies beside the Cooks River.

What he had said was *manowé*—which means "our food." The skull was that of a man he had killed and eaten!

The lure of the little known had drawn me to Pirimapoen, on Netherlands New Guinea's forbidding Casuarina Coast (map inset, page 586). Here, in what is perhaps the least visited corner of the inhabited world, I saw things I found almost beyond belief.

In another house, half a dozen skulls hung in the smoke-blackened rafters like so many grotesque grapes. The old man who owned the house grinned impishly at me. I pantomimed the stroke of a bamboo knife and closed my eyes to feign death. The old warrior nodded enthusiastically.

### Skulls of Parents Frighten Ghosts

These, too, were head-hunting trophies, discreetly tucked away in the rafters instead of being used openly as headrests by these astonishing people. Like the "pillow" I had seen before, each had a hole in the temple through which the brains had been removed to be eaten.

But, strangely enough, most of the grim relics I saw in Pirimapoen and other Casuarina Coast villages had nothing to do with head-hunting. The cannibals of this jungled shore, which takes its name from the feathery casuarina tree, live in utter terror of the spirits of their own ancestors, and try desperately to frighten them away. What could be more terrifying to a ghost, they reason, than the sight of its own mortal remains?

And so these simple forest people keep the skulls of departed fathers and mothers as constant companions, sleeping on them and even hanging them about their necks when danger threatens (pages 596, 598). For the same purpose, they wear human vertebrae as necklaces, and fashion daggers, nose ornaments, and harpoon heads from human bones.

In Pirimapoen, I learned much from Father

Cornelius H. van Kessel. The first outsider many of the Casuarina Coast tribesmen had ever set eyes on, he knows more about these shy natives than any man alive.

"This is really the last frontier," the bearded Dutch priest mused, "rough, unpredictable — and sometimes dangerous."

Only a few weeks after my visit, his words came back to me with new force as the newspapers reported the tragic disappearance of New York Governor Nelson Rockefeller's 23-year-old son Michael near this same desolate stretch of coast.

### Bones Age Quickly in Humid Jungle

I asked Father van Kessel about the age of the skulls I had seen in almost every house I had visited. He echoed my question.

"Old? They're not old at all. These people were taking heads and eating their enemies until the Dutch stopped the practice only a couple of years ago."

Constant fondling, sleeping on them, and carrying them into the forest on food-gathering expeditions, he explained, quickly gives the bones an ages-old look.

It was a strange and awesome world that gradually revealed itself to me in the days that followed. Violence and murder had existed so recently among these childlike people that, according to a local missionary, even the village teen-agers told of head-hunting raids they had taken part in.

I never ceased to marvel at the contradictions among these gentle killers. Agriculture, writing, the wheel, and, up to a few months ago, even clothing were unknown to them, but they turn out some of the most beautiful and delicately shaped wood carvings I have ever seen.

Here on the Casuarina Coast, one of the few corners of the world where money has no value, I watched the wife of a Canadian medical missionary paying her kitchen help. A handful of plastic beads or a length of nylon fishing line equaled a day's work. A man, she told me, will stay busy for a week to earn a pair of cotton shorts. A steel axhead commands a month's hard labor.

To see more of this swampy land, I joined forces with a medical patrol that was to work in the sprawlingly beautiful village of Ots-

janep, which lies just on the border between the Asmat and the Casuarina Coast.

As we wallowed north along the coast in the Dutch Government's little patrol vessel M.S. *Dourga*, we sighted an enormous crocodile — its head alone appeared to be nearly a yard long — that sunned itself lazily some three miles out in the Arafura Sea and then disappeared with a flourish of its great tail into the coffee-colored water. These seagoing man-eaters congregate at river mouths, waiting for anything edible the tide may bring them. The big saurians are still plentiful and unafraid along the coast, for men have not yet come to shoot them for their skins.

We left the *Dourga* at the mouth of the Ewta River, and journeyed upstream in a convoy of half a dozen log canoes. Each was striped with ocher and chalk and paddled by a crew of standing men. Jungle growth edged the swiftly flowing, iodine-dark stream so closely that the orchid-laden foliage enclosed it overhead within a twisting green canopy.

That night we set up camp in one end of the largest house in the village — a thatched, tunnel-like affair on stilts where the men gathered in the evening to gossip, smoke, and boast about their prowess as head-hunters. In a thoughtful mood the Dutch doctor pointed to a tall, quite handsome native clad in a pair of shorts. The cloth, once red, was now glossy and black with dirt.

"I wonder if we should have introduced clothing without giving him soap at the same time," he said half to himself.

### Head-hunting Makes a Way of Life

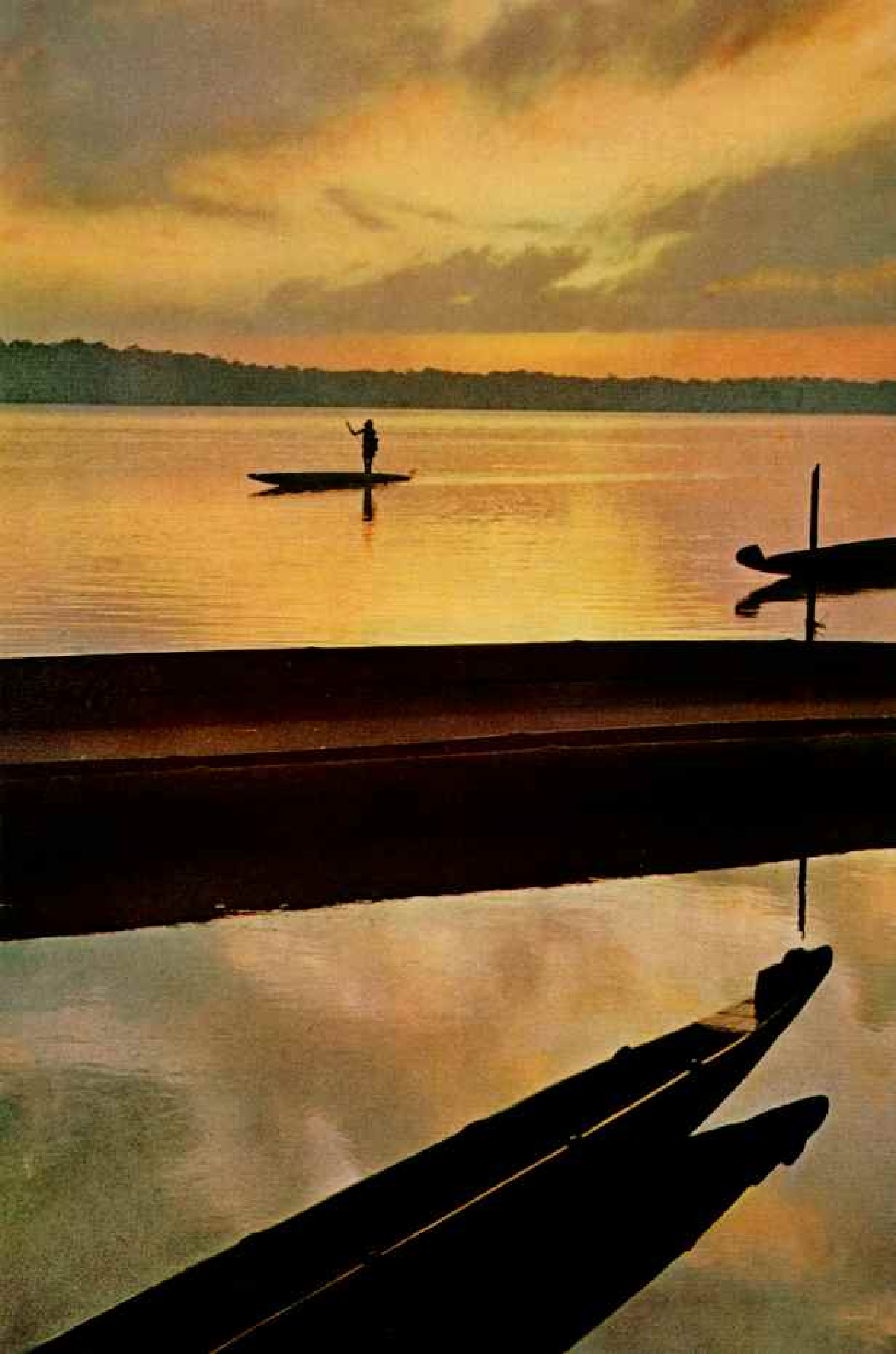
Everything these people have, he reflected aloud — social organization, art, wood carving, music, personal adornment — depends on head-hunting for its motivation.

"There's no answer," he concluded sadly. "We can't allow head-hunting to go on. But when it disappears, must everything else go, too? Must these people become imitation white men, with no cultural institutions of their own?"

Then, as we drifted into sleep, there was left only the soft buzzing of cannibal conversation a few feet from us and the indescribably beautiful music of a group of boys singing in the darkness outside. \* \* \*

### As if at the Beginning of Time, a Canoeman Skims Golden Waters at Dawn

Mangrove swamp and rain forest that wall the Eilanden River once gave sanctuary to Asmat wild men. Now these tribesmen leave their green haven and move to riverside villages where civilization offers more benefits. Here at Atsj shadows double the size of moored canoes. Fisherman paddles against the river's swift tidal current.





# Australian New Guinea

*Australian administrators help primitive Papuans prepare for their great leap into the future*

By JOHN SCOFIELD

*Photographs by the author*

THE DUTCH must often look wishfully east toward Australian New Guinea and wonder why nature didn't divide the assets of this enormous island a little more fairly. For on the Australian side lie richer soils, more people, and a political future unmarred by anything like the quarrel between Indonesia and the Netherlands.

Yet, essentially, the halves of the island are alike, for the Australians, too, are working

toward exactly the same end—eventual freedom for their half of New Guinea under a government of the Papuans' own choosing. But where the Dutch, mindful of an explosive political future, are hurrying to give their wards as much as possible while they can, the Australians, goaded by no such spur, take a longer view. Give us more time, they say. Don't force independence on these people before they are ready for it.

This is no plea of a greedy colonial power eager to hold a rich possession as long as possible. Despite eastern New Guinea's exports of copra, coffee, rubber, cacao, timber, and gold, Australia, thinly populated herself, goes into the red nearly 40 million dollars a year supporting the economy of this vast territory.

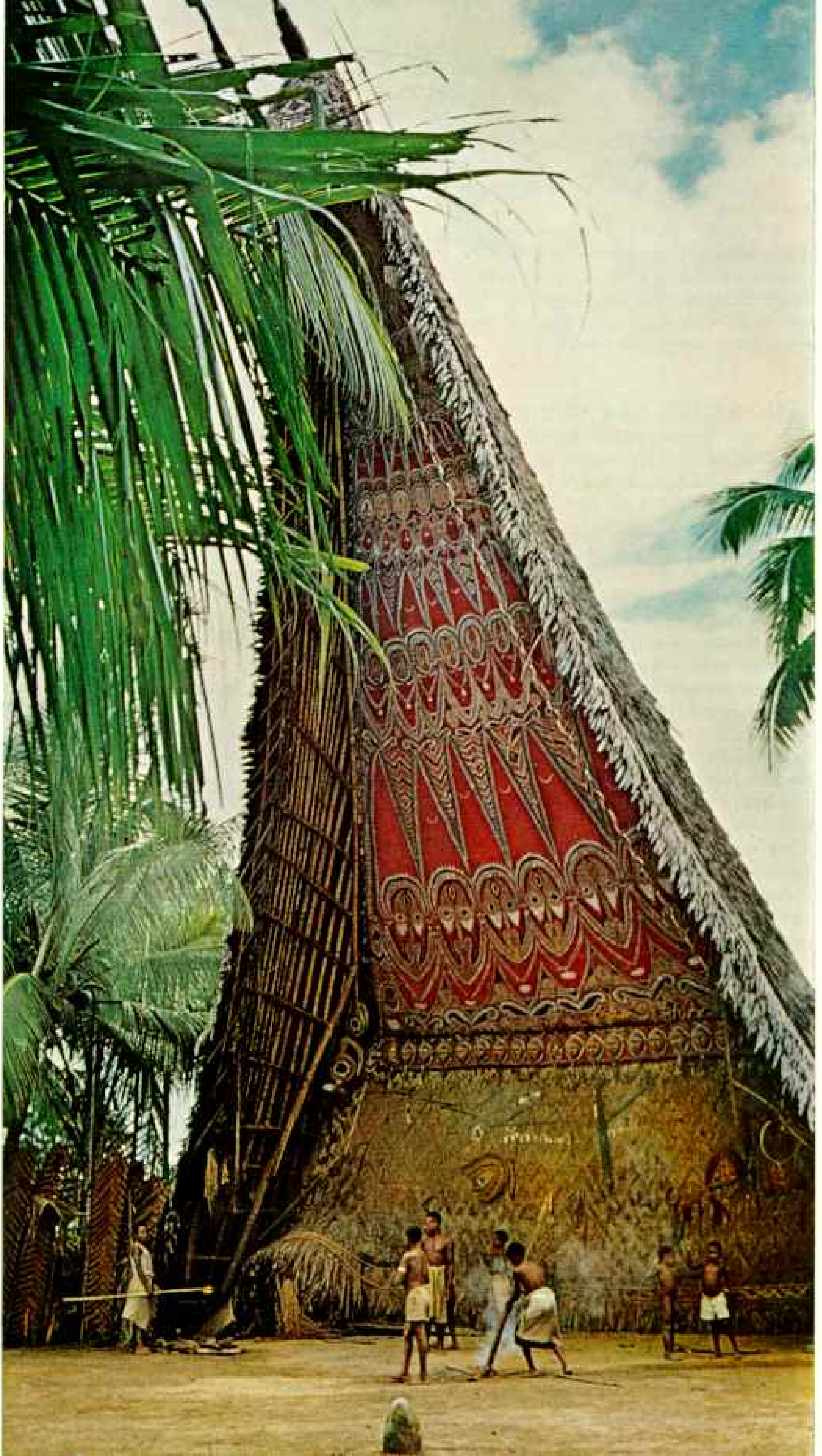
## **New Council Hall Echoes Maprik's Spirit Houses**

Winds of change ruffle east New Guinea, where Australian administrators train Papuans for eventual self-government.

Once Maprik life centered in spirit houses (opposite), with their façades of masks painted on bark. There youths endured coming-of-age ceremonies and elders debated village affairs.

Today, elected representatives from many communities meet in the hall at left to confer on such problems as spear carrying and village sanitation. Armed with long knives, the men will cut grass to keep down insects.





"Our only aim," Director of Native Affairs John Keith McCarthy told me, "is to advance these people socially, economically, and politically to the point that they can determine their future for themselves."

"Within the Australian Commonwealth?" I asked.

"Within or without," he said bluntly, and it was obviously an answer to which the territory's Australian administrators have given much thought. "We only hope the Papuans will carry with them a memory of what we have done and be our friends."

AUSTRALIAN NEW GUINEA's storied Sepik River, which threads what was head-hunter country within the memory of most of its inhabitants, made me think of the lower Mississippi. Like Old Man River, the broad, twisting ribbon of gray water writhes and turns upon itself as it meanders seaward through the swamps, leaving behind oxbow lakes and *barads*—narrow, canal-like channels (map, opposite).

At Kanganaman, 200 miles up the river, two natives rushed up to me, waving yellowed firearms permits and treasured copies of the gold-bordered GEOGRAPHIC. They were Mava and Rambur, noted ornithologist E. Thomas Gilliard's "shoot boys" on previous expeditions to New Guinea and New Britain.\*

Would I be offering rewards, as Masta Tom had done, for bird-of-paradise nesting sites? They were crestfallen when I explained that I wanted only to photograph their village.

A few minutes later a flashing stainless-steel bracelet on another villager's wrist announced a second surprise. Inscribed "6TH WORLD VOYAGE/BRIGANTINE YANKEE/1953-1955," it had been left behind by one of the young crew members of famed voyager Irving Johnson's globe-girdling *Yankee*.†

I found the once impressive village only a ghost of its old self. Nowadays the villagers are mostly women, children, and older men; the younger men spend their time as contract laborers on coastal plantations.

Kanganaman's magnificent *haus tambaran*, or spirit house, which soars 65 feet and has a nave 112 feet long, has been shorn by collectors of primitive art of its old wealth of carvings; practically nothing movable remains except one boldly carved debating chair that Kanganaman's elders stubbornly refused to sell (page 608).

But beauty remains along the Sepik. At Kanganaman early one morning the villagers

roused themselves long enough to dedicate two new houses in the old manner, and for a few magical hours I watched as they re-enacted the legend of their ancestor Mwaim. Eight-foot bamboo flutes, capped with superb little carvings made only a few weeks before, moaned pompously from inside one of the houses; women may hear their sounds but are never permitted to look upon these sacred instruments (page 609).

I remember falling asleep that night to the melancholy thumping of the huge *garamuts*, slit drums whose sounds link a dozen middle Sepik villages in a practical jungle telegraph. Now and then the queer cry of a flying fox punctuated the rhythm. And in the morning I awoke to the absurd tootlings of jungle birds filtering through the mists.

If nothing of the old Sepik had survived but the birds, it would still have been worth the trouble of getting there. Along the river were jeweled kingfishers darting from one island of floating vegetation to another. Majestic white herons waited until the 50-foot log canoe I shared with Australian Patrol Officer John Quinn was only a few yards away before flapping a dignified retreat. And there were ducks, more ducks than I had ever seen before—not even excepting the rafts of wild fowl I remember from 30 years ago when I was 17 and visited the coastal marshes of North Carolina.

But, despite all that is left in this most hauntingly beautiful of New Guinea's hidden places, I could not suppress a twinge of regret that so much must change.

I HAD VISITED Australian New Guinea once before. The urge to return had been irresistible, and now I had looked forward to another, longer stay in the center of the island—the jumbled ranges and lofty green valleys lumped together as "the Highlands," which still beckon as one of earth's last pioneer lands.

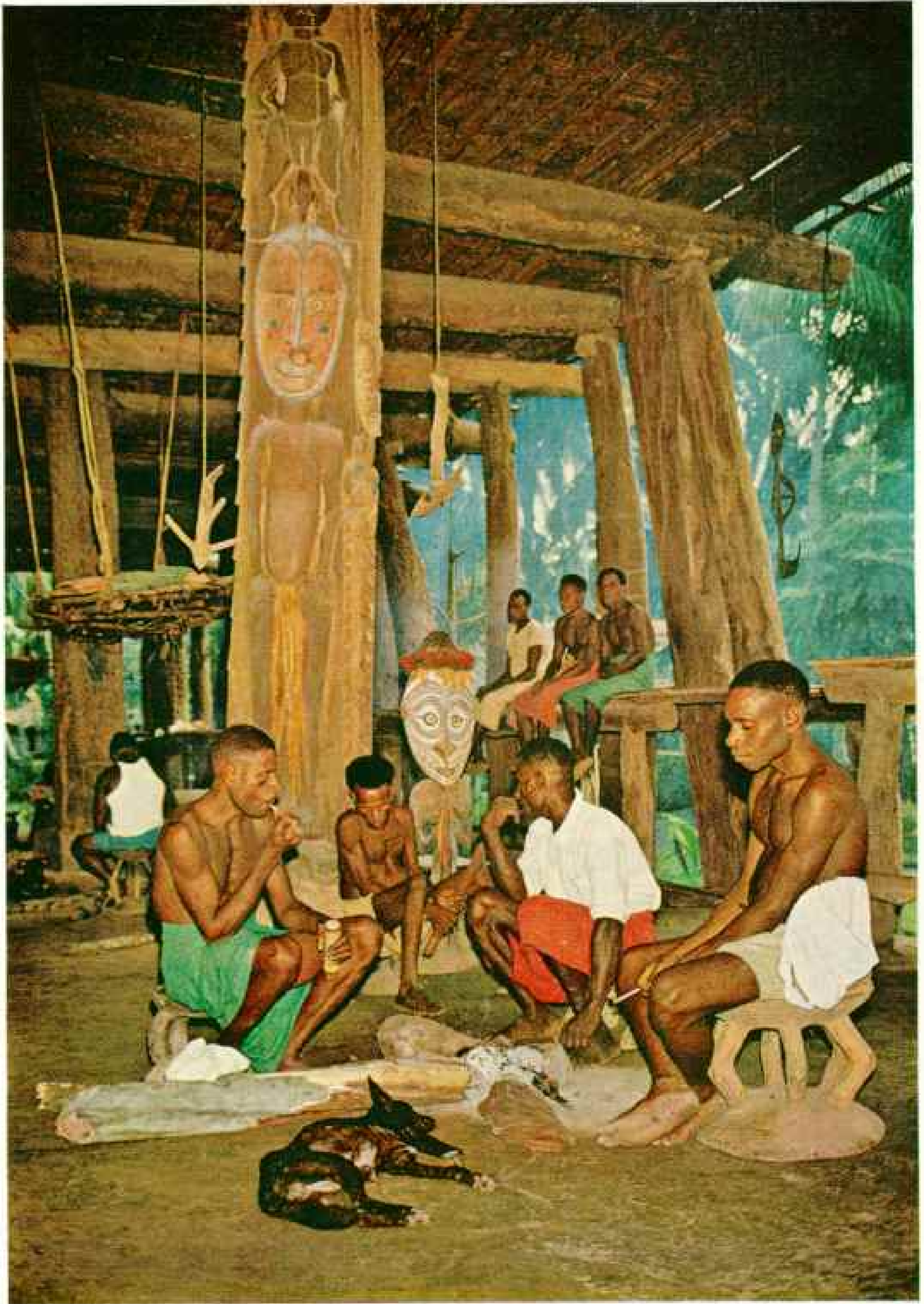
Where the western United States was a century and more ago, this hidden fastness stands today. Here, in the age of the atom, pockets exist where stone axes still flash and no white face has ever been seen.

\*See, in the NATIONAL GEOGRAPHIC: "New Guinea's Paradise of Birds," November, 1951; "New Guinea's Rare Birds and Stone Age Men," April, 1953; "To the Land of the Head-hunters," October, 1955; and "Exploring New Britain's Land of Fire," February, 1961, all by E. Thomas Gilliard.

†Irving and Electa Johnson describe a voyage along the Sepik River in "New Guinea to Bali in Yumber," NATIONAL GEOGRAPHIC, December, 1959.







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### Gone Are the Head-hunters. Lassitude Pervades Kanganaman's Spirit House

Once warriors met here to flaunt grisly trophies and recount battle triumphs before the debating chair's staring mask (center). Murder now outlawed, most men take jobs on coastal plantations. Those remaining huddle around mosquito-repelling fires. Crude hooks dangling from rafters hang bare of carved sculptures sold to collectors. Australia encourages preservation of such houses as relics of a dying culture.

shuttling of airplanes, its bakery and movie theaters, had inevitably lost much of the appeal it had a few years ago. But elsewhere the New Guinea Highlands remain one of the most colorful areas on earth.

#### Show Gives Natives Sense of Pride

In the heart of the Western Highlands, I saw what turned out to be the most dazzling ceremonial ever put on in the South Pacific. For two days the little town of Mount Hagen lay blanketed beneath a shimmering cloak of bird-of-paradise headdresses worn by somewhere between fifty and seventy thousand highland natives.

Some of the dancers had walked for a week over roadless mountains to reach the singing, carrying their precious feather headdresses wrapped in special holders of water-

proof leaves. From dawn to dusk the hour-glass-shaped *bundu* drums boomed, and the ground literally shook as thousands of feet stamped to primitive rhythms (pages 618-27).

I asked District Commissioner T. W. Ellis why he and the rest of Mount Hagen's handful of Australians—the town normally consists of only some 60 families—had worked so hard to arrange this staggering display. It certainly wasn't, I hazarded, just for the amusement of 1,000 or so Australians who flocked into town for the weekend.

"It certainly was not," he agreed. "These people are trying to make an enormous leap, right out of the Stone Age into the 20th century, and we want to help them.

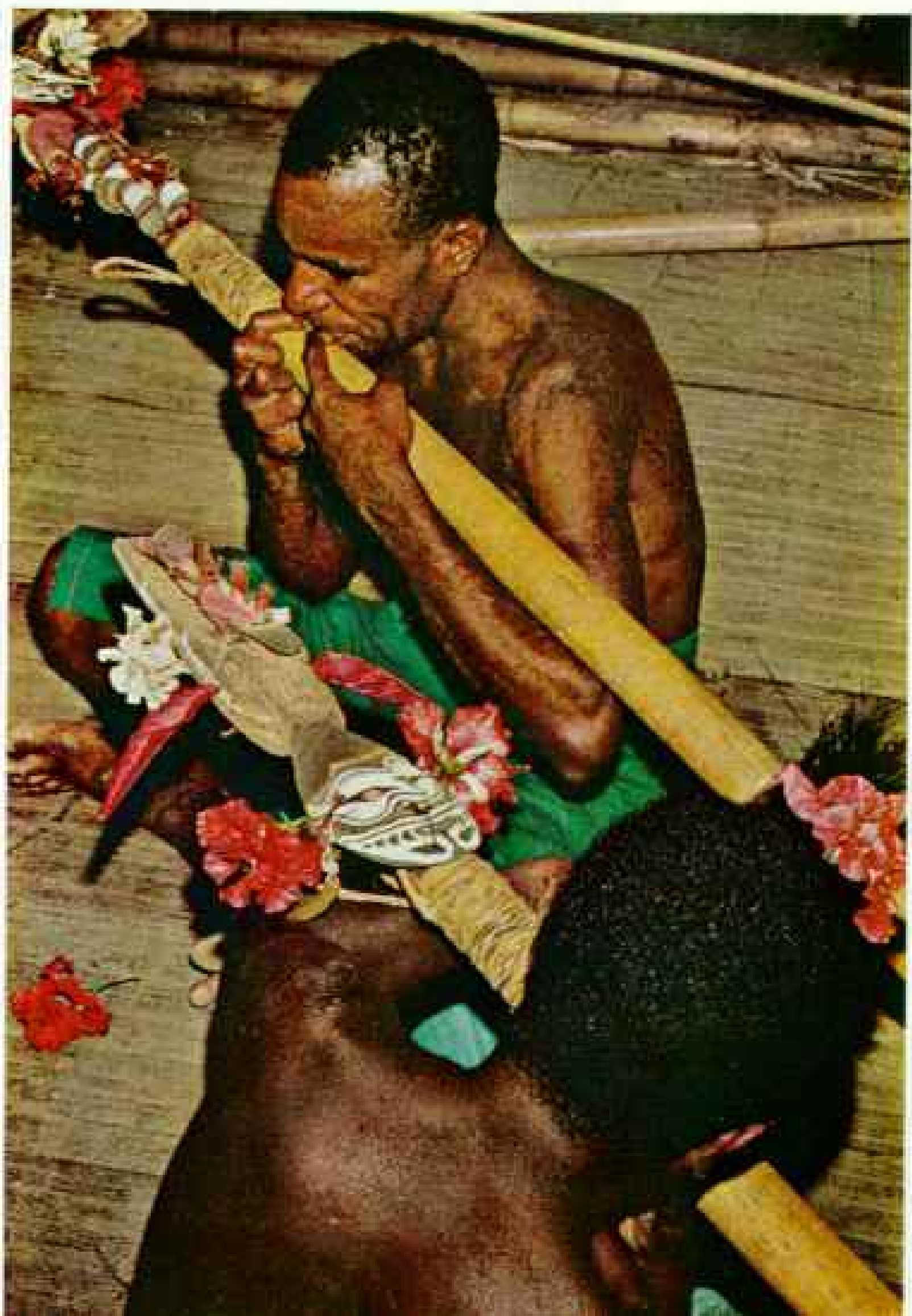
"A show like this, where they are the centers of attraction, gives them an enormous sense of achievement, and of pride in their district.



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Hibiscus blooms adorn a carved fertility symbol at the end of a ritual flute.

Sacred-flute players, sounding a musical prayer that many children will be born, perform at a ceremony dedicating two new houses at Kanganaman. Women are never permitted to see the bamboo instruments, but the music, heard from afar, stirs them to an ecstatic dance.





It's still too early to try to make them proud of being New Guineans; few of them have the slightest concept of the world beyond these mountains.

"Also," he went on, "getting thousands of natives together this way helps create tolerance among people who only a few years ago were traditional enemies."

But progress has its price. Now that they have left their high mountain valleys to gather in the white man's town, these plumed highland dandies can never be quite the

same again. Next year, if there is another sing-sing, one tribe will have copied another's peculiarities of dress or dance. And they will pick up the white man's gewgaws.

After the sing-sing, I bumped across the mountains in a Land-Rover to Wabag, threading my way for mile after mile through masses of warriors trudging wearily home. Already, some were wearing what were, to them, exotic decorations—bits of colored paper torn from magazines and rain-soaked labels from discarded meat tins—in place of the shimmering



bird-of-paradise plumes they had borne so proudly to the show.

As civilization's march eases life for the gaudily plumed humans of the New Guinea Highlands, I wondered if exactly the reverse might not be in store for the birds of paradise that have given the island its special place in so many minds. Prosperity has brought shotguns, and peace has brought freedom to roam what were enemy lands only a few years ago.

"The highland natives kill far more birds

than ever before," Sir Edward Hallstrom told me. The burly Australian philanthropist waved an arm toward the roomy outdoor aviaries of his wildlife research station at Nondugl, in the Wahgi Valley. "Now the only ones I hear are in these cages."

But despite the sea of plumes I had seen at Mount Hagen, the birds apparently are in no danger. Gentle Fred Shaw Mayer, who has devoted much of his life to the study of these most beautiful of the world's creatures, reassured me.

"New Guinea is one of the most mountainous lands in the world," he said. "So long as there are tree-covered peaks and vast cloaks of rain forest, there will be a haven for the birds of paradise."

**A**USTRALIAN NEW GUINEA's Director of Public Health, Dr. Roy F. Scragg, was in a thoughtful mood.

"Communications is the key to better health throughout the island, as it is the key to progress in any other direction," he said. He leaned toward me over the desk in his cluttered Port Moresby office.

"We could control malaria tomorrow if we had a road to every village. I'm sure the Dutch have told you that they face the same situation on their side of the fence."

I asked how roads would help solve this purely medical problem.

"By allowing field teams to spray every structure in Papua and the Trust Territory with DDT," he explained.

"No tropical country of this size has ever entirely eradicated malaria, so it won't be easy. But we don't see not starting just be-

#### **Aibom, in a Film of Blue Haze, Appears Lost in Time, as Idyllic as a Dream**

Croton and cannas frame the pathway, coconut palms rustle overhead, and thatched homes complete the picture of a tropical paradise. But swarms of malaria-carrying mosquitoes mar the image. With a single brush of his hand, the author killed a dozen blood-sucking insects. At night he saw the people take refuge beneath cotton netting or in cocoonlike woven bags.

Aibom produces pottery. Merchandise boats plying the nearby Sepik River keep the village in touch with the world.







Conjuring Up a Vision of Death Itself,  
Mourners Peer Ecily From Sooted Faces

Pounds-heavy necklaces of Job's-tears (grayish seeds), shrouds of fiber sweet potato sacks, and blackened, pig-greased faces bespeak grief among the Mogel people of the Highlands. These Mount Hagen women pay their respects at a new





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shrine to the ancestors of Ninji, a tribal headman. Such native traditions may not long survive the impact of the white man's culture. Caught between two worlds, the tribesmen fall victim to strange fantasies. Several years ago many of these people

embraced the "cargo cult," a belief that all the white man's riches were intended for the brown man and that ancestors would shortly send planes and ships with free goods. Only education can ease the tribes into the 20th century.



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Down payment on a truck goes into the bank at Mount Hagen. Bewigged and bearded coffee planter deposits one-shilling pieces saved by his clan for a vehicle to be used by all. As a symbol of his wealth, the Papuan wears a bib of bamboo strips. Each attests his ownership of ten gold-lipped pearl-oyster shells, the native currency of the region.

Many highlanders hoard money at home. An estimated £50,000 in one-shilling coins has disappeared in central New Guinea in recent years.

occupied by 12,000 or so Fore tribesmen and the neighbors among whom they intermarry.

I talked about kuru with Dr. Andrew J. Gray, the soft-spoken South African doctor who runs the government hospital at Okapa. The disease, which kills perhaps 150 of the region's ex-cannibals a year, takes its name from the Fore word meaning "to shake or tremble, as leaves in a wind," Dr. Gray told me. From muscular tremors, the disease progresses to inability to walk or hold the head

up and, in less than a year, to starvation when the victim is unable even to swallow.

"We think kuru may be a hereditary disease, possibly transmitted by a virus," Dr. Gray said. "We know what happens, but not why. Medical science is helpless against kuru. We can only let its victims die with their families. Right now there's no point in even bringing them to a hospital."

I asked Dr. Gray why newspapers had dubbed kuru the laughing death.

"The name contains a germ of truth," he told me. "Occasionally a victim will burst into uncontrollable laughter. Others may giggle and dance or joke." Most women and children afflicted by kuru experience a strange sense of well-being; the men more often react as would any normal person to the knowledge that he has an incurable disease.

In a hamlet not far from Okapa, I tried to visit a kuru victim, a woman in the early stages of the disease. But she had gone ahead of me to another group of native houses. When I got there, she had run ahead once more. It was obvious that her people were

cause we may not be completely successful." The goal, on Dr. Scragg's "side of the fence," is to have spraying underway in every area by the end of 1963. Fifteen years from the start of the program, he estimates, malaria will be under control, and the population of Australian New Guinea will have doubled.

"No single thing," Dr. Scragg summed up, "not more hospitals, or unlimited medicines, or ten times as many doctors as we have now — can save as many lives as island-wide spraying and the eradication of malaria."

#### *Kuru Poses Baffling Mystery*

At Okapa, deep in Australian New Guinea's Eastern Highlands, I learned about another medical problem, but one for which there appears to be no happy ending. Idyllic Okapa, discovered by a gold seeker in 1932, lies in the heart of the *kuru* country.

Nicknamed "the laughing death" — with more of an eye to sensationalism than to fact — kuru gives the world of medicine one of its darkest mysteries. This dread malady, almost invariably fatal, strikes only in the area

hiding her from me, and I gave up the attempt.

To me, this was the saddest thing about kuru, this shame the Fore feel about a disease that strikes them alone among all of mankind's millions.

**O**FF NEW GUINEA's eastern tip, between the Coral and Solomon Seas, lies a double handful of the South Pacific's loveliest isles. Yet visitors are all but unknown here, hotels are nonexistent, and even the adventurous yachtsmen who regularly pop up in out-of-the-way corners of Polynesia seem to have overlooked these Melanesian islands.

Of them all, I chose to visit Kiriwina, largest of the Trobriands—probably because I had so vivid a picture of it from reading, as a boy, Bronislaw Malinowski's *Argonauts of the Western Pacific*. Malinowski had gone there at the time of World War I to study the trading voyages of these remarkable people. Now, after 40 years and another war, I wanted to see how much they had changed.

Practically speaking, they haven't. True, I heard a group of teen-agers one evening strolling a coral path at dusk, strumming "Pistol Packin' Mama" on their guitars. But this, and the scrub-choked roads and airstrips that still lace the island's heart, were the only wartime legacies I was conscious of.

Otherwise Kiriwina remains a never-never land of arching coconut palms and delightful South

Seas villages peopled by some of the finest-looking natives in the Pacific (pages 630-33). The islanders still carve wondrously intricate prow and stern boards for their huge outrigger canoes, and they still make the daring voyages that link their home with other coral isles across many miles of open sea.

Even today the islanders have little or no knowledge of the world beyond their own shimmering waters.

"Pardon me, *taubada* [elder]," a G-string-clad schoolboy asked me one day in Kavatari, one of Kiriwina's hundred or so settlements. "What is the name of your village?" He pronounced his English slowly and with great care.

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**Spirit of adventure** rides with Chimbu tribesmen who fly for the first time to copra plantations on New Ireland. Wearing red *laplaps* given by the recruiter, the contract laborers leave highland villages for two-year terms of work.

At home these young men wear pig grease and feathers, but one of their leaders sits on the Legislative Council at Port Moresby (page 636).





"Wah-shing-tun, Dee Cee." I told him, shaping the syllables as precisely as I could.

"Is it as big as Kavatari?"

"Bigger," I had to admit, "but not half so beautiful."

"Ah," he said thoughtfully and sauntered away toward a group of chattering village girls, unabashedly beautiful in skirts of red-and-white banana fiber and nothing else.

But change is in the wind. "Until the last war," Assistant District Officer R. G. Orwin told me, "the Trobriands were kept as a sort of anthropologists' preserve; we Australians thought the outside world would contaminate them. But now we realize they are Papuans as well as Trobrianders. We can't leave them in a fish bowl for scientists to come and peer at. If they are going to survive in the modern world, they'll have to march along with everyone else.

"It won't happen in six months, or perhaps even in six years, but eventually these people must govern themselves through their own elected representatives in the Legislative Council in Port Moresby."

I would be the last to suggest that Kiriwina be denied its place in the modern world. But I like to think that, for a little while at least, it will remain as I remember it—the nearest thing I have ever seen to the "unspoiled" South Seas of old.

I island-hopped back from Kiriwina in a chartered Cessna on a morning when the sea sparkled below, but ahead the land lay wrapped in an angry froth of storm clouds. We spiraled ever higher, looking vainly for

### Toadstool Homes of the Fore People Crown a Ridge Above Patchwork Farms

Sweet potato fields blanket the almost vertical slopes of a spur in the Eastern Highlands. Tribesmen wall oval houses with close-set casuarina posts laced with cane and thatch them with kunai grass.

Among all the world's people, the Fore alone suffer from *kuru*, a nearly always fatal disease known as "the laughing death." The malady claims about 150 victims a year.

**Jabbing with planting sticks,** Mount Hagen women sow a row of corn. Good crops reward these skillful gardeners year after year. During World War II the Western Highlands produced 50,000 pounds of vegetables a month for U. S. forces.

a way across the Owen Stanley Range to Port Moresby. Straight down we could see the ground, but around us the peaks disappeared on all sides into mist and rain.

I noticed the pilot tapping the compass. He was making a tight turn, but the instrument failed to move. With a worried look he switched on the radio.

"Moresby, Moresby," I heard him call. "I think we are above Safia. The compass is out and cannot tell which way we are flying. Fuel for one five zero minutes."

I tightened my seat belt.

### Emergency Airstrip Saves the Day

Eventually we dropped onto a tiny emergency airstrip miles from the nearest white man and lacking even a native policeman. The plane was immediately surrounded by a dozen fierce-looking tribesmen. Each carried a long spear of sharpened ironwood. Probably friendly, I thought uneasily.

Lacking a compass, we had to rely on the knowledge of the natives. "Popondetta?" the pilot asked, naming a town far to the north, the way we had come. He pointed to where we thought north lay. Unanimously they pointed in exactly the opposite direction.

*(Continued on page 628)*



## Old enemies become friends in the fun of an intertribal fair

**F**ROM MOUNT HAGEN the invitations went out: "Come to the fair." Back from the clans came the word: "We accept."

For months the fairground bustled with preparations. Long houses rose to accommodate the guests, and tons of sweet potatoes, sugar cane, and tobacco filled storerooms.

Days before the carnival opened, tribesmen carrying drums and bird-of-paradise plumes began the walk to Mount Hagen. Some traveled more than 100 miles.

New Guinea's biggest party, the fair last September drew between 50,000 and 70,000 natives and 1,000 European guests. Some entered animals in the livestock show; others competed in bicycle races and log-sawing contests. But for most, the fair served as a sing-sing, a time for displaying wealth, parading in paint and feathers, dancing, and feasting.



**BUBBLE-GUM BLOWER** keeps tradition's facial tattoos.

**BEARDED AND CROWNED,** a pig raiser takes his entry to the stock show.



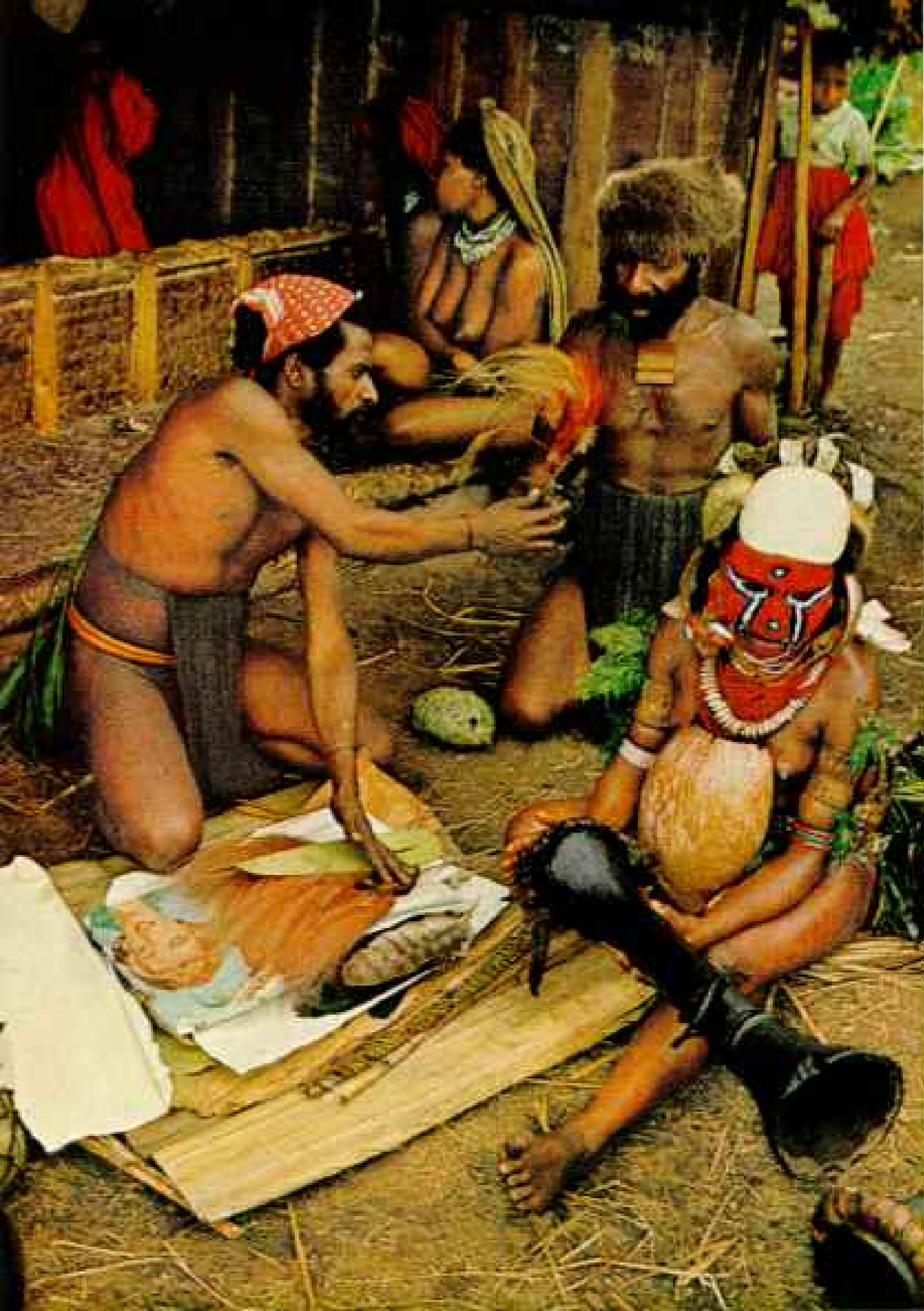


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**FEATHERS FLYING,** *bike racers await the starting gun. At the finish, the winner let go his handlebars and sailed into a fence.*

**MUSCLES BULGING,** *contestants section a log with a crosscut saw. Tribesmen call such saws "Pullim he come, shovim he go."*





**FAIRGOERS BROUGHT** a fortune in plumes; this man wrapped his in a cast-off advertising poster. Salvadori's greater bird of paradise contributed the red and buff ones; the New Guinea eagle supplied the prized striped feathers.

Ready for the dance, the girl at right wears face paints and bailer shells on forehead and stomach; she beats the lizard-skin head of an hourglass drum.

**FOREST PHANTOM** decks for a day of dancing. Cockatoo feathers and quills from the long-tailed honey buzzard wave from a wig trimmed with cuscus fur. Clay from the streambed covers his body.

**MAKE-UP ARTISTS** spend hours before the mirror. They apply facial designs with store paints laid over sooted faces. Man at right wears cuscus fur and bailer shell on his bark cap.











**WIGGED WARRIOR** *capers in a clown's false face*



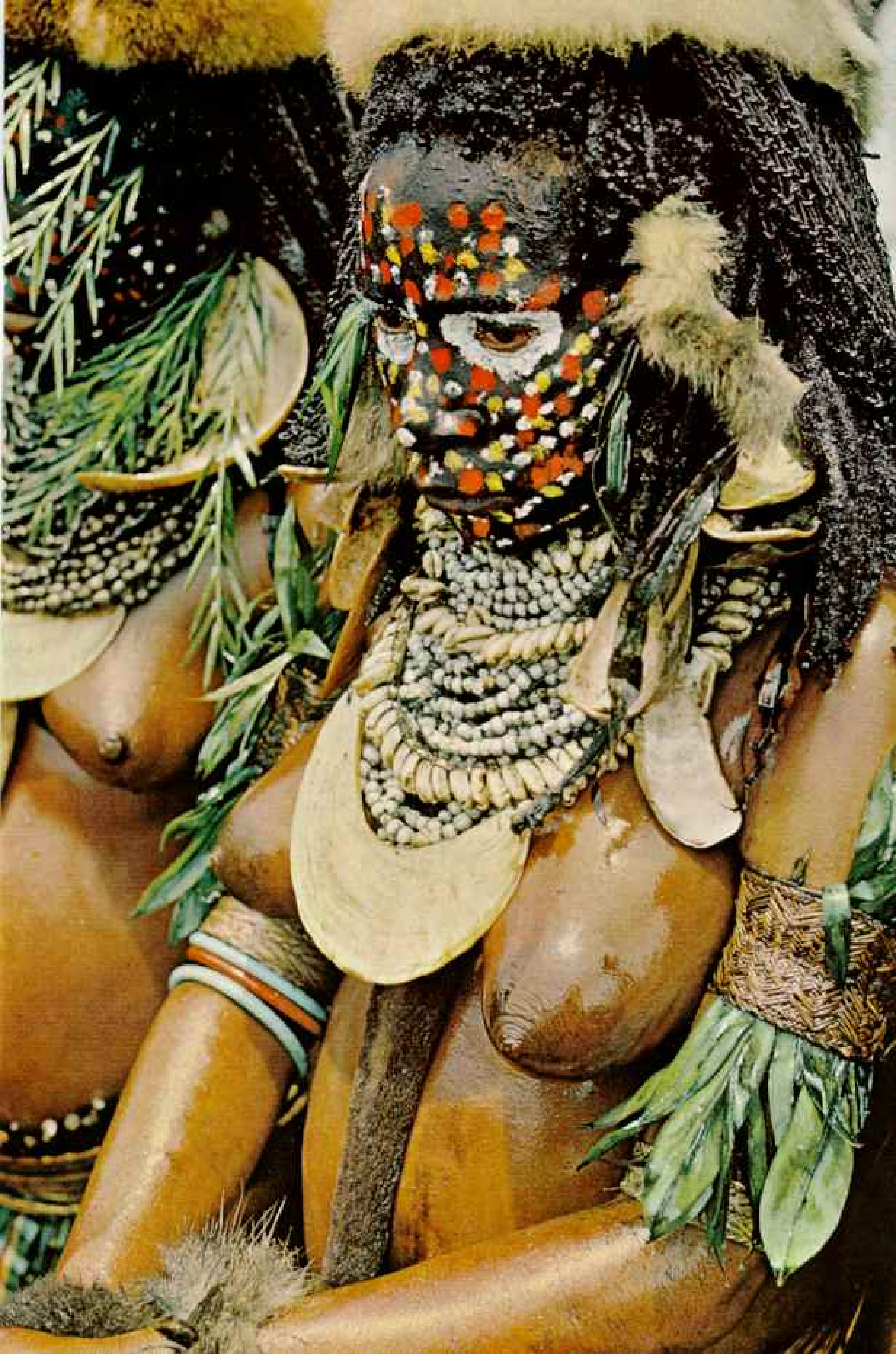
RESEARCHER © NATIONAL GEOGRAPHIC SOCIETY



**CATLIKE COSTUME** *distinguishes a "long-long," or make-believe crazy man, who charges among dancers and drives away evil spirits with his stone ax. He wears cassowary-quill whiskers and a wig of hairlike cassowary plumage.*

**JWELED WITH SHELLS** *and glossy with paint and pig grease, festival belles sit demurely at the sidelines awaiting their turn to dance. Furs, leaves, and woven armbands enhance their make-up.*

**SHIMMERING PLUMES** *from cockatoo, parrot, and birds of paradise adorn a chieftain. Crown plumes of the King of Saxony bird of paradise form the gemlike circlet from nose to forehead.*





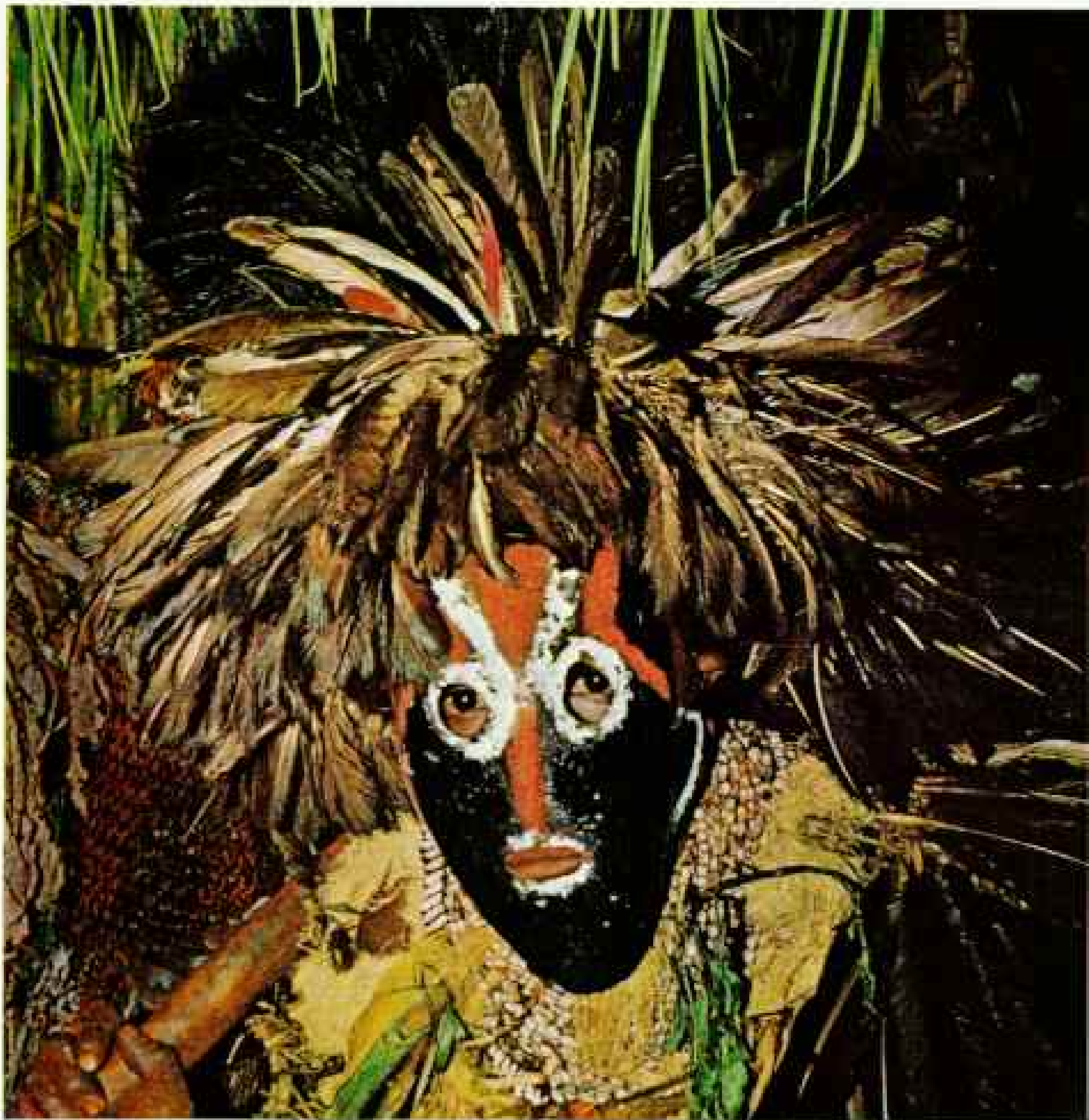


PARADING THEIR WEALTH, *Mount Hagen men carry gold-lip shells mounted on shieldlike plates of solidified gum. To garner prestige, they lend shells*





*to one another. Ten ornaments out on loan entitle a creditor to wear one omaak stick of bamboo on his chest (page 614).*



PHOTOGRAPHER © NATIONAL GEOGRAPHIC SOCIETY

*CALABASH MASK and bush of feathers disguise a clansman. His trip to the fair was the first ever made outside his remote neighborhood.*

*CIGARETTE rolled in newsprint relaxes a dancer.*

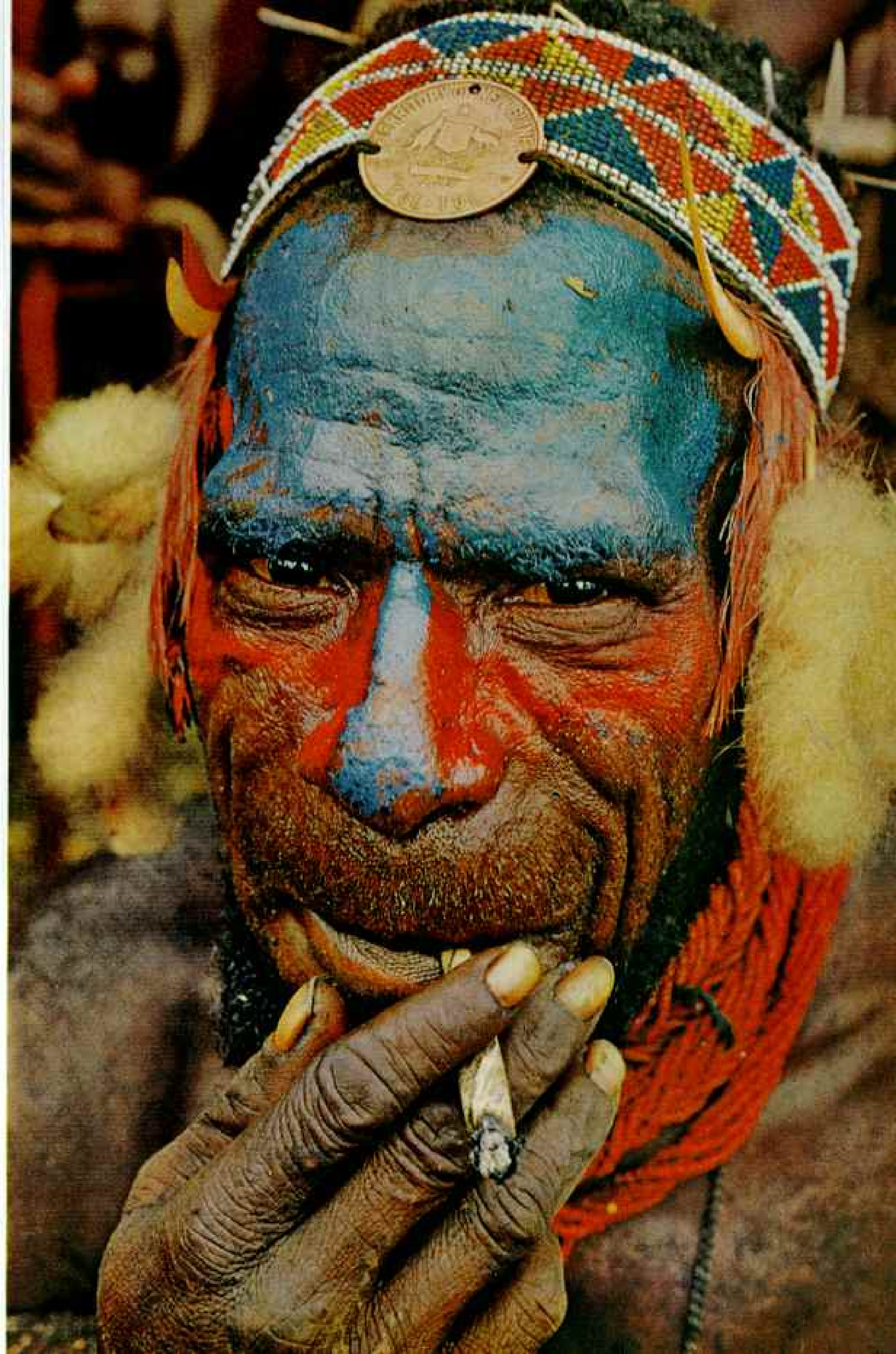


*MEDALS on foreheads identify luluais and tul-tuls, village leaders appointed by island officials.*



*GREEN SCARAB beetles adorn a golden headband.*









(Continued from page 617)

toward a mountain gap not quite obscured by clouds that now hung only a few hundred feet above us. We looked at each other and nodded. "We can always come back," the pilot said cheerfully. We took off in the rain.

But the natives were right, and an hour later we were skimming low under the clouds toward Popondetta, and below us lay the abandoned runways of the great wartime airbase at Dobodura.

It was typical of flying in New Guinea at its unpredictable worst. For this practically roadless island offers perhaps the most harrowing flying conditions of any place in the world. And yet, without the airplane, devel-

opment in New Guinea would have been virtually impossible.

Pilots said, with more seriousness than jest, "If you see a cloud in New Guinea, you can be pretty sure there's a mountain inside it." And a young Australian who took me from Mount Hagen to Nondugl, 20 minutes by air but half a day by dirt road, told me of two neighboring airstrips he often called at.

"They're exactly three minutes apart," he said, "from the time the wheels start rolling on one until they're on the ground on the other. But there's a gorge between the two; takes people six hours to walk it. That's why this is airplane country."

For my own part, I *know* it's airplane coun-



ALL AIRBORNE PHOTOS BY JOHN BERTZELL, NATIONAL GEOGRAPHIC STAFF © N.G.S.

try. In gathering material for these articles, I made exactly 65 flights, in just about everything from lumbering World War II DC-3's to the newest of jet helicopters.

But for all its nerve-wracking aspects, flying gave me some of my most rewarding moments in New Guinea. There was the dawn-streaked morning I circled Mount Lamington, the slumbering giant whose 1951 eruption engulfed some 3,000 people (above). A drafty Dakota freighter, skimming beneath low storm clouds, gave me breathtaking glimpses of the incredibly green Markham Valley, with its coffee and cacao plantations.

Another took me over the famed Morobe and Edie Creek goldfields, opened in 1926.

## Mount Lamington Still Smolders 11 Years After Blowing Its Top

Dormant 20 years ago, the volcano stood witness to one of the most agonizing struggles of World War II. Australian soldiers trudged along the nearby Kokoda Trail to repel Japanese invaders from the Buna area advancing on Port Moresby. For both sides, the battle was largely against nature. Malarial swamps, saw-toothed mountains, choking rain forests, and knife-edged kunai grass took fearful toll. Historians describe the terrain as a "military nightmare." Eventually, Japanese strength ebbed, and the Allies chased the enemy across the Owen Stanley Range to the sea.

Nature claimed another victory over man in January, 1951, when Mount Lamington exploded, leaving 3,000 dead.

Dredges from California were flown in piecemeal from the coast. Today only one remains in operation, and the mining company makes more money with its huge plywood mill than from the precious metal.

I flew above coastal copra plantations and the *lau-lau* gardens of the highlanders, where Stone Age farmers with pointed sticks raise more sweet potatoes per acre than the white man can with all his fertilizer and farm machinery. And I winged above the tumbled mountain fastnesses of the still untamed Kukukuku warriors, who smoke their dead like hams and paint them with ocher.

And always there were the comforts of Port Moresby to come home to.

### Beauty Goes, but Welfare Improves

Territorians, as the Australians in New Guinea call themselves, are apt to dismiss Port Moresby as "just a bit of Australia." And with its "go-kart" races and its milk bar, its white-shirted Papuan clerks and rush-hour traffic, it did seem matter-of-fact and pale after Kiriwina and the Highlands.

But there was much to see here, and much to learn. There were Pari and Kila Kila villages, for instance.

At first these untidy collections of tin-roofed shacks on the fringes of Port Moresby disturbed me (page 635). How much more beautiful, I thought, were the Trobriand villages with their nipa-thatched roofs and picturesquely dressed natives.

Then someone showed me an infant welfare clinic and a cooperative store in Pari. I saw a truck Kila Kila's fishermen had



Munching a yam after a swim in the sea, a grass-skirted Trobriand Islander epitomizes the happy disposition of her people. In these isles, where inheritance comes through the mother's line, women enjoy independence, respect, and oftentimes power to control tribal life.

Trussed pig goes to serve a mourning feast. Trobriand people believe that spirits of the dead fly back to the village once a year and share a meal in their honor. Unlike their mainland neighbors, the islanders do not fear ancestral ghosts.

bought to rush their catch to market, and the bus that takes the village men to and from work in Moresby a few miles away. And I saw figures that showed how many more of Kila Kila's and Pari's babies survive than was true in the "unspoiled" villages of the eastern islands.

And gradually even the beauty will come back. Not the beauty of primitive people living in harmony with their land and their sea, for that can never be recovered, but a new beauty as these people complete their big leap from Stone Age to Atomic Age and develop leisure and income.

Indeed, everywhere I went in Australian New Guinea I saw evidences of this determined movement toward self-sufficiency.

In the dignified chambers of the Legislative Council (page 636) I heard Kondom Agaundo speak as the elected representative of the Highlands' Chimbu people; it was difficult to believe that less than 30 years ago this gifted spokesman wore feathers and pig grease and had never seen a white man.

I watched as carpenters knocked together one-room school-





houses to further the territory's "crash" education program. From these tiny classrooms Australian teachers-to-come will seek out natives who can be trained to take their places.

#### Town Council Frowns on Spears

In the Maprik district, where spirit houses still tower eerily above every village (page 605), I attended a meeting of the Native Local Government Council, and rifled through the minutes of their deliberations.

"The Council," I read, "has decided that certain traditional practices are now obsolete. . . . The fashion of villagers carrying spears . . . is reviving distrust and fear." Henceforth, the council voted, neither spears nor bows and arrows would be carried in the Maprik area, except when a native was hunting wild game.

Thus, slowly, Australia's wards are marching along the road to self-rule.

But much remains to be done, and most of the people I talked with, both Papuans and Australians, agreed that eastern New Guinea has far to go before stable self-government can be hoped for.

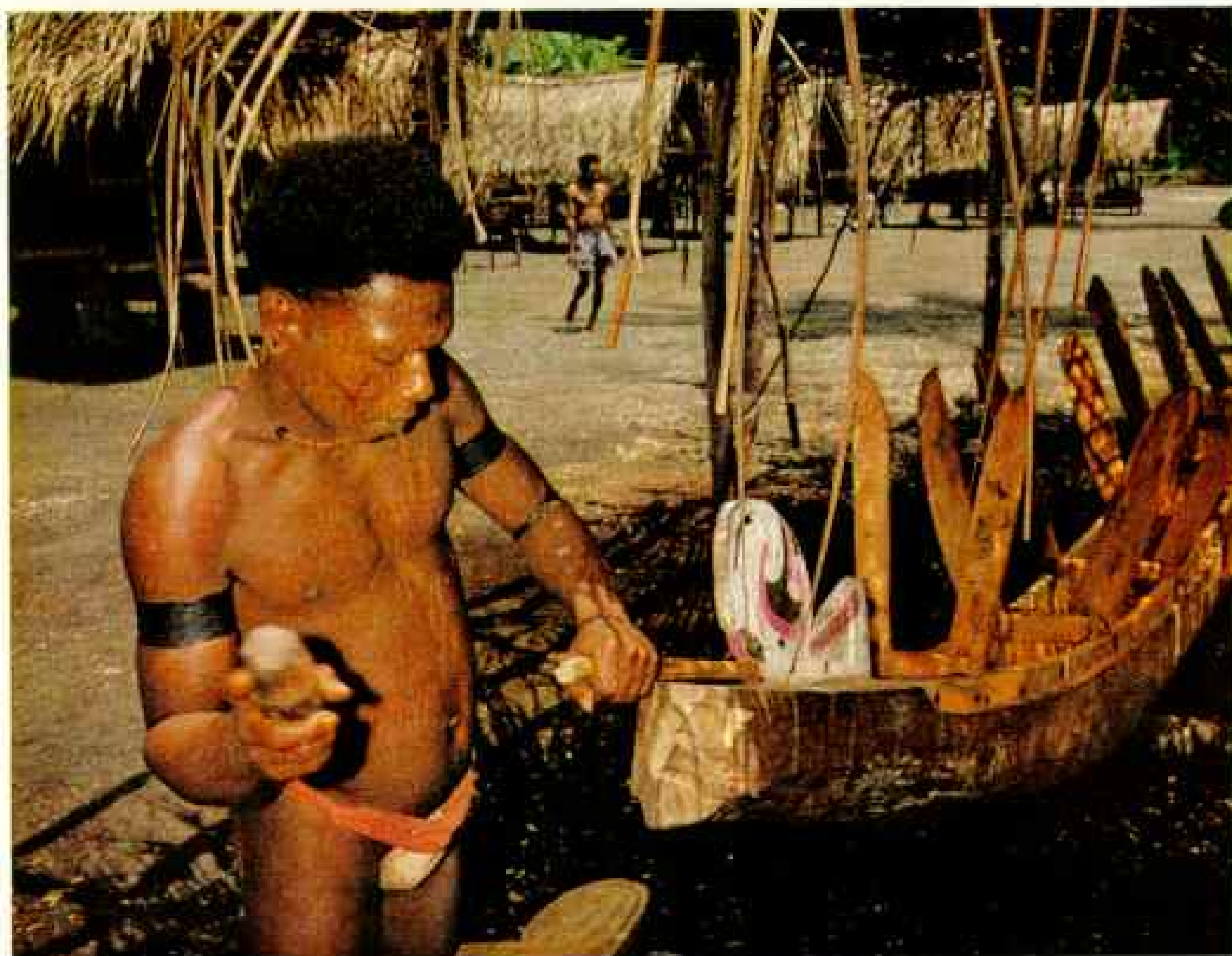
"It's so difficult," an English-speaking Papuan politician told me one day, "to stand on your own feet and carry all the responsibilities in a strange world."

For every Papuan who is sufficiently advanced to represent his people in a sophisticated parliament, or even in a simple native village council, there are thousands who are still puzzled and frightened by the changes that inexorably alter their lives.

To a man who lived in a Stone Age environment until ten years ago, or perhaps even until last year, an airplane or an outboard motor seems miraculous. In fact, the majority of New Guineans, conditioned by their isolation, accept them as just that. Obviously,

*(Continued on page 637)*





Craftsman hollows a log into a canoe. Upright ribs attached to the hull stand ready to receive the gunwales. Skilled sailors, Trobrianders still make ocean-going voyages in their dugouts.

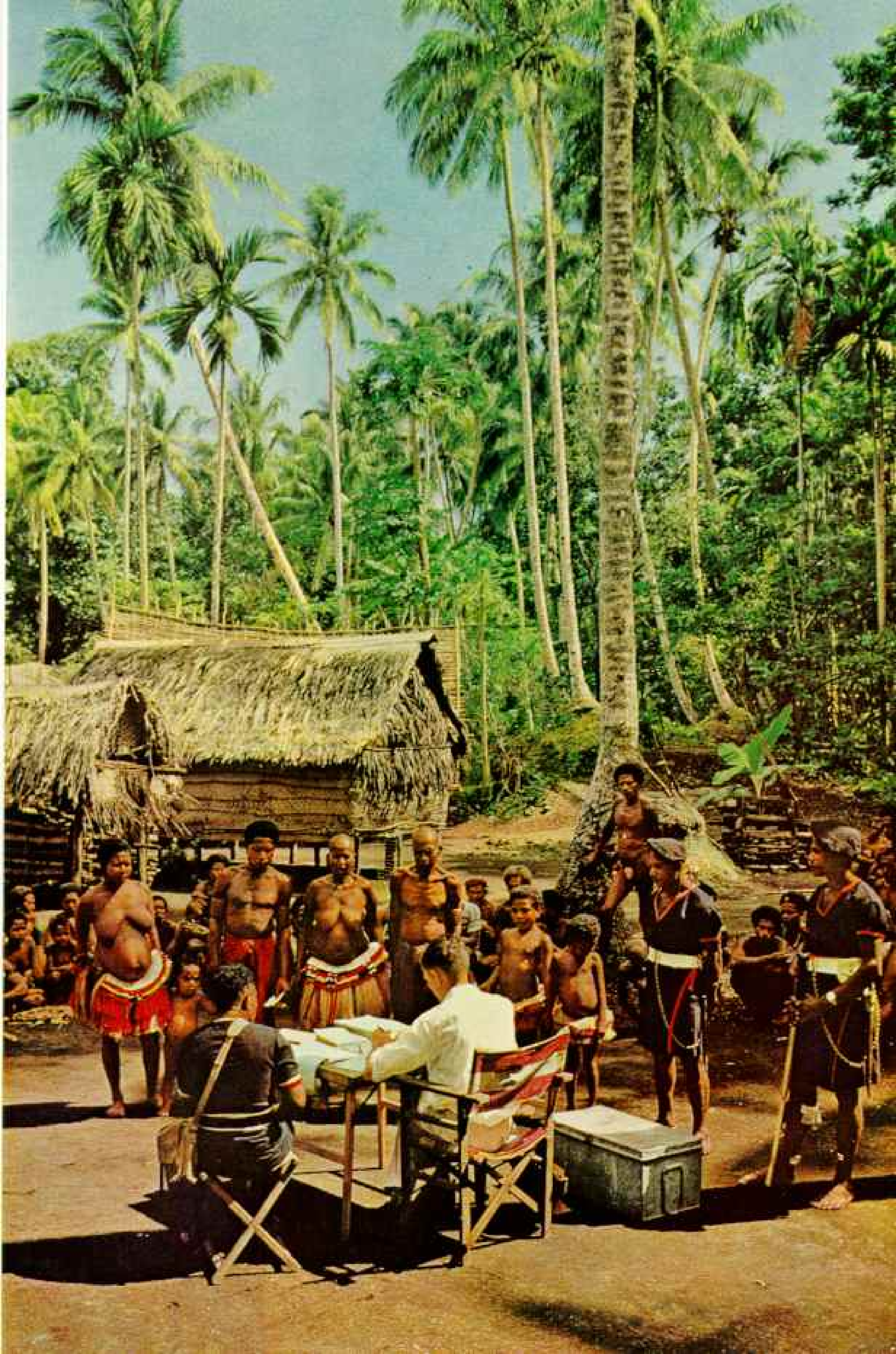


Intricate carvings cover the prow board of a completed canoe. Baby takes a make-believe sail with an elder, who squats on the poles of an outrigger covered with matting.

### Villagers Stand To Be Counted During a Trobriand Census

Patrol Officer Graham Smith checks face against name and records births and deaths. Giving the people fatherly advice, he threatens the "calaboose" if they fail to keep the village clean, to repair houses, or to stop spitting, which spreads tuberculosis. Patrol party includes two policemen (right) and an interpreter.









**Tattooed Mother Lets  
No Patch of Skin  
Go Unadorned**

This Motu woman from Hanuabada village takes her baby to market in nearby Port Moresby (opposite). She sells crabs wrapped in banana leaves and carried in the net bag.

Tattooing was done in her girlhood. A native artist drew the designs, which vary with each individual, and drove them into the skin with thorn and mallet.

Motunans believe that tattooing never gave pain until a girl undergoing treatment laughed irreverently and broke the spell.



Coastal native's clothes reflect Western influence; his airline bag holds betel nuts for chewing.

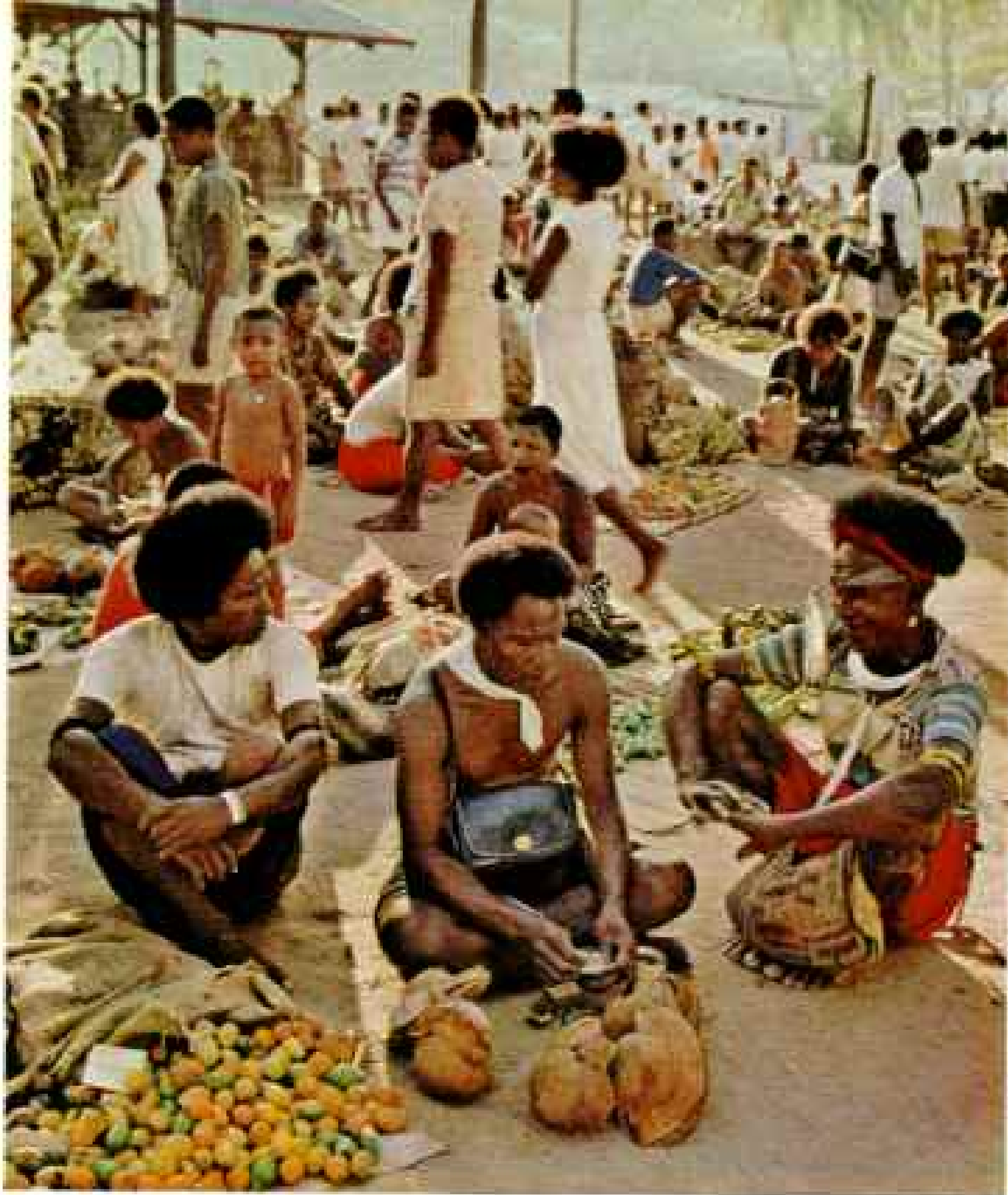
**Tin Roofs Crowd Pari,  
a Port Moresby Suburb**

"Romance of the South Seas seems lost here," says the author, "yet Pari represents improvement. Residents have a school, a co-op, and a truck to take produce into town. Tin housetops may not be picturesque, but they do not harbor scorpions, as thatch does."

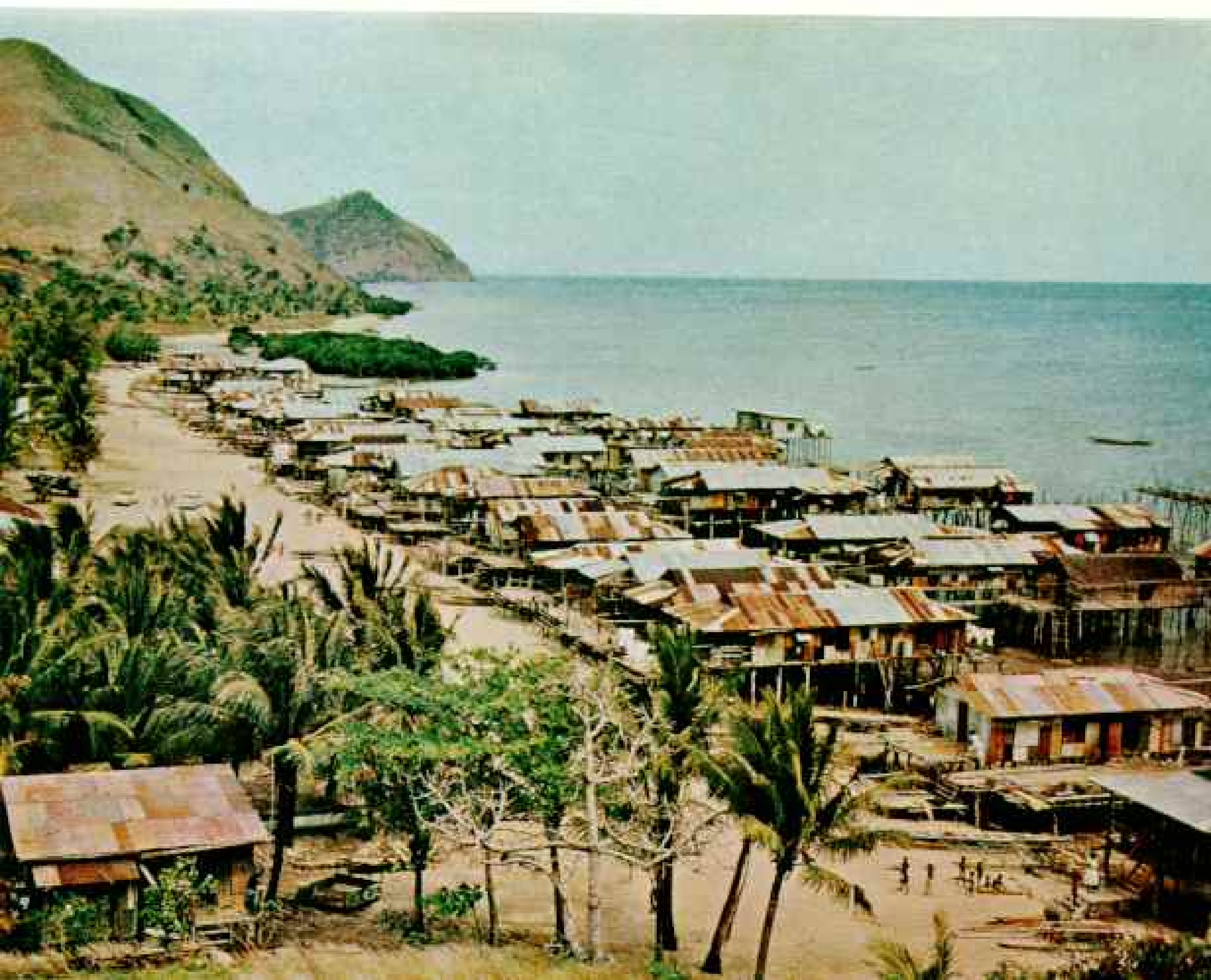




Tropical harvest from the ocean, brilliant fish tempt shoppers in Port Moresby's native market.



Islands of produce dot the market; vendors kill time with talk.







KODACHIRO (KOBÉ) AND HIS ENTRANCE BY JOHN SCOFFIELD, NATIONAL GEOGRAPHIC STAFF © N. G. S.





*(Continued from page 631)*

**Parking problems** beset Port Moresby, chief city and administrative center for both the Territory of Papua and the Trust Territory of New Guinea.

Exploring Papua's coast in 1873, English Capt. John Moresby found a break in the coral reef and sailed into a land-locked harbor, which he named for his father. After Britain claimed the area, a port rose on the harbor's rim.

**Hope for self-rule** lies in the Papua-New Guinea Legislative Council, where native representatives, meeting with European members, learn the processes of democratic government.

they say, no human agency could have fashioned either one.

Then the native learns about heaven and the white man's God, and often puts two and two together. That's where the gadgets, the cigarette lighters and the airplanes and the flashlights, come from! But why does the white man keep all these gifts for himself? Surely a fair share was intended for the native.

This reasoning often leads to an even stranger conclusion. From a mixture of envy and resentment the native passes to a feeling that one day soon his good things will arrive. So why, he may well ask himself, should he work for a living?

At the urging of a self-styled messiah, one group built docks 2,000 feet up on a mountainside. A giant wave, they were told, would roll just up to the wharves so ships could unload huge quantities of kerosene refrigerators and radios and Jeeps!

The people of a coastal village expected the arrival of submarines that would take them to America where they would be loaded with goods and sent back to live like the white man.

The strangest of these tales concerned a group of natives who, I was told by an Australian official, were patiently sitting on hens' eggs. They expected to hatch American sailors!

But the tragedy of the situation outweighs its humor. These are people who may have to rule themselves within a decade—or sooner.

And the native is not the only one who faces problems and an uncertain future. Young planter Tom Leahy, a nephew of the famous Leahys who discovered the Wahgi Valley in 1953, gave me another point of view.

"I have no bank account," Tom told me. "Everything I earn goes back into my farm in the Markham Valley. I figure that's helping to develop the country just as much as anything else. And yet, what's to prevent the Papuans from kicking all the Europeans out some day and taking everything we own?"

**WHENEVER** I begin to doubt the eventual outcome of all this, I think back to the voices of the young patrol officers I traveled with, gently urging the people of this huge and complex territory toward a better life.

The voice of Brian Hull, patiently explaining the workings of representative government to the onetime head-hunters of a Sepik River village.

The voice of tall, serious Graham Smith as he tried earnestly to convince an assembly of Trobriand Islanders that germs, not sorcery, cause tuberculosis.

The voice of John Quinn planting the thought that the splendidly carved beams from a vanished spirit house should be preserved instead of being cut up and used for a new dwelling.

And the voices of Patrol Officer David Hook and vivacious Chris, his wife, who cajoled nearly 7,000 bewigged Wabag warriors into leaving their mountain valleys; many of them for the first time in their lives, to venture on a visit of friendship into the territory of their traditional enemies, the Mount Hagen people.

As long as these dedicated men continue to do their job—and if politics and a changing world allow enough time—the future of this land that is so rich in human terms can be as bright as that of any "backward" territory on earth. **THE END**



# Telephone a Star

*Communications satellites  
will relay messages across  
earth's oceans and continents*

By **ROWE FINDLEY**

National Geographic Staff

**M**Y FIRST THOUGHT was of a hospital operating room.

There were the surgeons in spotless caps and gowns, bending intently over their work. There were the immaculate walls, the well-scrubbed floor, the strange-looking machines with their mazes of tubes and wires. Only the figure on the operating table was missing.

I was in a Bell Telephone Laboratories facility at Hillside, New Jersey, and my guide, engineer Robert H. Shennum, soon led me to a corner of the room where I beheld the patient.

It was a gleaming white sphere as big around as a truck tire. Hundreds of gemlike rectangles sparkled on its sleek surface, and around its middle ran rows of tiny windows. An extensible mast crowned by a wire coil sprouted from its top.

"Take a good look now," Mr. Shennum said. "Where it's going, you won't get another chance."

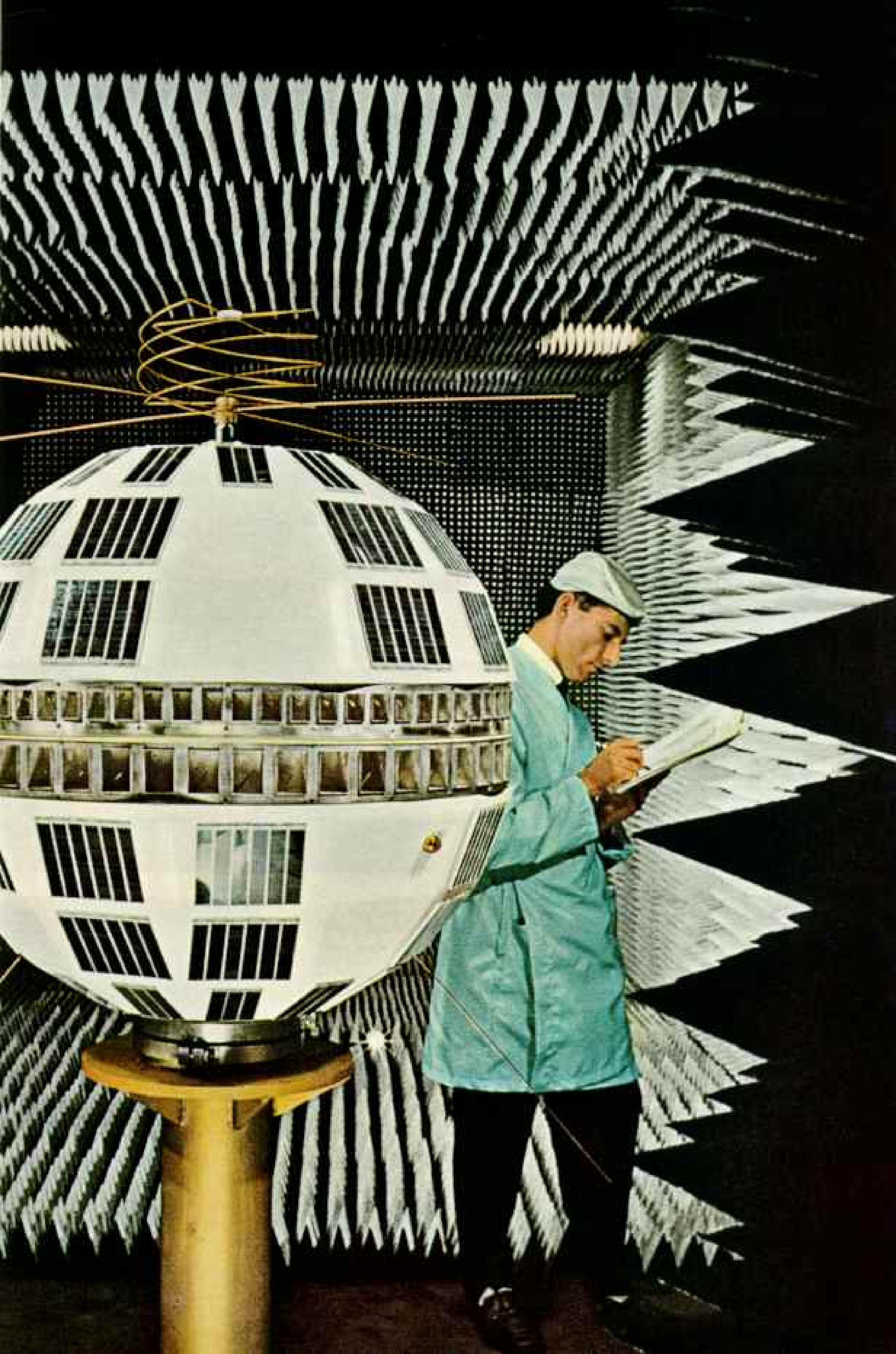
He was right, I won't see the sphere again. Instead I'll probably talk to it—or something very much like it. Chances are you will, too, for that gleaming ball with all the windows is Telstar,

**Mock-up of Telstar, a communications satellite scheduled for launching from Cape Canaveral in the next few weeks, gets an antenna check in a Bell Laboratories plant in Hillside, New Jersey. In space, Telstar will relay telephone, television, and telegraph messages across the Atlantic.**

Toothed plastic walls of the room absorb all but direct signals to Telstar's receiver, duplicating conditions in space. Technician checks test data.

EPIDORCHROME BY NATIONAL GEOGRAPHIC  
PHOTOGRAPHER ROBERT S. GOODMAN © N.G.S.







forerunner of commercial communications satellites designed to relay telephone messages across the world from a point thousands of miles in space. Of all the space objects launched so far, these satellites are the first that millions of people will actually use.

#### Automatic Phones Take to Space

Telstar—named for telecommunications and star—represents the electronic ingenuity of Bell Laboratories at Murray Hill, New Jersey, the research and development arm of American Telephone and Telegraph Company. Thus, from the birthplace of such miracles as the transistor, solar cells, and network television, comes another revolutionary device in the science of communications—a telephone relay station in space.<sup>46</sup>

And Telstar will have company in the sky. The National Aeronautics and Space Administration has contracted with the Radio Corporation of America to build a communications satellite called Relay, almost ready for launching, and with Hughes Aircraft Company for another known as Syncom. General Electric Company and Bendix Corporation are producing still another, named Advent, for the Department of Defense.

But several things distinguish Telstar from

<sup>46</sup>For a history of telephone communications—from conception to the age of space—see the following articles in *NATIONAL GEOGRAPHIC*: "Prehistoric Telephone Days," March, 1922, by Alexander Graham Bell, the only biographical article ever written by the inventor of the telephone; "The Miracle of Talking by Telephone," October, 1937, and "Miracle Men of the Telephone," March, 1947, both by F. Barrows Colton; and "New Miracles of the Telephone Age," July, 1954, by Robert L. Conly.



#### Assemblymen in Immaculately Clean Gowns Build Telstar Dust-free to Assure a Long Life

To be economically feasible, communications satellites must survive space hazards for 10 to 15 years; the experimental Telstar must live at least a year to meet design goals. Even a smudgy thumbprint on a vital part could cause contamination that would shorten life.

These men scrubbed hands, dried them on lint-free towels, and vacuum-cleaned shoes before entering the "white room" at Hillside.

Intent worker at left checks part of the command receiver that registers instructions radioed from the ground; two others test the code generator that sends commands to the satellite. At right, a panel plated with bluish cells for tapping solar energy goes onto Telstar.

Three times as hot as the sun's surface, a flame of ionized gas bursts from a plasma jet-spray gun with the roar of a jet plane's exhaust. The intense heat melts aluminum-oxide particles and shoots them into a stream, or plasma, that sprays an outside panel of Telstar. The tough coating that results is only a tenth as thick as a human hair. Operator wears welder's hood, aluminized jacket, and earplugs for protection against glare, heat, and din.





ROBACHOWSKI (ARABE) BY NATIONAL GEOGRAPHIC PHOTOGRAPHER S. ARTHUR STEWART AND HIS ASSISTANTS BY ROBERT P. BOHRMAN © N.G.S.



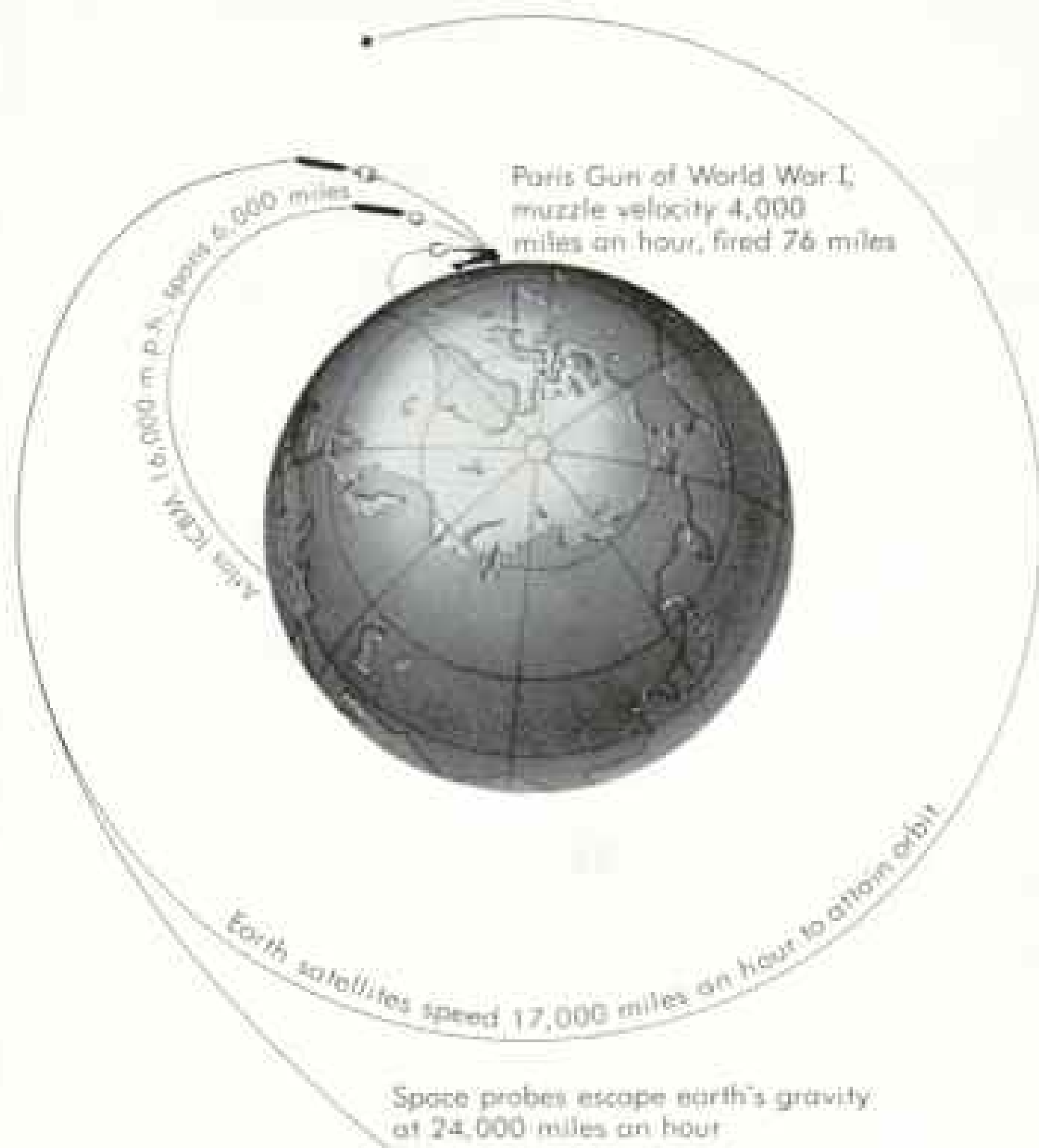


DIAGRAM BY STAFF ARTIST R. W. NICHOLSON © R.S.T.

### Speed Determines Whether a Rocket Falls, Goes Into Orbit, or Escapes Into Space

The German Army's Paris Gun of World War I fired shells 76 miles into the French capital, the longest range attained in artillery's history.

Atlas, when used as an intercontinental missile, races at 16,000 miles an hour and travels as far as 6,000 miles. To launch an earth satellite, a rocket must accelerate to 17,000 miles an hour. Space probes, such as Pioneer IV, escape earth's gravity with a speed of 24,000 miles an hour.

Sir Isaac Newton in the late 17th century postulated the laws that govern trajectories and explain how a satellite stays in orbit. Simply stated: A rocket launched with too little speed falls back to earth. With too much speed, it escapes. Between the extremes lies a range of velocities at which a properly aimed object orbits earth in balance between falling and escaping, and becomes a satellite.

its fellow projects. To begin with, A. T. & T., eager to pioneer in space communications, is paying its own way in both design and launching of its brain child. In addition to more than \$30,000,000 already spent on Telstar and satellite ground stations, A. T. & T. has entered a unique partnership with NASA, reimbursing the space agency for launching the satellite with a Thor-Delta rocket—some \$3,000,000. The outlays set a Space Age precedent for private investment.

#### Scientists Work in Dust-free Rooms

Since Telstar was scheduled to be the first of the new communicators in orbit, I had begun my tour of tomorrow's satellites at Bell's Hillside facility. There, Telstar was nearing completion.

What had looked like a hospital operating room was the fabrication laboratory for the satellite. Bell calls such laboratories "white rooms," and certainly no hospital ever took greater pains to keep out dirt and grime (page 640). Unlike hospitals, however, white rooms safeguard priceless equipment rather than people. In this case, the concern was for Telstar's delicate components, which are acutely allergic to dust.

In a white room, filters strain the air. Workers wear lint-free nylon caps and gowns, and vacuum-clean their shoes before they set foot in the laboratory. Engineers even use wash-

able crayon instead of chalk on the blackboards that inevitably stand near their conference tables.

I could have spent many hours exploring Hillside's Space Age workshop, but I wanted to learn how Telstar came to be. The place for that was the Bell Laboratories at Murray Hill, ten miles away, where the idea of Telstar was born.

At Murray Hill, I discovered, the problems are not all in the realm of science. A big worry is simply one of time.

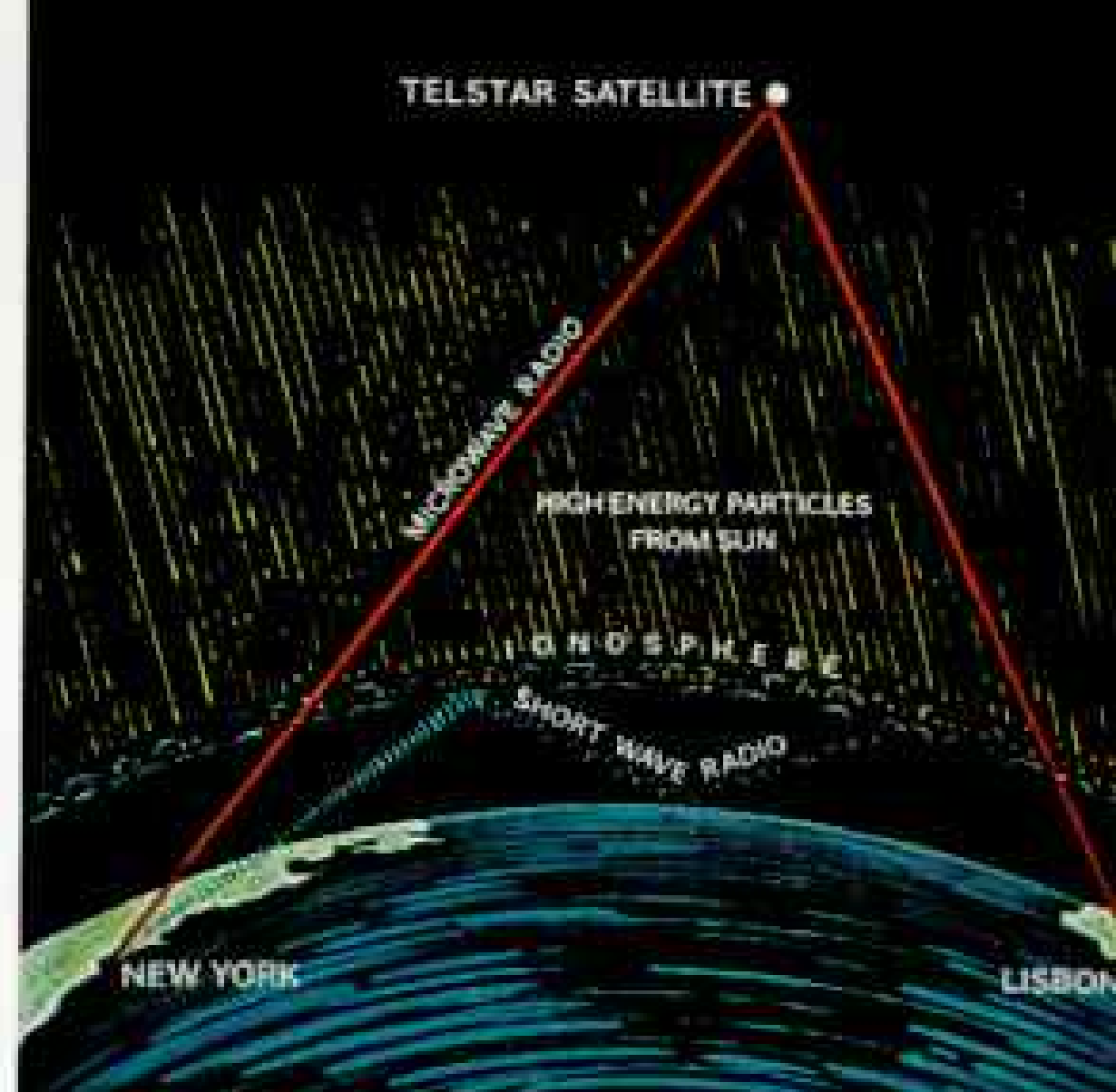
"In the past ten years," explained Alton C. Dickieson, director of Bell's transmission development, "the United States has seen a fantastic increase—about 75 percent—in its use of telephones. Communications carriers work night and day to keep up. We must constantly add new lines and circuits.

"But the oceans are the big barrier. The United States, for example, has only 550 telephone channels—both cable and radio—with which to handle some four million international calls a year. And in 1961 alone all transoceanic calls rose by 15 percent."

Television, he said, is another problem, for one TV signal takes up more than 600 voice channels. Though future developments may greatly expand cable capacity, the U. S. today cannot exchange by cable a single live television program with Europe.

"The challenge will increase with time,"





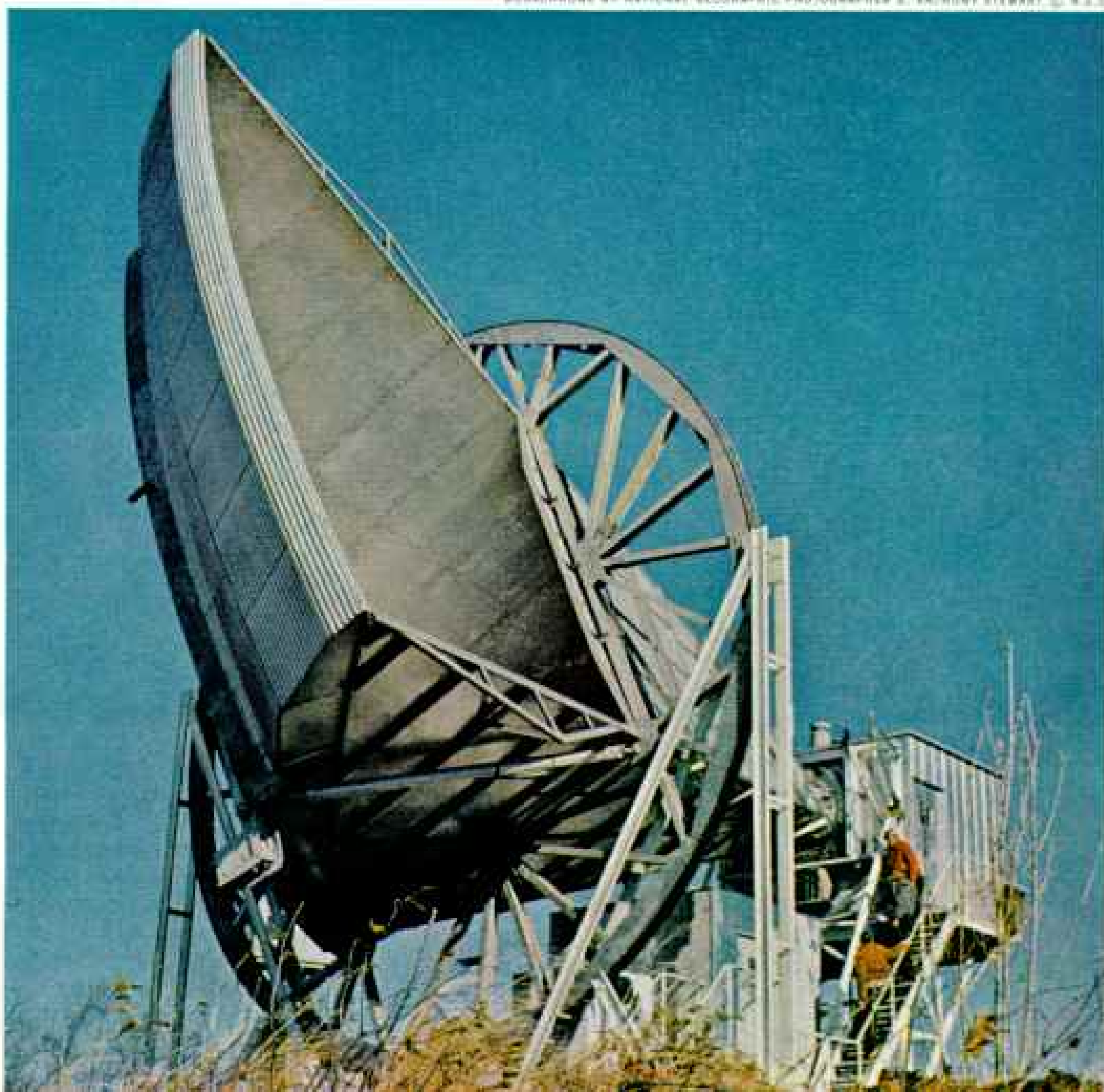
PAINTING BY STAFF ARTIST JOSEPH E. BARRYTT © N.G.S.


Short-wave radio signals bounce back and forth between the ionosphere and earth. But solar storms emit particles that cause the lofty reflective shield

to absorb signals, thus blocking reception. Telstar will receive and rebroadcast microwave messages that always penetrate the ionosphere.

Space Age ear trumpet, an 18-ton antenna atop Crawford Hill, near Holmdel, New Jersey, tracks and talks with satellites. Unique shape helps the Bell Laboratories' horn to receive signals as weak as the billionth of a millionth of a watt bounced to earth from the Echo I balloon satellite.

PHOTOGRAPH BY NATIONAL GEOGRAPHIC PHOTOGRAPHER B. ARTHUR STEWART © N.G.S.





Satellites at work:  
relay stations  
7,000 miles in space

**F**ROM LONDON to New York, from Chicago to Lisbon, messages will leap the Atlantic via communications satellites. Painting shows how two Telstars, part of a network of scores in polar and equatorial orbits, could link distant points.

Telstar at right picks up London messages on its upper belt of windowlike antennas and rebroadcasts to New York on its lower band. Satellite at left provides a similar link between Chicago and Lisbon. Mast antennas atop the Telstars and

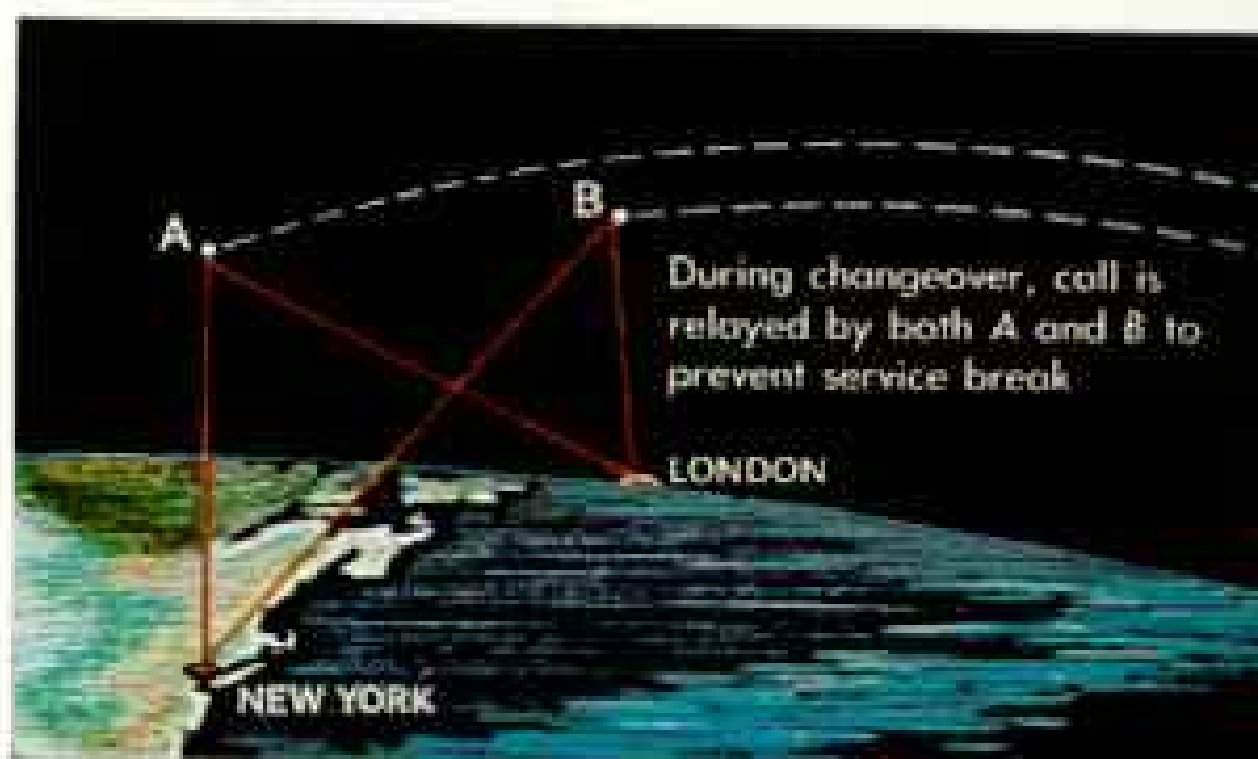
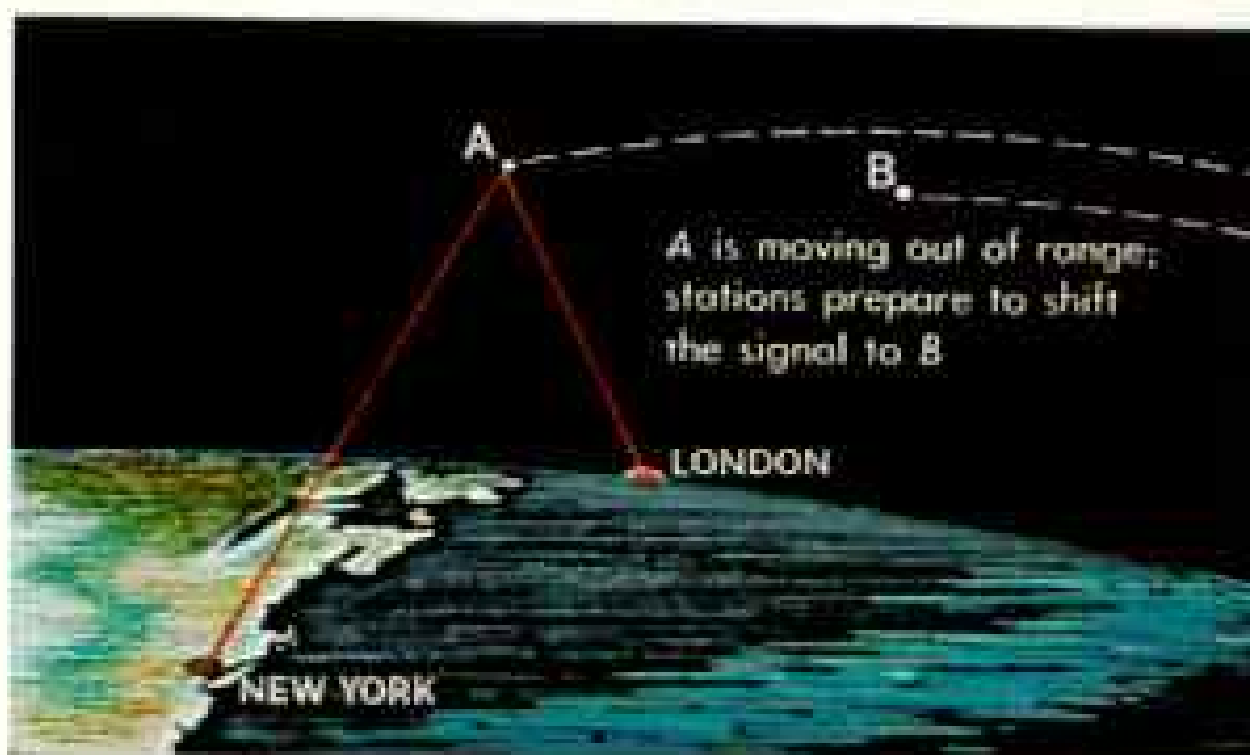


PAINTING BY STAFF ARTIST JOSEPH E. BARRETT © N.S.S.

whip antennas beneath send operational data to earth. The mast antennas also receive signals that turn the relay systems on and off during flight. Shiny solar cells change sunlight to electric power for receiver and transmitter.

Swirling gauze of clouds on the world's face follows cyclonic patterns long suspected by weathermen and recently confirmed by Tiros weather satellites.

### HOW GROUND STATIONS SWITCH MESSAGES FROM ONE SATELLITE TO ANOTHER







THE ENTRIES WERE BY ROBERT B. GOLDMAN © N.S.A.

Man-made rubies form the hearts of ground-station amplifiers called masers, which multiply weak signals from space 4,000 times. Synthetic rubies have the same structure as those found in nature. Amplifying energy comes from chromium atoms, which also make ruby red.

Kettleful of "space"—vacuum, cold, and solar heat and light—exists in a chamber that tests a part of Telstar. Plumes mark escape of the coolant, liquid nitrogen at  $-323^{\circ}$  F.



Mr. Dickieson continued. "World demand for telephone service will grow even faster during the next decade. Undersea cables are expensive, and microwave relays—radio voice transmission by means of towers spaced a few miles apart—cannot be built across an ocean."

But, I asked, why turn to satellites? Can't short-wave radio, such as radio hams use, solve the problem?

"The answer is no," he replied. "For one thing, short-wave channels are already crowded. For another, short-wave radio depends on signals bounced from one point on the globe to another, using a high layer of the atmosphere as a sort of electronic mirror. The difficulty there is that solar storms—sunspots—and other magnetic disturbances can play havoc with short wave and even block it out entirely [see drawings, page 643]."

"If you've ever talked between one country and another by short-wave radiotelephone, you know the fade, static, and interruptions that can occur. The problem is to find something that will reliably relay hundreds or even thousands of conversations across the world's oceans. A satellite network can do it."

Telstar is a sun-powered space station designed to receive microwave signals beamed from earth, boost their power, and fire them back to ground strong enough to be received. To understand just how Telstar does it, I went to Dr. John R. Pierce, an executive director of research at Murray Hill, who was first to offer concrete proposals for a communications satellite.

#### Jeweled Windows Tap Sun's Power

Dr. Pierce is a slender, soft-spoken man with an amazing mind some have compared to a computer. He has many talents, among them a gift for writing science fiction, published under the pen name J. J. Coupling.

"No one can doubt the urgency of a communications satellite system," Dr. Pierce began. "We estimate that 20 to 25 Telstars in a web of random orbits could provide telephone and television circuits to Europe, while 30 to 50 could eventually link all the countries of the world.

"Moreover," Dr. Pierce said, "satellites using wide radio bands—the frequencies lie in the range between 1,000 and 10,000 megacycles—can handle many more telephone channels than our present cables can, and television as well. They're like superhighways compared to country roads in terms of traffic."

I had visions of sitting in my own living room near Washington, D. C., and seeing broadcasts of an opening of the British Parlia-

ment or some future Olympic Games in Asia.

To learn more about Telstar, I met Eugene F. O'Neill, Telstar project director (page 650).

I found that those little gleaming rectangles I had seen—3,600 of them on the 170-pound ball—are solar cells that convert sunlight into electrical energy (page 641).

They are expensive items, those cells. Each one is coated with hard synthetic sapphire to protect it from radiation. Telstar must live and work while orbiting through the most intense part of the radiation layer known as the Van Allen belt.

"Reliability is everything," Mr. O'Neill explained. "Once a satellite leaves the launching pad at Cape Canaveral, you can't bring it down for repairs."

I asked how high Telstar would fly.

"The first model will have an orbit of 600 to 3,500 miles altitude and circle the globe every two hours and 40 minutes," Mr. O'Neill answered. "Later we plan an orbit 6,000 to 7,000 miles in space. With 50 Telstars circling the earth, at least one of them would be within range of any two sending and receiving continents virtually all the time."

Six thousand miles meant a 12,000-mile round trip for a radio signal. I asked if the signal wouldn't lose a great deal of its power on the way.

"Yes," Mr. O'Neill admitted, "between satellite and ground receiver alone, the signal's power will drop from two-and-a-half watts to about one-trillionth of a watt."

My amazement showed. "Then how can you ever hope to pick it up?"

Gene O'Neill smiled and said: "Go take a look at the receiver."

### Hearing Aid Weighs 340 Tons

Near Andover, Maine, you can see the reason for the O'Neill smile. There, in a pine-fringed clearing, A. T. & T. has built what surely is the world's largest ear trumpet. The 340-ton aluminum-and-steel antenna does just two things and does them well: With pinpoint accuracy it beams signals to satellites flying the immensity of space, and it scoops unbelievably faint radio signals from space while screening out surrounding noise. To protect the giant hearing aid, engineers have enclosed it in an inflated rubberized Dacron radome the size of a 14-story office building (page 650).

"During early tests of Telstar," Mr. O'Neill explained to me, "Andover will handle both the transmission and the reception of signals. It's no difficult trick to transmit—the real job comes in picking up the relayed signal,



FOODCHROME BY ROBERT E. GOODMAN © W. L. G.

Coil glows with heat that bonds pieces of a key amplifying device held within. The amplifier, which goes inside Telstar, gives radio signals enough power to reach ground stations. Called a traveling wave tube, it causes the signal to travel in a spiral path around a stream of electrons, from which it gains energy. Protective shield shadows the viewer's face with a grid pattern.

"A big problem is extraneous noise. When a communications engineer speaks of noise, he means anything that interferes with his signal. Did you know that heat released by falling rain can make a sensitive receiver roar like Niagara Falls? You yourself produce noise just by the heat of your body."

I asked what could be done about this electronic racket.

"Ten years ago," Mr. O'Neill replied, "we couldn't have strained Telstar's signal out of the mass of noise that exists everywhere. But that was before the maser."

At Murray Hill I had seen the maser (pronounced mayzer), an electronic marvel first brought to practical use at Bell Laboratories. Masers, whose hearts are synthetic rubies, amplify electrical impulses without picking up interference and without producing noise.

The word maser stands for "microwave amplification by stimulated emission of radiation." The ruby, a slender, rose-colored crystal about six inches long, operates in a bath of liquid helium at the fantastically low temperature of minus 456° Fahrenheit—nearly absolute zero.

"By means of masers," Mr. O'Neill said, "our big horn here can amplify Telstar's signal about four thousand times—enough for us to pick it up."



**Syncom**, Hughes Aircraft's flyweight satellite, will orbit to coincide with the earth's rotation. Here it rests on the nozzle of a small built-in rocket that will give the 60-pound communicator a final kick into synchronous orbit, 22,300 miles high, after a Thor-Delta lifts it from earth. Syncom undergoes tests at the Goddard Space Flight Center, a National Aeronautics and Space Administration facility at Greenbelt, Maryland.

**Relay**, a low-altitude satellite for NASA, acquires a solar-cell panel at R.C.A.'s space laboratories in Princeton, New Jersey. White plastic protects the antenna during its jarring ride to space.

KODACHROMES BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JOHN E. FLETCHER © N.G.S.



I learned that Andover was chosen for the ground station because of the site's remoteness from electrical interference and because of its easterly vantage point for keeping watch on satellites above the Atlantic.

When Telstar reaches its planned orbit, Mr. O'Neill's crew will make the first transmitting and receiving tests during the first passes within range of Andover.

"We'll have 20 to 45 minutes—the time Telstar will remain within our range on each pass," Mr. O'Neill explained. "But that will be enough. Our small tracking antennas will pick up Telstar quickly and put the main antenna on target.

"Then we'll put a test signal on the transmitter, followed by several telephone messages. Next we'll try a television signal. If we get a good picture on our TV monitor screens in the control room, we'll know Telstar is a complete success."

Later, Telstar's signals will be picked up by the Bell Laboratories receiving site near Holmdel, New Jersey (page 643), and still later by stations in Europe. France is building a station at Lannion in Brittany, and Britain is constructing another at Goonhilly Downs in Cornwall. With each new test, the day of space-borne telephone and television will be a little closer.

Telstar is scheduled to be first in orbit, but it will be only one of several satellites now being built for the same purpose. I saw another, the Radio Corporation of America's Relay, under construction at Princeton, New Jersey (lower left).

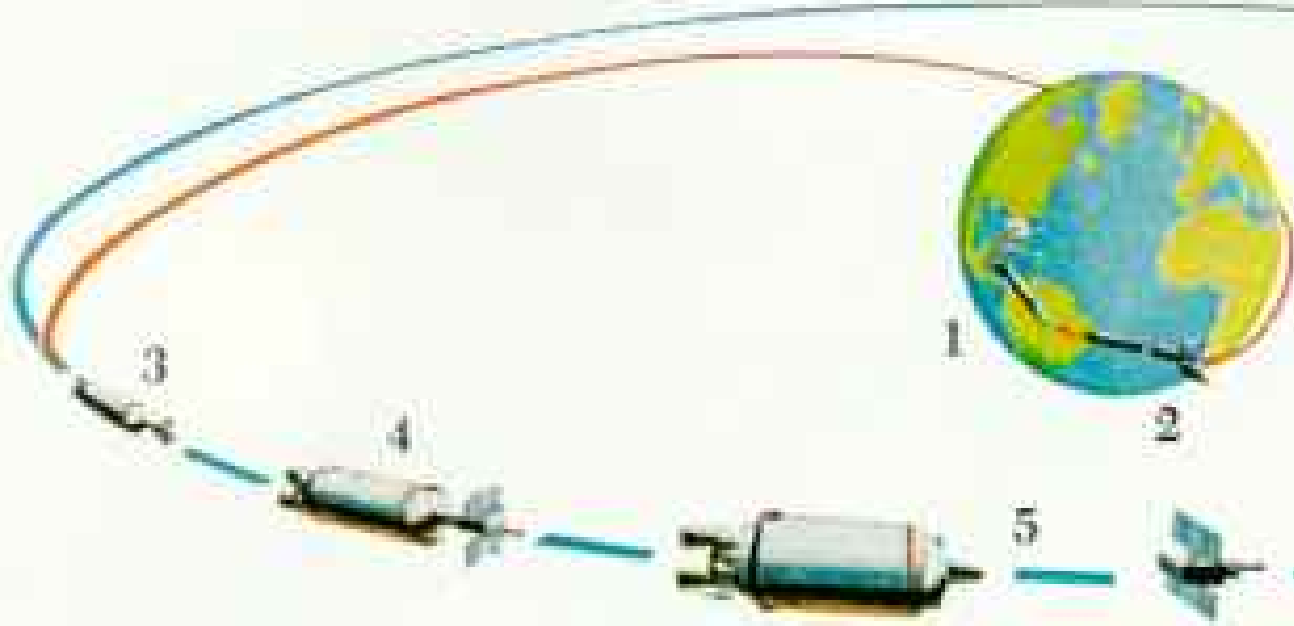
Though Relay looks different and weighs less (130 pounds total), it resembles Telstar in many ways. Both are pilot models for what may eventually be scores of satellites, all circling the earth in a few hours and handling traffic in turn as they pass the sending and receiving countries (see diagrams, page 645). Relay's launching date: late summer.

#### Syncom: Star That Never Sets

A quite different kind of communications satellite is nearing completion in Culver City, California. While Telstar streaks across the sky, this one, called Syncom (upper left), will hang perpetually in one spot—or so it will seem to us on earth. Actually, if Syncom reaches its ideal speed—6,800 miles an hour—and altitude—22,300 miles—it will exactly pace the earth's rotation. In other words, it will be synchronized; hence its name.

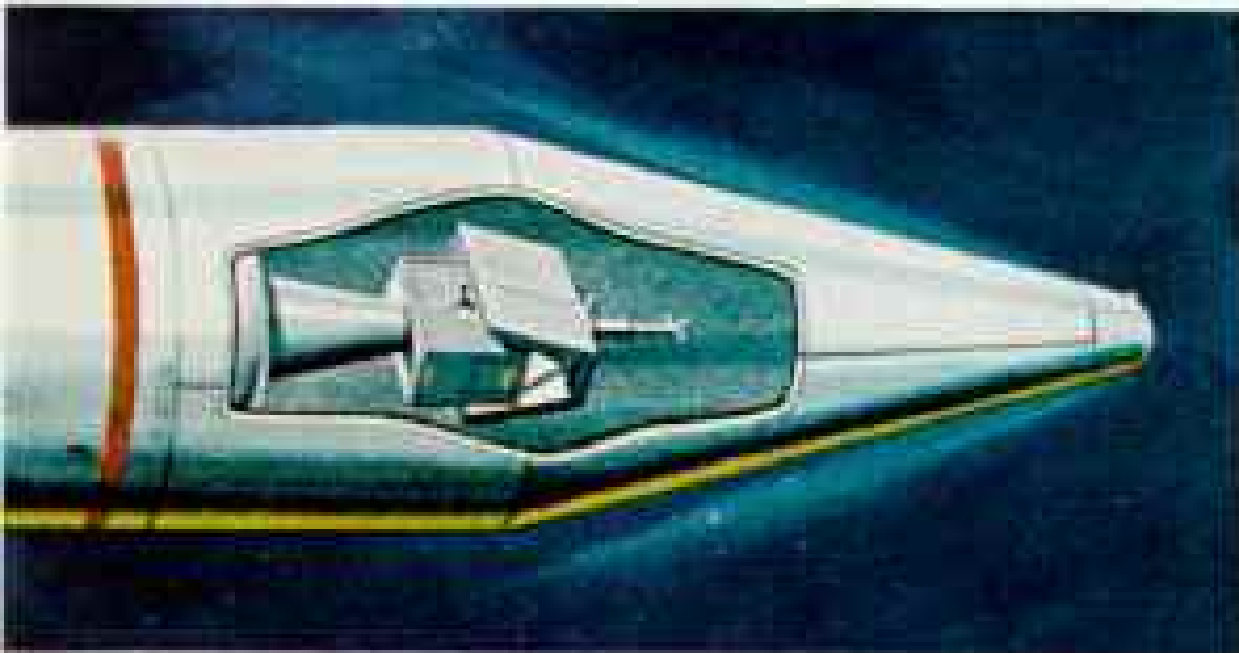
A fantastic idea, perhaps, but the men building Syncom are hopeful it can be done. They





Advent, the Defense Department's satellite, ascends to its station in space along a widening spiral path. The box-shaped space vehicle promises a reliable system of global communications for the Nation's military forces.

## HOW A SATELLITE UNFOLDS IN SPACE



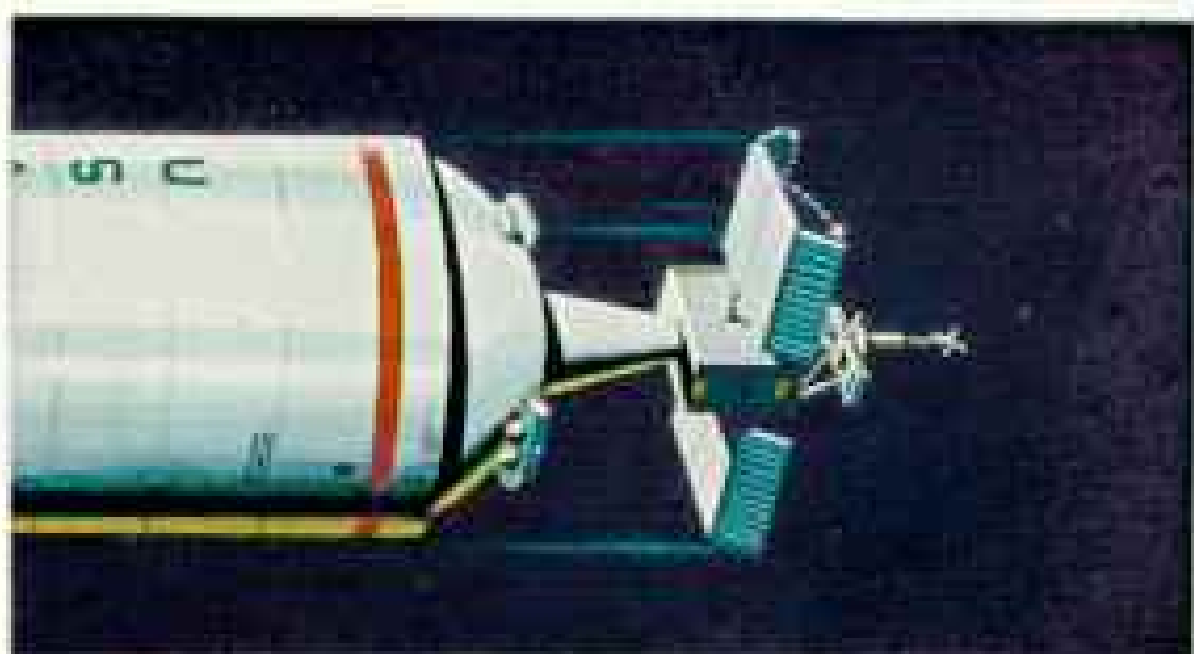
1. Fiberglass shroud shields Advent from air friction



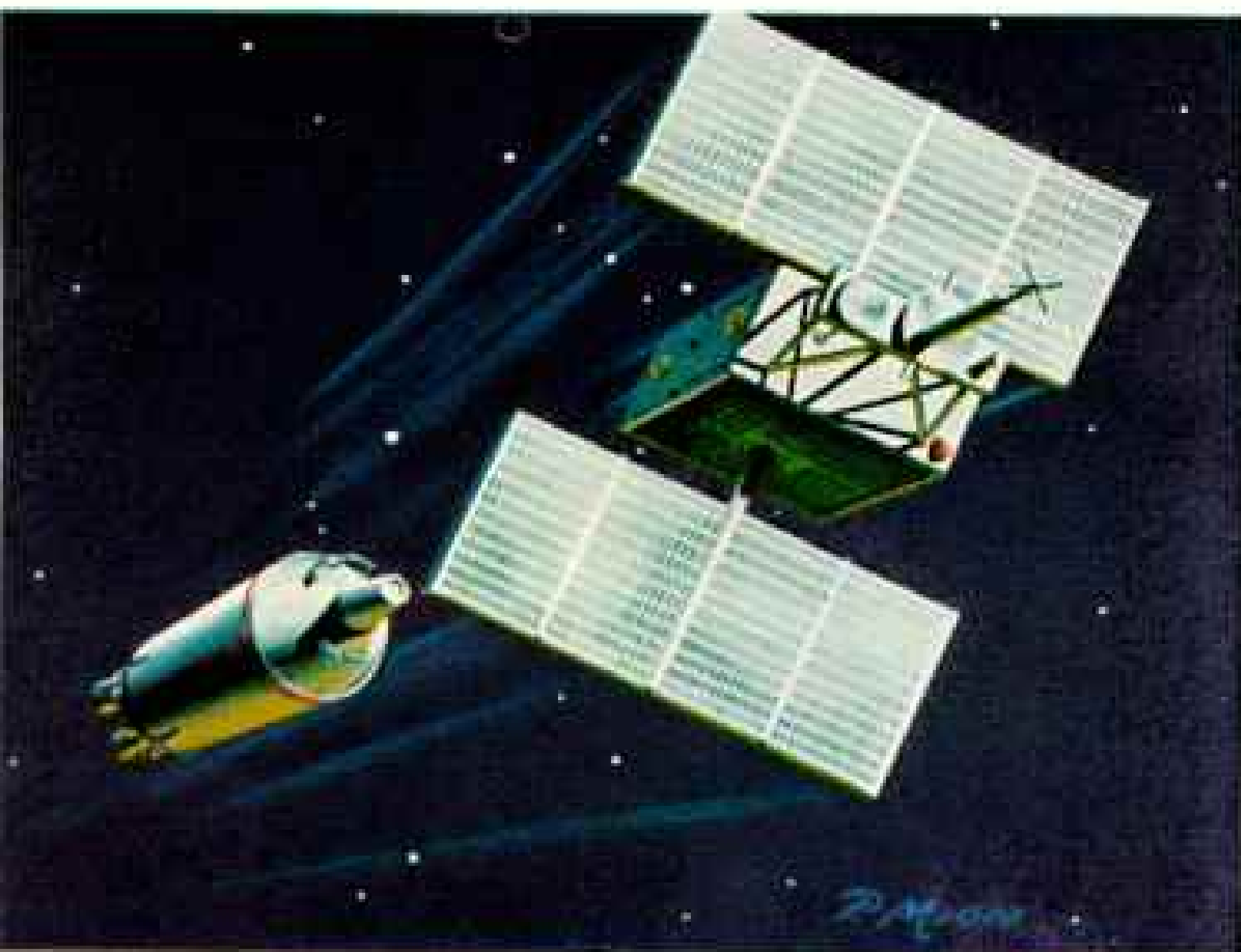
2. In space, the shroud parts, exposing satellite



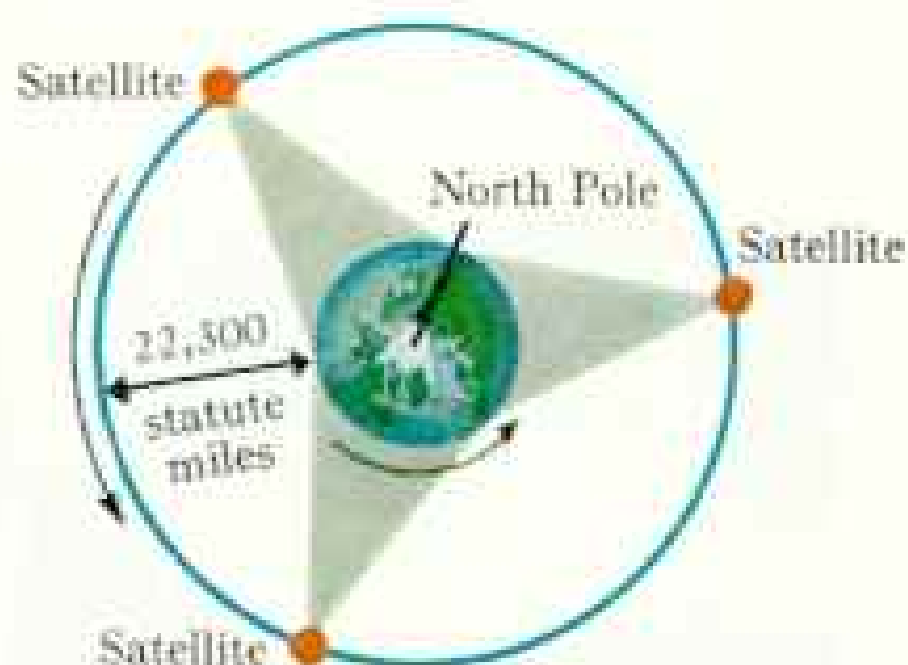
3. No friction tugs as solar paddles extend



4. Paddles unfolding, Advent coasts in orbit

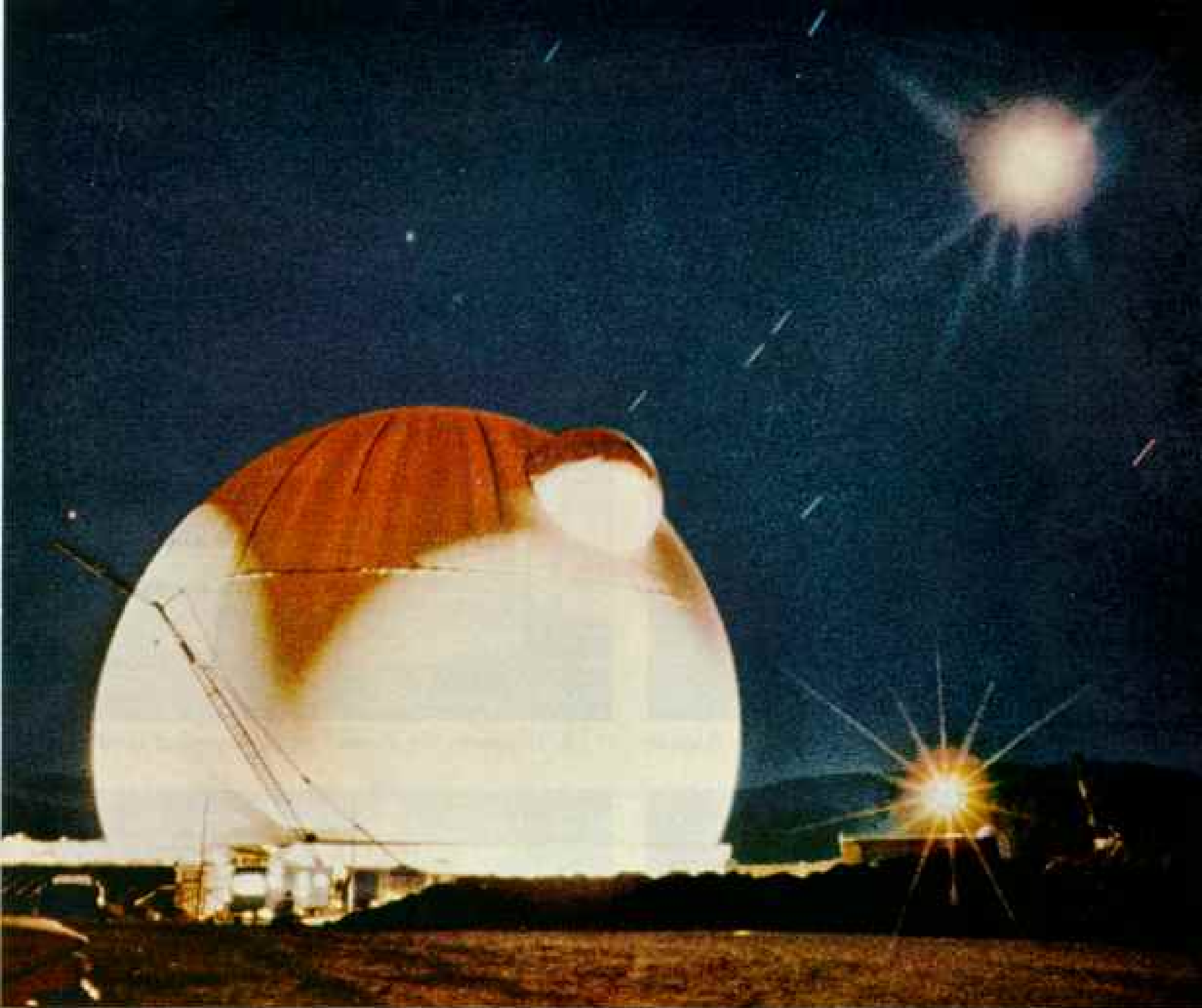


5. Explosive bolts free satellite; the 9-foot paddles, holding 38,400 silicon cells, convert solar energy into electricity



### Three Advents Can Relay Signals to Any Point but the Polar Areas

As if locked to the earth's turning, Advent will orbit once each 24 hours, its speed exactly matching the planet's rotation. Sun-powered flywheels turn the satellite so that its message-gathering antennas, like the moon's familiar face, constantly look to the globe.



BY DETACHMENT, LANSING AND WOODBRIDGE BY NATIONAL GEOGRAPHIC PHOTOGRAPHER OTTO JREIDEN © N.G.S.

Bubble of fabric, supported by air pressure, protects the world's biggest horn antenna at Andover, near Rumford, Maine. American Telephone and Telegraph Company built the 340-ton trumpet to converse with Telstar and Relay satellites. Seen under a full moon, the 160-foot-high dome shields the horn during construction. A rubberized Dacron cover has since replaced the temporary nylon shown here. Time exposure makes the stars in this photograph appear as diagonal streaks of light.

650



Model horn engrosses Eugene F. O'Neill (left), Telstar project director for Bell Laboratories, and Burdick W. Pierce, an A. T. & T. senior engineer. The model's dome, unlike the actual one, is transparent.

Dome prevents warping by wind and weather, which would distort the horn's tracking eye.

Turning with ballet-dancer grace, the huge horn has an error margin of less than 1/20 of a degree of arc. It rests on a mass of concrete—4,000 cubic yards.

**MODEL AND HORN ANTENNA**

The model is made of aluminum and steel. The horn is made of aluminum and steel. The horn is made of aluminum and steel.

Man appears fly-size as he inspects the temporary dome for leaks. During inflation a squall almost blew the loose nylon away; once filled, the bubble defied gales. During deflation smaller bulge covers the horn's cab and its sensitive instruments.

are scientists at the Aerospace Division of Hughes Aircraft Company. The Thor-Delta rocket bearing their 60-pound satellite is scheduled to roar into space next spring.

"The beauty of Syncom," project manager Gordon Murphy told me, "is that only three would cover the world. In effect they would hang 'motionless' above the Equator. Using one — and in some cases two — of the three Syncoms, any point on earth except for the polar regions could send messages to any other."

#### Space Age "Birds" Serve Man

Next day I stood beside what looked like a footlocker that had grown paddles. It was Advent, a synchronous satellite that General Electric and Bendix built for the Army.

Brig. Gen. William M. Thames, then commanding the Advent Management Agency at Fort Monmouth, New Jersey, explained why Advent weighs several hundred pounds, much more than its commercial cousins, such as Telstar.

"Our ground stations must be flexible," he said. "They need mobility to go into remote, possibly hostile areas. This means smaller antennas. Advent must make up the difference with more solar cells, circuits, and attitude controls. It all adds up to more weight."

Advent's weight requires a powerful rocket, and the satellite may wait a year before the hydrogen-fueled Centaur is ready to lift it to a 24-hour, synchronous orbit. Even with Centaur, Advent must climb to its 22,300-mile-high post by phases. First, it attains a 100-mile-high orbit clear of the atmosphere. Next, upper stages fire it into a far-looping transfer orbit. Finally, a burst of flame at the top of the transfer orbit hurls it into a circular path over the Equator (page 649). An early model Advent is due to fly this year at lower altitude — 5,000 to 6,000 miles.




FRANCIS & NATURAL GEOGRAPHIC SOCIETY

As I left Fort Monmouth, I saw a curious and moving sight in an era of space communications. It was a homing pigeon in bronze, GI Joe, the bird that saved advancing troops from bombing by friendly planes in World War II. The memorial honored all the homing pigeons that had served the Nation, birds with such famous names as Spike and Cher Ami. Now other "birds" replace them — electronic miracles with names like Advent, Syncom, Relay, and Telstar.







# Cities of Stone in Utah's Canyonland

*Where the Green River  
joins the Colorado,  
bristling pinnacles and  
arch-studded canyons form  
a little-known wonderland that  
may become a national park*

By W. ROBERT MOORE

National Geographic Staff

*Photographs by the author*

**O**N AND ON it stretched beneath our wings—a vast city of towering skyscrapers, massive domes, and bridges beyond an architect's dreams. Yet it was a city without a blueprint, the work of nature, not of man, and it had taken hundreds of thousands of years to build.

The only thing missing is the people, I thought. They'll come someday—thousands of them—to see these sights.

"It's one of the most spectacular spots in all Utah—and one of the least known," said Harlon W. Bement, Director of the Utah State Aeronautics Commission, as he nosed the Beechcraft down for a look at long-deserted cliff dwellings.

Sandstone colossus hewn by rain, frost, and wind, Druid Arch derives its name from a striking resemblance to England's Stonehenge, popularly associated with Druids. Here, in southeastern Utah's canyonland, a magnificent scenic wilderness awaits Congressional sanction as a new national park.

KODACHROME © NATIONAL GEOGRAPHIC SOCIETY



From this height the erosion-clawed land reminded me of a maze into which scientists might put white mice to test their ability to find their way out.

Next day we would become the mice, seek-

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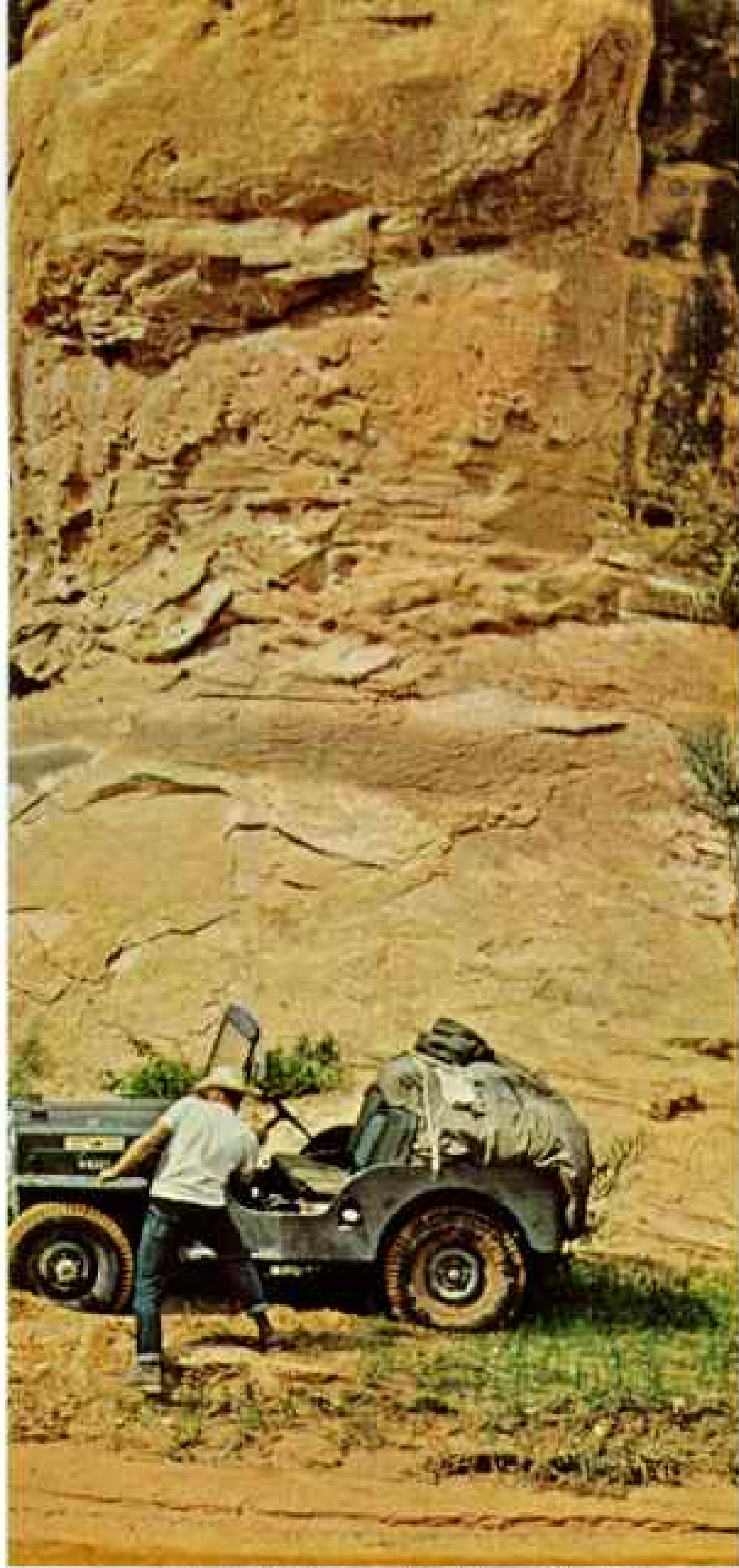
**The Author:** W. Robert Moore described seldom-visited canyon country of the western United States in "Escalante: Utah's River of Arches," in the September, 1955, *NATIONAL GEOGRAPHIC*. Chief of *GEOGRAPHIC*'s Foreign Editorial Staff, he has written 64 articles on subjects ranging from the American West to the Congo, Chile, Australia, and the ruins of Angkor Wat in Cambodia.

ing our way in and out of these kinking canyons by Jeep, horseback, and on foot.

The area we had seen is part of a 332,000-acre wonderland which Congress has been asked to set aside as Canyonlands National Park (map, page 657). Legislation sponsored by Senator Frank E. Moss of Utah has the strong support of the Kennedy Administration.

If the new park is created, thousands of visitors to these remarkable canyons will enjoy sights that only a handful have ever seen. Then perhaps such a fanciful name as *The Needles*—a title bestowed on one region of towering pinnacles—will be as famous as





STOCKHOLM BY W. ROBERT WHITE, NATIONAL GEOGRAPHIC STAFF © N.G.S.

### Devils Garden in Arches National Monument.

In the next few years this entire corner of Utah will be transformed by creation of huge Lake Powell behind the growing Glen Canyon Dam on the Colorado. Although the lake will not reach to The Needles area, it will enable boats to come within a few miles and will open many remote regions to exploration and enjoyment.

#### Into the Maze by Jeep, Then Saddle

Cold rain whipped around us at Monticello as our party of 11 stowed food, bedding rolls, and other gear into three Jeeps and the

### Riders Strain to Free a Jeep Trapped by Quicksand in Horse Canyon

The author and his party explored some 300 miles of canyon country—much of it unmapped. Here, where storms occasionally send flash floods pounding through The Narrows, they struck a treacherous spot. Two Jeeps raced safely across, but the third foundered. The others pulled it out.

Some canyons stop even Jeeps, and visitors must take to horse or foot to reach many of these wonders.

station wagon of Burnett A. Hendryx, our tour organizer from nearby Panguitch.

Arranging to switch from Jeep to horseback farther along the trail, we drove northward on U. S. Highway No. 160 for 13 miles. Then we turned westward onto a gravel road leading to Dugout Ranch, surrounded by irrigated alfalfa fields and massive red buttes in Indian Creek Valley (see map of author's route, next two pages).

Until a few years ago this cattle ranch was isolated. But not now. Uranium seekers and oil exploration crews have combed the desert valleys. So much traffic passes through the ranch holdings that on one gate I saw a sign with this pointed reminder: "It takes only a minute to close the gate, but it may take hours to pick the shot out of your hide if you don't."

Opening—and closing—several gates, we continued into wilder canyon country. We skirted the bold landmarks of North and South Six-shooter Peaks and reached Cave Spring for a noontime lunch pause.

Cave Spring is no imposing landmark. It isn't even much of a spring. The cave is an eroded undercut in the base of a sandstone cliff, the spring only a tiny puddle of water in a stone depression. It accumulates from an almost imperceptible drip that comes from a crack in the rocks.

But for centuries Cave Spring has afforded refuge and fresh water for Indians and others roaming the canyons. Several floor stones are hollowed and worn where prehistoric natives ground corn. The roof is smudged black by the many fires they kindled. More recently, ranch hands had been camping here while rounding up cattle that grazed in the canyons.

From Cave Spring we turned southward into Salt Creek.

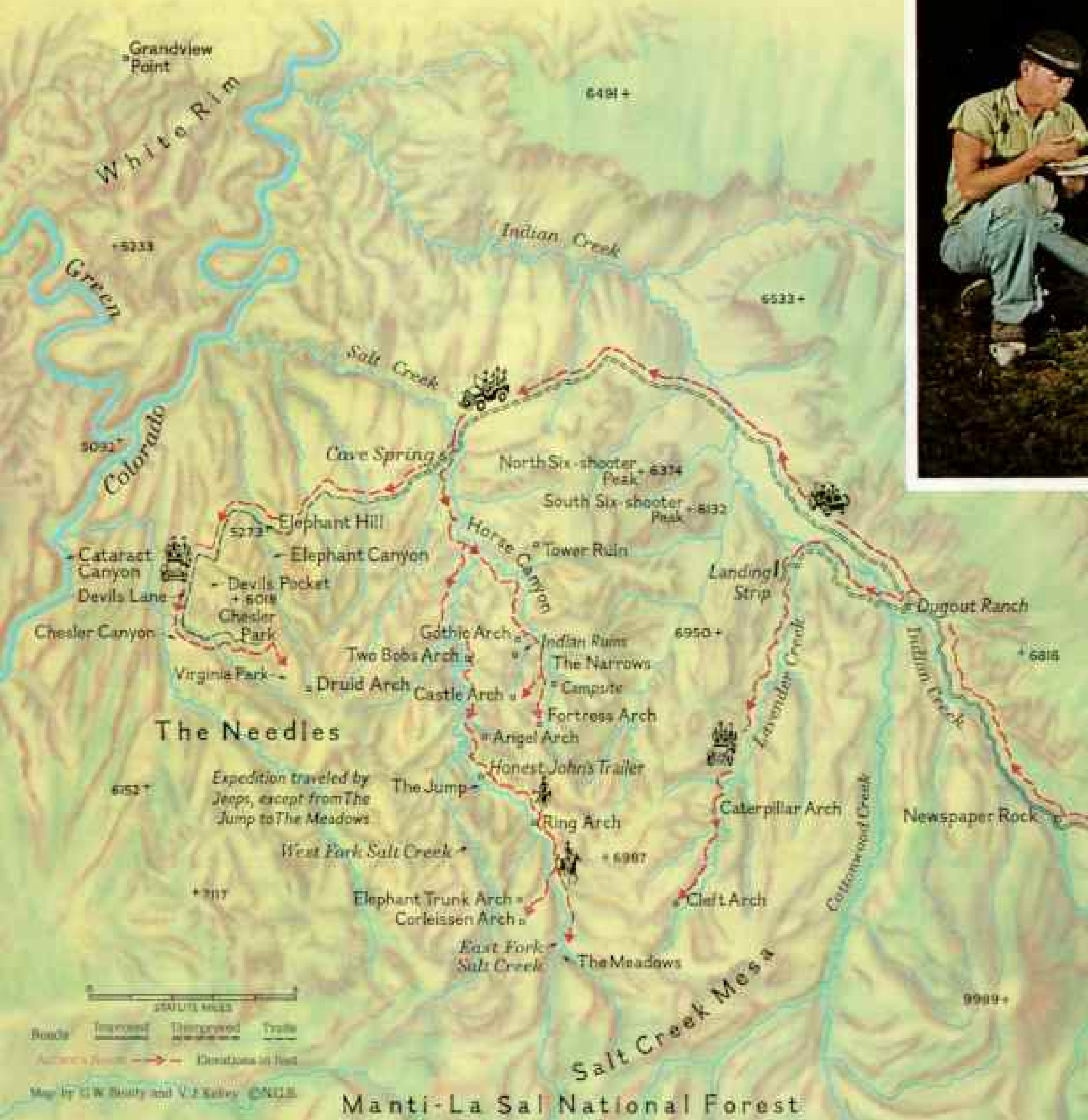
"If you fall into this creek you'll get mighty dusty," someone remarked.

We got dusty without falling in. The Jeeps plowed through a salt crust and threw up choking clouds of sand as we bucked our way through tangled brush and along dry streambeds that in rainy seasons can become raging torrents in the space of minutes. In places we did strike water—shallow puddles and small streams where springs came to the surface. Wherever there was moisture, we had to be alert against quicksand.

After leaving Cave Spring, we followed the Salt for three miles to its junction with Horse Canyon. Intrigued by this large tributary, we decided to explore it before going up the main canyon.

Though we were heading upstream, the cliffs thrust higher and higher above us. In contrast to the almost solid red sandstone walls that I had seen in the Escalante River area on an earlier trip to Utah, the canyons here were broken by numerous gulches and ravines. In places they opened into broad side valleys; elsewhere erosion-hewn walls crowded close in upon us.

656 Then we rounded a bend in Horse Canyon and came in view of Gothic Arch.



Manti-La Sal National Forest



SCETCHES BY NATIONAL GEOGRAPHIC SOCIETY



Pan-fried steaks and Dutch-oven biscuits satisfy hikers' appetites in Lavender Creek Canyon. Tired campers will soon slip into sleeping bags.

Nature's artful fingers molded Utah's gorges, mesas, and rock battlements. Red shading shows area of author's trips (left) into the proposed national park.





Strictly speaking, this is not an arch but a window high above the canyon floor, like Castle Arch (opposite page). Gothic, however, is triangular.

Some formations, such as Gothic, Castle, and Druid Arch (pages 652-3), have been divided into irregular blocks by cracking or jointing; these cracks have been opened up by the work of rain, frost, wind, plant roots, and sharp temperature changes.

Other formations, like Cleft Arch (pages 668-9 and 677), have resulted from gradual erosion of a cliff wall by swirling waters of a stream, as well as from weathering action.

#### Finger Marks 800 Years Old

While we were vainly seeking a way up the cliff to Gothic, we came upon a small cluster of Indian storehouses nestled in a protected ledge. Though abandoned perhaps 800 years ago, their stone-and-adobe walls still stand almost intact. And in the mud smeared on their inner surfaces we found the perfectly imprinted finger marks of the long-forgotten cliff dweller who had daubed them there.

In the thick deposit of dust on the storehouse floors, we discovered corncobs, dry and hard as bone. The primitive Indian farmers obviously gained no bumper yields from the flint corn they planted in the canyons; no cob was longer than two or three inches.

Potsherds strewed the ground. Some were painted with black patterns on a white base; others showed corrugations on their dark clay surface. The wall of a rock alcove displayed a row of pictographs; one portrayed a hunter drawing a bow.

Who were these canyon dwellers? Archeologists call them Anasazi, a Navajo term meaning the "ancient ones." The name applies to that large group of prehistoric Indians who once inhabited much of the plateau region of the American Southwest, particularly Utah, Arizona, New Mexico, and Colorado.

They are best known, however, for the two main periods of their cultural development—first as primitive Basket Makers and later as the Pueblos. In the latter period they built and then abandoned such extensive community centers as Pueblo Bonito, Hovenweep, and the spectacular cliff dwellings of Mesa Verde, Betatakin, and Keet Seel.\*

Archeologists do not know for certain all the reasons that caused the Indians to move on, but drought was one of the main factors. By the middle of the 13th century the whole northern portion of the plateau had been completely abandoned.

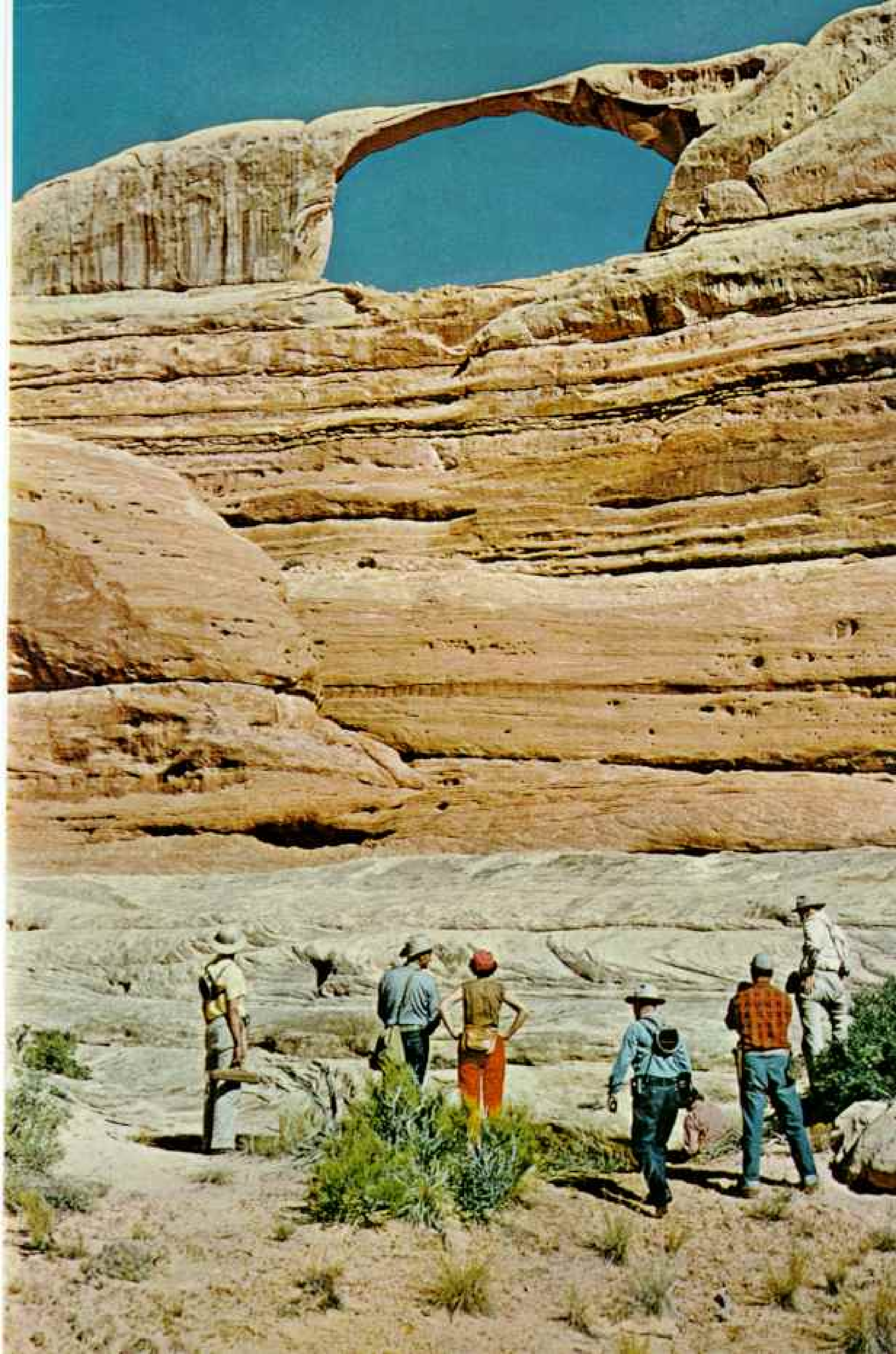
\*See NATIONAL GEOGRAPHIC: "Searching for Cliff Dwellers' Secrets," by Carroll A. Burroughs, November, 1959; "Ancient Cliff Dwellers of Mesa Verde," by Don Watson, September, 1948, and "Indian Tribes of Pueblo Land," by Matthew W. Stirling, November, 1940.



Window in the sky, Castle Arch surmounts an impregnable rampart. Thin tongue of rock roofs an opening some 130 feet wide. Members of the author's party tried to climb to it, but projecting ledges foiled them.

Hearty desert blossoms like the claret-cup cactus (left) and yellow cactus (below) defy summer's blistering sun and arid sands.



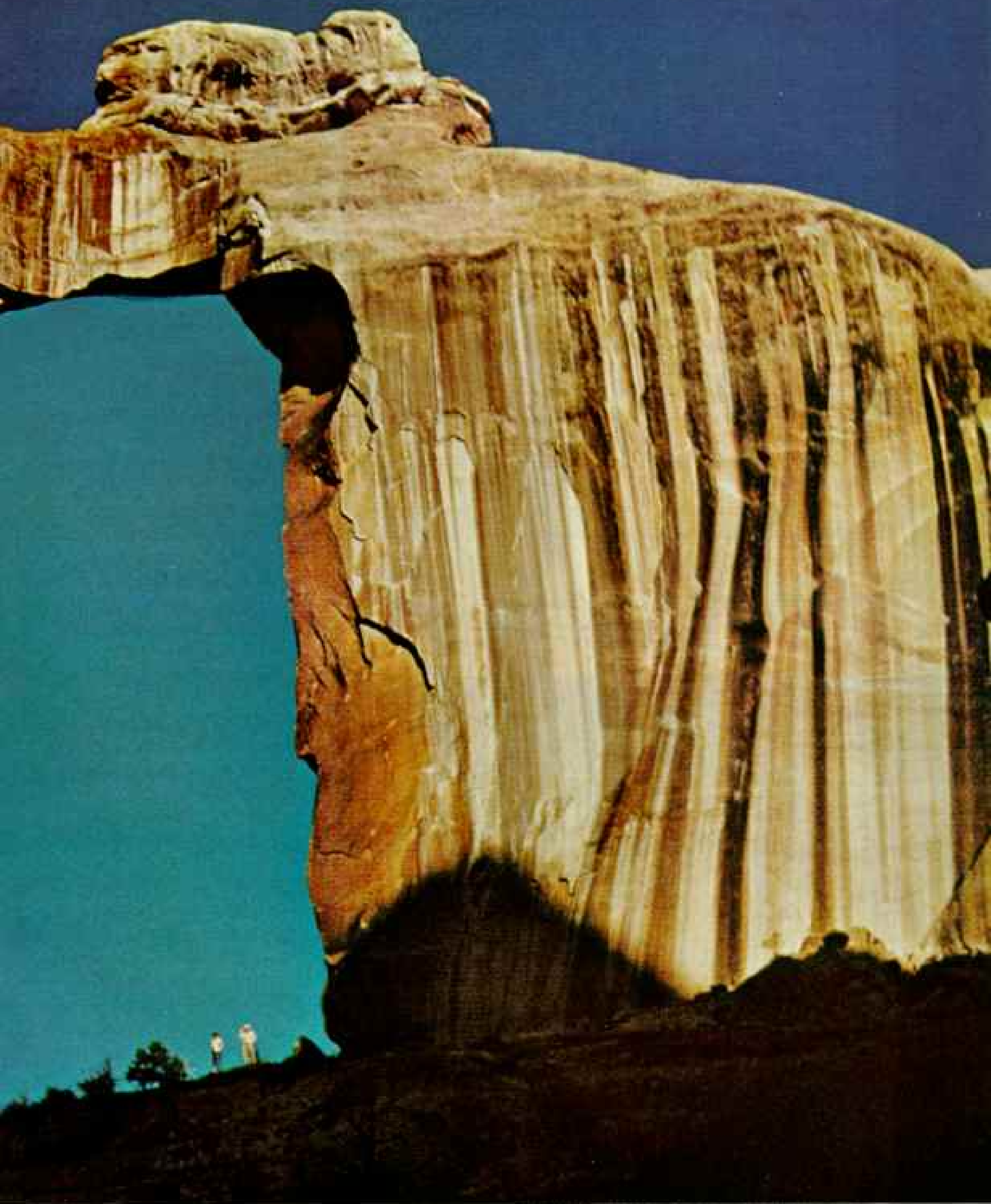




Angel Arch Glows Like Living Flame  
in the Glare of a Descending Sun

Men appear as Lilliputians in a yawning cavity  
150 feet high and 130 feet wide. Walls bear stains  
of "desert varnish"—a lustrous dark patina of





PHOTOGRAPHS BY FORBETT & WENDT © NATIONAL GEOGRAPHIC SOCIETY

iron and manganese oxides leached from the rocks by water. Late afternoon shadows creep up the base of the arch. Graceful figure of the angel ap-

pears to better advantage from the opposite side. Viewed here from the west, only the head, a projecting knob of rock at upper left, shows clearly.

The canyons of the Salt lie on the northern rim of the Pueblo lands. While we found no settlements to compare with Pueblo Bonito or Mesa Verde, we saw abundant evidence that hundreds of Indians had occupied this now-empty region. They grew corn, beans, and squash in the narrow alluvial flats and hunted game in the hills.

Threading the canyons, we came upon scores of their dwellings and storehouses, arrow-chipping grounds, and examples of their rude cliff art. Many small structures lie tucked in caves and rock niches; others are remnants of sizable communities. Some perch on incredible cliff ledges beneath sheltered overhangs; often they cannot be reached without using ropes or hewing new footholds.

About the dry, dusty settlements lay pieces of yucca sandals the primitive hunter-farmers wore, and bits of yucca cord they had twisted. Some cord fragments still were wrapped with rabbit fur and bird skins, which the Indians ingeniously fashioned into blankets. Instead of weaving them, they twined the fur- and feather-wrapped cords tightly together in parallel rows to produce light, warm coverings.

**Rocky roadblock** halts the author's caravan at East Fork of Salt Creek. Leaving Jeeps behind, the visitors continued on horses that had followed the cars. They fill canteens and water bag.

A mile or so beyond Gothic Arch we came to a canyon stricture, The Narrows. Here the stream has cut a channel through cliffs, forming a gap scarcely wider than our Jeeps.

I rode with Bob Robertson, a student at the University of Utah. He gunned the motor to hurry through, but the instant we hit a bend we made a sudden squashing halt. My side of the Jeep dipped sharply, the wheels sank nearly out of sight, and I found myself almost sitting in quicksand. It took the other two Jeeps to haul us to solid ground (page 654).

A short way above The Narrows, springs filled several pools and gave birth to a pleasant little stream. We set up camp on a grassy bank beside the water and spent the night serenaded by crickets and croaking frogs.

#### Dawn Pistol Wakens Campers

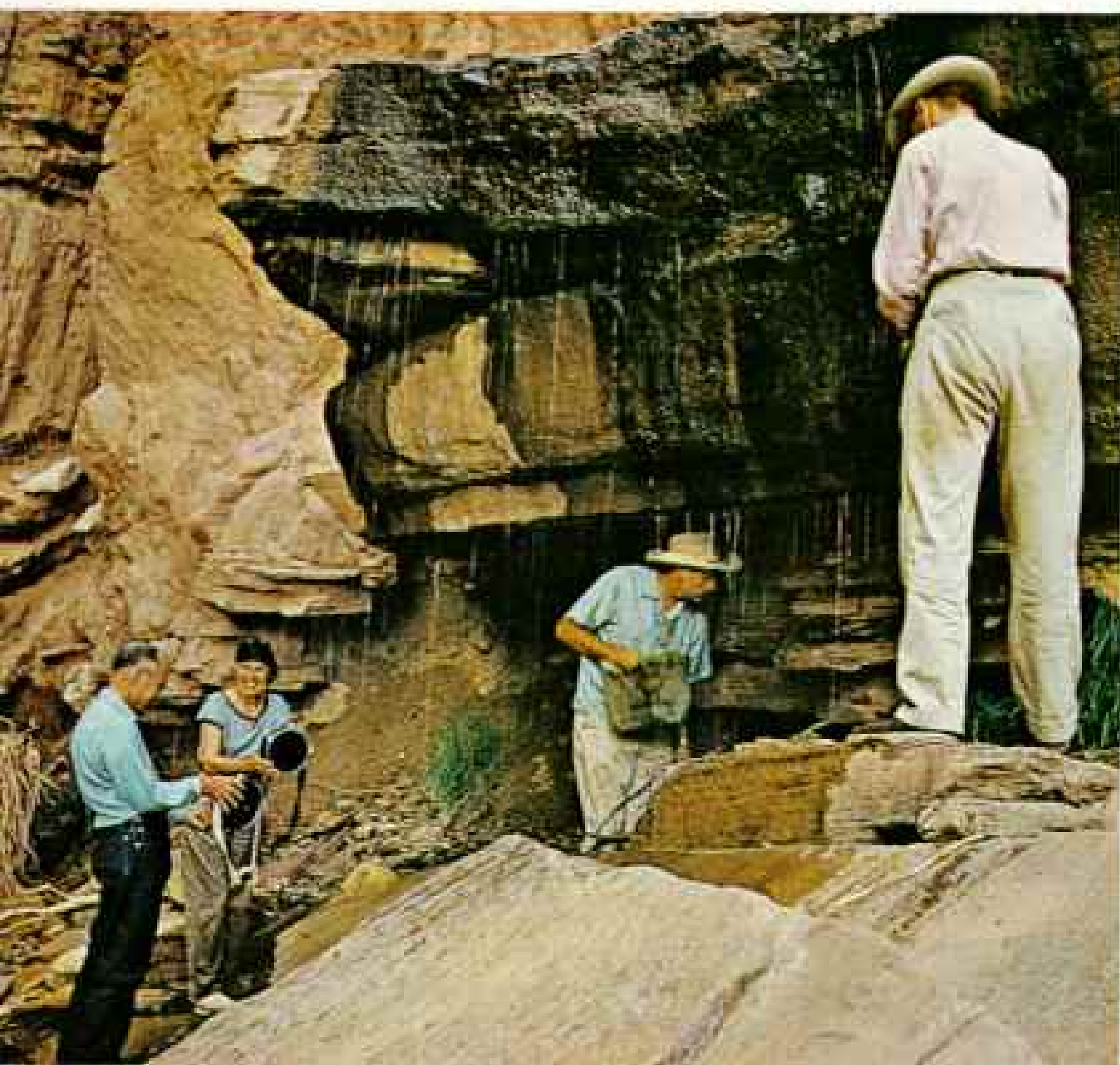
Next morning, and every morning thereafter, we were awake at five o'clock. Harlon Bement saw to that. If the dawn didn't wake us, he did — by firing his pistol. Then Burnett Hendryx and Bates E. Wilson, Superintendent of Arches National Monument, would fortify us for the trail with breakfast; both were masters at cooking on an open fire.

As we moved up the canyon, we spotted several Indian ruins on ledges. But our main goal was to find two arches — Castle and another, yet unnamed. We had photographed both from the air.

Again we rounded a bend and, in a side canyon, saw Castle Arch etched pink and white against the blue sky. Abandoning our Jeeps, we scrambled through brush and over slick-rock to get nearer.

At length we reached a natural amphitheater where red and white sandstone walls reared sheer above us. And in the high cliff rimrock stood the inaccessible arch, a delicately hewn band of rock framing a vast opening (page 659).

This spectacular arch had been photographed



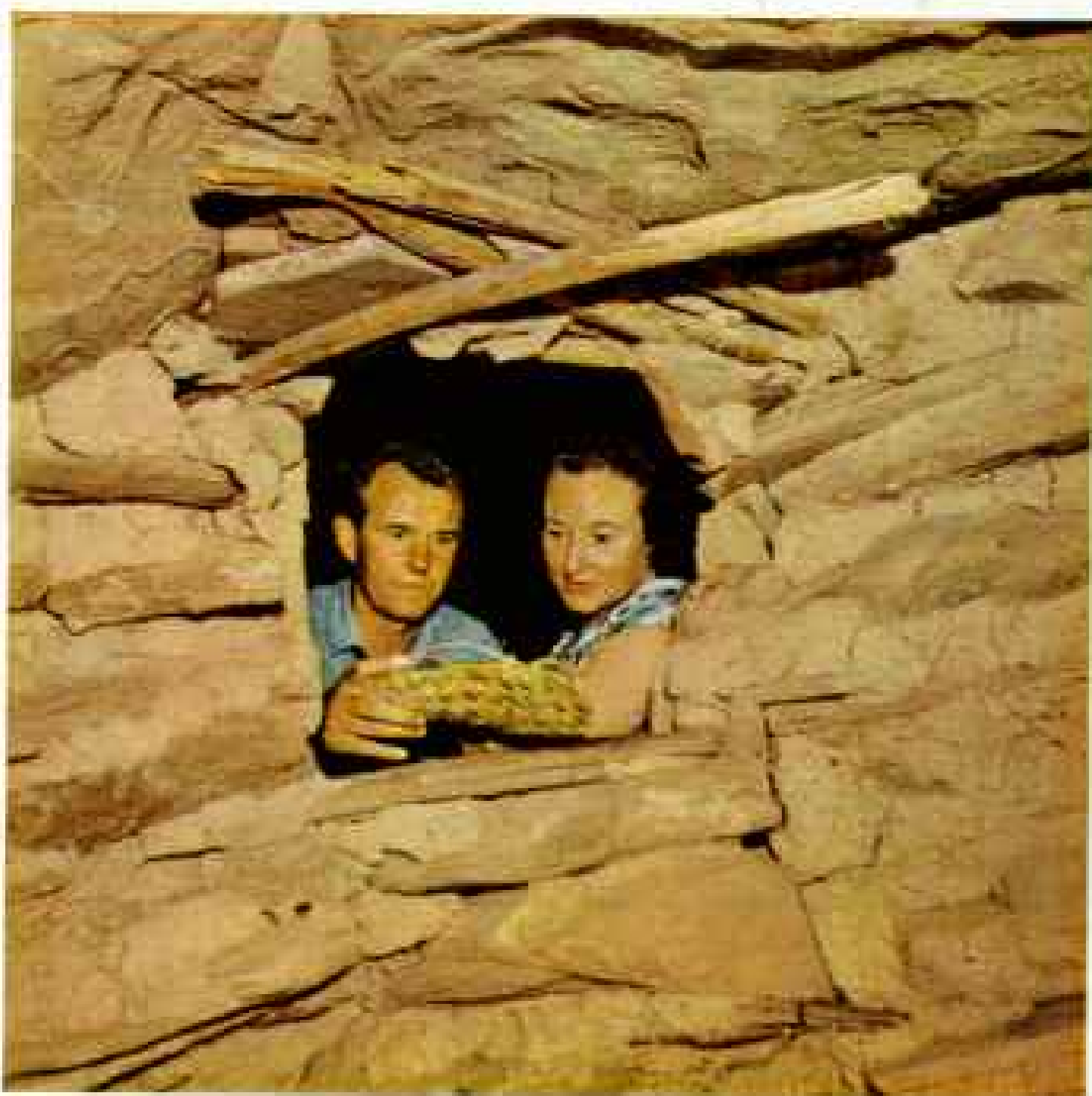


ANASAZI HOMES BY W. ROBERT MOORE (ABOVE) AND NATIONAL GEOGRAPHIC PHOTOGRAPHER STIG JENSEN © N.G.S.

### Cliff-face Caves Housed Stone Age Americans

Climbing stone steps worn smooth by prehistoric feet, visitors explore Tower Ruin high above a tributary of Horse Canyon. Here Indians dwelled centuries before Columbus discovered the New World. By the late 1200's, the inhabitants had abandoned these rock alcoves.

Centuries old, a sandal comes to light in an Anasazi house perched hundreds of feet above the Colorado River. Visitors peer through the combination door and window of a shelter that Indians may have used for storage.

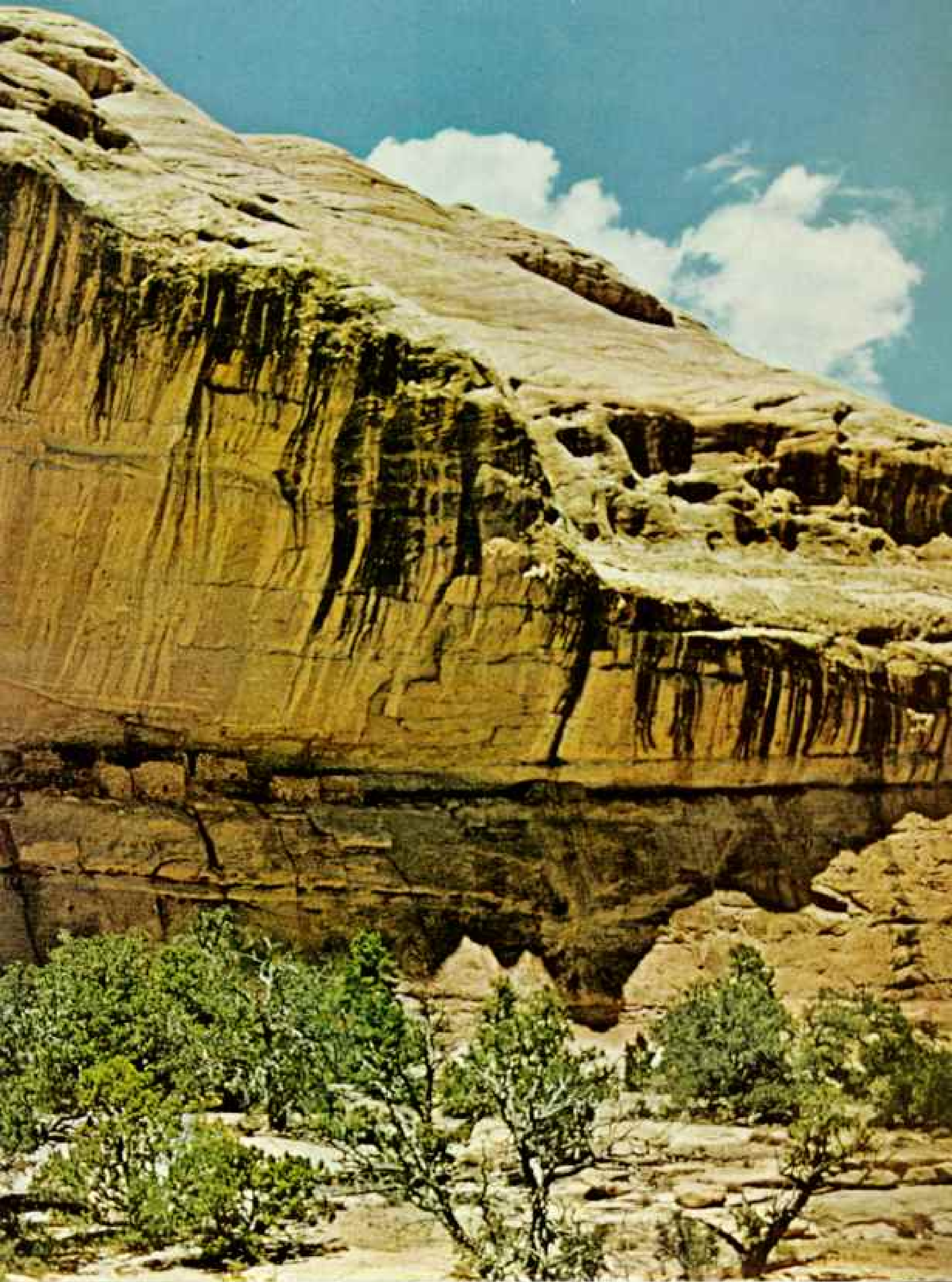






**Frowning Brow of Rock Sheltered  
Tenants of a Two-story Apartment**

Ruins of more than 40 stone-and-adobe structures line the ground level and upper floor of this long-abandoned community settlement in East Fork.



EDDACHROME BY BURNETT H. WENDON © NATIONAL GEOGRAPHIC SOCIETY

Occupants farmed the fields at the foot of their homes; cliff dwellers at Mesa Verde, 100 miles away, tilled mesa tops. Sheer walls forbid access

to the upper level, as the distant climbers learned; the inhabitants used ladders or ropes. Nearby the expedition found arrowheads and other artifacts.





and named earlier by photographers Ray and Virginia Garner and by Merle Winbourne of the National Park Service. From one angle in the curving gorge the cliff top resembles a castle, with the arch-cut rock extending like a bold flying buttress.

Later we hiked up another fork of the canyon and found the second arch, as massively rigid in appearance as Castle seems fragile. Erosion has carved an opening, perhaps 80 to 90 feet wide, through a heavy humped spur that rears above a rock-strewn defile.

The battlemented appearance of the sandstone layer capping the arch, as well as the big columnar end of the rock spur, suggested a crumbling mountain stronghold. We named it Fortress Arch.

Returning from upper Horse Canyon toward the Salt, we detoured across a valley to see Tower Ruin, an Indian dwelling in a high cliff-face cave near a towering rock pinnacle (page 663).

Within the cave, reached by a breathtaking scramble up steep slickrock and a final boost

up a juniper log, we found houses almost perfectly preserved. One structure, about 6 feet square and 6½ feet high, apparently had served the Indians as a storehouse; the other, slightly larger, as a dwelling. Walls, roof timbers, and roofs remained intact, even to the stone slabs the Indians used to cover the entrances through the ceilings. The projecting ends of the logs holding the roofs were charred, indicating that the builders had used fire to cut the poles to length.

#### Walls Plastered by Savage Hands

Back in Salt Creek, we headed upstream. Our route skirted a rock wall worn thin by a sharp loop of the stream. In places the stone is broken into toadstool-shaped columns and punctured by small windows.

Near one window we saw white hand marks on the rock. The prints had been made by placing the spread hand against the wall and splattering white paint around it, leaving an outline of palm and fingers.

These prints overlay older cliff markings,





Doodler's paradise, its meaning lost in antiquity, marches across Newspaper Rock in Indian Creek Canyon. Archeologists speculate that the wall may have flanked a trail where prehistoric artists used hard stones to cut animals, human figures, and symbols in a crust of "desert varnish."

Cave relics include bits of cord, potsherds, stone axhead (left), sandstone straper (right), and the well-preserved heel of a yucca-fiber sandal.



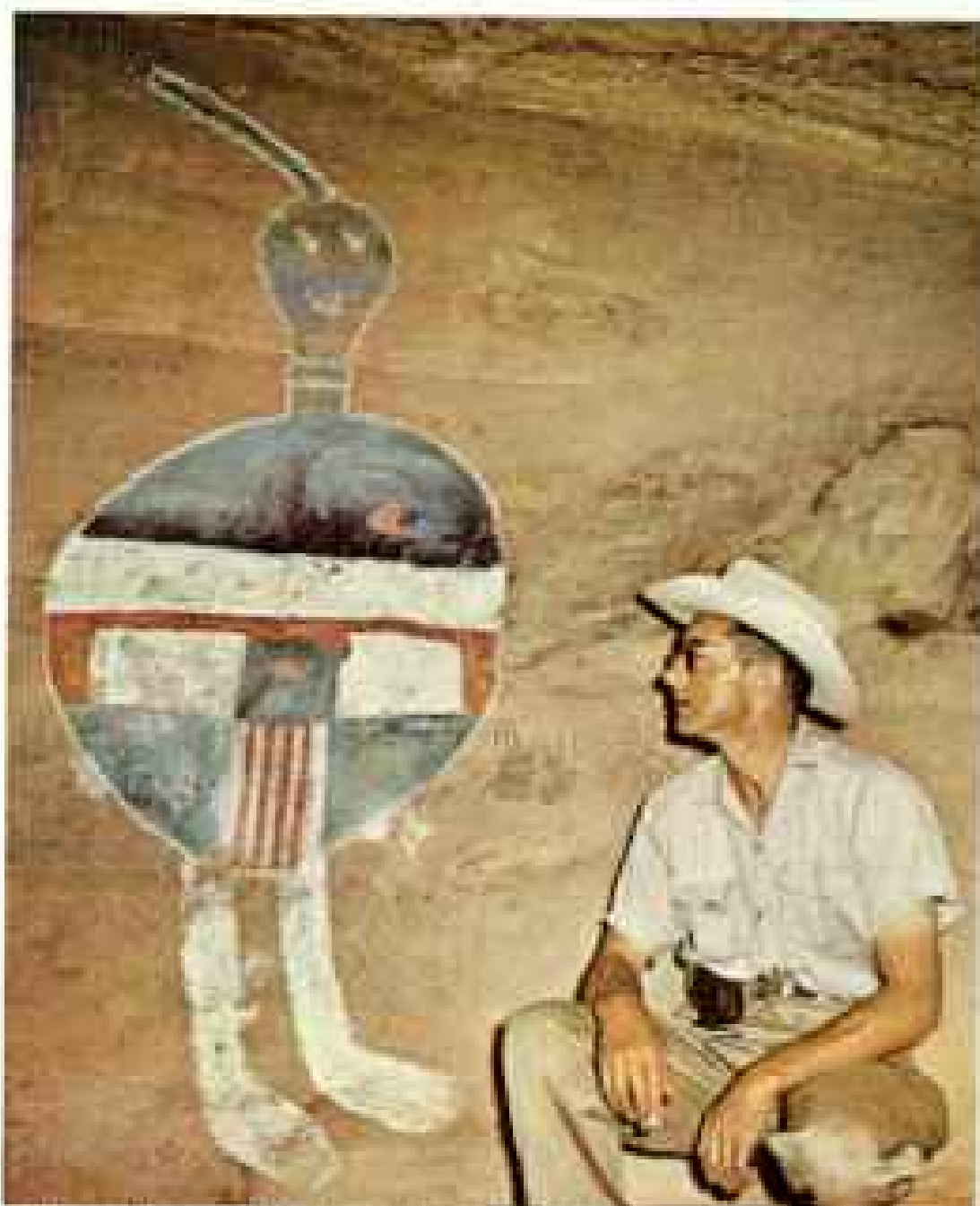
and they seemed so fresh we thought at first they had been made by some whimsical recent visitor. But from the window we saw other hand prints marking a cliff on the opposite side of the canyon. No modern passer-by could have put them there, for the rock drops sheer. The early Indian artist who made them obviously worked from a now-vanished ledge.

Near the cliff window we also came upon a flaking ground where the Indians fashioned arrowheads. Flakes of jasper and chalcedony strewed the slope. Among them were several arrowheads, broken during the shaping.

The arrow makers may have chosen this site as camp for the same reason we stayed to eat lunch there—water. A clear, cold spring pours from a small crevice beneath a rock at the base of the cliff and trickles away into the sandy streambed.

Three or four miles farther along the Salt, Bob Robertson and I spied an arch in a butte dominating a side gulch. Swinging around a wide bend, we saw it again, this time from the opposite side.

Ballooning figure, painted on a cave wall by primitive Indians, is red, white, and blue. Visiting Explorer Scouts labeled it the "all-American man."





Erosion, Gnawing at Soft Sandstone,  
Sculptures Lavender Creek's Labyrinth

Hogback ridge in the distance separates Lavender  
Creek and Salt Creek, only a few miles apart.  
When the ridge proved unscalable from the Salt





PHOTOGRAPH BY W. ROBERT RIVINE | NATIONAL GEOGRAPHIC STAFF © N.G.S.

Creek side, the author retraced his steps and rode 5.3 miles around it to enter this maze from the dry stream at lower left. He took this view on a pre-

liminary aerial survey. Cleft Arch, the canyon's most unusual formation, appears just to the right of center (see also page 637).





Eyes right, Caterpillar Arch lifts its hump atop a wall in Lavender Creek. Explorers

Two thick, rounded humps, linked by a narrower wedge of rock, form the crest of the butte. A large hole has broken through the wedge, suggesting a low, arched gateway flanked by the two broad, stubby towers. To us it became Two Bobs Arch, two Bobs having seen it simultaneously.

Some ten miles above the junction of Salt Creek and Horse Canyon, we came to another side gorge. Near its upper end stands Angel Arch, one of the most striking formations we had seen from the air. To reach it, we switched from Jeep to horseback.

From the air, Angel Arch had appeared large. From the rocky defile beneath the high cliff shoulder upon which it perches, it became even more imposing.

We scrambled up gullies and over massive broken boulders to get nearer. Some of our more agile climbers followed a rock seam to the arch opening itself. The rest of us stayed behind to photograph it as purple evening shadows crept toward the base (page 660). The arch gains its name from the contour of the rock on one side of the opening.

Eagerly, we returned the following morning to see it from the east, where the angel shows best. A projecting rock lump forms her head, which she holds modestly bent, gazing down into the canyon. She leans against the side of an arch, one wing folded down over her loosely draped figure.

Wilson and Hendryx managed to climb to the arch from this eastern face, finding a much

easier route here than on the western side.

Next morning we packed our gear back in the Jeeps and continued along the Salt. In the upper part of its course the channel divides into two branches, East and West Forks. We chose the longer eastern one.

Before reaching the junction, we passed below a high Indian cliff ruin commanding a wide sweep of the canyon. We climbed to its ledge, upon which perch well-preserved Indian storage houses. Here Bob Robertson found a stone fleshing knife, fragments of twisted cord, and sherds to add to the artifacts he and Alan Wilson, Bates Wilson's son, were collecting for the University of Utah. From this aerie we spotted other ruins dotting outlying cliffs.

#### "Honest John" Seeks Lonely Canyon

Two miles up East Fork, at a narrow bend of the canyon, we came to a rock shelf known as The Jump, over which the streambed makes a sharp drop. It barred our Jeeps; again we had to proceed by horse.

Below The Jump we found a car trailer that had been somehow dragged up the rough canyon. On a tree beside it was a sign: "Honest John Uranium Corp. No Trespassing."

Honest John wasn't home. Apparently he had not been there for some time. We set up camp in his dooryard—the tamarisk-covered sand flat—and hiked back and forth to The Jump to get water and take chilly showers under the slender threads of water dropping



PHOTOGRAPH © NATIONAL GEOGRAPHIC SOCIETY

scaled the monster's back, but slickrock sides balked attempts to reach the opening

from its ledge. In the bedrock at its base we found masses of flint-hard jasper, which the Indians used extensively for arrowheads.

During our first night in camp at The Jump, strong wind rose, hurling dust at us like a sharp sandblast. I propped up my duffel bag as shield to my sleeping bag and covered my head to ward off the stinging sand. When I awoke next morning, the wide ground sheet upon which Burnett and I had spread our beds was all but hidden by a dune.

Fortunately the wind had dropped, and the day dawned clear. Back in the saddle, we clambered up a high talus slope, got around The Jump, and continued up the canyon.

Here in East Fork of the Salt, we saw our most extensive and striking Indian remains. One rock alcove contained several storehouses or dwellings. And on the wall behind them an early Indian artist had painted four angular faces in red.

Within a cliff cave a short distance away, an artist had produced a far bolder, more ornate painting. It was our prize find of the entire trip. Working with red, white, and blue pigments, the artist had portrayed a balloon-bodied figure more than four feet high. Its colors still bright, the painting is unmarred except that some unknown visitor before us had outlined the figure with chalk (page 667).

Farther along the canyon we came upon a two-story community settlement that I had glimpsed earlier from the air. It nestles within a huge cliff undercut. One row of stone-

and-adobe ruins extends the length of a long gallery ledge, some 30 or 40 feet above ground level; a second row edges the base of the cliff below them (page 664).

Some are almost perfectly preserved, even to the poles, sticks, grass, and mud of the roofs. Of others only foundations remain.

Here Bates Wilson turned up part of a well-preserved sandal, woven of yucca fiber. At a kitchen midden, Harlon Bement found two rounded pieces of pottery, each about two inches across. A hole had been drilled in their centers; they may have once served as spindle whorls—flywheels to keep a spinning shaft in motion longer. Potsherds, broken arrowheads, and stone flakings strewed the ground.

#### Erosion Works With Imagination

Between the cave where we had found the Indian painting and the cliff settlement stands Ring Arch, the most symmetrical in the canyons. Weathering agents have cut an oval opening some 150 feet high by 100 feet wide through a thin red sandstone wall, leaving only a narrow rock band about the top of its curve. The end of the adjoining rock spur is sculptured into the shape of a huge jug handle, complete even to the finger opening.

Leaving East Fork and moving westward to explore side canyons, we saw two other impressive arches. We rode as far toward them as we could and then climbed the rough slopes of the ravines. While Bates Wilson led a group seeking a way up the steep slickrock

slope to one arch, Hendryx and Bement set off for the other. Later, while I photographed Bates's group in the one opening, I heard a triumphant echoing shout and saw the second group waving from the other.

Bates Wilson came back to report that the arch opening he had measured was 125 feet 6 inches across by 36 feet high. We gave it the name Elephant Trunk Arch, for with a little imagination the formation looks like the bulky heads of two elephants, their joined trunks arched against the sky.

Bement and Hendryx found theirs to be

among the largest of all the arches we saw on the trip. It punctures a rock wall that links two higher cliffs; its opening stretches just over 166 feet in length and is slightly more than 100 feet high. They named it Corleissen Arch for the late Harley J. Corleissen, former Chairman of the Utah State Road Commission.

#### Narrow Ridge Forces Wide Detour

Eastward beyond these arches the canyon broadens to form The Meadows. And just beyond rise the walls of Salt Creek Mesa, backed by Manti-La Sal National Forest.

Only a narrow hogback ridge separates East Fork's drainage from the upper end of long Lavender Creek, a branch of Indian Creek (page 668). But to reach an arch in Lavender that we had seen from the air, we had to retrace our path through the Salt, return to Dugout Ranch, then thread nearly the full length of Lavender Creek—a distance of 53 jeep miles (map, page 656).

The arch we were seeking offers an unusual example of geological action on a tongue of rock that once formed a kink in the stream. Water sweeping around the cliff had worn deep alcoves on either side and had left a thin wall between them.

Then the rock tongue was fractured lengthwise into two narrow slabs. Erosion, working independently on each slab, created two large irregular openings which overlapped and formed an arch some 130 feet wide by 80 feet high. Had there been no fracture during the formation of the arch, the span would have been more than double its present width.

Because of its unusual appearance as a result of the splitting, we gave it the name Cleft Arch (page 677).

Near the top of the lofty wall on the opposite side of the canyon, we saw a small, delicately arched rainbow of stone. Several other arches have perforated Lavender's walls. One similar to Ring Arch, but smaller, has been cut by a stream dropping from a higher cliff face. During

*Circling over the Colorado in a helicopter, Secretary of Agriculture Orville L. Freeman and his 14-year-old son Michael plot their position. Bridgelike strip reinforces the Plexiglas window of the closed door. Secretary Freeman accompanied Secretary of the Interior Stewart L. Udall (extreme left) on a survey of the canyons.*

PHOTOGRAPH BY STEE WOODEN © NATIONAL GEOGRAPHIC SOCIETY







EDUCATED BY NATIONAL GEOGRAPHIC PHOTOGRAPHER STEVE IMBOTTEN © N.G.S.

### Helicopter Picks Its Way Through Stone Sentinels

To inspect proposed national park land, Secretary Udall made a five-day swing through the canyons of southeastern Utah last July. Returning to Washington, D. C., he told NATIONAL GEOGRAPHIC: "Canyonland is a complex of natural wonders unequalled anywhere. It will make one of the most remarkable areas ever added to our national park system."

A U. S. Air Force H-21 settles down in Chesler Park.

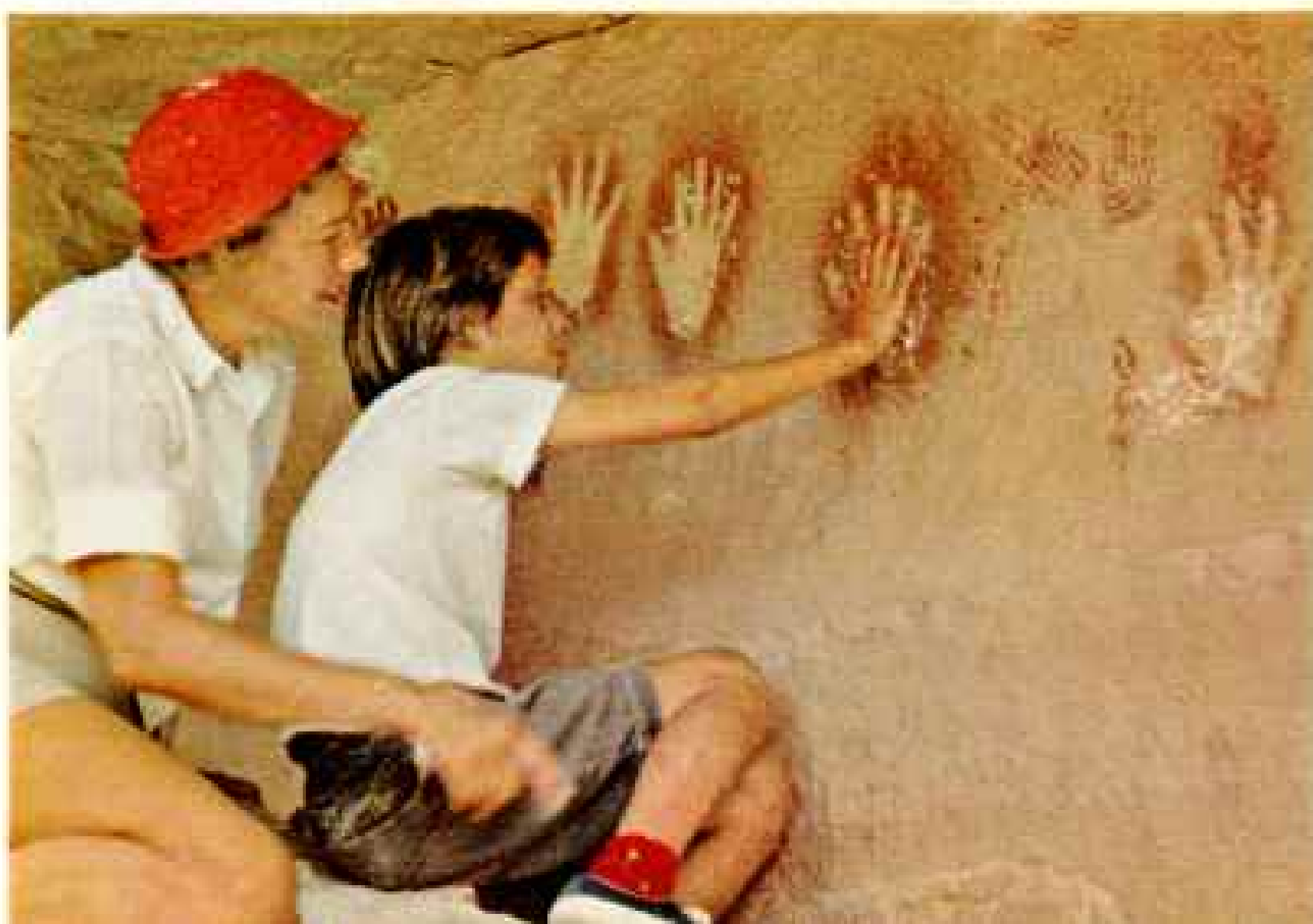
Boatman serves pancakes to Secretary Udall and 12-year-old Gordon, son of Frank E. Moss, United States Senator from Utah, at their river campsite near Dead Horse Point. Here the Colorado meanders gently between canyon walls.



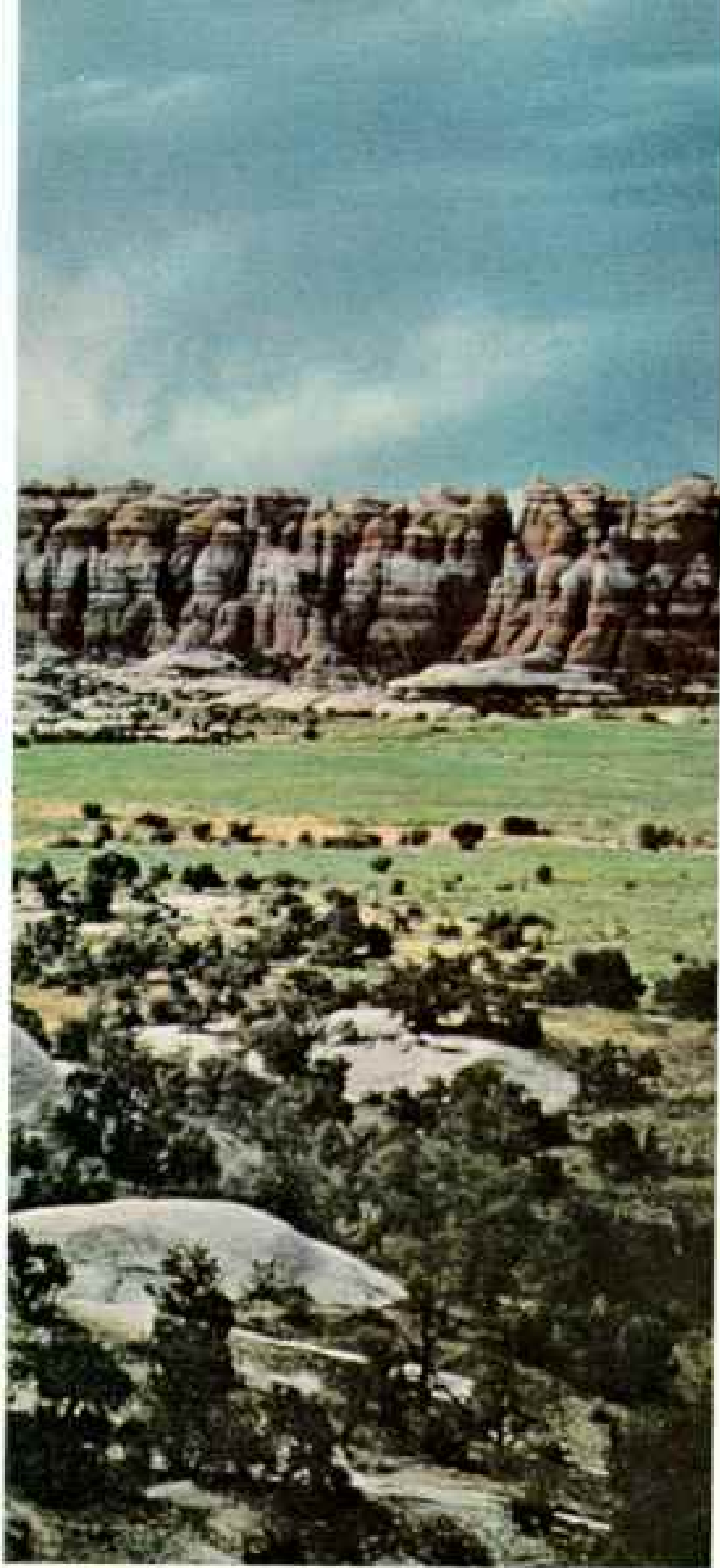


SCAPCHERED BY W. ROBERT MOORE (ARIZ.)

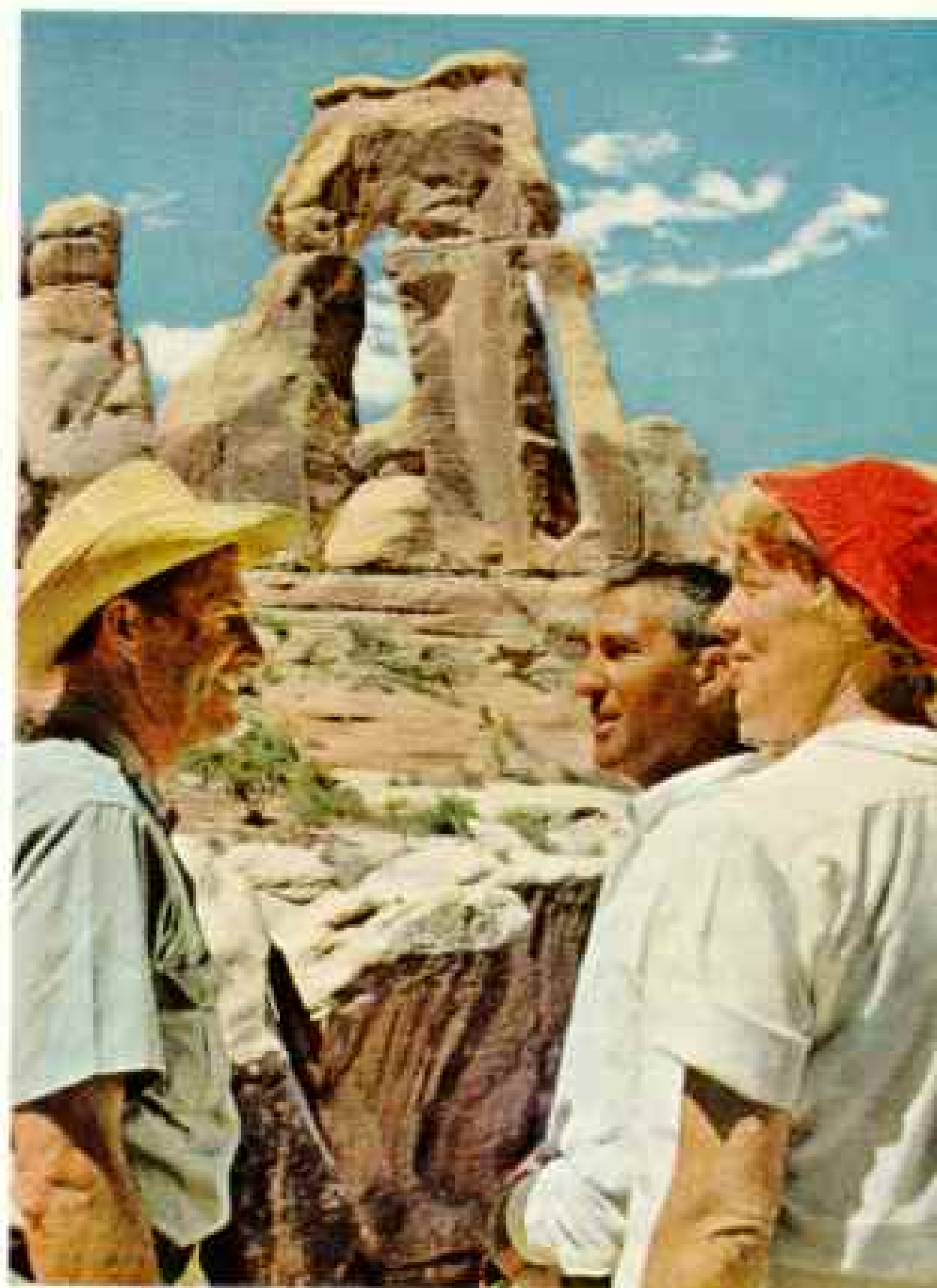
Fifty-story-tall minarets of rock ring Chesler Park in The Needles region. Horizontal cracks and ridges in the spires mark strata deposited eons ago when a sea covered the area. Piñons and junipers dot the meadow.



Hands across the centuries, Mrs. Stewart L. Udall and daughter Lynn match palms with the painted prints of prehistoric Indians on a wall in Devils Lane.



AND OTIS INBODEN, NATURAL GEOGRAPHIC STAFF © N.G.S.



View of Druid Arch rewards the Udalls after a hot, grueling climb from Chesler Park (pages 652-3). Bates E. Wilson, the first white man to approach Druid on foot, guides the hikers.

Broad-billed hats shade the Udalls on a Colorado cruise with river-boatman Don Smith as pilot.





rains, the opening acts like the mouth of a wide pitcher.

We turned our Jeeps across the sagebrush flat to gain a closer view of it, and had gone only a short distance when all of us shouted almost in unison: "There's another arch!" Along the rimrock of the canyon wall ranged a series of scallops and cavelike undercuts that suggested an enormous creeping caterpillar. One of these humps arched free to frame a sky opening (page 670). We named this formation Caterpillar Arch.

### The Needles—Nature's Skyscrapers

Lavender Creek marked the end of our exploration on this trip; after we returned to Monticello, the party disbanded. But later, with Bates Wilson and three friends from Moab, I returned to probe The Needles.

Again we came to Cave Spring, and from there drove to Devils Pocket, a pleasant hollow lined with green springtime grass and massed patches of flowering beeweed, yellow as mustard. Above and about us soared sheer cliffs and pinnacled walls.

We clambered up out of Devils Pocket and down again into Devils Lane, a quarter-mile-wide corridor extending several miles. Some of these long canyons crease The Needles area.

"Geological explanation for their formation," Bates said, "is that underlying layers of salt have dissolved. This made the floors sink to their present levels."

We rode for two miles along the grassy avenue of Devils Lane and then turned into Chesler Canyon, named after a stockman who ran cattle there. Finally we climbed into a spectacular oval of meadow. This is Chesler Park, rimmed by towering red spires above skyscraper walls—The Needles (page 674).

Just southeast of Chesler Park, reached by a roundabout route along Chesler Canyon, lies Virginia Park, another rock-encircled open space remarkably similar to Chesler. Save that they lack water, here are two of the most delightful camping spots in the West.

The liveliest invasion of Chesler's seclusion came last year when Secretary of the Interior Stewart L. Udall arrived by helicopter to investigate the possibility of the area's becoming a national park (pages 672-5). While here, the Secretary also sought one of the same

goals we did: Druid Arch, at the head of Elephant Canyon. This was another of the arches that Harlon Bement had found on his flights. Swooping low over the rock rim of Chesler, Bement spied it, a big double-slotted opening, puncturing a high shoulder of rock (pages 652-3).

"Even after we knew where it was," Bates Wilson said, "it took Alan and me two years to discover which canyon fork it occupied."

When they did locate it, they found no accessible way to the arch itself. Nor did we, who had to content ourselves with a face-on view of the arch from a slickrock ledge across the deeply cut canyon.

While we were photographing Druid, white, fleecy clouds came scudding across the sky. Within minutes they had massed into a solid cover and turned black. The wind honed itself to a cutting edge.

Back in camp, we huddled close to the fire and ate an early dinner. Though it was late May, the clouds spat flurries of snow.

We awoke next morning to find a thin layer of ice in our water buckets, but sunshine again flamed on The Needles. Forty miles away, the La Sal Mountains glistened with new whiteness. Their snowy crests served as guideposts on our way out of the canyons.

### Flying Survey Makes New Discoveries

In Moab I joined Harlon Bement for another air trip over the region. On this flight the erosion-gouged landscape no longer seemed as chaotic as it had at the outset. Now I was able to fit together the patterns of the canyons and locate the arches, Indian ruins, and our campsites.

During this quick aerial recapitulation, we spotted three other arches we had not seen before. Subsequently, Harlon telephoned me in Washington. "I've just flown over the area again," he said. "We've located six new arches in a side canyon just beyond Ring Arch. And there's another right across the valley that looks like a honey!"

I was not surprised that he had found more. Our aerial flights and two ground trips had probed only a portion of this fantastic region. And it may be years before visitors succeed in cataloguing all the arches of Utah's cliff-hung canyonland. THE END

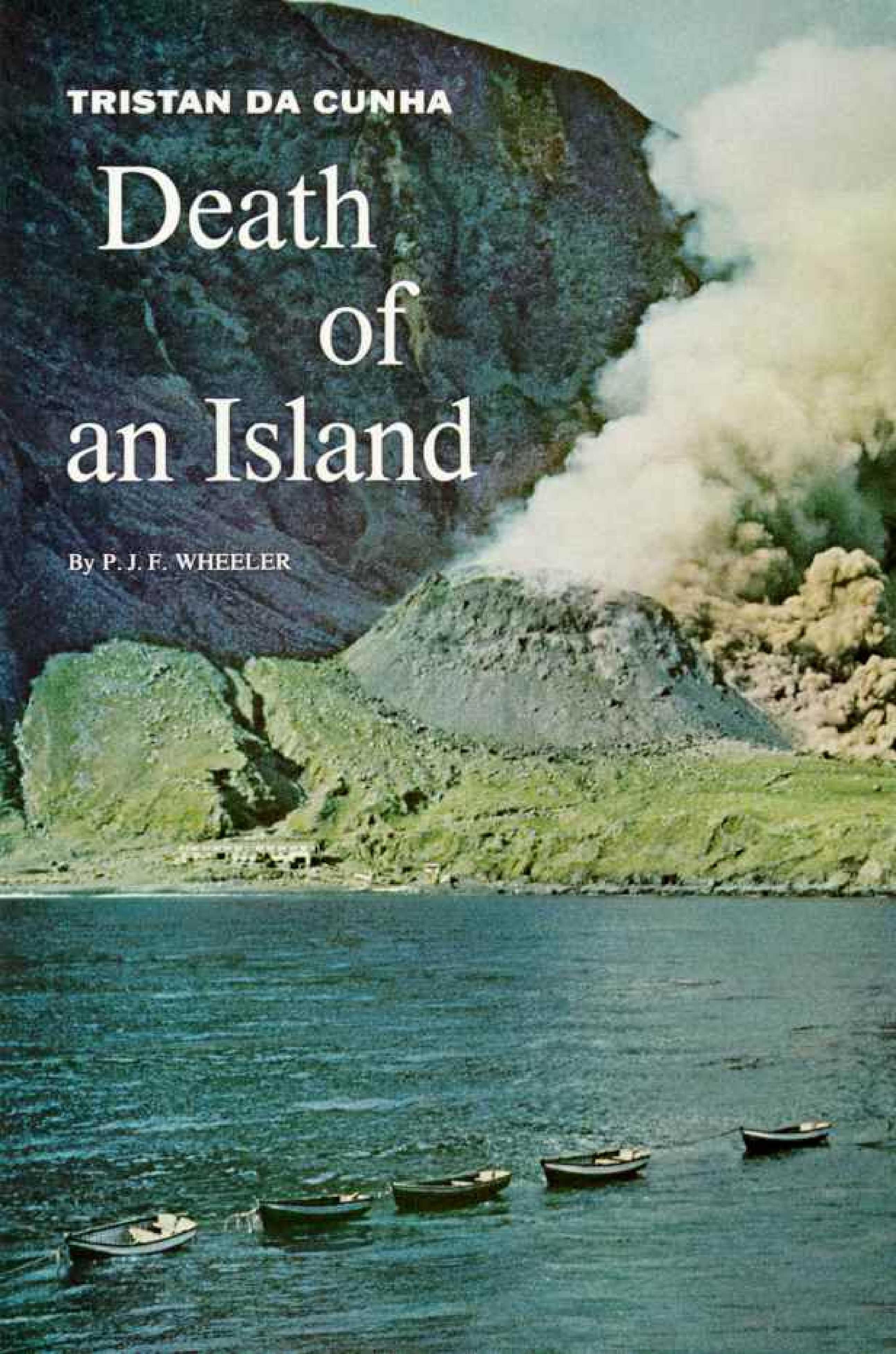
Cleft Arch's dual walls of rock soar like flying buttresses. Blue sky peeps through slits where spans of the freak formation, split lengthwise by rock fracture, fail to meet.



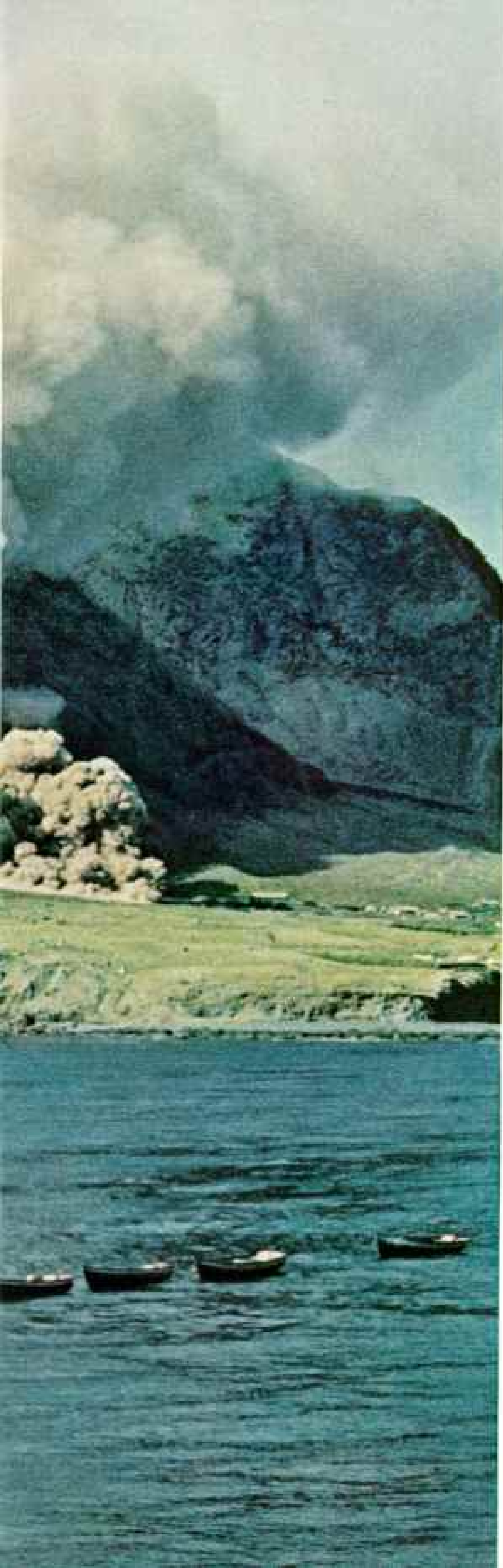
**TRISTAN DA CUNHA**

# Death of an Island

By P. J. F. WHEELER







"Volcano Sends Islanders to Exile in 20th Century," headlines announced last autumn as Tristan da Cunha, a lonely isle in the South Atlantic, burst into the news. Here is an exclusive eyewitness account by the island's British Administrator. He describes the eruptions that drove Tristan's 264 inhabitants from the only home they had ever known.

**A**LTHOUGH MILD TREMORS had been shaking Tristan for two months, we did not regard them with great alarm. We had duly reported the news to England, and scientists there had decided that the shocks resulted from a slight settling of the earth's surface along a possible fault line. Thus reassured, we began to accept the subterranean jolts as part of life on the island.

Then, in mid-September, I was attending Evensong in the island's little church when suddenly the walls heaved, the floor trembled, and for a sickening second the roof threatened to cave in. The quake—the most severe that we had yet felt—passed in a moment, and the island chaplain, Father C. J. Jewell, carried on his service. But in that moment I felt the first intimation of possible disaster.

I had been appointed Administrator of this isolated British possession earlier in the year. Named after the Portuguese admiral who discovered the island in 1506, Tristan da Cunha lies—along with its smaller sister isles of Inaccessible, Nightingale, Middle, and Stoltenhoff—about halfway between South America and Africa (map, page 682).

An American, Jonathan Lambert, styling himself king of Tristan, attempted unsuccessfully to colonize the 37-square-mile island in 1811; five years later, the United Kingdom took possession of the Tristan da Cunha group. A British force remained for one year and, when the garrison finally departed, one of its members, Corporal William Glass, elected to settle

**Birth of a volcano threatens the Settlement of Edinburgh, at right, and the island's spiny-lobster freezing plant at left. Growth of this great steaming "bubble" forced abandonment of Tristan's only village, interrupting a century and a half of British occupancy of the island. String of dinghies has been towed to safety by a fishing vessel.**

### Women and Children First! Men Push a Fragile Craft to Sea

Wearied by a long walk to safety and a cold night spent in sheds and on open ground, refugees set out for the fishing vessel *Tristania*, which will ferry them to Nightingale Island, one of Tristan's uninhabited neighbors. An erupting volcano forces their departure, October 10, 1961.

Rare calm pervades the sea; heavy swells or violent storms usually batter the shore.

The boat—one thickness of canvas stretched over a wooden frame—is light and easy to launch. Handling such small boats in rough seas is not always simple. In 1885, loss of an even sturdier lifeboat took the lives of 15 island men.

These fugitives include schoolmistress, nurse, and families of the government staff. Wife of Tristan's only physician stands between the oars, a protecting hand on her child. Her husband, who remained on shore, took the picture.



on Tristan with his family. From this beginning—supplemented from time to time by shipwrecked sailors and once by the arrival of five women from St. Helena—the permanent population grew until by 1961 it had reached more than 260 souls.

All the people are related by intermarriage, and all bear one of only seven family names: Glass, Green, Hagan, Rogers, Swain, Lavarrello, and Repetto. The last two are the legacy of shipwrecked Italian seamen who chose to stay on the island in the 1890's.

When I arrived on Tristan, I found a land

bypassed by the 20th century. Huddled in a single village on a plateau overlooking the sea, the thatched houses resembled Scottish crofters' cottages of the Western Isles (page 687). The way of life, simple and severe, had changed little in 150 years. The Islanders knew of motor cars and television only from pictures. Their language is old-fashioned English with local quirks: "How you is?" queries the Islander; "T's fine," you answer.

The Tristan da Cunha Development Company provided the island's sole industry—and its chief contact with the mysterious world be-



ACQUAINTANCE BY DR. NORMAN SANDS, LONDON EXPRESS NEWS AND FEATURE SERVICE. © NATIONAL GEOGRAPHIC SOCIETY

yond the horizon. Every year the company's fishing boats, *Tristania* and *Frances Repetto*, steamed out from Cape Town, 1,800 miles away, for seven months of fishing in Tristan waters for spiny lobsters (crayfish). Frozen in a plant on the island, the crayfish were then shipped abroad and marketed as "Tristan Brand Rock Lobsters."<sup>\*</sup>

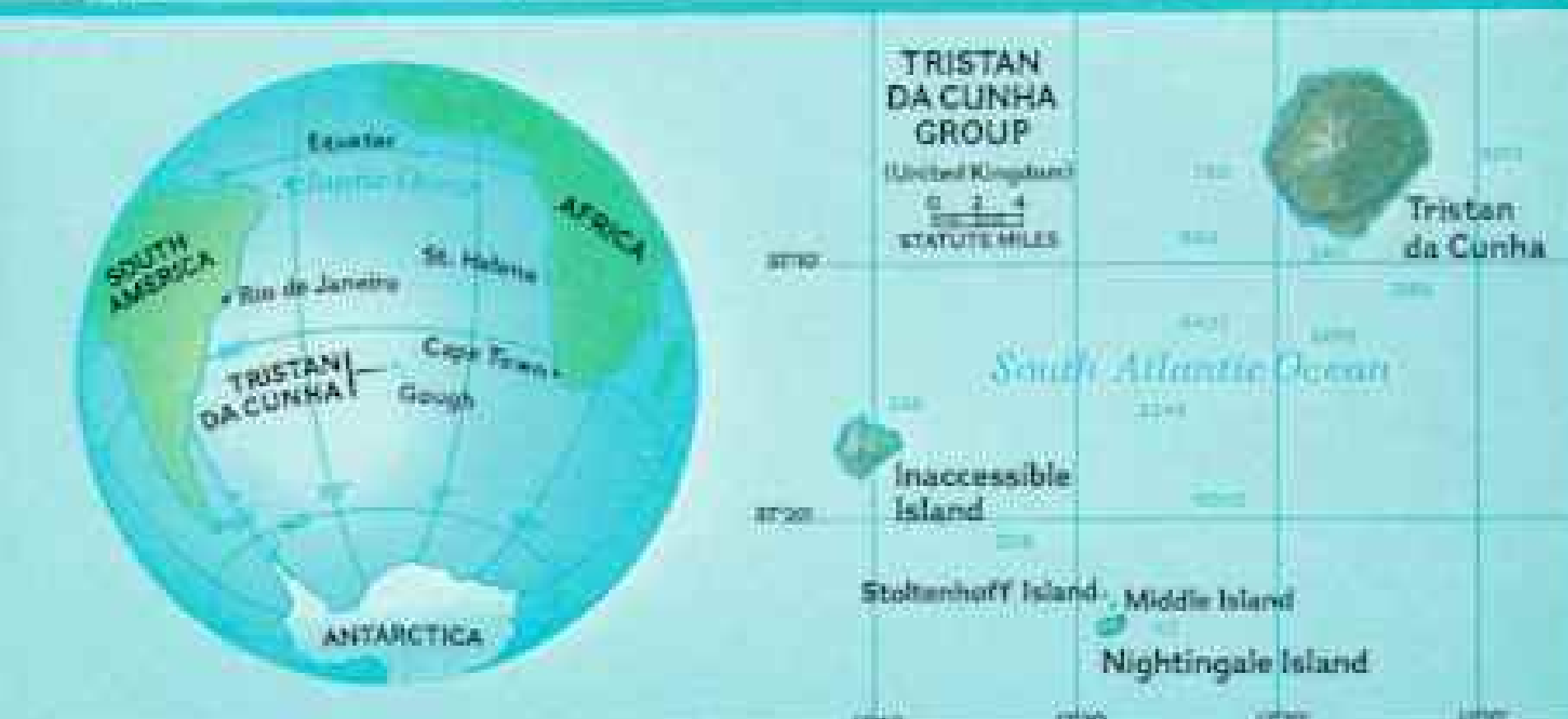
The week before that first major quake, the long-awaited *Tristania* arrived—the first ship to call for five long, stormy months. Her master, Capt. M. T. Scott, met me soon after the evening church service was over. In Cape

Town he had read news dispatches about the tremors and had regarded them as something of a joke. But the intensity of that Sunday shock left Scottie surprised and somewhat concerned.

We agreed that the task now, with a ship off the beach, was to determine the extent of the disturbances. Accordingly, we decided to dispatch a party to Nightingale, some 16 miles away, to learn if the shocks were jarring a wide area or were confined to our island.

<sup>\*</sup>See "New Life for the 'Loneliest Isle,'" by Lewis Lewis, NATIONAL GEOGRAPHIC, January, 1950.





Wind-swept isolation surrounds Tristan da Cunha, five small islands in the South Atlantic. Many place names record trivial events: Ridge-where-the-goat-jump-off; Down-where-the-minister-land-his-things. Tristan Islanders raided uninhabited Nightingale and Inaccessible for birds and eggs.

The next morning the Island Agricultural Officer, Dennis Simpson, gathered together a small scouting party at Little Beach, just north of the Settlement. One of Tristan's distinctive long boats — made of canvas stretched over a wooden frame, because of the scarcity of timber (page 681) — delivered them through a rough sea to *Tristania*, which promptly weighed anchor and then headed southwest toward Nightingale Island.

We who stayed behind organized around-the-clock watches in order to record the in-

tensity and the time of each future quake. We employed a simple grading system for intensity: One that merely shook the houses slightly we graded "A"; one more prolonged and louder, "B"; and one that really rattled the pictures on the wall, "C."

During the first five days that Simpson and his party were away, we recorded 89 shocks. Every morning and evening we would transmit a bulletin listing the tremors of the previous 12 hours. The party on Nightingale picked this up on an ordinary radio set.



WIDE WORLD

**Heartsick fugitives**, gathered at the rail of the Dutch liner *Tjisadane*, take a last look at the only home they have ever known. The ship, which picked them up at Nightingale Island, now heads for Cape Town, South Africa. Bewildered Islanders face an entirely new life in the United Kingdom. Low hills border the Potato Patches.

About a week later, *Tristania* returned with Simpson's party. I was startled to learn that throughout their stay nothing had broken the tranquillity of Nightingale except the surf crashing on the rocks and the cries of sea birds wheeling overhead. With a sense of relief, I realized that if Tristan should become untenable we could at least find refuge on Nightingale.

The men of Tristan had erected 40 or more wooden shacks on Nightingale to afford shelter during their annual foraging expeditions.

The island's large and fascinating bird population—which includes several million great shearwaters alone—furnished the Islanders with eggs and with low-grade guano to fertilize their all-important potato crops.

We immediately cabled our discoveries to the volcanologists in England, but they still doubted that the Tristan shocks were due to volcanic activity. They also saw nothing remarkable in the absence of tremors on Nightingale. Again we were reassured, happily anticipating a swift return to normal.



Our new sense of security, however, was short-lived. A group of Islanders skirted the 6,760-foot summit of Tristan's volcanic cone to inspect the scrawny cattle that grazed on the few acres of pastureland at Stony Beach across the island. Foul weather closed in, cutting off all visibility on the mountain and stranding the party for several days.

During their absence we had only one tremor, the first that could fairly be graded "D." Ornaments tumbled from mantelpieces, crockery rattled in cupboards, and there was a pronounced thump followed by a prolonged shudder. Yet when the men returned from

Stony Beach, they heard the news of this quake with astonishment. They had felt nothing at all.

The discovery that the shocks might be localized in the area of the Settlement was at once disconcerting and encouraging: disconcerting because our homes might be threatened, encouraging because somewhere on the island itself we might find a haven.

We prepared to investigate how far the tremors extended to east and west. We sent three men to the east; after climbing 2,000 arduous feet up Plantation Gulch, they made camp just below the winter snow line. On the





AGSACHROME BY C. J. C. WIND-EDWARDS © N.C.S.

way up they felt a slight tremor, but when we compared notes later, we concluded that it had been more pronounced in the Settlement.

A second party went westward to the end of the Settlement plateau. From there they, too, climbed the mountain and set up camp just below the snow line.

Still a third party, led by Father Jewell, erected their tents southwest of the village near the Potato Patches, which were Tristan's chief source of food. The stone-walled plots, each about 30 yards square, were individually owned, and each yielded between 100 and 200 bushels a year (page 688). Before the fish-

### **Cloudy Halo Circles a Gullied Volcanic Cone of Ash and Lava**

Forbidding Tristan lifts stark barricades straight from the sea, its central peak rising 6,760 feet. Rain-gouged gulches score the ash of the summit, slice through a tangle of tree ferns and wind-twisted evergreens, and drop down 2,000-foot cliffs to the sea. Eons ago the original volcano raised the island 18,000 feet from the sea floor; the 1961 eruption was the first in historic times.

Edinburgh's 60 homes cluster on a tongue of land at the right. Nowhere does Tristan offer a safe harbor.



Salvage party from the British Navy frigate *Leopard* moves into Edinburgh. Landing three days after the Islanders' flight, sailors retrieved abandoned possessions for return to their owners.

#### Edinburgh Cottages Huddle Below Cliffs That Rained Cascading Boulders

Earthquakes that preceded the eruption jammed doors tight and cracked the walls. Ground heaved, split open, and rose in a bubble as the volcano groped for a vent.

Four-foot-thick gable ends of the stone houses face the prevailing winds. New Zealand flax in the gardens forms windbreaks and provides thatching.

Streetless Edinburgh took its name from an earlier Duke of Edinburgh, a visitor in 1867; the present Duke landed briefly during his round-the-world tour (NATIONAL GEOGRAPHIC, November, 1957).

ing company brought a measure of prosperity to Tristan, the Islanders counted their wealth in potatoes rather than cash.

For 48 hours all was quiet on Tristan. Icy conditions—canvas tents frozen stiff every night—soon drove the eastern party down from the mountain, but the better-equipped group on the other side stayed on.

On the third day, a second "D" racked the Settlement. The mountain party noted it as only a slight disturbance, but Father Jewell, walking near the Potato Patches, felt it in all its intensity. Like us, he graded this "D."

It was clear that although the tremors shook the mountain flanks, the loudest and most prolonged shocks centered on the Settle-



ment plateau. We began to wonder whether this ledge—some three miles long by half a mile wide—was going to slide into the sea. All we could do was wait—and hope.

#### Boulders Crash From Escarpments

The end of September brought another alarming development. Immediately behind the fishing factory and just behind the Settlement itself loomed two sheer cliffs of loose stone that began to disintegrate. With a sharp crack, rocks broke away from the cliff and crashed to the foot, raising clouds of dust hundreds of feet high. One killed a cow not far from the houses; often, panicky sheep barely scrambled aside as death hurtled by.

The cascade of rocks soon cut a waterpipe

running the length of nearby Big Beach from a spring to the lobster packing plant (page 692). To keep the factory in operation, we ran an emergency pipeline from the main village water supply. But rocks then began to smash against the concrete structure protecting this vital spring and, on the morning of October 9, wrecked the installation completely. From that moment the Settlement was without running water. Our position was obviously becoming difficult.

Every tremor brought still more rocks crashing toward the village, but the Islanders accepted the situation stoically. One day, while the hail of stone was at its height, many found that they could no longer budge doors and windows that had opened and closed

RESEARCHING (OPPOSITE) BY STEWART MILLER © N.A.S. CENTRAL OFFICE OF INFORMATION, LONDON







40 (INCHROME LABOYE) AND 40 EXTRA (INCHROME) OPPOSITE) BY DON E. BIRZELL, AND (INCHROME) BY LEWIS LEWIS © N.A.S.

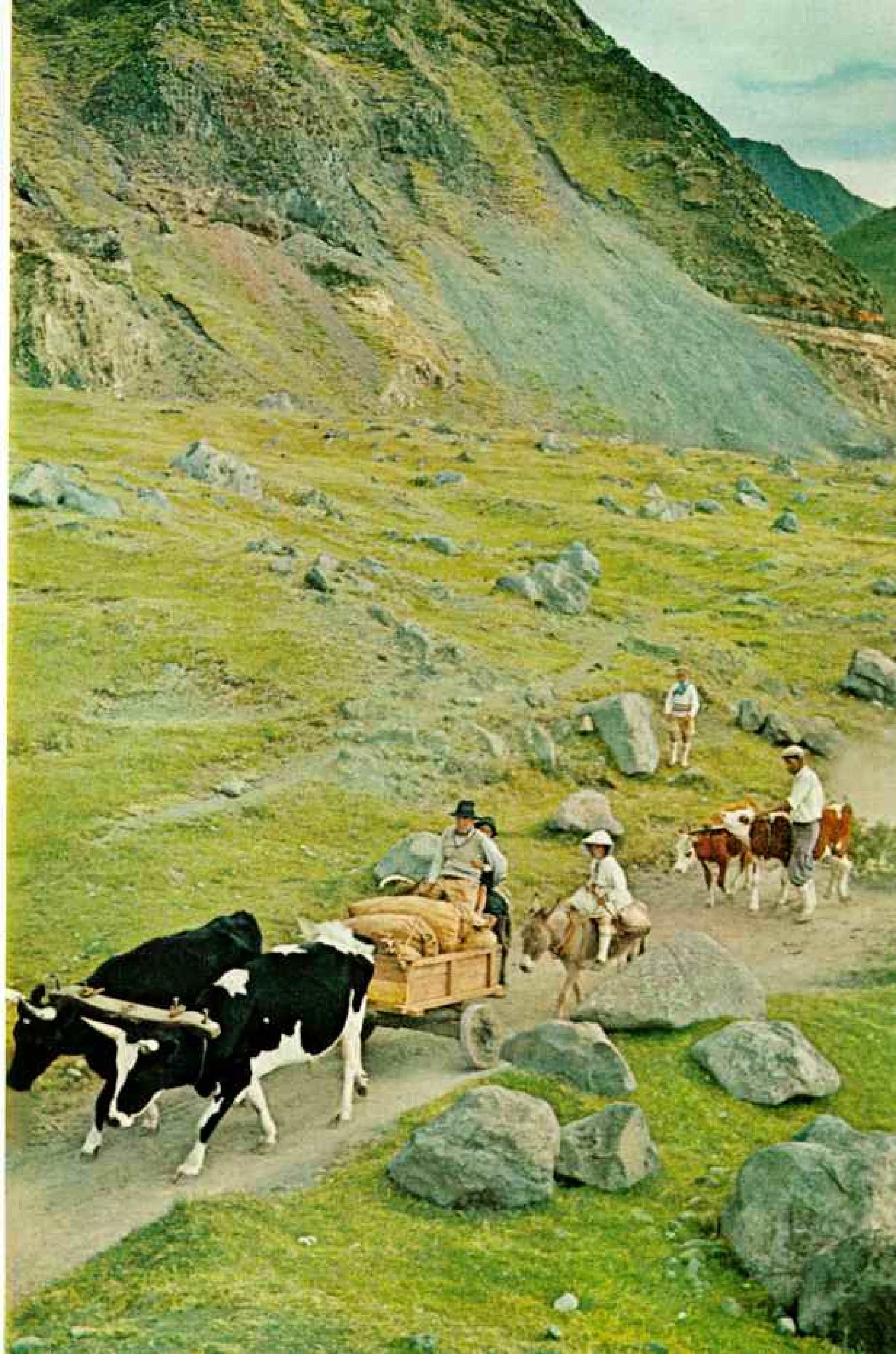
Women set seed potatoes as men spade. The tubers formed the mainstay of Tristan's diet, together with fish and sea birds and their eggs. Stone walls, serving as windbreaks and livestock guards, separated plots. Here worried villagers spent their last night on the island.



Morning wash pummeled on a flat volcanic rock: Rosa Rogers bears one of only seven surnames found among the Islanders.

#### Oxen Haul In Tristan's Harvest: Bagged Potatoes and Twisted Firewood

Islanders wear white stockings of homespun wool. The cart rides on solid wheels; driftwood contributed parts of its frame. Steers pull evergreen boughs gathered on the cliffs. Tristan had no cars or paved roads; its only motor vehicle was a tractor. Livestock were left to forage on the island when the inhabitants abandoned their homes.



freely a few hours before. Upon inspection, we discovered crack lines on the walls of houses and across the footpaths.

That night, as I sat in my house, Peter Repetto, an intelligent young man who ran the island's store, came down to tell me that many Islanders were moving out of their homes at the east of the village. Outside, I found torches bobbing hither and thither, families carrying suitcases and sacks across their shoulders, babies in their arms. They were all moving into the thus far untouched houses of neighbors to the west, making their beds on floors or in any unused corner.

#### Writhing Earth Builds a Cliff

It was a strange, silent, uncanny evacuation. No one gave an order. The Islanders had, as if by common consent, suddenly decided they would abandon their homes to the spreading, ominous cracks.

But the next morning when some of the evacuees returned to see their houses, they found that the doors now opened and shut with ease. Many of the cracks in the ground had closed up. Clearly something very odd was going on beneath us.

That same afternoon new cracks and crevices lacerated the slope some 200 yards from the most easterly house. Along one crack the ground separated and, while one side remained stationary, the other lifted more than ten feet, creating a vertical cliff on top of which teetered a boulder as big as a piano. The sight of that precariously balanced rock, more than anything else, drove home the fact that there must be some enormous pressure forcing up the ground. Time, I felt, was running out.

I went back through the village and struck the old naval shell case used as a community gong. In happier times, its clang had announced fair fishing weather, summoning men to their boats. Now, in twos and threes, they drifted down to the village hall. Quickly, quietly, we laid plans for leaving the island. Then the men went to tell their womenfolk to pack warm clothes and blankets.

By radio we raised Cape Town, informing the Royal Navy of our predicament. The Navy moved fast; within hours relief stores were jammed aboard the frigate H.M.S. *Leopard* and she was tearing at top speed to our help.

By chance, *Tristania* had stood off the beach that morning and Scottie had been

anxiously watching the ground through his binoculars. We decided that an embarkation late in the afternoon would be impossible. *Tristania*—only 164 feet long—could not possibly hold all of us overnight.

The danger spot east of the Settlement kept swelling at a rate of about five feet an hour and was rounding into the shape of a bubble; an eruption seemed imminent.

What would happen if it finally occurred? Would lava roar thousands of feet into the air? Would Tristan disintegrate? I could not help but remember Krakatau, the East Indian isle that exploded in 1883 with a loss of 36,000 lives. There was nothing for it now but to evacuate the Settlement.

The men collected their suitcases and rucksacks, the women their small children. Slowly, sadly, in little groups we straggled through the gathering dusk toward the Potato Patches, two long, hard miles away.

That night the temperature dropped almost to freezing. The old people and the sick huddled in our two tents. The women crowded together within the rough stone walls of the potato sheds. The men crouched in the ditches, seeking protection from the wind that swept in from the sea.

Offshore *Tristania* had moved up opposite us, and *Frances Repetto* had been called back from her fishing grounds off Inaccessible Island. It was comforting to see their lights as the night grew blacker.

#### Islanders Face Calamity Calmly

Talk ceased and the Islanders dozed. I was sleeping with my family at the bottom of a ditch, huddling into an old mailbag to keep out the bitter wind. Someone shook me into consciousness, and I stumbled to the radio. Scottie was on the other end.

"The bubble's blown open, Peter," he said simply. "It's pushing up rock and hot cinders and belching smoke."

To alert us, the ships had fired rockets and signaled on the wireless. But we had slept through it all—mercifully oblivious of the climax that had come.

In the chill half-light of dawn, I assembled the men and we walked back along the track over which we had struggled with our belongings only a few hours before. Crossing Hottentot Gulch, we mounted a rise that commanded a view of the village. Just beyond the houses white smoke swirled from the mouth of the new volcano. Here was the agent of





SPALDCHURCH BY LEWIS LEWIS AND MICROCHROME BY BRITISH ADMIRALTY © NATIONAL GEOGRAPHIC SOCIETY

### Before and After: Backyard Volcano Dooms a Quiet Home

In January, 1950, NATIONAL GEOGRAPHIC pictured this cottage where villagers were making rope from home-grown New Zealand flax. Bearded Sam Swain turns a machine salvaged from a shipwreck. Sheep-skin dries on a wall.

Twelve years later the deserted cottage awaits destruction by the three-day-old volcano, which has broken through the earth several hundred paces away. Incandescent streams of lava and cinders will soon thrust down the slope and out to sea.





BOAT HARBOUR, BY STEWART MILLER © N.E.S.

### End of the Lobster Plant: First Abandoned, Then Destroyed

In 1949 the fishery began to exploit the island's sole commercial resource, spiny lobsters. A South African venture, it paid wages, giving Tristan Islanders their first cash income. A store sold clothes, nails, matches, soap, canned food, flour, and many other essentials, all formerly obtained by barter from a few passing ships. Imported foods introduced toothaches.

Here rocks shaken from the cliffs strew the beach. Some wrecked the factory's water pipe, faintly visible at left as a thin white line. Distant gang of men are salvaging equipment, three days after the initial eruption, in fear of another rock fall.

**Steaming cinders** bury the plant and push out to sea two weeks after the salvage operations shown above. Houses of the Settlement lie at right, lost in vapor.

our undoing—this raw, open, fiery wound in the earth. Weary, drained of emotion, we could only stare at it silently.

Then, while some of us hastily salvaged what we could from the houses, others passed through the eerie emptiness of the village and down to Little Beach. There, a mere 200 yards from the erupting volcano, they pulled down four long boats from the grass bank and launched them into the sea.

Very soon they were rowing down past the Settlement toward the Potato Patches, where the women waited to be evacuated. The rest of us walked back with the few things that we were able to carry.

Boat Harbour Bay, near the Potato Patches, is a difficult beach on the best of days, but now a westerly wind churned the sea and the surf was breaking across the rockbound mouth of the bay. Two attempts by the long boats to sweep in past the rocks—one nearly ending in disaster—convinced us of the real danger of trying to ferry out the women and old people from here.

So back up the cliff they climbed, almost numb with fatigue, to



follow the long, rough track through the Settlement and down to Little Beach. There, in calmer waters, the boats shuttled them out to *Tristania* and *Frances Repetto*. Then, loaded with all the possessions we had previously salvaged and helped by the island's only motor vehicle (a tractor-trailer), the rest of us again plodded to Little Beach.

Finally, with *Tristania* jammed to the gunwales, we too embarked for the last, sad journey from Tristan. Precisely at 1 p.m. on October 10 we pulled up our anchor and moved slowly toward Nightingale. As we looked back, we could see the beginnings of a second eruption in the center of a bog immediately behind the most easterly house.

I watched the little gray crofts disappear

into the distance. My eye lingered on the village hall where the men used to gather in the evening for a game of billiards.

On Saturday nights the whole village would turn out for community dances—cleaned and starched. I remember the curious steps that had evolved through the long years of isolation, particularly the “pillow dance,” wherein ever-changing partners, at the head of a snake of dancers, meet on a pillow to exchange a kiss.

I picked out the little church, half buried in the grassy slope on which it was built. The Islanders had cut two-foot-thick blocks of stone from the mountainside for its walls. The old settlers had bred a God-fearing and honest race on Tristan. As a result, the island

W. J. SCOTT







SPORT AND GENERAL PRESS AGENCY, LTD.

"We were amazed at our first sight of Cape Town and its buildings," said one of the refugees aboard the *Tjisadane*. Said another: "We really are one big family. I hope nobody will ever part us. We must stay together whatever happens." Faces of these passengers reflect their concern. Devils Peak, Cape Town, rises behind them.

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CAPE PHOTO, LTD.



**Rescued puppies**, named Tristan and Cunha, wriggle in the arms of author Wheeler (left) and Comdr. P. S. Hicks-Beach, captain of the *Leopard*.

Livestock living off the land were left on Tristan to support themselves in case it proves habitable again, but most dogs were shot lest they ravage the other animals.

Mr. Wheeler, who administered the islands, returned to England to care for the Islanders and find work for them.

had never held either a jail or a criminal.

Ironically, tragedy had struck just as the Tristan da Cunha Development Company, the source of the Islanders' livelihood, had begun to score its first successes, just as running water had been installed in each house, just as a new sewage scheme had brought modern sanitation to every dwelling, and just as the remote island was becoming self-supporting.

But as the Settlement slipped below the horizon, the Islanders watched without a tear. It was, perhaps, enough to be alive.

Capricious fortune smiled again. A Dutch liner, the Royal Inter-Ocean *Tjisadane*, had been due to call at Tristan to pick up staff members returning to the outside world at the end of their two years' service on the island. Learning of our distress, *Tjisadane* changed course for Nightingale and rendez-

Hand in hand, Mr. and Mrs. Frank Glass leave a thanksgiving service in Cape Town. A few days later they sailed for England. The older Islanders, sketchily educated and lacking skills and immunity to contagious diseases, face an uncertain future.

— THE CAPE PRESS, FROM BLACK STAR



voused with us there on the day following the evacuation. We were thus enabled to shift the Islanders and their possessions to the liner for a swift, comfortable passage to Cape Town.

To the ship's company of H.M.S. *Leopard*, which arrived shortly after the Islanders left, fell the melancholy task of walking through the ghost village, searching empty cottages for prized possessions (page 686). Everything of value the sailors found they packed as carefully as if it were their own and loaded it aboard *Leopard* for eventual shipment to the rightful owners.

Finally came the most heartbreaking job of all: Out of mercy, the sailors destroyed the dogs the Islanders had been forced to leave behind. They could not, however, bring themselves to shoot two puppies they found in the village. These they named Tristan and Cunha and adopted as ship's mascots.

That is the end of my story, for the island of Tristan da Cunha may not be inhabited again during our lifetime.

Within Tristan's simple cottages, thatched with New Zealand flax that grew in every garden, the Islanders had evolved a rich and dignified way of life that scorned time. Tirelessly, women had carded wool and spun it into yarn on old-fashioned wheels in order to knit the high white stockings that had become traditional attire.

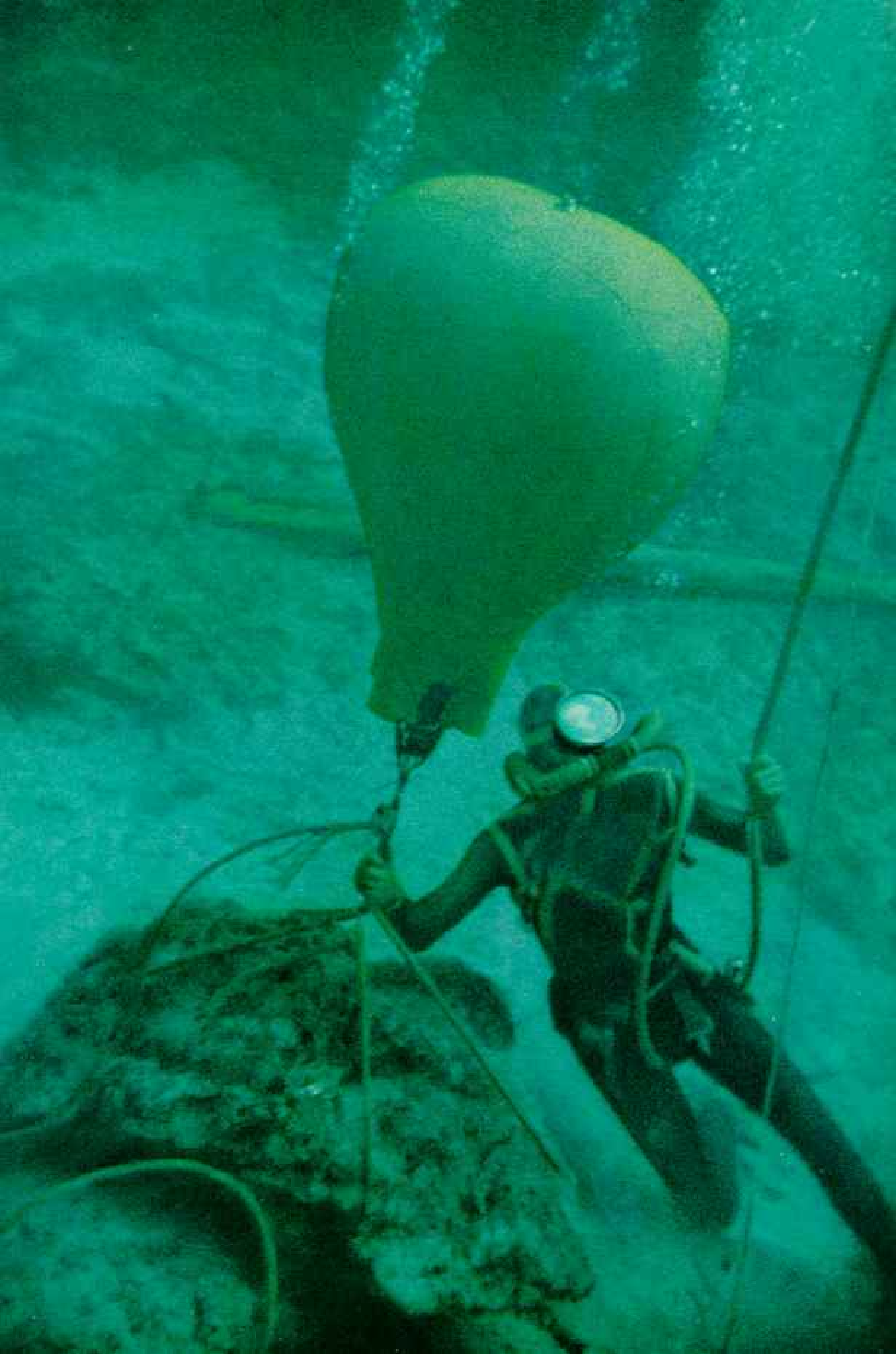
Men, for their part, had spent long days fashioning soft moccasins to aid footing on the island's cindery slopes. Bullock carts, Tristan's chief means of transport, had trundled through the village just as they had for more than a century.

#### Simple Folk Enter Complex World

For all the Islanders it is an end and a beginning—for many of them a difficult one. From Cape Town, they traveled on to their nominal homeland, Britain. After a warm reception, they spent a few months in an army camp in Surrey, and last January were rehoused at Calshot on the south coast of England.

The Tristan Islanders face the future with hope and nostalgia. Their way of life died on an October day in 1961. They are adrift in a new, glittering, mechanized world. They will, in time, adapt to it. But the first steps are not easy.

Fortunately, they have accepted the unsettling events with grace. As Martha Rogers, the island's Headwoman, said, "There is God's hand in this — we were meant to leave, and He will look after us." THE END





CAPTAIN KEMÂL ARAS cut the one-cylinder diesel engine. The echoes stopped thundering from the gray cliffs of Cape Gelidonya. *Mandalinci* drifted a bit, then stopped. Kemâl came to the foredeck where the veteran French diver Frédéric Dumas and I stood ready in our Aqua-Lungs.

"I say here," said Kemâl, the best sponge fisherman in all Turkey. He pointed to the dark-blue water under the bow.

"We'll see," I said, and Dumas and I jumped, holding our masks with one hand lest they be knocked off as we splashed in.

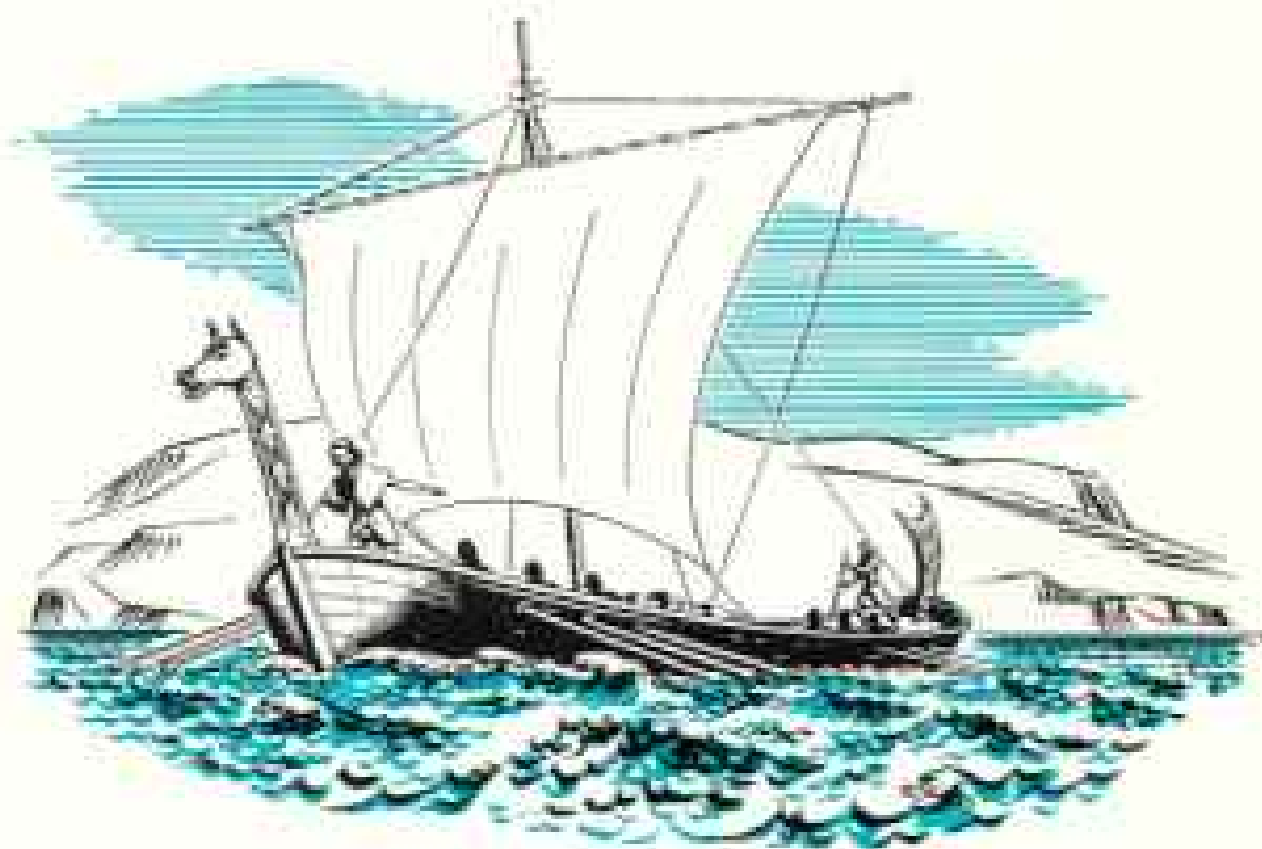
When the bottom loomed up, it seemed unfamiliar, and I had a moment of panic. I recalled our difficulties a year earlier, when we had first searched here for the wreckage of the oldest known seagoing ship, a vessel of the Bronze Age sunk 32 centuries ago.\* Then my sigh of relief disappeared into the bubbles of my exhaust. I recognized the sandy bowl 90 feet below the surface, with its huge boulder at one end and a mass of rock which held a heap of copper ingots at the other.

I swam closer. The ingots were still there. We picked at them with our knives. They were immovable, cemented together by more than 3,000 years of sea growth.

Looking for something on which to tie our safety line, I glimpsed another heap of growth-covered objects under a rock. I turned to look for Dumas and saw him 20 feet away, waving at me. He had found a large white stone with a hole in its middle.

When our time was up, we swam toward the surface. Ten feet down we hung onto the line for the decompression stop, and I had time to worry once more. The wreck seemed smaller than I had remembered it. Was it possible that those ingots scattered below us were only jetsam, dropped from an overloaded ship trying to clear the cape?

Expedition director George Bass, and Dr. Rodney Young, his chief at the University Museum in Philadelphia, had invested the museum's money in this expedition in the belief that here was the wreck of a ship, and that there was a lot more to it than copper ingots and a few bronze tools. No one could



## Oldest Known Shipwreck Yields Bronze Age Cargo

By PETER THROCKMORTON

*Diving 32 centuries into the past, archeologists off the coast of Turkey bring up relics of Trojan War times*

be sure until tons of sand and rock were removed. But George, a trained archeologist and diver, agreed with me that parts of the ship's hull might still exist. If we could find such parts, they might answer questions about Bronze Age ships that scholars have posed since the beginning of modern archeology.

A jerk on the weighted line from the boat to the bottom signaled that our time was up. Anxious faces greeted us as we climbed the ladder. Dumas, the most experienced diver in our international expedition, was a founder

\* Since this remarkable find was reported in "Thirty-three Centuries Under the Sea," in the May, 1960, NATIONAL GEOGRAPHIC, examination of salvaged objects has led experts to reduce their estimate of the wreck's age by 100 years.

### Air-filled Balloon Strains to Lift Relics From the Cape Gelidonya Wreck

The ugly 200-pound lump contained part of the cargo of a Bronze Age trading ship. When dissected, the mass revealed bronze tools and oxhide-shaped ingots of copper. Some archeologists think the ingots may have been a primitive form of money, representing the value of a cow or an ox. The expedition recovered more than a ton of artifacts.

DETACHMENT BY HENRY GREER AND DRAWING (ARROWS) BY STAFF ARTIST JOHN W. LUTHERS  
IN COLLABORATION WITH HOWARD I. CHAPPELL, BRITISH MUSEUM © N.G.S.

of the French Navy's Underwater Research Group—Capt. Jacques-Yves Cousteau was another—and we eagerly awaited his appraisal. He agreed that the rock probably concealed more than was immediately visible. And he spoke excitedly about the stone with the hole. He thought that it was the anchor of a ship.

In any case, we were off on a true archeological treasure hunt, seeking things even more precious than those golden statues that sponge divers dream about. To the archeologist, the intrinsic value of the objects he finds is less important than what they tell him. Potsherds and pieces of metal or wood which seem like so much junk can be full of meaning if their relationship is understood.

Bits of pottery are especially welcome, as a dating tool. In the ancient Mediterranean, styles of pottery sometimes changed nearly as drastically and as often as styles of clothing in our times; thus, stylistic comparison of potsherds from one site with pottery found and dated elsewhere in the Mediterranean frequently enables an expert to place their dates within a century.

#### Dry-land Techniques Move to Sea Floor

Archeologists reconstruct whole buildings from a few stones, or furniture from a trace of discolored earth; sometimes they discover why the furniture was buried and who destroyed the building. Such knowledge is the raw material of history. And our ship—if only there was one—might give us clues to the way men lived 32 centuries ago.

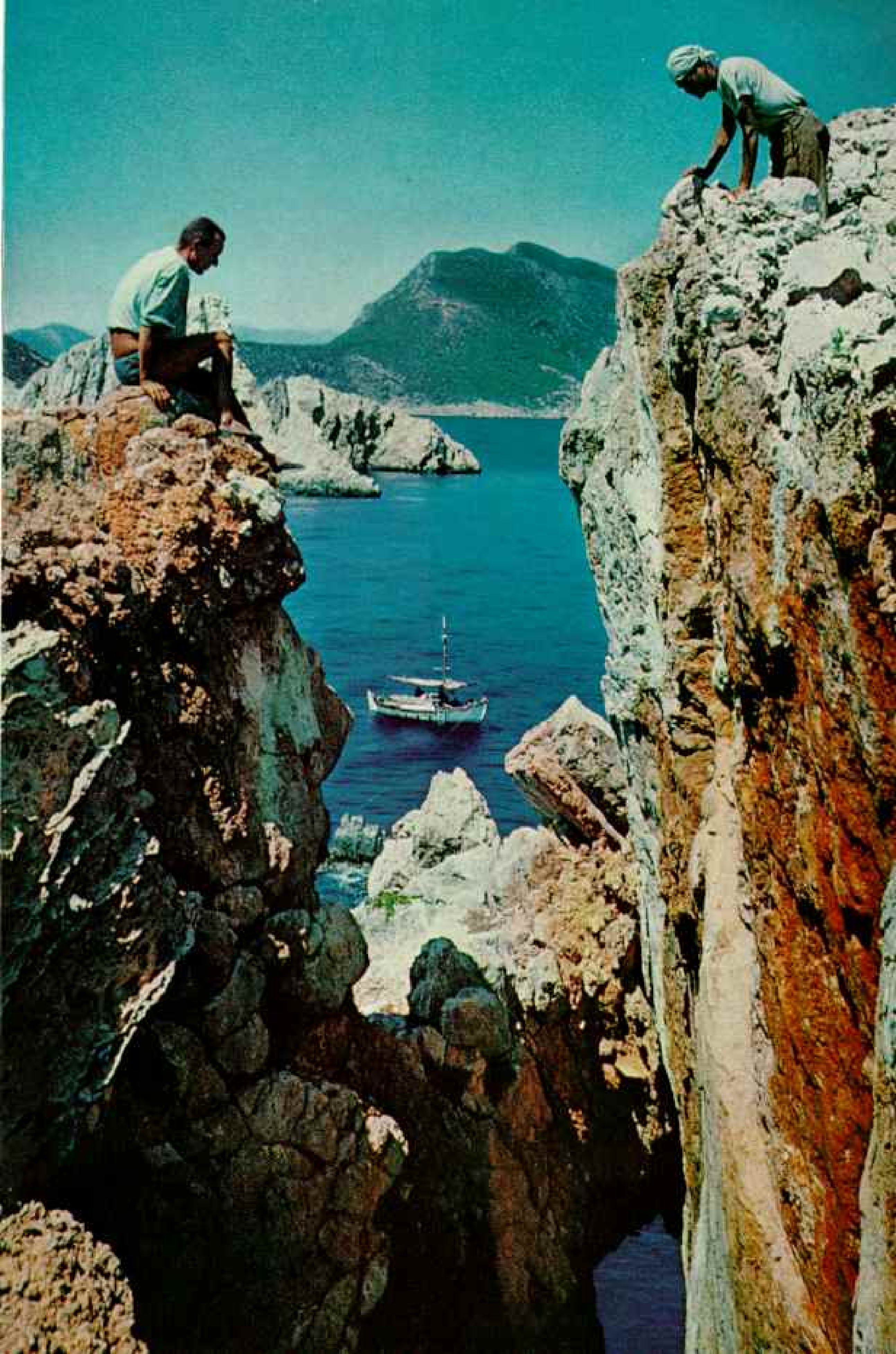
Before moving anything, the archeologist makes a careful plan of his site. He maps, measures, photographs, draws, and takes notes. Such reconstruction is tedious enough on land. We would try the same technique on the sea bottom—a far more difficult job (page 706). Moreover, we would challenge the currents off Cape Gelidonya, among the most treacherous in the Mediterranean.

None of us realized how much paraphernalia we had until we unloaded in June on a beach opposite Sulu Island. This is the nearest anchorage to Cape Gelidonya offering fresh water; it lies some 20 miles from Finike (map, page 703). We had cases of diving and camera equipment, and camping gear for more than 20 people; markers, drawing boards, and plastic “paper” for sketching underwater with ordinary pencils. Miss Joan du Plat Taylor of the University of London Institute of Archaeology, a specialist in Bronze Age material, brought a trunk of chemicals for treating the objects we would find.

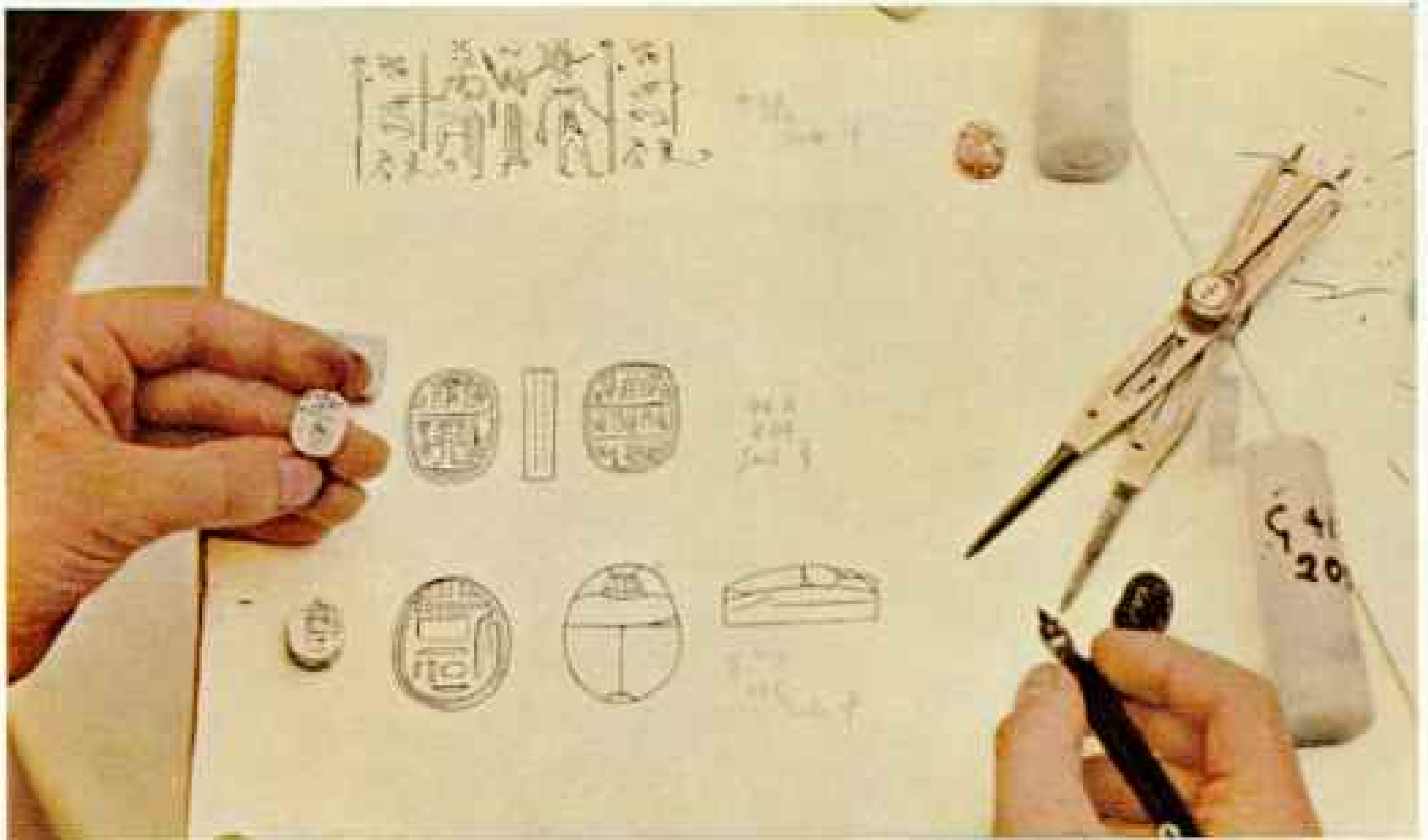
**Battling a current,** diver Claude Duthuit steers his find toward the ladder of *Lutfi Gelil*. He dives with an air hose—a necessity when air compressors for refilling Aqua-Lung tanks needed repair. Hoses proved cumbersome and sometimes kinked, forcing a diver to share his companion's mouthpiece.

**Rocky ramparts** of an island off Cape Gelidonya frame the Turkish sponge boat *Mandalinci* as she moors above the spot where the Bronze Age ship went down. Scientists speculate that the vessel sank like a stone after striking an undersea pinnacle.









We set up a camp and dammed a stream to form a pond for soaking the salt from our encrusted finds. We had a second ship, *Lutfi Gelil*, a 60-foot sponge dragger captained by Kemâl's friend Nazif Goymen. We would dive from her rather than from the 38-foot *Mandalinci*, since she was more stable and had heavier hoisting gear (page 703).

#### Divers Harassed by Dangerous Currents

Kemâl placed buoys attached to half-ton anchors on each side of the wreck site to serve as moorings, and we settled down to a routine. In the early morning, after breakfast, we climbed aboard *Lutfi Gelil* and chugged off on the hour's run to Cape Gelidonya. As soon as the mooring was picked up, the first shift jumped over the side.

Most days the current ran hard, and we had to struggle down the weighted rope called the shot line. The Turkish divers in their awkward suits and helmets also had their troubles with the current. One day "Uncle" Kasim Arslan was swept off.

We hauled him back aboard by his lifeline like a hooked fish, and could hear him cursing inside his suit before we had his helmet off. Captain Kemâl gently chided him for "trying to go to Finike without leave." From then on, the younger sponge divers learned to use the Aqua-Lung, and "going to Finike" became the accepted term for getting caught in the current.

After a few days the wreck began to look like an archeological site, with meter sticks, tapes, and boxes of tools. Different areas soon acquired nicknames. The "rock" was a boulder big as a truck, dominating the site. The "platform" was a rock that held a heap of ingots above the sand. The "gully" ran between the rock and the "cliff," the



**Prized finds**—scarabs from Syria inscribed with hieroglyphics—suggest that the Bronze Age ship may have traded with that country. The remains of what appeared to be a chest yielded the seals, plus maces and weights for a scale. Draftsman Terry Ball's rendering of a cylinder seal (top) shows a deity and two worshipers.

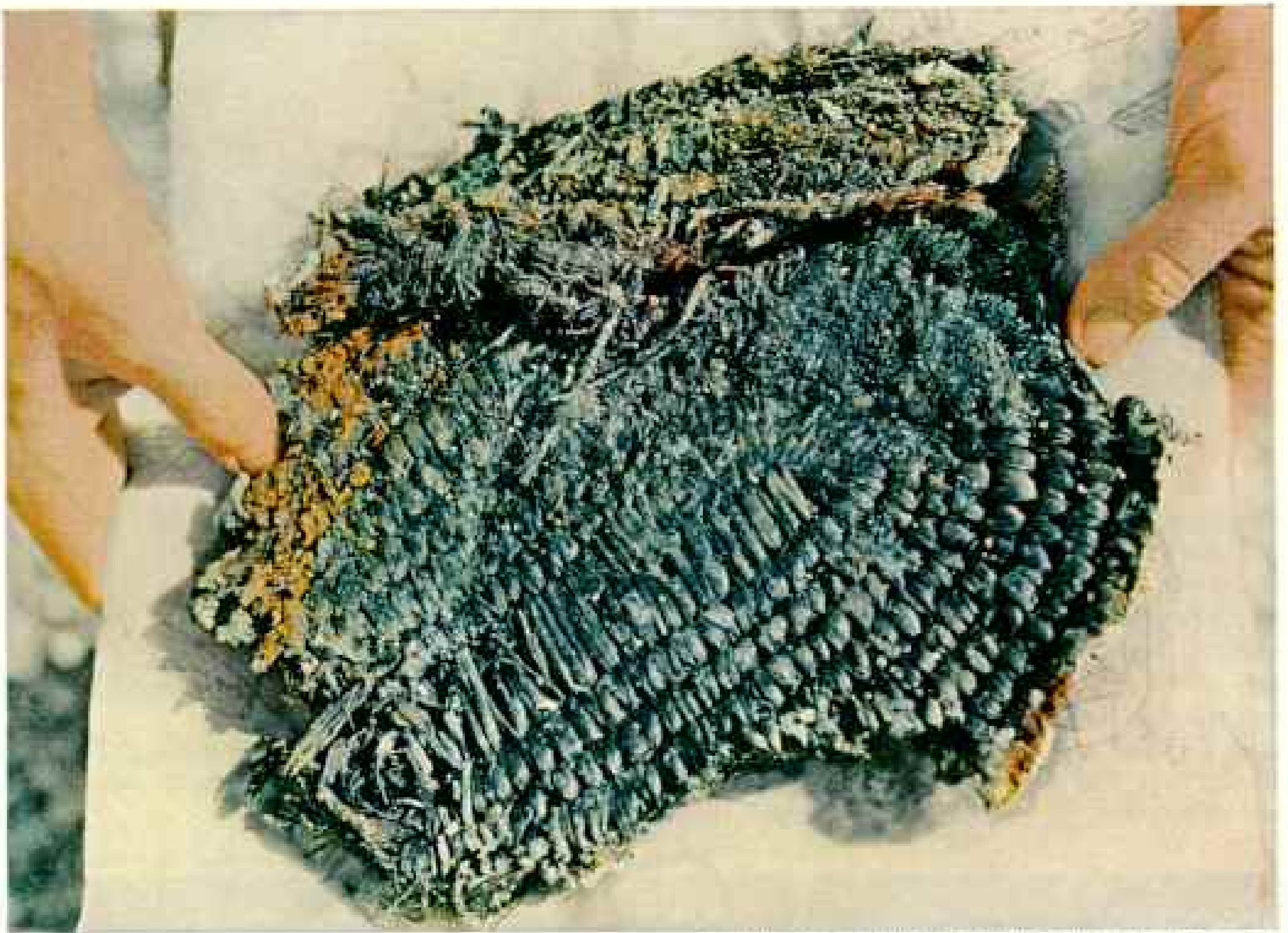
**Chipping cautiously**, chief diver Frédéric Dumas frees a limestone mass that preserved bits of the ship's hull. Numbered tags mark fragments of wood protruding from rock. The deposits, six to eight inches thick and hard as concrete, covered vessel and cargo.



Arm lashed to a rock, a draftsman braces against the current. With a pencil he sketches cargo profiles on a sheet of frosted plastic. Nonchalant fish, a two-banded bream, ignores the intruder.

ILLUSTRATIONS BY MIKE GREEN (THIS PAGE AND OPPOSITE) AND PETER THROCKMORTON © N.A.S.





BOUACHERE BY LOUIS MARDEN, NATIONAL GEOGRAPHIC STAFF © W.C.B.

Under the sea for 3,200 years, this fragment of a basket was recovered from the sunken vessel. Made of matting and rope, it probably held tools, weapons, and household utensils. Divers found the relic sandwiched between copper ingots.

slope forming one side of the site. A draftsman would sketch atop the rock as naturally as if he had been at his desk, while a team of divers, on their knees like gardeners, cleaned weed from the gully, and a photographer braced himself for a picture.

Two red mullet took up residence when they discovered that in the course of the work we dislodged edible worms. Draftsmen were startled by groupers hanging over their shoulders, as if checking the drawings for accuracy with mournful eyes.

#### Rock Proves to Be Mass of Copper

In the evenings we ran back to the beach and to our one big meal of the day (divers eat lightly while working), usually rice, beans, tomatoes, and fish. Then photographer Herb Greer headed for the darkroom to develop his film, while the archeologists planned the next day's work.

In a week we had cleaned up most of the loose material. One day Dumas noticed that the platform was hollow underneath. He chipped at the overhang and exposed the corner of an ingot. Part of what we had taken for rock was actually copper, welded into a

mass by sea-deposited limestone. More chipping showed that half the platform was metal.

While we pondered how to handle this find, Dumas noticed an oddly shaped stone at the gully's mouth and gave it an experimental bash with his hammer. A cloud of green "smoke" rose—copper sulphate. Dumas had exposed another ingot, under another heap of concreted metal objects.

Although familiar with the limestone growth which covers all objects exposed underwater in the Mediterranean, we were not prepared for growth that was eight inches thick in some spots. We re-examined the gully and found it full of metal. In places ingots were stacked five deep. We went wild with joy, and sent off happy telegrams to our sponsors.\* Then, not so happily, we turned to the problem of raising the material.

Our expedition had expected to salvage a few hundred pounds of objects, and to excavate hull fragments embedded in sand. Now we were faced with tons of material embed-

\*These included, besides the University of Pennsylvania Museum, the American Philological Society, the Littauer Foundation, the Council of Underwater Archeology, and individual contributors.





Soundings in feet  
Map by Barbara Mahanell and Jan Halpern  
© N.G.S.



Crosses mark sites for future study

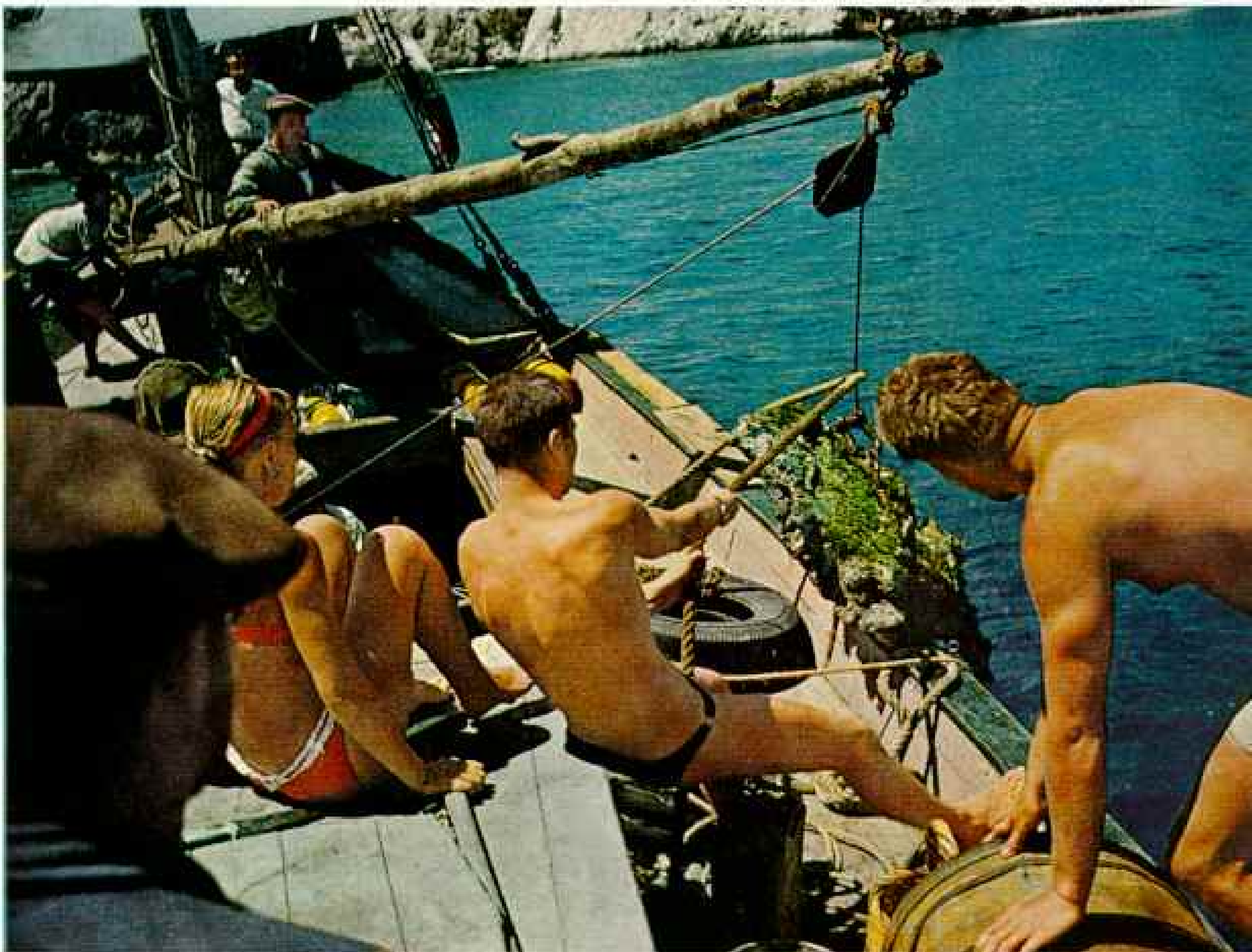
**BRONZE AGE WRECK**  
Author's party explored remains of oldest known sea-going vessel, at 90-foot depth



Graveyard of ancient ships, Turkey's reef-strewn waters hold the bones of countless merchantmen that sailed from Cyprus, Crete, Egypt, and other trade centers. In four years of exploration, the author charted forty-odd wrecks, including the Bronze Age ship.

Plucked from the sea floor by winch and cable, limestone-encrusted cargo goes aboard the *Lutfi Gelil*. Claude Duthuit guides the lump; the author crouches at right. Earlier, divers hammered loose masses weighing as much as 400 pounds; draftsmen plotted their exact positions on the bottom. Expedition members on shore fitted them back together like pieces of a jigsaw puzzle.

BOGACHVONE BY HERB GREER © NATIONAL GEOGRAPHIC SOCIETY





RETIACROHME BY PETER THROCKMORTON © NATIONAL GEOGRAPHIC SOCIETY

**Husband-and-wife team, expedition director George Bass and Ann apply plastic preservatives to remnants of the ship. Mrs. Bass paints the largest recovered timber; her husband coats bits of brushwood that may have fed cook stoves or cushioned cargo against the hull. Nylon shades them from the sun at their beach camp (page 708).**

ded in solid rock. If we tried to cut it apart on the bottom, we were likely to be at it for years, and to do a messy job in the end. We knew how agonizingly time consuming it was to plot each object as we broke it loose. But if we plotted less carefully, we would negate our whole purpose.

#### Archeologists Resort to Auto Jack

Dumas had an idea. Why not break the mass into chunks, raise them, and put them together again on land?

I asked, "How can we loosen the chunks?"

Dumas had another idea: an automobile jack. If we jacked under the concreted heaps, they might break from the marble bedrock.

We sent for a jack, and spent three days chiseling away to get it into position. We pumped. The jack groaned and leaked oil.

Sea pressure had filled it with water. We drained it, changed the oil, and tried again.

Three tons of thrust pushed against the mass. A crack appeared, then a cloud of copper sulphate. A chunk rose inch by inch as we cheered into our mouthpieces, then shook hands solemnly all around.

Dumas lashed a rope sling around the chunk and attached the steel wire which led to *Lutfi Gelil's* winch. We swam somersaults all the way up the shot line.

Captain Kemâl maneuvered *Lutfi Gelil* over the wreck. The ship heeled and the mast groaned as the weight came on it, but we hauled the load over the bulwark. The chunk was mostly metal, copper ingots, stacked as they had been in the ancient ship's hold.

On the beach we chipped stone off the chunk without breaking the ingots. We did

the same with all the other chunks, fitting them together again. It was a jigsaw puzzle with pieces moved by sweating squads. But eventually we had a large part of the cargo laid out where we could photograph and draw it, positioned exactly as it had been found.

Many traces of hull planking had been preserved under the heaped cargo. These were drawn in place and the plan began to take shape, hinting at a ship's construction. The plan did not show which pieces had been ribs and which planks, but it did indicate that one end of the ship had lain in the gully and the other at the platform. An intact hull section would show how the planks were fastened to the ribs, and furnish the key to make sense of what we had found. Would we find such a section? As time passed, our hopes began to fall.

But we continued to find other interesting things, such as a mass of blue and white beads, identified by Miss Taylor as probably Phoenician.

When the concretion was chipped off the ingots, many seemed in as good condition as when they left the foundry more than three millenniums ago. Miss Taylor called some



**Bronze knife**, one of many household utensils uncovered, lay on the sea bed between a billhook and a *shish*, or spit, exactly like those used in Turkey today.



**Double ax**, made of bronze with oval shaft hole, served both as weapon and as symbol of divinity in pre-Hellenic days.

**Adz** lay buried beneath copper ingots. Wood adheres to the blade; experts doubt that it came from the handle.







typically Cypriote. Others were of a type heretofore found only in Sardinia.

Most had makers' proofmarks cast into the copper, and incised signs—probably marks of ownership—scratched by traders. Some had file marks on their edges, perhaps made by potential buyers testing for quality.

We found tools with incised letters in the still undeciphered Cypro-Minoan script, used on Cyprus in the late Bronze Age.

Most of the ingots were the familiar "oxide" shape I had seen on my first trip. But we also found others, each resembling a

discus; some had been broken into halves, quarters, eighths, or smaller pieces, perhaps as units of exchange.

The collection soaking in our fresh-water pool (page 710) included hammers and chisels that might not have looked out of place in *Mandalini's* toolbox if they had been made of steel instead of bronze. There were bronze plowshares like those used in some parts of Turkey today; picks, shovels, axes, adzes, awls, and knives (page 705); arrow and spear points; and parts of bronze bowls.

I was cleaning an unfamiliar instrument



HERB RYAN

when Captain Kemâl walked by. I asked him what he thought of it. "That? It's a pruning hook." Another piece that had mystified us he recognized as a *shish*—the skewer on which one makes shish kebab.

Could the ship's owner have been a junkman? Or a smith who went from place to place, trading new implements for old, like modern tinkers in Turkey who go from village to village trading copper pots? This theory was strengthened when we found bronze blanks, ready to be worked into tools.

When Captain Kemâl heard the junkman

### Divers Map the Wreck as Archeologists Would Mark a Dig on Land

Driving spikes into the bottom, the underwater team made triangulations and plotted the site accurately. To work 90 feet down, archeologists had to become expert divers.

Man at right holds a measuring rod. Diver at left loads potsherds into a basket.

theory, he laughed until he cried: "Raising junk is bad enough," he said. "But junk three thousand years old—ridiculous!"

The ravages of the sea and the centuries had done strange things to what was once a ship's cargo. In places we found well-preserved copper next to bronze that was riddled. In others, copper and bronze had corroded to practically nothing, while lumps of pure tin had turned into a white powdery oxide. Well preserved by concretion, the remaining amount of wood, bone, and matting was amazing—and maddening, because it was never quite enough. The wreck gave fascinating, tantalizing hints, but denied us proofs.

### Homer's *Odyssey* Offers a Clue

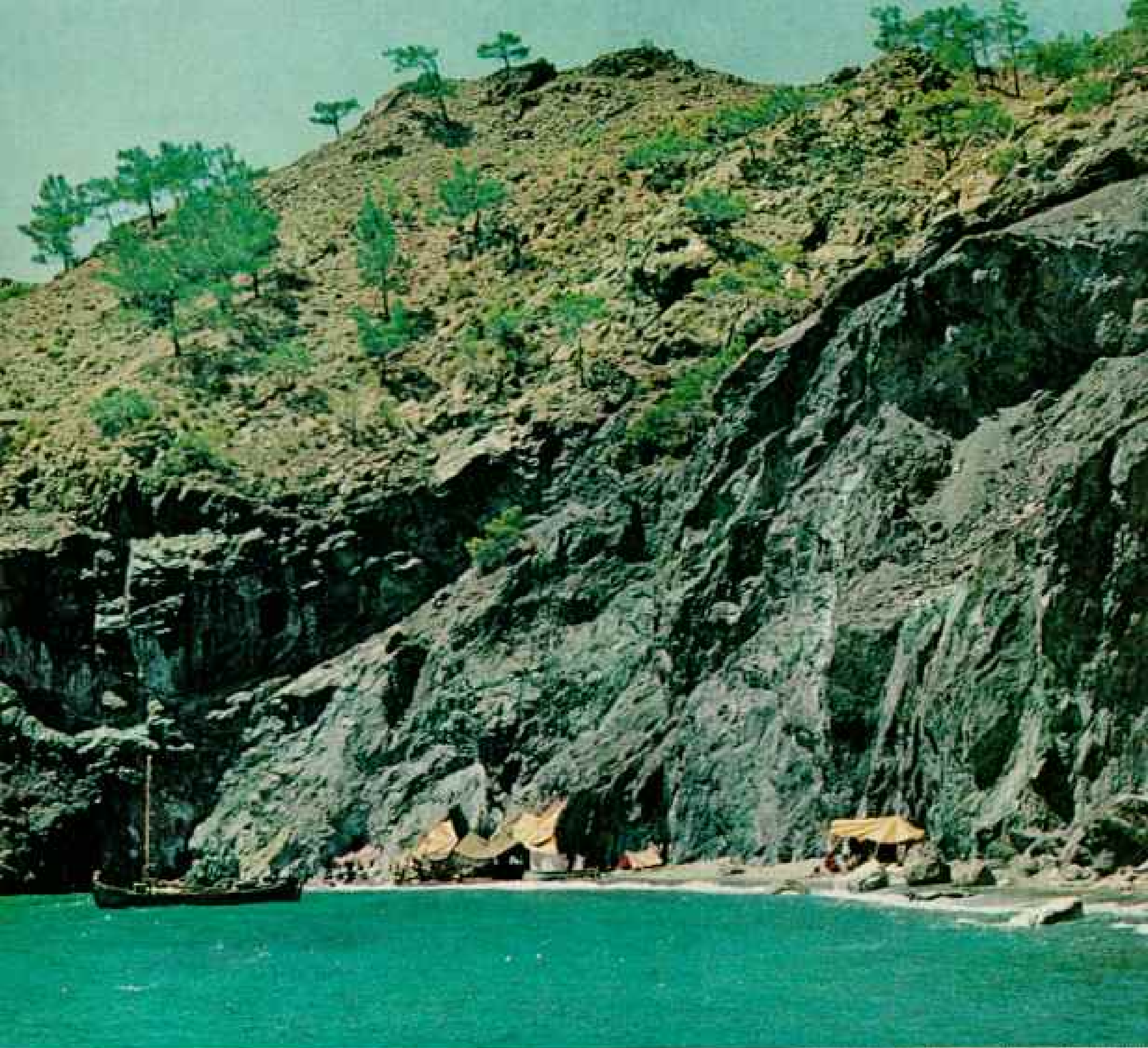
The stick problem was typical. We found dozens of hardwood sticks and traces of many more. What were they? Firewood? Tool handles? Could they be part of the ship?

Some Mediterranean sailing ships still have a canvas screen just above the bulwark, to keep out the spray. Homer, in the *Odyssey*, tells how Odysseus made a brushwood bulwark to keep out the sea.

The only way George Bass was going to answer questions like this was through a perfect record of each scrap found. Everything was drawn in place and photographed from several angles. While the camp slept, he pored over the growing pile of photographs and drawings.

Unscalable cliffs formed a half circle that not only protected our camp and the ships from the wind but also kept out any breeze (page 708). The beach got so hot during the day that rubber soles melted and tools left in the sun became too hot to touch. Without refrigeration, uncooked meat spoiled in a day, fish in a few hours.

Isolated, we took up strange hobbies. Dumas developed a passion for stonework and built himself a platform high in the rock with stone benches, carefully engineered steps, and a smooth floor of gravel lugged from the other end of the beach. Ann Bass acquired a



PHOTOGRAPHER BY PETER THORCHMORTON (ABOVE) AND M

pet white rabbit named John, which lived in the photographic darkroom and ate watermelon rind.

The flies became so bad that the draftsmen had to work under nets. Minor cuts, kept open by continual immersion in sea water, had to be covered the moment one reached the beach or flies would infect them.

One day an unmarked caïque sailed close to us at the wreck site. Kasim hailed her. She put on speed, circled us, and went off in silence. A visit to Finike solved the mystery. A local newspaper had run a story saying the Yankee treasure hunters had salvaged two tons of gold and were still at it! Any dark night now, someone might come to our unguarded site to seek that imaginary gold, and destroy precious archeological evidence. If we did not finish by fall, we might find nothing next spring.

*Mandalinci's* compressor blew a valve and the generator burned out. Breakdowns meant

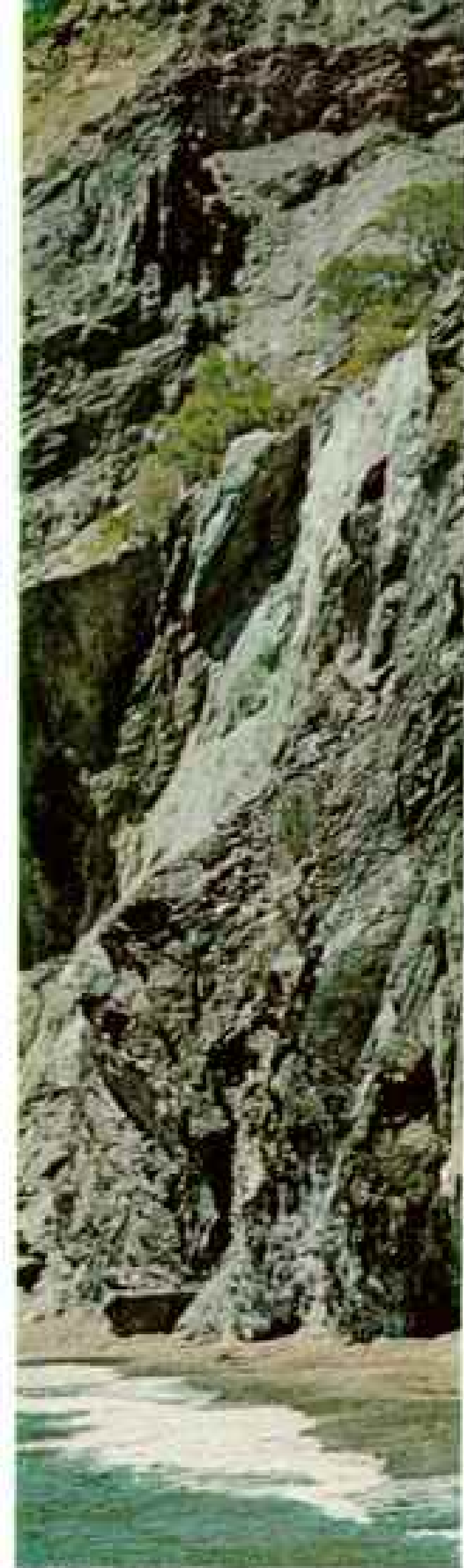
work at night. Exhaustion made us careless, and carelessness created more work, more exhaustion, and sometimes danger. Nazif smashed his hand while mooring.

*Lutfi Gelil's* engine was one continual breakdown. After spending all night repairing it, Kasim went to sleep without checking the lube oil in *Mandalinci's* motor. The bearings burned out. Kemal was so mad that he quit speaking to Kasim. Photographer Greer got caught in the current and a costly underwater camera "went to Finike."

Then, one afternoon, diver Waldemar Illing appeared on deck, grinned, and showed something to George Bass, who shouted and began to dance. We thought he was sun-struck.

He held an inch-long, pencil-thick piece of black stone, engraved with wonderful pictures of a god and two worshipers (page 700). It was a cylinder seal, for sealing clay tablets — perhaps the signature of a Syrian merchant who had been on board.





BRUCE © NATIONAL GEOGRAPHIC SOCIETY



Lamps burn late as expedition members seek to solve mysteries of the Bronze Age ship. Where did it embark? Where was it bound? With daytime devoted to diving, night afforded the main opportunity to study finds. Gernolf Martens (left) and the author clean artifacts by lantern light.

Forbidding cliffs wall the expedition camp on the crescent beach, an hour's boat trip from the wreck. "Stones fell from the heights every night," reports the author, "and we feared a landslide might cover us at any moment. In late summer, waves flooded the site and water ran under our cots."

Finally, things were beginning to look up. When we ran back to camp we found that Nazif's hand was better; moreover, he had produced a banquet of frankfurters with plum pudding for dessert, to be served with a bottle of raki Kemal had brought out from some secret corner of *Mandalinci*.

Next day Kemal said good morning to Kasim, and the weather was perfect. We broke out the air lift, our underwater "vacuum cleaner." This was a 100-foot flexible tube extending to the area to be excavated. Compressed air, delivered to the lower end of the tube by a hose, would rise and lift mud, water, and sand with it.\*

We began air-lifting just outside the gully and found many well-preserved objects. The most interesting of these were several scale weights. Made of hematite, a reddish iron ore, they were a Bronze Age version of scale weights in an old-fashioned country store.

A lump of rock at the gully's mouth also

seemed full of objects. We raised it with great labor, to find only the green stains of decomposed copper.

But our disappointment vanished when we explored the sand underneath the lump and found a row of planks extending into the gully. Sandwiched between the wood and a compacted mass—in this case copper and bronze pieces and unbelievably fragile organic matter—was a layer of ballast stones. It was an undisturbed cross section of the ship. At last! Now we had visible proof that we were dealing with the remains of a ship, and not with objects thrown overboard.

Toward the gully's end we came to what may once have been a wooden chest. Inside were many more weights, forming several almost complete sets. I picked up a white object as big as my fingernail. I held it next

\*The air lift and its use were described by Marion Clayton Link in "Exploring the Drowned City of Port Royal," NATIONAL GEOGRAPHIC, February, 1960.



Splinters of history re-create the past as the author cleans bronze artifacts in the camp's fresh-water pond. Free-lance writer-photographer turned amateur archeologist, Mr. Throckmorton first learned of the Bronze Age wreck from Turkish sponge divers.

Like ancient tribute bearers, seamen shoulder copper ingots. Turkish Capt. Kemal Aras stows the four-armed metal "oxhides" into a launch for shipment to the museum in Bodrum. Hours later, on September 13, 1960, the expedition broke camp.

to my mask and saw hieroglyphs. It was a Syrian scarab. Perhaps our ship had traded with Syria. Next to the scarab we found the stone head of a ceremonial mace, possibly an official's badge.

The discovery of the scarab, the weights, and the cylinder seal prompted further speculation. The time of the wreck, according to our dating of some of these finds, was approximately 1200 B.C. — an era of political upheaval in the Mediterranean. Vaguely known "Peoples of the Sea" struck south at Egypt, plundered the city of Ugarit on the northern coast of Syria, and may have destroyed copper foundries on Cyprus. Undoubtedly our ship played a part in the drama of the times.

Did it carry Syrians or Cypriotes with their riches, fleeing the invaders? Or maybe its cargo was a shipment of copper and tin to make



bronze—for Greeks or Trojans battling at Troy with the “spears of bronze” mentioned in the *Iliad*. Nobody knows exactly when that decade-long struggle took place, but it is generally placed between 1200 and 1180 B.C.

One night, heavy seas washed us out of our beds. Soon we would face the *lodos*, the wind that brings rain. It could loosen rocks above the camp. Time was running out.

In our rush to finish the work, the weakest of us performed feats which at the beginning of summer we would have thought impossible for the strongest. We swung 10-pound sledge hammers underwater. The hammer men strapped on 25 to 40 pounds of lead, and tied themselves to the rock so that the current would not sweep them away. A partner held the chisel. There were bruises, but no broken fingers. No one complained.

With an eye on the weather, we searched the site for material we might have missed. Was any metal concealed under layers of rock? Luis Marden of the NATIONAL GEOGRAPHIC arrived with an underwater metal detector, and we found more metal pieces.

The site looked naked. Great chunks had been torn out of the sea bottom and a whole area stripped of sand and weeds. The weather broke; we had three days of storm. Without regret we packed up and ran for Bodrum.

#### Salvaged: One-ton Key to Bronze Age

We had won. We had moved tons of rock and sand, and dived thousands of hours without a bad accident. Now more than a ton of salvaged bronze and copper objects are displayed in the Crusader's castle of St. Peter in Bodrum. This stronghold was built with stones from King Mausolus's tomb, one of the Seven Wonders of the Ancient World. Now it is a museum of underwater archeology, housing mementos of eight and a half centuries before the time of Mausolus.

It will take years to analyze these objects completely, and to assemble our thousands of drawings and photographs into a final plan. Only then will we know as much as we can about the fabulous Bronze Age argosy which lay off Cape Gelidonya for 3,200 years before we found her. THE END

FOUNDED BY STEPHEN SMITH (OPPOSITE) AND PETER THURCKWORTH (© NATIONAL GEOGRAPHIC SOCIETY)





# Nuclear Power for



**N**IGHT—the long, lonely polar night—descends once more over a village on the far-off rim of Antarctica, a cluster of huts that I know as well as I know my own home in Virginia. But, for the men at McMurdo Sound, this winter night will be unlike any other in Antarctic history.

A nuclear power plant has been built on a bleak, rocky shoulder of Observation Hill

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**The Author:** Rear Adm. George J. Dufek, as Commander U. S. Naval Support Force, Antarctica, headed the Navy's 1955-59 Operation Deep Freeze. In 1956 he led the plane crew that made the first landing at the South Pole. After his retirement, he became Director of the Mariners Museum at Newport News, Virginia.

(pages 728-9), below the peak where stands a cross to Capt. Robert Scott's gallant South Pole party of 1912. Thus, if all goes well, the main U.S. Antarctic base will be supplied with light and power by atomic energy rather than by the diesel oil of the past. The saving in uncounted gallons of fuel—and in the huge cost of sending that fuel down there—marks a revolutionary step in polar exploration.

Navy Seabees and representatives of the manufacturer, Martin Marietta Corporation of Baltimore, erected the reactor during the December-through-March Antarctic summer just past. Its name is PM-3A. PM stands for portable, medium-powered; 3 for the third such reactor design; A for field installation.

By REAR ADM. GEORGE J. DUFEK, USN (Ret.)

# the Polar Regions



PHOTOGRAPH BY GEORGE J. DUFEK © NATIONAL GEOGRAPHIC SOCIETY

Despite its prosaic name, however, PM-3A opens a dramatic new era in man's conquest of the remotest continent, and, incidentally, fulfills an old dream of mine.

In 1959, when I retired from the Navy, I had spent a large part of my life in Antarctic and Arctic exploration. For years I had been urging nuclear power in budgets for Operation Deep Freeze, the U. S. Navy's huge maintenance and supply mission in Antarctica.

I finally turned in my parka and mukluks, in the belief that I had seen the last of the polar regions. But scarcely a year later I found myself on special assignment at the opposite end of the world in a fantastic city hidden in the Greenland Icecap.

## Flags and Escape Hatches Mark a City Buried in the Greenland Icecap

Camp Century, one of the world's most extraordinary military installations, lies 150 miles from the western edge of the mile-and-a-half-thick icecap that blankets virtually all Greenland. The under-ice community, heated and lighted by a nuclear power plant, contains 21 tunnels, including a Main Street 1,100 feet long.

Nearly one hundred scientists and soldiers spent the past two winters at the camp. Devoted to year-round polar research, they defied extreme surface temperatures of  $-60^{\circ}$  F. and winds up to 125 miles an hour.

Ramp permits vehicles to descend into trench

Coolers, jutting above the ice, exhaust waste heat from the nuclear power plant



WORKING BY W. ROBERT BOYD © A.P.C.

Workers test one of 15 hatches through which men could escape in emergency.

# Cutaway View of Camp Century and Its Nuclear Power Plant Under Greenland's Icecap



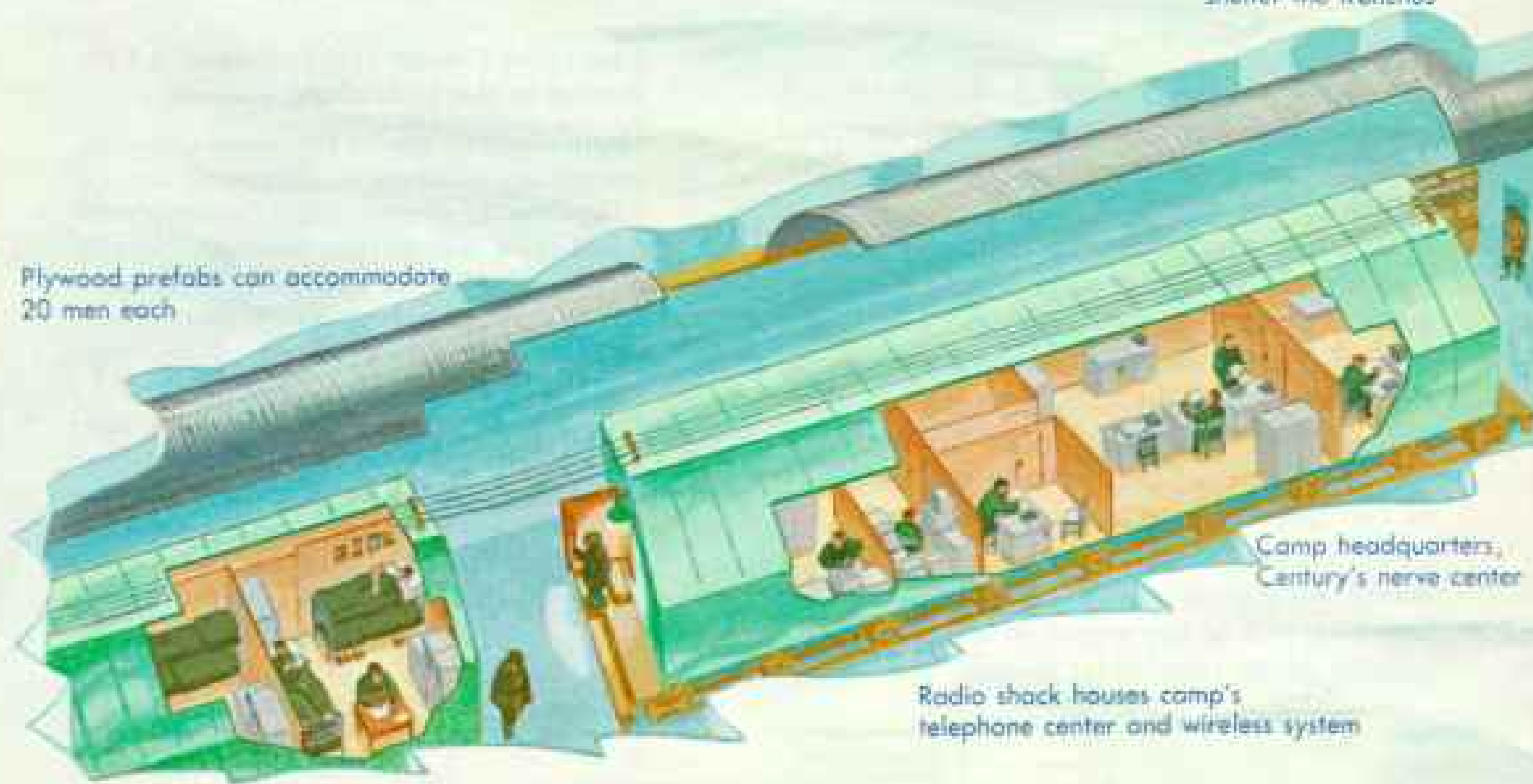
Red flags mark snow-covered trenches



Garage repairs tractors and sled trains

Corrugated-metal arches shelter the trenches

Plywood prefabs can accommodate 20 men each



Camp headquarters, Century's nerve center

Radio shack houses camp's telephone center and wireless system



Escape hatch

Feedwater apparatus pumps water into steam cycle

Heat from nuclear reactor produces steam for turbine-generator

Evaporator produces steam to melt glacial ice for camp's water supply

Power plant control center

Substation distributes power to camp

Steam turns turbine-generator, converting heat to electricity

Condenser converts steam back to water for steam cycle

Cooling system for power plant

Mess hall and kitchen serve as many as 200

Freight shaft

Men enjoy hot showers beneath 125-mile gales and -60° F. temperatures

Main Street, 1,100 feet long, leads to stand-by diesel power, research laboratories, and quarters

Shell artist: Robert C. Kagle  
Research by Eugene M. Sibert  
© National Geographic Society

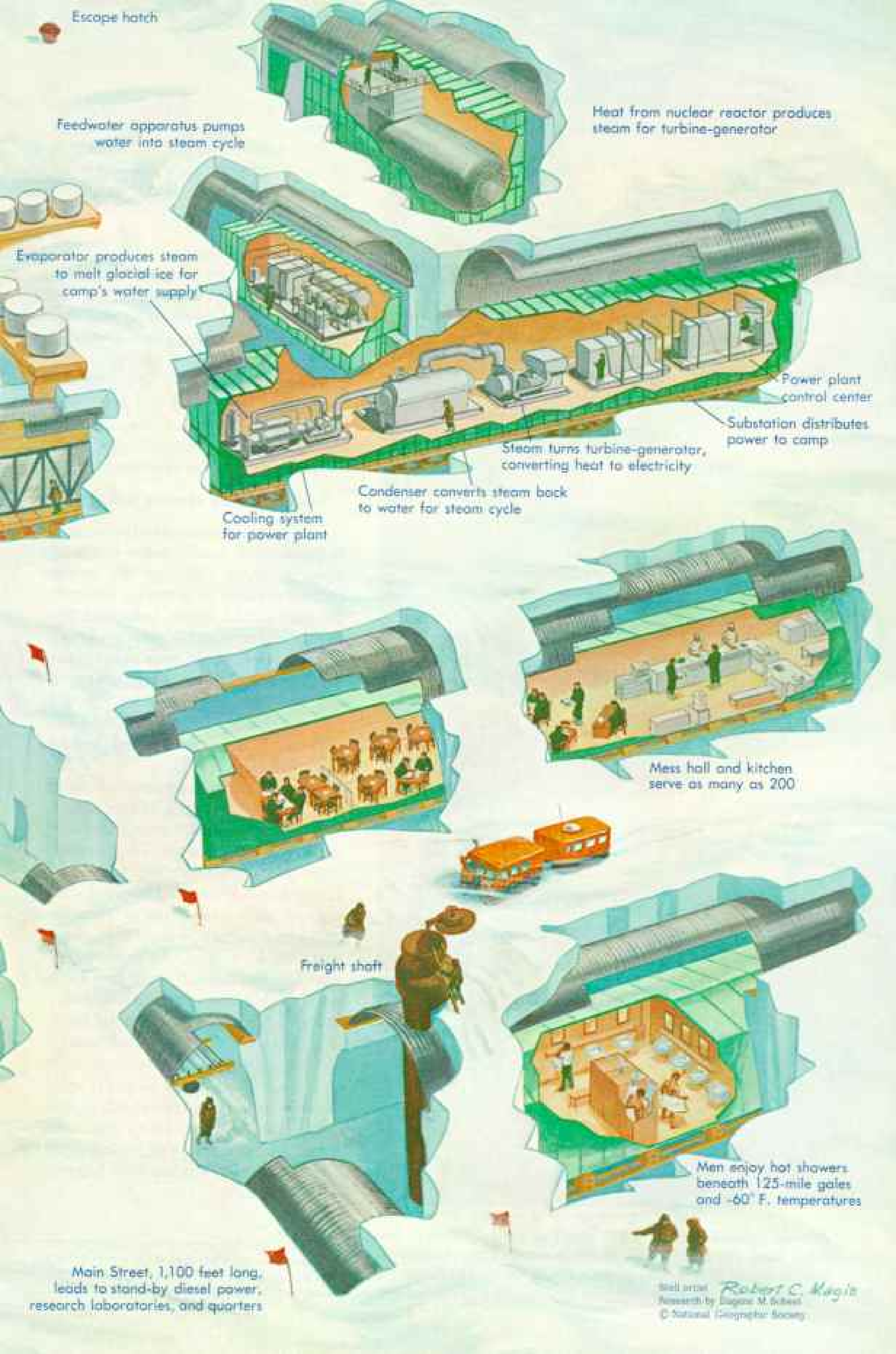




ILLUSTRATION BY G. D. BOGGS © NATIONAL GEOGRAPHIC SOCIETY

Atomic reactor trench takes shape at Camp Century, 886 miles from the North Pole. United States Army Engineers, who installed the nuclear plant, worked 12- to 14-hour shifts and used some six thousand tons of supplies and equipment.

From a control room of the U. S. Army's Camp Century, I heard a radio message, brief but exultant, flash out across the white waste of ice and snow to Thule Air Base, 150 trail miles away.

"PM-2A has gone fission... core critical 0652 hours."

The words, embodying a nuclear pun, said much—and implied far more. In a chamber adjoining our control room, splitting atoms yielded energy from fission in the heart of a nuclear reactor, the PM-2A.\* Tell-tale instruments had touched off a spontaneous cheer at the moment the untried core achieved a sustained—or critical—chain reaction.

#### Under-ice City Houses 100 Men

The steam produced by the nuclear furnace soon would begin coursing through pipes, spinning the power plant's turbine to generate electricity that would warm halls and living quarters. Surplus steam—as we were to see—would even operate the unique water system. Century—a city built entirely under ice—would become the first fully equipped community to be powered and heated solely by atomic fuel.

Though I am a veteran of polar life, I found Camp Century amazing. Here, about 100 men lived and worked beneath the ice. The "streets" were 21 tunnels, arched with corrugated iron plates and covered with tons of snow (see cutaway view on preceding pages). Within these burrows the U. S. Army Polar Research and Development Center had built comfortable barracks, hot showers, a modern kitchen, an automatic laundry, hospital—even a gymnasium.

Camp Century exists essentially as an Arctic research base. Its snug comfort and many conveniences, too costly and too difficult to maintain except by nuclear power, permit year-round scientific studies in a bitterly hostile climate.

\*PM-1, another reactor, was built by the Martin Marietta Corporation to provide heat and power for an Air Force radar station near Sundance, Wyoming.

I could not help but see the promise and the possibilities the Army's techniques held for that other ice-mantled land I knew and loved, Antarctica.

There, as a contribution to the International Geophysical Year, the United States had established six research stations and McMurdo Naval Air Facility. Four remain active, and we regard them as permanent. The reactor at McMurdo Sound has recently been installed. Another has been authorized for the base, and one each for our new Byrd and new South Pole Stations. All four would save the United States an enormous fuel bill, an item that has always figured large in our Antarctic research and exploration budgets.

Under-ice caverns modeled after those at Camp Century house new Byrd Station, in-

land and exposed to the full fury of the world's worst weather. No doubt the new South Pole Station will be similarly housed.

#### Polar Fuel Oil: \$6 a Gallon

From my years with Deep Freeze, I could appreciate the role of atomic power in these plans. I left my command in 1959 knowing all too well the cost and difficulty of supplying our bases with fuel.

Up to now about 60 percent of the Antarctic cargo lift has consisted of fuel, most of it oil for heat and light, the rest aviation gasoline. The Navy pays 12 cents a gallon for fuel oil in New Zealand. By the time that oil gets to McMurdo Sound, it costs 40 cents a gallon. For the inland stations, the charge runs as high as \$5 to \$6 a gallon.

PHOTOGRAPHS LEFT AND RIGHT BY R. ROBERT WHITE © R.S.P.



Unpacking atomic fuel, a technician wears rubber gloves to keep these elements clean after removal of plastic wrapping. Forty-three pounds of uranium will operate Century's atomic plant for two years.

Crane lifts the nuclear plant's "hot" waste tank onto the floor of a prefabricated building. Shipped by sea, the 413-ton, \$3,000,000 reactor arrived in carefully marked sections—a giant do-it-yourself kit.







HE ENDSCHROUWED BY W. ROBERT WOODS, NATIONAL GEOGRAPHIC STAFF © N.G.P.

Tension etches a technician's face at a crucial moment in the loading of the nuclear plant. Grasping a long handling tool attached to a fuel element, the crewman carefully lowers it into a small opening in the reactor vessel.

Heart of the nuclear unit, the reactor vessel at upper right will contain the core—fuel elements and control rods—that powers the plant. The elements will go beneath the holes at center. Water will serve as coolant and radiation shield (opposite page). Suspended lid will seal the core.

Anxious specialists watch the control panel of the power plant. Fueling required about six hours.





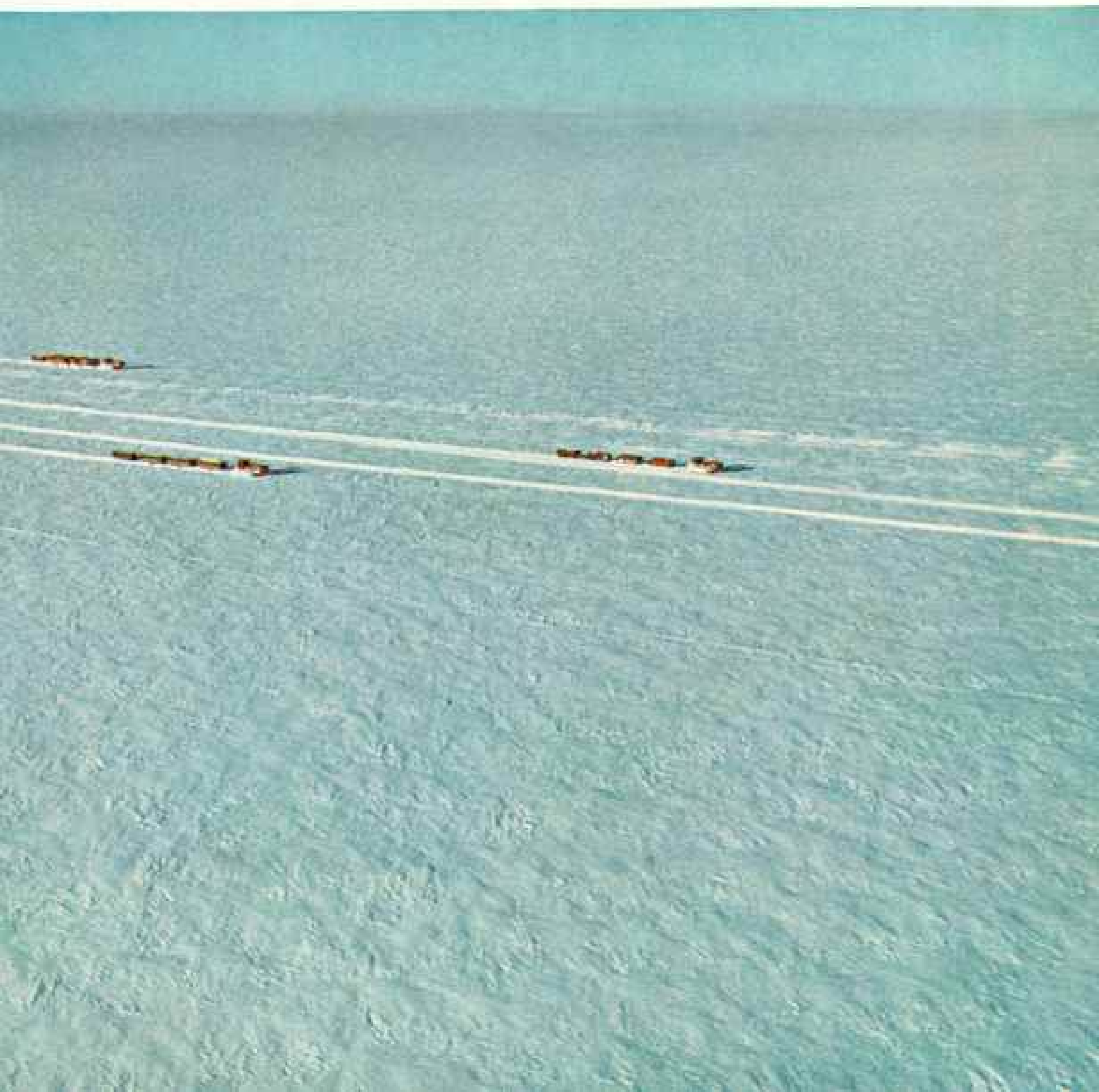
© NATURAL GEOGRAPHIC SOCIETY

Crewmen insert uranium fuel elements into the reactor vessel at the bottom of a tank containing deceptively clear water. Each hour Century's plant produces enough heat and light for 1,500 average American homes. Radioactive solid waste goes to the United States for disposal by the Army Chemical Corps.

**Coastal mountains** cradle the icecap that overlies four-fifths of Greenland. Hundreds of glaciers pour majestically from the ice into bays and fiords rimming the world's largest island.

**Arctic convoy**, a series of tractor trains known as a swing, averages three miles an hour between Thule and Century. Caterpillars with extrawide treads tow sledges laden with as much as 100 tons. Wanigans—trailers mounted on skis and fitted with bunks, mess halls, and showers—make up the command train (not shown).

720







In a NATIONAL GEOGRAPHIC article in 1959, I pointed out that it was costing some \$250,000 a year to heat and power the 18-man South Pole base alone. There is also a tremendous cost in human effort and ingenuity, and even human life. I said then, "I feel certain that the benefits of the controlled atom will be felt in Antarctica in the very near future."\*

The reactor powerhouses at Camp Century, in Greenland, and McMurdo and other Antarctic bases will bring more than savings in effort and money. They will mean increased time for exploration, mapping, geological investigation, and other scientific studies. Opening the way, Camp Century represents both a daring concept and an amazing feat of engineering.

I felt I had something of a personal stake in the Camp Century experiment. After retiring from the Navy, I had served as a consultant on polar problems for Alco Products, Incorporated, of Schenectady, N. Y., the company that built the camp's reactor.

On my trip to Camp Century I was accompanied by W. Robert Moore, Chief of the National Geographic's Foreign Editorial Staff, and by Whittie J. McCool—"Jack" to everyone—the supervisor of reactor experiments of Alco (formerly American Locomotive Company).

#### Sailing an Ocean of Snow and Ice

We flew to Century by way of Thule, the sprawling Greenland coastal air base where 7,000 Americans operate the largest United States installation in the Arctic.

From Thule our course took us up over the Greenland Icecap, high above a snow trail twisting around crevasses and pointing inland like an arthritic finger.

Land quickly disappeared, replaced by sastrugi—waves of snow sculptured by wind. Sometimes the vast expanse of snow, following the contours of buried mountains, looked like sand dunes of the Sahara. At other times the tips of mountains protruded from the icecap and built curving snowdrifts. These peaks reminded me of ships maneuvering at sea, with the drifts their foaming wakes.

We knew that the men of Century were still living atop the icecap in Jamesway huts, the wood-frame, canvas-sheathed shelters used in Antarctica too.

\* See "What We've Accomplished in Antarctica," by Rear Adm. George J. Dufek, NATIONAL GEOGRAPHIC, October, 1959.



PHOTOGRAPH BY DANIEL F. BYRNE © NATIONAL GEOGRAPHIC SOCIETY

Ice stalactites fringe a crevasse in the Greenland Icecap. Explorers who laid out the convoy route between Thule and Camp Century encountered dozens of dangerous ice canyons. Trailmakers dynamited such hazards and filled them in.

But the Army Engineers and their young camp commander, Capt. Thomas Evans, were preparing to move into the permanent Camp Century, the under-ice town where men could live in warmth and comfort only 886 miles from the North Pole.

Camp Century was so named because its projected site lay 100 trail miles from inland Camp Tuto near Thule. But a survey team, finding conditions at the site unsuitable, continued 38 miles farther to the present location, which met all requirements.

At the time of our visit, Century still depended for heat and power on supplies of diesel oil shipped from the United States to Thule by tanker and hauled to Century by tractor train. But the day was not far off when the oil deliveries would begin to dwindle, for PM-2A, Century's future source of power, was about to undergo its first test.

#### Snow Machine Takes Street-sized Bites

Capt. André Broumas, Century's executive officer and later its commander, was waiting for us at the airstrip in a tractorlike Weasel. Looking like overstuffed teddy bears in our arctic clothing, we clambered aboard and rumbled toward the hidden city a quarter of a mile away. We wouldn't have suspected that anything lay under the ice if we hadn't seen what resembled fat, round chimneys sticking above the snow (page 712).

"Escape hatches leading up from the tunnels," Captain Broumas explained. "There are 15 of these hatches, each with a ladder inside. In an emergency such as a fire, we could get to the surface without using the tunnel exits. Our present camp will be used as a temporary survival base, always kept stocked with emergency supplies and a radio."

The Weasel stopped by a ramp descending to a tunnel, and we gazed at a geyser of snow spouting from a nearby trench (page 725).

"That's the Peter Snow Miller digging a tunnel," said Broumas. "We bought three from the Swiss, who use them to keep roads open in the winter. In one slice that machine can cut a trench nine feet wide and four feet deep. Quite a timesaver when you're building a whole town under ice and snow."

We followed Broumas into the chill maw of an arched cave where several tractor-tread vehicles were parked, through a surprisingly large garage building, and finally through a door that opened on Main Street.

"Main" indeed! The tunnel, 18 feet wide and 23 feet high, extended four average city blocks, or 1,100 feet (page 726). A tractor

train clattered over the street's wood-beam surface, carrying various stores from the outer world. A working party in a Jeep stopped to examine a coil of fire hose on a wall.

"These hoses tap the camp's water-distribution system," Broumas said. "Inside the buildings we have a sprinkler system. A blaze could be disastrous."

I saw his point. One of the camp's problems is to keep the tunnels cold enough to prevent collapse. From air wells drilled in the underlying snow, fans draw air out of the snow itself and into the tunnels.

I was glad when Captain Broumas led us inside the modern buildings, all well-insulated prefabs. Lest their heat melt the snow, each structure stood on wooden blocks four feet above the tunnel floor and four feet from the nearest tunnel wall (page 727).

Here was the comfort I had dreamed of in the Antarctic. Each 76-foot-long barracks contained a recreation room and five 12-by-13-foot cubicles (page 725). They were warmed by electric heaters—for the moment still drawing current from diesel generators—with fans to circulate the air.

Outside again, my boots grew heavy—it was hard to breathe at the surface camp's 6,500-foot altitude. The tour finally ended, and after a good dinner we were assigned to our small rooms in the Jamesway huts. A sleeping bag never felt better.

#### Steam-drilled Wells Supply Camp

The next day Raul Rodriguez, a civilian Army engineer, was our guide. His specialty was the camp's ingenious water-supply system, which he helped develop and perfect.

At all other polar camps I had known, you got water by laboriously hauling snow and melting it with an oil-fired heater. Camp Century, however, uses live steam to dig its wells, and, with PM-2A now critical, produces steam economically from atomic energy, not oil. Rodriguez showed us a scaffold and pulley located in one of the tunnels.

"It's much like an old-fashioned well," he said, "but instead of a bucket we use two steam nozzles. The first melts down through the snow until we strike ice. Then we replace that nozzle with a second one, which contains a water pump and horizontal steam jets. They melt a bell-shaped chamber into the surrounding snow and slowly descend into the ice. From the resulting pool, water is pumped to the surface as required. So far we've drawn half a million gallons from this well and one like it at the temporary camp.



"As for sewage," he added, "we dump that into other wells, where it freezes."

My thoughts turned to the Antarctic once more. Our McMurdo Sound base sits on solid ground. In the winter plenty of snow lies near at hand, but men must collect it in weather sometimes as cold as  $-50^{\circ}$  F. In the summer, temperatures rise above freezing and the snow recedes to the hills, making collecting trips long and costly.

A solution there will be to use the abundant surplus heat of a nuclear power plant to distill sea water from McMurdo Sound. At the South Pole Station, on the other hand, we could use Camp Century's system, melting ice with steam pipes running from a nuclear power plant.

#### First Rule With Reactors: Safety

The big day arrived when we moved from the temporary camp into permanent, sub-surface Camp Century. The nuclear power plant was nearly complete; meanwhile diesel oil powered the generators.

It was a day of luxuries. After stowing my gear in the new quarters, I went next door to the showers, gazed fondly at the modern plumbing, and then stood for long minutes under a hot downpour. I confess I felt slightly guilty, knowing that every bit of fuel that made the shower possible had been pains-

takingly hauled 150 miles from Thule by tractor train. Perhaps the next occupant of the room would relax in the knowledge that *his* hot shower was the work of PM-2A, which now requires only 43 pounds of uranium-235 every two years to keep going.

At lunch that day, conversation turned to the reactor.

"Tomorrow we load the fuel elements," announced Maj. James W. Barnett, resident engineer and project officer for PM-2A.

That evening I sat in on a blackboard "chalk talk" that Jack McCool gave to his loading crew. He reviewed each detail in the placing of fuel elements in the reactor. For the first time I noticed a tense attitude in the men. A mistake or accident could result in a burst of killing radiation.

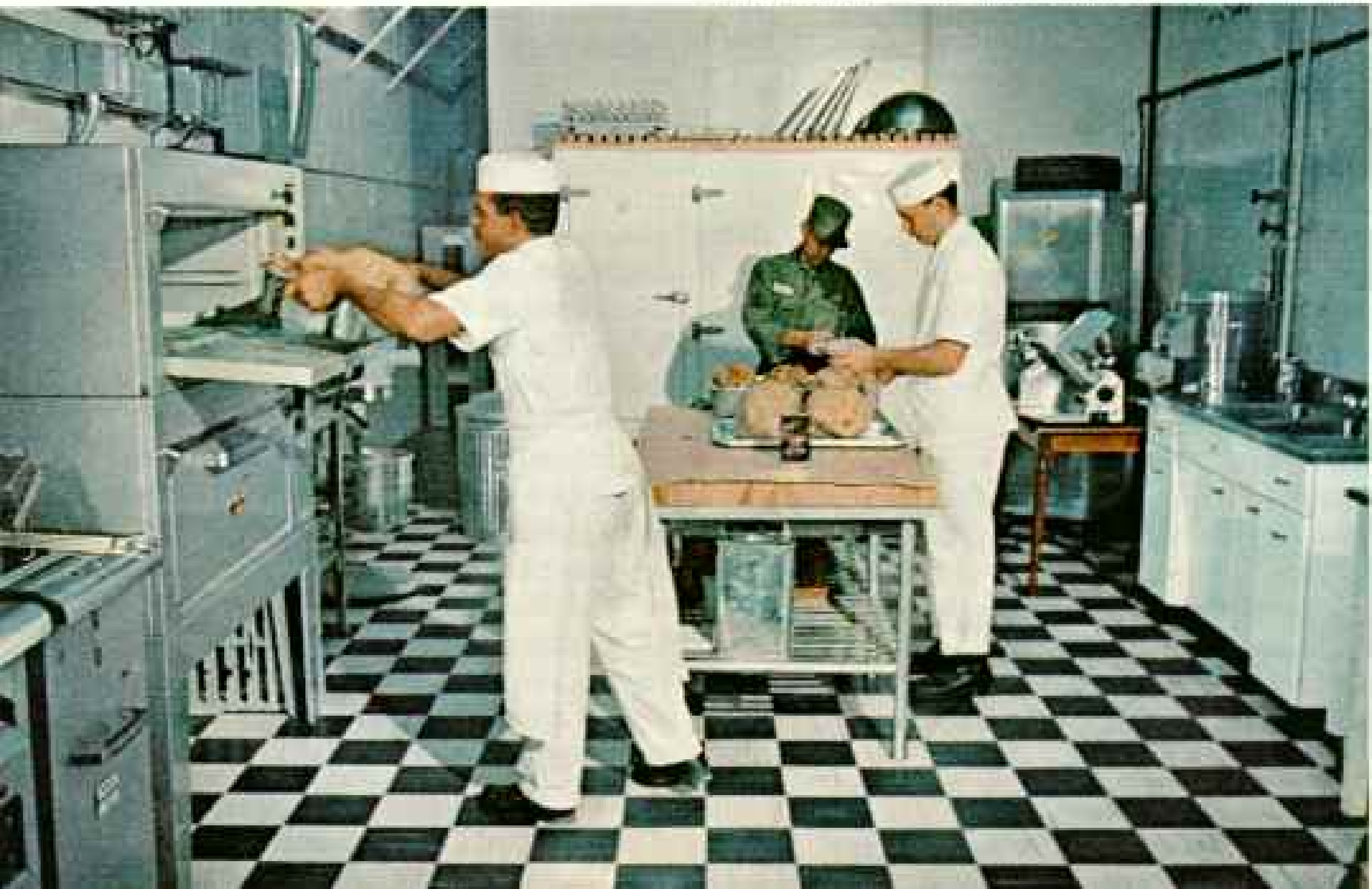
When I arrived at the reactor building next morning, the loading crew already had gathered. Gazing down into a pool of crystal-clear water—excellent shielding against radiation—I could see the stainless-steel vessel that would contain the reactor core—the assembly of fuel elements and control rods.

At the other end of the pool I saw a big latticelike rack. This would eventually store spent fuel. Today, as a test, it would be loaded briefly with the shiny new fuel elements, before they went into the reactor vessel.

The loading crew resembled a group of

Modern kitchen encased in age-old ice turns out enormous meals to satisfy the appetites of men working in cold. Frozen storage presents no problem: The icecap provides a free deep freeze. Here, cooks prepare a turkey dinner.

BY DETACHMENT BY W. ROBERT MOORE, NATIONAL GEOGRAPHIC STAFF © N.G.S.





HE ENTANGLED BY WHITIE J. MASON © R.S.B.

**Cut-and-cover technique** stemmed from several years of experiments in Greenland. Powerful Swiss plows called Peter Snow Millers cut trenches as deep as 35 feet and hundreds of feet long. Men roof the trenches with overlapping steel arches and spray snow onto the roof, where it solidifies.

Warm, well-lit quarters contrast with cold huts of early camps in the polar regions.

At Century on March 8, 1951, the U. S. Army Polar Research and Development Center became the first Army unit to operate its own portable nuclear power plant.





EXTRACHROME BY D. R. BUCHHEIT © N.A.S.

Lowered by a parachute harness, an engineer inspects Camp Century's ever-deepening well. Steam nozzles that gouged out the hole melted a pool from which the base draws an average 10,000 gallons of water a day.

### Sub-freezing Cold Keeps Walls and Ceilings From Melting

This view looks into Main Street from the lighted slope heading into the tunnel. On side tunnels, suction fans pull in fresh, snow-cooled air; warm air escapes through roof vents. Electrically heated pipes carry sewage to an outfall beyond the camp, where it is dumped into a shaft and eventually freezes.

surgeons dressed for an operation. They wore rubber gloves, long coats, cloth helmets, and shoe covers of canvas with plastic soles. All this was necessary to prevent dirt, hair, or dandruff from falling into the pool's pure, filtered water.

Those who wore eye glasses had them taped to their heads, and each man had emptied his pockets of coins, fountain pens, and combs. Any of these could foul a water pump or the reactor's controls.

New, unused fuel elements are not dangerous to handle, but great care must be taken not to scar or abrade their 0.005-inch-thick metal covering. One man lifted an element from its steel carrying drum, placed it gin-

EXTRACHROME BY WHITTE L. MIDDLE © N.A.S.





gerly on a table, and removed the protective plastic wrapping (page 717). Another crew member attached a long metal handling tool to the fuel element. Tool and element were then carefully lowered into the protective tank of water until the fuel dropped gently into position in the rack.

As loading continued, crewmen reported to the control room by two-way loudspeaker.

"Control, we are in loading sequence number 21. Inserting fuel element number 32-S into spent fuel lattice position 32."

"Control, roger. Your BF-3 count rate is increasing slowly and variably: 60...65...70...65...70...75...counts per second."

The BF-3 count rate was in direct proportion to the low rate of nuclear fission in the fuel stored inside the spent fuel rack. In an ill-designed rack, even spent fuel can resume a chain reaction. The low count from the new fuel proved that the design was sound.

The test was a long process. Not until 10:30 at night were all the fuel elements in place in the rack. Then began the second phase, underwater transfer of fuel elements into the reactor core.

There was one particularly bad moment about 2:15 in the morning, when a technician spotted what seemed to be a dime on the reactor's stainless-steel core support structure.

How it got there no one knew, and all attempts to dislodge it failed. After two agonizing hours, Jack McCool peered intently through the water and announced with a grin: "That's

no dime, it's an abrasion!" Everyone sighed.

The structure, probably scratched in its long journey by ship and tractor train from the United States to Camp Century, was tough and durable. The mark was unimportant on a non-nuclear surface.

Fueling recommenced. Finally at 4:55 a.m.—more than 18 hours after the job began—the welcome message came from control.

"We know you boys are dead tired, but there's something we want you to see. Put the cover on the core, and then come watch PM-2A go critical."

We all went up to control and gathered around the instrument console (page 718).

Methodically pushing a series of buttons,

BY ILLUSTRATION BY W. ROBERT MOORE, NATIONAL GEOGRAPHIC STAFF © N.G.S.



**Barrack lights** cast a welcome glow in a dark and frosty tunnel. Numbered plywood panels fit together so easily that Century's construction crew put up a prefabricated building a day. Each of these barracks includes a small lounge.



**Ice Age meets the Atomic Age in Antarctica.** On December 14, 1961, the U. S. Navy supply ship *Arneb* steamed into ice-locked McMurdo Sound carrying a prefabricated nuclear power plant and an atom-powered automatic weather station. The two systems arrived 50 years to the day after Roald Amundsen became the first man to reach the South Pole. Caterpillars unloading *Arneb*'s heavy cargo swing out in a seven-mile arc across thick ice to reach McMurdo by circling Observation Hill, at right.

Antarctica's first nuclear reactor, like Camp Century's a 1,500-kilowatt plant, occupies a site leveled by Navy Seabees on the flank of Observation Hill. Beyond stretch the buildings and streets of McMurdo, Antarctica's largest base.

a technician raised the neutron-absorbing control rods that held the reactor in leash. First he eased them up half an inch at a time, then a quarter of an inch . . . a tenth. Gauges showed increasing fission activity; the BF-3 counter sounded like a flock of chickens eating corn from a hardwood floor.

"If a uranium prospector heard that noise," a technician said, "he'd think he'd found a fortune."

"There *is* a \$340,000 fortune in fuel in that reactor—enough to heat and power the camp for about two years," Jim Leslie said.

Needles crawled upward, wavered, then surged upward again.

"She's critical!" Leslie, head of reactor operations at Alco, announced. He immedi-



FORNIFORMS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ALBERT MOLDAV © N.G.S.

ately glanced at his watch. "It's 6:52 a.m."

The control room echoed to cheers, and the first smiles in 24 hours spread across tired faces. It was done—Camp Century had its reactor. This was just a test, and there would be many more. But with each trial, the day would come closer when this outpost under the polar ice would depend for its existence on the harnessed atom.

A new chapter in man's conquest of the Arctic had begun. The date: October 2, 1960.

A few days later we said goodbye to Camp Century and began the flight homeward. My thoughts were all with the things I had seen in that remarkable city under the ice.

Now that man has learned to live comfortably in the polar wastes, many developments

may follow. For example, Canadians have indications that the largest oil reservoir in North America may lie beneath their Arctic Archipelago.

United States oil tankers plodding along to our northern military bases would be sitting ducks for enemy submarines. If we had stations modeled after Century, U. S. dependence on such convoys would be cut sharply.

To my mind the greatest potential for nuclear power projects may lie in the Antarctic. For some time to come the principal export of that vast polar continent will be scientific knowledge; yet Antarctica may one day pay off in hard cash.

It may contain large amounts of valuable minerals. Antarctica is, of course, a land mass.



Tropical vegetation once flourished there, and promising deposits of coal have been found. We have also discovered traces of gold, silver, copper, manganese, tin, lead, and other minerals. There may be uranium. Perhaps we will find some mineral whose use is not even known today.

When a rich strike is made, nuclear power will make commercial mining feasible.

In a few years commercial planes may be flying across the Antarctic, eliminating a third of the time and distance between points of the Southern Hemisphere. The United States Navy has surveyed an ice-free site for a possible jet airport at Marble Point near McMurdo. Spectacularly scenic, the area would make a magnificently rewarding stopover for international travelers.

In 40 years, scientists say, the world's population of three billion will have doubled, and the Southern Hemisphere, now with a relatively sparse population, will gain in importance. We should plan for this, not shrug

and say the Antarctic is far away. So were Alaska and the lands of the Louisiana Purchase years ago.

Scientists are fascinated by the food potential of the little Antarctic krill, a crustacean the size of a small shrimp that exists by the billions in South Polar waters and may one day help to feed a hungry world.

#### Weather Reports From Atomic Stations

Also, consider weather. The first automatic nuclear-powered weather station is now on the air at Axel Heiberg Island, north of the Canadian mainland. Every three hours the station transmits data on temperatures, winds, and barometric pressures. A network of such stations in the Antarctic could provide priceless information about the effect of that continent on half the world's weather.

The list is endless. Both polar regions hold promise for mankind. And nuclear power could help to fulfill that promise much sooner than any of us have imagined. THE END

**Peter Snow Miller whips up a miniature blizzard at the new Byrd Station, Antarctica, where a U. S. Navy task force has built a Century-like city. Designed to keep Alpine passes open in winter, the Swiss machine digs a 300-foot-long gash 9 feet wide and 4 feet deep in less than an hour. Experts can hold it to a tolerance of half an inch.**

730



# NATIONAL GEOGRAPHIC Society

16th & M Streets N.W.

Washington 6, D. C.



National  
Geographic  
Magazine

ORGANIZED IN 1888 "FOR THE INCREASE AND DIFFUSION OF GEOGRAPHIC KNOWLEDGE"

The National Geographic Society is chartered in Washington, D. C., in accordance with the laws of the United States, as a nonprofit scientific and educational organization for increasing and diffusing geographic knowledge and promoting research and exploration.

The Society has conducted more than 180 expeditions and scientific projects. It disseminates knowledge to millions through its world-famous National Geographic, its 21 million color maps a year, its books, monographs, bulletins for schools, its information service for press, radio, and television.

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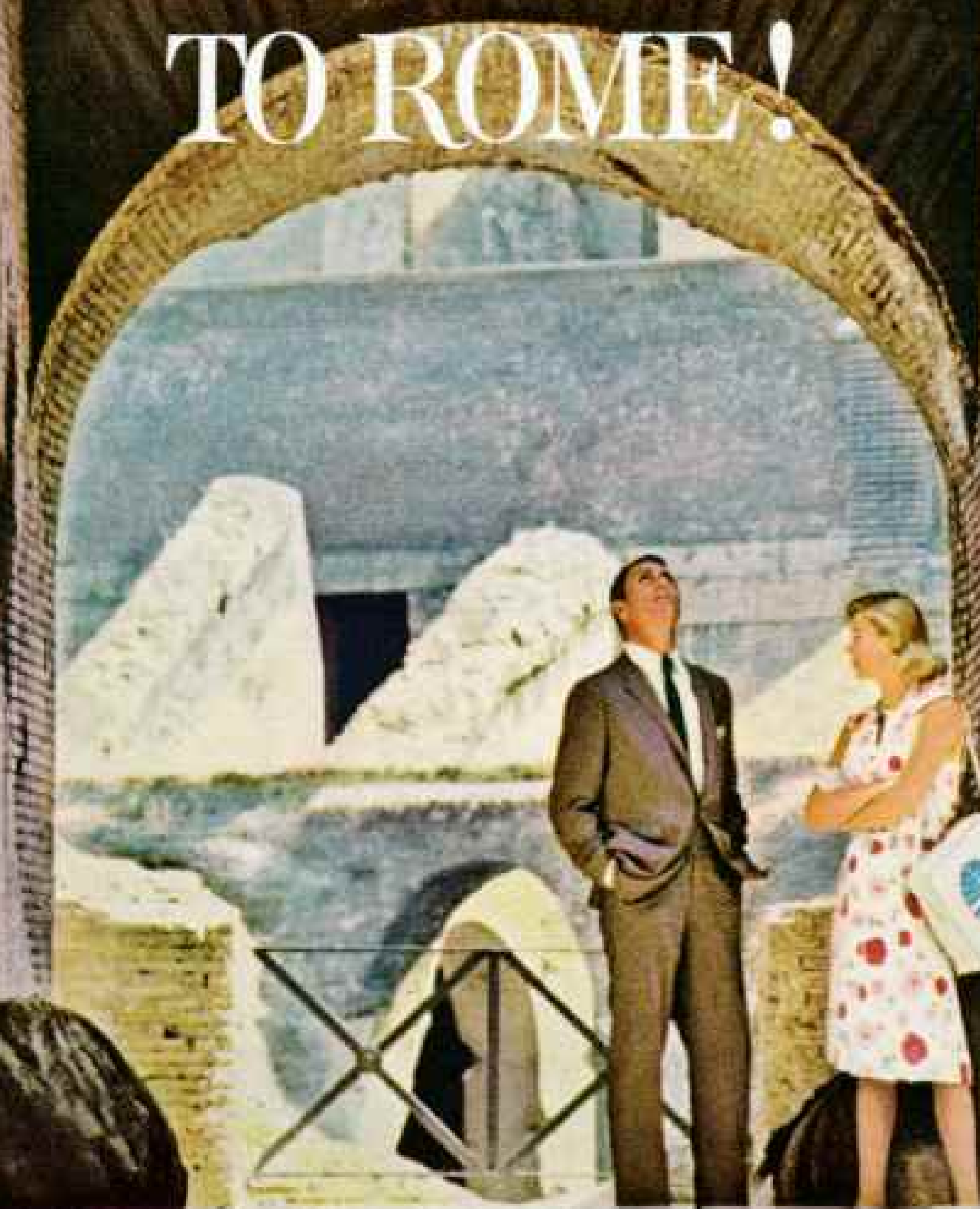


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## History preserved in Antarctica's icy grip

At Cape Evans, Antarctica, the cabin and supplies of the gallant British explorer Robert Falcon Scott look as if he had left them only yesterday. So reports NATIONAL GEOGRAPHIC photographer Albert Moldvay, here recalling one of the epics of exploration as he sits amid packing cases of oil and gasoline for Scott's ill-fated expedition of half a century ago.

Gasoline? In Antarctica? Shipped there in 1910? Yes, for Scott was experimenting with motor-driven sledges as well as using dogs and sturdy ponies. In the end, he and four companions fought their way to the

Pole afoot, reaching it on January 18, 1912 —only to find that the Norwegian explorer Roald Amundsen, with dog teams, had beaten them by 35 days. Scott and the members of his party all perished on the way back.

A forthcoming GEOGRAPHIC will bring up to date the story of man's unrelenting assault on Antarctica in an article by Rear Adm. David M. Tyree, Commander, U. S. Naval Support Forces, Antarctica, with illustrations from Al Moldvay's alert camera.

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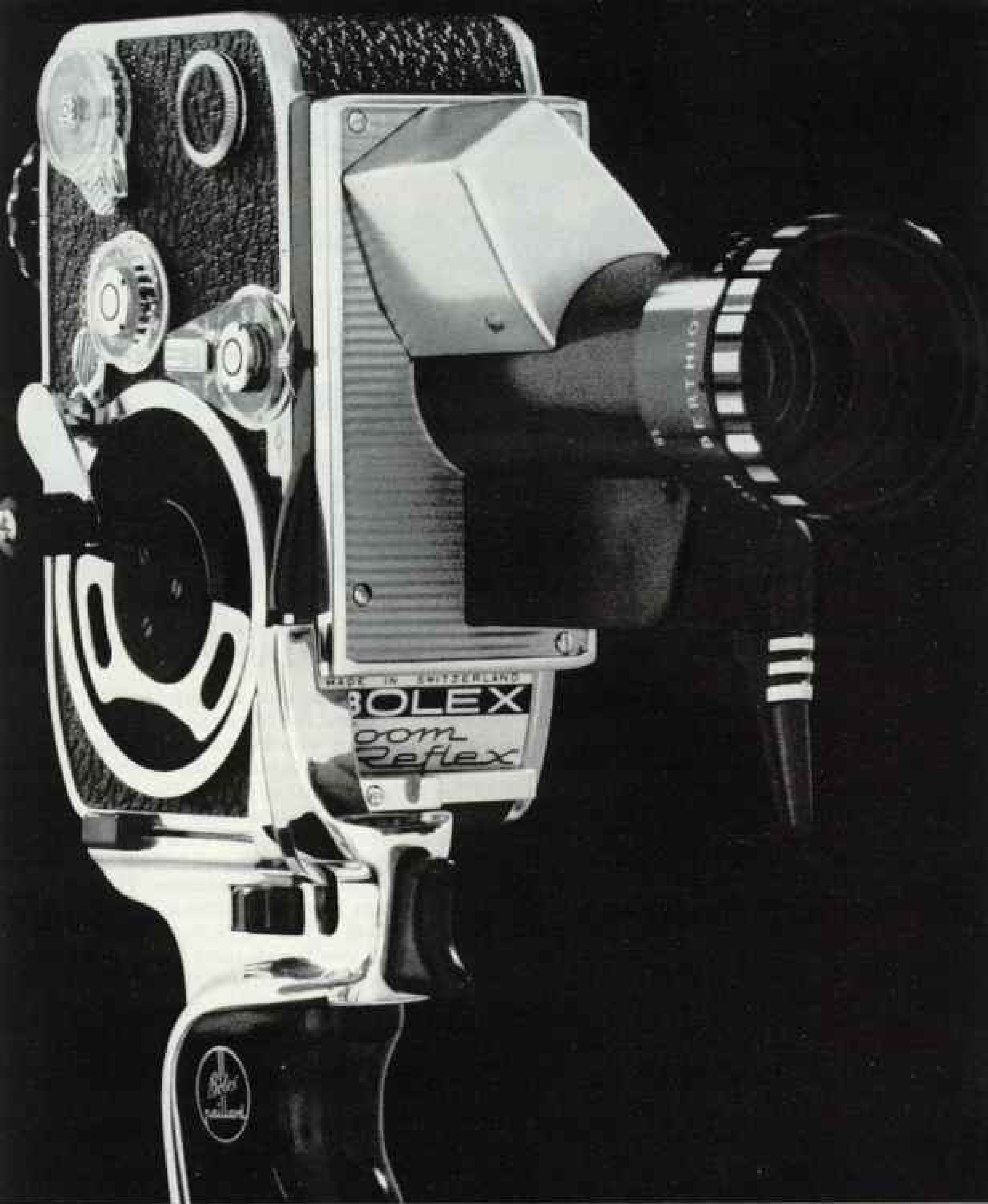
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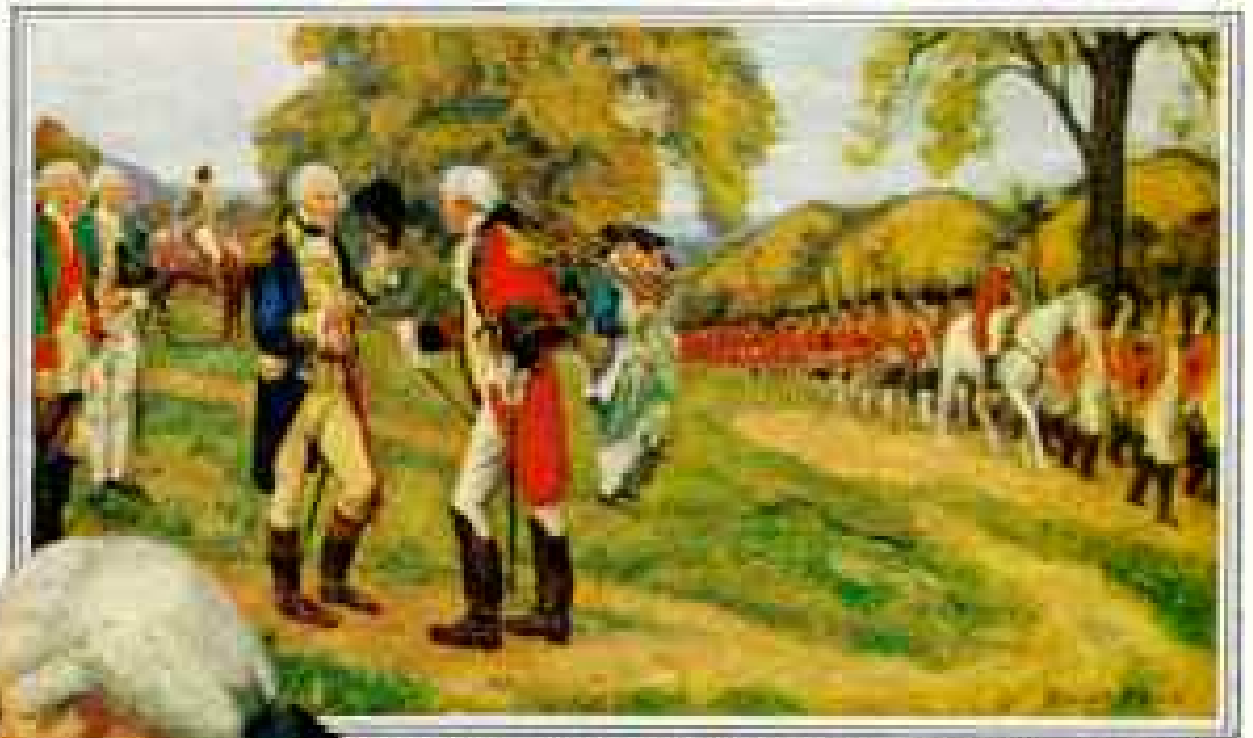
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British General Burgoyne presents his sword to victorious American General Gates at Saratoga, October, 1777. Painting by H. E. Smith.



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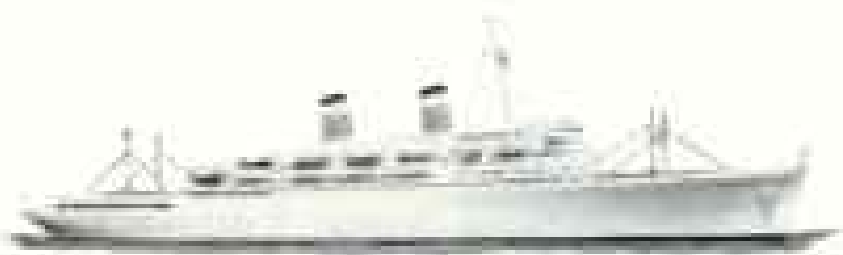
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Here's the big new Dodge with hardtop wagons priced from \$3,292.\* Custom made for the big car man, this 880 wagon is the roomiest Dodge of them all. It gives you 91 cubic ft. of cargo space, over 8 ft. of cargo length back of the seats.



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Lancer wagons are priced from \$2,306.\* They come in two series, the low priced 170 and the deluxe 770. Either way, you get a wagon that cruises at turnpike speeds, yet uses gas sparingly, as a compact should. There are two things you don't get: squeaks and rattles. The reason is Chrysler Corporation's Unibody Construction.

\*Manufacturer's list price exclusive of destination charges. White steel wall tires, wheel covers and luggage rack optional, extra.

# Chrysler Corporation

*Where engineering puts something extra into every car*

DODGE ■ DART ■ LANCER ■ CHRYSLER ■ IMPERIAL ■ DODGE TRUCKS  
SPACE DIVISION ■ MOPAR ■ AIRTEMP ■ CYCLEWELD ■ MARINE AND INDUSTRIAL ENGINES ■





Cuzco, ancient Inca capital of Peru



Famed Sugar Loaf watches over Rio

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A round trip to South America really means 'round' when you fly the Jets of Pan Am® and Panagra. It's the *only* airline system that can fly you down one coast to Buenos Aires and back the other. You see the *whole* continent for the price of a round trip to Buenos Aires! From Copacabana Beach to the high Andes . . . every day is a new adventure! South America abounds with breath-taking scenery and deluxe hotels. You find gracious service everywhere. Enjoy all-year Jet Economy fares: for example, New York to Buenos Aires, as low as \$599 round trip. Start on either coast . . . see the West Coast of South America by Panagra Jets, the East Coast by Pan Am Jets. Leave the U.S. from any of 7 gateway cities. Call your Travel Agent or Pan American.



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**THE TIRE THAT GIVES YOU A SECOND CHANCE  
(THERE'S A SECOND TIRE INSIDE)**

Captive-Air Double Eagle doesn't go flat. Because it's actually two tires in one. ■ Chances are nothing will ever damage the outer tire — the famous Goodyear Double Eagle. Giant cords make it 70% stronger than an ordinary tire. ■ Yet, if the improbable happens, you get another chance. Because, inside there's a second tire to protect you — an "inner spare."

that's made of nylon-and-steel cord that carries the load for up to 100 miles, until you or your wife can conveniently stop for service. There's no more fear of blowouts, and no more worry about flats. ■ Beyond question, Captive-Air

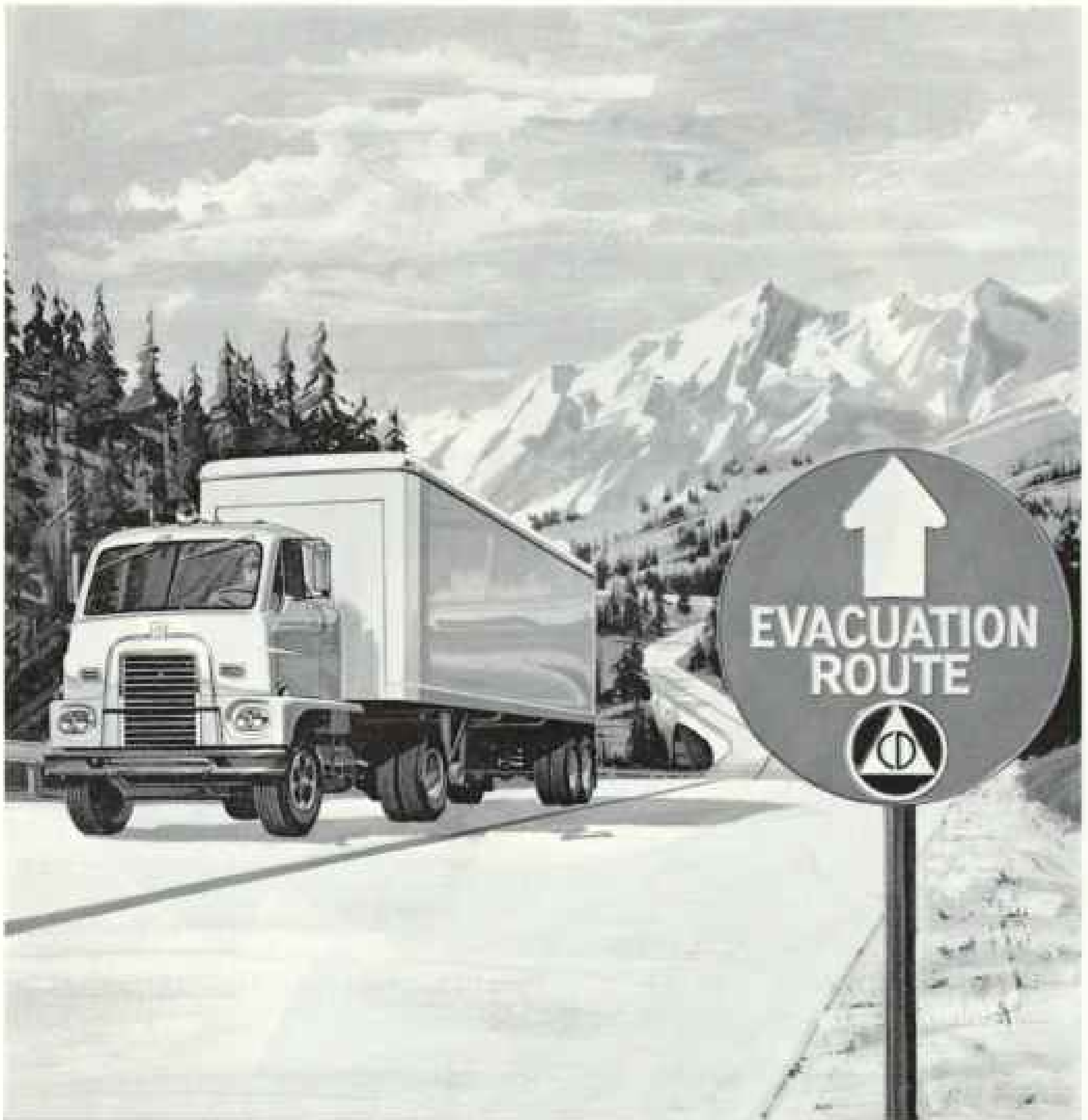
Double Eagle is the safest tire that man can make and money can buy. And surprisingly, it costs no more than other premium tires.

**GOOD YEAR**

MORE PEOPLE RIDE ON GOODYEAR TIRES THAN ON ANY OTHER MAKE

Double Eagle, Captive-Air, T. M.'s, The Goodyear Tire & Rubber Company, Akron 25, Ohio.

*Trucklines are America's lifelines*

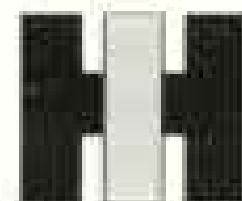


## There's one job trucks don't want

If there were a national emergency tomorrow, trucks might become the only means to keep America rolling. Naturally the trucking industry hopes that no such emergency will ever arise. But the readiness of trucks and truckers for a job they don't want is one of our great national resources today. ■

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East: Earrings \$9 Necklaces \$8.50 Heart Brooch \$9 Circle Brooch \$8 Necklaces \$10 Earrings \$13 Brooch \$11.50

Center, reading down:

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Right, reading down:

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is you at the Hammond



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← *four feet long* →

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THE BALSCOPE TEN  
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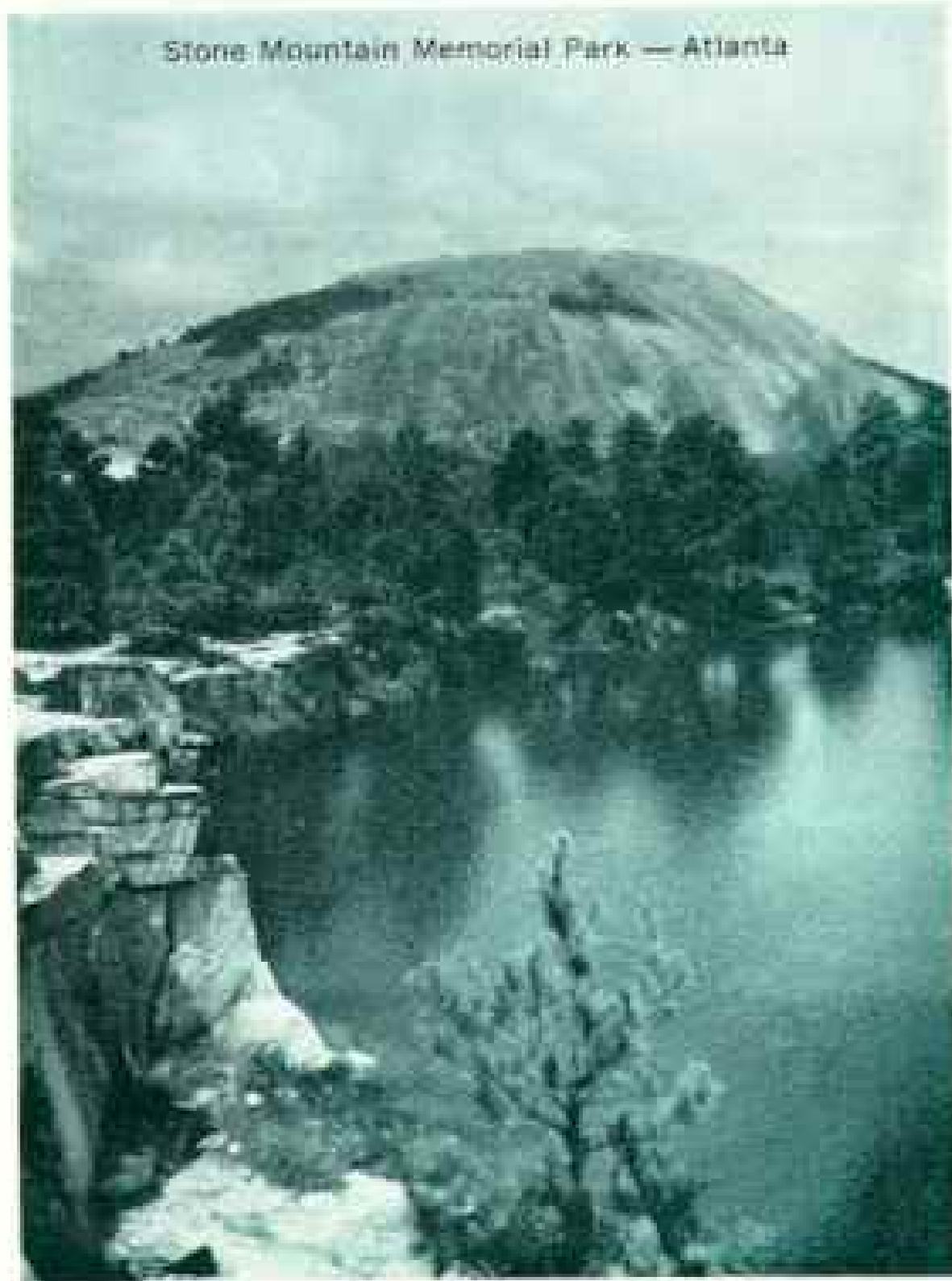
Enjoy true flavor in foods with Adolph's Salt Substitute. It looks, sprinkles, seasons like salt. Also try Adolph's new Seasoned Salt Substitute—an exciting blend of ingredients including herbs and spices. Both kinds are dietetically sodium free.

**Adolph's**



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Write for  
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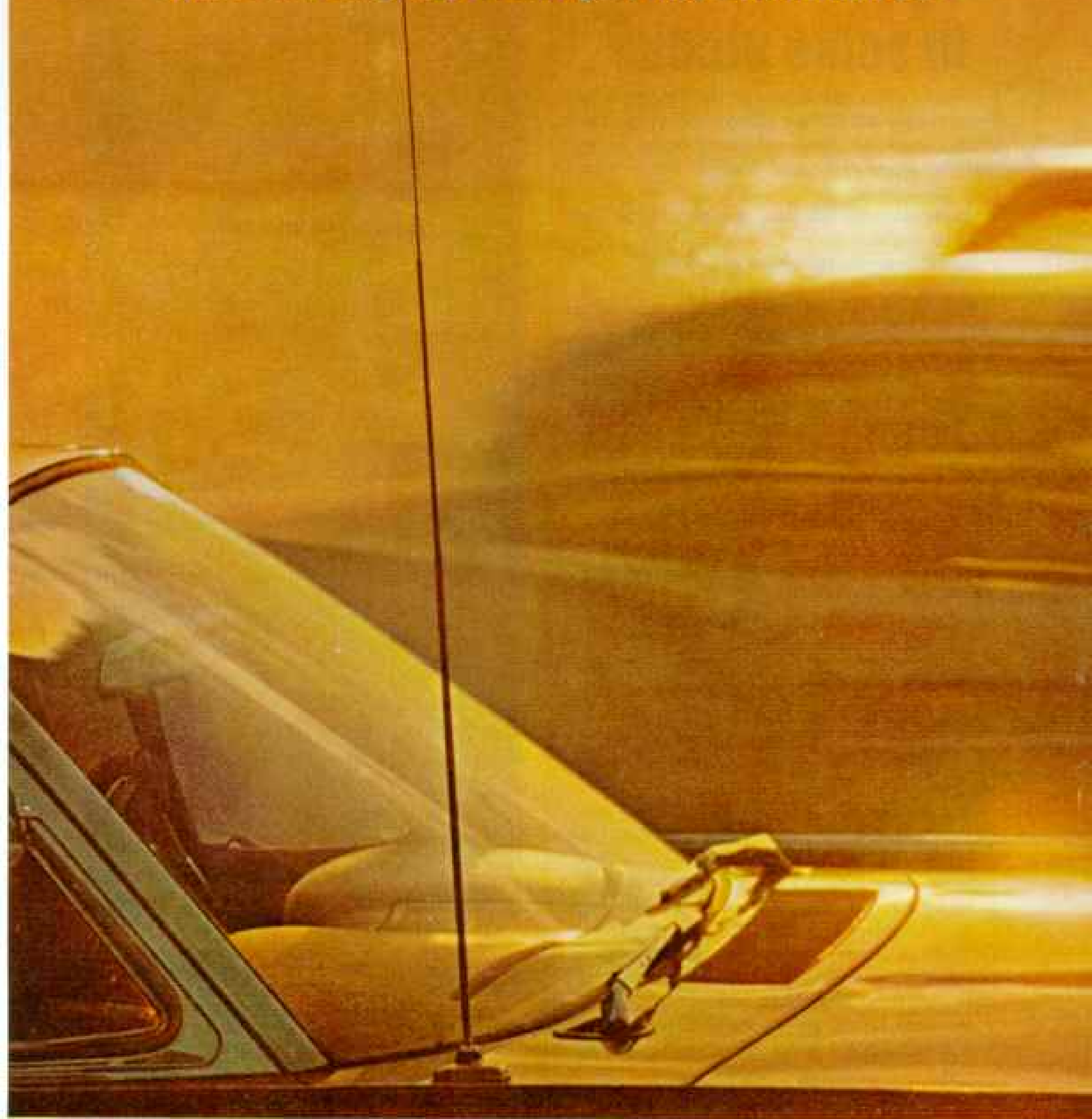
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PRODUCTS OF  MOTOR COMPANY

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# Do you have a loss in some stock?

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Sometimes we tell these people to hold on to their stock.

Sometimes we tell them to sell it.

Why?

Because every such question is a case unto itself . . . Because, basically, each one boils down to a brand new problem of investing.

But given a man's objectives, given the sum he could realize from the sale, the problem becomes one of comparing the prospects for the stock he owns with the outlook for all other stocks suitable to his investment objective.

A fair-sized job, true.

It involves ready access to any number of facts about sales and earnings, about policies, products, and plans . . .

Relative comparison of performance, both past and present . . .

Careful consideration of company managements, industry prospects, business in general, the world situation as a whole.

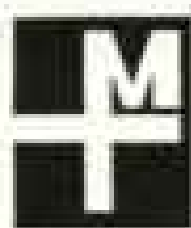
The average investor just doesn't have that much information—not on hundreds of stocks anyway.

But we have a Research Department—one of the biggest and best in the business—that does have that kind of data at hand, and their opinion about selling (or buying) any security is yours for the asking.

And while you're about it, you might like to have a current review of your complete portfolio, a detailed analysis based on your own particular objectives.

We will be happy to furnish that, too, if you'll just write—

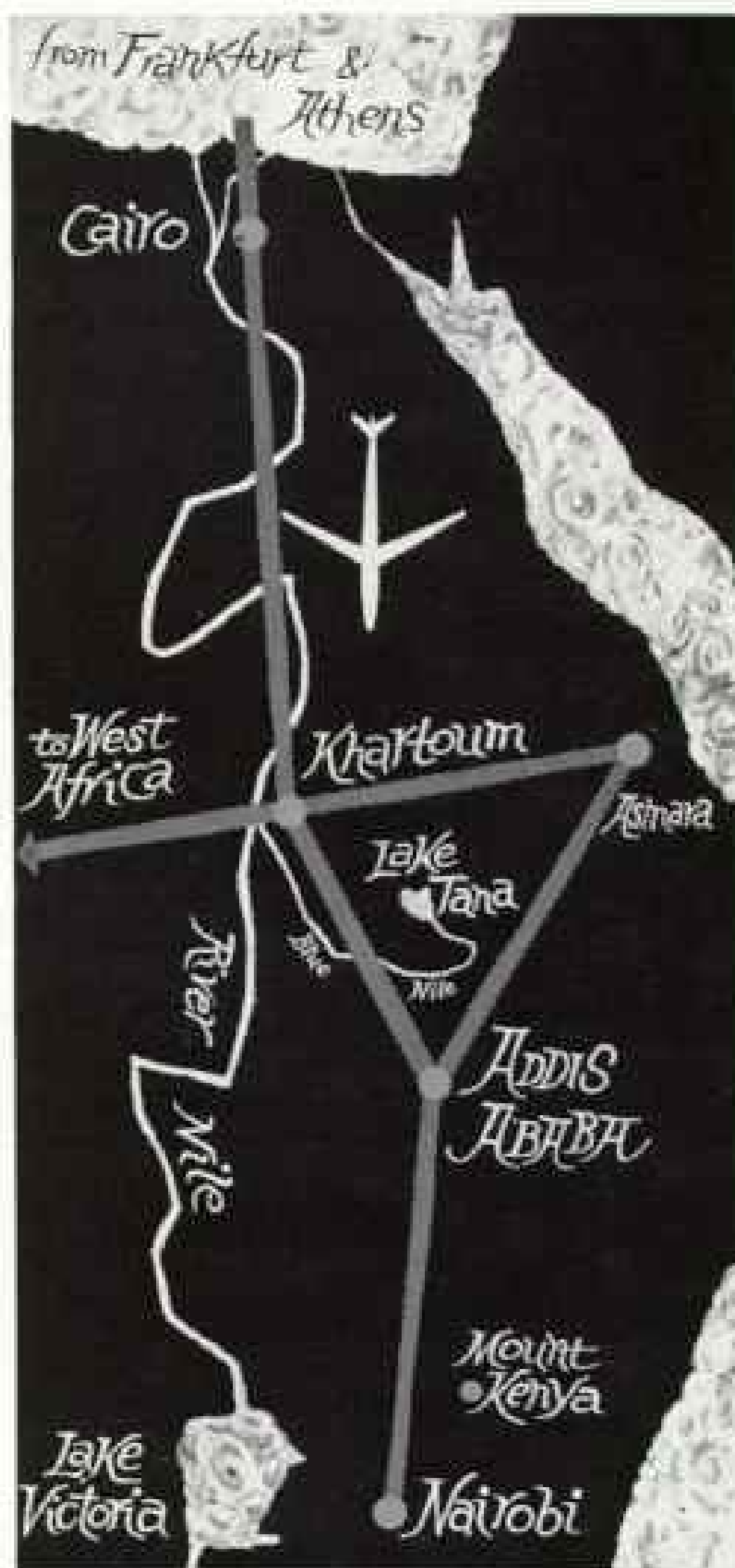
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All the enjoyment of hearing again is yours when you discover the Sonotone "Wisp" Hearing Aid. It amplifies a full range of sounds with amazing clarity.

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## ghost-hunting?

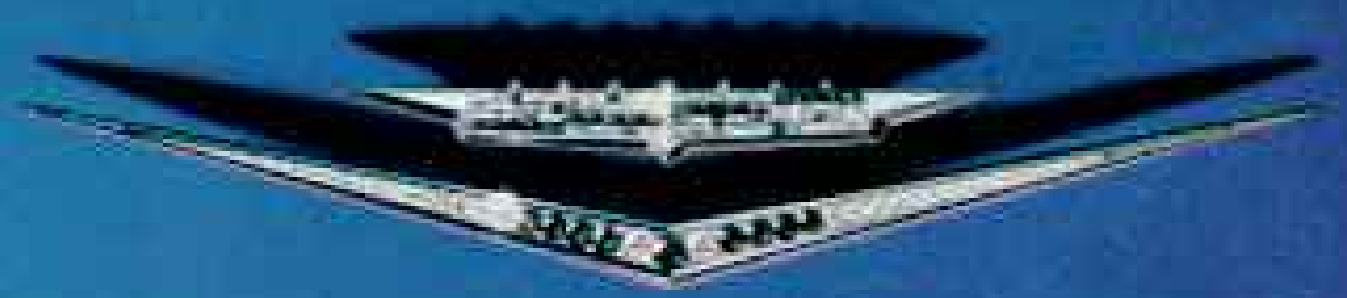
Step into the enchanted past of Charleston's plantation river gardens. Stand before the Constitution sideboard at Fort Hill. Read on the tombstones in Alston Cemetery, the fate of beautiful Theodosia Burr. Hear the muffled thunder of Marion and his Men across the bridge at Black Mingo. Recall your favorite ghost in

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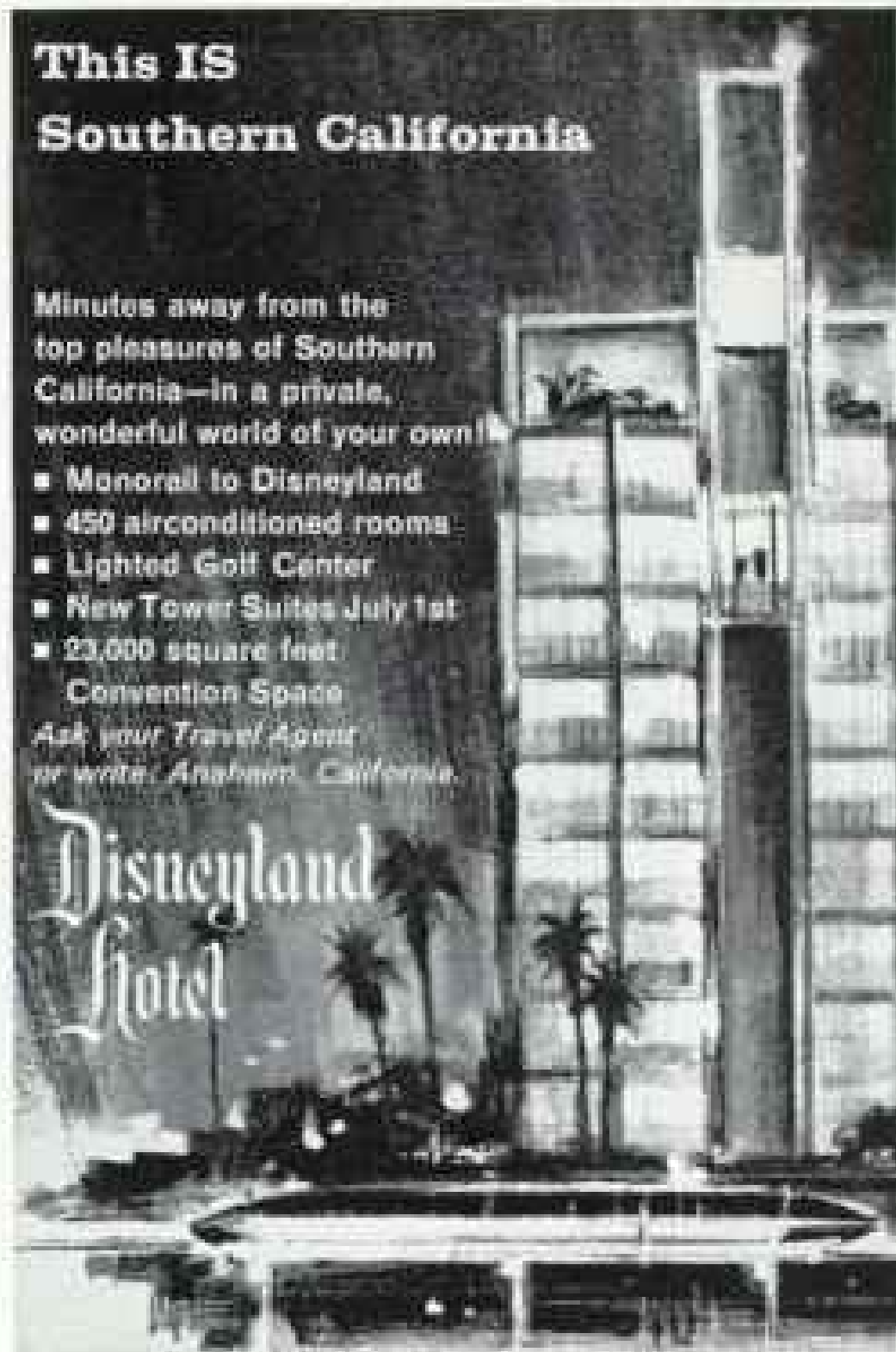
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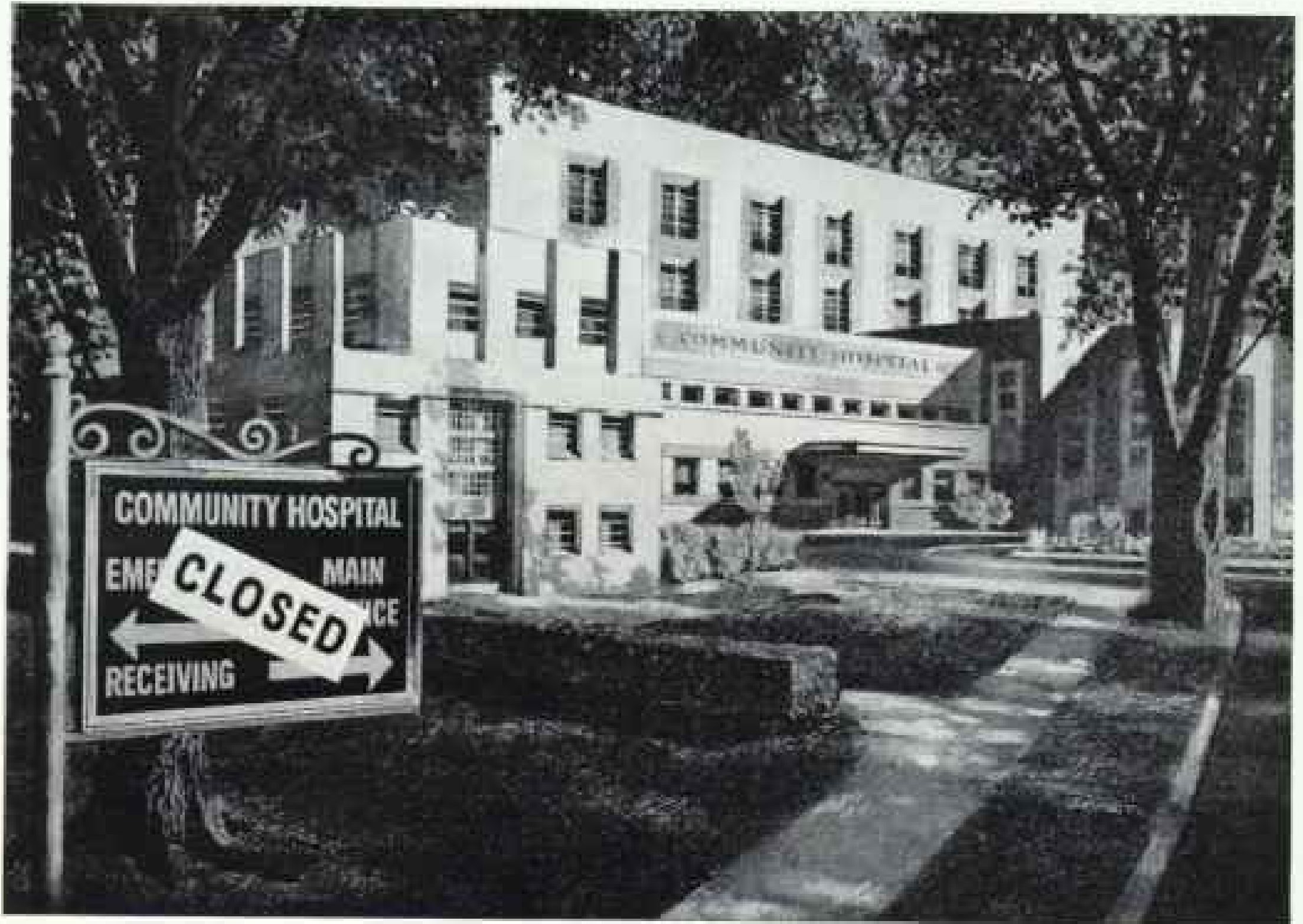
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Preference: N. J. Shore  N. J. Lake Country



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Shocking thought—a community without a hospital!

Consider some situations in which the hospital often makes the difference between life or death:

- a young child swallows a poisonous substance and becomes critically ill;
- a driver is seriously hurt in a traffic accident;
- a man is suddenly stricken with a heart attack on his way to work.

Where but in the hospital would *everything* be ready to help save these lives and others—the skilled services of doctors, nurses and their co-workers; the latest facilities to speed the sick, injured and disabled along the way to recovery?

*Our hospitals now admit over 23 million patients a year—evidence of the vital role which hospitals play in our lives. The hospital stands ready to help when you have ailments which cannot be treated properly by your physician in his office or in your home.*

During National Hospital Week—May 6-12—you have been invited to visit your hospital. Accept this invitation. Observe its work. Find out how you, as a volunteer, can help make it an even better hospital.

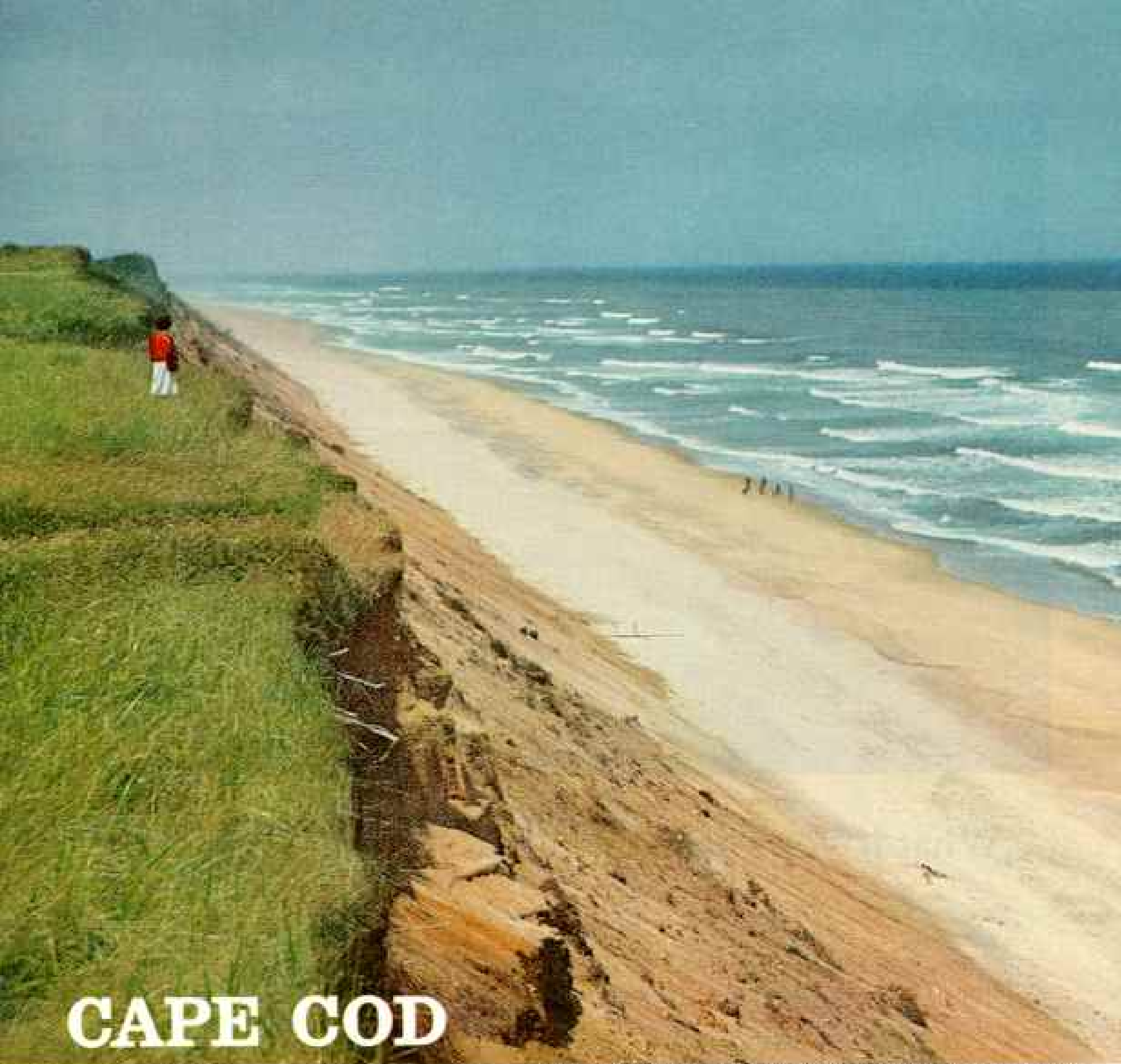
The welfare of our hospitals is the responsibility of all of us—not just the concern of a few individuals in the community. With your support, your hospital need never close its doors.

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*Dunes at Nauset Beach, Cape Cod National Seashore, Massachusetts*

to know its magic beauty, hold a seashell to your ear

Henry David Thoreau thought Cape Cod so beautiful he wrote a book about it. Because he wanted readers to know the music of the waves on this lovely beach, he invented the "talking-book" — by asking his readers to hold a conch-shell with its "sea-sounds" to their ears.

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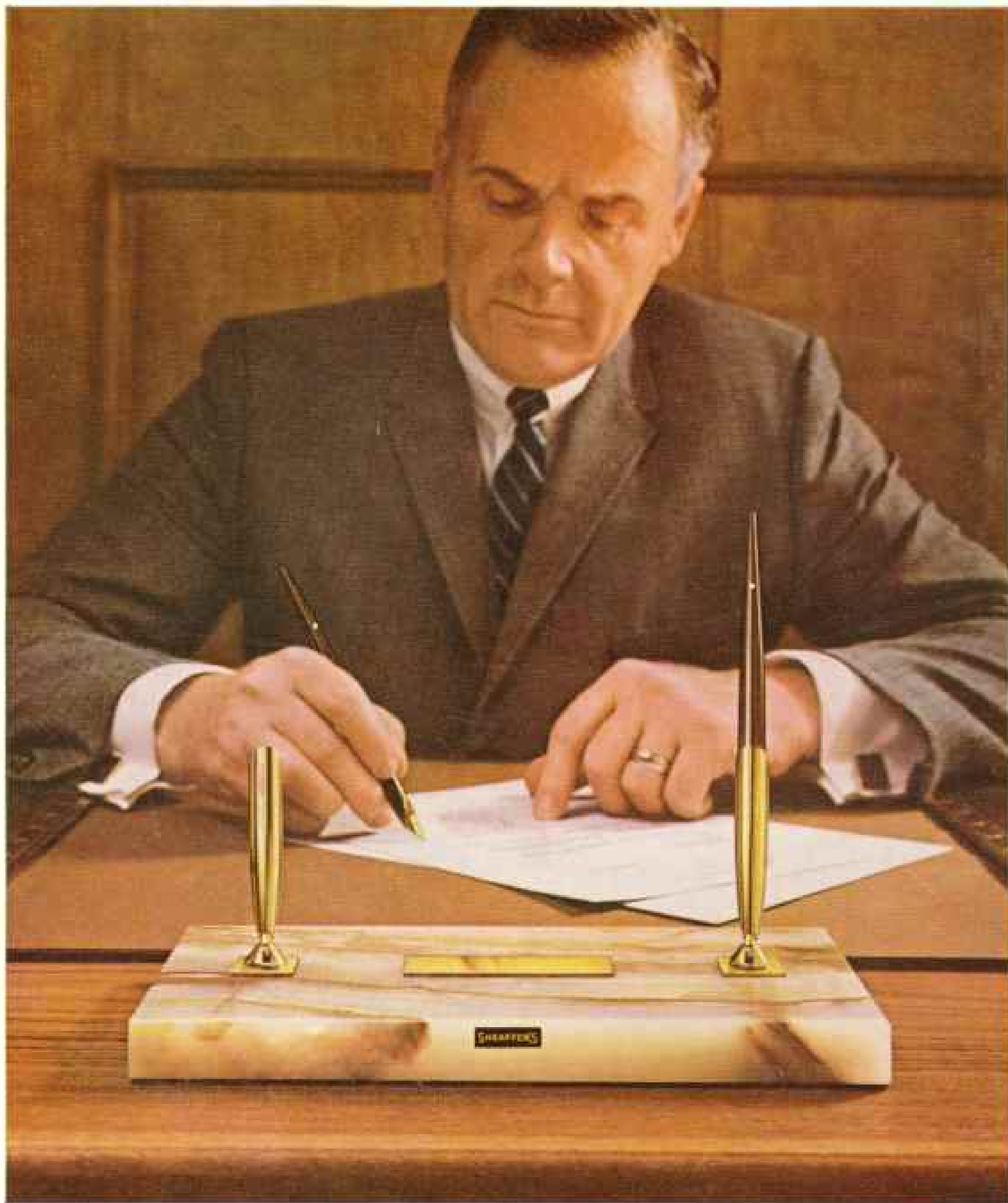
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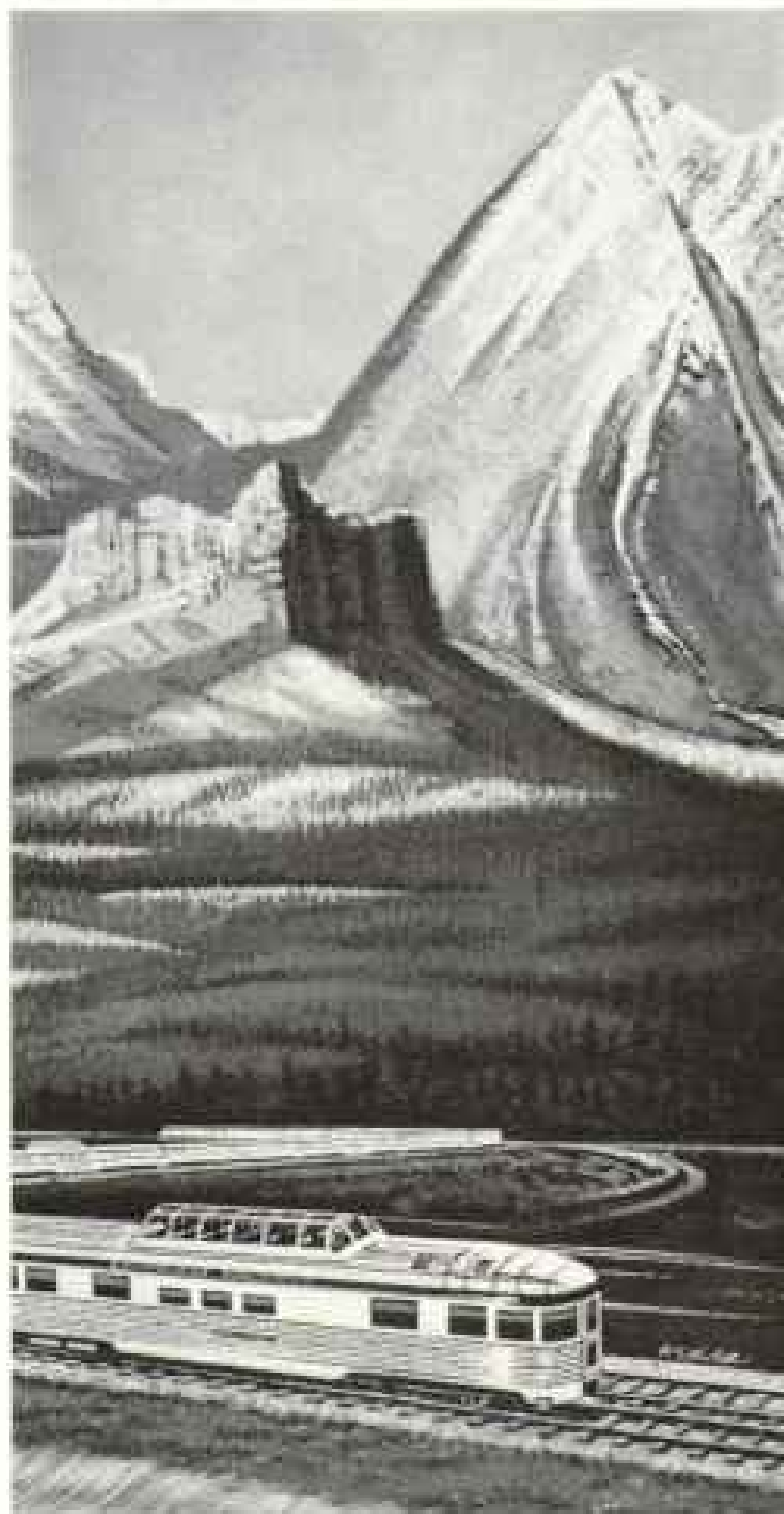
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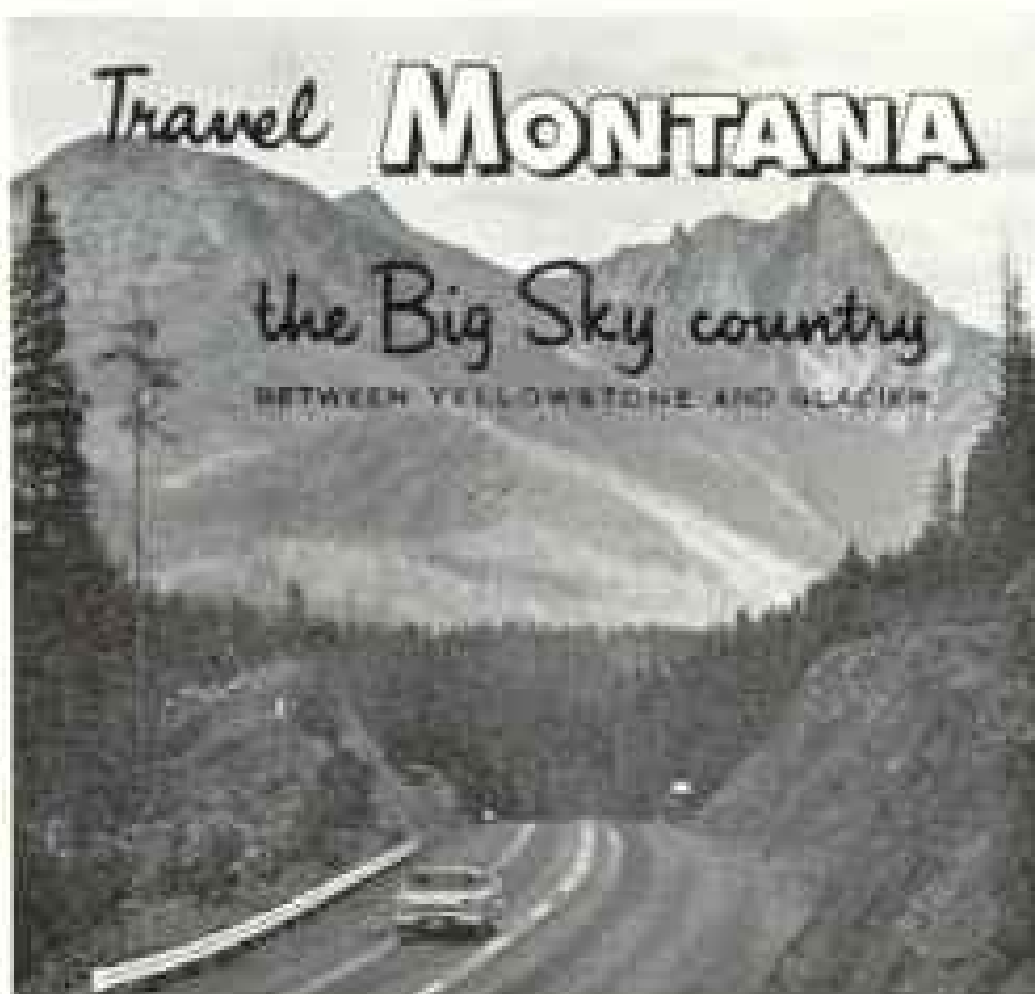
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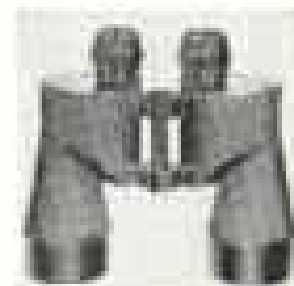


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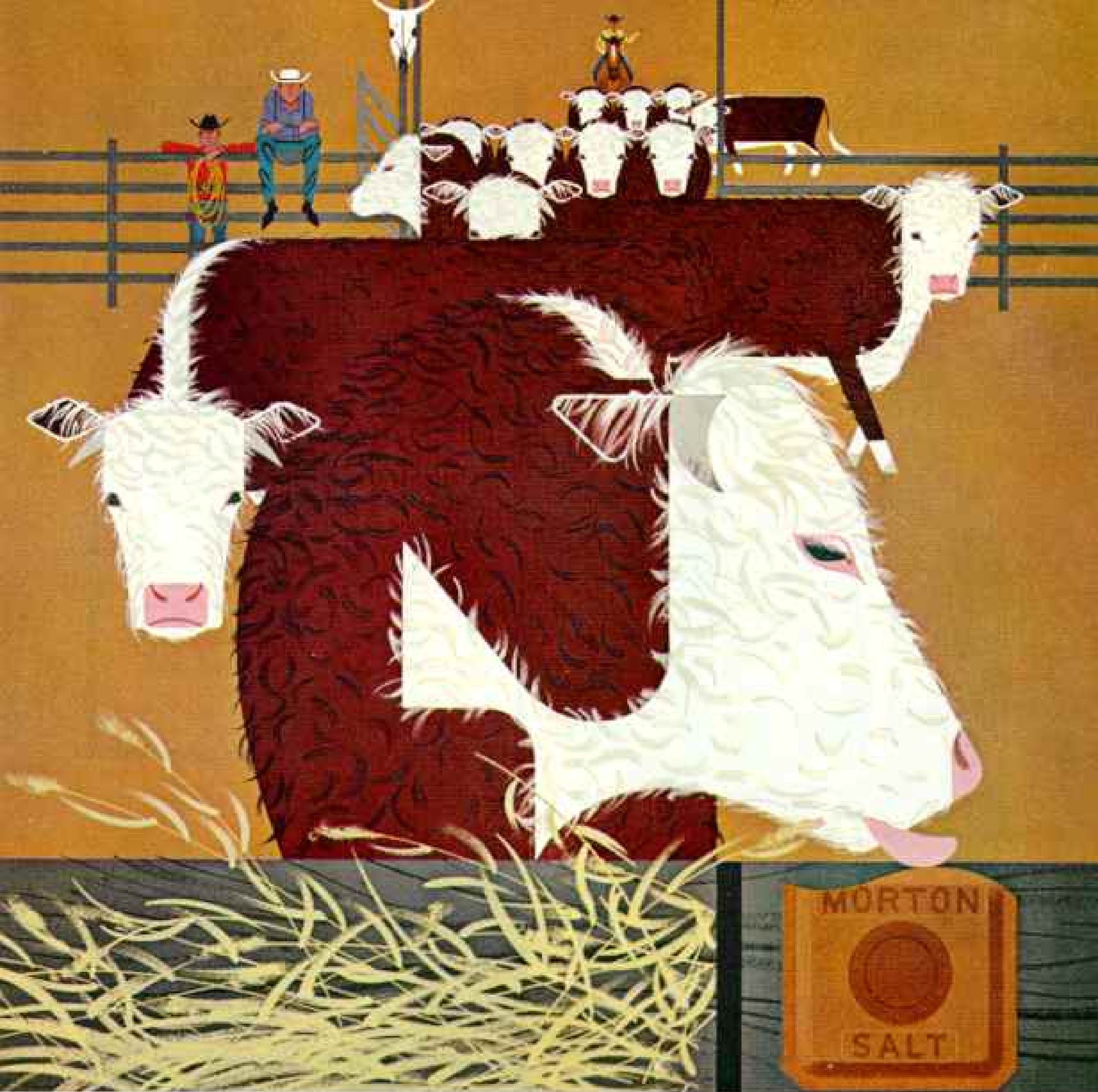
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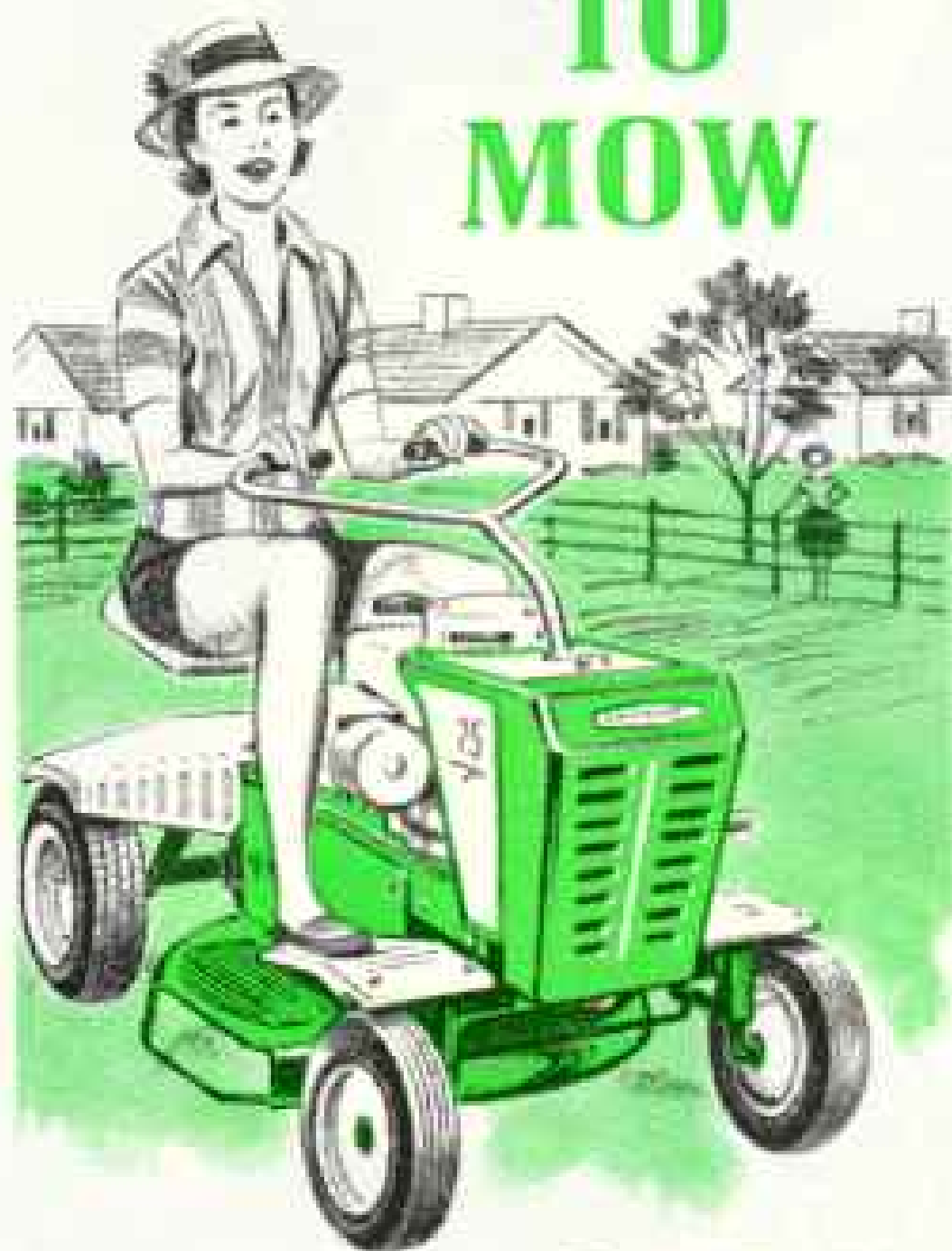
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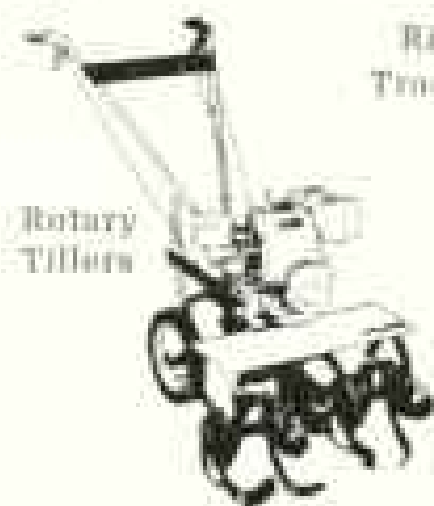
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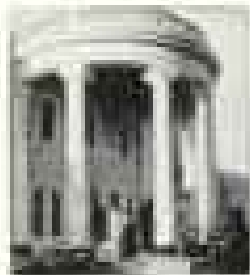
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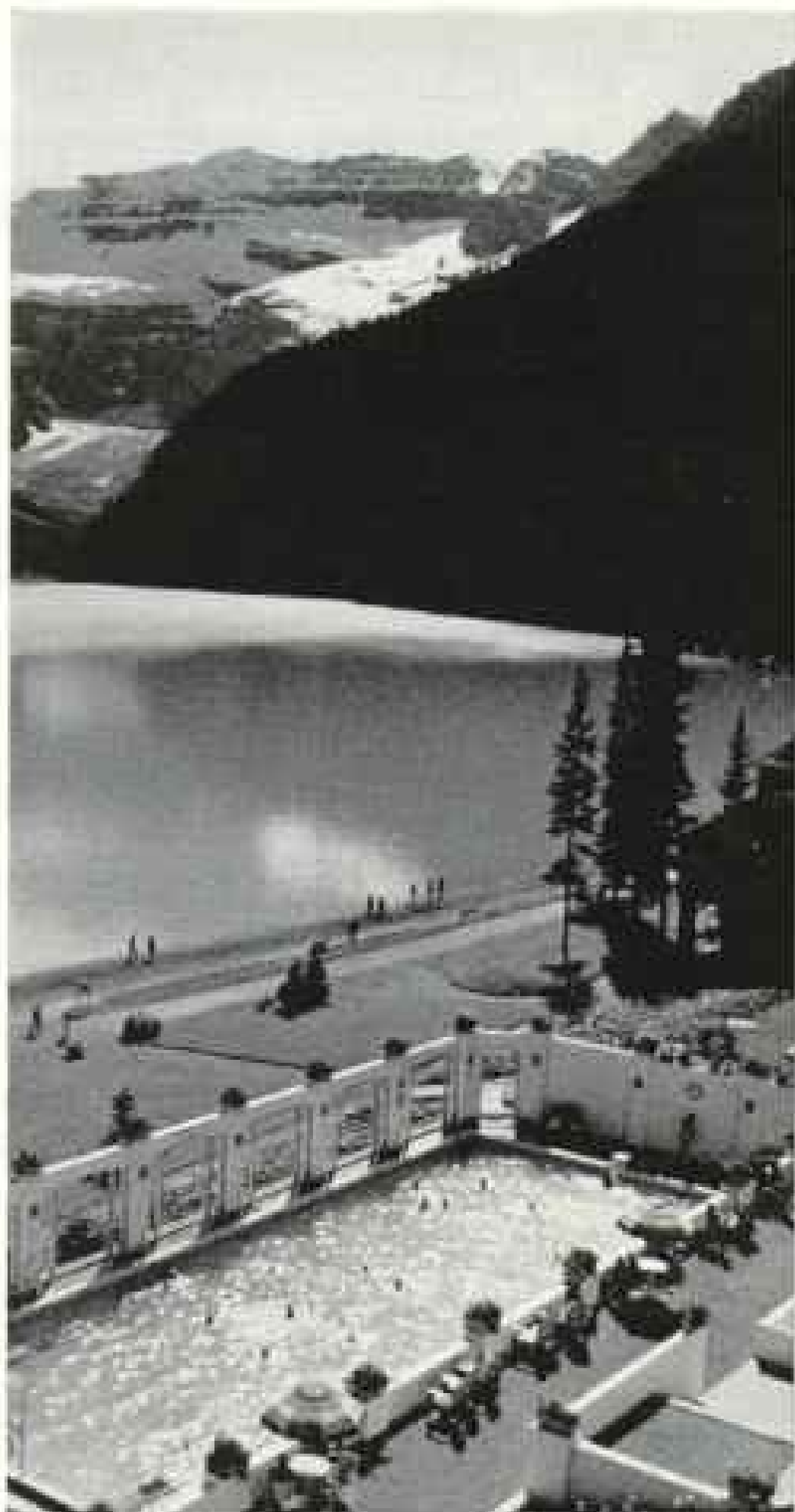
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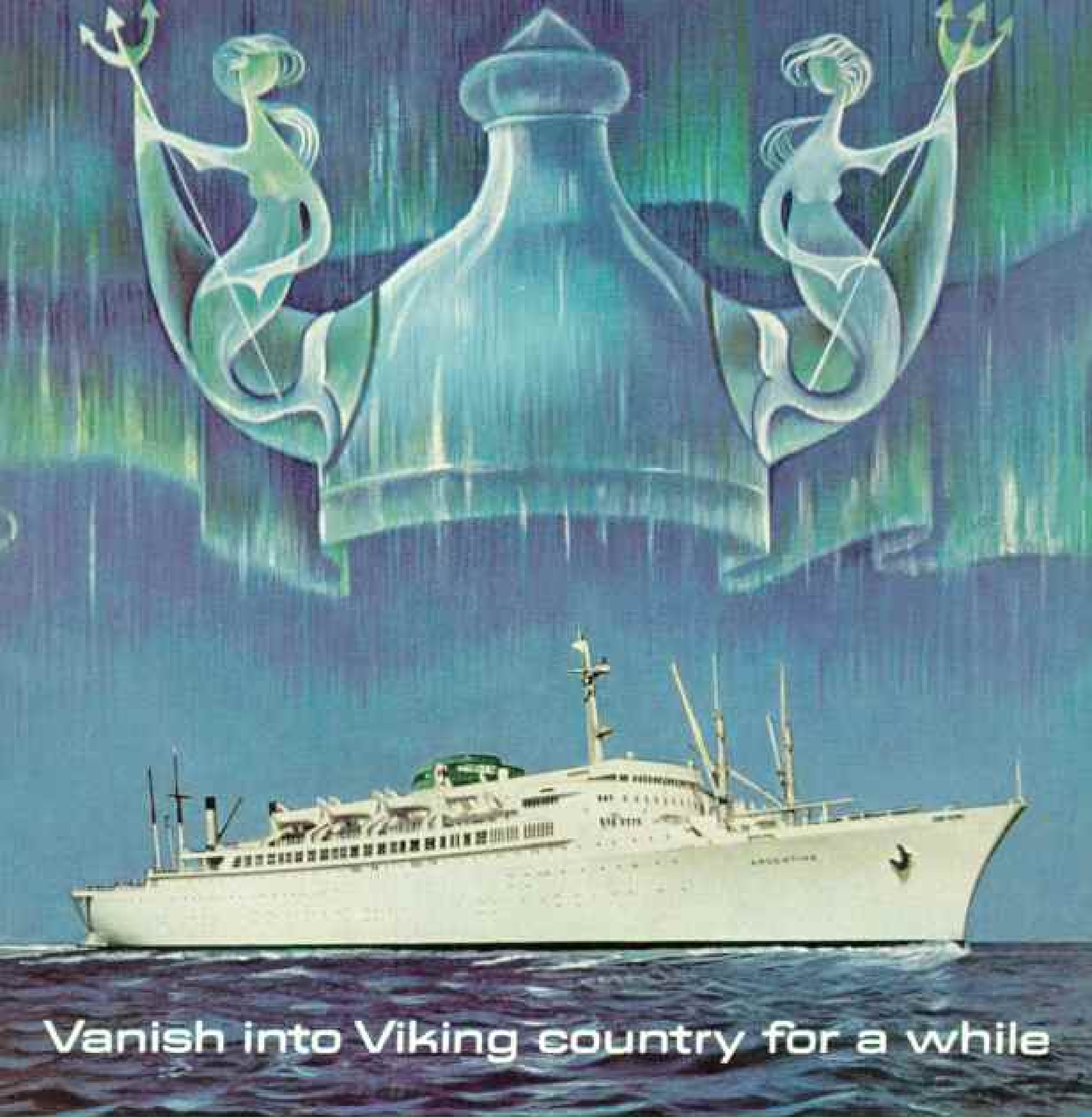
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