VOLUME CXII NUMBER SIX

THE NATIONAL GEOGRAPHIC MAGAZINE

DECEMBER, 1957

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THE NATIONAL GEOGRAPHIC MAGAZINE

I Found the Bones of the *Bounty*

Lonely Pitcairn Island, Home of the Descendants of History's Most Famous Mutineers, Yields Its Secret to a Diver

BY LUIS MARDEN

Foreign Editorial Staff, National Geographic Magazine

With Photographs by the Author

THE COURSE was WNW. The breeze had fallen during the night, and just before dawn the ship had almost completely lost way in the water. Her sails hung loose from the yards. Cordage slatted against the masts, the blocks creaked, and the chuckle of water at the bows died to a whisper. As the vessel rolled gently in the calm sea, the trucks of her masts traced slow arcs against the blazing stars of the Southern Hemisphere.

Distant 10 leagues, under the brilliant blue-white star Vega, the volcanic peak of Tofua rose from a dark sea. The moon, in her first quarter, filled the sails with a white radiance.

Eight bells struck. Fletcher Christian, acting mate of His Majesty's Armed Vessel *Bounty*, came on deck to relieve the watch. The ship's commander, Lt. William Bligh, was asleep in his cabin below.

"I am now unhappily to relate one of the most atrocious acts of Piracy ever committed," Bligh later wrote. "Just before sun-rising, Mr. Christian, with the master at arms, gunner's mate, and Thomas Burket, seaman, came into my cabbin while I was asleep, and seizing me, tied my hands with a cord behind my back and threatened me with instant death, if I spoke or made the least noise: I, however, called so loud as to alarm everyone; but they had already secured the officers who were not of their party. . . . Christian had only a cutlass in his hand the others had muskets and bayonets. I was hauled out of bed and forced on deck in my shirt. . . .

"The boatswain was now ordered to hoist the launch out, with a threat, if he did not do it instantly, to take care of himself. . . . Particular people were now . . . hurried over the side: whence I concluded that with these people I was to be set adrift.

"Christian . . . then said—'Come captain Bligh, your officers and men are now in the boat, and you must go with them; if you attempt to make the least resistance you will instantly be put to death:' and without any further ceremony, holding me by the cord that tied my hands, with a tribe of armed ruffians about me, I was forced over the side. . . . A few pieces of pork were now thrown to us, and some cloaths, also . . . cutlasses. . . . We were at length cast adrift in the open ocean."

One of the Sea's Greatest Stories

So, on April 28, 1789, began one of the greatest sea stories of all time: the mutiny in the *Bounty* and its fantastic train of events.

Bounty had sailed from Spithead in December of 1787, under orders to proceed to Otaheite (Tahiti) in the South Sea, there to take on breadfruit for transport to the West Indies. She stayed nearly six months at "the finest island in the world," taking on plants, and then proceeded to Endeavour Strait by way of Tonga, the Friendly Islands. There,

Black Sand, Green Palms, Thundering Surf: Everyman's Dream of the South Pacific

Since its discovery by Samuel Wallis in 1767, Tahiti has symbolized paradise to writers, painters, and escapists. Benign climate, spectacular scenery, and friendly natives make the island a lotus-eaters' land.

All Kodachromes by Luis Marden, National Geographic Staff

Tahiti's Matavai Bay Saw Capt. William Bligh and the *Bounty* Sail into History

This wide, sheltered anchorage served as a base for Pacific explorers for more than a century. Wallis, Bougainville, Cook, and Bligh anchored beyond the surf at right. The *Bounty* came here in 1788.

off Tofua, the famous mutiny took place.

In a boat only 23 feet long, heavily laden with 19 men to within 7 inches of the water, Bligh performed the most celebrated open-boat voyage in the chronicles of the sea (page 730). In 41 days he sailed from Tofua to Timor, 3,618 nautical miles, without the loss of a single man.

As the launch pulled away from the *Bounty*, the castaways heard the mutineers shout "Huzza for Otaheite!" Christian and his mates did return to their island paradise, where 16 of them elected to remain ashore. Eight threw in their lot with Christian; with them went six native men from Tahiti and Tubuai, 12 Tahitian women, and a little girl.

Suddenly in the night they sailed from Tahiti and vanished from history. Not until the ship *Topaz* of Boston touched at Pitcairn Island, a lonely rock 1,300 miles southeast of Tahiti, 18 years later, was the mystery solved.

Rudder Preserved in Fiji Museum

Christian had taken his little band to this uninhabited island, stripped the *Bounty*, then run her ashore and burned her. Trouble over a woman touched off a wave of violence and murder. When the *Topaz* arrived in 1808, only one of the original mutineers was still alive.

The story of the *Bounty*, with its incredible amalgam of adventure, violence, and mystery, has long fascinated me. While on assignment in the Fiji Islands some years ago, I was astonished to find in the museum at Suva some lengths of worm-eaten planking held together by copper fastenings, marked "Rudder of H. M. S. *Bounty*." The curator told me the rudder had been fished up from six fathoms of water at Pitcairn in 1933.

Two things surprised me: first, that there had still been visible remains of the old vessel as recently as that; and second, that they lay in such shallow water.

Here was a chance to combine my interest in submarine photography with a story for the National Geographic on the Pitcairn colony. I did not know whether any traces of the burned *Bounty* still remained on the sea bed, or, if they did, whether I could find them, but I wanted very much to try.

Last winter I sailed for Pitcairn from Panama on the New Zealand Shipping Company's *Rangitoto*. Ten days out from Panama we raised the island (map, pages 734-5). It lay low on the horizon, a slate-colored smudge against the bright gold of the westering sun.

We had still more than an hour's steaming to reach the island, as Pitcairn's 1,100-foot height is visible from 45 miles away.

All passengers embarking for Pitcairn at Panama must take passage through to New Zealand, because sometimes wind and sea make it impossible for the boats to come out, and the ships continue on to New Zealand without stopping. No one may land on Pitcairn without permission from the governor of Fiji, who administers the island.

"You're in luck," Capt. C. R. Pilcher said at my elbow. "We've got a calm sea. You'll have no trouble getting ashore."

The captain handed me his binoculars. Through them I could see three small boats rising and falling on the long Pacific swells.

The island rose slowly out of the sea and gradually took on the shape of a crouching lion rimmed with the white of breaking seas (page 732). The boats waited until we stopped; then they shipped their long oars and pulled for our dangling Jacob's ladders. From the bridge I stared curiously down for my first look at the Pitcairn Islanders.

My first impression was one of friendliness. Every upturned face wore a smile, and some people were waving and calling to friends on board. With practiced maneuvers the boats were warped alongside, and almost instantly the Pitcairners began swarming up the ladders, with the women in the lead.

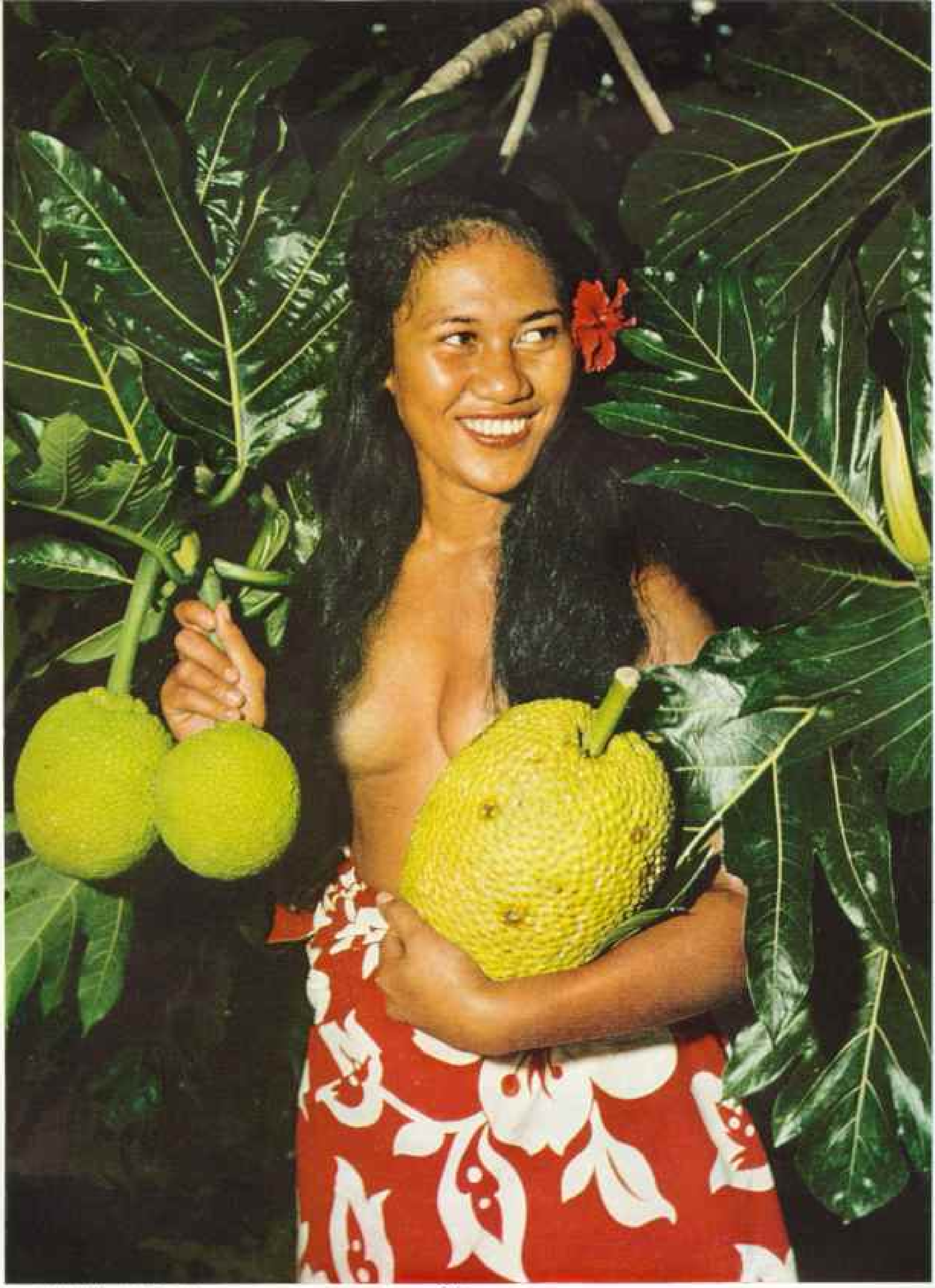
The first men to reach the deck lowered lines to the boat and began to haul up palm-frond baskets full of trade goods—fresh fruits, wood carvings, baskets. The women wore loose cotton dresses and the men were in shirts and dungarees. All were barefoot.

Christian's Descendant Comes Aboard

A tall, broad-shouldered man came up the companion ladder. He wore a high-crowned palm-leaf hat and, as he smiled, his white teeth looked dazzling in a handsome tanned face. He held out his hand to the captain. This was Parkin Christian, 73-year-old great-great-grandson of Fletcher Christian and chief magistrate of Pitcairn Island (page 741).

"Welcome to Pitcairn," he said (he pronounced it Peet-kern), when the captain had introduced me. "Hope you enjoy your stay."

I left Parkin talking with the captain and went down to the promenade deck, where the islanders stood surrounded by passengers eagerly buying fruit from the baskets: pineapples, bananas, limes, and mangoes.



Beauty and the Breadfruit: Prime Elements of the *Bounty* Story

Bligh sailed to Tahiti for young breadfruit trees to transplant to the West Indies as cheap food for slaves. Friendly girls and easy life ashore, contrasted with harsh conditions at sea, led some of his crew to revolt.

The features of the Pitcairners, both men and women, were more strongly European than I had expected. They were tanned and brown skinned, but most were no darker than sunburned, brown-haired Englishmen. The women looked more Polynesian than the men.

Hymn Bids Ship Farewell

The *Rangitoto* stayed only an hour; then I said goodbye to my shipboard acquaintances and climbed down the swaying Jacob's ladder. When the last islander had taken his place in the boats, the ladders were pulled aboard the *Rangitoto* and someone called out, "A song for Captain Pilcher and the ship!"

A man began to sing, one by one the others joined in, and then 70 voices of men and women rose in clear harmony, singing the hymn "In the Sweet Bye and Bye." High above us the rails were white with waving handkerchiefs; as the last strains died away, our boat captain called out, "Cast off!" and we moved slowly away from the ship.

I turned toward shore. The sun had set behind the rocky heights of Pitcairn, and blood-red streaks, like rents in a blast furnace, slashed across the darkening sky.

A voice sang out, "Tillah, tillah! Anybody bin see ah tillah?" The heavy tiller was passed over my head. Then a dozen hands raised the mast, made fast the shrouds, and hoisted our jib and gaff-rigged mainsail.

"H'ist hah shrodes higher!" called the captain, and the men hauled on the shrouds to tauten them.

Left to themselves, the islanders conversed in Pitcairnese. Though difficult for an outsider to understand at first, this was not nearly so unintelligible as I had expected. They used many nautical terms, and the accent was somewhat like that of parts of the West Indies.

As we drove toward the island, with the lee rail well down, my neighbor on the crowded thwart said: "It's darking."

Night does not really fall; it rises, starting at the water's edge and suffusing upward like ink creeping up a blotter.

The man thumped a crate of my air tanks. "I heardsay you gwen dive in Bounty Bay."

I admitted it.

"Man," he said, "you gwen be dead as hatchet!" Why a hatchet should be deader than a doornail, or anything else, I never found out, but it signifies utter extinction.

Boat Rides Combers into Bounty Bay

As we approached the shore, the darkening island grew taller; the recumbent lion was slowly getting to his feet. In the half light I could see a line of white breakers ahead. Stark against the sky a pinnacle of rock rose 700 feet—Ship Landing Point. At its base lay the rocky cove called Bounty Bay.

At the captain's shouted "Down sail!" the canvas came down with a rush, and the mast was unstepped. We waited just outside the surf while the captain, holding a long steering sweep, scanned the breakers ahead. The 14 rowers lay on their oars, not even turning their heads, until a particularly high wave lifted us and then let us slide down its back.

"Pull ahead!" cried the captain, and the long oars bent as they dipped in unison. We shot forward as a big sea rose under our stern. The men pulled like demons, keeping just ahead of the roller. At express-train speed we rushed past three black rocks on the port hand, entered a narrow channel of calmer water, then slowed and gently bumped against a sloping grid of logs and planks (page 739).

Ready hands seized the bows of the boats as lanterns bobbed at the head of the wooden slide. Several men from our boat jumped into the waist-deep water and started to hand crates and bundles ashore. One presented his broad back to me, said "Ready, mate?" and

Beginning of an Epic Voyage: Captain Bligh Is Cast Adrift

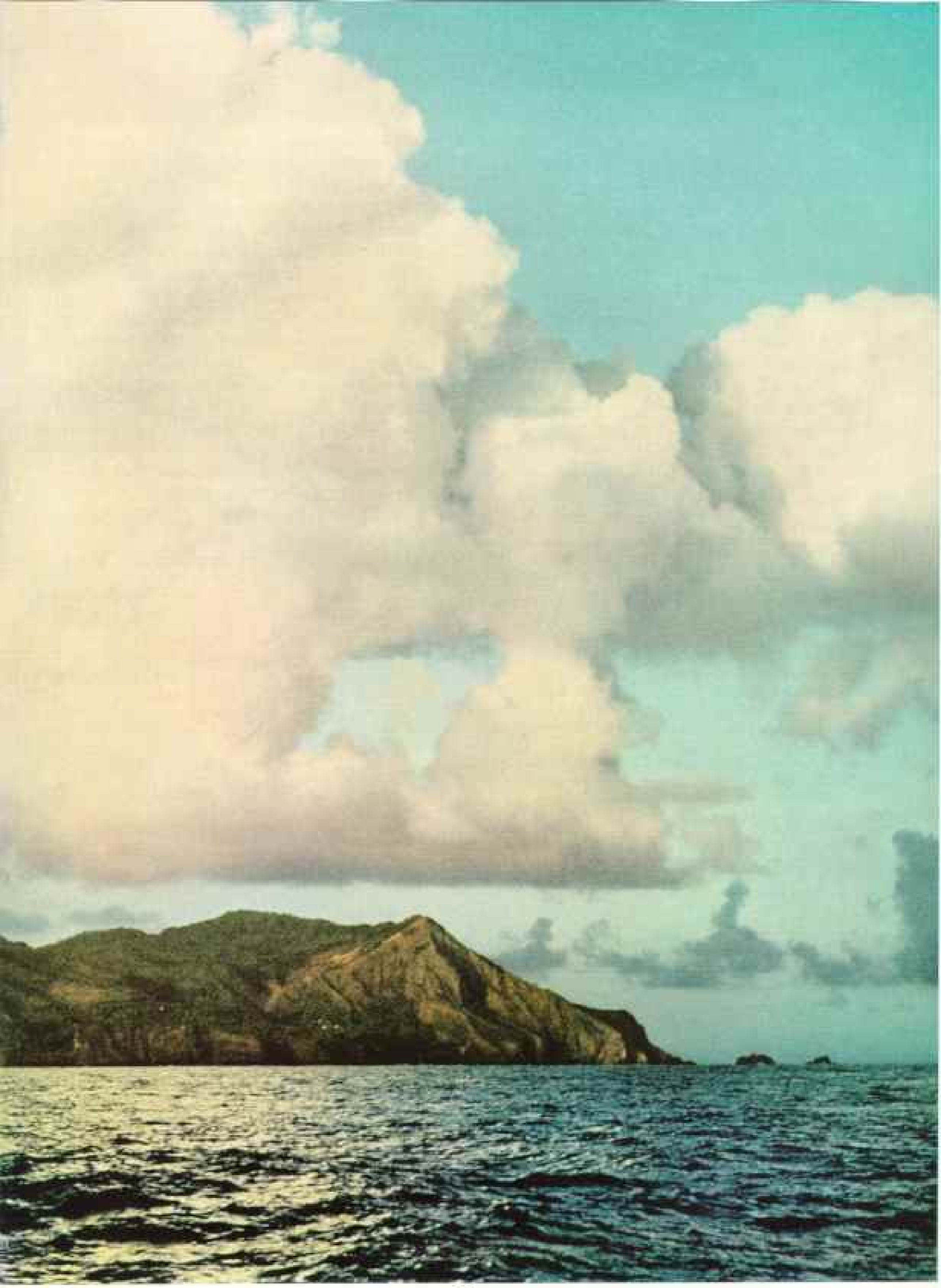
On the morning of April 28, 1789, acting mate Fletcher Christian and other *Bounty* crew members seized and bound Bligh and forced him into the ship's launch. Eighteen loyal officers and men went with him. The mutineers grudgingly granted them some bread and water, a little pork, compass and quadrant, and four cutlasses. The 23-foot boat was so overloaded that she had only 7 inches of freeboard.

Bligh, a master navigator, accomplished the incredible feat of sailing 3,618 nautical miles across the Pacific to the friendly Dutch settlement at Timor. For 41 days he fought starvation, thirst, pitiless sun, and the cruel sea itself. His feat remains the world's most celebrated open-boat voyage.

This old print was published in London in 1790. The artist shows breadfruit trees in tubs fastened to the taffrail. Actually they were kept in the great cabin. Gleeful crewmen soon cast them overboard.

Pitcairn Looms in Early Morning Light Like a Crouching Lion Bedded on the Pacific

So it appeared to Fletcher Christian and his eight shipmates when they sighted the island in 1790. With natives from Tahiti and Tubuai—6 men, 12 women, an infant girl—the mutineers founded a colony that still exists.



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On This Isolated Rock the *Bounty* Mutineers Hid from the World for 18 Years

Crewmen who stayed in Tahiti were captured and tried in England, but Christian and his henchmen were never brought to justice. In 1808 an American ship found only one of the original mutineers alive.

then carried me pickaback in to the landing.

Above us the escarpment rose 250 feet to The Edge, beyond which the houses of the village began. Figures passing before the gas lanterns threw long shadows on the white boats. The unloading went forward rapidly, and a pile of mailbags, sacks, boxes, and crates grew on the shore.

Now I met Allen Wotherspoon, the island schoolteacher, a New Zealander who had come to Pitcairn a year before, and Pastor Lester Hawkes, a Seventh-day Adventist missionary.

On Pitcairn the chief magistrate is the head of local government, but the schoolteacher is government adviser, representing the British governor of Fiji.

"You are lucky," Wotherspoon said. "We had very little sea tonight, and you got your things ashore in a dry state. Sometimes we take a green one, and everything gets soaked."

When the boats had been unloaded, the men secured a cable to one of them; a donkey engine coughed, and the boat moved slowly up the slide, its heavy keel squealing and groaning. The Pitcairn boats are 37 feet long and well over 7 feet high at the stem.

When the last boat was stored, everybody, including the women, picked up a sack, a box, or a bundle, and we started up the trail. The heavier boxes and mailbags would go up tomorrow by telpher, or cableway.

Someone asked, "Where's ah man gwen stay long fa me?"

I introduced myself to Fred Christian, at whose home I was to live. Fred is six feet five inches tall, with a broad brown face, curling gray hair, and a gentle smile.

Tom, Fred's 21-year-old son, also shook my hand.

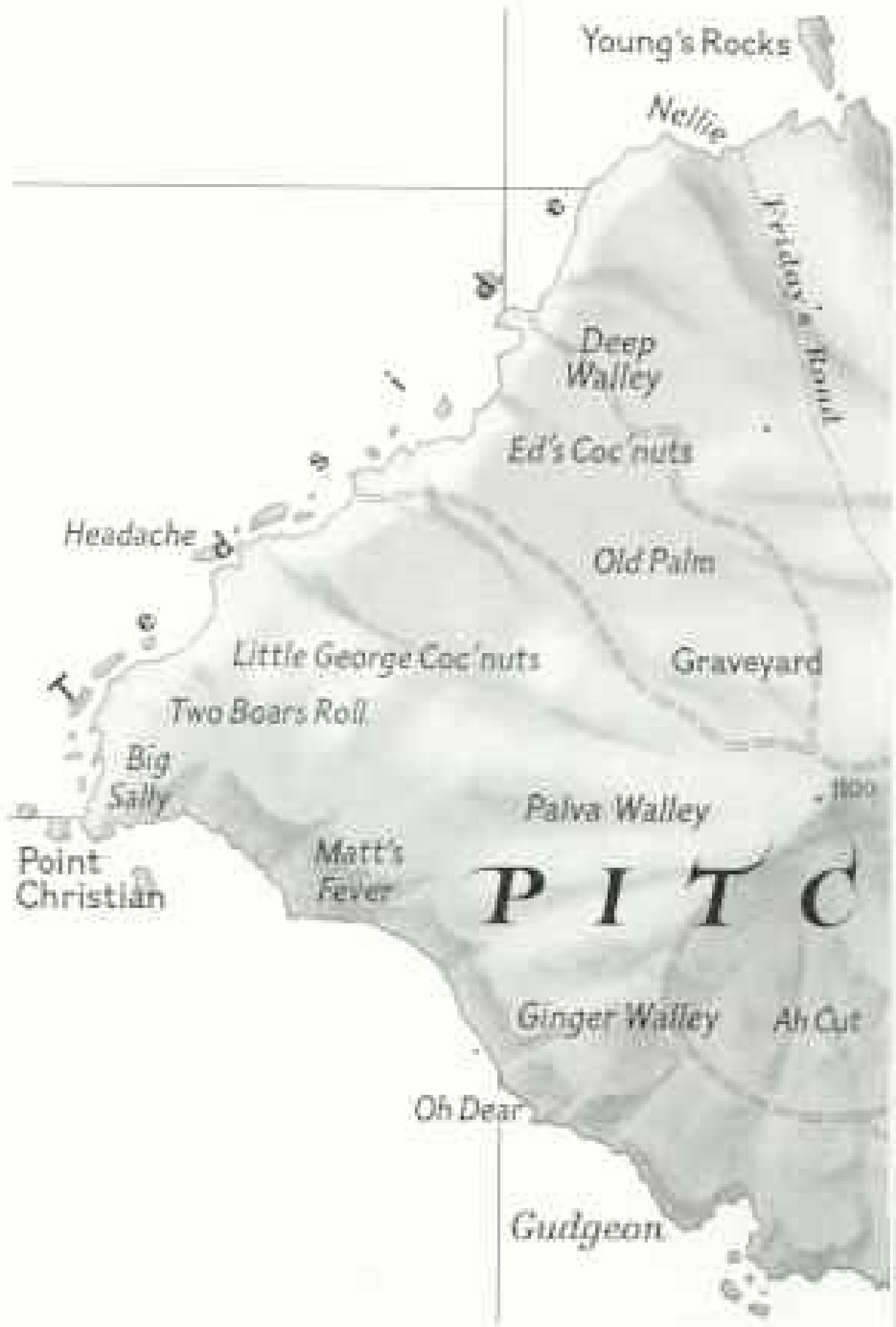
The steep trail is cut into the side of an

"Breadfruit" Bligh: an Old Portrait

When Lt. William Bligh, R.N., was selected to command the *Bounty*, he had already demonstrated his talents. In 1776, at the age of 23, he was sailing master of one of the two vessels of Captain Cook's third voyage of discovery.

On his return to England after the mutiny, Bligh took command of the *Providence* and successfully accomplished the transplanting of breadfruit from Tahiti to the West Indies.

Later Bligh was appointed governor of New South Wales, but was deposed by an armed insurrection. He returned to England, became a Vice Admiral of the Blue, and died in 1817.



Pitcairn: Crater of a Dead Volcano

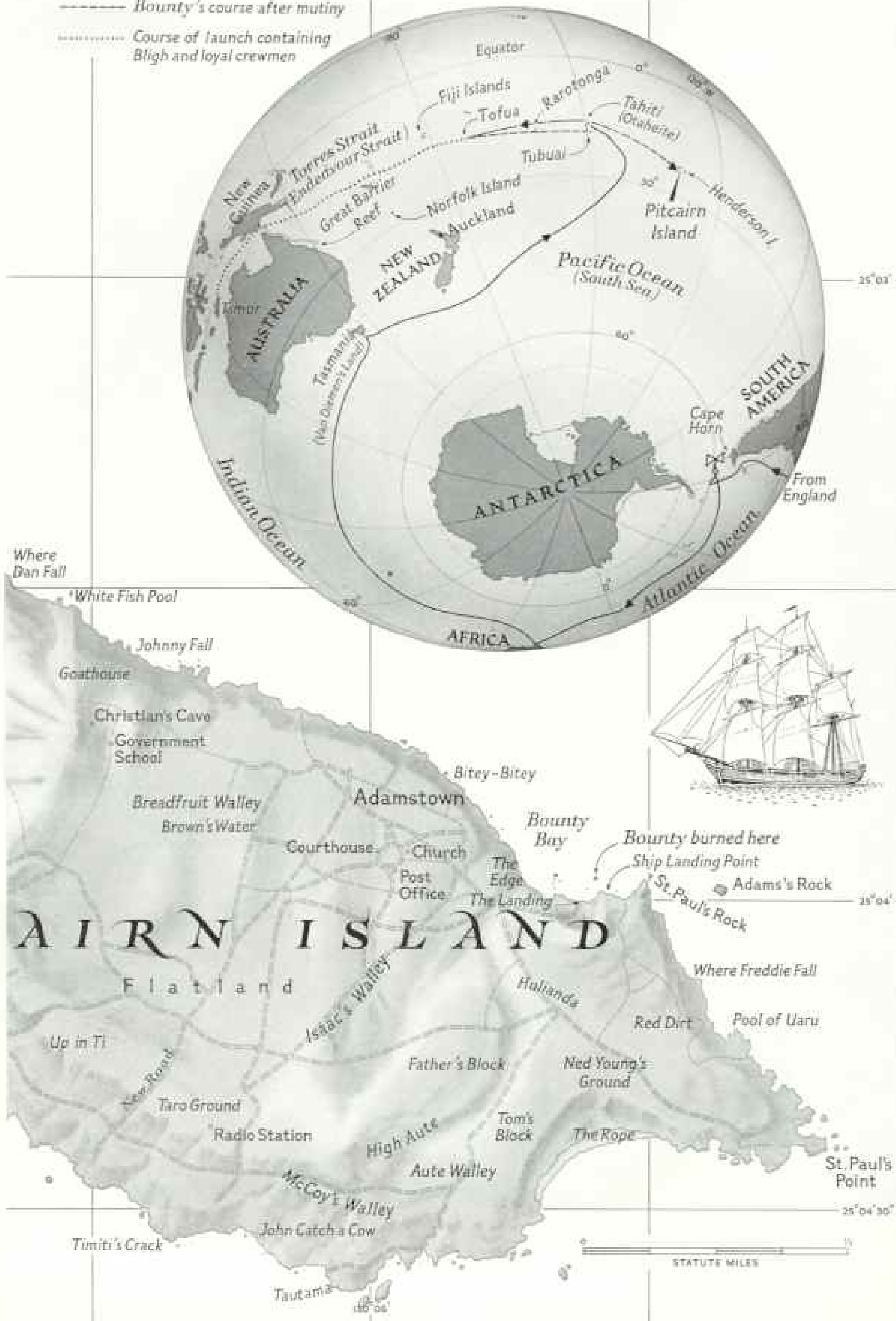
Place names reflect the speech of the islanders, most of whom descend from the *Bounty* mutineers.

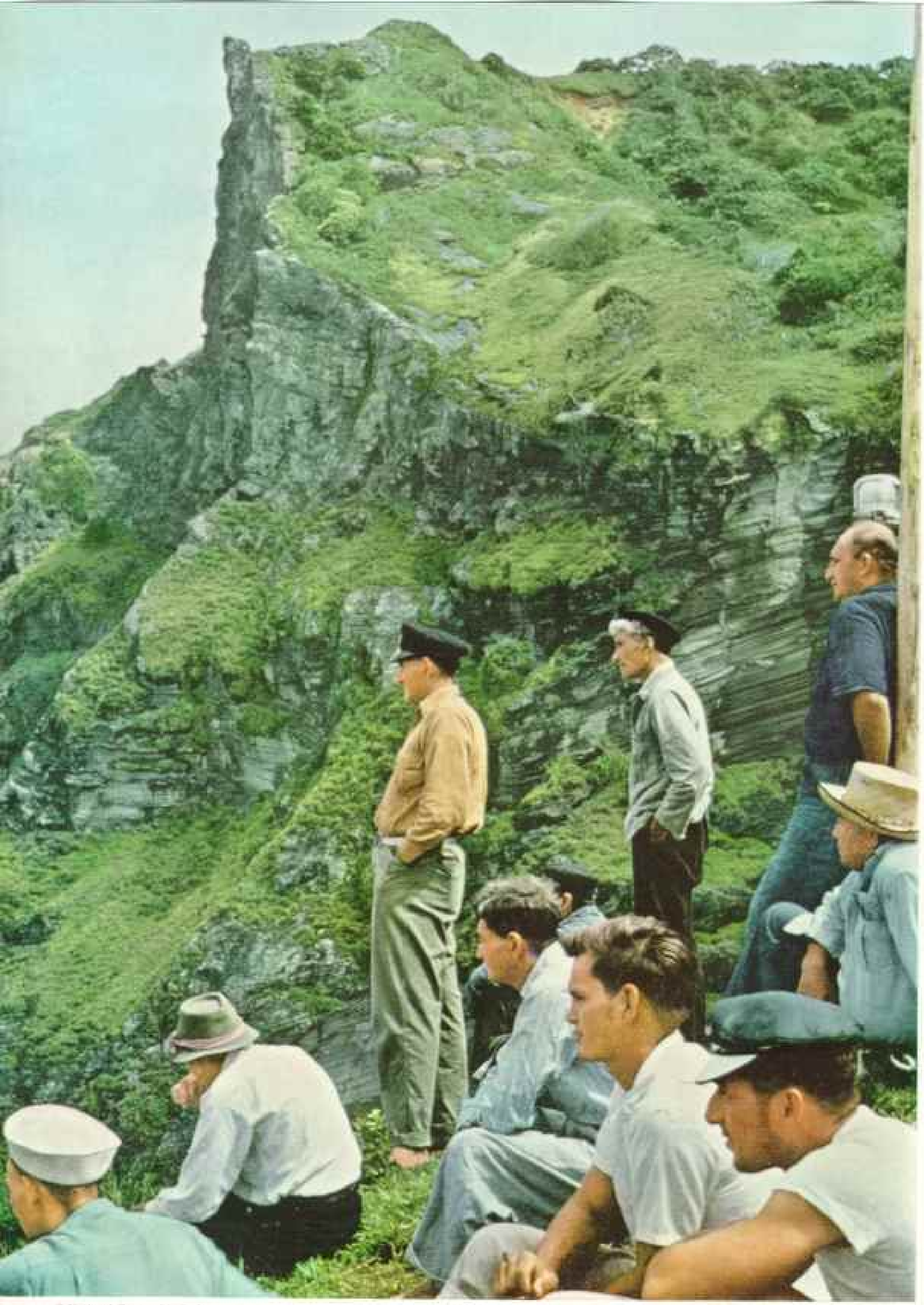
The globe shows the track of the *Bounty* to Tahiti and Pitcairn. For a month she tried to beat around Cape Horn against prevailing westerlies. Finally she put about and sailed eastward past Africa.

Bounty's course before mutiny

Bounty's course after mutiny

Course of launch containing Bligh and loyal crewmen





Pitcairn Men Stare Intently Out to Sea for Sight of a Passing Ship

First man to spot a vessel on the horizon cries, "Sail ho!" A bell then rings, summoning boat crews to put to sea.

escarpment. Bare feet take the best grip, and my rubber-soled shoes slipped and skidded. I began to pant, and the women, most of whom carried far more than I, looked at me with friendly amusement.

Finally, a series of stony steps helped us over The Edge, and the trail leveled off. Beyond, I saw the lights of houses on both sides.

The pastor was one of the last to turn off, but Wotherspoon, Fred, Tom, and I went on, lighting our way with electric torches. We passed under the aerial roots of a big banyan tree and Fred said, "We home now."

"No Mister or Mrs. Here"

We said goodnight to the schoolteacher and turned aside to a house of gray, unpainted weatherboards that rested on big foundation stones. A generator plant buzzed in an outbuilding, and the house shone with light.

Flora Christian took my hand at the door.

"I hope you be happy here," she said.

"Thank you, Mrs. Christian," I replied.

"No Mister or Mrs. here; I'm Flora."

"Yes," Tom said with a grin, "we all use our Christian names here."

Of the island's 153 souls, 55 are surnamed Christian; there are only half a dozen surnames on the whole island. To avoid confusion, no two Pitcairners have the same given name.

"Come have a bit o' supper," Flora said, leading us to a porch furnished with a long oilcloth-covered table. Over my protest I was seated in a chair at the head of the table. Flora, Fred, and Tom sat on benches at the sides. Fred bowed his head and said grace.

I had known before coming to Pitcairn that almost everyone on the island was a member of the Seventh-day Adventist Church. All the Adventists of my acquaintance are vegetarians. So I was surprised when Flora placed before me a big platter of steaming corned beef, along with heaped plates of island vegetables.

Fred is an elder of the church, and I asked him about Adventists eating meat.

"O-a, we always eat meat on Peet-kern; church don't forbid it," he said. "We eat bully beef, salt beef, and fresh goat meat."

Pastor Hawkes told me later that vegetarianism is not an inflexible tenet of his church. Pitcairners, in view of their isolation and lack of variety of diet, have more reason than other Adventists to eat meat, he said.

This license does not extend to pork, however, as Adventists strictly obey the Mosaic injunction against eating the flesh of pigs. This seems a strange prohibition for a people who are half Polynesian, for throughout the South Pacific pork—*puaʻa*—is always the center of any feast. Pigs rooted and ran free on the island from the time the mutineers brought them until John Tay, a missionary from the United States, converted the islanders to Seventh-day Adventism in 1886. Since then not a squeal has been heard on Pitcairn.

Another Biblical prohibition restricts the island diet still further.

"And whatsoever hath not fins and scales ye may not eat; it is unclean unto you."

Adventists interpret this to mean large, visible scales, so that smooth-skinned fish are forbidden, as are shellfish.

In early accounts of life on Pitcairn I had read of parties going down the steep cliff face called The Rope to gather shellfish on the rocks below. So far as I could learn, these are a kind of whelk or winkle. I asked Fred if he had ever sampled them, and he replied with a twinkle, "O-a, I used to *like* them, when I was a heathen."

Islanders do catch lobsters and crabs for fishing bait. I am an old New Englander, and my mouth watered at the sight of the handsome red-and-black spiny lobsters. Occasionally my thoughtful hosts would cook one for me, and everybody would watch in a kind of fascinated horror as I ate it.

Before going to bed, we all drank a cup of "hot drink"—Ovaltine. Adventists eschew all stimulating drinks, even the nonalcoholic ones such as coffee and tea.

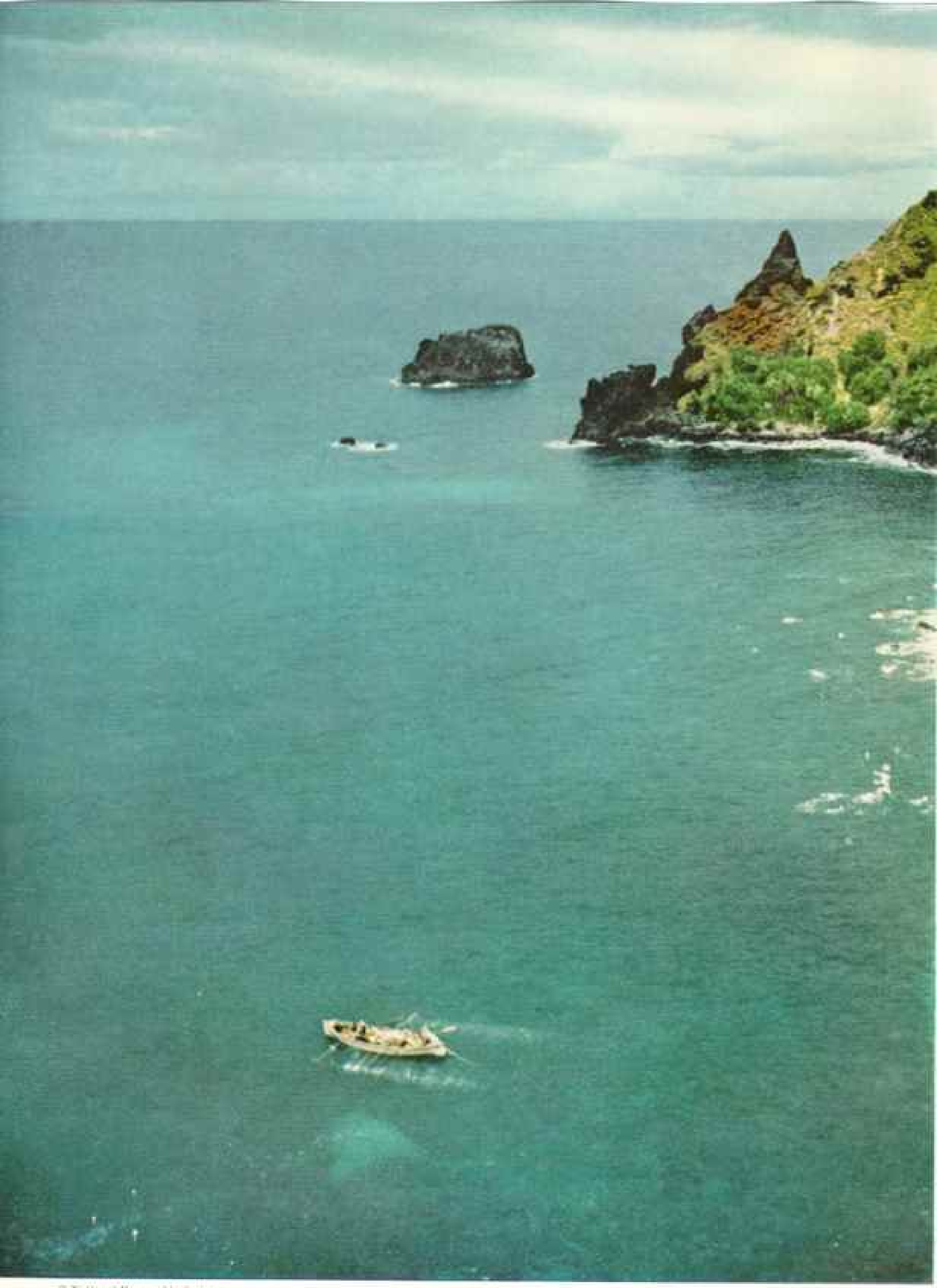
Bell Calls Men to Public Work

I was awakened my first morning on Pitcairn by the island bell ringing.

"Public work," said Fred, thrusting his head inside my door. When this bell sounds three times, all able-bodied males from 16 to 60 must report to the courthouse and do whatever work the island council decides must be done —road mending, repairs to the landing slide, land clearing. Today the job was to bring the freight up from the landing.

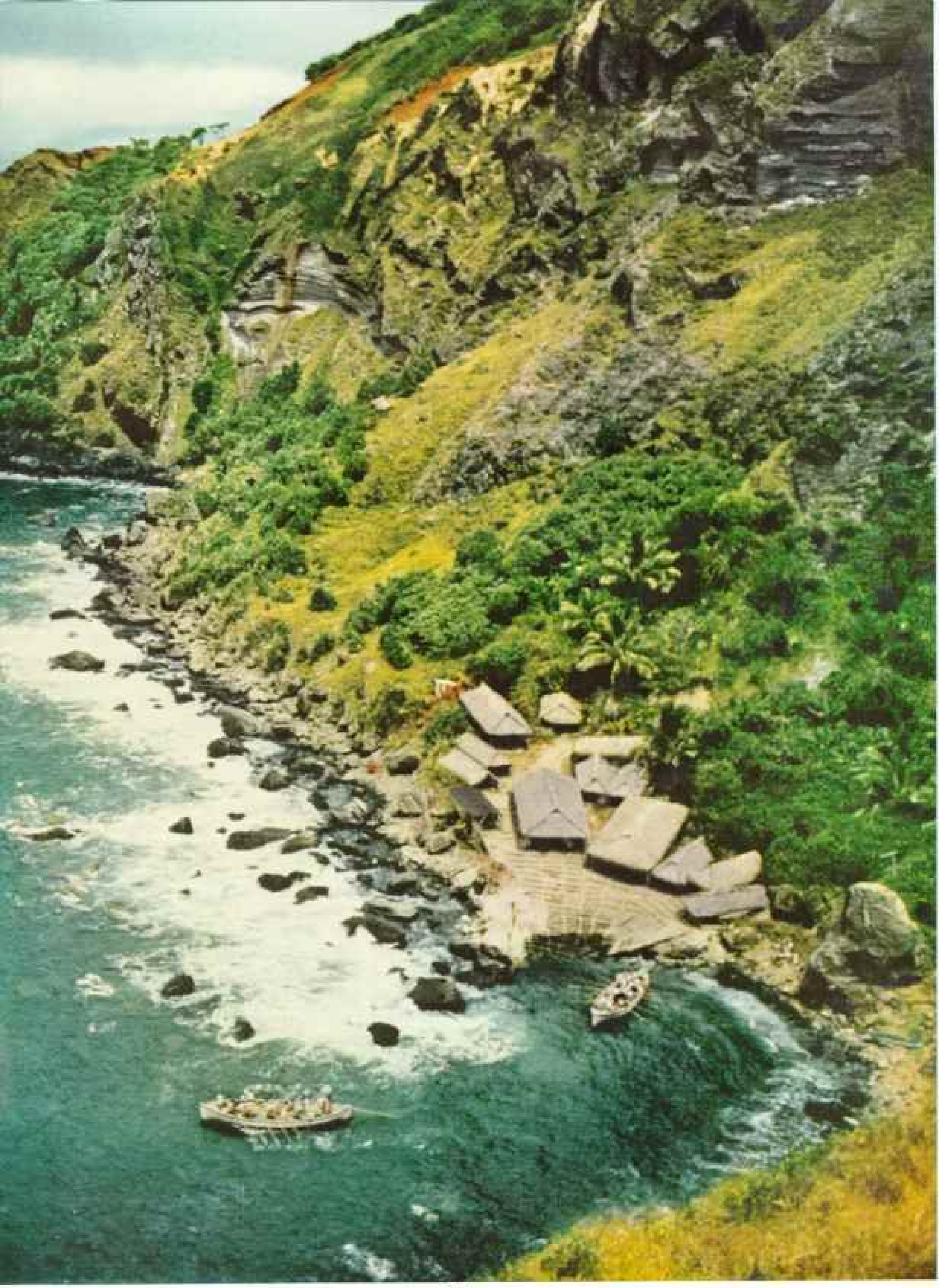
Tom Christian is wireless operator for the island. He must be on the air twice a day, morning and night, and so is exempt from public work. He offered to guide me round Adamstown, and then "up ah hill" to the radio station. Fred, who at 73 is still stronger and more agile than I am, accompanied us.

As we walked down the path, Fred greeted the people we passed: "Bout yawly gwen?"



Three Longboats Pull Out of Bounty Bay to Meet a Visitor at Sea

Ships may arrive at any hour of the day or night. They do not anchor, but heave to a few miles offshore. Boatmen sell souvenirs to passengers and trade fresh fruit for ship's groceries (pages 779, 781).



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Bounty Was Run Ashore and Burned in the Shallow Water of This Rocky Inlet

Christian and his followers destroyed the ship in 1790 to hide from searchers. The grid of logs and timbers (right) helps oarsmen haul their craft up to the thatched boathouses beyond reach of the smashing surf.

(Where are you going?) Islanders say this instead of "Good morning."

The women said: "We gwen up ah hill, pick *kumara*" (sweet potato).

To me they said: "Enjoy yourself?"

They seemed to ask it with a genuine concern. Pitcairners are gentle and kindly, and so hospitable that I felt instantly at home.

The main track of Adamstown—"Pitcairn Avenue"—parallels the sea; houses stand at random on both sides. On a flat square cut into the steep slope stand the courthouse, church, and post office (page 771).

Since Pitcairn has no taxes or customs duties, stamps furnish the government's only revenue. Because of collectors' demands, they bring in sizable sums. On July 2, 1957, when a new set of stamps was issued, orders totaled $1,740 the first day. By the end of the month nearly $3,000 worth had been sold.

Post Office Crowded on Mail Day

While I talked with Roy Clark, the American-born postmaster who came to Pitcairn in 1909, Oscar Clark, assistant postmaster, rang the bell four times: mail call. It was the mail that came in with me from the *Rangitoto*.

Mail day is an exciting time for the islanders. They may not have received mail for weeks, if bad weather has forced ships to bypass them. Roy and Oscar locked themselves in the post office and distributed the mail to pigeonholes, one for each family. They came to the porch and called off a list of names. Only people whose names were called crowded into the miniature building.

After the letters come the parcels. These are most eagerly awaited by the Pitcairners; since there are no shops on the island, all their buying has to be done by mail. Women regularly order from Sears Roebuck and Montgomery Ward in the United States.

I saw some cloth-wrapped parcels that bore a label familiar to me: "O. Mustad and Sons, Oslo, Norway." They contained fishhooks, 65 pounds of them, ordered by one man for all the fishermen on the island.

From the courthouse square switchback paths lead "up ah hill" toward the cultivated ground and the wireless station. We walked through thickets of rose apple, a tree imported to Pitcairn about the turn of the century.

"This stuff's a nuisance," said Tom. "Crowds out everything else."

Yet the rose apple is a boon to deforested Pitcairn. It grows so fast that it keeps the island hearths well supplied with firewood.

As we climbed higher, we could look down over the scattered red roofs of Adamstown to the open sea (page 785). Lush green valleys, filled with a dense growth of banana and plantain, alternated with ridges running down to the sea. Deep in the valleys bunches of ripe *fe'i*, the red banana, flashed fire-orange.

As we talked, Tom thrashed his way through the high grass and guava bushes beside the trail and emerged with a ripe watermelon. He drew his sheath knife and sliced it lengthwise.

All Pitcairn males wear a sheath knife on the belt (page 769). It looks very seagoing, but its chief use is to slice and peel the fruit that is always in someone's hand.

We sat under a pandanus tree and ate the melon. I leaned against the gray roots that sprang out from the base of the trunk like Gothic flying buttresses and looked out to sea. My thoughts drifted back to the *Bounty*.

After Fletcher Christian and his fellow mutineers set their captain adrift, they tried to settle on the island called Tubuai, about 400 miles south of Tahiti. The natives there were hostile, however, and the mutineers found themselves in a constant state of warfare. The malcontents among the men demanded to return to Tahiti "and there separate where they might get weomen without force."

Three Mutineers Ended on Yardarm

Feeling his authority weaken, Christian made this speech:

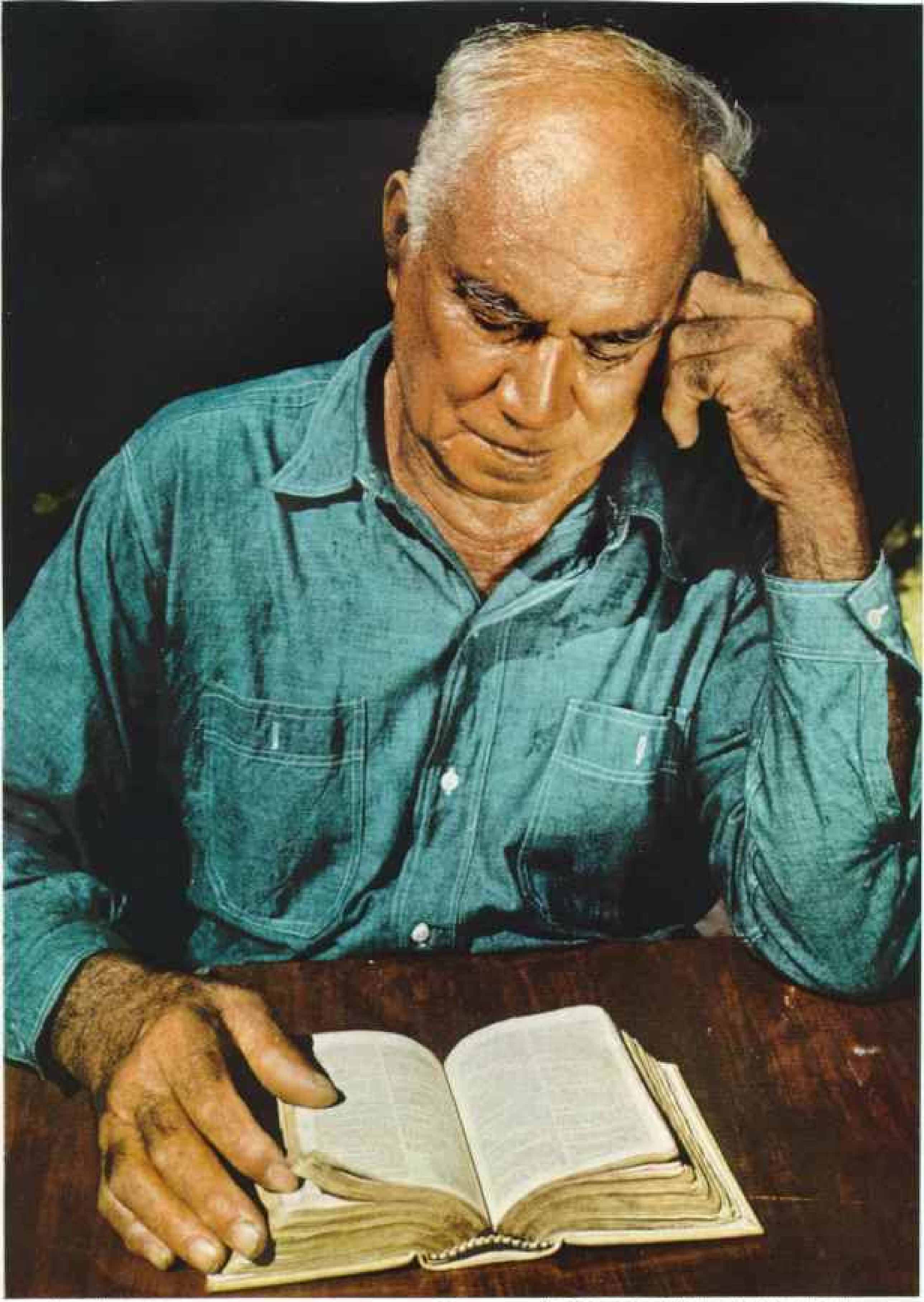
"Gentlemen, I will carry you, and land you, wherever you please. I desire none to stay with me, but I have one favour to request, that you will grant me the ship, tie the foresail, and give me a few gallons of water, and leave me to run before the wind, and I shall land upon the first island the ship drives to. I have done such an act that I cannot stay at Otaheite."

Christian knew the Admiralty had a long arm, and that sooner or later they would send a ship to look for him and his henchmen.

When Christian and his eight comrades set sail, 16 mutineers remained at Tahiti. They were to regret it. True to Christian's fears, the frigate *Pandora* arrived in Matavai Bay a year and a half later and captured all the mutineers except two who had been killed.

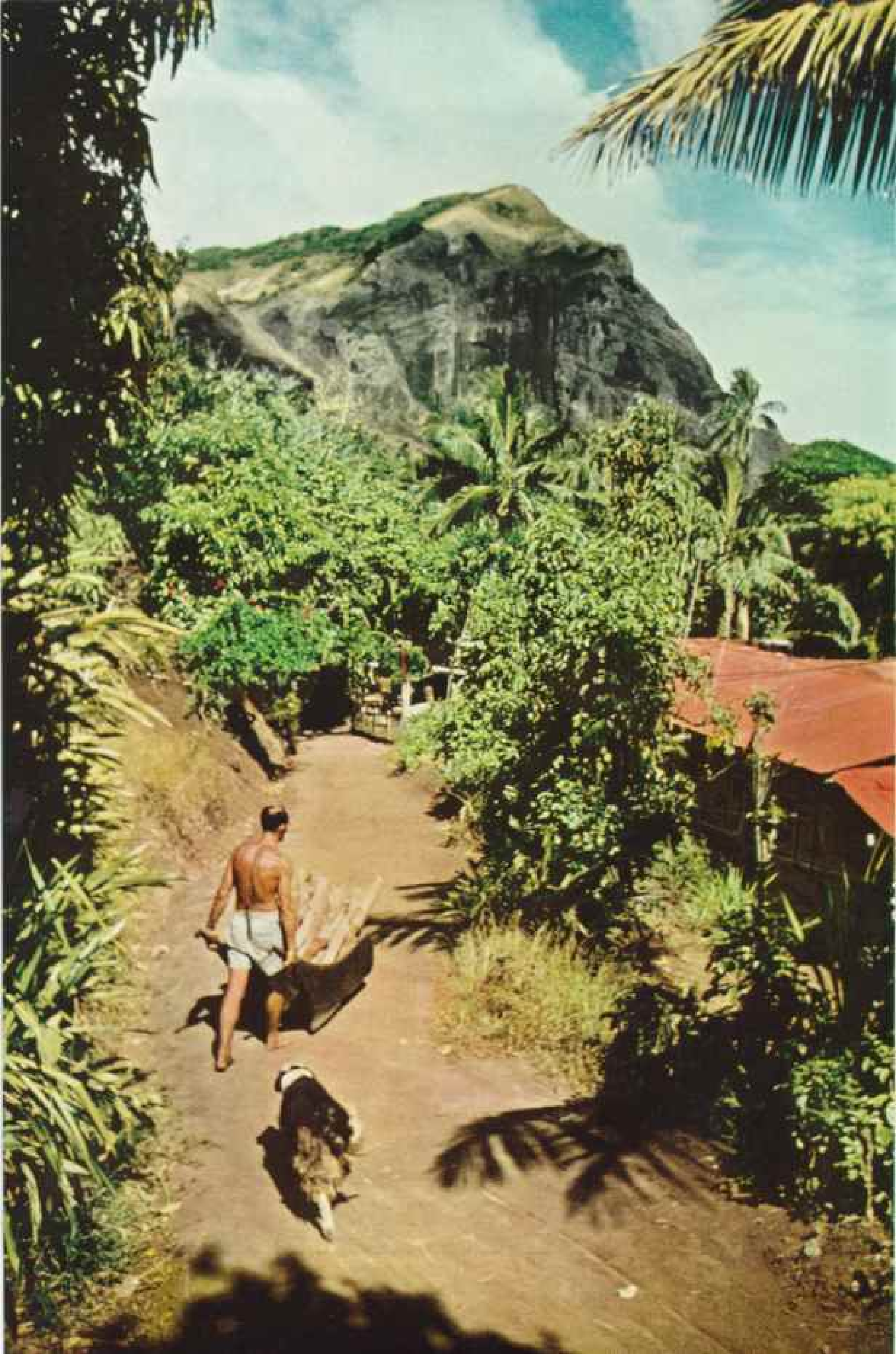
The *Pandora* was wrecked on the Great Barrier Reef on the homeward journey and four mutineers, as well as many seamen, went

(Continued on page 749)



All Kodachromes by Luis Marden, National Geographic Staff

Parkin Christian, Great-great-grandson of Fletcher Christian, Reads *Bounty*'s Bible



← Main Street Is Easy on Bare Feet

Barrows are the only wheeled traffic in Adamstown, Pitcairn's sole settlement.

The peculiar shape of wheelbarrows reflects Pitcairn's needs. Beveled front edges slip easily through brush, metal-shod rear runners serve as brakes, and curved handles hook around the hands to prevent runaways on steep descents.

↑ Women Bake Bread Twice a Week

Islanders shape square ovens with an ax from slabs of soft volcanic rock. Hilda Young preheats her oven with firewood from the rose apple, introduced from Norfolk Island before the turn of the century. Fortunately, the tree grows almost as fast as islanders can cut it. Hilda does frying and boiling over a wood fire built on a sandbox (right) known as a bolt.

Crack of the Cricket Bat Links the Isle to England

Smooth and level ground is hard to find on Pitcairn, so the cricket pitch, set up on the lawn in front of the school building, is made of matting.

This is an all-woman match. Some wives and girls bowl and bat with the best of the men and sometimes meet them in play.

A British Crown Colony since 1838, Pitcairn is administered by the governor of the Fiji Islands, more than 3,000 miles away. Ships passing from Great Britain to New Zealand provide the island's chief contact with the world.

During the whaling era, a century ago, Pitcairn was visited by more American ships than those of any other nation. At that time the dollar was the unit of currency; today New Zealand and British pounds are standard.

Men Strain and Pull but Cannot Budge the Women

A tug of war between men and women climaxes field sports held during Christmas and New Year's week.

Invariably the women win such contests. Asked the reason, they grin and reply: "We heavier."

Pitcairn women work just as hard as men and are nearly as strong.

Steep trails as well as the outdoor life help keep inhabitants athletic.

Ordinarily there is little time for play. Fishing, gardening, and souvenir-making keep everyone busy from dawn to dark six days a week.

Pitcairn observes Saturday as the Sabbath, as nearly all the islanders belong to the Seventh-day Adventist Church. A missionary converted the people to Adventism in 1886.

↑ Islanders Say Grace Before Dinner

No Pitcairner starts a meal without giving thanks, a custom established by the last mutineer, John Adams, about 1800. Here the Hilda Young household sits down to its Christmas feast.

Baskets Serve as Christmas Stockings →

Upper: When children are abed, parents go from house to house to fill baskets with sweets and gifts.

Lower: Adults on Christmas morning inspect family presents, which they found hung on trees.

down with her. The survivors got away in the boats and eventually returned to England, where the 10 mutineers were tried. Four were acquitted and six were found guilty. Three of the latter obtained pardons, and the other three were hanged from the yardarm of a man of war.

What Christian wanted was a hospitable but uninhabited island where he could live out his life without fear of discovery. In a book called *Hawkesworth's Voyages* in the *Bounty*'s library he found a description of what sounded like just such an island. It occurred in an account of Capt. Philip Carteret's voyage around the world in 1766-9.

"It was not more than five miles in circumference, and seemed to be uninhabited; it was, however, covered with trees. . . . It lies in latitude 25° 2′ S., longitude 133° 21′ W. . . . It is so high that we saw it at the distance of more than fifteen leagues; and it having been discovered by a young gentleman, son to Major Pitcairn of the marines . . . we called it PITCAIRN'S ISLAND."

The name holds interest for Americans, as the Maj. John Pitcairn mentioned was in command of the British Marines at Concord when the first shot was fired in the American War of Independence. He was later mortally wounded in the battle of Bunker Hill.

Christian decided to steer for Pitcairn. Unfortunately, Captain Carteret had been more than three degrees off in his reckoning of longitude, an error of 178 nautical miles west of the true position.

Christian seems to have cruised for weeks looking for this island, and he nearly had another mutiny on his hands before sighting it.

When the mutineers first landed, they found signs that humans had been there before them. Rude carvings were cut into cliff faces, polished stone axes lay about, and near one *marae*, a platform built of stones on which stood crude idols, they found a human skeleton. But they saw not a living soul. Today we know these remains belong to primitive Polynesians who once lived on Pitcairn Island.

No one knows the exact date on which the *Bounty* arrived at Pitcairn Island, but it was in the first days of 1790. Having landed all the stores, plants, and livestock, the ship's crew stripped her, ran her ashore, and burned her on January 23, 1790.

Christian divided all the land into nine portions among his fellow seamen and himself, leaving none for the Polynesian men. Their resentment smoldered; later it was to burst violently into flame.

Through succeeding generations the land of Pitcairn has been so subdivided through inheritance that by the time I arrived on the island some people owned only four feet of ground. Others are completely landless.

Even individual trees have owners, but no one objects if anyone who is hungry picks an orange or a coconut.

"All right you pick coc'nut," Fred said, "so long you eat it under the tree. Cahn't cahly it away."

Wind Powers Island Transmitter

Climbing again, we emerged on a grassy hill, almost 900 feet above sea level. Here stands the radio station. The transmitter works on batteries powered by a wind charger. Tom Christian listens for ships' calls every morning and transmits in the evening. His point of contact for regular communications is Rarotonga, 1,900 miles away.

Fred and I waited while Tom took his readings and sent out a call. No one answered; so we continued our stroll around the plateau.

I had left northern winter behind when I crossed the Equator, and now in mid-December it was high summer on Pitcairn. Sea breezes keep the temperature pleasant most of the time on this subtropical island. There is usually plenty of rain—fortunately, because the island depends on it for its water supply. The houses have corrugated iron roofs from which the rain runs through gutters and spouts into cement tanks.

The top of Pitcairn consists of an undulating savanna, set here and there with gray-trunked pandanus trees and thickets of dark-green rose apple. The highest point, 1,100 feet, is on a ridge above Palva Valley, west of the island's center. The early voyagers all described Pitcairn as being heavily wooded, but now axes and goats have rendered it nearly treeless, as far as big timber is concerned.

As we walked along a path skirting a cliff

The Descendants of Deep-sea Voyagers Are Superb Rough-water Boatmen

Pitcairn men have been called "the world's finest surf boatmen." All are trained from the age of 14 to row, sail, and steer.

Each of three boats on the island has a captain. Crewmen seem to pay little attention to him until moments of critical action, then all pull as one man.

Oars Flash in Unison as a Longboat Leaps the Pacific's Crashing Surf

Rollers incessantly smash against Pitcairn's volcanic slopes. Bounty Bay, a rock-bound inlet, is a bay in name only. Nowhere does the island's six-mile circumference give full shelter from the sea's angry moods.

Kodachromes by Luis Marden, National Geographic Staff

A Long Steering Sweep Guides the Boat Past the Sharp Rocks of Bounty Bay

Pitcairn longboats are framed in native mango wood; passing ships contribute the planking. Once free of the surf, the rudder is shipped, the mast stepped, and the boat sails out to the hove-to ship.

that dropped almost sheer to the foaming surf, I could see bearded billy goats and their bleating nannies skipping down cliff faces. Reforestation is a losing business as long as the goats remain on the island. They clip green shoots right down to the ground. Cutting of firewood and the cropping of the goats has caused erosion on several steep slopes. Whole hillsides have slipped down into the sea, leaving only the raw red clay.

Pitcairn is only 2 miles long by about a mile wide, and after 167 years of habitation every prominent rock, cove, or cliff has acquired a name (map, pages 734-5).

I had seen one point on the southwest coast of the island marked "Oh Dear" on the map, and I asked Fred how it got its name.

"Well, native man wading 'long shore there, drop his *malu* [from Tahitian *maro*, loincloth] in water. You know that's all they wear, and he look down and say 'Oh dear!' "

Another point offshore on the west side bears the designation "Headache."

"One man gwen fishin' 'long that place, when his boy say: 'Let's go back, my head hurts!' Before he get him back, he dead."

The old accounts speak of "clouds of sea birds," but today one sees only occasional frigate birds swooping and gliding on their tapered high-aspect-ratio wings, opening and shutting their black scissor tails, and pairs of snow-white terns fluttering in graceful arcs against the dark-green foliage of the valleys.

In our walk I saw only one species of land bird, a warbler with erectile head feathers, that chirped and hopped busily among the rose apple trees. Pitcairners call them sparrows, doubtless because they reminded the English sailors of their own little town bird.

Birthday Party a Lucullan Feast

We slipped and skidded down a steep trail that plunged toward Adamstown. Near the bottom we met a man wheeling a barrow.

"You bin firewood?" Fred asked.

"Ee-yeh. Pick some plun [banana] too."

From one of the houses just below came the high, shrieking laughter of a woman, a sound as Polynesian as baked pig.

We met Flora coming down from the hill at the trail that debouched at Fred's door. "Bin up planting taty [potatoes]," she called. "Yawly invited long fa us go birthday party."

I had a quick bath in half an oil drum filled with heated rain water, dressed, took a flashlight and joined the family going up the hill.

About 50 people were seated at two long tables made of planks laid on trestles. Piled high on the tables were unbelievable quantities of food: big platters of boiled goat meat, corned beef stewed in coconut milk, chicken, boiled fish, pihi (made of yams, plantains, bananas, or pumpkin), maize, loaves of freshly baked white bread, mounds of peas and beans, hills of butter, arrowroot, and pineapple pudding, avocados, rock melons (muskmelons), mangoes, and watermelons. Here and there stood pitchers of "drink," a sweet, red liquid made by steeping strawberries in sugar water.

And of course, baked breadfruit.

"Coc'nut Milk Make Sawdust Taste Good"

The Pitcairners are amazing trenchermen. I thought I could hold my own at table, but I was forced to yield to professionals. Fred urged me to have some more beef in coconut milk.

"Coc'nut milk make even sawdust taste good," he said.

I believe it. The coconut milk used in Polynesian cookery is not the water that comes from inside the nut. It is made by steeping the flaked meat of a ripe coconut in hot water, then kneading it. The creamy liquid that results imparts a delicate flavor to whatever is cooked in it, seems to tenderize meats, and is very nutritious.

Len Brown watched the fish he had helped catch disappear.

"My, dem soon scoff up hem fish; want one he piece, tak' whole platter."

At length even Fred, the master of us all, had to stop. The host looked anxiously at Fred's stilled knife and fork and asked,

"Can I bring you anything?"

"Yes," murmured Fred, "bring me another stomach." He smiled beatifically and added, "I always say Fletcher Christian find a good place to hide."

I could barely croak my admiration to Jessie Clark, who laughed and said, "We have only one meal a day on Pitcairn: start in morning and end at night."

Actually, two meals a day are eaten: breakfast, a heavy meal at about 11 o'clock when everyone comes down from working on the hill, and supper at about 8 or 9 at night.

After the party Chester Young told me that the old island dishes are disappearing.

"Have you ever tasted humpus-bumpus?" he asked. "Eddie? China-in-the-milk? Potta?"

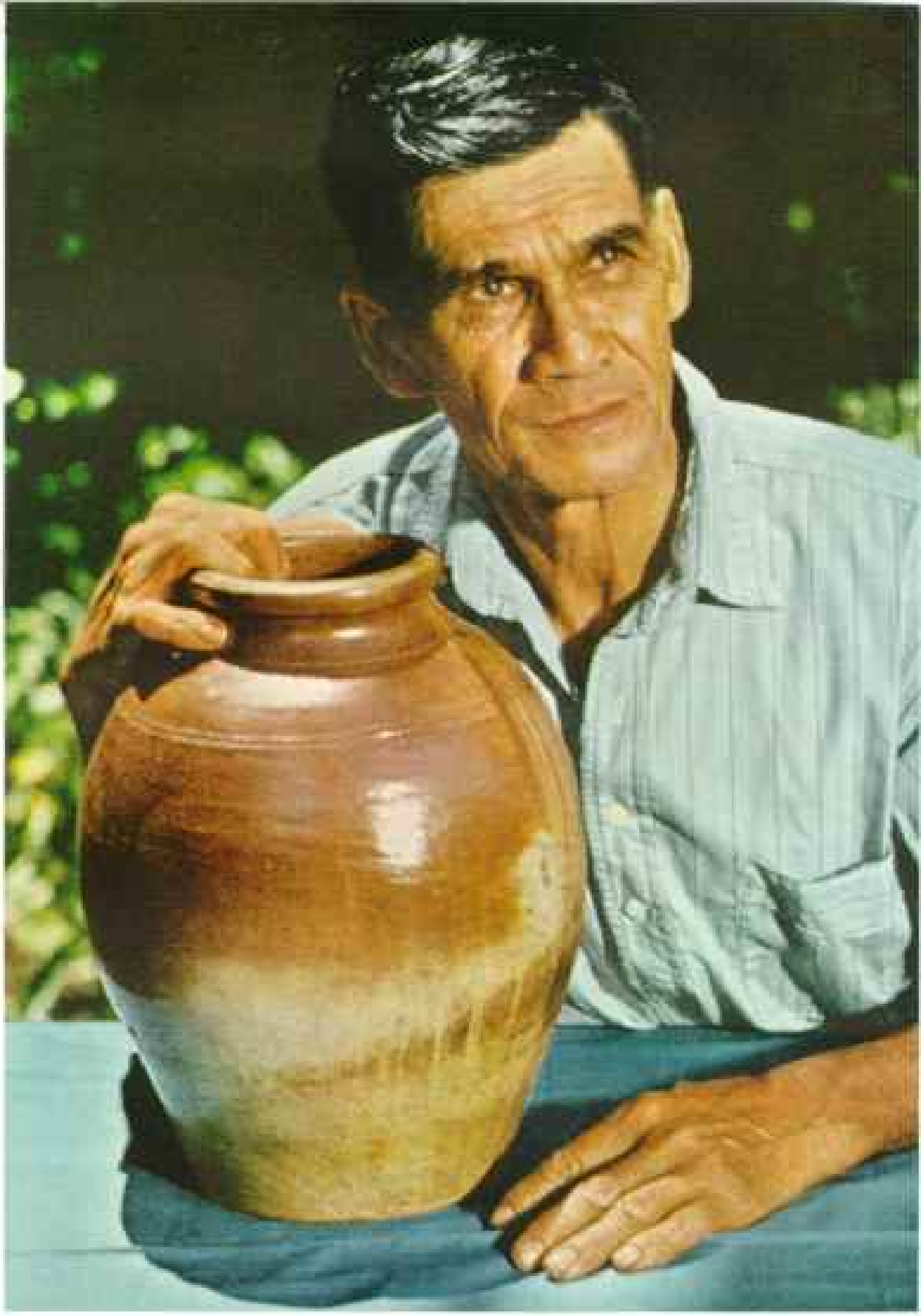
English Sailors and Tahitian Women Bred a Handsome, Sturdy Race

Eight *Bounty* seamen and 19 Polynesians joined Fletcher Christian when he left Tahiti to colonize Pitcairn in 1789. The initial settlement of 28 has grown to 153.

➔ John Christian, a direct descendant of Fletcher Christian, was chief magistrate when Queen Elizabeth made her Empire Tour in 1953. John and his wife journeyed to Fiji to be presented to the Queen. He holds an earthenware jug taken from the *Bounty* before her destruction in 1790.

⬇ Aunt Lily Warren, 79 years old, proudly wears the medal of the Order of the British Empire. Queen Elizabeth bestowed the honor on Aunt Lily in recognition of 30 years' service as midwife on Pitcairn. Lily has officially retired, but: "If they ask for me, I go," she says.

One of many islanders helped into the world by Lily is Ailsa Young (right). At 15 years she wears the flower and soft good looks of her Tahitian ancestors. Few Pitcairners look so strongly Polynesian; most resemble their English forefathers. They speak an accented English, mixed with some Tahitian words and phrases. The younger generation, having a New Zealand schoolmaster, is losing the island way of speech.



734

From This Cave Fletcher Christian Anxiously Scanned the Sea

Tradition says the mutineer retired to his high lookout to watch for ships "half in fear, half in hope." Trees screened the opening in Christian's day.

"Not yet," I admitted.

"Why, man, you've not eaten Pitcairn food."

All these I savored in time. Humpus-humpus is made of mashed ripe bananas with arrowroot flour, fried as fritters or baked.

Flora told me about Eddie, bananas cooked in coconut milk.

"It's not Eddie the name," she said, "but they put it that way. Eddie—that's Lucy's husband—he like it, so that's why they call it for him."

China-in-the-milk is another favorite way of preparing green bananas in coconut milk; potta is made by stewing taro greens in the same liquid.

Goat Fence Divides the Island

As the days went by, I became more and more absorbed into the life of the community. Allen Wotherspoon, the schoolteacher, had started a men's and a ladies' club. One night I attended a meeting of the former.

Anything may be discussed. One man said that people should not shoot "white birds," the lovely terns that fly in pairs along the cliffs. Another brought up the question of whether or not a small boat should be built to make use of a 12-horsepower gasoline engine that had been left on the island by an American scientist. Most men thought this not practical because of the difficulty of obtaining gasoline, since ships refuse to carry it. Lighting plants and other engines on the island run on diesel fuel.

Then someone brought up the question of goats. The chairman looked resignedly heavenward and everyone laughed. Goats are a sore point on Pitcairn.

The original goats were probably imported by the mutineers. There are now 400-odd goats on Pitcairn, confined to the southern half of the island by a five-foot-high fence.

Anti-goat Pitcairners say:

"They nuisances, do lots of damage."

Pro-goaters say, with Flora:

"If war come, ships cut right off, and we'll go stranded with no meat." Pitcairners remember vividly the war years, when they were almost completely isolated.

A goatmaster, elected each year, is in charge of all island goats. With eight helpers he brands the new kids as they come along. No household may keep more than two breeding nannies. The goatmaster also organizes shoots when the people need fresh goat meat.

I was delighted to hear Flora refer to the rifles used as "muskets."

Both schoolteacher Wotherspoon and Pastor Hawkes try to convince the people that the goats must go for the good of the land. They remain, by and large, unconvinced.

On Pitcairn today there are only three of the original surnames: Christian, Young, and McCoy. The forebears of the Browns migrated from New Zealand; the original Warrens and Roy Clark came from the United States.

The reason there are no representatives of other mutineer surnames is that in 1856 the British Government, fearing overcrowding on Pitcairn, moved the colony to Norfolk Island, east of Australia. After a few years, some of the people grew homesick and returned. These were the nucleus of today's colony.

Floyd McCoy is the only representative of his family on Pitcairn. From the age of 14 Floyd has been a close student of the island's history, and today he has the best collection of books on the subject on Pitcairn.

Floyd is also inspector of police, but he has very little to do in that line, for there is no serious crime on Pitcairn.

"Our chief offense," said Floyd, "is false report, and there is not too much of that." In other words, gossip—the bane of any small, isolated community.

Floyd is the custodian of two *Bounty* relics, an ax and an anvil. When he visited Norfolk Island, Floyd wanted to bring back the *Bounty's* copper kettle, but his relatives there would not part with it.

The kettle is of particular interest to the McCoys because back in the mutineer days William McCoy had used it to distill alcohol from the roots of the *ti* plant.

This happened in April of 1798, but long before that date the dark cloud of violence had settled over Pitcairn. The little colony had lived in peace for about two years after the burning of the *Bounty* in 1790. Then the wife of John Williams, one of the mutineers, died in a fall from a cliff.

Williams took the wife of one of the Tahitians, who banded together to take revenge. Over the next few years there followed a series of bloody battles and violent deaths. Fletcher Christian was shot to death as he worked in his field; William McCoy threw himself into the sea after drinking too much of his home-distilled alcohol.

(*Continued on page 761*)

Floyd McCoy Speaks to the World from His Radio Shack

QSL cards, proof of contact with radio amateurs round the world, cover the walls of Floyd's radio room. Many ham operators have heard his call, VR6AC. He is on the air Tuesdays and Saturdays at 0700 Greenwich time.

Bounty's Remains Are Discovered After 167 Years on the Ocean Floor

Though it has been known since January 23, 1790, the day *Bounty* burned, that she lay at the bottom of Bounty Bay, no one had found the exact site until National Geographic writer-photographer Luis Marden, using self-contained diving apparatus, discovered the spot in January of 1957.

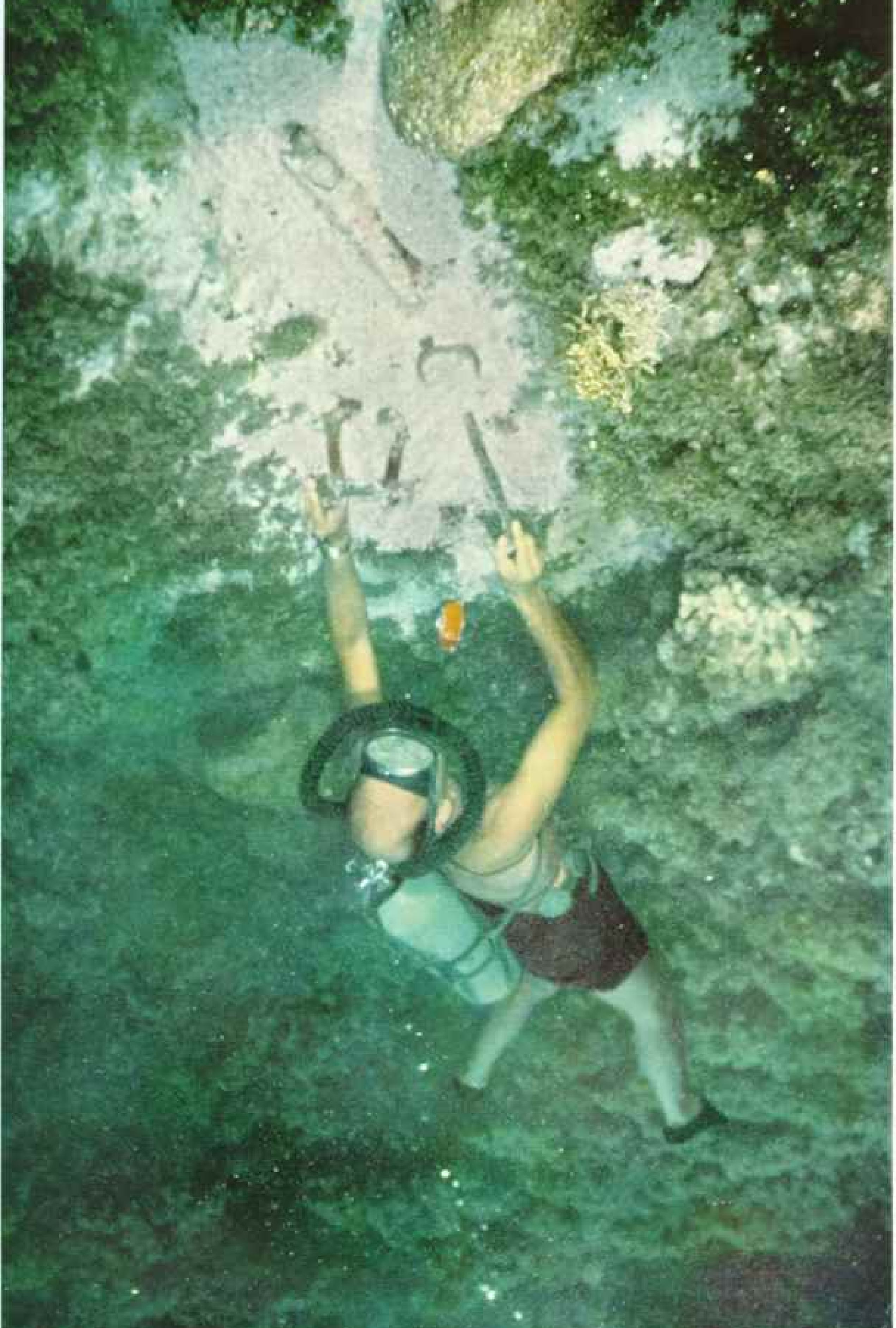
Because the hull had been destroyed by fire and sea action, no signs of a wreck could be seen. Twenty to 40 feet of turbulent water covered the site.

Mr. Marden located the *Bounty* by estimating the ship's position from a known group of iron ballast bars close to shore, then searching for unusual shapes in the limestone-encrusted sea bottom. He cut the objects from the calcareous growths with hammer and chisel.

➔ Marden examines some of the objects he discovered along the line of the ship's keel. He holds copper fittings. Rudder pintle, or pivot pin, and oarlock lie in foreground.

Above: Thomas Christian, great-great-great-grandson of Fletcher Christian, holds the 15-pound pintle. He learned Aqua-Lung diving from the author.

← Broad arrow, symbol of British Government ownership, was struck into the larger copper and bronze pieces.



Original Plan of the *Bounty*: His Majesty's Armed Vessel Was Born a Merchantman

When the British Admiralty in 1787 sought a ship to send to the South Sea in quest of breadfruit, it bought the 220-ton *Bethia* for £1,950. She was refitted in Deptford at a cost of £4,456 and renamed *Bounty*.

The vessel was armed with four short four-pounders and ten swivel guns, mainly for protection against hostile islanders. Her hull was completely sheathed in copper to protect the wood from teredos and to lessen fouling.

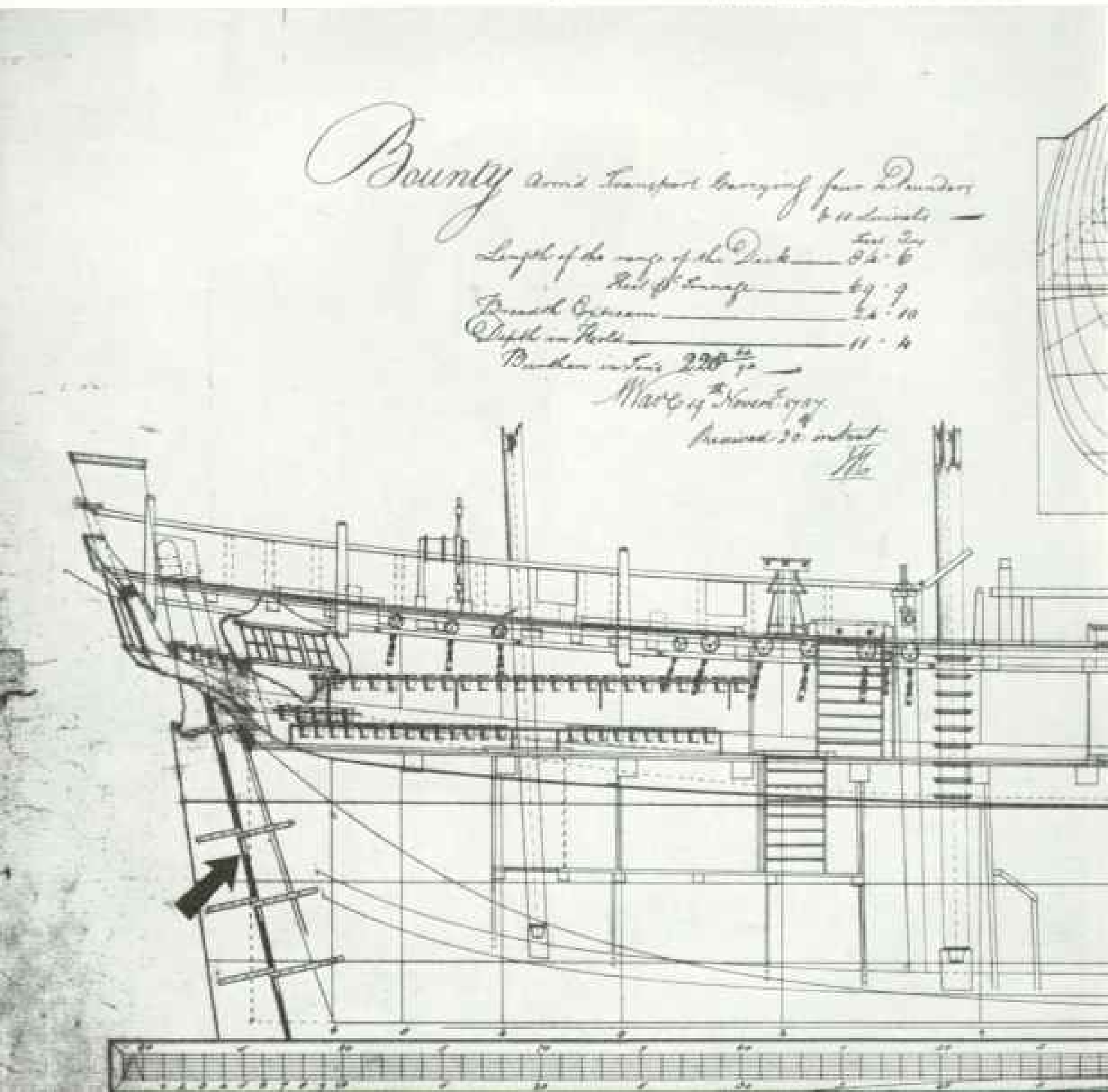
Copper sheathing had been tried for the first time in 1761. The Admiralty learned that dissimilar metals such as copper sheathing and exposed iron hull fittings when immersed in the sea set up a galvanic current that eroded the iron. Copper or bronze fittings solved the problem.

This Admiralty plan shows *Bounty* as she was refitted to carry breadfruit plants. At the stern, the entire great cabin, normally the captain's quarters, was made over into a plant conservatory. The cabin floor was sheathed with lead, and long racks were installed with holes for the plant pots. Lead drains caught precious dripping water for re-use.

When the author discovered the spot where the *Bounty* went down, he uncovered an elbow-shaped lead pipe, in all probability one of these drains.

While fishing in 1933, islander Parkin Christian found *Bounty*'s rudder and one pintle some distance from the site of the hull. Apparently, following seas had wrenched them off as the ship drove ashore. Later Parkin raised them by grappling.

Superimposed arrow at left indicates the probable position of the broken pintle shown on page 760.



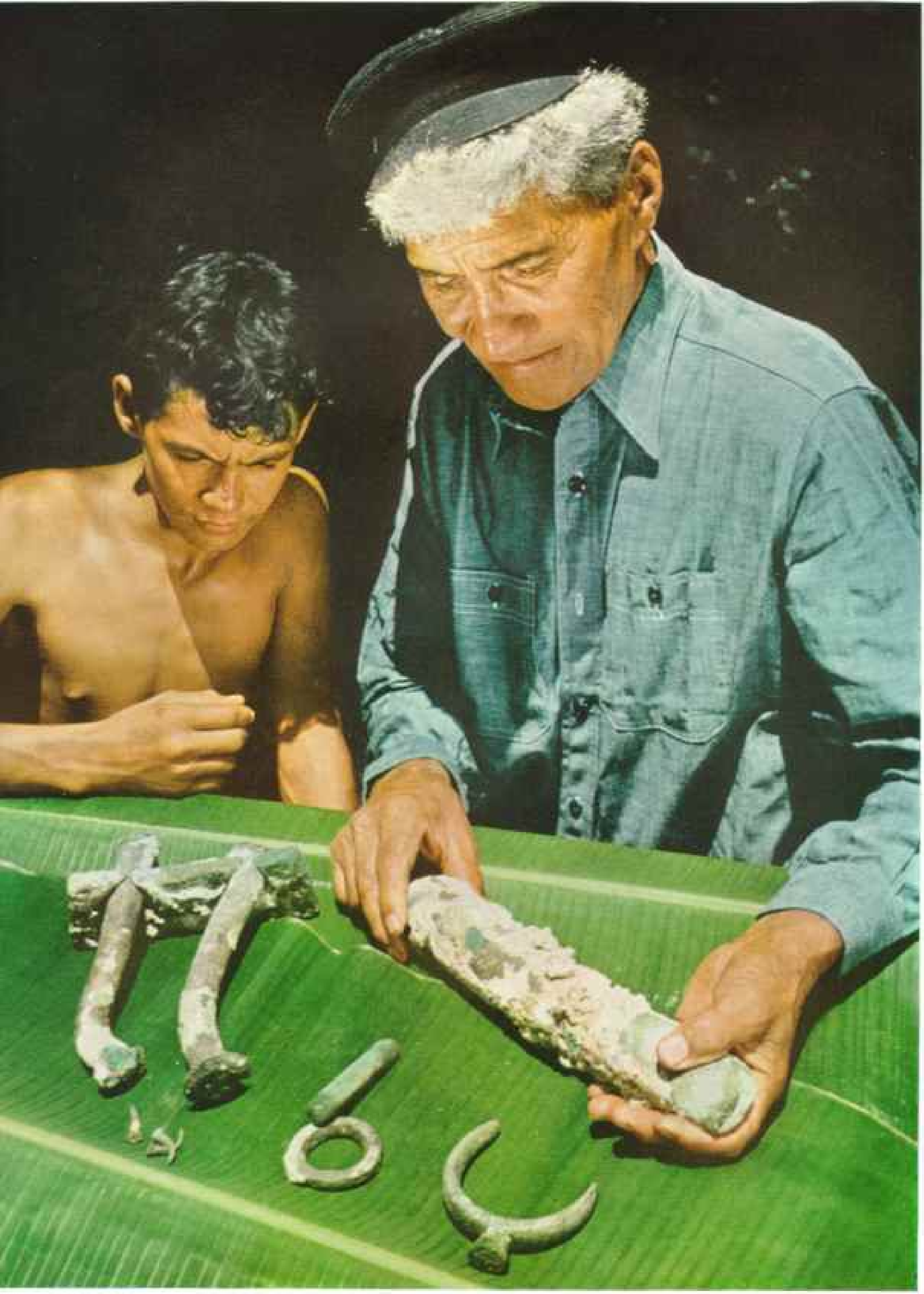
Bounty Sails for the Movies

When Metro-Goldwyn-Mayer in 1935 filmed Nordhoff and Hall's classic, *Mutiny on the Bounty*, the studio built an exact copy. Charles Laughton as a brutal Captain Bligh paced her quarterdeck and snarled his orders. While the film cast Bligh as an unmitigated villain, history has much to say in his behalf.

The new *Bounty* was meticulously reconstructed from Admiralty plans. Here, under all sail to royals, she foots along in a light breeze.

Bligh complained that the original *Bounty*, though ship-rigged, was too small for a voyage around the world. He records that "she was ornamented with a pretty figurehead of a woman in a riding habit."

759 Metro-Goldwyn-Mayer



Fletcher Christian's Heirs Study Parts of the Ship Sailed by Their Ancestor

Fred Christian, four generations removed, shows 16-year-old Fletcher Christian relics from the sea bottom. Fred holds a rudder pintle. Other objects are hull fittings, an oarlock, and sheathing nails, all of bronze or copper.

Nine years after the *Bounty* landed, all the Tahitian men were dead, and only two mutineers, Alexander Smith, seaman, and midshipman Edward Young, were still alive.

Young died of asthma a year later, leaving Alexander Smith the only man on Pitcairn, patriarch of a flock of women and children.

When Capt. Mayhew Folger in the ship *Topaz* of Boston called at Pitcairn to look for seals in February of 1808, he was astonished to see a canoe put out to sea from what he thought was an uninhabited island. In the canoe were three young men, bearing presents of fruit and a pig.

The youths took the captain ashore to meet their "father Aleck" Smith.

Bounty Bible Goes Home to Pitcairn

Smith is better known as John Adams, the name by which he called himself when other vessels touched at the island some years later. It was his real name; Smith was a pseudonym he assumed when signing the *Bounty*'s articles.

Adams one night dreamed of the Angel Gabriel, who showed him the wickedness of his past life and put the fear of divine retribution in him. From that time forward, Adams began to instruct the little community in religion, using for the purpose a Bible that had come in the *Bounty* (page 741).

Years later, the Bible was given to a visiting whaler, who took it to the United States. There it remained until 1950, when it was returned to Pitcairn. It now stands in an honored place in the church.

Captain Folger wrote to the Admiralty telling of his discovery—the first news the outside world had heard of the whereabouts of Christian and his companions. Oddly enough, he and one of his officers aboard *Topaz* gave three different accounts of Fletcher Christian's death, all based on conversations with Adams. One version said Christian was shot by the Tahitians; another that he died a natural death; still another that he threw himself from the cliffs and was dashed to death on the rocks below, the last perhaps confusing Christian's death with that of McCoy.

Why should Adams have told two or three different versions of Christian's end? Could it be that he did it to conceal the fact that Christian had escaped from Pitcairn and returned to England?

In the years 1808 and 1809 rumors were current in the Lake District of England, Christian's birthplace, that Fletcher Christian had returned to that part of England.

At about that time Capt. Peter Heywood, late midshipman of the *Bounty*, who had been tried for mutiny, found guilty, and then pardoned by the King, was walking in Fore Street, Plymouth. He noticed walking ahead of him a man who reminded him strongly of Fletcher Christian. The stranger, hearing footsteps behind him, turned round, looked at Heywood and instantly ran off.

Since then, some students of the *Bounty*'s history have speculated on the possibility that Fletcher Christian returned to England. C. S. Wilkinson, in his book *The Wake of the Bounty*, even suggests that it was Christian who inspired Samuel Taylor Coleridge to write *The Ancient Mariner*.

(*Continued on page 767*)

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Ballast Bars Lie in Crashing Surf

Heavy seas made diving impossible in Bounty Bay except in rare calms. Two divers raised a 300-pound iron bar only with the greatest difficulty. Limy encrustations so firmly cemented the bars to the bottom that the salvagers had to break them free with crowbar and sledge.

Tom Christian, one of two Pitcairn men the author taught to dive, here measures the span of a bar.

Bounty's Anchor Fluke Protrudes from Sand Like a Broad Arrow

A happy accident uncovered the relic. Irving Johnson's yacht *Yankee*, which called in February, 1957, moored outside Bounty Bay in calm weather, and crew members dived from a launch close to the ship. Using an Aqua-Lung, Wilford Fawcett spotted the fluke by chance on his first dive.

The anchor's position in 50 feet of water well outside Bounty Bay leads the author to believe that Fletcher Christian dropped a stern anchor, then paid out enough cable to enable him to enter the rock-bound inlet. Tradition records that a bow line was made fast to a tree. The ship was probably held thus, bow to shore, while she was stripped of everything useful before burning. As anchor chain had not yet come into use, flames must have burned through the hemp cable, leaving the anchor on the bottom.

Some years ago a similar anchor was recovered in Matavai Bay, Tahiti. Island tradition says it was one of the *Bounty*'s. As Bligh's careful log did not record such a loss, the big iron hook must have been one of two left by Christian. On his return to Tahiti after the mutiny, Christian took aboard native men and women, then sailed secretly in the night, abandoning the anchors.

Today the anchor from Matavai Bay rests in the Auckland War Memorial Museum in New Zealand. Its shape and dimensions correspond exactly to the one shown.

Bounty carried at least five anchors—two bowers, a sheet, a stream, a kedge—and probably spares in the hold.

Raised from Ocean's Gloom, the Anchor Sees Sunlight Again

Irving Johnson volunteered to raise the relic. With consummate seamanship he maneuvered the 96-foot-long *Yankee* through heavy swells into position directly above the anchor. He then lowered his own Danforth anchor to waiting divers, who passed a wire loop from fluke to fluke. Using her winch, *Yankee* then took a strain. The mass of iron trembled and shifted, but would not break free from the sand.

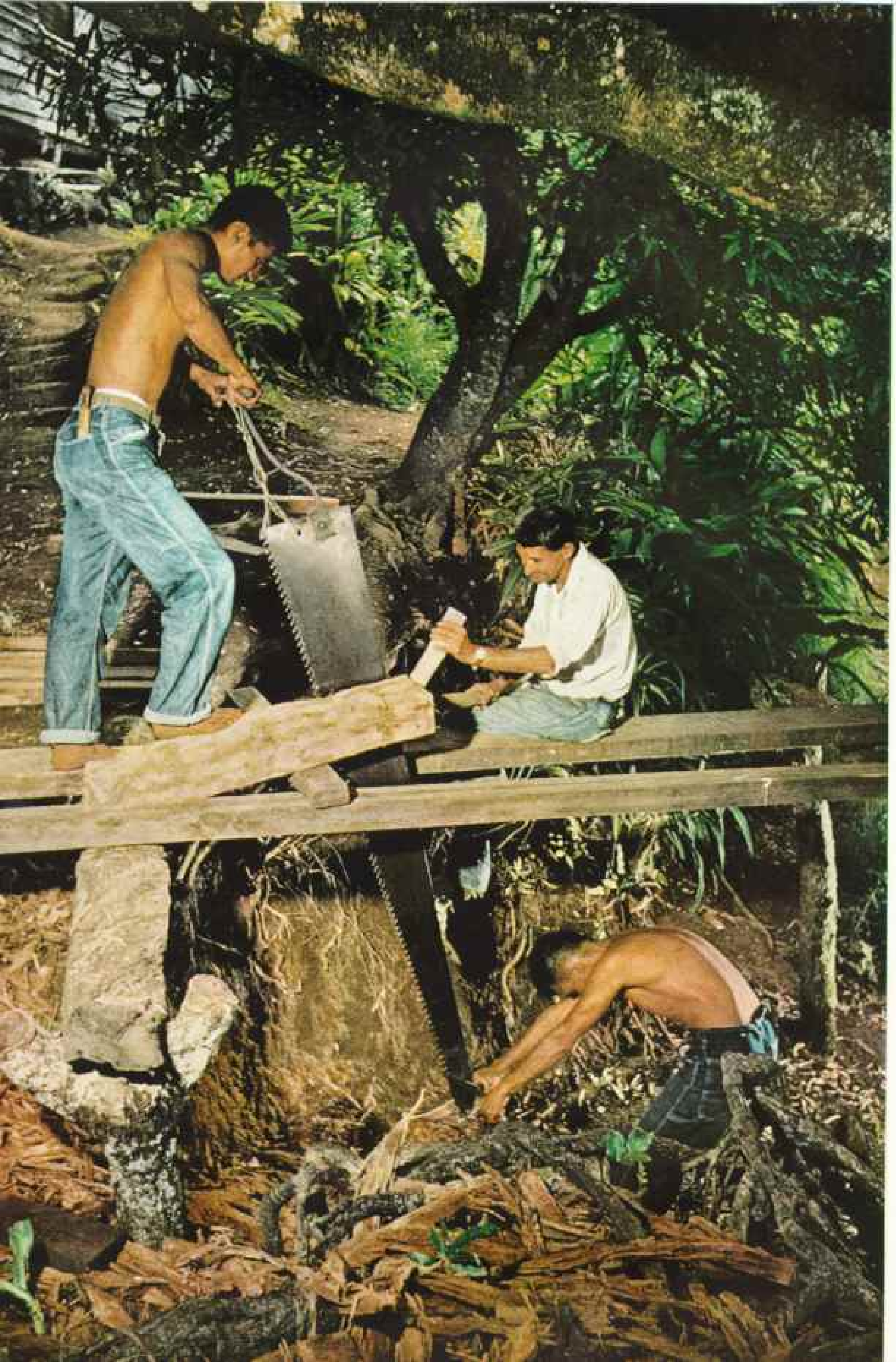
"I remembered," says Captain Johnson, "that my dentist, when pulling a tooth, yanks from several directions, so I maneuvered the *Yankee* to take a strain alternately from each side."

After 15 minutes of hauling and jockeying, the old anchor suddenly let go in a cloud of sand (below).

Here, as the hook emerges, divers make fast extra lines.

→ The salvaged 12-foot anchor rests on the landing in Bounty Bay. When it broke free from the bottom, most of the wooden stock remained buried and only the fragment shown at the feet of young Fletcher Christian was recovered.

The anchor is the old Admiralty pattern, which was distinguished by straight-V flukes. Rounded flukes did not come into use until about 1810. The short length of chain attached to the ringbolt probably was used to make the anchor fast when it was raised to the cathead.



It Takes a Strong Back to Work the Ancient Pit Saw

Pitcairn men are skilled woodworkers. Those who emigrate to New Zealand usually work as shipwrights and carpenters.

Three men usually work on a sizable piece of wood. To keep the long blade from pinching, the third workman taps a wedge into the cut. Big timbers are imported from Australia and New Zealand.

Jigsaw Canoes Are Built in Halves

Original settlers hollowed dugouts from single logs, as on Tahiti, but soon ran out of big trees. Their descendants are forced to construct boats of cunningly fitted pieces. Wood is so precious that no block, however irregular, is discarded. The author counted more than 40 pieces in this canoe.

Natural curvature is used wherever possible; some bits are shaped by the adz. Strakes are screwed together and calked with pitch. Surprisingly, these patchwork boats stand years of pounding in heavy seas.

Canoes used to be made from wood of the *bauru*, a kind of hibiscus. Nowadays island women peel so much of its bark to make souvenir "grass" skirts that few trees get a chance to mature. Mango and breadfruit wood, used as substitutes, are heavier but last longer.

Islanders use canoes chiefly for fishing. In calm weather a fleet of 25 boats may take off for fishing grounds offshore. Mostly bottom-dwelling species, such as snappers, take the bait, but occasionally jacks, albacore, and tuna sweep in from the open sea and strike.

Hooks are baited with crab or lobster speared by women in rock crannies along the shore. Best catches are made at night under torchlight.

A sum of gold ducats Captain Bligh carried has never been accounted for. Could Fletcher Christian have used it to buy passage back to England? The question adds one more facet of mystery to the many-sided adventure of the *Bounty*.

Fred had told me that his grandfather Thursday October Christian (son of the original Thursday October Christian, Fletcher's first born) had pointed out a spot next to a big pandanus tree where Fletcher Christian had been shot while he worked in his garden, and buried by the women who found him.

I persuaded Fred, Tom, Len, and young Fletcher to go up the hill with me to dig at the place, to see if we could find any trace of a body. It was a blazing hot day, and my friends trudged along without enthusiasm. They carried "muttocks" for the digging.

On a hillside waist high in grass Fred pointed to the spot, and the young men set to work. When they had dug a hole about two feet deep, the three gravediggers threw down their mattocks and disappeared into the grass. In five minutes they returned carrying a big watermelon and some pineapples. We sat in the scant shade and cut up the fruit.

Pitcairn pineapples are the best tasting in the world, I make no doubt. The juice runs from them in a continuous stream when you bite into them, and the flavor must be tasted to be believed.

It was too hot for much exertion. Half-heartedly the boys dug down to about four feet. Then Fred said:

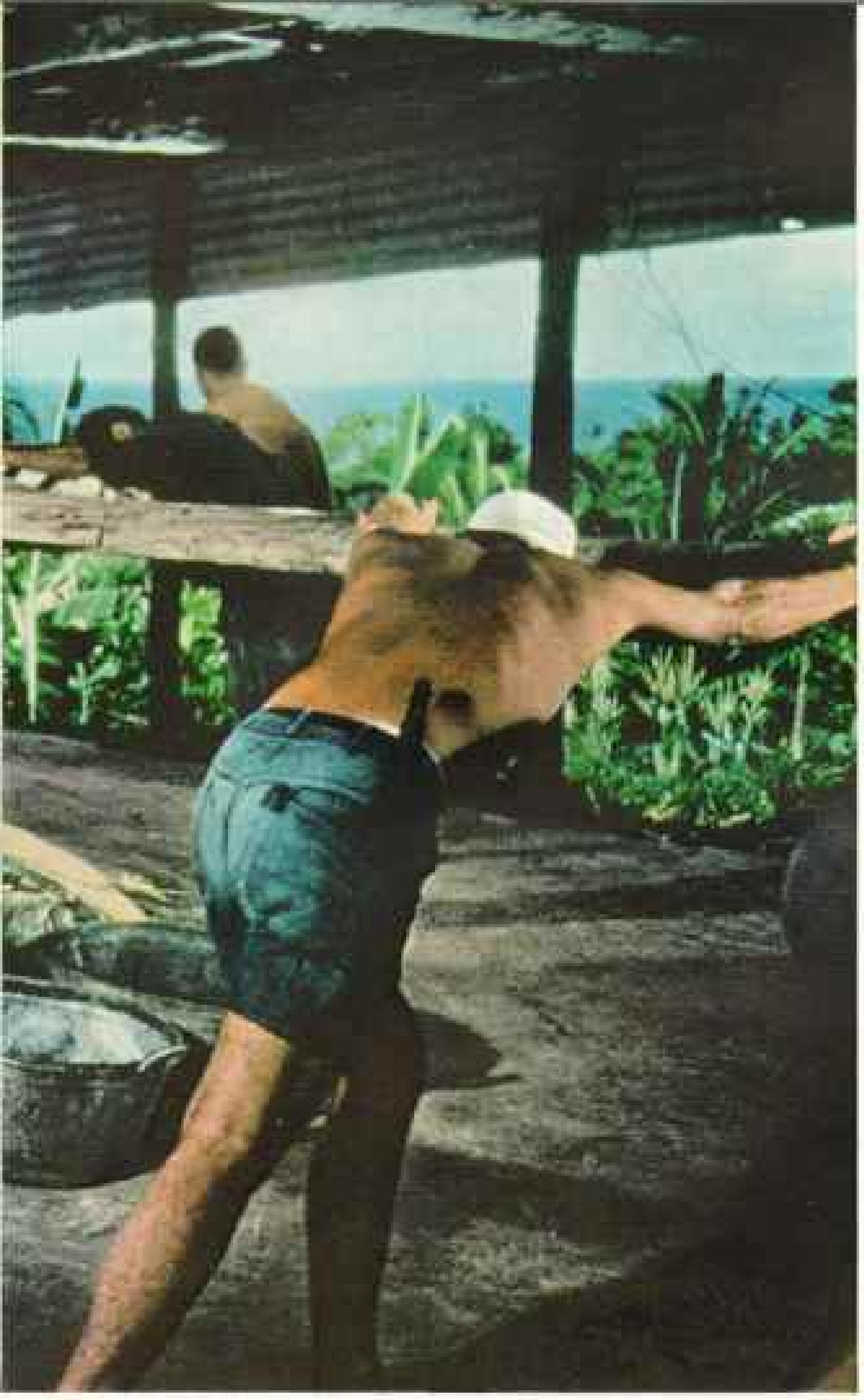
"I doan' think them black wimmens bury him—or if they do, they doan' have time to bury him deep. So cahn't be here."

We picked up the tools and walked down the hill. I still do not know whether Fletcher Christian is buried on Pitcairn or in England.

Pitcairn a Regular Port of Call

I had always thought of Pitcairn Island as remote, and so it is; yet I was surprised to find how often ships visit the place. Last year, for example, there were more than 60 calls. In practice, one can count on seeing a ship about every 10 days.

Usually they stay about an hour, though some stop longer. Of one who generally stops only half an hour, Flora would say:



Like Sailors Toiling Round a Capstan, Islanders Turn a Sugar Press

Pitcairn people work hard for a living. Men, women, and even children are busy from daylight to dark cultivating gardens, carving wood, weaving baskets, and catching fish.

Eight men, two to each bar, trudge around this heavy cast-iron press, which was manufactured years ago in the United States. Seamen all, they wear sheath knives fastened to the belt, usually in back where they do not interfere with nautical activities.

Chester Young sits on the hub and plays a chantey on a harmonica. Thelma Brown feeds cane stalks into the iron rollers. Pressed juice pours into the tub.

Opposite, below: Men take advantage of a calm day to go fishing. Putting to sea in home-built canoes, they fish with hook and line for reef fish and deep-water species.

The feel of a nibble at the hook does not excite the Pitcairn fisherman. Instead, he watches the cruising fish through a waterglass and strikes only when he sees it mouthing the bait.

Scanning the bottom through such a glass 24 years ago, Parkin Christian spotted a *Bounty* rudder pintle that lay partly uncovered after a storm had disturbed the sand.

Pitcairn women weave strips of pandanus leaf for baskets and hats to sell to tourists on passing ships. They sun-dry the palmlike leaves, dye them in vats, and rip them into narrow ribbons. Souvenir baskets usually bear the word "Pitcairn" worked into the design.

"O-a, he a hurry-up captain."

If there is anywhere in the world where the romance of the sea should still cling to ships, it is Pitcairn. Yet even at this place fast and reliable motor vessels have reduced the comings and goings of deepwater vessels to the soullessness of a bus schedule.

On occasion captains have announced to Parkin as he climbed to the bridge:

"Sorry, we can stop only half an hour this time; if we stay longer we shall miss the tide going up the Thames."

The Thames estuary is 8,300 sea miles away from Pitcairn Island.

Pitcairn lies about halfway between Auckland and Panama, which are 6,500 miles apart, but it is almost 400 miles north of the shortest route between the two. Thus islanders live in apprehension of a change of route that would deprive them of their chief contact with the outside world and their principal source of private revenue.

Islanders are hard hit when too many ships call on Saturday, the Adventist Sabbath, because their religious principles will not permit them to trade then. In 1956, 14 ships came on Saturdays. The people still go out to the ship and give some fruit away, but they will not buy or sell on that day.

Island Timetable Geared to Ships

Everything on the island is geared to the coming and going of ships. There is always keen rivalry among the men to be the first to sight an incoming vessel. Usually Tom has talked to the ship by wireless, and he knows about when she is due.

The people begin to take their basketloads of souvenirs and fruit down to the landing several hours before the expected arrival (page 779). They carry baskets and bunches of bananas suspended from a shoulder pole, called a *to'o*. Most of the names of utensils are still pure Tahitian, probably because they are things the women used.

Almost anywhere you go on Pitcairn you will see men carving wood and women weaving baskets (pages 769 and 777). When the men are not at sea or working in the fields, they are usually whittling a piece of wine-red miro wood to make a flying fish, a turtle, or a sea bird. Tourists on the ships take all the island can produce.

I sat one day with the men up under the flagpole at The Edge, looking out to sea for the ship (page 736). Suddenly a man sprang to his feet and sang out, "Sail ho-o-o!"

I saw nothing, but, like the rest, I took his word for it and started down the hill. One youth raced to the bell to give the signal: five strokes repeated three times.

Children are not permitted to go aboard ship, and one man called out to some youngsters who had started down the trail:

"Bout yawly orkal sullen gwen?" (Where are you little children going?)

"We gwen narwy." (We're going swimming.)

More people arrived at a half trot. Someone called:

"John, where's you-a?"

Receiving no answer, he asked another man, "You ka bout he-sa gone?" (Do you know where he's gone?)

"I kawa. I no bin see-um." (I don't know. I haven't seen him.)

Pitcairners have been called the finest surf boatmen in the world. These descendants of seamen live from early youth on and by the sea. All boys from the age of 14 go into the boats to train; at 15 the boy becomes a crew member and pulls an oar.

Three boats, *Ho Ho*, *Nuni*, and *Surprise*, were in use when I was on Pitcairn, while a fourth, the *Barge*, was resting. A boat rests for four months, then goes back into service for a year.

My notebook records a trip out to the *Mataroa* of the Shaw Savill Line, on a day when great green-and-white combers were crashing on the black volcanic rocks of Bounty Bay.

"By the time she arrives, the sea has moderated a bit, but as the three boats put out to sea, each in turn is lifted high on the rollers, hesitates with bow hanging in air, then slides down the translucent green hill of water, oar blades flashing (page 750). Be-

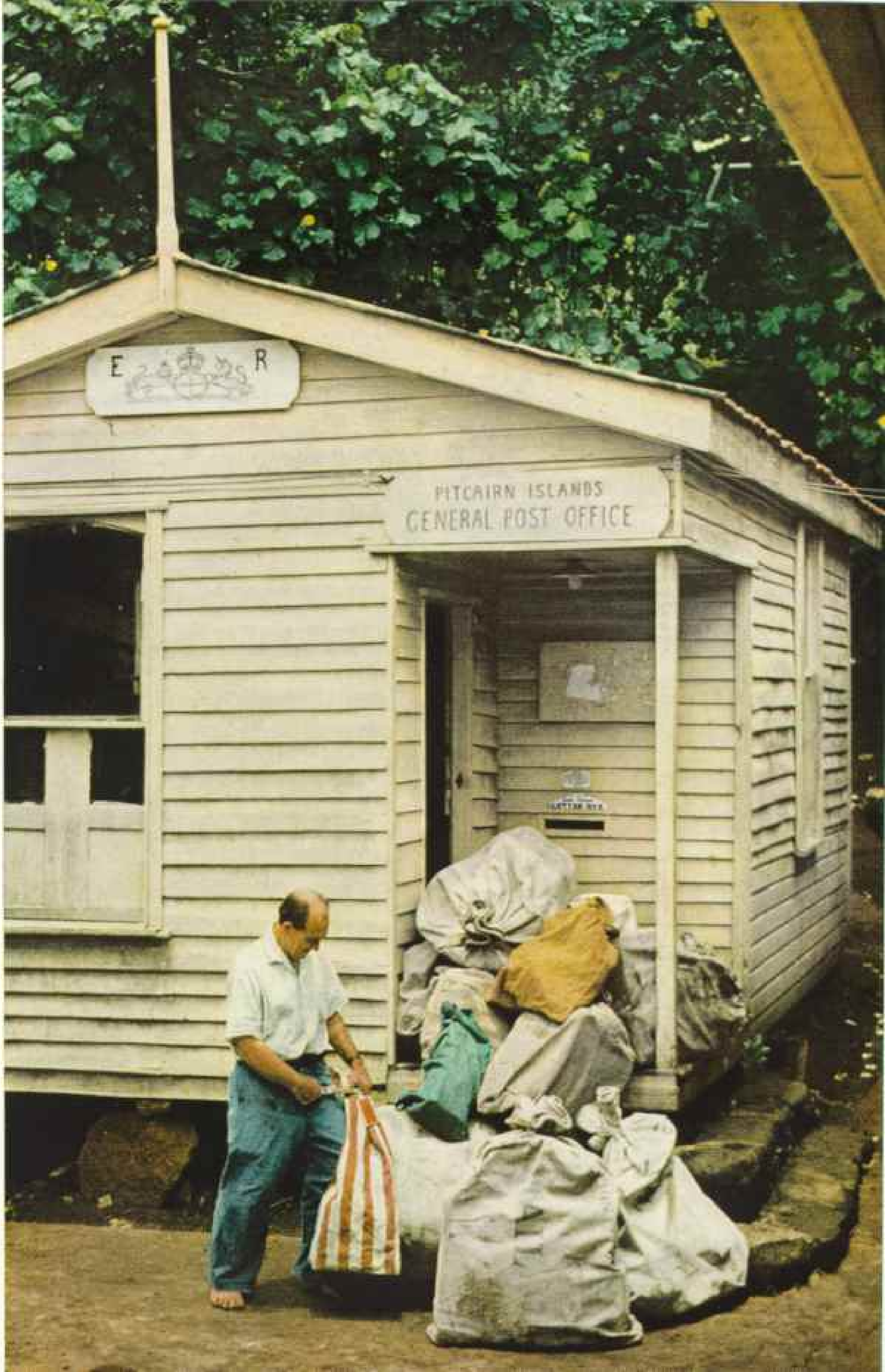
Pitcairn Post Office Is Known to Stamp Collectors All Over the World

This small office bulks large in Pitcairn affairs, for all government revenue comes from the sale of stamps.

Law requires every visiting vessel to take on mail, but deliveries are made only by ships flying the Royal Mail flag.

"Pitcairn Islands" include three uninhabited isles, Oeno, Ducie, and Henderson, which are grouped politically with Pitcairn. The postal cachet's use of the plural confuses some amateur philatelists.

Here postmaster Roy Clark, a native American, lifts bags of registered and ordinary mail.


E R
PITCAIRN ISLANDS
GENERAL POST OFFICE

yond the combers, we set our sails and proceed to steamer rendezvous three miles out.

"Boat piled high with baskets of fruit and souvenirs. Clement says, 'I doan' like to take fruit out to ships like this. Rather cahly it inside.' I have seen him eat five pineapples without stopping. And half a watermelon. Good man.

"I am riding in Len's boat, *Surprise*. Roy chaffing Len about several days' growth of beard, said ship's people would think islanders a run-down lot if he went out like that, said he looked like a heathen. Len shot back: 'Well, den, you-a call yus Maker a heathen? He never shave.' "

When the boats come alongside a ship, two are usually made fast astern and one forward. One man stays in each boat on watch; these positions are changed every 10 minutes so that everyone has a chance to go on deck.

After selling their curios, the islanders rush to buy at the ship's shop. The fastest trade is in sweets. The islanders buy "lollies" by the box. Canvas yachting shoes, tinned milk, soap, and even watches move briskly.

It is a Pitcairn tradition to sing from the boats before casting off. One captain told me that if trading has been unusually good the passengers hear a lusty rendering of the hymn "God Be with You Till We Meet Again."

Duddy and Mummy Guard Bounty Bay

On our homeward run, the helmsman pointed our boat too close up into the wind. The captain shouted:

"Let'er off! Let'er off! You want her sail like Flattie?" Flattie is the outermost of three rocks that stand at the entrance to Bounty Bay. The first two rocks are called Duddy and Mummy, after Thursday October Christian 2d and his wife.

We landed and hauled the boats out as the sky took on a strange mulberry color that contrasted sharply with a robin's-egg-blue sea. The two colors were divided clearly, as if the horizon were drawn with a straight edge. As we topped the ridge, the glow suddenly went out and the sky turned to lead.

On Pitcairn many things—buildings, tools, foodstuffs—are owned in common. When a ship comes in, a certain amount of fruit is contributed to a common fund by every householder. As community property, the fruit is traded en bloc to the ship's steward for staples such as wheat flour, potatoes, onions, or sugar. The articles so obtained are divided on the courthouse square into 48 equal heaps, one for each household.

One of my chief objectives in coming to

The Sun Back-lights Gudgeon Sea Cave as in a Doré Woodcut of Dante's Inferno

Entry is possible only at low tide in a calm sea. Boatmen must lower their heads as they pass the entrance. Long swells send seas thundering into the grotto and fill it with mist.

When the tide creeps higher, all but blocking the entrance, each surging sea, like a stroking piston, compresses the air inside. Visitors then feel a stunning blow on the eardrums.

Pitcairn had been to find, if possible, the resting place of the *Bounty*. I questioned the islanders about any visible remains. Everybody knew that a clutch of iron ballast bars lay in the surf, almost on shore, but no one could tell me anything of the actual ship.

"It-sa gone," they all said. "Nothing left."

Everyone knew, of course, that she had gone down in Bounty Bay. The question was, exactly where?

I soon found in going over the area with a waterglass, and later in diving to the bottom, that no "wreck," as such, remained. The burning, the fishing up of timbers more than a century ago, and, above all, the relentless pounding of the Pacific combers had demolished the *Bounty*. The most one could hope to find would be metal fittings.

One night at Fred's house Parkin told me how he found the *Bounty's* rudder.

It was 1933. Parkin Christian and Robert Young had been fishing, and they were paddling their canoe toward shore. At the entrance to Bounty Bay, in 40 feet of water over a sand bank at the foot of weed-covered rock, they stopped. Parkin got his waterglass over the side and scanned the bottom.

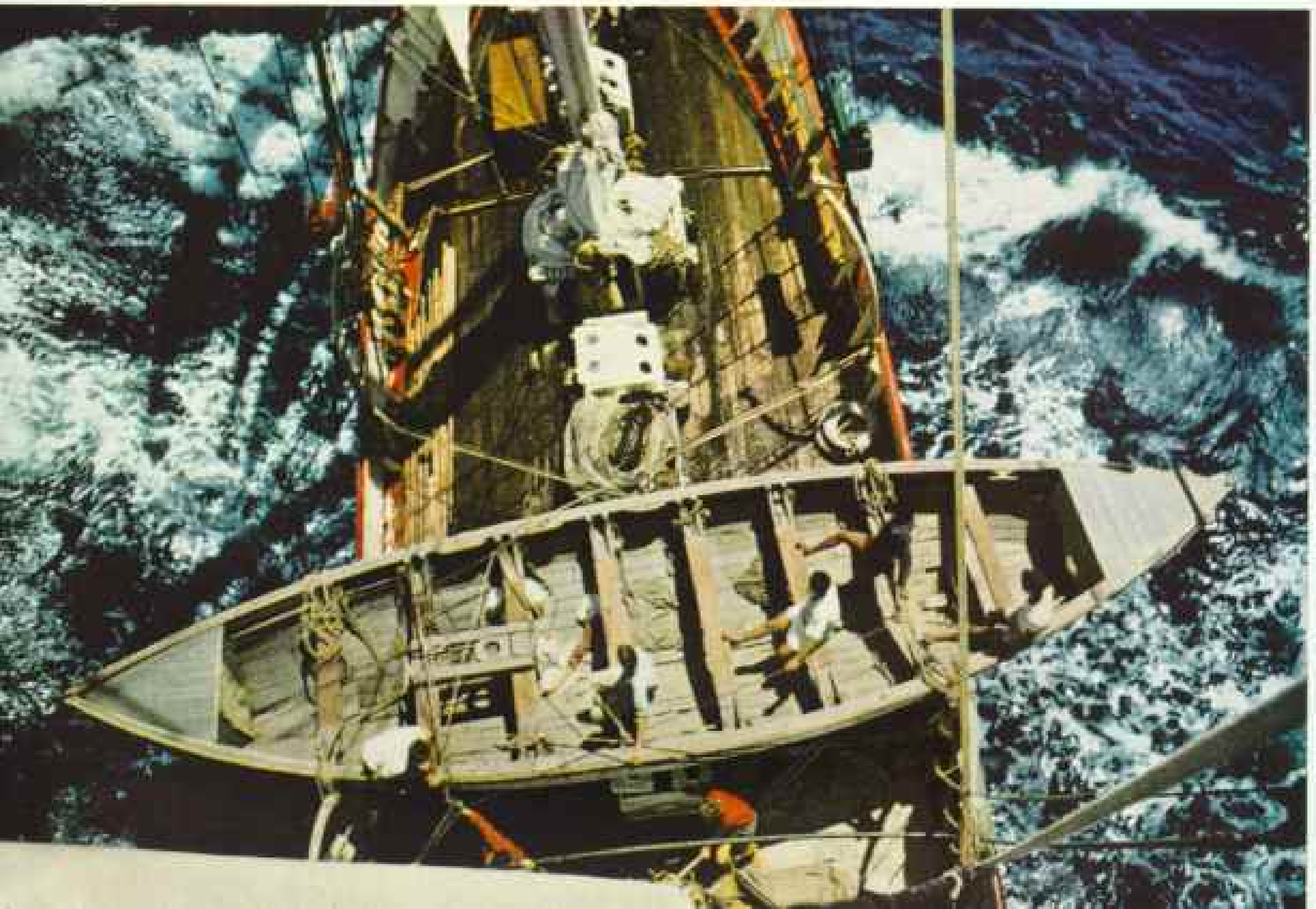
"These nanway [a kind of fish]," said

♠ Steady Hand Holds *Yankee*'s Wheel

Clifford Warren takes the helm as the brigantine clears the Pitcairn cliffs for Henderson Island.

♦ Longboat Rides Athwart Steel Bulwarks

For 23 years Captain Johnson has taken Pitcairn men and their boat 120 miles to Henderson to cut wood.



Parkin, "they lived there, and I try to look for fish. The gudgeon is laying on top of the sand right out, and I start to sing out:

"'There's the *Bounty*'s gudgeon!'

"Then I catch myself, I say, 'Oh, what a fool; I know I can get it for myself.'

"We come ashore. I pull my canoe up and start for home. I come get a line and sinkers and off I go again. I don' want even my wife to know where I'm goin'.

"I get it up first time; it come only so high, then it slip off. It stand right up on bottom; so I let the noose down and it go right down as though I put a hat on my head, and up he come.

"A chap don't see what I take out of my boat. He ask me did I catch any fish; I say I get one."

The gudgeon (it actually turned out to be a rudder strap and pintle) had at first slipped from Parkin's noose; it struck the bottom and uncovered some planks and timbers. It was the *Bounty*'s rudder. Parkin returned the next day to fish up the rudder, but it was heavy and he needed help; so he could no longer keep his find a secret.

Bounty's Voyage Begins with Breadfruit

The *Bounty* started life as the merchant ship *Bethia*.

In 1787 one of the secretaries of state had addressed a letter to the Lords Commissioners of the Admiralty:

"The Merchants and Planters interested in His Majesty's West India Possessions have represented that the Introduction of the Bread Fruit Tree into the Islands in those Seas to constitute an Article of Food would be very essential Benefit to the Inhabitants, and have humbly solicited that Measures may be taken for procuring some Trees of that Description ... to be transplanted in the said Islands. ...

"I am in Consequence to signify to your Lordships His Majesty's Command that you do cause a Vessel of proper Class to be stored and Victualled for this Service. ..."

The planters thought that the breadfruit, which Dampier, Cook, and others had described as a cheap and nutritious substitute for bread, would make good food for slaves.

The *Bethia* was renamed in recognition of George III's bounty to the West India merchants. She was of 220 tons burden and she had an over-all length of about 100 feet.

The *Bethia* had been sheathed in wood, but for better protection against the shipworm (*Teredo navalis*), the Admiralty ordered that the vessel be sheathed in copper.*

Copper sheathing had been tried for the first time in 1761, with only partial success, because designers of that day were ignorant of the phenomenon of electrolysis. When ferrous and nonferrous metals are immersed in salt water, a galvanic electric current is set up which rapidly corrodes away the iron.

To prevent such corrosion, the *Bounty*'s gudgeons, pintles, and other exposed underwater fittings were also made of copper and bronze, and so have lasted intact to this day.

Ship Stripped Before Burning

We may picture the mutineers on January 23, 1790—Christian well aware that all signs of habitation on Pitcairn must be destroyed, the others torn between the fear of discovery and the knowledge that by destroying the ship they would forever cut themselves off from the world they knew.

All agreed at last, and everything useful in the *Bounty* was taken ashore: top hamper, timber, all the metal that could be drawn, sails, compasses, chronometer, glass from the great cabin windows, sheet lead for musket balls, forge, muskets, cutlasses, hand tools, pitch, earthenware, guns.

In my mind's eye, I see the *Bounty* anchored in eight fathoms well outside the semicircle of Bounty Bay. One calm day cable was paid out, and she was worked into the bay and run aground. Following seas must have slammed her rudder from side to side with shuddering crashes until it snapped off, and, with a final lift under her stern, the sea-worn little vessel struck hard upon the shore.

Then they set fire to her. Once she was alight, she must have made a stout blaze, with her sun-dried timbers and pitched seams.

I can see her blazing away, and hear the crackling of the flames. The little band huddles silently on shore, watching the flames eat away their last hope of seeing England again.

Lady Diana Belcher, in her book on the mutiny, speaks of the arrival at Pitcairn in 1841 of "H. M. S. *Curaçoa*" (*Curaçao?*) under Capt. Jenkin Jones. She writes:

"Captain Jones, having ascertained the spot where the *Bounty* had been sunk, succeeded, with some difficulty, in raising the charred hull, and found that such had been the solidity

* See "Shipworms, Saboteurs of the Sea," by F. G. Walton Smith, NATIONAL GEOGRAPHIC MAGAZINE, October, 1956.

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Fred Christian Carves ➔ Wooden Flying Fish

All Pitcairn males are expert carvers, selling their miro-wood creations to passing voyagers. Each man stamps his name on his products.

A favorite design is the fanciful flying fish, with incised scales, inlaid eyes, and orangewood teeth. Other subjects are vases held in a carved hand, turtles, sea birds, walking sticks, and boxes with puzzle locks.

Carvers maintain small sheds for workshops. Some have primitive lathes worked by foot.

Fred receives mail orders from all parts of the world. Sometimes a ship's officer requests a special piece for delivery on the return voyage. In such instances Fred stamps the owner's name, as well as his own, into the wood.

➔ Miro heartwood shows variegated grain. Pithy outer layer is discarded.

Loggers on Henderson Drag and Carry Miro Timbers to the Waiting Longboat

Once Pitcairn was covered with trees, but ruthless cutting deforested the island in a few generations.

Six times the size of Pitcairn, uninhabited Henderson is densely forested.

Yankee remained 24 hours, and Islanders slept ashore in order to cut as much wood as possible. Each axman blazed his mark into the wood he felled and on return to Pitcairn claimed his own pieces.

In 1957 *Yankee* made her last cruise under Captain Johnson. If her new owner does not call at Pitcairn, Islanders will have to sail their open boats to Henderson, a hazardous undertaking.

Henderson Island has a curious connection with literary history. In 1820 the Nantucket whaler *Essex* was rammed and sunk in mid-Pacific by a sperm whale. Two of her lifeboats landed on Henderson. Finding little water and no food, the shipwrecked mariners put to sea again and finally were picked up near the South American coast after a three-month voyage. Incredible hardships reduced them to cannibalism. From the *Essex* story, Herman Melville drew inspiration for *Moby Dick*.

of her timbers, that her 'heart of oak' had survived the power of fire and water, and the effects of submersion for half a century."

It seems difficult to believe that a vessel not equipped with special salvage and lifting devices could have raised the "charred hull" of the *Bounty*. No doubt Captain Jones did bring to the surface some sizable timbers of the old ship. In any case, so far as I can ascertain, nothing more was seen of her until Parkin Christian grappled the rudder to the surface in 1933.

Len said to me one day: "I can show you one copper bar. My father first see it 'bout 15 years ago. I dive down to it and touch it, but it's stuck to the bottom."

This was the first word I had had of anything definite that might mark the site; so on the first calm day we got Len's canoe and paddled out to the place where Len had seen the copper bar.

Fifty yards offshore Len stopped paddling and turned to take bearings. He sighted over one shoulder at the soaring rock spire of Ship Landing Point, then looked up at The Edge.

"She right here," he said.

Sea Floor Yields Bronze Rudder Pintle

I lifted the waterglass over the side and pressed its glass bottom into the heaving sea.

"See it?" Len asked.

I shook my head. Len peered over my shoulder and pointed. Deep in a fissure I saw a short, gray-green bar, too straight to be a natural growth. Little yellow wrasses flickered unconcernedly over it, indifferent to the encrusted fragment of history.

I shrugged into the harness of my Aqua-Lung, put on rubber flippers and face mask, and fell backward, diver-fashion, into the sea.

Turning over, I flutter-kicked my way down into the miniature valley, past flowerlike small corals, until my hand closed on the bar. It was cemented firmly to the bottom.

Directly above, Len's face peered through the disk of the waterglass. I made a hammering motion. The face disappeared, and a hammer and cold chisel were slowly lowered to me on a cord.

I stood on my head in the cleft in which the bar lay. Down there my head and shoulders were in comparative calm, but every few seconds the surge would slam into me and my wildly kicking feet were then powerless to hold me vertical. Helplessly I would crash against the coral fingers that clung to the rock and feel the stings that meant the sharp fingers were scoring crimson lines on my legs.

For a quarter of an hour I chipped away around the sides of the two-inch-thick bar. When I had cut a trench in the limestone bottom all the way around it, I inserted a steel rod, heaved, and the bar came away.

In the boat we turned the bar over and over. It tapered slightly to a rounded and eroded point and the upper end was irregular; it was evidently a pintle that had broken off from the rudder strap which held it. I think this is the second of four pintles shown on the Admiralty plan (page 758).

Parkin had pointed out from The Edge the spot where he recovered the rudder; that was only a dozen yards from the rocky embrasure that held the pintle we recovered, but though Len, Tom, and I searched the area minutely in the calm days that followed, we found no other trace of the *Bounty*. Obviously, the main body of the vessel lay elsewhere.

Where Did the *Bounty* Go Down?

"I think," I said to Len, "that as the ship drove ashore, the following seas broke off her rudder. The pintles dropped in the sand, and the *Bounty* drove aground some distance beyond. What do you think?"

"Sound reasonable," said Len.

"Well, then," I said, "where did the ship itself go down?"

We talked it over. The thing is relatively simple, we thought: The *Bounty* was about 100 feet long; the ballast bars are over there in the surf; the rudder and pintles were found out there; all we have to do is draw an imaginary line between the two places, cruise along this line on the bottom, and we are bound to find some trace of the ship.

Cruise we did; every day of reasonable calm we filled the air cylinders and dived. We nearly plowed furrows with our chins in the bottom. But we found nothing.

Then, late one afternoon nearly six weeks after my arrival on Pitcairn, I took Chester Young out to show him how diving was done. By this time we were losing hope, but we paddled out to near where we had found the pintle.

Len helped me on with my Aqua-Lung, and I dived first. While waiting for Len, I took my bearings on the big rock under which the pintle had lain and cruised slowly over the animate carpet of undulating seaweed, scrutinizing the cove bottom closely. Big jacks swam round me, watching curiously. On a

Three Longboats Take On Goods for Trade with a Passing Ship

Passengers bound to or from New Zealand eagerly buy curios and fresh coconuts, pineapples, oranges, lemons, grapefruit, bananas, and avocados. Pitcairn's fertile volcanic soil gives an exquisite flavor to all fruits.

bed of weed I saw a crescent-shaped object.

Thrusting my face closer, I saw it was an oarlock. Unlike the standard U-shaped oarlock, this one had one arm markedly longer than the other, forming a tilted crescent that looked strikingly like a new moon or the symbol of Islam (page 757).

As I watched, 14 Moorish Idols, bizarrely shaped black-and-yellow reef fish, swam in echelon over the crescent—Moorish fish maneuvering over a Moorish crescent. Fantastic coincidence that only the sea can produce!

Then I came unexpectedly on a long, sandy trench. The end nearest me was covered with white limestone secreted by calcareous algae—lithothamnion, a stonemaking plant—and I could see little squiggles in the surface, a curious marking that resembled nothing so much as petrified worms.

I thrust my face closer, almost touching the bottom. My heart gave a jump. The squiggles were encrusted sheathing nails, *Bounty* nails—dozens of them. I looked up for Len. He was just above me, staring questioningly. I reached up my hand for his, pumped it violently, and pointed. He looked up grinning and nodding, and we shook hands again.

We had found the resting place of the *Bounty*.

Bounty Nails Give Off "Smoke"

Beyond, two other trenches stretched toward the spot where the ballast bars lay in the yeasty surf. I had been searching too far to the eastward. Apparently, prevailing winds and currents had veered the ship as she went ashore. The bow had pivoted on the shore, and the stern had swung round to the west.

I began to chip away at the layer of nails. At each blow of the hammer a puff of black "smoke" arose—carbonized wood of the *Bounty*, still clinging to metal fastenings. It was extremely difficult to hold a position on the bottom. Ever and again, the sea would bowl us over completely or carry us shoreward sprawling on our backs.

Near the nails I came on a long bolt, partly uncovered. I carefully chipped down both sides until it came free. Swinging up to the bobbing canoe, I thrust the bolt over the side.

Len and I saw enough to convince us that we had found the line of the keel, or at least one of the main strakes of the hull, though we saw no planks or ribs. Everything was covered by a hard, limy growth.

As we dug deeper, we came upon fragments of the copper with which the *Bounty* had been sheathed, in good condition and almost an eighth of an inch thick. Deeper digging should bring up larger pieces of the ship.

Broad Arrow Identifies Oarlock

That night I polished and buffed a bronze sheathing nail until it shone like gold. A piece of the original *Bounty*! The burnished gold surface caught the light with a mesmerizing effect. As I stared and dreamed, I seemed to see the shipyard at Deptford, with the *Bounty* on the stocks and the shipwrights swarming over her. I heard the ringing hammer blows, the "chink, chink" of the caulking irons, and the "chid, chid, chid" of the adzes paring away the solid English oak. I smelled the winy odor of new timbers oozing sap in the hot sun, the resinous smell of pitch, and the clean astringent scent of Stockholm tar in the rigging.

A leather-aproned workman, perched in the scaffolding, drives another nail into the copper sheathing, and says to his mate:

"Off to Otaheite and the Great South Sea! Damn my eyes, Sam'l, I've 'alf a mind to ship myself."

As I worked, the noisy electric light plants were turned off and a hush fell over Adamstown, for it was the eve of the Sabbath.

By the soft yellow light of kerosene lamps, Fred's family gathered for prayers. Fred's shock of curly gray hair shone like a halo in the lamplight. The light and shadow lay on the bowed heads of the little group with the bold chiaroscuro of a Rembrandt.

After prayers I watched Flora scrutinize the bronze oarlock in the beam of an electric torch.

"I look for the broad arrow," she said, referring to the symbol struck into all large fittings of the Royal Navy in the 18th century, "but I doan' find it." She handed the heavy metal crescent to me. I snapped on my flashlight, and the three strokes of the broad arrow leaped out at me (page 756).

"That's it, all right," said Fred. "She's

(*Continued on page 789*)

Climbing a Jacob's Ladder Is Not so Easy as It Looks

Longboats tie up to the ship fore and aft. One man remains in each boat as ship tender, while his companions swarm up the swaying ladder. Pitcairners sell their goods for money or trade for food.

All Kodachromes by Luis Marden, National Geographic Staff

Rangitiki, in a Swirl of Foam, Turns Her Back on Pitcairn Island

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Oars Shipped and Sails Set, Longboats Come About for the Return

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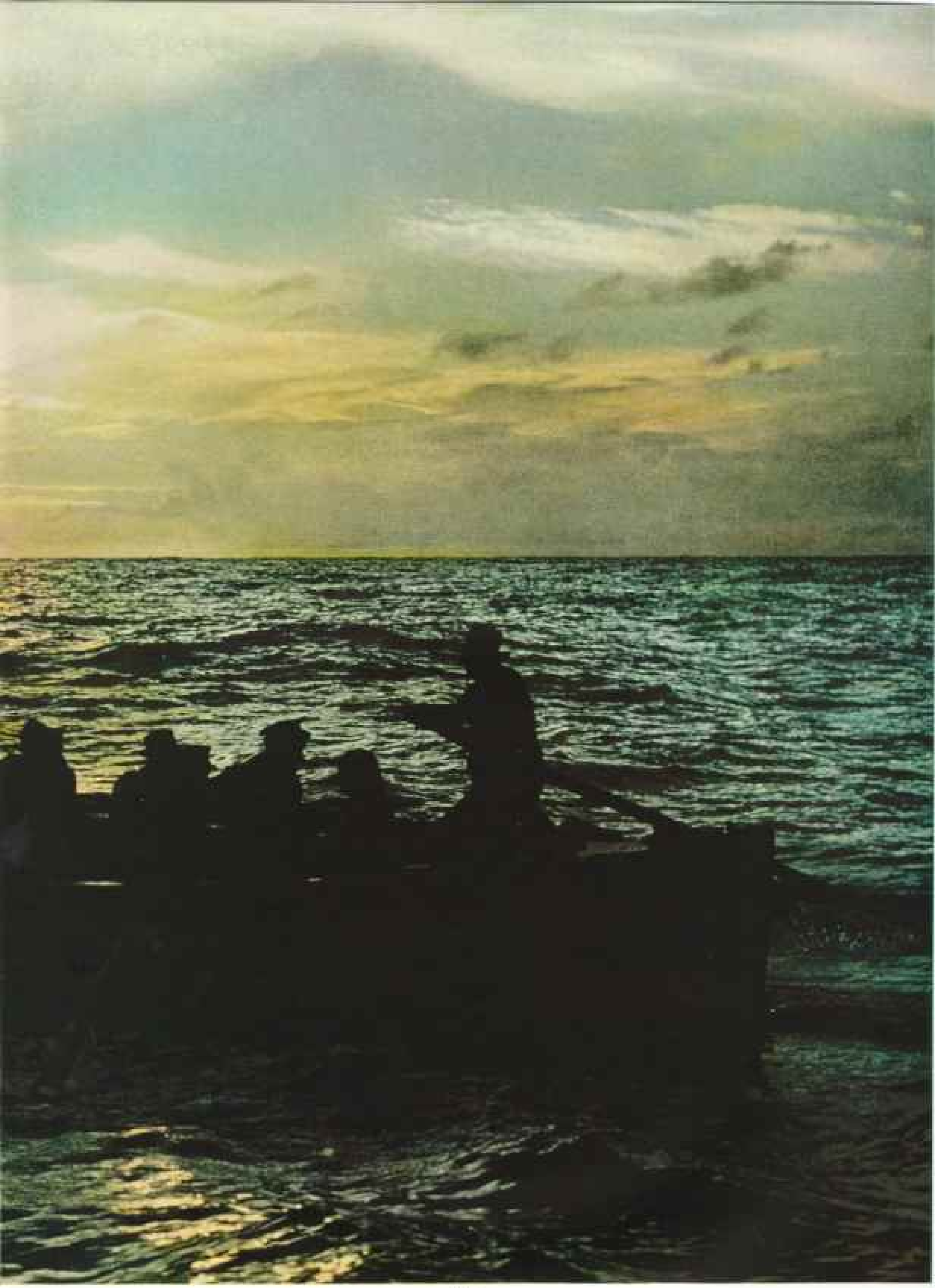
Len Brown's *Surprise* Leads a New Year's Race in a Complete Circuit of the Island

Seen from Christian's Cave, Adamstown's Red Roofs Dot Pitcairn's Green Plateau

Houses stand at random on both sides of the main path, which runs parallel to the sea. Made of wood and resting on stone piers, they cling to the island's shoulder about 300 feet above the shore. Coconut palms rise above pandanus, candlenut, and rose apple.

A Ship Sails over the Horizon Against Sunset's Fading Glow

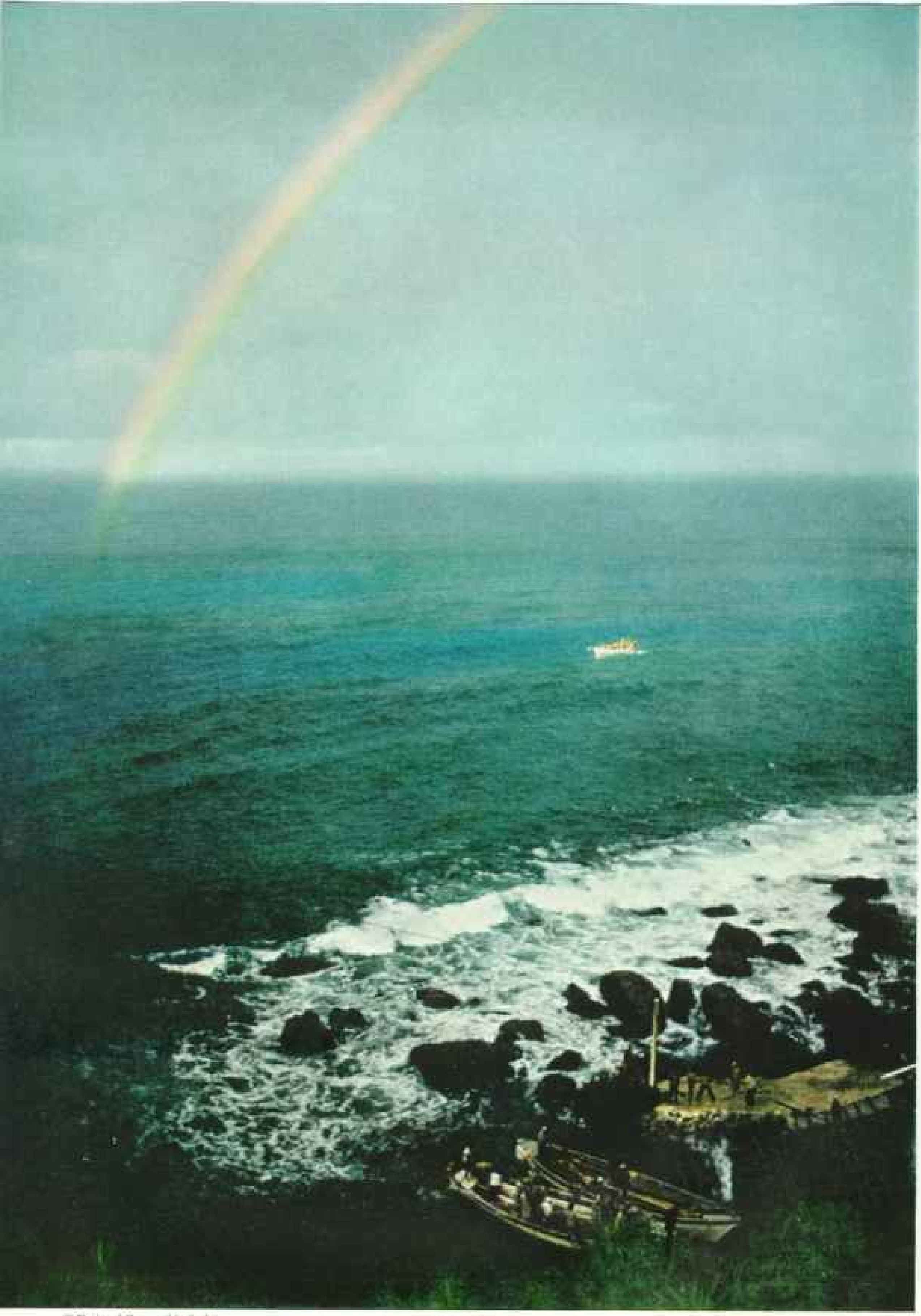
Some captains steam out to sea as soon as the longboats have made fast. On casting off, the boats face a three- to five-mile sail back home. Other skippers heave to so close that boatmen hoist no sail but row out.



787

With the Short Stroke of Experienced Seamen, Islanders Row Home at Dusk

When a visiting ship brings scantlings and planking, her crew ties the wood in bundles and throws it overboard for the longboats to retrieve. Sharp-eyed oarsmen rarely miss a bundle bobbing in the waves.



At Day's End the Last Longboat Comes Home Under a Rainbow's Arch

from the *Bone-ty*." I thought back. This could only have come from the *Bounty*'s cutter, for the launch had been cast adrift with Bligh and his loyal men in it.

By great good fortune, one of the *Bounty*'s anchors was later found by a diver from the globe-girdling yacht *Yankee* during her last visit to Pitcairn (pages 762-5).*

During my stay on Pitcairn, I asked Parkin why he thought his ancestor had mutinied. He replied: "Because he was an honest man and Bligh call him a thief; say he steal some coc'nuts."

This is the standard story, but it is difficult to determine in the case of the mutiny in the *Bounty* which of the two chief actors—Bligh or Christian—has been treated unjustly by history. Volumes, literally, have been published on both sides of the story.

Bligh Greeted as Returning Hero

What then, was the real cause of the mutiny? As usually happens in real life as opposed to fiction, neither side of the question is all black or all white.

When Bligh returned safely to England after his epic open-boat voyage, he was greeted as a hero and martyr. But after the court-martial of the captured mutineers, the climate of public opinion changed, and ever since Bligh has been pictured as an unendurable martinet and even a monster.

Hear Bligh himself:

"It will very naturally be asked, what could be the reason for such a revolt . . . I can only conjecture that the mutineers had assured themselves of a more happy life among the Otaheiteans, than they could possibly have in England; which, joined to some female connections, have most probably been the principal cause of the whole transaction.

"The women at Otaheite are handsome, mild, and cheerful. . . . The chiefs were so much attached to our people, that they . . . made them promises of large possessions. Thus the mutineers imagined it in their power to fix themselves in the midst of plenty, on the finest island in the world, where they need not labor, and where the allurements of dissipation are beyond any thing that can be conceived."

Fletcher Christian left no written record, but he has been quoted by several witnesses. *Bounty* crewman James Morrison recorded in his journal that when Bligh was ordered by Christian into the boat, he "begged of Mr. Christian to desist, saying 'I'll pawn my honour, I'll give my bond, Mr. Christian, never to think of this if you'll desist'; . . . to which Mr. Christian replyd 'No, Captain Bligh, if you had any honour, things had not come to this. . . . I have been in hell for this fortnight passed and am determined to bear it no longer, and you know Mr. Cole that I have been used like a dog the whole voyage.'"

There is no doubt that Bligh had a caustic tongue and an irascible nature. He drove his men and was impatient with inefficiency. But the records show that he used the cat-o'-nine-tails less than many other commanders of his day, and that he was solicitous of the welfare of his men. In dirty weather off Cape Horn, he kept a fire going below and even gave up his own cabin to the men who had wet berths. Most remarkable, he brought them through the long voyage without a single case of scurvy.

Christian seems to have been oversensitive—today he would be called neurotic—and given to a feeling of persecution. Like Bligh, he had a quick temper.

It seems evident that the unpremeditated mutiny arose from a sudden impulse on the part of Christian, who smarted under Bligh's hazing, but that the opportunity was quickly welcomed by the rest as a chance to return to an island paradise.

Tahiti Still Lures Men to Linger

I have walked on the black sand beach of Matavai and looked across the green thunder of the surf to the anchorage of Wallis, Cook, Bougainville, and Bligh (page 726). Whatever may have been the song the sirens sang, I am certain in my own mind that it must have been in the Tahitian tongue.

Capt. Irving Johnson, who has sailed the South Sea in *Yankee* for more than 20 years, knows at first hand the difficulty of keeping a crew together at "the finest island in the world." He says:

"I don't see how Cook, Bligh, or any other navigator had any men at all left to work the ship when leaving Tahiti."

The irony of it all is that when the breadfruit reached the West Indies at last—at the cost of mutiny, piracy, shipwreck, murder, and exile—the Negro slaves there found it tasteless and would not eat it.

* See, in the National Geographic Magazine: "The *Yankee*'s Wander-World," January, 1949; and "Westward Bound in the *Yankee*," January, 1942, both by Irving and Electa Johnson.

How Man-made Satellites Can Affect Our Lives

By Joseph Kaplan, Ph.D., D.Sc.

Chairman, United States National Committee for the International Geophysical Year

Dr. Kaplan, Professor of Physics at the University of California at Los Angeles, is outstandingly qualified to discuss satellites. On behalf of the National Academy of Sciences, he supervises all United States participation in the International Geophysical Year. He is also a member of the IGY Technical Panels on Rocketry and the Earth Satellite Program, and has for decades been interested in the problems that satellites are expected to help us solve. One of the world's most distinguished geophysicists, he has headed the Mixed Committee on the Upper Atmosphere of the International Union of Geodesy and Geophysics, and is the new President of the International Association of Geomagnetism and Aeronomy. Despite the great range of his interests and honors, Dr. Kaplan says that what he likes best is teaching elementary physics to undergraduates whose main interest is not science.—*The Editor.*

EARLY in October TV and radio brought you some unearthly music you had never heard before—a series of high-pitched notes in subtly varying rhythms, each note distinctly clear and crisp, sounding a little like a one-note xylophone.

What you heard was the music of a sphere, and a most extraordinary sphere at that.

It came from the pioneering artificial satellite, the first thing made by man to become a true celestial body and circle our globe in a predictable orbit. Perhaps you've even been out satellite-watching and have followed the telltale spot of brightness in the twilight of dawn or dusk.

The first satellite, launched by Soviet scientists in connection with the International Geophysical Year, was one of a group designed to do essentially the same job as the satellites to be sent aloft as part of the IGY effort of United States scientists.* Since I have been concerned with the U. S. satellite program from its beginning, I want to stress that what follows applies specifically to U. S.-built satellites, but in general to Soviet-built satellites as well.†

In view of the great tasks planned for them, these remarkable objects are surprisingly small, measuring less than two feet in diameter—about the size of a library globe. (In fact, the test spheres scheduled to precede the full-size U. S. satellite measure only 6.4 inches in diameter.) Nevertheless these shining metal balls may well represent humanity's most far-reaching scientific achievement in a century. They already symbolize one of history's boldest exploratory ventures—and promise to bring before long benefits to be felt throughout the world.

Space Holds Answers to Basic Problems

Rather emphatic statements, these, and you may well ask, how so? Why do we want artificial satellites in the first place? Just what will they do up there, flitting by hundreds of miles above us, and how can they help us in our day-to-day lives down here?

One might answer that satellites can teach us much about the most fundamental problems of science. A lot of the clues we want—in physics, geophysics, and astrophysics, for example, and in meteorology and astronomy—can be found only up where satellites will be, or can be gathered better up there.

On the strictly practical side the data provided by satellites will enable us to improve many things we already possess, such as radio and television communications; satellites will also help us along on the road to achieving

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11-ton Rocket Blasts Off into Purple Dawn ← Carrying a Satellite in Its Nose

This painting depicts one of six scheduled satellite launchings to be made at Patrick Air Force Missile Test Center, Cape Canaveral, Florida. The thin blue streak on the horizon is the Atlantic.

Suggesting an enormous nickel-plated cartridge, the three-stage rocket roars up from the launching platform. Steam, caused by white-hot exhaust striking the platform's water cooling system, lingers at left. The eight-story gantry crane that erected and serviced the missile has rolled back on its track. Boat-shaped blockhouse shields launching controls.

Within 10 minutes the satellite will swing into its orbit, 300 miles above the earth (next two pages).

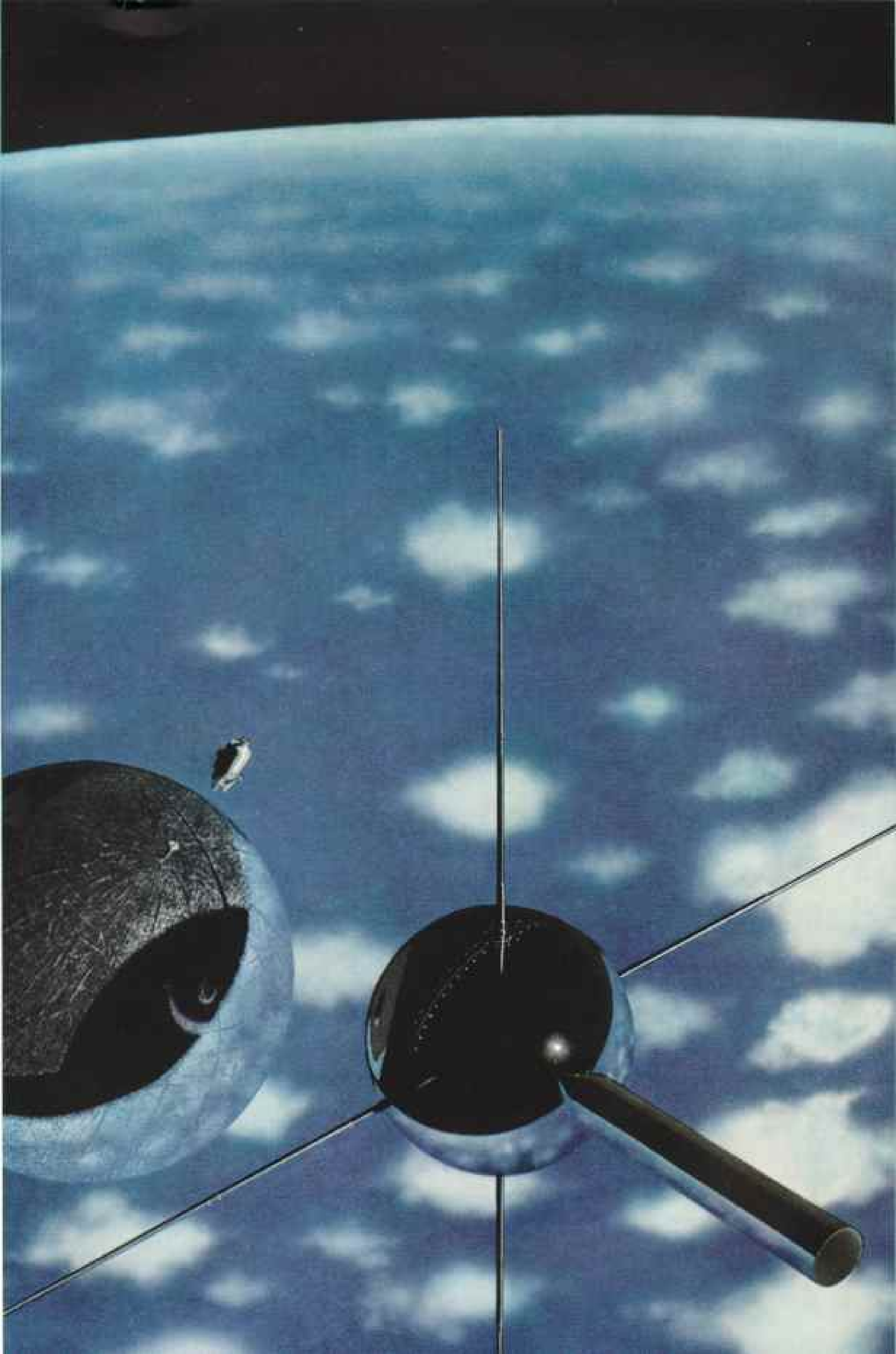
The dramatic paintings on the following pages are the work of National Geographic artists, who spent months in painstaking research to picture scenes man as yet can only imagine. Leaders of the United States National Committee for the IGY gave valuable counsel on rocketry and astrophysics.

* See "The International Geophysical Year: Man's Most Ambitious Study of His Environment," by Dr. Hugh L. Dryden, National Geographic Magazine, February, 1956.

† See "Space Satellites, Tools of Earth Research," by Dr. Heinz Haber, National Geographic Magazine, April, 1956.

Spent U. S. Rocket, Its Nozzle Still Aglow, Launches Globe-girdling Moons

As dawn breaks over the Caribbean, the last of the rocket's three stages attains a speed of some 18,000 miles an hour and reaches its launching altitude of 300 miles. Small and compact, the 21½-pound main satellite leads the procession. Instruments in the projecting tube measure earth's magnetic field, and four antennas broadcast findings. The subsatellite (center), a foil-covered plastic balloon released with the satellite, reveals density of the upper atmosphere. Here the subsatellite ejects its compressed-air inflation cartridge. Red dash in its line of trajectory marks the drop-off point of the stage-two rocket.



things we now only dream of, such as predicting the weather accurately, perhaps even controlling it. And since new basic knowledge gleaned through satellites will range literally from the inside of the earth to the sun and beyond, we can expect to be led to achievements we cannot even dream of now, any more than the telephone was dreamed of before the use of electricity.

To enlarge on this outline with more specific answers is the purpose of this article, but first let me project a picture of a typical IGY satellite at work.

Dust from Space in Deep-sea Sludge

Scientists eagerly await the recording of the satellite's signals on magnetic tape. The tape, in turn, can produce jagged patterns on a cathode-ray oscilloscope—similar to a TV picture tube—or on 35-mm film.

The film moves five feet a second and records patterns that can reveal as many as 48 categories of information. Some of this information concerns the operation of a satellite itself, say the changing strength of its batteries. But the rest reveals things scientists have long wanted to know.

For example, how dense is the meteoric dust in the upper atmosphere? These bits of stone and metal have been estimated to float to the earth at the rate of a thousand tons a day; they can be identified as part of the sludge at the bottom of the oceans.

Whenever a meteoric particle hits the satellite, a microphone notifies its transmitter; a radioed response then shows up in the pattern on the film. That microphone will record particles so small that if one flew into your eye you would hardly notice it.

Not only will we know the number of particles hitting the satellite during its circuit of the earth; one of the jagged lines on the film will enable us to time their impacts within one ten-thousandth of a second. The more recording stations we have, the better we'll be able to pinpoint areas where the count of particles drops or rises significantly.

And so we will learn to what degree the tiny meteors come in showers or spread out more or less evenly in space. These clues will interest not only the astronomer; they may at last yield evidence for the meteorologist, who would like to know whether meteor showers in the upper atmosphere affect rainfall.

By now we know a lot about our earth's surface, but a lot of what we know is not quite accurate. We have only a rough idea of the shape of the earth, for instance: it's like a ball flattened at top and bottom, but there is a bulge around the middle, and the entire curvature is somewhat irregular.

This bedevils the geodesist. He can map a country and even a continent with considerable accuracy, by building up a network of triangles through painstaking surveying, and then orienting the entire network on a single marker known as the geodetic datum point. For France this point is in the Pantheon in Paris, and for the U. S., Mexico, and Canada it's in a meadow near Lucas, Kansas.

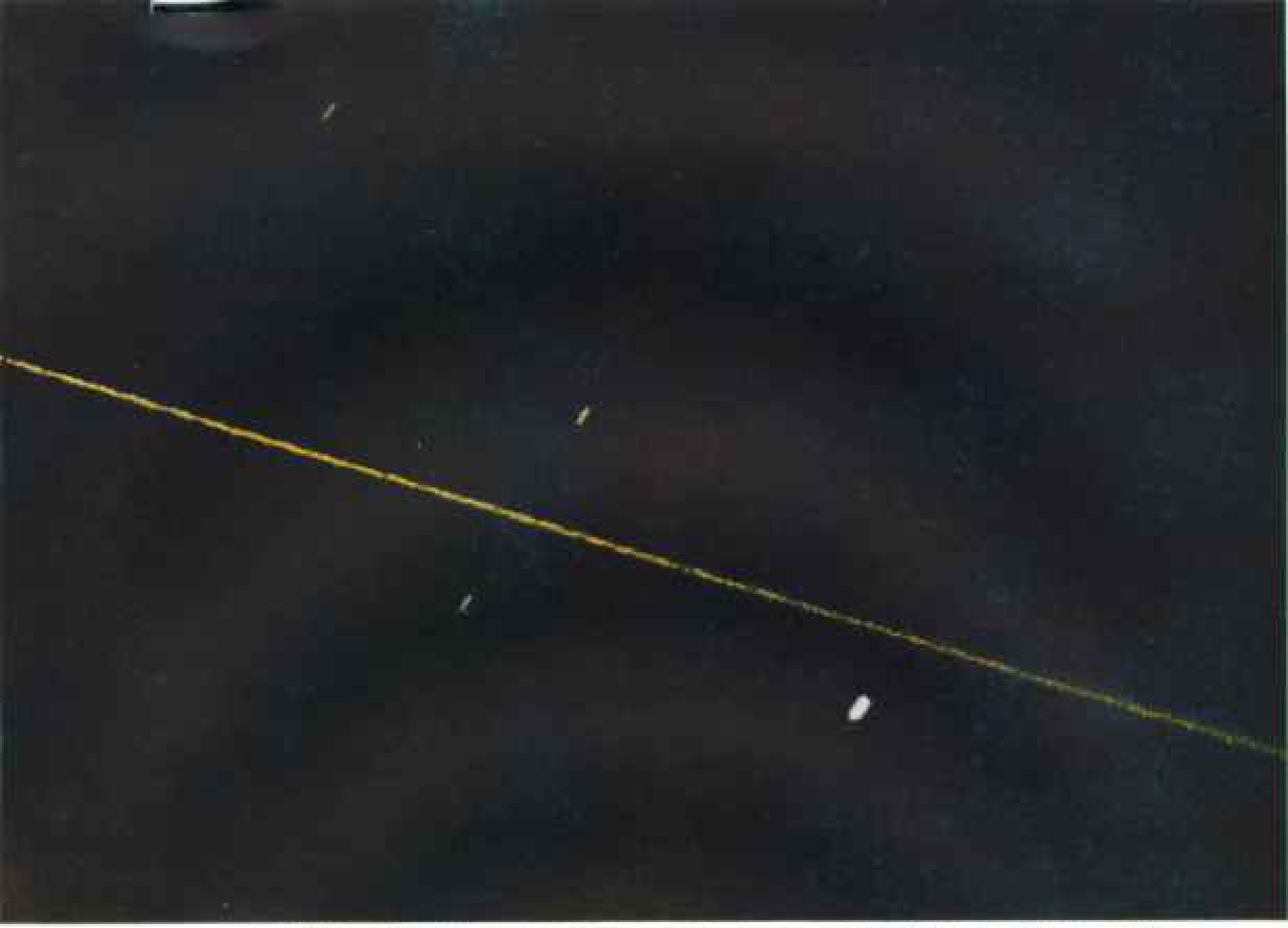
This triangulation technique, however, cannot be applied over water, and therefore cannot link continents to one another. Nor can it yield precise positions for islands in the ocean, relative to continents or to one another. Thus intercontinental distances now are believed to err by as much as 2,000 feet and, some scientists say, even more. The positions of some Pacific islands are in error as much as a mile, and that can cause trouble.

Travel across the Pacific, for example, depends heavily on the U. S. Coast Guard's electronic loran system, which helps ships and planes locate themselves on their charts. But loran itself depends on maps, and if its base stations are off a mile, the guiding patterns they send may be off five miles. This can mean the difference between life and death in rescue operations. A satellite can help us do away with these errors by giving us a reference point in the sky.

Telescope-cameras to Track Spheres

First we must compute the satellite's orbit, with the help of ingenious antennas and radio receivers which will record its signals. Then observing stations around the world, equipped with powerful telescope-cameras, will refine the orbit calculations; their photographs, precisely timed and linked with the radio data, will reveal the satellite's elliptical path around the earth. From that we will calculate the location of the earth's center.

From then on, radio signals from the satellite, together with the orbit calculations, will let us locate the positions of the antennas precisely. The U. S. Army Map Service, which is sending teams to Kwajalein, Luzon, Wake, Guam, and American Samoa, hopes to establish reference points on these islands accurate within 100 feet in respect to each other and to the center of the earth.



W. E. Garrett, National Geographic Staff. 35-mm Super Anscochrome exposed at 250 ASA; 180 mm. f:2.5 telephoto lens

A Man-made Comet, the Rocket Shell of the Soviet Sputnik Flashes Across the Sky

Apparently tumbling end over end, the rocket appears brightest when its walls catch the sun's rays. It fades when the hollow end faces the light. This natural-color photograph traces three seconds of the shell's path, left to right, across the edge of the constellation Leo Minor into Leo (see Map of the Heavens). Astronomers at the U. S. Naval Observatory, Washington, D. C., verified the coloration of the reddish and white stars from their charts. White star at lower right is 54 Leonis.

Gloved Hands Examine a Gold-plated Moon

To balance temperatures within the U. S. satellite, designers covered the 3/100-inch-thick magnesium shell with gold, a reflector of radiant heat. An aluminum coating produces a mirrorlike finish.

Dr. Herbert Friedman (left), of the U. S. Naval Research Laboratory, here inspects the plastic-foam-encased nerve center.

When we know the distance from a point on the earth's surface to the center of the earth, we'll also be able to plot the shape of the earth: it will be like constructing a lop-sided wheel when you are given spokes of different lengths.

Satellites, then, can serve as visual and electronic reference points in the sky. Thus they could save millions of dollars and make life easier for hundreds of men now mapping with tape and theodolite amid the trackless jungles and snowy peaks of South America.*

Satellites may even in a way look inside the earth and confirm or upset some basic geophysical assumptions.

One of these theories concerns the mantle of the earth—that is, the material between the earth's solid crust and its liquid center. This material is thought to have some of the paradoxical qualities of pitch. Hit it hard, and it will crack. Put pressure on it gently, and it will give and then revert slowly once the pressure is off. Because of these qualities, some parts of the earth keep rising long after heavy layers of ice have melted. Finland is a case in point. Conversely, the delta areas where the Nile and the Mississippi deposit much silt keep sinking as weight is added.

Watery Hill Rises in North Atlantic

Now some scientists claim that the earth's crust has irregular bumps on its equatorial bulge which raise the sea level as much as 300 feet; supposedly embedded in the crust of the earth are knots of material of such exceptional density that their gravitational pull draws water to swell above them. The Finnish geodesist Tanni speculated that one such watery hill 150 feet high exists in the North Atlantic.

Proof that such bumps exist would cast

* See "Men Who Measure the Earth," by Robert Leslie Conly, NATIONAL GEOGRAPHIC MAGAZINE, March, 1956.

Inflatable Subsatellite Expands from Crumpled Ribbon to Gleaming Sphere

The foil-covered quarter-pound subsatellite rides the third-stage rocket folded like an accordion. At the moment of its release a compressed-air cartridge inflates the sphere and then falls free (page 792). Aerodynamic forces in the exosphere are so slight that the subsatellite remains spherical despite an open valve.

Dr. Hugh L. Dryden (left), Director of the National Advisory Committee for Aeronautics and a Trustee of the National Geographic Society, lifts a collapsed subsatellite with cartridge. Holding an inflated subsatellite is its inventor, William J. O'Sullivan, Jr., a member of the committee's Pilotless Aircraft Research Division. Seal of the committee shows the Wright brothers' first powered flight in 1903.

National Geographic Photographer B. Anthony Stewart

Midget Tape Recorder Serves as a Moon's Electronic Memory

Engineers and scientists of the United States Army Signal Corps built this recording unit to ride the cloud cover satellite shown on page 801.

Weighing about a pound, the recorder stores data collected by the telescopic "eyes" as the satellite passes over the sunlit half of the earth.

As the satellite enters the earth's shadow, where it can no longer detect clouds, a day-night switch shuts down power to conserve batteries. Re-emerging into sunlight, the satellite repeats the recording process.

Built into the instrument package is a tiny interrogator switch tuned to the radio frequency of 10 tracking stations throughout the world. On a signal from any station, the switch turns the tape recorder to playback and the stored data are then broadcast.

U. S. Army Signal Corps

doubt on the "pitch" theory of the earth's mantle. It would mean that the mantle must be more rigid than we thought; otherwise those bumps would be flattened by the pull of gravity toward the earth's interior.

How can we make sure? Again, by watching the orbit of a satellite.

Satellites Wobble as Gravity Varies

Such bumps on the earth's surface, unlike mountains, would vary the gravitational pull on a satellite. This is so because mountains, as a rule, have less mass beneath them than flat land; the bumps, on the other hand, supposedly rest on mass as dense as that of flat land. Therefore they should exert more pull on a satellite than either flat land or mountains, thus bringing the satellite closer to the earth and making it wobble a little as it passes over them. These wobbles, recorded by telescopes, will reveal bulges just as a record of the up-and-down motions of your car would describe the uneven surface of a highway.

Now I'd like to tell you about a truly amazing part of the great satellite effort—the measurement of cosmic rays and the cloud belt around our Equator, certain energy given off by the sun, and the magnetic forces that surround our globe. But first, I must say something about pure science.

If you visit a scientist in a laboratory and ask him what he's up to, he'll probably be happy to talk. But if you ask, "What will this thing you're doing be good for?" he may become uncomfortable or annoyed, like the pioneering physicist and chemist Michael Faraday when he was asked that question by a member of Parliament. Faraday is supposed to have replied, "I can't tell you what it'll be good for. But I'll tell you this: one of these days you'll be taxing it."

Granted, then, that we cannot always see the link between a highly important scientific discovery and its most practical results until these results have been achieved. We must keep in mind that this is certainly true in the case of much eagerly awaited work to be done with satellites.

The first full-size U. S. satellite will measure the energy radiated to us from the sun in the form of ultraviolet light.

We want to do this because this energy is important to radio communications, and also because it can give us further clues to the behavior of the sun, whose power is really the mainspring of all life on earth, even of the energy that drives your eye muscles as you read this.

Most of the sun's ultraviolet light never reaches the earth—a good thing, or we'd all suffer lethal burns. Instead, some 20 miles above us a portion of the sun's ultraviolet rays

—those with very short wave lengths—interact with oxygen. The result is ozone, and this in turn is a very efficient absorber of the ultraviolet rays of longer wave lengths which would be highly dangerous to life on earth.

This satellite will travel high enough to tap the trunk line from the sun, so to speak, before most of these solar radiations are absorbed by the atmosphere.

"Electrical Weather" Bedevils Radio

The sphere will measure ultraviolet light with ionization chambers. These are thimble-sized cylinders with windows in front to let the radiations enter. Once in, they give an electrical charge to a gas inside—they ionize it. The more ionized this gas, the better it conducts electricity. If we record the changing conductivity of the gas, we can tell how much energy comes in through the windows.

Our ionization chambers are adjusted to respond only to energy of a certain wave length, 1215.7 Angstrom units, which we call Lyman alpha. That happens to be the wave length of a certain significant percentage of the sun's ultraviolet rays which interests us most right now.

Why?

Because Lyman alpha and similar short-wave radiations create havoc with long-range radio communications.

Such radio communications are possible in the first place because ultraviolet rays of extremely short wave length ionize air particles in the upper ionosphere. This ionization provides a veritable sea of charged particles which forms a reflecting layer, a kind of mirror, from which short-wave radio signals shot up from one part of the earth are bounced back to another part. Thanks to this, Marconi managed to send radio signals leapfrogging across the Atlantic in 1901. Before that it was thought impossible to receive radio signals from a transmitter far away because they travel in straight lines, like light, and cannot follow the curvature of the earth.

Lyman alpha energy also ionizes air particles, specifically in the lower border of the ionosphere, below the "reflecting mirror" we have just described. However, the result is not another reflecting mirror but a sea of particles that absorbs short-wave radio signals. This region keeps changing in density, from day to day and with the seasons. This might be called the "electrical weather" of the upper atmosphere.

When satellites have taught us a little more about this, we shall know a lot more about why our short-wave communications sometimes cease for hours altogether, or how a police car in Washington, D. C., can lose contact with headquarters and receive music from Paris.

Geiger Counter to Probe Cosmic Secrets

We already suspect that great variations in Lyman alpha intensity coincide with the spasmodic solar flares during which the sun puts out more energy than usual. Satellites might help us discern more definite patterns in Lyman alpha fluctuations, and let us forecast just when radio communications will be good and when they will be disturbed. Satellites will be especially useful during the IGY because that's the time in the 11-year cycle when solar flares are most active.

The second U. S. satellite planned for the IGY will carry different instruments and attempt a survey of primary cosmic rays—how many are over what place at what time.

There's much we don't know about cosmic rays. But we can say that they are chiefly hydrogen and helium nuclei, that they move nearly as fast as light, and that they are the most powerful particles we know, many times more powerful than those released by thermonuclear fusion in a hydrogen bomb.*

On earth we find it difficult to capture primary cosmic rays—cosmic rays in "mint condition," we might say. Various particles in the upper atmosphere interact with them, and what reaches earth is the debris of these collisions. But monitoring satellites will

* See "Trailing Cosmic Rays in Canada's North," by Martin A. Pomerantz, NATIONAL GEOGRAPHIC MAGAZINE, January, 1953.

Outstretched Antennas Read the Secrets of Earth's Weather

Meteorologists seek clues to long-range weather forecasting by measuring both solar energy absorbed by the earth and the energy radiated back into space from the planet. High-flying satellites promise direct solar observations unobstructed by atmosphere.

This drawing visualizes a satellite passing over India and Ceylon. White sphere at antenna end detects earth's long waves; shielded instruments sample shorter solar waves reflected by the earth. The black ball tests all wave lengths. Readings are recorded on magnetic tape and broadcast to the ground.

Stars are plotted exactly. Milky Way appears at left as a wisp of smoke rising from the North Pole; Little Dipper shows behind antenna at right.

Gilbert Emerson

800

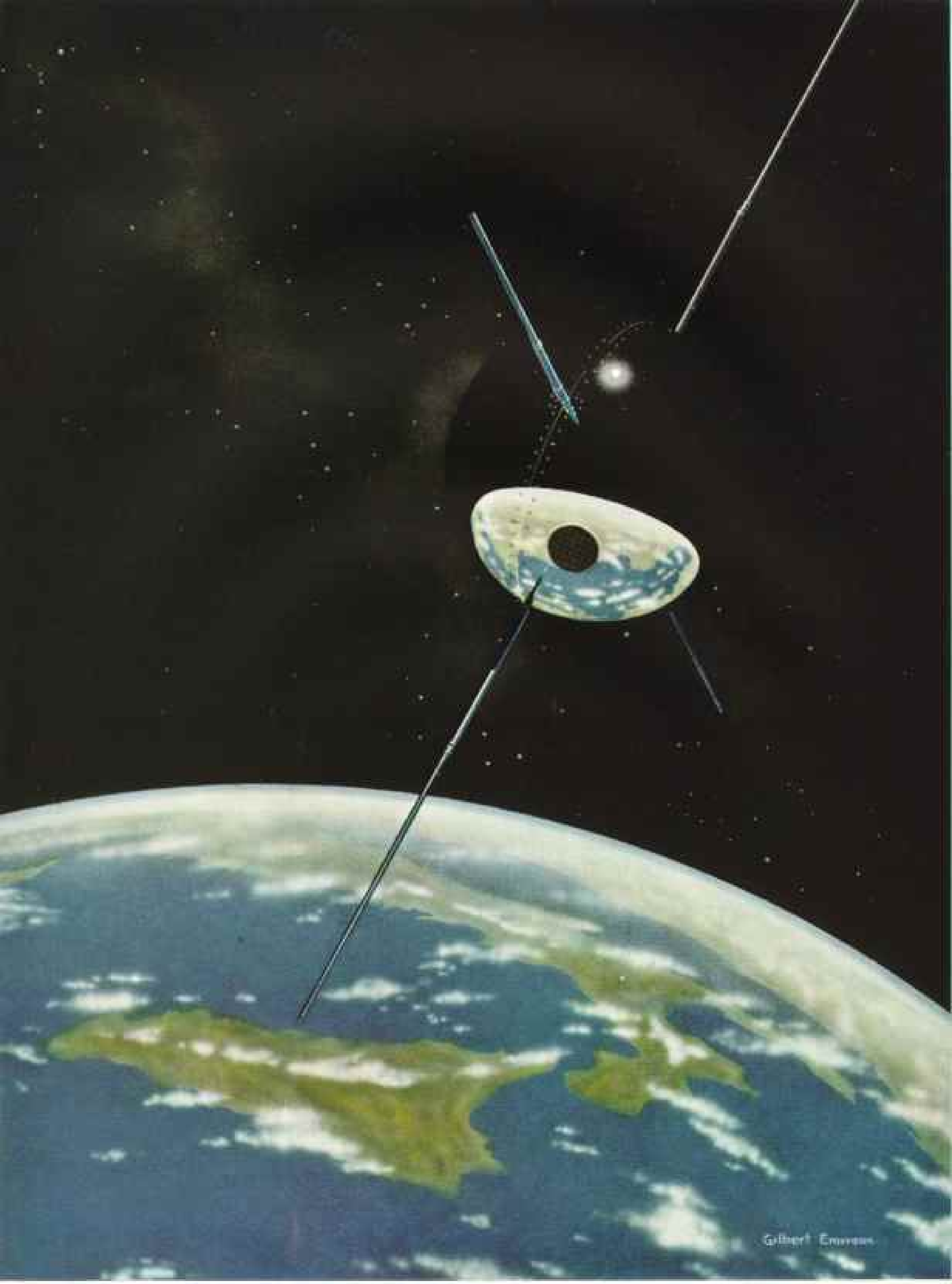
Camera-laden Satellite Detects a Typhoon's Ominous Pin Wheel

Future satellites 2,000 miles in space may carry television cameras and telescopes to scan weather and read the heavens simultaneously.

Painting depicts the Pacific typhoon Trix as it might have been monitored on May 9, 1957. A glass bubble pointed earthward protects the wide-angle television lens. Solar batteries on the upper dome surround a spectroscopic telescope for recording the make-up of stars. Buttonlike protuberance between the antennas houses jet stabilizers. The China coast appears beneath clouds at left.

← Satellite monitors, restlessly patrolling the earth, would give forecasters an ever-current view of the world's weather. Here Dr. Sigmund Fritz (left), research meteorologist of the U. S. Weather Bureau, and Albert K. Showalter, chief of the National Weather Analysis Center at Suitland, Maryland, chart typhoon Trix's circling winds for use in the painting.

Kodachrome by John E. Fletcher, National Geographic Photographer



Scanning Earth, a Cyclopean Eyeball Reflects Sea and Land as Blue and Brown

This satellite carries U. S. Army Signal Corps instruments designed to read the distribution of clouds and aid interpretation of weather phenomena. The whirling eye's cross-hatched "pupil" sweeps across north Africa, whose image appears inverted on the "cornea." Clouds drift across Sicily and the Italian boot.

measure primary cosmic rays with a geiger counter, record them on tape, and transmit this information to earth. Such cosmic ray data will be a great contribution to nuclear physics and a source of new clues to the nature of the universe.

Sun Acts as a Mighty Cyclotron

We can produce relatively weak equivalents of cosmic rays with a cyclotron, a machine in which electricity gives speed to atomic particles and magnetism gives them direction. When these forces are applied repeatedly, the particles keep accelerating. We assume that what we do in the laboratory on a small scale, nature does on a vast scale in space; that tremendous energies are generated by cosmic cyclotrons. Our sun is such an accelerator and emits some cosmic rays. But most of them, we believe, come from far in space, and their sources there are still a mystery.

In any case, we already know that the heavier varieties of cosmic rays can kill living cells by destroying the nuclei of their atoms. That's why exposure to primary cosmic rays might endanger people who may someday venture into the upper atmosphere. Satellite data will advance the many serious studies already under way to determine what difficulties man will encounter up there.*

Our third major endeavor will be making measurements of the earth's magnetic field, which we have so far been able to do only close to the earth. We know that magnetic force guides cosmic rays so that more shoot toward the poles than toward the equatorial regions. That same force also makes possible the colorful aurora and is closely linked to many communications problems. New knowledge of the earth's magnetic field will aid physicists and enable us to improve our communications in the polar regions.

Man May Eventually Control Weather

People often ask if science can't do something about weather. Actually there's no reason to think that the meteorologist can't do just that. His chain of progress, I think, will be along the lines suggested by my colleague A. F. Spilhaus, Dean of the University of Minnesota's Institute of Technology, concerning the dealings of man with nature: first measure; then understand; then predict; and finally you may be able to control.

Of course we've been making meteorological measurements all along. The U. S. Air Force weather service flies 35,000 miles a day, and the U. S. Coast Guard spends some 16 million dollars a year to operate 18 weather-patrol ships carrying observers from the Weather Bureau of the Department of Commerce.† But perhaps no more than five percent of the world's air is being watched regularly.

If we want to predict weather accurately, we need the world-wide picture. That's where satellites come in. One of two weather experiments being readied for U. S. satellites is to measure the heat budget of the earth.

Most of the heat we get from the sun hits the equatorial regions. Some of it is reflected right back into space. The rest is absorbed where it hits the earth, heating the land and evaporating ocean water. Some of that remaining heat is radiated back into space at night, but most of it passes on to the surrounding areas and toward the poles. The oceans carry about 10 percent, and the rest of the heat, borne by warm, moisture-laden air, flows north and south from the tropical areas.

The excess heat in the tropics and the deficiency at the polar regions are the chief factors behind all our abruptly changeable weather and our slowly changing climate. But we can't accurately predict either unless we know what the earth's heat balance is.

Sphere to Scan Earth's Cloud Cover

Meteorologists say they know fairly closely how much heat comes to the whole earth from the sun over a number of years, and they know that approximately the same amount must go back into space. What they do not know is how much comes daily, monthly, during a season, or yearly, for that matter, and how it is distributed over the earth.

An ingenious satellite, with four measuring devices sticking out like ping-pong balls on spears, can give us data to determine the heat budget over the equatorial belt. You'll get an idea of how this satellite will look and work on page 798. Once we know how much more heat comes down onto the equatorial regions than goes back up, we can calculate how much heat travels toward the poles and thus determines the weather in the Temperate Zones.

Our other weather experiment involves a weather-patrol satellite, to let us keep an eye

* See "Aviation Medicine on the Threshold of Space," by Allan C. Fisher, Jr., National Geographic Magazine, August, 1955.

† See "Rugged Is the Word for Bravo," by Phillip M. Swatek, National Geographic Magazine, December, 1955.

Kodachrome by John Bryson

The Author Watches Colliding Gases, Aglow in an Auroral Tube, Mimic the Northern Lights

Dr. Kaplan's extraordinary achievement, the laboratory reproduction of aurora, mixes oxides of nitrogen and atomic nitrogen, whose clash 60 miles up in the sky produces the eerie northern lights. Scientists envision ionosphere craft gulping atomic gases as jets swallow air and using their energy for propulsion.

on the earth's ever-changing cloud cover over a belt 300 miles wide. Meteorologists had their appetites whetted for this in October, 1954, by a photograph made from a rocket 100 miles up, showing the spiral whorl of a hurricane developing over the Gulf of Mexico. But this photo revealed only a small part of the broad pattern, and by the time it was ready for study, the storm was over Texas.

The weather-patrol satellite will scan the whole United States in ten successive strips. It will come by every hour and a half, and will carry a photoelectric cell—like the electric eye in a camera exposure meter—to plot the varying light intensities below. The electrical impulses from the cell will give us a series of cloud cover panoramas, to help us chart storm patterns.

Such data should take us a long way toward the understanding and prediction of weather.

Nitric Oxide Lights Up the Sky

Now, what about control?

Well, let me tell you about something that happened earlier this year at White Sands, New Mexico. Scientists tossed 20 pounds of nitric oxide some 70 miles above the earth, with a rocket, just to see what it would do. The results were profound. During the daytime this modest amount of chemicals produced an ionized layer which bounced back radio signals more efficiently than naturally ionized layers. At night the nitric oxide reacted with oxygen up there to form a blob of light about two miles across. At times it was as bright as Venus.

We noticed no effects on the weather. But we realized that we had made a start in the exciting business of modifying the upper atmosphere through chemistry. These experiments will continue, and as satellites and other IGY research projects yield their information, serious attempts at weather control may not be far behind.

Now that we're looking a bit into the future, let's also consider how satellites might help us achieve other triumphs of chemistry in the upper atmosphere—speeding up aircraft with power from the sun, for instance, or literally lighting up the world at night.

I stumbled onto my first clues to the chemistry of the upper atmosphere when I was a graduate student at Princeton, 30 years ago. One night I set up an experiment involving an electrical discharge in a glass tube that contained active nitrogen, and went to the movies. Air leaked into the tube somehow, and when I came back I saw the tube glow with a beautiful yellowish-green light.

I analyzed its wave length and found that here for the first time the light of the aurora had been produced in the laboratory by chemical means. Since then we have discovered a lot about the aurora—that nature produces it with electrically charged particles from the sun, mostly protons.*

The aurora appears only in high latitudes, but over all the earth the sun's energy produces a similar luminous display—the night airglow. A significant part of this occurs through another chemical reaction—ultraviolet light interacting with oxygen some 60 miles above us. The result is a force which may benefit us greatly. Let me explain.

Oxygen commonly occurs as O_2, meaning two atoms of oxygen stuck together. But up there the sun's ultraviolet rays pull these pairs of atoms apart and leave separate oxygen atoms: simply O, which we call atomic oxygen. The energy which the ultraviolet light expends in doing this passes into these loose oxygen atoms. And when they combine once more into pairs, that energy is released.

This reaction might conceivably be produced in the power plant of a light plane or rocket traveling 60 to 70 miles high. Thus, once up there, it could utilize this solar energy extracted from atomic oxygen. Admittedly the amount of energy thus available would not be very large. But then we are only beginning to learn about these phenomena and their possible uses.

Particles Scarce in Upper Atmosphere

We might envision satellites as pieces of laboratory apparatus and the upper atmosphere as a tremendous laboratory where we will carry out experiments impossible on earth.

One advantage for the chemist is that in the upper atmosphere particles of matter are far scarcer than in the best vacuum we can produce on earth. To get an idea of this difference, think of atoms as people, and then compare the New York subway crowd with the number of travelers you might meet in the lonelier parts of the Sahara.

Because particles are so scarce in the upper atmosphere, it takes comparatively small amounts of chemicals to produce reactions

* See "Unlocking Secrets of the Northern Lights," by Carl W. Gartlein, National Geographic Magazine, November, 1947.

spreading out over huge areas. Thus the larger satellites we consider for the future could be equipped to generate intense ultraviolet light, and so create vast pools of atomic oxygen. Aircraft flying through these pools could utilize that power. Speculation? Yes; but theoretically possible.

With improvements in rocketry, we may eventually manage to shoot a satellite into an orbit 22,000 miles high, where it would circle the earth exactly once in 24 hours. Since the earth also completes one revolution in that time, this satellite could remain, in effect, over the same spot above the Equator. There it could produce ultraviolet light to create airglow artificially and light up a city.

In this way, we could light up the entire North American continent at night to the brightness of a cloudy day.

"Assistant Sun" Might Illuminate World

A number of such satellites—perhaps 10—could light up the world. The total energy required even for this would be surprisingly small, probably no greater than that of the electricity used in New York last night.

You may ask, why light up the world? I don't know. I'm simply pointing out that we may eventually have a sort of assistant sun to command, to turn on or shut off as we wish.

Furthermore there has been speculation for many years that we may be able someday to

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Sputnik's Burned-out Rocket Casing Sails into the Big Dipper's Bowl

On October 4, 1957, the U.S.S.R. fired a rocket carrying the first artificial satellite. In the virtual vacuum hundreds of miles above ground, rocket and satellite parted company and each began orbiting the globe approximately once every 96 minutes. The Russians announced the man-made moon's weight as 83.6 kilograms (184.3 pounds). Speed was about 18,000 miles an hour.

This picture was made in Washington, D. C., before dawn on October 18. Wispy clouds veiled much of the moonlit sky, but stars hung motionless in a clear area embracing Polaris and the Big Dipper. Suddenly a new light, as bright as the brightest star, appeared in the dark sky and raced across the heavens like an airplane's running light.

Thus the spent rocket fragment emerged from earth's shadow into predawn sunlight 300 miles aloft. Alternately glowing and subsiding, it arched through the Big Dipper and disappeared in two minutes. The satellite itself, following about 16 minutes later, was barely visible to the unaided eye.

A 15-second exposure made at 6:06 o'clock records the rocket's path and shows its light diminishing in intensity as it tumbled end over end (page 795).

Walter Meayers Edwards, National Geographic Staff

transmit electric power through radio beams as we now send it through wires. Then a nuclear power plant to supply a city might operate in a satellite above it.

Plans are already under study for large satellites to retransmit radio, TV, and telephone signals from the earth. Three such satellites, spaced around the world and orbiting at the speed of the earth's rotation, would revolutionize transoceanic communications.

Certain short waves, now useless because they shoot right through the ionosphere, could accommodate millions of telephone conversations and a multitude of television signals.*

Now let me touch on how satellites being planned may tell us about the nature of our universe.

Astronomers have a lot to put up with. Looking at the stars through our atmosphere is like looking through a dirty window, and the light that does come into the telescopes is contaminated by the airglow from the earth's upper atmosphere and by scattered light in the lower atmosphere.

We hope that we shall be able eventually to send photometers high above this atmospheric mess to seek better data on the distribution of light in our galaxy, and on the light from the millions of other galaxies outside our own. The light from other galaxies, if it can be isolated by filters and measured, will help us decide whether the universe is finite or infinite.

"Moon" May Check Einstein Theory

Someday, too, we may come to grips with a remote but fascinating riddle. Imagine that a man leaves the earth, travels in space at tremendous speed, and returns 20 years later. Will he be 20 years older, like the people he left behind? Or will he have aged less than they have? One implication of Einstein's general theory of relativity is that he will have aged less, depending on how fast he travels. A satellite could give us proof.

We would use two so-called atomic clocks, in which atoms of the element cesium vibrate at a steady rate. One would stay on earth. The other would go aloft with the satellite. Both clocks would be started at the same time.

According to this view of the theory, the satellite's clock should run behind the other one. This difference would be tiny, of course, because the satellite—comparatively speaking—goes neither far nor fast. Nevertheless, says one scientist, even a time difference of one part in five billion would constitute proof. But if the clocks read the same, this interpretation of Einstein's theory of relativity would have to be severely modified.

We now have clocks accurate to better than one part in a billion. They are too big to go aboard presently planned satellites, but we might make such clocks smaller, and I am sure that the satellites will get bigger.

Still another field in which satellites promise interesting data is biology. Eminent scientists are now planning experiments for future satellites carrying living organisms. Consider, for example, the preparations at the Air Force's Aeromedical Field Laboratory at Holloman Air Force Base in New Mexico.

Trained Mice to Test Weightlessness

Maj. David G. Simons, the physician who recently reached 19.32 miles in a research balloon, is chief of the Space Biology Branch there. The project, in brief, is to put mice inside a "bio-satellite" and observe what they do as they speed around the earth.

Satellites are in effect weightless, because once they are in an orbit their velocity balances the pull of gravity. Knowing the physical and mental reactions of organisms at zero gravity is of great interest to scientists planning manned flights at great altitudes. Mice and monkeys have already been sent up 37 miles in rockets, and thus put into the weightless state for about two minutes.

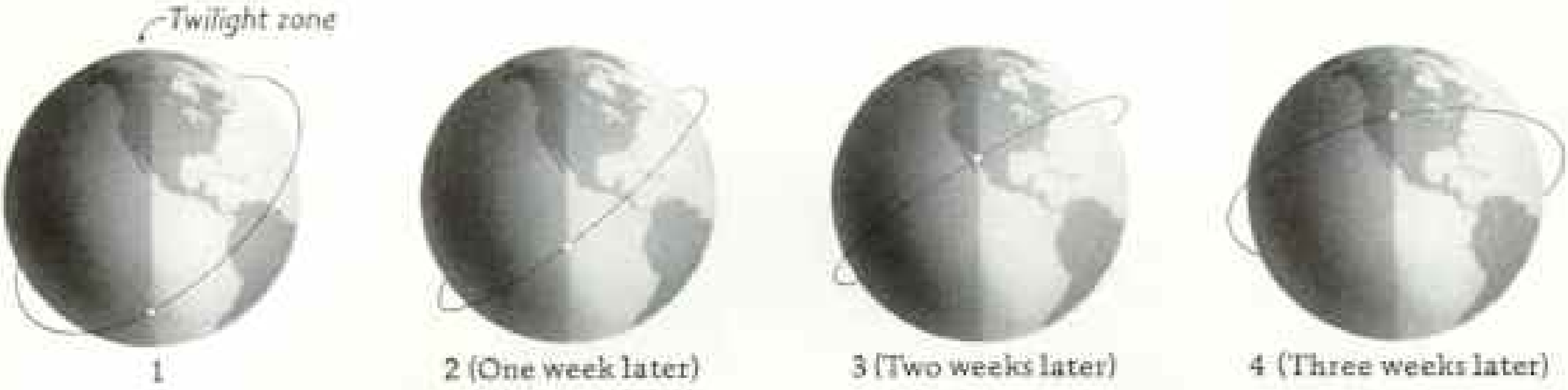
A bio-satellite might keep a mouse supplied with food and oxygen for 30 days; television apparatus could let us observe the mouse at regular intervals, say one minute out of five.

The satellite mouse would be trained—to hit a switch, for example, in order to avoid an annoying stimulus. Once at zero gravity, the mouse would presumably be upset and therefore unable to hit the switch as often as it might want to. But after being up for some time, it might again remember what it had learned and hit the switch at a rate more in keeping with its previous performance.

Sphere Spreads Intellectual Excitement

Now, after discussing things that are quite a bit in the future, I should like to talk about some important things satellites are doing for mankind right now—by spreading intellectual excitement generally and so creating a climate all the more fertile for great discoveries.

* See "New Miracles of the Telephone Age," by Robert Leslie Conly, NATIONAL GEOGRAPHIC MAGAZINE, July, 1954.



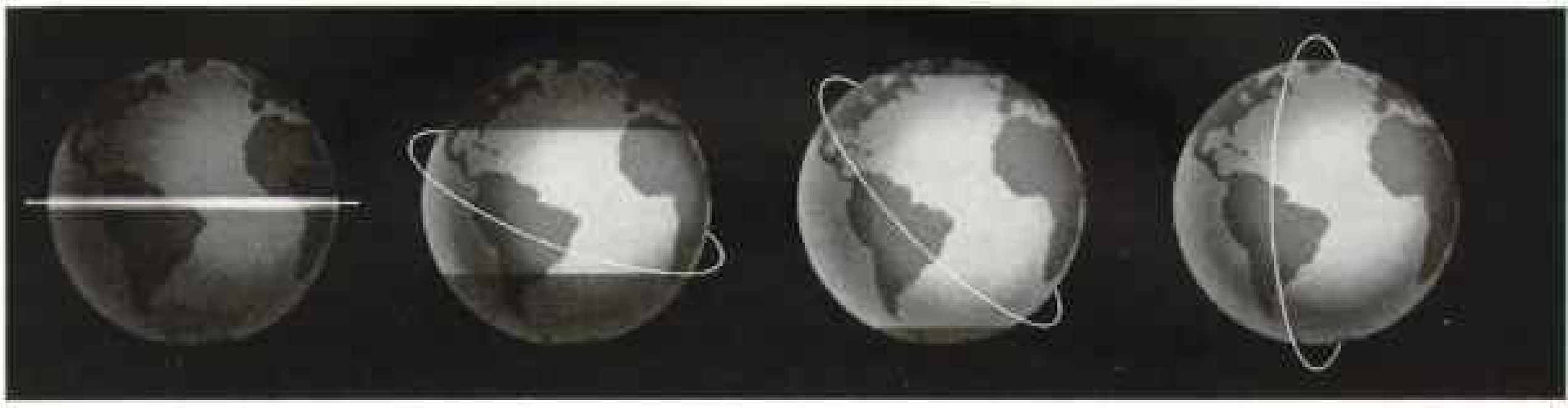
Tilting Orbit Reveals the Satellite to Moonwatchers in Many Latitudes

Because of gravity's more powerful effect at the earth's bulging Equator, the satellite's orbit precesses, or pivots, like a child's top slowing down. These sketches show the effect of precession on the baby moon's visibility.

Figure 1 pictures the satellite (white dot) as it orbits at a 45° angle to the Equator. On this course it enters the twilight zone—the only point at which it can be seen—over the southeastern Pacific.

Figures 2, 3, and 4 show the same satellite's orbit at weekly intervals. In each case the tilt, proceeding in opposite direction to the earth's rotation, has caused the satellite to cross the twilight zone farther north. The process is reversed on the opposite side of the globe.

These diagrams show visibility of satellites launched on four different courses. Orbit 1 gives a view of the speeding sphere only to residents of the Tropics. Orbits 2 and 3 add spectators in the Temperate Zones. Orbit 4, from pole to pole, reveals the moon to the entire rotating world.



It is said that if a fully instrumented satellite can stay up a year, it should gather enough data to keep scientists busy for years just to fit in the new facts with what we know.

The more interest mounts among both beginning and mature scientists everywhere, the better the chances will be for a veritable quantum jump in scientific endeavor—what is sometimes unfortunately called a breakthrough. I don't like this word, because it sounds too much like something that went according to plan. I prefer to talk about a fallthrough. You fall through the ice of ignorance where it happens to be thinnest—and satellites will help thin a lot of that ice.

To help make sure that they do, we will publish the U. S. satellite data as quickly as we can, so that they can be readily consulted by scientists anywhere in the world.

We know from experience how much the prompt publication of scientific findings can do for us. We have already given out freely the upper-atmosphere information obtained by research rockets.* In consequence, theoretical physicists in countries unable to launch rockets themselves have worked on this material and in their turn published results that we ourselves were in no position to work out at that time.

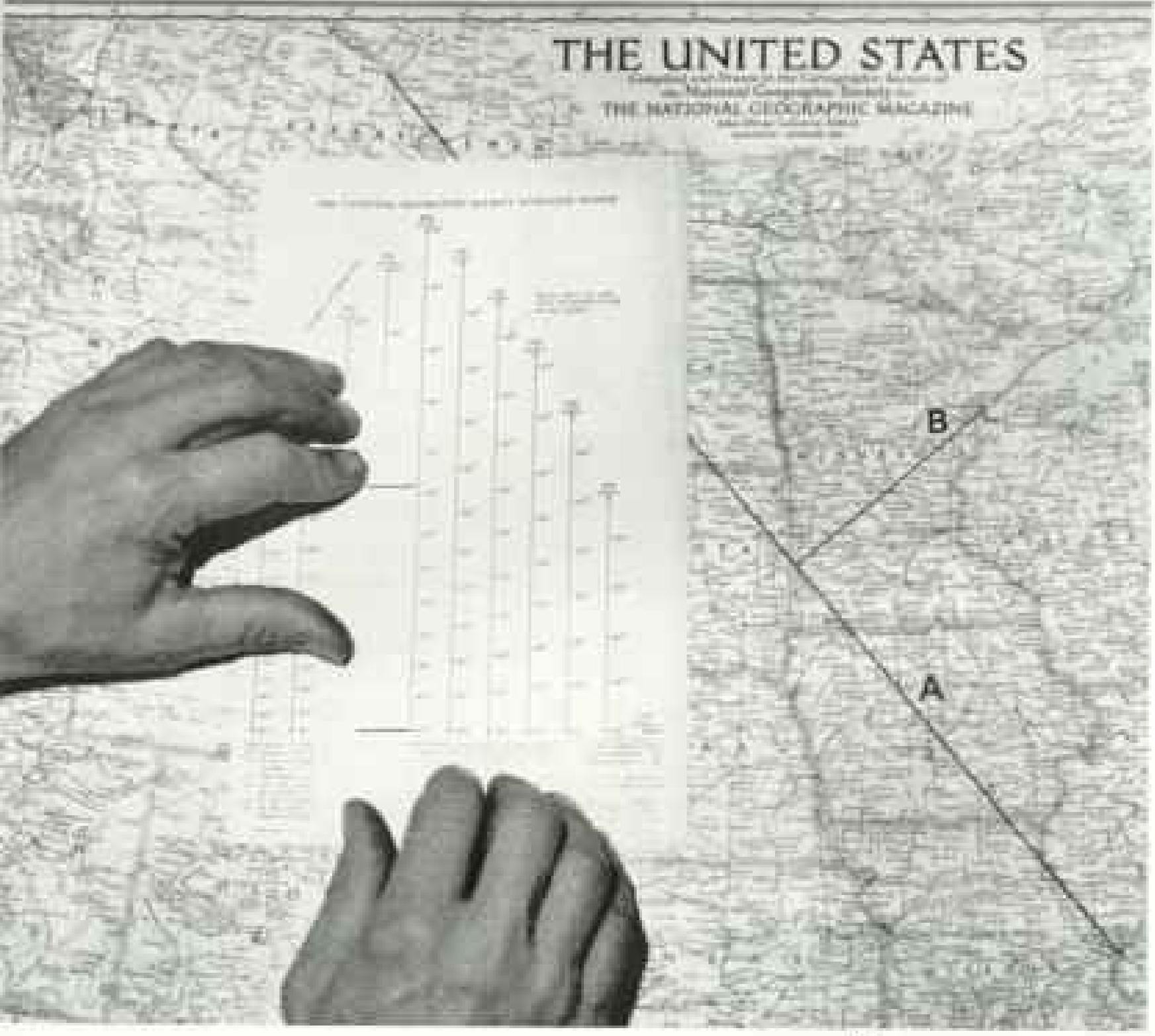
To sum up, then, let me say that the odd music of the satellite represents the culmination of a long chain of human dreams and achievements: Lucian, the Greek satirist, fantasticated about a naval vessel carried to the moon by a whirlwind; Benjamin Franklin's kite drew electricity from a cloud; the U. S. Army Air Corps–National Geographic Society's research balloon *Explorer II* rose to 13.7 miles in 1935; and Chinese rockets of the 13th century foreshadowed today's sky-piercing giants.

Dawn of the Space Age

Last, but surely not least, satellites lead us to intriguing thoughts about man's changing place in the scheme of things.

Once man thought his earth the center of the universe. Then science taught him that he was merely hurtling through space on one

* See "Rockets Explore the Air Above Us," by Newman Rumstead, NATIONAL GEOGRAPHIC MAGAZINE, April, 1957.



Map and Finder Give the Satellite's Position

The National Geographic Society's Satellite Finder (opposite) should be used with its September, 1956, MAP OF THE UNITED STATES.

Illustration at left shows how an observer in Duluth, Minnesota, might locate a satellite expected to pass over Saskatoon, Canada, and St. Louis, Missouri.

First the watcher draws a straight line (A) representing the satellite's predicted path between the two cities, as announced by newspapers or radio. Then, from Duluth, his own position on the map, he draws line B to meet line A at right angles. Line B gives the direction in which he must look.

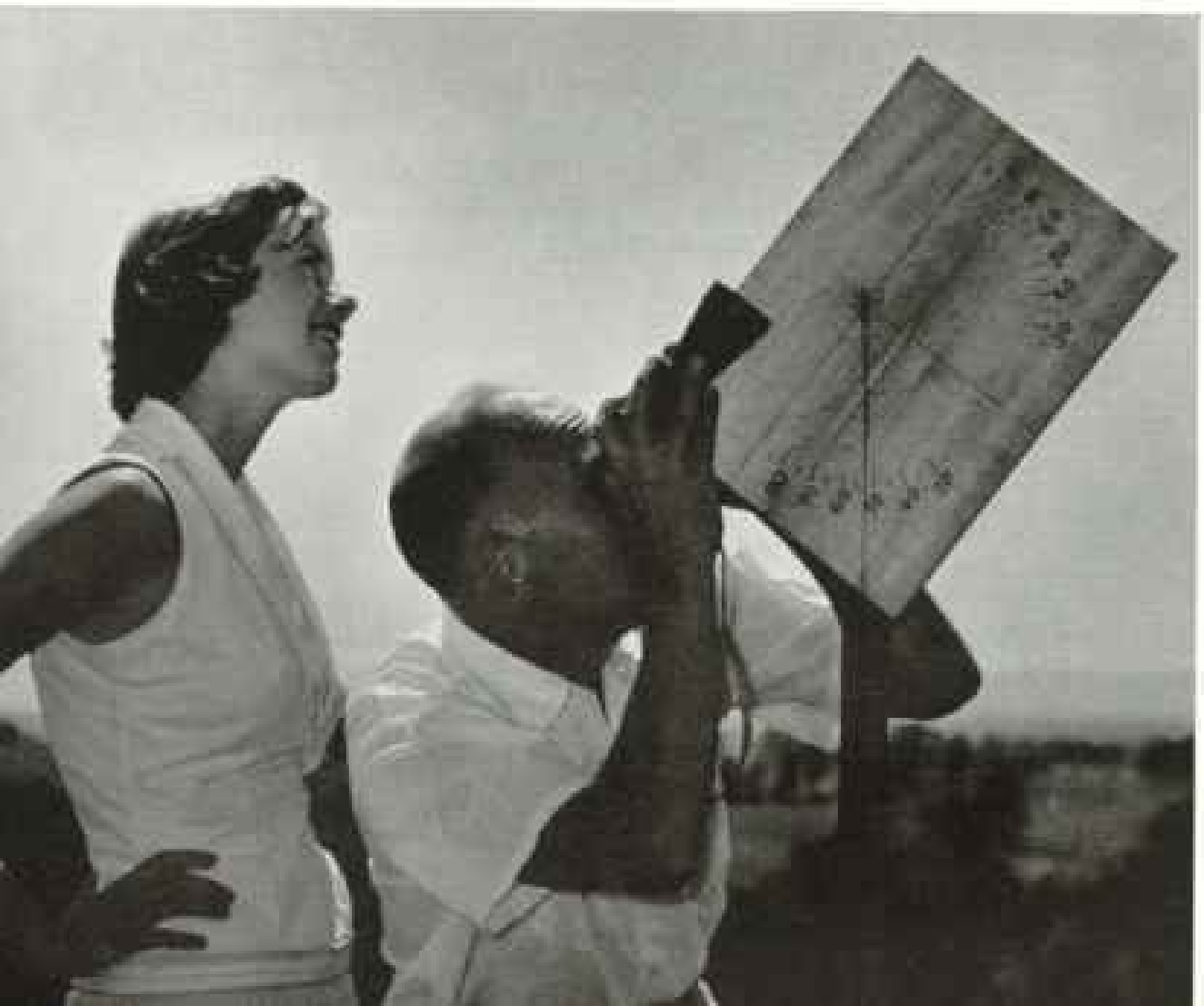
The Society's Satellite Finder Determines the Angle to Watch in the Heavens →

Next the observer selects the column on the finder representing the announced height at which the satellite is flying. Measuring the map's line B, he applies its length along the column, beginning at the 90° mark. The length of the line indicates the angle above the horizon at which he should look.

Duluth's hypothetical observer figures his angle at 54°. Others may find that their line B exceeds the height of the column; in such cases the satellite probably will be too distant for observation.

Knowing the satellite's flight path, angle, and time of passage, the observer should see it just before sunrise or after sunset, when the earth's surface is in shadow but the sphere is lit by the sun. Telescope or binoculars should be used. The finder will, of course, show the proper elevation anywhere along the orbit line, if the height of the satellite is known.

The National Geographic Society, collaborating with the United States National Committee for the International Geophysical Year, has already sent finder kits to 100 volunteer Moonwatch observation stations across the Nation.



Watchers Zero in on an Imaginary Moon

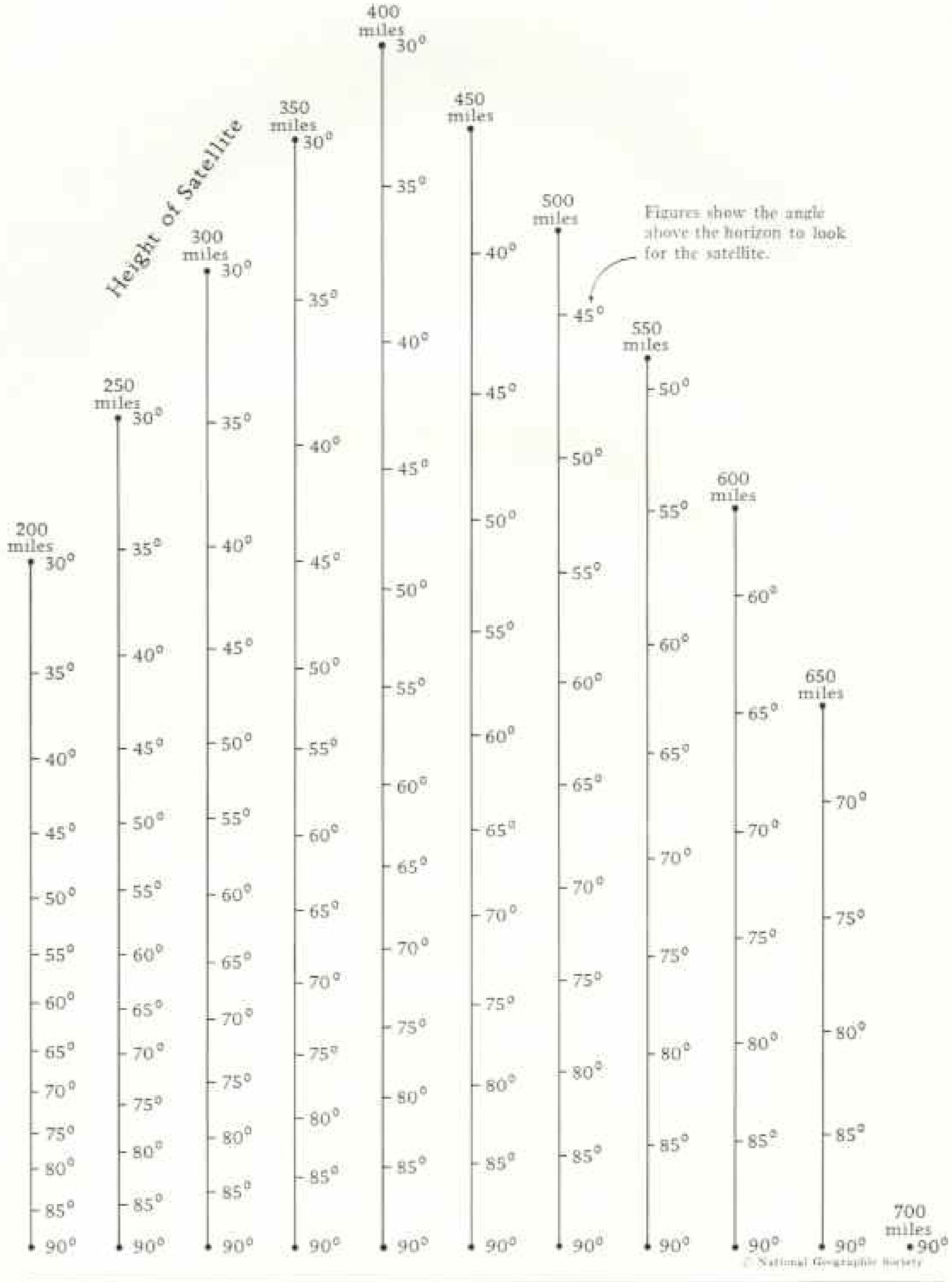
National Geographic Cartographer Welliman Chamberlin designed the Satellite Finder in cooperation with the Smithsonian Astrophysical Observatory, Cambridge, Massachusetts.

Here Mr. Chamberlin trains his binoculars skyward. To measure elevation, he uses a homemade protractor and plumb line. For direction he employed a pocket compass.

Nancy McCracken, a neighbor and amateur astronomer, awaits her turn.

John E. Fletcher (above) and Neil P. Davis, National Geographic Photographers

THE NATIONAL GEOGRAPHIC SOCIETY SATELLITE FINDER



This finder, printed on heavy, translucent plastic for use directly on The Society's September, 1956, MAP OF THE UNITED STATES, may be ordered from the National Geographic Society, Washington 6, D. C., $2.00 postpaid per kit of finder and map. The map alone is available at 75¢.

810 National Geographic Photographer Bates Littlehales

Tiny Test Sphere, Forerunner of the U.S. Satellite, Takes Power from the Sun

Prior to launching a full-scale, 21½-pound satellite, the U. S. Naval Research Laboratory plans to loft four of these 3¼-pound balls into the sky to test rocketry and radios. Naval scientist Roger Easton, one of the designers, holds the first of the four with its pedestal. The aluminum orb spans 6.4 inches. Its six foot-long antennas serve two separate radio transmitters. One operates on short-lived conventional batteries, the other on six solar-battery units behind the windowed openings. If by chance the sphere achieves an orbit, the solar cells will make it possible to hear and track the world-circling orb for years.

of many satellites of one of many suns. Now, as man has begun to put up true satellites of his own, he is in a way making himself the center of a universe of his own creation.

Furthermore, in view of more and bigger satellites to come and of the feasibility of making the space around us into our laboratory, we may be said to be extending the area we control. Thus we are in a way extending our earth.

Consider all these things and you may find that to describe the IGY satellite program as man's greatest achievement in a hundred years is not saying too much.

It may, in fact, turn out to be an understatement.

Notice of change of address for your National Geographic Magazine *should be received in the offices of the National Geographic Society by the first of the month to affect the following month's issue. For instance, if you desire the address changed for your February number, The Society should be notified of your new address not later than January first. Be sure to include your postal-zone number.*

New Chart for Watchers of the Skies

As Satellite Flights Turn Our Eyes Toward the Heavens, Your Society Maps the Guideposts of the Firmament

By Allan C. Fisher, Jr.

Senior Editorial Staff, National Geographic Magazine

WHEN our sun has granted man his nightly respite and thousands of more-distant suns begin a slow procession across the sky, members of the world's oldest fraternity take up their vigil on dark hilltops or in shadowed fields and back-yard lawns.

They are the stargazers, the nocturnal legions known to every age of history and to every land. They have no rules, no roster. Their only bond is the universal pastime of observing the constellations, those groups of stars that form picture-book images and wheel around our celestial doorstep.

With powerful telescopes modern astronomers may look far beyond our home galaxy, the Milky Way, to island universes composed of billions of suns. But all of us can find beauty, as well as a challenge to the imagination, in the stars visible to the unaided eye. There are about 6,000 of these, though only some 2,500 can be seen at any one time and place.

Sky Images Traced by the Ancients

Long before man began keeping records, the ancients thought they detected a relationship among certain of our neighbor stars. Some appeared to be grouped together. Moreover, to an imaginative eye, these groups seemed to form outlines that resembled animals and humans. Gradually our remote forebears evolved many such fanciful assemblages—the constellations—and populated the night sky with legendary beasts, heroes, and gods.

Today these spangled figures, though the creation of a superstitious and antique age, are heaven's guideposts, each representing an area or division of the sky. Their rich lore is a part of our heritage.

Strewn about the celestial canopy are 88 constellations, which astronomers divide into two classifications, original and modern.

The 48 listed as original had all been described, named, and recorded by the second century A. D. These are constellations visible from the Northern Hemisphere, which nurtured early civilization. The origin of most of them is lost in man's misty past. In the modern category are "down-under" star groups, constellations of the Southern Hemisphere that could not be seen by the ancients and so were compiled in relatively recent times.

All these stellar groupings, the storied and the new, are included in the National Geographic Society's MAP OF THE HEAVENS, distributed as a supplement with this issue of the Magazine.*

The map, a year in preparation, comes at a time when the advent of artificial satellites has stimulated man's interest in the skies. It presents on its reverse side star charts for both hemispheres and for each month. These charts were designed by Dr. Donald H. Menzel, Director of the Harvard College Observatory. One need not have previous experience in sky-watching to use and enjoy them. Accompanying instructions are simple and concise.†

Notations on the front of the map help locate those brilliant but sometimes elusive objects, the planets Venus, Jupiter, Mars, and Saturn. These bodies do not follow the general movement of the stars but wander seemingly erratic paths of their own. The very name, planet, is derived from a Greek word meaning "wandering."

Stars Wheel Around Celestial Poles

A new recruit to stargazing will not have pursued his hobby long before he appreciates why an entire series of monthly charts is essential in his quest. He will note that some groups of stars are visible on any good viewing night and at any hour. Others journey from an easterly direction and vanish beneath the western horizon, and these groups do not appear at all during certain months.

But the stars are faithful to us in their fashion. The reasons for their conduct can be readily grasped.

* Members may obtain additional copies of the new MAP OF THE HEAVENS (and of all standard maps published by The Society) by writing to the National Geographic Society, Washington 6, D. C. Prices, postpaid to all countries, 75¢ each on paper; $1.50 on fabric. All remittances payable in U. S. funds.

† See "The Heavens Above," by Donald H. Menzel, NATIONAL GEOGRAPHIC MAGAZINE, July, 1943.

We all know that the earth rotates on its axis. Because of this toplike motion, the stars seem to wheel about two fixed points in the sky, one in the Northern Hemisphere and one in the Southern. These celestial poles mark the alignment of earth's axis.

Polaris, the North Star, lies at the end of the Little Dipper's handle very near the north celestial pole. Therefore, to northern eyes it hangs motionless, while other stars circle it like the lights of a giant Ferris wheel.

The constellations near Polaris, such as Cassiopeia, Cepheus, and Draco, may be high or low in the sky, but in northerly latitudes they are always above the horizon. They are known as circumpolar groups. Other constellations—though they too circle the North Star—are more distant from the pole, and so drop below the horizon during a part of their journey.

Southern Hemisphere Lacks Polar Star

The location of Polaris is a cosmic accident, but it greatly simplifies orientation in northern skies. Unfortunately the Southern Hemisphere is not so lucky; it lacks an axis star to serve as pivot for its marching lights.

Once the viewer understands why some stars rise and set, he is ready for the next step—why these same stars disappear from the picture book at certain periods.

Four little minutes are responsible.

Though our solar day adds up to 24 hours, one full turn of the earth in reference to any given star takes only about 23 hours and 56 minutes. The explanation lies in the fact that the earth, while rotating, is also traveling around the sun. After a day's journey through space, we see the constellations in slightly different positions from those they occupied the previous night. In effect, the stars have gained approximately four minutes in their transit of the sky.

So slight a gain in time may not seem appreciable, but it adds up to a full 24 hours in the course of a year. As a result, many familiar star groups at times are overhead during daylight hours and cannot be seen.

The circumpolar constellations also are affected. Though visible each night, their positions change drastically with the passage of months. The Big Bear, for example, is near the zenith in March but stands close to the northern horizon in September.

If their latitudes permit, inexperienced star watchers should begin with Ursa Major, the celebrated Big Bear, easiest quarry of all. It contains the Big Dipper. Two stars forming the front of the Dipper's bowl point to Polaris. Draco, the Dragon, also is easy to find. It coils around the bowl of the Little Dipper.

Of all the constellations in the heavens, Orion is conceded to be the most beautiful. A fearless hunter, he carries a club, a lionskin, and a sword. Three bright stars stud his belt. Unfortunately this splendid huntsman is not circumpolar; he is at his fiery best during the winter months (pages 814-5).

One legend ties together half a dozen of the ancient constellations: Cassiopeia, Cepheus, Andromeda, Cetus, Perseus, and Pegasus. All are neighbors, celestially speaking, and a tale was woven to fit this fact.

Vain Cassiopeia, the mother of Andromeda, boasted too loud and long about her own beauty. This angered the sea nymphs; so the god Poseidon dispatched the monster Cetus to ravage the coast. Hoping to appease this evil creature, Andromeda's father, Cepheus, had his daughter chained to a rock. Then the heroic Perseus appeared. He slew the monster, married Andromeda, and whisked her away on the winged horse Pegasus.

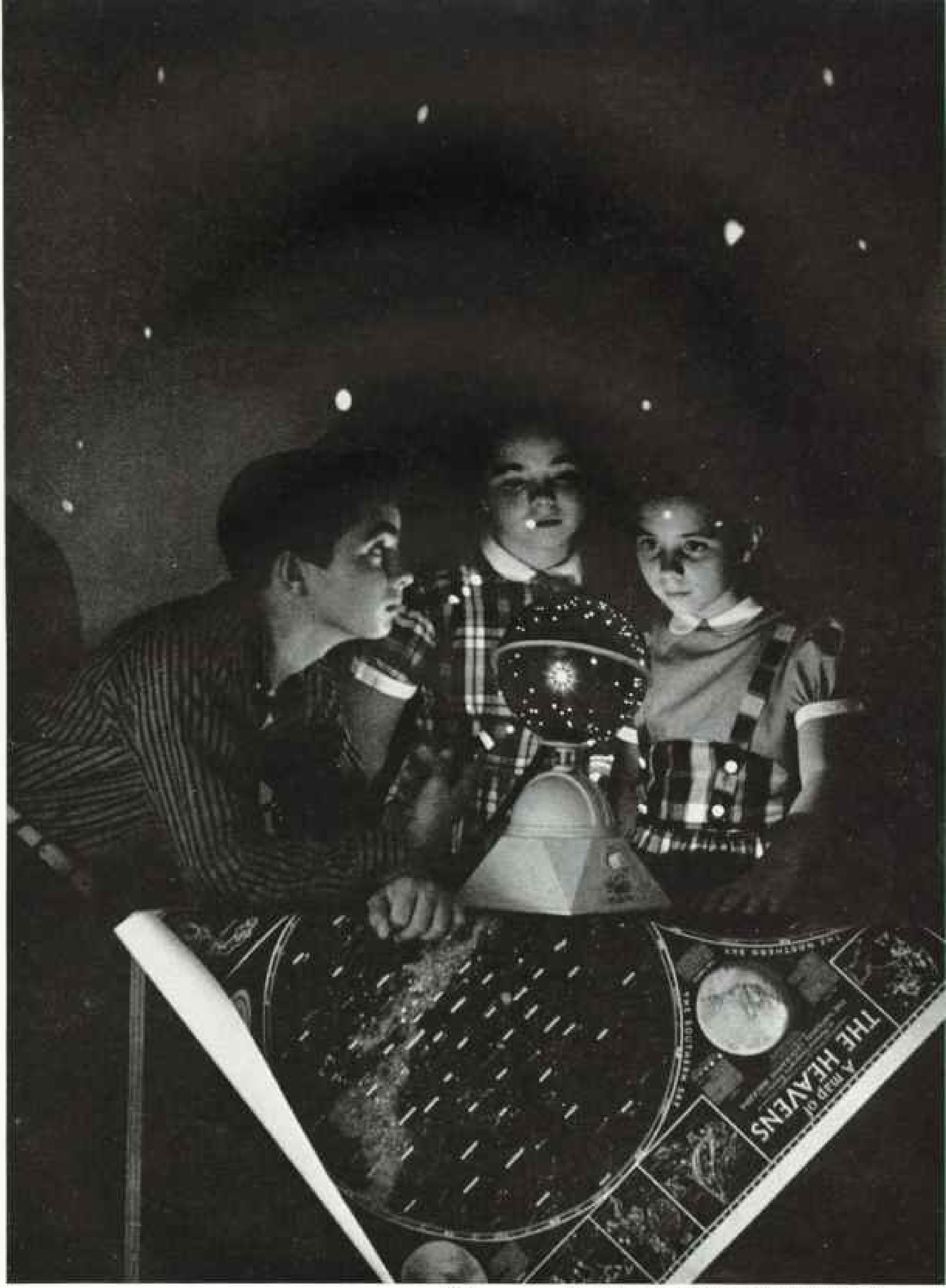
A modern discovery has enhanced the fame of the lovely chained lady. If viewing conditions are flawless, you may see near Andromeda's right elbow a hazy dot of light. This is the most distant object visible to the unaided eye, the Andromeda Nebula, a spiral galaxy some 2,000,000 light-years distant. It contains an estimated hundred billion suns.

The recently completed Sky Atlas, a project of the National Geographic Society and the California Institute of Technology, charts tens of thousands of such galaxies. Astronomers at Palomar Mountain photomapped the heavens to a depth of a billion light-years, expanding known space at least 25 times.*

Stars Migrate in 4,000 Years

Though most southern constellations fall in the modern category, some are of classical origin. More than four thousand years ago, when these groups first were recognized, probably in ancient Mesopotamia, they were visible from latitudes farther north than they are today. Since the earth rotates on its axis with a slow "wobble," the celestial poles

* See "Sky Survey Charts the Universe," by Ira Sprague Bowen, and "Exploring the Farthest Reaches of Space," by George O. Abell, National Geographic Magazine, December, 1956.



813 National Geographic Photographer Thomas J. Abercrombie

Map of the Heavens Helps Youngsters Identify Stars Projected by a Toy Planetarium

The National Geographic's new chart shows major stars in the northern and southern skies. Insets picture legendary heroes and zodiacal animals superimposed on constellations that bear their names.

very gradually change direction, with a consequent shift in star positions.

The sages of early Greece catalogued a number of southern constellations, observed by earlier peoples, and these groups have a colorful mythology and classic names, such as Centaurus (the Centaur), Lupus (the Wolf), and Argo Navis (the Ship Argo). However, at least a fifth of the southern sky was little known until the geographic explorations of the 15th and 16th centuries.

What the southern heavens lack in legend they compensate for in eye appeal. They have a brilliance and delicate beauty that the north cannot equal. The brighter stars are more numerous and stand higher in the sky. The fainter ones crowd closely together to enhance the glow of the Milky Way—itself a setting for the blazing Southern Cross.

"Animal Circle" Girdles the Heavens

Many stargazers, once they know their way around the sky, will want to observe the 12 constellations of the zodiac, those signs which some people endow with mystic powers over the affairs of men. The zodiac, or "Animal Circle," began as a very ancient scientific contribution. Men observed that the sun moved across the heavens in a prescribed yearly path, known today as the ecliptic. They divided this path into 12 parts, each identified by a constellation. These familiar groups are: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius, Pisces.

There is an old truism that reasonably good vision is not the only desirable equipment for stargazing; one should also be able to give full play to the imagination.

A critical eye may conclude that many constellations bear small resemblance to the creatures for which they are named. Indeed

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Stars Wheel Across a Winter Sky in New York's Hayden Planetarium

Night falls cloudless and serene. Towers of the city fade to dim outline on the horizon. Slowly, like a great orchestra tuning up, the stars pierce a canopy of black. The audience gasps at the illusion, for these heavenly bodies appear even more brilliant and glorious than true ones seen from a mountaintop.

Here the projector casts lights representing stars visible in December from the latitude of New York City. Just above the center of the opposite page, three bright stars, evenly spaced, form Orion's belt. Betelgeuse, a red star of first magnitude, marks his shoulder; Rigel, his leg. Sirius (left), in Canis Major, is the brightest star in the sky—except our sun, which is itself a star.

National Geographic Photographer Thomas J. Abercrombie

816 University of Chicago

Comet Flies a Glowing Tail Millions of Miles Long

First sighted late last summer, Mrkos-1957d flashed brighter than any comet seen in recent years. The visitor is named for a Czech astronomer; the letter "d" designates it as the fourth comet recorded this year. As Mrkos approached the sun, radiation pressure caused its long tail of luminous gases to stream away in the opposite direction, making it seem to stand on its head in the sky. The word comet comes from the Greek *komētēs*, meaning long-haired.

most people, at least initially, find it difficult to visualize these star groups with flesh and sinew, in the classic manner, as artists have represented them on the new map. Moreover, the difficulty is enhanced by a great variation in apparent brightness among key stars in many groups.

Despite viewing difficulties, most moderns prefer to visualize sky pictures in the patterns established by the ancients. To do otherwise, they feel, would divorce the observer from much of the legend, romance, and mystic appeal of our heavens. Other persons take the old star groups and convert them with a creative eye into new pictures.

Whatever you may behold in the constellations, an ability to identify them is invaluable. No one who knows them well is lost so long as he can see the night sky. Directions are apparent, and he may even make a shrewd guess as to the approximate time. For a navigator, of course, knowledge of the guidepost groups is essential. They help him locate the 55 stars used in celestial navigation.

Whence Came the Christmas Star?

December's advent always revives among sky watchers a favorite topic: the possible origin of the Christmas star that led three Wise Men to the Prince of Peace.

One school of thought believes the star was of miraculous origin; another that the Biblical reference is symbolic rather than literal. A third holds that an astronomical explanation is possible.

Astronomers know that Jupiter and Saturn approached one another three times in the year 7 B.C. During such an event, a "close conjunction," they might have seemed to merge into a single blazing object. Man has so toyed with his calendar that it is conceivable Christ was born in 7 B.C. Therefore, some authorities believe the Wise Men saw a conjunction of planets, not a star.

Still others think the star may have been a nova, or exploding star, or perhaps a supernova. The prefix "super" is reserved for inconceivably powerful stellar explosions of the kind that have occurred three times in the Milky Way in the past 900 years. Briefly such a cataclysm may give off more light than all the stars in a galaxy combined.

A third explanation holds that the Wise Men saw a comet. Advocates of this theory point out that the tail of the comet may indeed have made the "star" seem to stand above Christ's manger.

Though men may differ in their speculation about the Christmas beacon, though they may disagree on the imagery of the heavens, each feels the same awe, wonder, and humility at the beauty of a star-filled night. Give the watcher his darkened hilltop, touch off the fires in the abode of the gods, and his cares vanish in a surge of the spirit.

Bright Dyes Reveal Secrets of Canada Geese

Dyed-in-the-egg Goslings and Grown Honkers with Neckties Help Scientists Improve the Lot of These Majestic Birds

By John and Frank Craighead

With Photographs by the Authors

TWO baffled Idaho hunters brought their day's bag into a checking station one frosty November day and asked the conservation officer for an explanation.

They dangled a pair of plump, grayish-brown Canada geese. Around each snakelike throat was knotted a brilliant plastic necktie, one yellow, the other red.

One of the hunters shoved his cap back, perplexed. "I've shot plenty of geese," he said, "but these are the first ones that came wrapped for Christmas!"

In time this report reached us at the Cooperative Wildlife Research Unit at Montana State University. Just the summer before, we had knotted those markers on the same geese—then two-month-old goslings. Yellow meant a "girl," red a "boy" (page 828).

Colors Help Trace Goose Travels

Over the past five years a score of us—including Montana Fish and Game biologists and State University students—have pried into the community life of the Great Basin Canada goose (*Branta canadensis moffitti*) in one of the most intensive investigations this splendid waterfowl has ever undergone.

By injecting vegetable dye into nearly hatched eggs, we have produced goslings colored a startling red, green, or blue (page 821).

Our files are crammed with detailed "biographies" of more than 1,000 goose nests, including notes on the number of eggs laid in each, the number hatched, and the goslings that survived to the flying stage.

These activities reflect an important new trend in bird study, a shift from research on the natural history of a species to the intimate study of a single population.

Colored neckbands and dyed goslings have proved invaluable tools in following the daily, seasonal, and annual doings of goose society in a typical nesting area. They have helped tell us whether flocks are increasing, dwindling, or just holding their own, and they have revealed vital facts and principles on which to manage wisely a magnificent, once-threatened natural resource for the enjoyment of future Americans.

Rare is the human pulse that fails to quicken at the sight and memorable sound of a wedge-shaped flight of Canada honkers, foretelling spring and fall as surely as thawing snows and yellowing leaves. Generations of hunters have held this heavy-bodied, boldly marked fowl in highest esteem.

Traits of *Branta canadensis* cannot help but warm even the coldest scientific inquiry. Parents display a remarkable concern toward their young—or even toward those of other geese, as my brother Frank and I saw demonstrated one spring on the upper Snake River of Wyoming.

Half a dozen times our looming yellow raft frightened hours-old goslings out of their nests into the Snake's fast-moving waters. Oddly, but characteristically, a gosling separated from its broodmates would "adopt" the raft and faithfully follow us for miles.

One, trying to keep contact with the rubber boat, bobbed valiantly alongside through surging currents. At times it disappeared

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The Authors

National Geographic members first met John and Frank Craighead, twin naturalists, as youthful falconers in "Adventures with Birds of Prey," July, 1937. An Indian youth of royal blood read the article and invited the authors to visit him; their experiences were described in "Life with an Indian Prince," February, 1942.

As Naval officers in World War II the Craigheads organized the Navy Survival Land Training Program. From their remarkable experiment in emergency subsistence among the Kwajalein islands came "We Survive on a Pacific Atoll," January, 1948.

Earning doctorates at the University of Michigan, the brothers next wrote of their adventures seeking rare alpine flowers amid Wyoming's peaks in "Cloud Gardens in the Tetons," June, 1948, and described their animal studies in the same region in "Wildlife Adventuring in Jackson Hole," January, 1956.

Now 41 and each the father of three children, Frank is a wildlife biologist for the U. S. Forest Service, and John heads the U. S. Fish and Wildlife Service's Cooperative Wildlife Research Unit at Montana State University, Missoula.

Canada Geese, Sketched from a Blind, Find Winter Haven in a Maryland Waterfowl Refuge

Snowy cheek patches above a black-stocking neck mark the continent's most widely distributed wild goose. Ten subspecies, ranging from arctic tundras to Mexican lagoons, vary from the size of a mallard to that of a swan. One, now thought extinct, grew to 18 pounds. These birds average about 10 pounds.

Strong family ties keep geese and goslings together for nearly a year; pairs are believed to mate for life.

Canada goose fossils have been unearthed in Ice Age deposits. By 1676 a few birds had been sent from North America to England, where large flocks now range wild. Other transplanted birds thrive in New Zealand.

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Painting by National Geographic Artist Walter A. Weber

Tailflaps Down, Visitors Brake for a Landing After an Evening Banquet in a Cornfield

Primarily grazers, undisturbed geese observe mealtime with clocklike regularity. Feeding flocks post sentinels to warn of danger. Some Canada geese, as in Montana's Flathead Valley, seldom migrate; others seasonally wing nearly 4,000 miles between breeding and wintering grounds. The familiar V-shape of flocks in flight gives the rear birds an unobstructed view while their leader breaks trail through the air.

One captive honker lived 35 years, but at least 30 percent of those in the wild never reach their first birthday. A midsummer molt leaves geese earthbound for nearly a month (page 827).

completely in a swirling eddy of the swift channel, popping inevitably to the surface like an indestructible yellow cork.

We skirted a gravelly bar on which a pair of nesting geese had lost their eggs to floodwaters. As we watched, the gander raced across the current, feigning a broken wing to draw us off. The female, flattened against the ground, called urgently. The gosling responded, and, as we drifted past, the goose slipped between raft and orphan to herd the young adventurer ashore.

It was a clear-cut case of kidnaping—for protective custody.

Montana Valley a Paradise for Geese

These Snake River studies led to more intensive investigations in western Montana's spectacular Flathead Valley. There 27-mile-long Flathead Lake offers security and nesting seclusion on many small islands. In late spring, green shoreline meadows serve as brood areas, providing succulent grasses, spike rush, dandelion, pepperwort, and other goose delicacies. Flowing from the lake's southern tip, the swift Flathead River twists some 50 miles through the valley, its craggy islets offering haven for more breeding geese.

Nearly a month of air and ground census taking one spring revealed some 900 geese in the valley, about half of them nesting, the remainder too young. By the time the many nesting pairs were located by intensive search afoot and afloat, we had recorded more than 1,200 eggs. It was on some of these that my co-workers and I—including State biologist Dwight Stockstad and graduate student Mary Geis—tried our first experiment.

To follow and record the movements of goslings during the first few weeks of life, we had to mark them somehow so we could identify known broods at a distance. We borrowed a trick that had been used successfully on common barnyard chicks but never, to our knowledge, on wild geese: injecting harmless dye directly into the egg.

At selected island nests throughout the lake we dyed our eggs, carefully leaving several in each clutch untouched to determine later if dye affected hatching success.

A few days after treating our first nest we returned to see the results. The parent geese flushed and circled nervously offshore, honking their protest at this second intrusion.

All six of the dull, grayish-white eggs were cracked. The shell and membrane of one had been chipped away, revealing a normal wet, clammy gosling within. Clearly visible at the tip of its black beak was the egg tooth, used to chisel its way to freedom.

An hour later two goslings were out, damp down still clinging to their fragile bodies. One lay on its side, too exhausted to right itself. A yellowish, featherless bulge protruded from its belly: the egg sac, laden with nourishment. Within the next 24 to 48 hours this swelling would gradually subside. Nature provides well, and not until this survival ration is gone does the gosling begin to feed.

When the April sun had dried the first hatched goslings into fluffy, golden balls of down, the other four lay in the nest, helpless, wet—and bright scarlet!

Soon all six huddled together, cheeping noisily. Interestingly, no color barrier seemed to exist. The dyed goslings themselves seemed unaware of their difference. But how would the parents react?

Peering through the spotting scope a day later, Mary Geis reported the goose and gander leading a tiny flotilla of four red and two yellow goslings around the far point of the island. In all our observations, dyed eggs hatched as readily as untreated ones, and colored young were unhesitatingly accepted as members of a happy goose family.

Vigilant spying on our colored goslings during the following weeks furnished answers to many of our questions. The young left their nests within 48 hours after hatching; their first objective was to reach water. For some families it was simple. But others, where shores were steep and rocky, had to leap off eight- and ten-foot precipices. Most broods traveled from two to ten miles to reach shallow water and green lakeside pastures, the journey averaging about three days.

Tiny Goslings Struggle to Water

Families generally chose the water route. A few groups, however, made overland excursions of nearly three miles; others trekked across a wooded two-mile-wide peninsula.

We watched one brood of eight fluffy five-ounce goslings leave the nest and make their way by land. Each fallen log in their path loomed as a mountain; each foot-deep depression presented a yawning chasm.

One tumbled into a six-inch rocky crevice, fighting desperately for several minutes before it emerged. Another struggled frantically through an almost impenetrable, thorny thicket

↑ A Dash of Dye Inside Goose Eggs . . .

Near the end of their four-week incubation period, a biologist swabs shells with alcohol, then injects dye. Harmless coloring spreads over the imprisoned embryos. A touch of collodion from the flask in foreground seals the puncture.

. . . Gives Goslings a Scarlet Hue ↓

Normal yellow chicks huddle amiably with their bizarre broodmates. Once hatched, goslings cannot be dyed by dunking, for the oily down sheds dye like water. Weeks of spying on red, green, and blue goslings revealed movements and mortality.

of wild rose, dropping briefly from exhaustion before moving on.

Later a scattered trace of golden down told of small, wild tragedy. A feral cat, its tracks clean-cut in the mud, had snuffed out a straggler just as it reached its goal—the relatively secure waters of the lake. All signs indicated that only three of the original eight goslings reached open water to continue across the lake to the brood area that so mysteriously beckoned them.

This case, of course, was not typical. Of the broods traveling entirely by water, most members arrived safely. All told, four of every five goslings hatched in the valley reached the brood areas alive.

We determined this fact—a vital one to our study—by relating the number of colored goslings seen in the brood areas to the number of colored ones that hatched. We had found we could safely assume that the total of all goslings lost was in proportion to the number of colored ones lost. Thus our dyed-egg experiment rewarded us by disclosing the early gosling mortality for the entire population.

Flightless Goslings Dive from Treetop

In our systematic search we found that nine pairs of geese out of every ten chose to nest on islands of the lake or river, most of them on the ground. Frank and I had found earlier a similar percentage of island nests in the Jackson Hole valley of Wyoming.

But occasionally a Canada goose will elect to lay her eggs in an unoccupied fish hawk's nest 60 or 80 feet above the ground. The circumstances that cause her to do it are still a mystery.

One pair appropriated the nest of a red-tailed hawk on a cliff ledge high above the Flathead River. Others asserted squatters' rights in great blue heron rookeries. The 70-foot spar of an aged ponderosa pine served as home one year for a great horned owl and two years later for a goose.

These high-nesting geese appeared generally more successful in hatching their broods than those nesting on the ground. Desertion and predators took a lighter toll. But how did

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A Living, Honking Cloud Mills Above a Canadian Sanctuary

Each year more than 50,000 migrating Canada geese stop to rest at the Jack Miner Migratory Bird Foundation near Kingsville, Ontario. Mr. Miner founded this refuge in 1904 by keeping a few captive geese as decoys on a pond near his home.

Canadian National Film Board

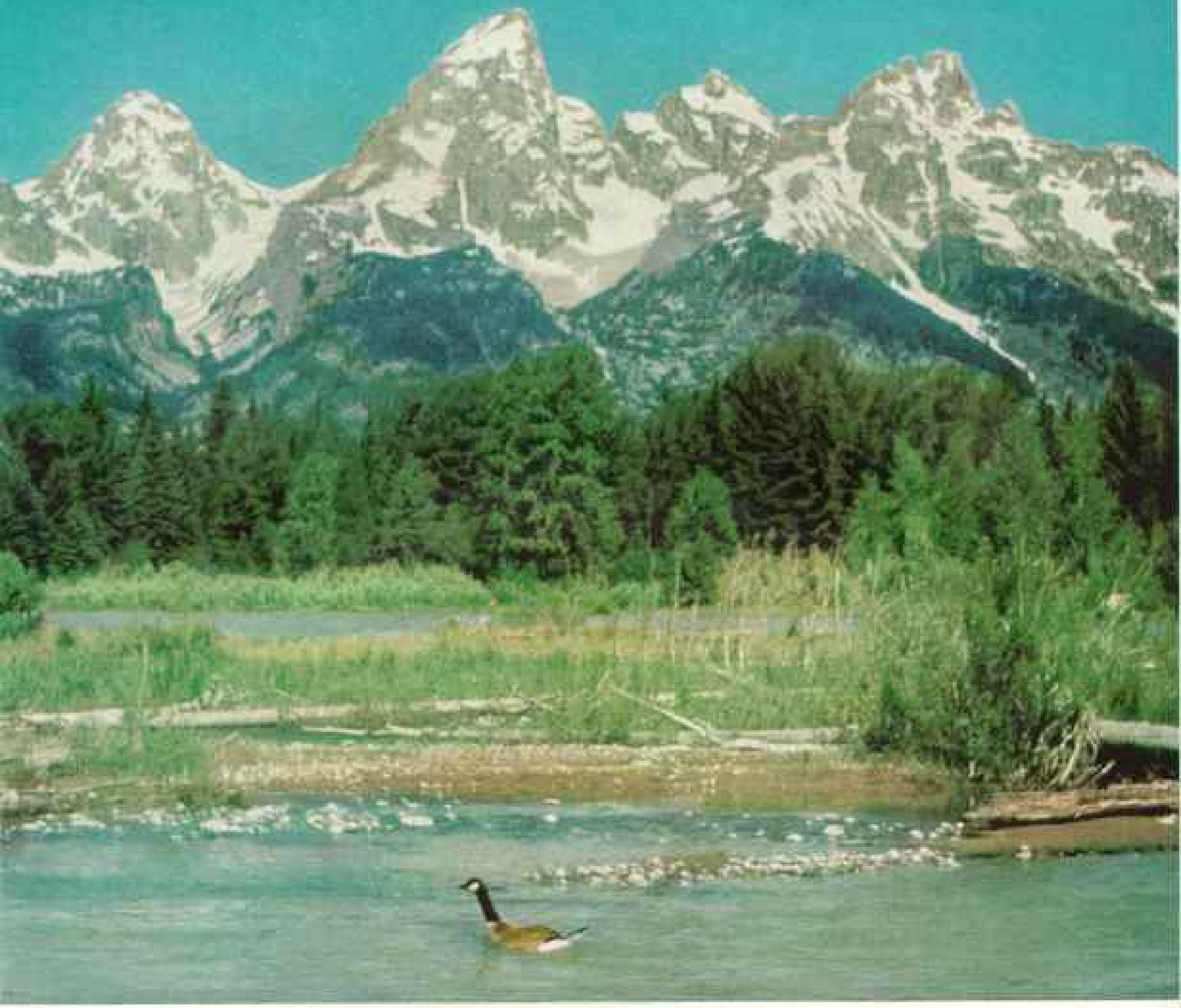
↑ To Safeguard Hidden Chicks, a Canny Honker Leads Watchers on a Genuine Wild-goose Chase

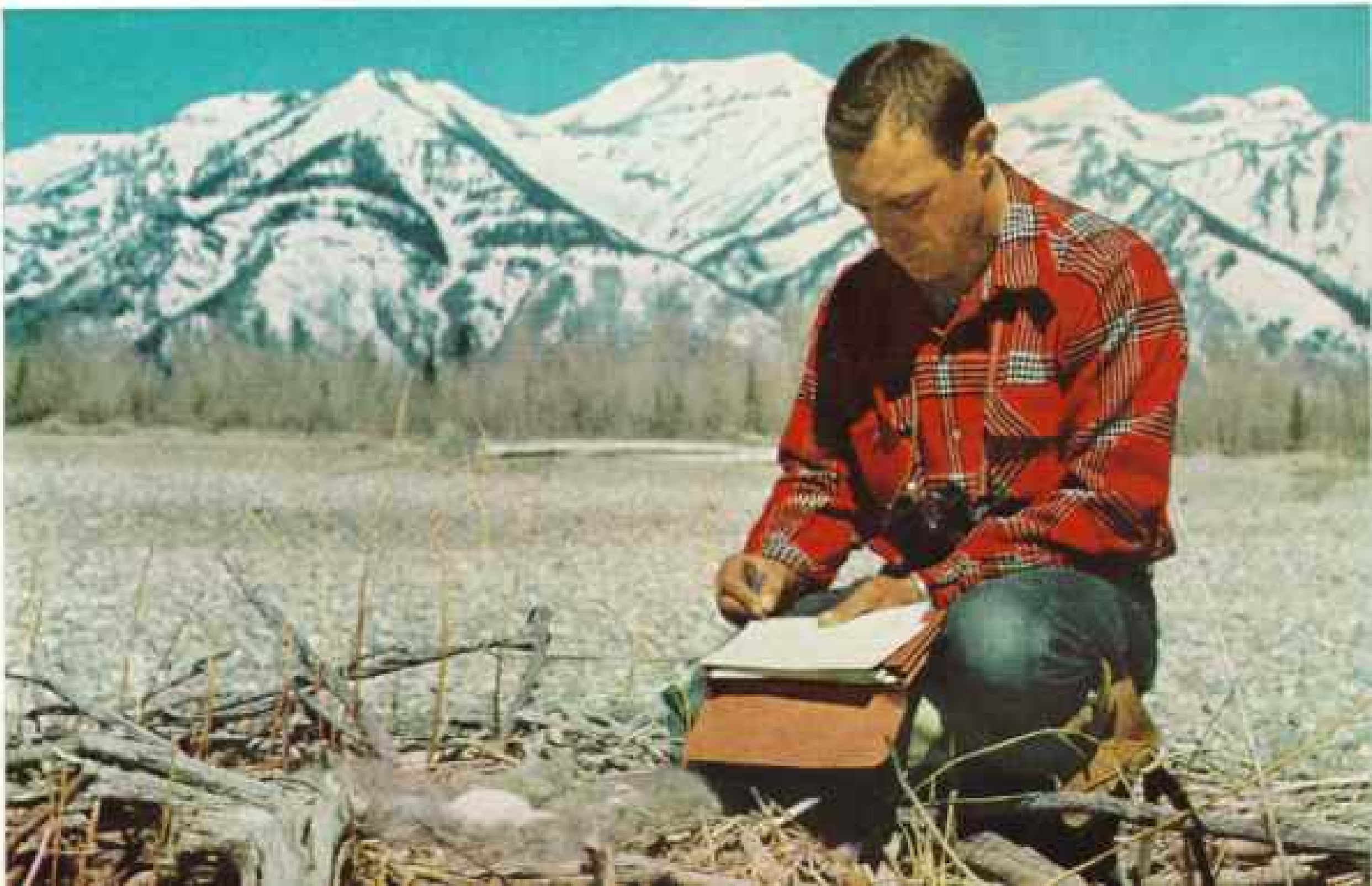
Parent geese often feign a broken wing to draw intruders from the nest.

Fir, spruce, and pine jostling on the far bank of Wyoming's Snake River creep up the flanks of the Teton Range. The highest peak is 13,766-foot Grand Teton, which the elements have gnawed to needle point.

← Biologist Dwight Stockstad boosts Bob Brown for a peek into a goose nursery 80 feet aloft in a Flathead Valley ponderosa pine. The treetop proved too dangerous to climb; later an aerial reconnaissance revealed four eggs. The flightless goslings fluttered to earth unhurt. Ospreys built the nest.

→ Frank Crairhead tallies goose eggs on the Snake River. During a three-year study the authors counted the number laid, hatched, and destroyed to determine if the goose population was effectively reproducing itself. Spring floodwaters from the snowy Tetons (background) proved the honkers' deadliest foe.





their offspring, unable to fly until midsummer, reach the ground safely?

An old rancher once gave me an explanation: "I seen it happen," he related solemnly. "Them little ones each grabs a big goose feather, that curved kind off the back, and they just spindle down like a helio-copter!"

A tree nest, some 40 feet from the ground, told us the true story. A previous visit had shown it held five goose eggs, nearly hatched. Normally the lake lapped at the base of the tree, but the low water level of early spring had exposed a broad expanse of fine, light sand beneath it.

Checking, one misty dawn, student Bob Brown and I discovered four tiny depressions in the sand. From each led barely visible gosling footprints. The tracks joined the heavy web prints of an adult goose and led straight to the water. But where was the imprint of the fifth gosling's safe landing? Instead, we found its tiny body impaled on a sharp stick jutting from the sand. For this one the journey had ended before it began.

It took three more years of watching before Dwight Stockstad and I witnessed the miracle of descent. What we saw bore out fully the story told by the prints in the sand.

To increase the number of safe nesting sites in the Flathead Valley, our Research Unit had nailed platforms high up in trees. This proved successful, and we found that a number of normally ground-dwelling geese were using them.

On one of these platforms a goose had recently hatched three eggs. As we watched, she glided from the nest to the water and uttered a series of short, sonorous honks. Almost immediately the three goslings leaped into space. Each flailed its stubby wings during the descent, thus breaking the fall. All three landed unhurt in the water.

Weight Doubles in a Week

In early summer we shifted operations to the brood areas—shallow bays fringed by lush green lakeside meadows.

Goslings are prodigious eaters, their appetites matched only by their phenomenal growth. They double their weight in the first week of life, and they grow at this rate until the end of the fourth week.

Dark feathers begin to appear during the fifth and sixth weeks; now they seem truly ugly ducklings. Now, too, our dyed goslings lose their colored down and become indistinguishable from their broodmates. Though awkward looking, young geese at this stage can run nearly as fast as a man and swim as well as their parents. They graze greedily, their serrated bills clipping the pastures as neatly as a sharp lawn mower.

By early July the Flathead Valley goslings are well feathered. A casual observer cannot tell them from their parents. But at this point in the life cycle of a goose, nature enacts another of her myriad mysteries.

The adult birds begin to lose their flight feathers while those of their offspring are still only half grown. Thus, for three to four weeks, the entire goose population is flightless, vulnerable. Instinctively it seeks safety in heavy shoreline vegetation or open water.

This state of affairs, unfortunate for a goose, is a happy one for a biologist. Now he can most readily trap, band, and mark birds for future identification.

On the shore at one of the more populous brood areas we erected a circular wire-mesh corral, some 20 feet across and three feet high. Wings flared from its entrance about 100 yards along the shore and into the water, shaping a large "V."

Flightless Birds Corralled by Boat

In four motorboats we circled the largest flock of water-borne geese and goslings, gradually herding them toward the trap. Reluctantly the flock moved into the corral. A few older, wiser geese spun at the last moment and literally charged the line of boats and shouting men. Spray flew as they alternately ran on the water and dived under the boats, to surface safely yards offshore.

Finally we closed the gate on nearly 50 captives. When student Gus Gustafson stepped into the corral, the flightless birds dodged and fluttered, futilely trying to clear the low fence.

"Sounds like a fleet of French taxicabs," he shouted with a grin over the panicky honking.

Swiftly he netted one goose at a time and handed it to Bob Brown, who determined its sex. Dwight clamped a numbered band on its right leg, students Ralph Stockstad and John Morrison weighed the bird, and Mary Geis recorded the data. Soon all the adult geese—nearly half the flock—were banded and released.

For an aluminum legband to tell its story, the goose wearing it must be re-trapped or recovered after death. We knew that many of our geese

Captured Geese Travel from Pen to Scale for Banding and Weighing

Flightlessness at molting time exposed this flock to capture on Pablo Reservoir, Montana. Like shepherds driving sheep, biologists and students in motorboats herded the birds across the water into the wire corral.

Here, in assembly-line fashion, the birds are taken with a dip net (left), examined for sex, legbanded, weighed in the metal funnel, and finally released. The roundup yields basic population data—fundamental knowledge that may help preserve and increase the species.

← **"It's a Boy!" Says the Red Necktie on This Wide-eyed Gosling**

To binocular-equipped conservationists the plastic neckband, fastened with a falconer's slip-proof knot, announces a bird's age and sex several hundred yards away. Numbered aluminum legbands (left), when returned to the U. S. Fish and Wildlife Service, yield valuable data for safeguarding our wild-fowl heritage.

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would not survive a full year, for nature has decreed a high turnover in waterfowl.

The recovery of thousands of leglands—each stamped with a number and the words, "Write U. S. Fish & Wildlife Service, Washington, D. C."—is most important. When returned with full information, they tell us how, when, and where our geese (and other banded birds, of course) die. Thus we may take steps to control excessive mortality and predict how many geese can safely be taken by hunting.

Nature, unfortunately, did not anticipate the automatic shotgun or the current hordes of enthusiastic waterfowl hunters. Man can and should harvest the surplus, but no more. If he cuts into the principal, soon there will be no interest. The aluminum band helps tell us whether our budget balances.

But, to fathom the inner workings of a population, we needed to know more than metal legbands could tell us. We had to be able to recognize geese of known age and sex while they were still free.

To mark our young geese harmlessly and permanently, we devised a soft loop of half-inch plastic tape to be knotted about the bird's neck. Tried on captive geese, it had proved harmless, durable, and easily seen by the unaided eye at a considerable distance.

Now came its first test on wild honkers. Down our assembly line moved the goslings. Each was sexed, banded, weighed, and finally decorated with a necktie—yellow for the female, red for the male. Next year it would be green and violet, then white and orange.

Thus, a year and a half later, it came about that two puzzled hunters in Idaho bagged a pair of geese "already wrapped for Christmas." Others were seen and reported in Oregon, Washington, Nevada, and several as far off as southern California.

These distant records were valued bits of information. But a greater satisfaction came one blustery spring day when the spotting scope showed us a pair of honkers setting up housekeeping on an island in the Flathead River. The goose wore a yellow plastic marker, telling us what years of field observation had not revealed: that at least some of our geese nest at two years of age.

Biologists have discovered that, like human communities, goose communities have traditions. One tradition is established because the gosling becomes attached to the surroundings it perceives during the first few months of life. This particular area is firmly "imprinted" on each bird. Influenced by this imprint when nesting time arrives, geese return year after year to the area of their birth.

This behavior has an important bearing on survival. It means that when too many geese are annually harvested from the population of any breeding ground, the number that will instinctively return there to nest is reduced.

Thus a decline in the number of nesting geese in a given area warns that the population is on the downgrade. Unless carefully managed, they will eventually disappear, as already has happened in so many areas.

New Colony Thrives as Young Return

Conversely, this characteristic has a useful application. Geese can be transplanted to an area which formerly had none, and their offspring will become established and return each year to nest. In time a new nesting population builds up where previously none existed.

Many consider the Canada goose a wary, intelligent bird. Hunters, particularly, have a way of exaggerating the honker's know-how. Actually, the crow and the raven, those clever black bandits of the bird world, can and frequently do outsmart the Canada goose.

When leaving their nest to feed, geese usually cover their eggs with a matted quilt of gray down—an intelligent camouflage precaution, it appears. Yet they signal their intention of taking flight by posturing and calling, and their departure is as noisy as a jet take-off. Ravens associate this behavior with food.

One morning on the Snake River Frank and I watched a raven attracted just this way. When the geese had left, the raven flew in

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← **Goose-bander Grover Elgan Frees a Gander Leg-marked for Life**

Where a roundup into a shoreline corral is impractical, Flathead Valley honkers in midsummer molt are pursued by motorboat and scooped up with a dip net as they surface from a dive. Geese trying to escape can submerge at least three minutes, dive 25 feet, and swim 100 yards under water.

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↑ Mother Turns Eggs as Her First-born Watches

Egg rolling distributes warmth and prevents the membrane from sticking to the shell. Leaving the nest to feed, the goose blankets her eggs with down to guard against cold and conceal them from predators.

←Week-old goslings test their aquatic skill under parents' watchful eyes. Baby geese feed themselves, swim, and dive expertly when they first touch water. Adults' sex is difficult to distinguish even at this range. Bird at left, with heavier body and thicker neck, appears to be the male.

←Lower: John Craighead inspects a sleepy-eyed brood recently hatched. Their mother built the nest by scooping out a hollow and lining it first with debris and then with down plucked from her breast.

↓A goose leads her young to the safety of water. Enormous appetite, gratified by lush pasturage, doubles a gosling's weight in a week.

low and effortlessly, methodically combing the gravel bar. A wisp of loose down caught his eye. He wheeled instantly and dropped beside the nest. Before we could intervene, an egg had been punctured and drained.

Our Snake River studies indicated that predatory ravens and spring flooding, which washed nests and eggs away, accounted for the loss of one potential gosling of every four. The flooding we could alleviate; our data helped lead the Bureau of Reclamation to regulate water levels on the Snake during the breeding season. But we don't yet know how to stop ravens from stealing eggs.

Such predation, though spectacular and efficient, doesn't alarm us. A goose cannot outwit a raven, but nature has endowed her with an effective defense: the ability to lay a large clutch of eggs, and often to re-nest when the first attempt fails.

Some geese will lay as many as ten eggs, and the average is five. Despite predators, floods, and desertion, a goose population will manage to hatch an average of three goslings for every nesting pair.

Even this was not enough 20 to 30 years ago, when a "waterfowl depression" cast its pall over North America. Then drought, uncontrolled drainage of nesting marshes, and overshooting shrank flocks of ducks and geese to a fraction of their former teeming millions.

Vigorous action by the U. S. Fish and Wildlife Service, the Canadian Government, and State and private organizations has saved our waterfowl heritage from going the way of the prairie chicken or the heath hen. Regulated hunting, drainage control, refuge and marsh building, surveys, and research have done much to restore flocks to safer levels. Their numbers have doubled, and possibly even tripled, since the mid-1930's.

In a few months the snow-blanketed Flathead Valley will stir to an unseen, unheard signal as the wintering flocks disband and begin nesting. Once again we will be busy—banding, dyeing, counting, watching. It is no small reassurance to know that each year more of America's millions of sportsmen come to realize that our strange activities have a vital purpose.

That change is typified by a veteran Montana goose hunter we had been meeting in the valley for several years during our fall census taking. He made little effort to conceal his amused skepticism over our chilly task.

One afternoon last year, however, he stopped to hand me a metal legband.

"Found this yesterday on a goose I shot about two miles up the lake," he said. "Thought it might help with your countin'."

Parents Escort a Convoy of Goslings; Necks Droop at Danger's Approach

H. H. Shelton

Bringing Old Testament Times to Life

Archeologists Combine Scientific Methods with Shrewd Deduction to Paint an Ever-clearer Picture of Life in Biblical Days

By G. Ernest Wright, Ph.D.

"OF ALL SCIENCES, the two making the most progress in the world today are nuclear physics and Palestinian archeology."

Behind this startling declaration by Dr. William F. Albright of the Johns Hopkins University, one of the great scholars of our century, lies the fact that in our time archeologists have rediscovered the Near East. Their trowels have unearthed the ruins of ancient civilizations whose names ring thrillingly in the ear—Assyria, Babylonia, and Ur of the Chaldees.* Such Biblical sites as Jericho, Hazor, Tirzah, Shechem, and Gibeon are giving up their secrets.

These excavations have shed a brilliant new light on the wandering herdsmen who gave the world three of its great faiths—Judaism, Christianity, and Islam—as well as its most influential religious document, the Bible.

Ruins Reflect an Age of Violence

More than 20 years ago I received my first taste of Palestinian archeology at the Biblical city of Bethel, in what is now the Kingdom of Jordan. I was a young student then, working under Dr. Albright's direction.

We lived for two and a half months in tents pitched in a fig orchard, slept on beds with as many humps as a herd of dromedaries, went on breakfast-food diets to avoid the concoctions of the native camp cook, and drank boiled water. But even these acts of iron self-discipline failed to save us from dysentery.

Nonetheless, our excavation in Bethel went forward; digging had scarcely begun when walls appeared beneath the surface. Our elation at finding mere masonry baffled the Arab landowners, who were unshakable in their conviction that we were after gold. But the Israelites who had lived here 3,000 years ago were desperately poor; their ruins boast no glittering statues, no jeweled sarcophagi.

As the first novelty wore off, I began to share the Arabs' bafflement. The uninitiated student—such as I was—can find little excitement in a jumble of toppled stones from an impoverished Israelite home. The boredom is compounded when, after you plan, photograph, and remove the stones, you find immediately below them another confused jumble like the first.

Yet, oddly, it was this very reiteration of ruin, the monotonous succession of devastation, rebuilding, and fresh devastation, that eventually gave me a stirring insight into the birth throes of our religious heritage. For here was stark evidence of an age of unremitting violence, pillage, and sudden death.

Stone Statue Unlocks a Mystery

Virtually every generation saw its homes sacked and burned by invading armies. Had we lived then, I think we would have prayed as fervently as the Biblical psalmist, though perhaps without his depth and beauty:

> In thee, O Lord, do I put my trust; let me never be ashamed: deliver me in thy righteousness. . . .
> My times are in thy hand: deliver me from the hand of mine enemies, and from them that persecute me.
>
> Psalms 31:1, 15

At about the time I was receiving my initiation at Bethel, a group of Bedouin gravediggers in eastern Syria unearthed a stone statue. This fortunate turn of a spade provided a major key to a mystery that had long vexed students of the Old Testament: "Who were the patriarchs, the forefathers of the Israelites, and whence did they come?"

For when a French expedition followed up

*See *Everyday Life in Ancient Times*, a 356-page book with 120 illustrations in color, published by the National Geographic Society, Washington 6, D. C. $5.00, U. S. funds. Postpaid.

The Author

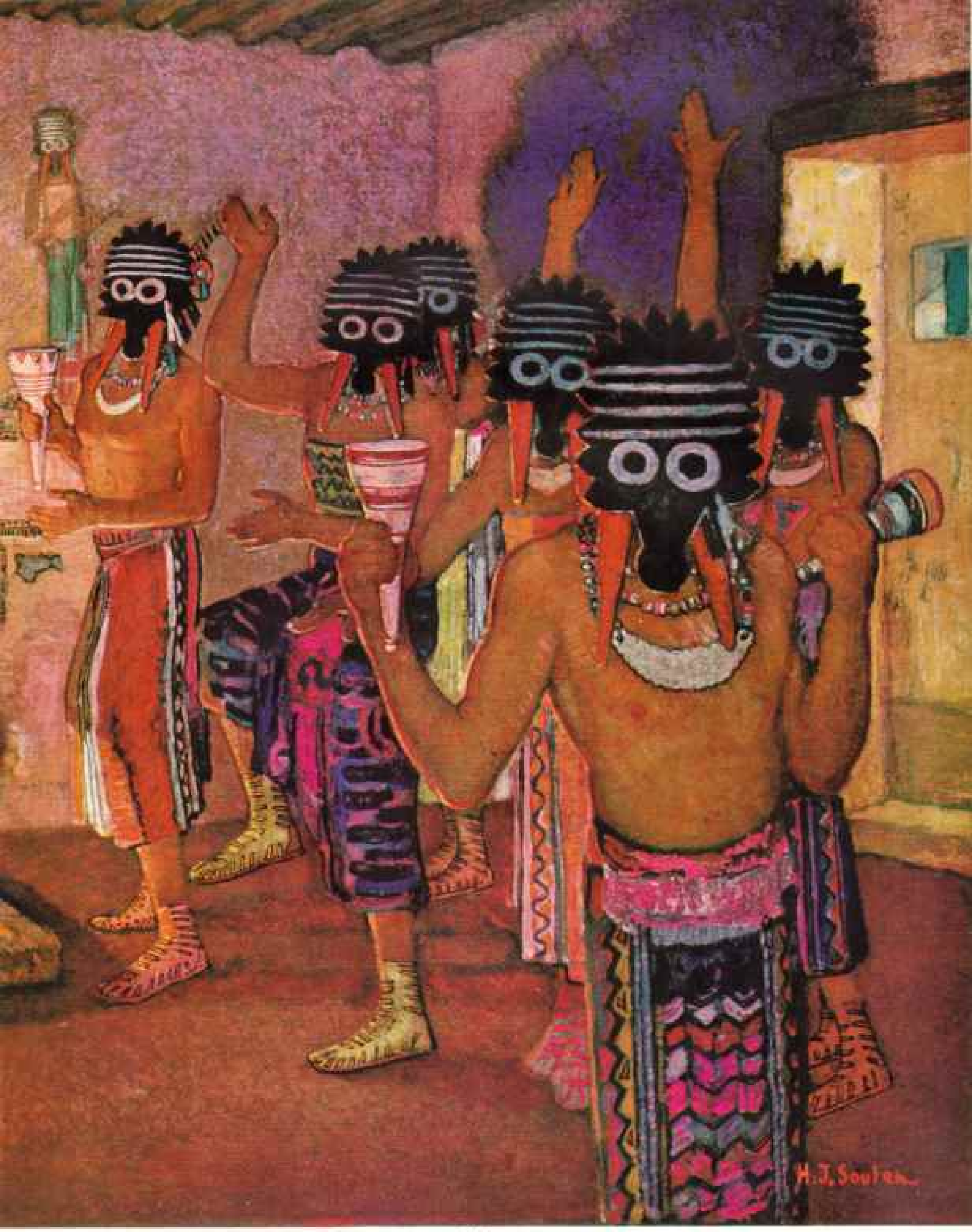
Since receiving his Doctorate of Philosophy from the Johns Hopkins University in 1937, G. Ernest Wright of Chicago's McCormick Theological Seminary has been intimately identified with Palestinian archeology. Last summer, as Archeological Director of the Drew University–McCormick excavations at the site of ancient Shechem, he led the largest American expedition to the Holy Land in the past 30 years.

Dr. Wright edits *The Biblical Archaeologist*, a publication of the American Schools of Oriental Research, and is a past Field Secretary of that institution. He is the author of *Biblical Archaeology* and a co-author of *The Westminster Historical Atlas to the Bible*.

Votaries of an Unknown Deity Dance in a Jordan Valley Shrine

With a painting of a primitive religious rite in the Palestine of 55 centuries ago, the NATIONAL GEOGRAPHIC MAGAZINE begins a series by Henry J. Soulen vividly re-creating life in Bible Lands in ancient times.

Old Testament scenes range from the days of the patriarchs through the Exodus and the conquest to the establishment of the Hebrew monarchy. All are as accurate as the latest archeological studies can make them. The artist spent four years in research and painting, using hundreds of sketches and photographs made during his own travels in the Holy Land and working intimately with the author, a distinguished Biblical archeologist. Infinite attention was given to details of clothing, hairdress, weapons, pottery, furnishings, and decorative motifs.



835

Ghassulian People Call to Mind Pueblo Indians of the Southwestern United States

These masked dancers lived in Palestine 1,500 years before Abraham, the Hebrew nomad, left his home in Mesopotamia and migrated to the Land of Canaan. Their culture flourished when the Stone Age was giving way to copper and bronze.

Ghassulian artists left suggestions of their beliefs and manner of living in remarkably intricate and brilliant frescoes on mud-brick walls—the earliest paintings of religious significance found anywhere in the Near East.

Artist Soulen has reproduced on the wall of the shrine much of the source material he used for this imaginative painting. The meaning of star, elephantlike masks, and horn-shaped cups is uncertain.

the Bedouin find by excavating on the spot, they discovered the ancient city of Mari buried under the shifting sands of centuries. This seat of empire had flourished from some time in the third pre-Christian millennium until about 1700 B. C., when it was subjugated by Hammurabi, king of Babylon.

In the palace of the kings of Mari, a mammoth 300-room edifice covering seven acres, the French party found more than 20,000 tablets inscribed with cuneiform writing. Names of long-vanished north Mesopotamian towns preserved on these and related tablets —Nakhur, Til Turakhi, Sarugi, Phaliga— bore an uncanny resemblance to the kinsmen of Abraham mentioned in the Book of Genesis —Nahor, Terah, Serug, and Peleg. Also prominently mentioned was the city of Haran, which Genesis treats as the traditional home of the patriarchs.

Amorites Invade the Fertile Crescent

We know that about 2000 B. C. Semitic nomads, called Amorites in the Old Testament, fought their way into the highly civilized Fertile Crescent—the semicircle of arable land arching from Palestine to the Persian Gulf—in one of history's first recorded "barbarian" invasions (map, pages 838-9).

We also know that Haran was an Amorite center at the time the patriarchs were there. In addition, the Biblical names Abraham and Jacob have their Amorite counterparts in Abamram and Jacob-el. The Mari tablets also refer repeatedly to a troublesome tribe of Benjaminites.

In the light of this evidence, scholars now assume that the Biblical names of Abraham's kinsmen were actually patriarchal clan names, either applied by the Semitic people to towns they founded or borrowed by them from cities seized during the 2000 B. C. invasion.

Patriarchs Lived Like Modern Bedouin

Eventually the founding fathers moved south from Haran into the hill country of Palestine. Here, during the early part of the second millennium B. C., they followed the timeless pattern of nomadic life. Cattle and flocks of sheep and goats furnished them with food, clothing, and shelter. They slept in goat-hair tents and migrated with the seasons and the pasturage. The donkey was their principal beast of burden. Occasionally they quarreled with other groups over land and water rights.

A painting in the tomb of an Egyptian nobleman at Beni Hasan, dating from about 1890 B. C., depicts a clan of Semitic nomads from Palestine. Some of the men wear only a kiltlike skirt of brightly patterned wool; most of the other men and women wear elaborate, colorful tunics fastened across one shoulder,

How the Paintings Were Made

FEW artists know the Holy Land as well as Henry J. Soulen. By camel, by car, and afoot he has visited and sketched most of the places immortalized in Scripture.

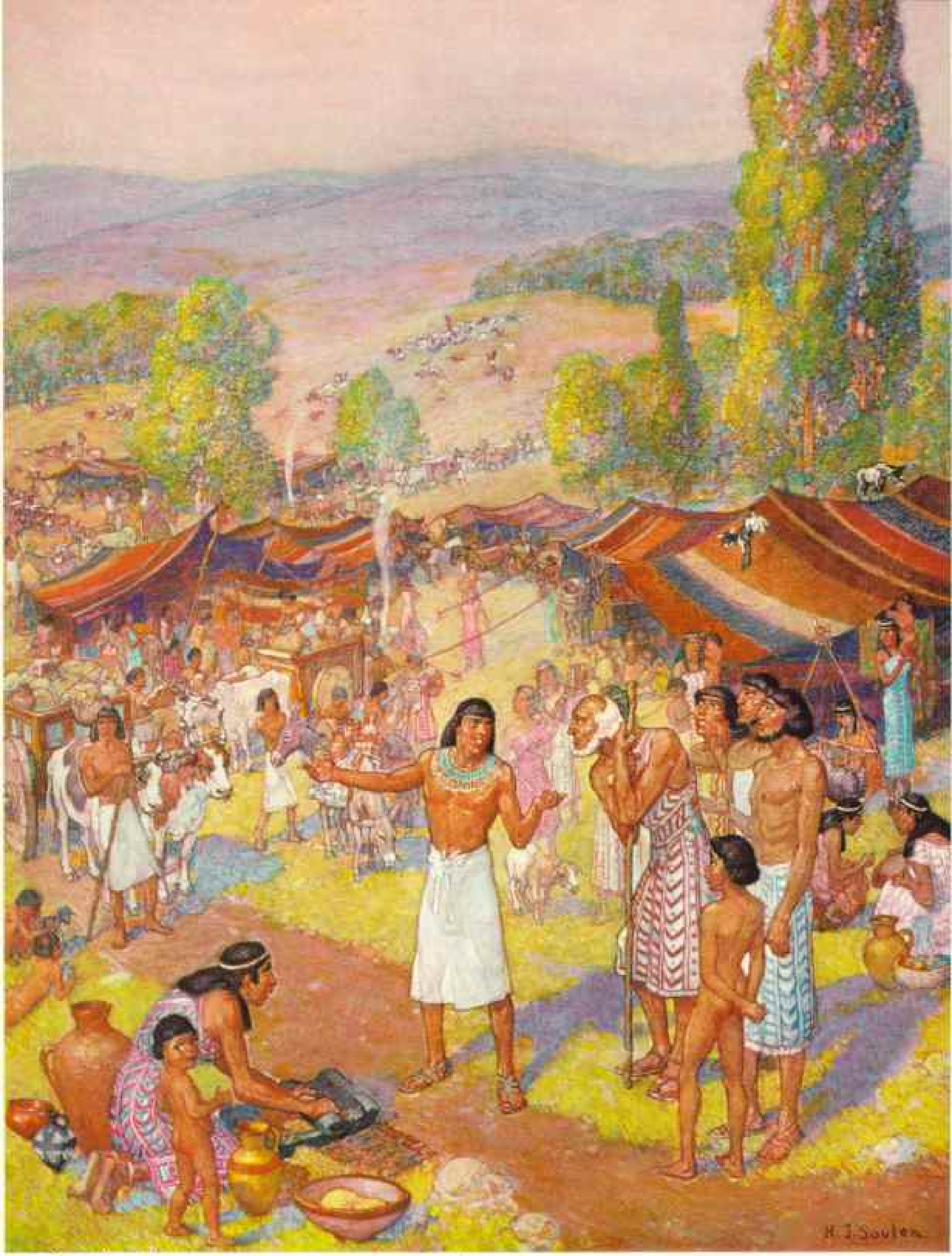
Soulen developed a striking technique for capturing the vivid colors and shifting moods of the Holy Land. Using 250 pastel crayons of his own manufacture, he made hundreds of on-the-spot sketches on sandpaper. Why sandpaper? Because its rough surface caught the broad, deep tones of his crayons better than any other medium. Constant reference to this "catalogue of colors" enabled him to infuse his canvases with all the brilliant hues of the Palestinian spectrum.

The artist studied countless archeological reports, as well as the actual pottery, ornaments, and other artifacts brought to light by excavators. For example, in the representation of Gideon's rout of the Midianites on page 850, Soulen derived the costumes of the Israelite soldiers from an ivory carving of just such a soldier of 3,000 years ago found in the ruins of ancient Megiddo. Gideon's sword is taken from an original in the Palestine Archaeological Museum.

To portray the furnishings of King David's palace (page 856), Soulen copied a table shown on the sarcophagus of King Ahiram of Byblos, a near-contemporary of David. An eighth-century B. C. basalt relief now in Istanbul's Museum of the Ancient Orient furnished the details of the chariots at Megiddo (page 860).

In Soulen's portrayal of the meeting between King Solomon and the Queen of Sheba (page 862), Solomon's throne follows the description in I Kings 10:18-20, and also incorporates elements of a royal throne carved on a Megiddo ivory. The colorful frieze decorating the palace wall is based upon actual Egyptian pictures of Palestinians during Biblical times.

The fact that the artist himself has lived with Bedouin nomads lends special realism to the tents pictured on the opposite page.



"They Took . . . Their Goods . . . and Came into Egypt, Jacob, and All His Seed"—Genesis 46:6

Drought has stricken southern Canaan; the flocks of Jacob and his sons face starvation. A messenger brings word inviting the entire family to the Land of Goshen in Egypt, where Joseph, Jacob's favorite son, is prime minister. Woman at left grinds wheat. Oxen pull solid-wheeled carts loaded with Egyptian grain. Kids gambol on one of the goat-hair shelters, copied by the artist from today's Bedouin tents, since they probably differed little.

leaving the other bare (page 843). Their baggage is strapped on the backs of donkeys, and the men carry spears, bows, and throwing sticks. One carries a lyre, indicating that music was popular among the nomads.

Still another Egyptian source, an adventure story of 39 centuries ago, offers us a fascinating glimpse into the patriarchal way of life during this period. A courtier named Sinuhe had to flee Egypt and took refuge "in the East" with a chieftain much like Abraham or Jacob.

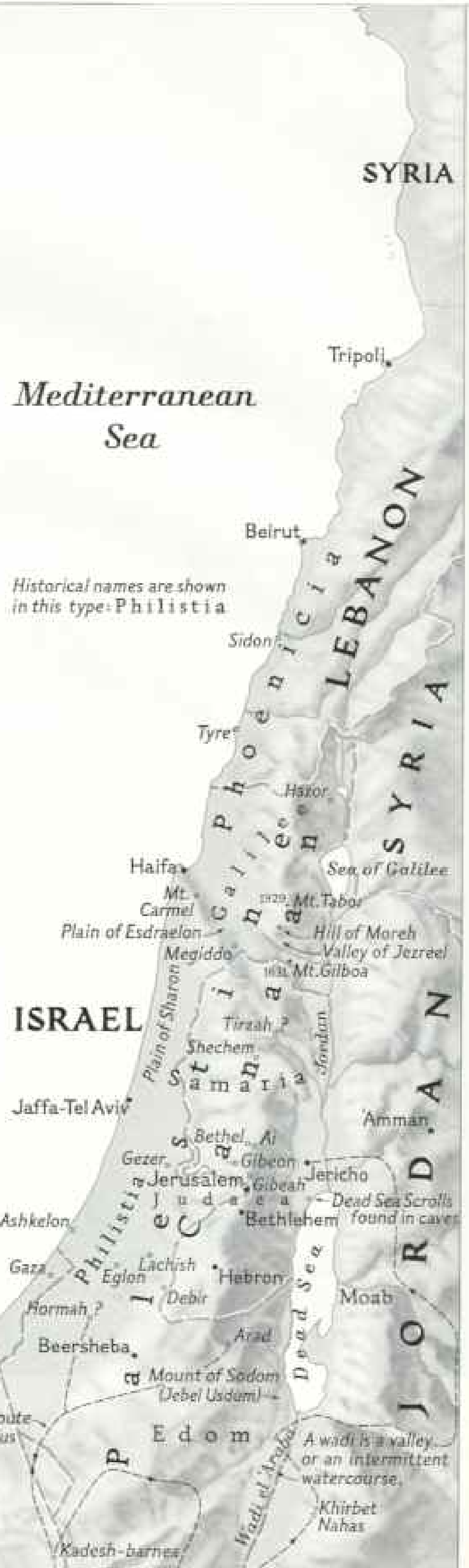
"It was a good land," wrote Sinuhe. "Figs were in it, and grapes. It had more wine than water. Plentiful was its honey, abundant its olives. Every [kind of] fruit was on its trees. Barley was there, and emmer. There was no limit to any [kind of] cattle. . . . Bread was made for me as daily fare, wine as daily provision, cooked meat and roast fowl, beside the wild beasts of the desert, for they hunted for me and laid before me, beside the catch of my [own] hounds."

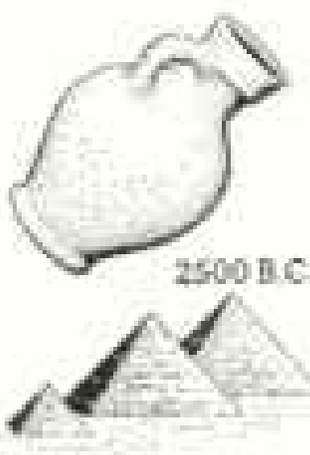
Genesis offers only one detailed life history of a Hebrew patriarch—the story of Joseph. The favorite son of Jacob, Joseph was sold into slavery by his jealous brothers and taken to Egypt. There he found favor with the Pharaoh, rose to become prime minister, and later saved his family from the ravages of a Palestinian famine (page 837).

Slaves Often Became Court Favorites

The authenticity of the Egyptian local color in the story of Joseph has been corroborated to a startling degree by archeological evidence. For example, Joseph's first success in Egypt came when Potiphar, the captain of the guard, made him "overseer over his house." Egyptian records show that such an office actually did exist in the houses of great nobles. Two other titles mentioned in Genesis, "chief of the butlers" and "chief of the bakers," also occur in Egyptian inscriptions.

Furthermore, a study of ancient Egyptian officials reveals that it was not uncommon for slaves to become court favorites and rise to





1856 STEEL AGE

Dead Sea Scrolls found (1947–1956).

Translation of Behistun Rock inscriptions in Iran unlocked secrets of Assyrian and Babylonian literature (1847). Discovery of Rosetta Stone furnished key to Egyptian hieroglyphics (1799).

1500 IRON AGE

Fall of Jerusalem to Saladin, sultan of Egypt (1187).

A.D.1000

Crusaders capture Jerusalem (1099).

Jerusalem fell to Moslems (637).
Eastern Roman Empire under Constantine adopted Christianity (330).
Council of Nicaea (325) affirmed belief in divinity of Jesus, thus defining basic doctrine of Christianity.

Jerusalem destroyed by Romans (70).
Crucifixion of Christ.

BIRTH OF CHRIST

Essene community of the New Covenant began (150–100).
Translation of Old Testament into Greek began (275).
Return of Jews from Babylon (538).
Fall of Jerusalem, beginning of Babylonian captivity (587).
Assyrians conquered Palestine (745–32).
Ezion-geber copper smelter (1000).
First kings of Israel: Saul, David, and Solomon (1020–922).

500 B.C.

Philistines occupied coast of Palestine (1175).
Israelites, under Joshua, invaded Palestine (1250–1200).

1200 LATE BRONZE AGE

Moses led Israelites from Egypt (c. 1300).
Israelites entered Land of Goshen and remained there from about 1700–1300.

1500 MIDDLE BRONZE AGE

Joseph, a former slave, became prime minister of Egypt during this time.
Hyksos conquered Egypt.
Journeys of the Patriarchs (2000–1700).

2000 EARLY BRONZE AGE

Time of Abraham (2000–1800).
Amorites invaded Fertile Crescent.
Mari thrived in eastern Syria from 3000 to 1700.

2500 B.C.

Pyramids of Egypt.
First Egyptian invasions of Canaan (2800–2400).

3000 B.C.

Unification of Egypt, First Dynasty. First great urban development. Beginning of city state system, Syria-Palestine.
City of Ai (3250–2400).

3500 B.C. CHALCOLITHIC AGE (COPPER AND STONE)

Ancient picture writing developed in Mesopotamia (3500–3000).
Ghassulian people in Palestine.

4000 B.C.

Halaf painted pottery culture in northern Mesopotamia.

4500 STONE AGE

First pottery appeared.

5000 B.C.

Jericho flourishing as oldest known fortified town.

positions of power. Joseph's case is also helped by the fact that the majority of scholars believe his career may be dated during the period of Hyksos domination. These Asian invaders conquered Egypt about 1700 B. C. and occupied the throne for some 150 years. Themselves alien in the land, the Hyksos Pharaohs might logically have preferred fellow Asians in posts of responsibility.

'Apiru Seized for Wartime Work

The entry into Egypt of the patriarchal family also corresponds with known custom, for Egyptian archeological sources indicate that from time immemorial Asian nomads had been permitted to cross the border in times of famine.

When the lean years had ended, Joseph's brothers remained in Egypt's Nile Delta, in land just west of the present-day Suez Canal. There they settled with other Asian Bedouin.

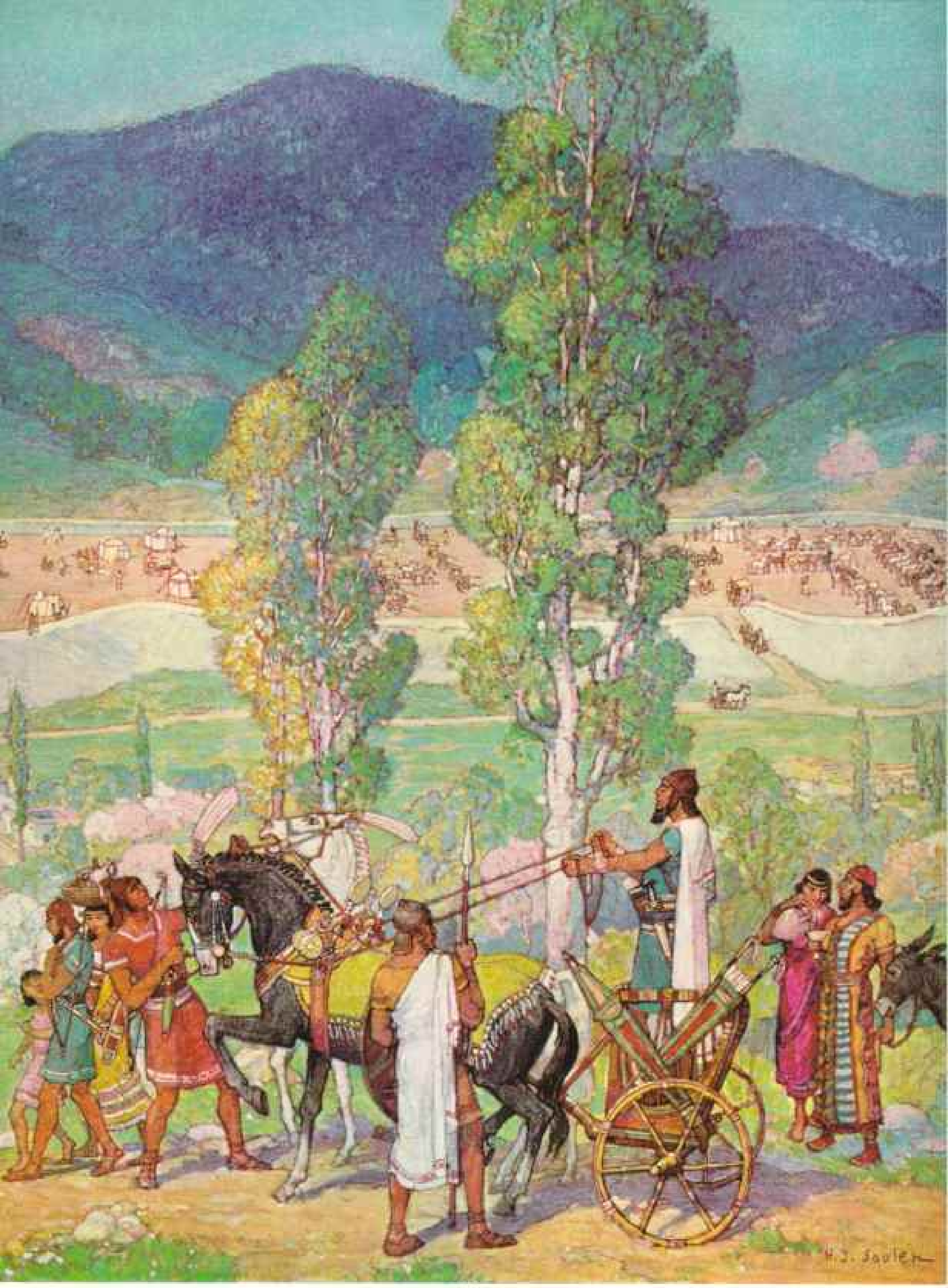
The Egyptians called such strangers in their midst by various names. One was 'Apiru, which is related to the word Hebrew.

About 1300 B. C. the Pharaoh Rameses II planned a new campaign against Palestine and Syria. To support the offensive, he commenced building a base in the eastern delta. The 'Apiru were a ready source of cheap labor, and the Pharaoh forced numbers of them into virtual state slavery.

When the burden grew intolerable, the descendants of Jacob struck out for freedom. Under Moses—whose name, curiously enough, is Egyptian, related to Rameses and Thutmose

"Thy Walls Shall Shake at the Noise of the Horsemen, and of the Wheels . . .

The prophet's words about the Babylonians might well apply also to the Hyksos, a Canaanite people who introduced the blitzkrieg in the 17th century B. C. Their lightweight horse-drawn chariots, made possible by the use of spoked wheels, swept from Syria to the Nile and kept Egypt subject to Hyksos rulers for a century and a half.



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. . . and of the Chariots, When He Shall Enter into Thy Gates"—Ezekiel 26:10

"The cities are walled, and very great," spies of Moses reported after seeing double-walled cities like this Hyksos fortress at Hazor, north of the Sea of Galilee. Ramparts of whitewashed earth surround the 175-acre chariot park. Lack of chariots forced the Israelites to keep to the hill country during most of the conquest of Canaan.

—they shook off Pharaoh's yoke and made an epic march to a sacred mountain in the craggy wastes of the Sinai peninsula, there to be molded into a nation under one God.*

Fortunately, archeology enables us to reconstruct much of the story of the Exodus with a high degree of confidence. But locating Mount Sinai is an archeological problem that may never be satisfactorily solved.

Yet evidence favors the traditional location in the Sinai peninsula, which the author has used as his model. It is so far off the beaten track that one can hardly imagine fifth-century Christians inventing it at a time when the pilgrim traffic was being encouraged and accessibility was a prime factor in pinpointing holy sites.

To see "that great and terrible wilderness" of Sinai is to wonder how the Israelites ever survived their march through its harsh desolation. And, almost automatically, one harks back to the manna provided by God when food was scarce. The Book of Exodus describes it as "a small round thing, as small as the hoar frost on the ground" (16:14).

Manna Traced to Desert Insects

Once again we find a Bible story buttressed by solid fact, for the miracle of the manna from heaven recurs annually in Sinai. Every summer without fail, white droplets of a sweet and nourishing substance appear mysteriously on the bushes. At peak season a man can gather more than two pounds of it a day.

In 1927 a zoologist of Jerusalem's Hebrew University, Professor F. S. Bodenheimer, journeyed to the Sinai peninsula in quest of the secret of manna. His trained eye quickly unraveled the mystery: the little honeydew drops are given off by scale insects.

These tiny creatures suck up plant saps which, while poor in the nitrogen the insects require to balance their metabolism, are rich in carbohydrates. Using the nitrogen, they excrete the excess sap as sweet drops. Evaporation quickly converts the liquid into a sticky solid.

To this day, manna is a favorite confection in the Near East. The most famous variety comes from Kurdistan, and vendors hawk cakes of it on the streets of Baghdad under the name of *man*.

Markab Reminiscent of Biblical Ark

The climax of the Israelites' wandering through the Sinai desert came at the sacred mount, where, according to Hebrew tradition, a new nation was born. There the people received their laws and erected two of the central objects of their religious life—the Ark of the Covenant and the Tabernacle, or tent shrine.

Archeologists know that such portable tent shrines were relatively common among the ancient Bedouin. For example, a relief from the Roman period, found at Palmyra in central Syria, shows a camel bearing upon its back a small sacred tent.

Vestiges have also survived into modern times. The Ruwalla Bedouin, who wander the Syrian Desert, possess a strange feather-decked structure of wooden poles (page 864). This is the Markab, the Ark of Ishmael, which to this day is the tribal standard of the Ruwalla. For generations, whenever the tribe has moved as a body, the Markab has been placed on a camel to lead the migration.

The Markab is strikingly reminiscent of the Ark of the Covenant which led the early Israelites in war and migration. Numbers (10:35) tells us: "And it came to pass, when the ark set forward, that Moses said, Rise up, Lord, and let thine enemies be scattered; and let them that hate thee flee before thee."

From the hardships of the wilderness, the

* See "Sinai Sheds New Light on the Bible," by Henry Field, NATIONAL GEOGRAPHIC MAGAZINE, December, 1948.

Amorite Nomads of Abraham's Time Bring Eye Shadow to a Court of Egypt

Palestine for centuries was a highway of conquest and commerce between Asia and Africa, but its pastoral peoples kept few records. We would know comparatively little about this ancient land were it not for the Old Testament and a multitude of records from neighboring empires. Temple and tomb decorations and clay tablets from Egypt, Mesopotamia, and Babylon give many a clue.

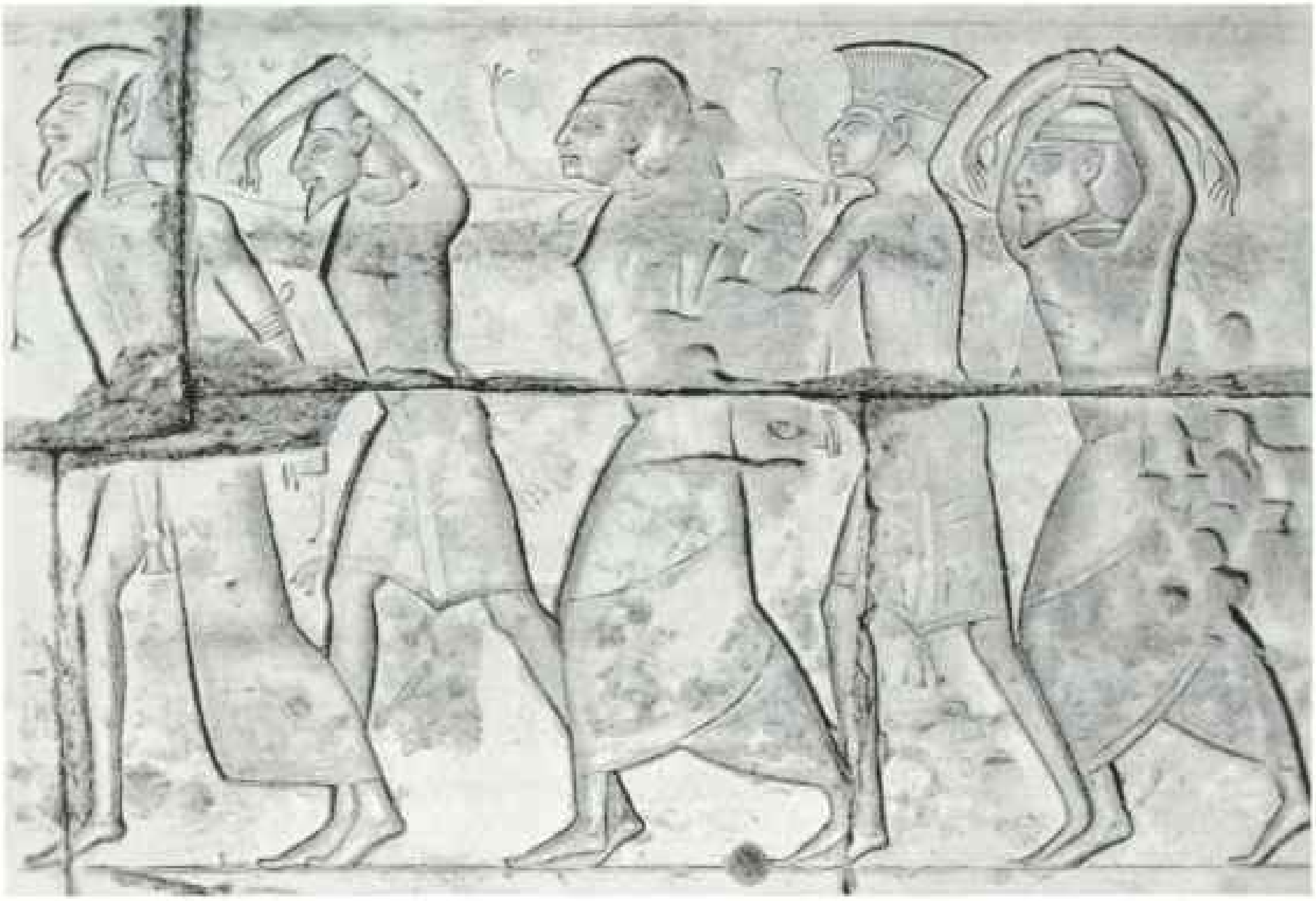
The wall of an Egyptian noble's tomb at Beni Hasan bears this revealing picture of a Near Eastern clan of the 19th century B. C. Hieroglyphics explain that the visitors came to trade antimony, an eye cosmetic prized by the Egyptians.

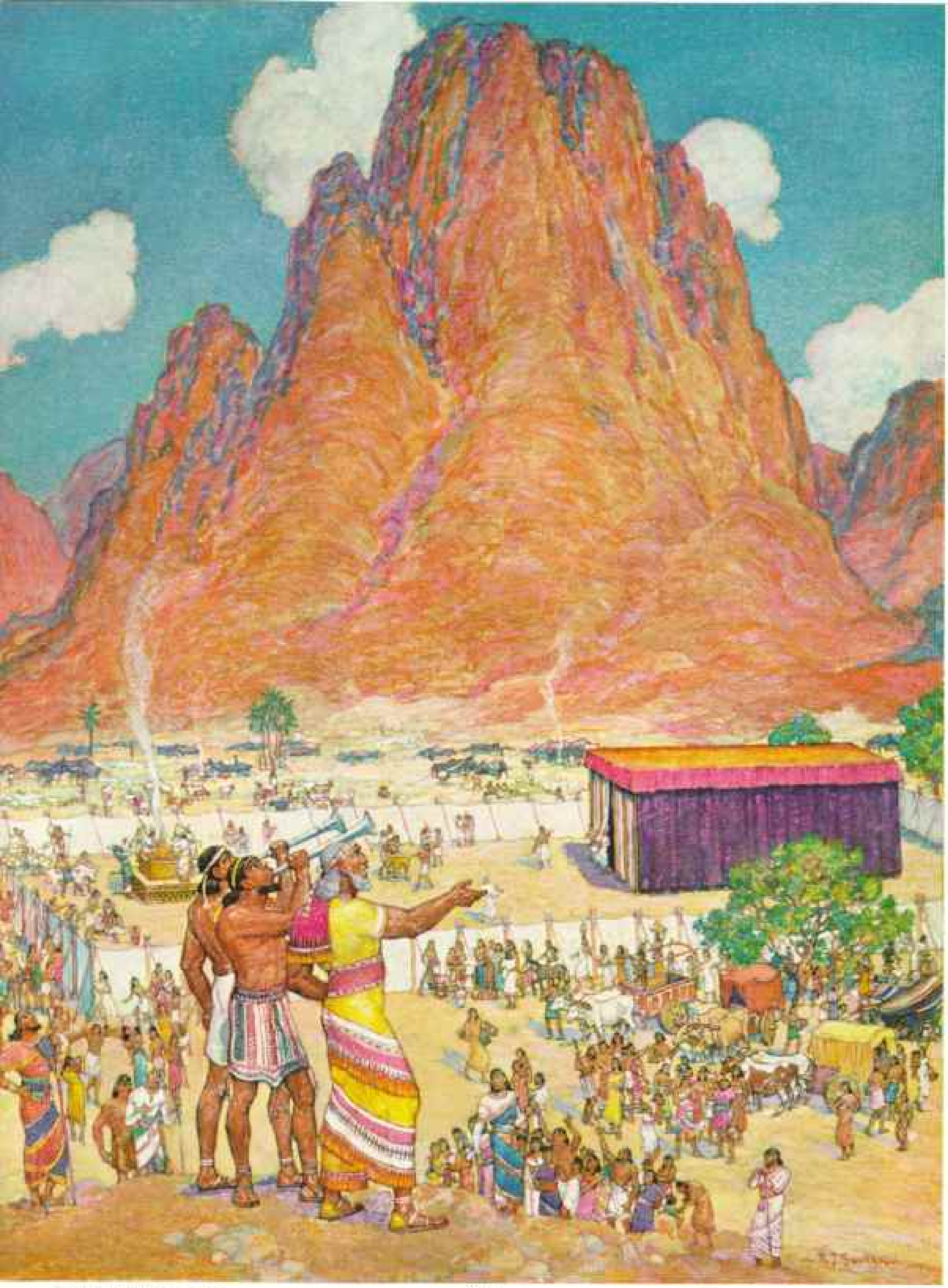
Linen skirts of the two Egyptian officials (right) and the gay woolen tunics of the Bedouin reappear in the painting of Jacob on page 837. Weapons are bows, throwing sticks, and javelins; the musical instrument is a lyre, the Biblical "harp." Bellows carried by the two asses show that the Semitic tribesmen were metalworkers as well as herdsmen.

The whole tableau calls to mind the description of Lamech's family in Genesis 4:19-22.

✦ Foreign Captives Parade in Rope Fetters Before an Egyptian Pharaoh

This detail of a rock carving on the mortuary temple of Rameses III near Thebes shows features and dress of four peoples conquered by Egypt in the 12th century B. C. Left to right: a Libyan from the desert; a bearded Semite from Syria or Palestine; a Hittite from Asia Minor; one of the Sea People from the Aegean—probably a Philistine like those on pages 846–7; and another Semite.





"Make Thee Two Trumpets of Silver . . . for the Calling of the Assembly"—Numbers 10:2

Fleeing from Egypt, the Children of Israel encamped for a year at the foot of Mount Sinai, on whose heights Moses received the Commandments. Here the Israelite leader calls his people together at the Tabernacle, built especially to house the Ark of the Covenant. Priests within the courtyard burn offerings on the altar and perform sacred ablutions in a large metal laver. Sinai is the modern Gebel Musa, Mount of Moses.

new nation of Israel—armed with a divine covenant—emerged into the rich and civilized land of Canaan. Most scholars agree that they arrived during the 13th century.

In any case we know that by about 1220 B. C. the Israelites were already established in Palestine and had tasted defeat at the hands of their former masters, for at that time Pharaoh Merneptah erected a monumental stone commemorating his victories in Palestine. Upon it, in the earliest known reference to Israel outside the Bible, Merneptah boasts:

> The people of Israel is desolate,
> It has no offspring;
> Palestine has become
> A widow for Egypt.

At first, however, the Israelites were highly successful. Relying heavily upon surprise, they proceeded to attack the fortified cities which, to their unsophisticated eyes, seemed "walled up to heaven." And inside the walls flourished the Canaanites, a people skilled in arts, in crafts, and in warfare.

Even those who know little about the Bible have heard how Joshua "fit de Battle of Jericho" and won for his people the land of milk and honey promised by the Lord. And archeology has now found evidence of Israel's conquest of a number of Palestinian city-states between 1250 and 1200 B. C.

Investigations at the site of Jericho itself, however, have been inconclusive. Sifting the findings of several expeditions, we know only that Jericho was already a thriving city about 5000 B. C., in the dimness of the Neolithic period.* Perhaps in Joshua's time Jericho was already an uninhabited tell, or mound of ruins; or perhaps the centuries have merely eroded all signs of the Israelite victory.

"A Desolation unto This Day"

According to the Bible, Joshua's next conquest was Ai, a city in the hills north of Jerusalem. Perhaps never has a more succinct description been given of the common fate of the ancient East's civilizations than that in Joshua 8:28: "And Joshua burnt Ai, and made it an heap for ever, even a desolation unto this day."

A French expedition excavated Ai between 1933 and 1935. While it proved to be an important city, with one of the finest temples in pre-Roman Palestine, its date was Early Bronze Age (about 3250–2400 B. C.). By the time of the Israelite invasion, it had long been an abandoned ruin. Therefore it could not have been destroyed by Joshua's warriors.

But our dig at neighboring Bethel, only one and a half miles away, provided a vital clue to the true story of this part of the Israelite conquest. Stripping away layer after layer of ruins, we worked our way through the period of the Judges and on back past the year 1200 B. C.

Suddenly we encountered evidence of a raging, all-consuming fire. Well-built homes had been destroyed to their foundations. Above them and in them was charcoal debris, in places at least five feet deep.

This had been no casual raid; someone in the 13th century B. C. had purposefully burned and demolished the city. And it was obvious that a new people had settled on the ruins, a rude, unskilled people who did not know the refinements of their predecessors and were perhaps too poor to care.

Israelite Conquest Dated

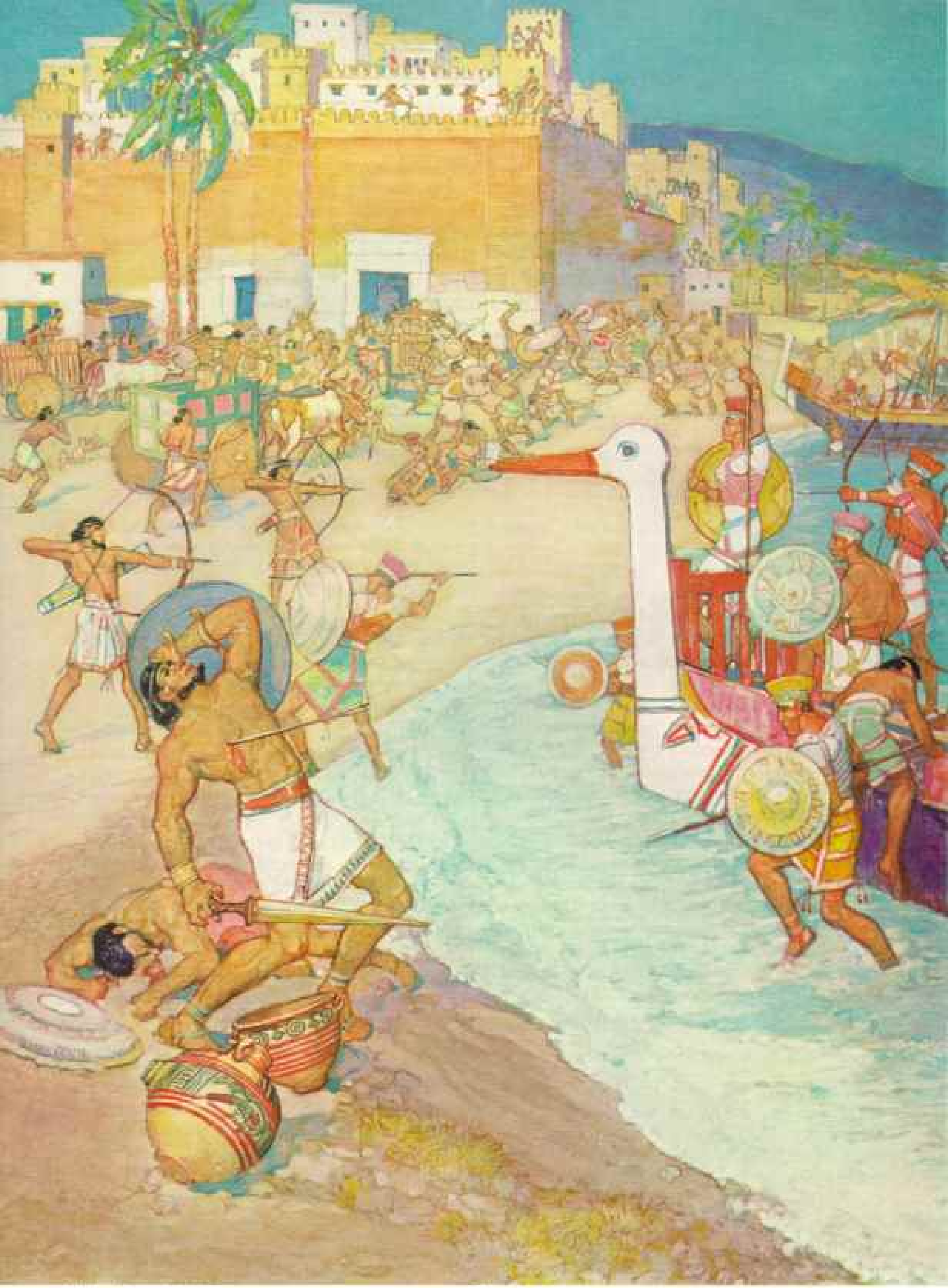
Further digging disclosed that Bethel was founded in the early Bronze Age, about the time Ai was destroyed. How are we to interpret this finding? It seems obvious that Bethel, as Ai's replacement in the area, was the city that Joshua actually did conquer. But the invading Israelites settled in Bethel's ruins and soon hid the signs of destruction.

On the other hand, the older ruin near by was very much in evidence. It was only natural that, in the oral tradition that underlies the Bible, the scene of the conquest gradually shifted from the rebuilt settlement to the imposing tell. It is also significant that in Hebrew the word Ai means "the ruin."

Has the same thing happened at Jericho? Did its ruins attract the conquest tradition from another site in the area? At this moment we simply do not know. But, since archeologists have found ample evidence of terrible destruction and rapid resettlement by 13th-century invaders at other sites—notably Lachish, Eglon, and Debir—it is safe to conclude that an Israelite conquest actually occurred and is reasonably well dated.

In the fall of 1956 and again last summer I encountered further evidence of Joshua's work

* See, in the National Geographic Magazine: "Jericho Gives Up Its Secrets," by Kathleen M. Kenyon and A. Douglas Tushingham, December, 1953; "Hashemite Jordan, Arab Heartland," by John Scofield, December, 1952; and "The Ghosts of Jericho," by James L. Kelso, December, 1951.



"Haste Thee, and Come; for the Philistines Have Invaded the Land"—1 Samuel 23:27

About 1175 B. C. the seagoing Philistines swarmed down from the Greek islands, attacked Egypt, and seized Canaan's rich coastal plain. Carvings in an Egyptian temple picture their goose-billed barks. A miniature Viking ship, which resembles the Philistine vessels, also served the artist as a model.

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Smooth-shaven, Feather-helmeted Warriors Assault the Bearded Canaanites at Ashkelon

Harried by the Philistines for nearly two centuries during the period of the Judges, the Israelite tribes finally united under a king to throw off their tormentors. Only then did the Hebrews wrest from their enemies the jealously guarded secret of making iron tools and weapons. Palestine takes its name from the Philistines.

848 Kathleen Kenyon

Excavations in Jericho Reveal the World's Oldest Town Wall

Neolithic men laid the stones in this picture at least 7,000 years ago. The bottom wall still stands to a height of 18 feet. By Joshua's time successive ruins had already buried the rampart within a 70-foot mound.

when I visited the site of ancient Hazor, north of the Sea of Galilee. There the James A. de Rothschild Expedition of Hebrew University in Jerusalem was excavating under the direction of Gen. Yigael Yadin.

Former Chief of Staff of the Israeli Army and its leading strategist in the 1948 war with the Arab states, Yadin put aside a brilliant military career to pursue his first love, archeology. The place where he chose to dig was one of the greatest cities of ancient Palestine. Indeed, the Bible says that in Joshua's time Hazor was the chief city of the north and the only one in Galilee that he destroyed.

Investigating the 25-acre mound where the fortified city had once stood, Yadin's expedition soon unearthed important provincial buildings of the Israelite government.

But his most exciting finds were made north of the tell, where a rectangular plateau some 175 acres in extent is surrounded by sloped walls of packed earth. We know that such raised areas date from about 1700 B. C. Archeologists theorize that they were erected by the Hyksos, who used horses and chariots to launch the world's first blitzkrieg. With them they overran western Asia, conquered Egypt, and maintained a large and prosperous empire—until the Egyptians defeated them with their own weapons.

Henry Soulen's paint-

ing of Hazor on pages 840-1, incidentally, shows the dizzying speed with which 20th-century archeologists are learning about the ancient Near East. His portrayal, based on what was until recently up-to-date information, depicts the earth-walled chariot park lying apart from the city. Now, thanks to the excavation carried out by General Yadin, we know that the "parking lot" and the city actually lay within the same fortification.

Test diggings on the plateau indicated that in Joshua's day the enclosure had become a densely settled city, surely the largest in all Palestine, with a population of at least 30,000 to 40,000 people. The houses contained evidences of thriving trade, including pottery from the mainland of Greece. This pottery dates almost to the time when the Greeks besieged Troy for the lovely Helen.

But suddenly, at this point, life in the Hazor enclosure came to an abrupt end. Joshua, most archeologists agree, had arrived.

The healing soil soon covered the scars of destruction, and for 3,000 years farmers have sown their crops above the ruins. But anyone poking in the earth today can easily find the remains of that ancient Canaanite city.

Here, then is a vivid and factual commentary on the terse story in the 11th chapter of Joshua, which many scholars have hitherto refused to take seriously:

"And Joshua at that time turned back, and took Hazor, and smote the king thereof with the sword: for Hazor beforetime was the head of all those kingdoms. And they smote all the souls that were therein with the edge of the sword, utterly destroying them: there was not any left to breathe: and he burnt Hazor with fire."

Iron First Came from Meteorites

The time of Joshua is succeeded by the period archeologists term the Iron Age. By the 12th century this new and precious metal had come slowly into use. It was a particular boon to agriculture, displacing softer copper implements and even that last survivor of the Stone Age, the flint sickle.

While iron had been known for centuries before it became of utilitarian age, its chief source had evidently been meteorites. Then, sometime before 1200 B. C., the complex process of smelting it was discovered—probably in the region of Anatolia, in present-day Turkey. There the kings of the great Hittite Empire jealously guarded the secret, keeping a corner on the market at a time when iron was as valuable as gold and silver.

Throughout the time of the Judges, says Israelite tradition, the people of the Old Testament were hard put to defend themselves against predatory neighbors equipped with iron weapons. We now know why this was so.

About 1175 B. C. the "Sea Peoples"—whose ranks included the Philistines—invaded the coast of Palestine. Having been forced out of their own homelands, these emigrants from the Greek world tried to take Egypt, were beaten back, and eventually settled along the coastal plain of Palestine (pages 846-7).

Weights Hold Key to Biblical Riddle

The newcomers soon became Israel's most dangerous opponents and for a time after 1050 B. C. virtually ruled Palestine. Of necessity Israel adopted a monarchial form of government; only strong kings like Saul and David (circa 1020-960 B. C.) could save the Hebrews from Philistine absorption. And even then, through an irony of history, the country received its name—Palestine—not from the Israelites but from the Philistines.

Excavations in Philistine territory, particularly in tombs, have shown that these invaders used iron both for jewelry and for weapons.

Furthermore it appears that they emulated the Hittites on a smaller scale by monopolizing iron production in Palestine. This seems to be the background of the difficult passage in I Samuel 13:19-21.

This same passage, incidentally, offers a splendid example of how archeology is illuminating otherwise incomprehensible Biblical verses. The King James Version reads:

"Now there was no smith found throughout all the land of Israel: for the Philistines said, Lest the Hebrews make them swords or spears: But all the Israelites went down to the Philistines, to sharpen every man his share, and his coulter, and his ax, and his mattock. Yet they had a file for the mattocks, and for the coulters, and for the forks, and for the axes, and to sharpen the goads."

However, the Revised Standard Version tells us: "every one of the Israelites went down to the Philistines to sharpen his plowshare, his mattock, his axe, or his sickle; and the charge was a pim for the plowshares and for the mattocks, and a third of a shekel for sharpening the axes and for setting the goads."

In 1611, when the King James Version was published, it was impossible for scholars to

"Blow Ye the Trumpets . . . and Say, The Sword of the Lord, and of Gideon"—Judges 7:18

Gideon raises his javelin on Mount Gilboa. Camped below are Midianite nomads from the Arabian Desert. Plundering the Israelite countryside, they use the newly domesticated camel for the first time on a large scale. Beyond, torches flare on the Hill of Moreh. Mount Tabor stands in the far distance.

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"The Children of the East Lay Along in the Valley Like Grasshoppers"—Judges 7:12

Gideon's tiny band of 300 men routed the Midianite host by a stratagem. Stealing by night down the hills overlooking the Valley of Jezreel, the Israelites suddenly broke clay jars hiding their torches and filled the air with shouts and the blasts of rams' horns. Here the enemy deserts his encampment and flees in panic toward the Jordan.

understand what the verses really meant. The later rendering stems from the archeological discovery in Israelite homes of small weights bearing the Hebrew word *pim*. Before 500 B. C. people had to weigh out their money—actually, precious metal—on balances in order to make purchases. The basic unit was the shekel, weighing about 11.4 grams; a pim was two-thirds of this.

What then is the verse from Samuel saying? Simply that the Philistines monopolized metalworking in Palestine at the time Saul ascended the throne. They would permit no smith in Israel, "lest the Hebrews make . . . swords or spears" and win their freedom. As a result the Hebrew farmer had to take his broken or dull tools to a Philistine smith along the coast, and there had to pay exorbitant prices for repairs.

In the case of this particular verse, the archeologist would also ask the Bible translator to look again at the names of the tools. How sure can we be that these English terms are correct? We can certainly say that plowshare is wrong, because the Biblical plow had no share to turn a furrow. Farmers used a metal plowpoint which they affixed to the end of a forked stick. Most pre-Davidic specimens are of copper and are nearly always badly dented from use in Palestine's rocky soil.

The Philistine control of iron, of course, also included the secret of its smelting. Only after Saul and David had smashed the power of the coastal cities do we suddenly find iron implements in use by the Israelites.

David Created Israel's Golden Age

Present-day excavators are also uncovering multiple examples of the activities of David and Solomon. By studying Biblical documents in the light of ancient remains and modern geography, we can infer that David—a brilliant general, politician, and administrator—took advantage of a period of international weakness to create a small empire extending from Sinai and the Gulf of 'Aqaba to southern Syria and well into the Syrian Desert toward the Euphrates. His was probably the strongest army between that river and the Nile. And his reign ushered in Israel's brief golden age.

David's son Solomon was not a general. He spent his energies in trying to hold together his father's empire, in transforming his court into a place of culture in accordance with Phoenician and Syrian standards, and in undertaking a variety of royal business enterprises. Both David and Solomon sought specialized architectural assistance from the Phoenician king, Hiram of Tyre. Hiram's craftsmen and his famed "cedars of Lebanon" played key roles in the building of the Temple in Jerusalem.

The three paintings opposite and on pages 856-7 and 862-3 show what happened to the Israelite court as it progressively assimilated the culture of the day. The simplicity of Saul and the restrained dignity of David are both in striking contrast to the baroque profusion of Phoenician decoration in Solomon's court.

Megiddo Guarded Ancient Highway

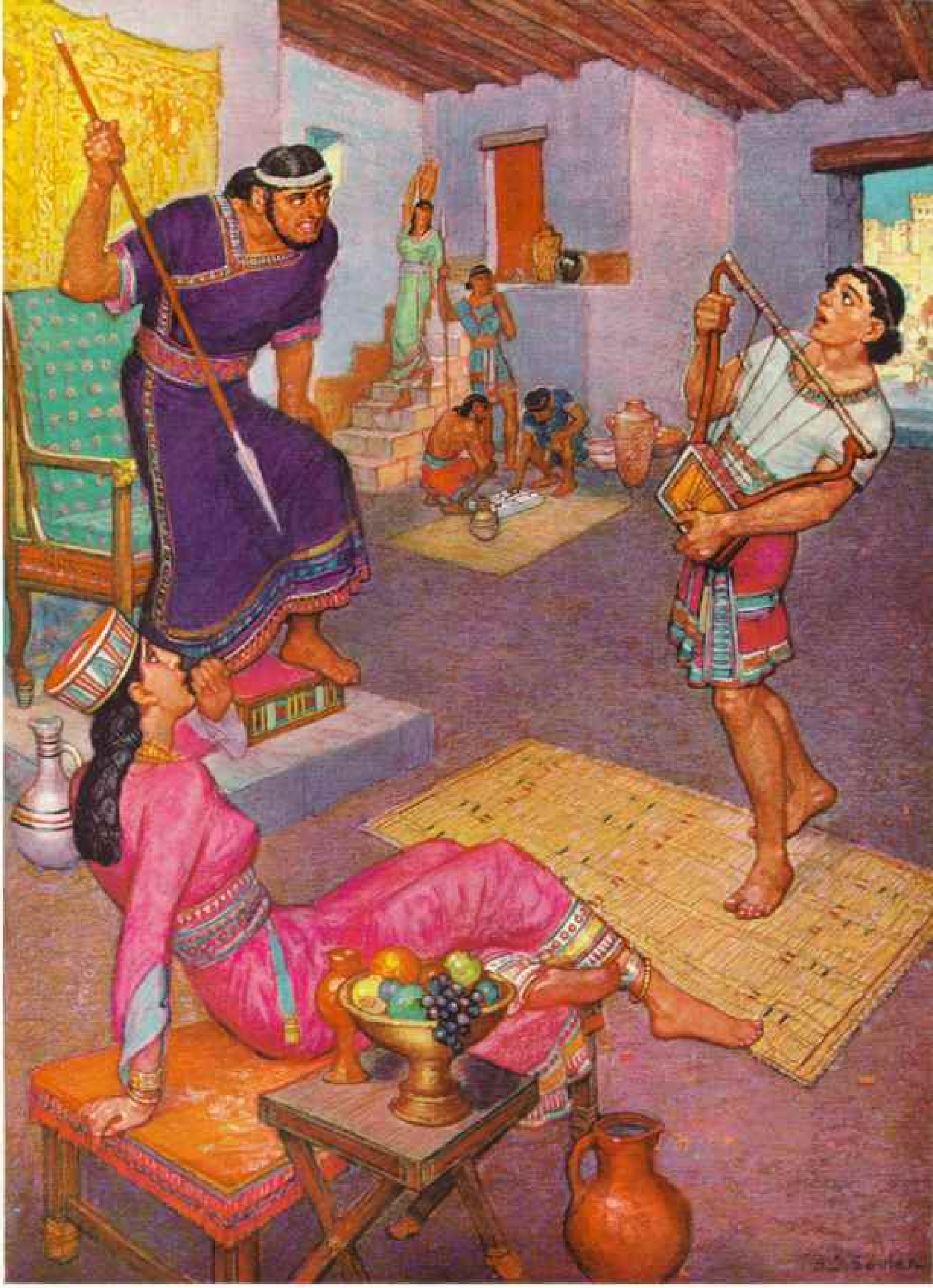
The most arresting example of Solomon's building activity yet unearthed is at Megiddo. The mound containing its ruins stands today in Israeli territory at the opening of a mountain pass (pages 858-9). Through the centuries this pass has been on the chief highway linking Egypt with Syria. Megiddo, guarding the approach from the north, was the scene of a number of great and bloody battles.

Egypt's most formidable monarch, Thutmose III, describes in detail a victory he scored there about 1468 B. C. The Judean king, Josiah, lost his life at Megiddo in 609 B. C., battling the Egyptian army of Pharaoh Necho. As recently as 1918 the British under General Allenby fought an important engagement there against the Turks.

So frequently was this spot a battleground that the word Armageddon (from the Hebrew *har Megiddo*, Mount Megiddo) has come to mean any cataclysmic conflict. The Book of Revelation singles it out as the pivotal spot where the forces of good and evil will meet in a final climactic struggle.

Recognizing the enormous strategic importance of Megiddo, David and Solomon made it one of the chief provincial centers of the Jerusalem government. About 975 B. C. David erected a residence there for his district commissioner, setting it in a walled courtyard. Solomon later built a much larger residence for his commissioner, provided him with a private stable, and added a new city wall, a solid mass of stones nearly 12 feet wide.

A covered gateway contained four different entries, one following the other. The Megiddo gate was the first archeologists had found that conformed closely to the east gateway of the Solomonic Temple in Jerusalem as described



***"And David Played . . . and There Was a Javelin in Saul's Hand"*—I Samuel 18:10**

As David strums his lyre in Saul's fortress at Gibeah, the moody king threatens his life out of jealousy. Soldiers game with dice on the dirt floor of a throne room boasting little splendor.

by the prophet Ezekiel (40:5-16). Another turned up at Hazor last August.

Of special interest are the stables built in the city (page 860). Here Solomon quartered a portion of his horse-drawn chariots. Judging from the size of the stables, the complement might well have been three squadrons of 40 to 50 chariots each.

Besides building a powerful and mobile army, Solomon also profited handsomely as a middleman for horses and chariots. Dr. Albright now interprets I Kings 10:28-29—a puzzling passage in the King James translation—to mean:

"And the source of Solomon's horses was from Cilicia. The king's traders bought them from Cilicia at the price of 150 silver shekels for each horse. And a chariot was imported and delivered from Egypt at the price of 600 silver shekels. And in the same way they [the chariots] were delivered through their agency to all the kings of the Hittites and Aramaeans."

Archeology has even discovered a successful Solomonic business enterprise that is not mentioned in the Bible.

In 1934 Dr. Nelson

(*Continued on page 859*)

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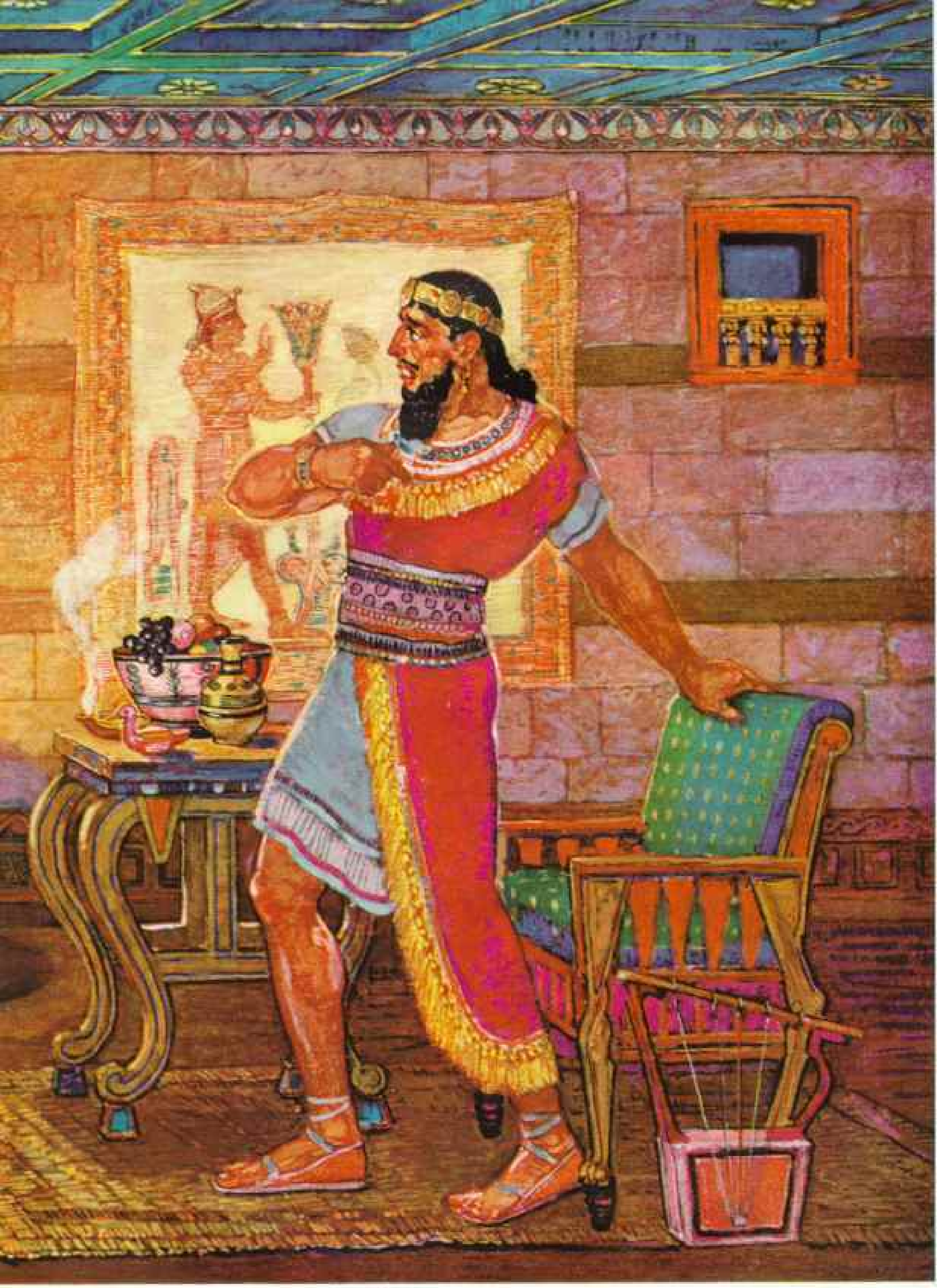
The Mount of Sodom, a Barren Wasteland, Rises Sharply Above the Dead Sea

No one has ever found the destroyed cities of Sodom and Gomorrah, but scholars believe they stood in the Vale of Siddim across from these cliffs. Possibly floodwaters of the Dead Sea engulfed them following an earthquake.

"And Nathan Said to David, Thou Art the Man . . . Thou Hast Killed Uriah the Hittite . . .

A stern prophet confronts the angry king in his palace at Jerusalem. Architecture and furnishings are more elaborate than those of Saul; both David and Solomon borrowed heavily from the Phoenicians for ideas and artisans. Floors are wood. Walls are made of courses of carefully dressed stone alternating with cedar beams.



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. . . with the Sword, and Hast Taken His Wife to Be Thy Wife"—II Samuel 12:7,9

The scarlet of David's robe and the purple of Saul's garb (page 853) denote royalty; these dyes cost too much for commoners. Pottery lamps—simple saucers with pinched lips—burn olive oil with hemp wicks to produce a feeble light. Bathsheba, the queen David stole from the warrior Uriah, became Solomon's mother.

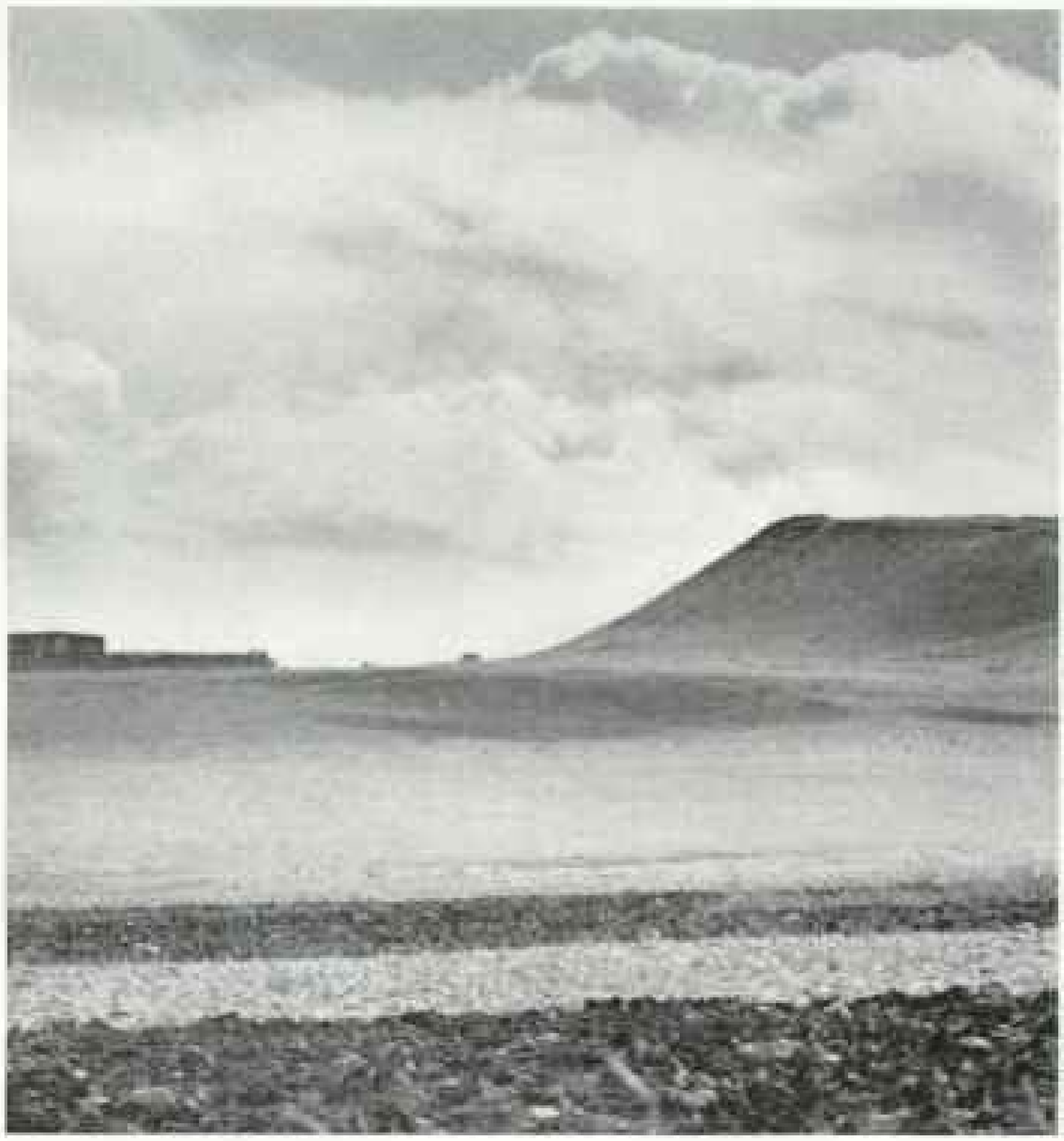
Peaceful Farmers Plow Armageddon's Battlefield Below the Mound of Megiddo

Ruins of 20 cities, one atop the other, lift the tell of Megiddo far above the Plain of Esdraelon. For 5,000 years this man-made hill was one of the most strategic spots in Palestine. Its successive fortresses looked down on the Syria-Egypt highway, a route heavily traveled by merchant caravans and invading armies seeking the mountain pass southward to the Plain of Sharon.

By the time the 13-acre mound was abandoned about 400 B. C. so many violent and decisive battles had been fought on the plain below that Megiddo gave its name to Armageddon, the final battle between the power of God and the hosts of evil foretold in the Book of Revelation.

Furrowed by Excavators, Megiddo Shows an Ancient City Plan

Archeologists once planned to level Megiddo's 70-foot-high tell as a model of Near Eastern excavation. The goal proved too costly, but an area stripped to bedrock and layers peeled off the top have vastly increased knowledge of Bible times.



Glueck, one of the greatest of modern archeological explorers, descended by camelback into the forbidding Wadi el 'Araba, a deep and barren rift running from the Dead Sea to the Gulf of 'Aqaba. For two centuries during Biblical times the Israelites and the Edomites had waged sporadic war for control of this ancient "Death Valley." Dr. Glueck wanted to know why.*

Mining Flourished in Solomon's Reign

At a place called Khirbet Nahas, or "Copper Ruin," he found the answer. Here, in centuries gone by, had thrived a profitable copper-mining operation. Dr. Glueck discovered the remains of large buildings, miners' huts, and enclosure walls some seven feet thick. On both sides of the area were great quantities of copper-bearing sandstone.

On the basis of the pottery strewn about the site, Glueck dated the Copper Ruin between the 10th and 6th centuries B. C. He fixed its most flourishing period during and immediately after the time of Solomon.

The king's role became obvious when Glueck discovered that Khirbet Nahas was but one of a whole string of such camps throughout the valley. To exploit the mines in this distant area on such a scale must have required the organizational powers of a strong central agency. Only the government of Solomon could have underwritten such an enterprise.

To the south, beside Israel's port of Eilat, where the Wadi el 'Araba opens onto the Gulf of 'Aqaba, Glueck also searched out the site of ancient Ezion-geber. From here, according to the Bible, a fleet of Solomon's ships plied the Red Sea on trading missions to southern Arabia and Africa.

A previous searcher for Ezion-geber had noted an insignificant-looking mound of sand about a third of a mile from the seashore, but had been unable to date it. Glueck saw immediately that the pottery fragments strewn over the mound were of the same type as those in the mining camps. But to his vast surprise, Glueck found no evidence whatever of a seaport; instead he found a metal refinery, the most elaborate ever discovered in the ancient Near East.

While the factory and its surrounding houses covered only an acre and a half, its importance may be deduced from the fact that it was defended by a heavily fortified brick wall. The main opening was a covered gateway with three entries, each protected by guardrooms.

Located in the middle of the wadi, the

* See, in the NATIONAL GEOGRAPHIC MAGAZINE: "An Archeologist Looks at Palestine," December, 1947; "On the Trail of King Solomon's Mines," February, 1944; and "Geography of the Jordan," December, 1944, all by Nelson Glueck.

"And Solomon Had Forty Thousand Stalls of Horses for His Chariots"—1 Kings 4:26

At Megiddo the Hebrew monarch kept 150 chariots to guard a pass on the high road from Syria to Egypt. Here a groom binds a fetlock. Soldiers play "hounds and jackals," an ancestor of backgammon.

ancient factory was purposely exposed to the winds that continually funnel down the valley from the north. An ingenious arrangement of air channels in the refinery's high brick walls harnessed these gusts to furnish a forced draft for the furnace rooms.

Glueck called this site the "Pittsburgh of Palestine"; from the pottery and other objects, he assigned its construction, too, to the 10th century B. C.

The difficulties of building and servicing such an isolated factory must have been enormous. Again, only a merchant prince like Solomon could have handled it. Thus the mining camps of the Wadi el 'Araba, combined with Ezion-geber, reveal the great Israelite king in a previously unknown role, that of a copper magnate.

Ancient Plaque Describes Farm Year

The military genius of David and the commercial ventures of Solomon raised the Hebrew standard of living from bleak poverty to a level of relative prosperity. In the reign of Solomon, says I Kings (4:20), "Judah and Israel were many, as the sand which is by the sea in multitude, eating and drinking, and making merry."

Fortunately archeologists have been able to piece together a relatively detailed picture of the everyday life of this period.

Agriculture continued to be the basis of the national economy. A small limestone plaque recovered from the ruins of Gezer in 1908 provides a 10th-century calendar of the Palestinian agricultural year. Probably a schoolboy's exercise slate, it contains a mnemonic rhyme seemingly similar in purpose to our own "Thirty days hath September. . . ." The rhyme starts with autumn:

The two months of [olive] harvest;
The two months of planting [grain];
The two months of late planting;
The month of hoeing up of flax;
The month of harvest of barley;
The month of harvest and festivity;
The two months of vine-tending;
The month of summer fruit.

The Israelite farmer did not live on his scanty acreage but rather in the nearest town. There he was afforded some measure of protection from intermittent raids and counter-raids. In turn, each town lay within the orbit of a fortified city, where the entire countryside sought refuge in time of war.

Cities were chronically overcrowded, since houses had to be built within the available walled-in space. As a result, bizarre architectural angles and shapes abound in Israelite ruins. Most houses were of two stories. The main central room, sometimes not completely roofed over in larger dwellings, was on the lower level. Here the women cooked and baked and performed their domestic chores, and here the family took its meals. In general there was no furniture. The Israelite ate, slept, and sat on the floor.

Stone or wood stairways commonly led to upper levels, but apparently ladders were also used. The upstairs rooms provided space for sleeping and relaxation. On summer nights the roof was an ideal refuge from the heat. Its surface was evidently composed of straw mixed with mud and lime. While this mixture was serviceable, it had to be rolled after every rain to prevent leaks.

The Israelite diet was simple—and monotonous. Parched or cooked wheat and barley were staples; sometimes the Hebrew housewife would grind the grain into a coarse flour, mix it with olive oil, and bake it into flat cakes of bread.

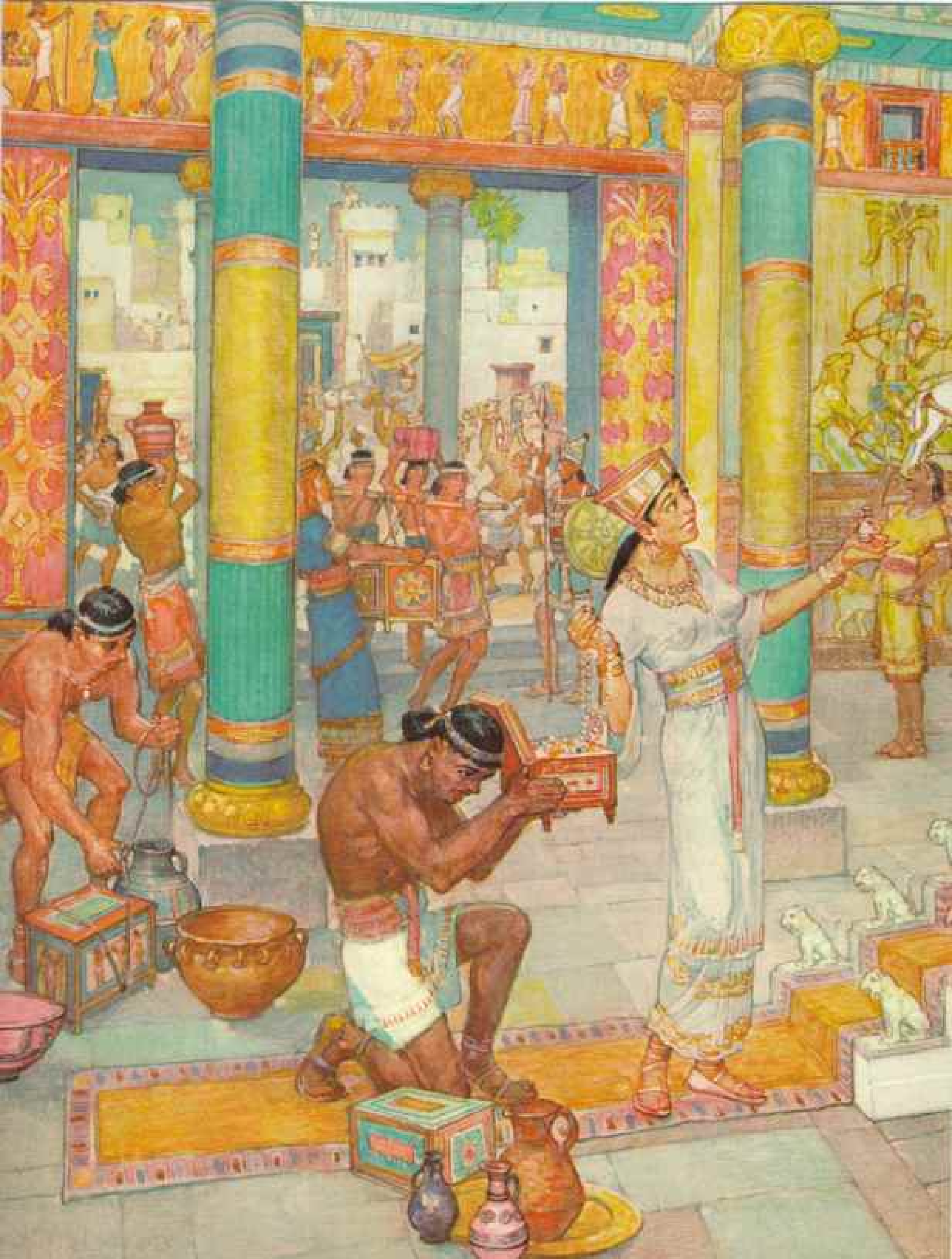
This standard dish was garnished with lentils, horse beans, and other vegetables, including cucumbers. Onions, leeks, and garlic supplied flavor. Fresh and dried fruits and wild honey were the only sweets. As is still the case among many Arabs, meat was reserved for festive occasions. Wine, of course, was the universal drink, although the Hebrews also prized goat and sheep milk.

Israelite Men Wore Wrap-around Skirts

Among Bible readers there is a widespread but erroneous belief that the Israelites dressed much like modern Bedouin. Actually the basic garment of the Israelite male was a short wrap-around skirt made of cloth or leather (page 850). This was held in place by a kind of belt that also served to hold weapons and valuables.

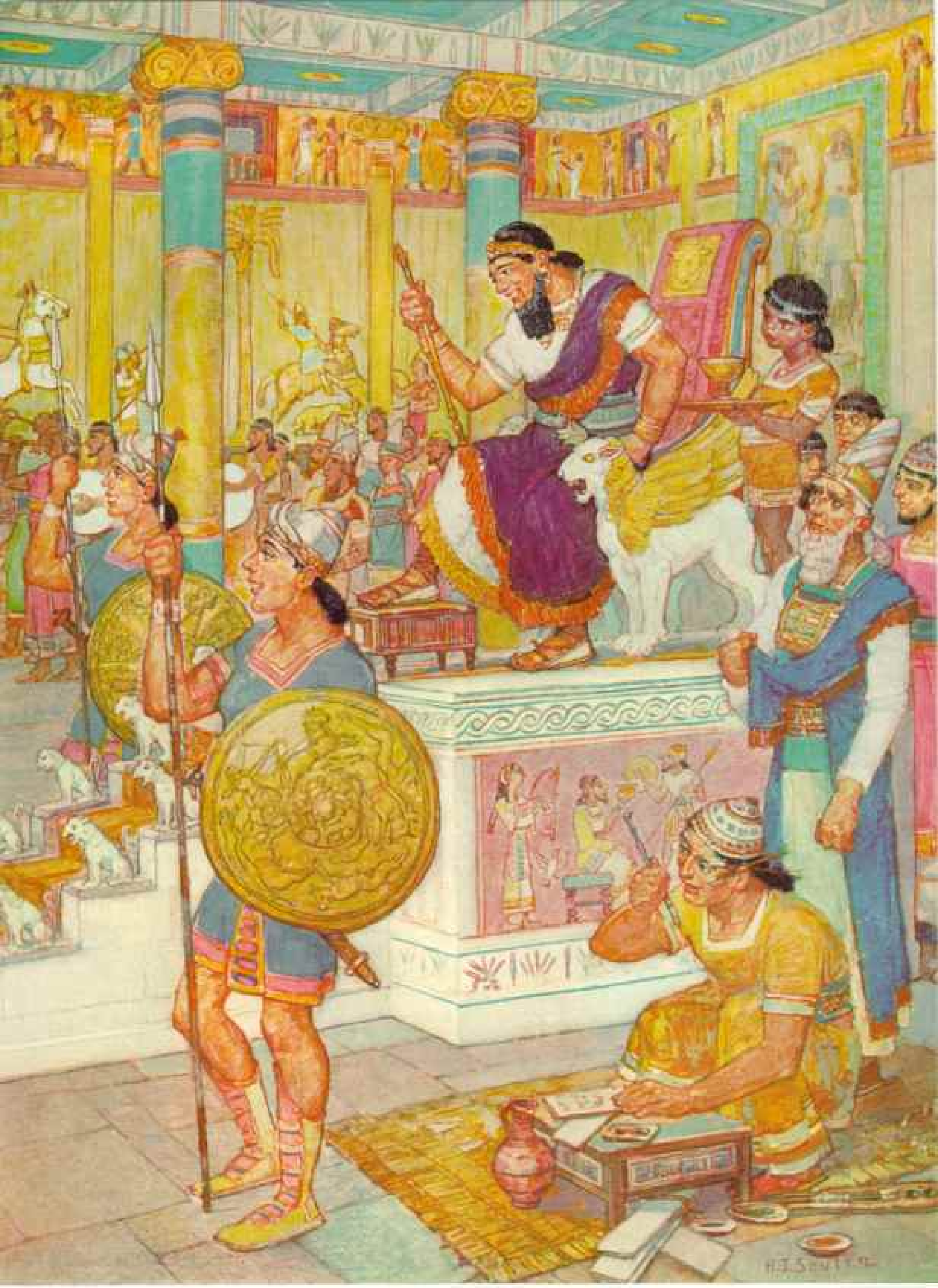
The upper trunk was usually covered by a short-sleeved garment much like today's T shirt. In brisk weather a sleeved cloak was worn over this. While these cloaks encompassed a broad range of styles, the typical example was long, rather close fitting, open in the front, and decorated along the edges. At night it served as bed and blanket.

Save for the short skirt, articles of feminine attire were virtually identical. A woman's



"And When the Queen of Sheba Heard of the Fame of Solomon . . . She Came to Jerusalem . . .

Inheriting from David a kingdom unified and at peace, Solomon embarked on a vast program of trade and construction. He strove to exceed all the kings of the earth in riches. Streams of foreigners visiting Jerusalem to sample his wisdom were dazzled by the sheen of ivory and the glitter of gold in his magnificent palace.



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. . . with Camels That Bare Spices, and Very Much Gold, and Precious Stones"—1 Kings 10:1, 2

The powerful merchant queen traveled some 1,200 miles from southwestern Arabia to try his wisdom "with hard questions." The royal house of Ethiopia claims descent from their son Menelik. Here the high priest stands behind a scribe who records the queen's gifts on wooden tablets. Drums and trumpets herald the procession.

864 John Scofield, National Geographic Staff

Feathered Ark of Ishmael, Standard of a Syrian Tribe, Is a Modern Ark of the Covenant

When the Ruwalla Bedouin migrate, a she-camel carries before them this sacred symbol captured from rival nomads in 1793. On old-time war marches the tribe's most beautiful maiden rode the litter, and warriors regarded it as a rallying point beyond which they would not retreat. Ostrich feathers and acacia sticks make up the ark, which stands in front of a goat-hair tent. Some 33 centuries ago the Israelites, wandering through Sinai toward the Promised Land, carried their own ark as an assurance of divine guidance.

everyday garb was most likely to be tunic and cloak, supplemented by a long, relatively narrow scarf draped over the head and falling down the back to the tunic's hem.

Jezebel Not the Only Painted Woman

The Hebrew love for adornment also extended to jewelry; anklets, bracelets, rings, and beads sprinkle the ruins of every town. We also know that Jezebel was not the only painted woman in Israel. Archeologists have dug up a large number of bowls that were used to mix cosmetics. Women blackened their eyebrows and eyelashes with manganese and antimony; they tinted their lower eyelids green with malachite or turquoise; red ocher heightened the color of their lips.

The Israelites' way of life was a reflection of their era, of their geographical situation, and, perhaps most importantly, of the religious revolution they embodied. But as archeology brings us ever closer to this hardy, fiercely independent people on their own terrain and in their own time, I am struck anew by the essential changelessness of the human plight. For what we read in the ruins is only a faded image of the same strivings, the same ideals, and the same hopes that motivate us today.

In our age the shadow of the sword has been replaced by the more terrible shadow of the violated atom. And, despite 3,000 years of strife, Palestine is still racked by war and rumors of war. But all of us can still dream with the prophet Zechariah of a day when "There shall yet old men and old women dwell in the streets of Jerusalem. . . . And the streets of the city shall be full of boys and girls playing. . . ."

President Eisenhower Presents to Prince Philip the National Geographic Society's Medal

GREAT BRITAIN'S widely traveled Prince Philip, Duke of Edinburgh, received the Special Gold Medal of the National Geographic Society from the hands of President Eisenhower at the White House on October 18, 1957.

The tall, blond prince, who is a British naval officer by training and profession, was awarded the honor for bringing "to millions a better understanding of our planet and its peoples" through his world travels and for his encouragement of science in Great Britain and the Commonwealth.

Modestly His Royal Highness said, "I can hardly believe that this has happened," and commended The Society for its "practical and concrete contribution to better understanding between the English-speaking peoples."

Ceremony in Historic Cabinet Room

President Eisenhower, eighth president of the United States to present a medal on behalf of the National Geographic Society, said he counted it "a very great privilege" to act as the representative of "one of the most highly respected and esteemed organizations of our country."

The presentation was made during the visit of Queen Elizabeth II and her husband Prince Philip to the Nation's Capital as guests of President and Mrs. Eisenhower. The officers and trustees of The Society were invited to the informal but impressive ceremony in the historic Cabinet Room.

As the President and Prince Philip entered with Dr. Melville Bell Grosvenor, The Society's President and Editor, they faced the brilliant white glare of camera lights from a phalanx of photographers ranged along the great octagonal table around which the President meets with members of his cabinet. Before them in its case reposed the medal (page 868).

"Mr. President, Your Royal Highness, Ladies and Gentlemen," said Dr. Grosvenor, "first, may I thank you, Mr. President, a long-time member of the National Geographic Society, for doing the honors this morning in behalf of The Society.

"Our Society exists for the increase and diffusion of geographic knowledge. We are happy to honor those who contribute to that goal.

"Such men as Hillary and Hunt, Peary and Byrd have added to the world's geographic knowledge by reaching the heights of Everest or the uttermost ends of the earth.

"But Prince Philip has made great contributions to geography in a different way. Here are the words inscribed upon this medal: 'To His Royal Highness, the Prince Philip, Duke of Edinburgh, whose questing spirit has taken him to the far corners of the globe and brought to millions a better understanding of our planet and its peoples.'

"From equatorial jungles Prince Philip has traveled to the fringe of Antarctica, visiting some of the loneliest scientific stations of the IGY. One of these stations was in Graham Land. His Royal Highness gives its population as '60 temporary inhabitants and several million penguins.' Another was the remote Atlantic island of Tristan da Cunha. 'You may not have a TV set on Tristan,' Prince Philip has said, 'but you won't get ulcers either.'

"Prince Philip's eagerness to go where the going was rough—his encouragement of science and his interest in the far and hard-to-reach places—his concern with those of the British Commonwealth who seldom see his like—all these qualities, plus a very human personality and a keen sense of humor, have endeared Prince Philip to millions beyond the British realm.

"It is for these reasons that we honor him today.

"Mr. President, here is the gold medal, designed by Mr. Felix deWeldon, a leading sculptor of this country."

"Friend of So Many Americans"

"Your Royal Highness," President Eisenhower said, "one of the most highly respected and esteemed organizations of our country is the National Geographic Society.

"For me it is a very great privilege to act as their representative in presenting to you this medal, so well earned for the reasons given in the citation, and particularly because you are here on a state visit to our country and as the personal friend of so many Americans—among whom I proudly number myself.

"So it is a very great pleasure to hand you this, on behalf of The Society, and my congratulations."

Prince Philip, in accepting the medal, displayed the good-humored charm and modesty that delighted Americans during the royal good-will visit to the United States.

"Thank you very much," he said. "Mr. President, Mr. Grosvenor, I can hardly believe that this has happened. And all I can say is that I don't really deserve this because I know what others have done to get it and my contribution has been very small."

Prince Philip paused, then alluded to the article "Off the Beaten Track of Empire," by Assistant Editor Beverley M. Bowie, which appeared with an introduction by the Prince in the November, 1957, NATIONAL GEOGRAPHIC MAGAZINE. The article was prepared with the help of His Royal Highness's personal reminiscences and his diaries.

"Contribution to Better Understanding"

"I've read the National Geographic off and on for several years," the Prince said. "But when your letter arrived offering me this medal and to write the article which you put in, I can only say that I was amazed—particularly about the article!"

His face and words became solemn as he continued. "We have heard quite a lot in recent years about the need for better understanding between the English-speaking peoples. I think that this gesture of yours and the article which you have written and put in your magazine are practical and concrete contributions to a better understanding between the English-speaking peoples."

After the ceremony, the Prince and President Eisenhower examined more closely the handsome gold medal. The President and Prince Philip then greeted the National Geographic Society officers, trustees, and other representatives present:

Dr. Gilbert Grosvenor, Chairman of the Board of Trustees; Dr. John Oliver La Gorce, Vice-Chairman of the Board; Dr. Thomas W. McKnew, Vice-President and Secretary; Dr. Robert V. Fleming, Treasurer; Dr. Lyman J. Briggs, Chairman of the Research Committee; Dr. Alexander Wetmore, Vice-Chairman of the Research Committee; and the following trustees:

Rear Adm. L. O. Colbert, former Director of the United States Coast and Geodetic Sur-

vey; Dr. Hugh L. Dryden, Director of the National Advisory Committee for Aeronautics; Ernest E. Norris, retired President of the Southern Railway; and Lloyd B. Wilson, Honorary Chairman of the Board, Chesapeake and Potomac Telephone Companies. Also Mr. deWeldon; Melvin M. Payne, Senior Assistant Secretary; Frederick G. Vosburgh, Associate Editor of the Magazine; Walter M. Edwards, Illustrations Editor; Edwin L. Wisherd, Chief of the Photographic Laboratory; and Wilbur E. Garrett and Gilbert M. Grosvenor, Picture Editors.

Half-century-old Tradition

Shackleton, Byrd, Lindbergh, Amelia Earhart—these are some of the pioneers of our century who have received similar National Geographic awards from the hands of Presidents of the United States. The first was Comdr. Robert E. Peary, who in 1906 was presented with a National Geographic Society medal by President Theodore Roosevelt in honor of his Arctic explorations.

Since that time Presidents Taft, Wilson, Coolidge, Hoover, Franklin D. Roosevelt, Truman, and Eisenhower have honored The Society as well as the recipients by presenting its highest honor. The British Mount Everest Expedition received the award from President Eisenhower at the White House in 1954. The medal bore the names of Sir John Hunt, leader, Sir Edmund Hillary, and Ten-

Prince Philip Receives the National Geographic's Special Gold Medal

"Our Society exists for the increase and diffusion of geographic knowledge. We are happy to honor those who contribute to that goal." So spoke Editor Melville Bell Grosvenor at White House ceremonies on October 18 when President Eisenhower presented The Society's special gold medal to His Royal Highness the Prince.

The award recognized Prince Philip's life-long interest in geography and science and commemorated his 40,000-mile, four-month journey among British Commonwealth peoples in 1956–57.

Other Society officials taking part in the presentation include Dr. Gilbert Grosvenor, Dr. John Oliver La Gorce, Dr. Thomas W. McKnew, Melvin M. Payne, and Dr. Robert V. Fleming.

"I can hardly believe that this has happened," Prince Philip said. Here His Royal Highness, Dr. Grosvenor, and President Eisenhower examine the gold medallion (next page).

National Geographic Photographers Edwin L. Wisherd (above) and Barse W. Littlehales

Medal Traces the Prince's Globe-girdling Tour

Created by sculptor Felix W. deWeldon, The Society's special gold medal bears Prince Philip's profile on the face. Reverse carries Philip's crest (top) and follows his route across Africa and aboard the royal yacht *Britannia* (bottom). Seal, penguin, whales, and sailing canoe mark high spots of the voyage. Five linked rings below Australia symbolize the 1956 Olympic Games, which the Prince opened in Melbourne. The relief map also traces Philip's 9,000-mile tour of Canada in 1954. The 4-inch medal of 24-karat gold weighs 2 pounds 4 ounces.

zing Norkey, and the inscription read: "Extraordinary courage and skill and outstanding service to geography in the triumphant conquest of Earth's highest mountain, May 29, 1953."

Following are the other distinguished men—and one woman—to whom National Geographic medals have been presented by Presidents:

Sir Ernest H. Shackleton, for Antarctic explorations, by President Taft, 1910.

Col. George W. Goethals, USA, "to whose ability and patriotism the world owes the construction of the Panama Canal," by President Wilson, 1914.

Comdr. Richard E. Byrd, Jr., USN, and Floyd Bennett, for first reaching the North Pole by airplane, by President Coolidge, 1926.

Col. Charles A. Lindbergh, for his solitary flight from New York to Paris, by President Coolidge, 1927.

Rear Adm. Richard E. Byrd, USN, for first reaching the South Pole by air, by President Hoover, 1930.

Amelia Earhart, first woman to achieve a solo transatlantic flight, by President Hoover, 1932.

Lincoln Ellsworth, for Arctic and Antarctic explorations, by President Franklin D. Roosevelt, 1936.

Gen. H. H. Arnold, for "distinguished contributions to the science and development of aviation," by President Truman, 1945.

NATIONAL GEOGRAPHIC Society

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National Geographic Magazine

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To increase knowledge, the National Geographic Society has conducted 150 research projects and exploring expeditions literally to the ends of the earth. The Society diffuses knowledge through its monthly National Geographic Magazine and its books, nine million large color maps a year, bulletins for schools, and news releases on world events for press, radio, and television.

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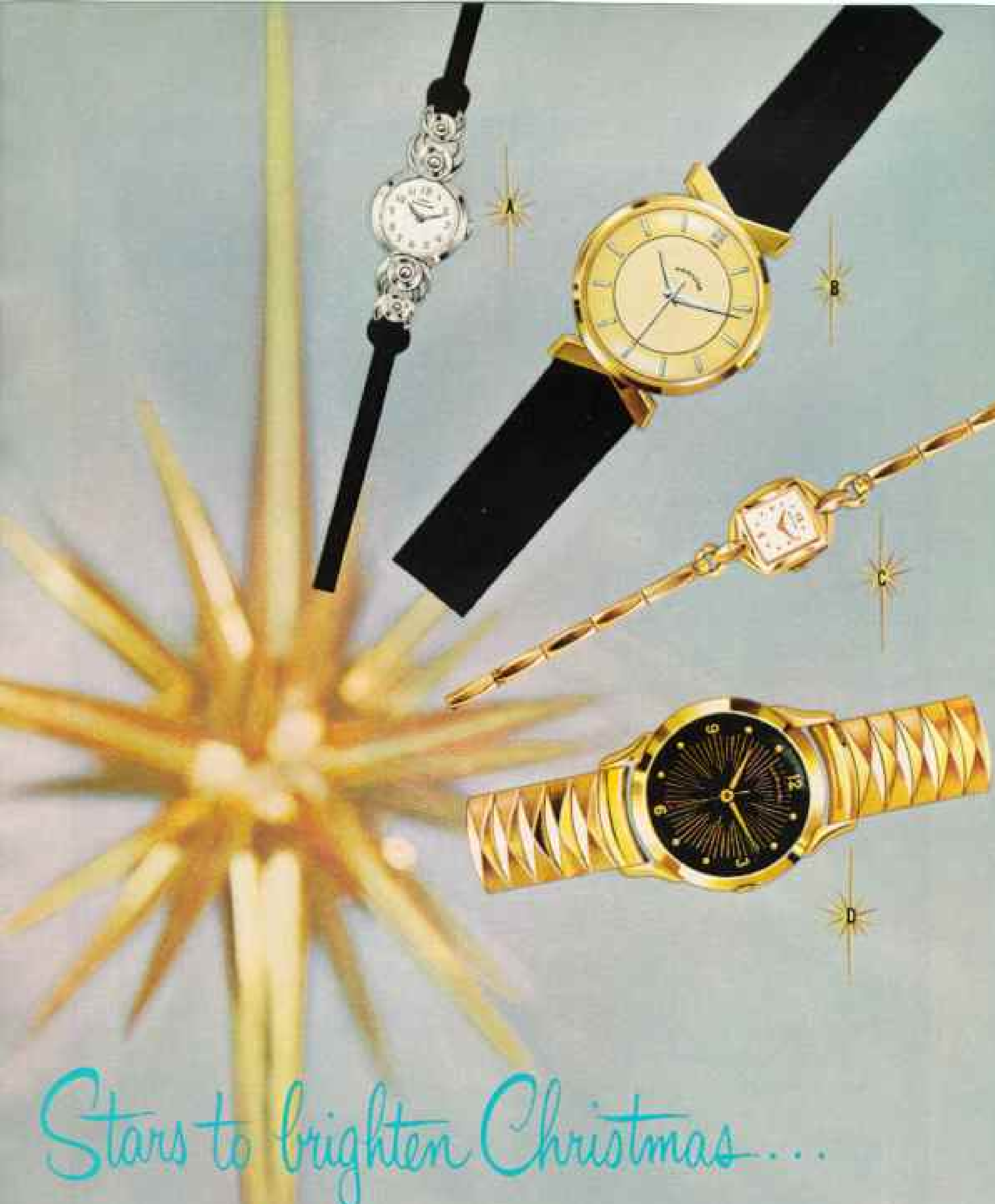
Stars to brighten Christmas . . .



Stars to wish on and stars to give are combined this Christmas in a shining selection of Hamiltons for the special names on your gift list. Look for these stars in your Hamilton jeweler's window. Let them guide you to a truly memorable gift. **A.** Charm R, $150; **B.** Golden Tempus, $175; **C.** Mimi, $75; **D.** Lincrest, $89.50. Hamilton Watch Company, Lancaster, Penna.

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the watch fine jewelers recommend more often than any other

SPENDING Christmas in strange places is nothing new for members of the NATIONAL GEOGRAPHIC MAGAZINE staff, but writer-photographer Luis Marden is the only one thus far to spend most of the holiday under water. Free as a fish in his Aqua-Lung, he searched the floor of the Pacific off Pitcairn Island for a novel Christmas bounty: the remains of the ill-starred ship burned by Fletcher Christian and his men after the mutiny on the *Bounty* in 1789.

How the quest later succeeded is told in this issue by Mr. Marden—with 40 pages of his color photographs—in "I Found the Bones of the *Bounty*."

The world has no more determined pursuer of a fascinating fact or a revealing picture than Foreign Editorial Staffman Luis Marden, whether the pursuit takes him 200 feet under the sea or six miles above the earth. Making photographs for a story on aviation medicine, he rode a screaming Air Force jet through 40 body-wracking parabolic curves to get the perfect picture to illustrate the phenomenon of weightlessness—objects suspended in mid-air in the cockpit.

This 23-year veteran of the National Geographic's staff was born 44 years ago in Boston. Using all the five foreign tongues he has acquired in roaming the world for the Magazine, he wishes you, on our behalf:

Joyeux Noël *Buon Natale* *Boas Festas*
Fröbliche Weihnachten *Feliz Navidad*

And a very Merry Christmas.

RECOMMENDATION FOR . . . AND INQUIRY ABOUT *Membership*

Members of The Society roam the world through the pages of their official journal, the NATIONAL GEOGRAPHIC MAGAZINE. Their enthusiastic nomination of friends for membership explains The Society's phenomenal growth. Members receive the Magazine and its 10-color maps without cost beyond their annual dues, which are less than nonmember subscriptions.

Those who are interested in The Society's work and its Magazine but do not know a member should inquire (below) concerning membership.

to: THE SECRETARY
NATIONAL GEOGRAPHIC SOCIETY
WASHINGTON 6, D. C.

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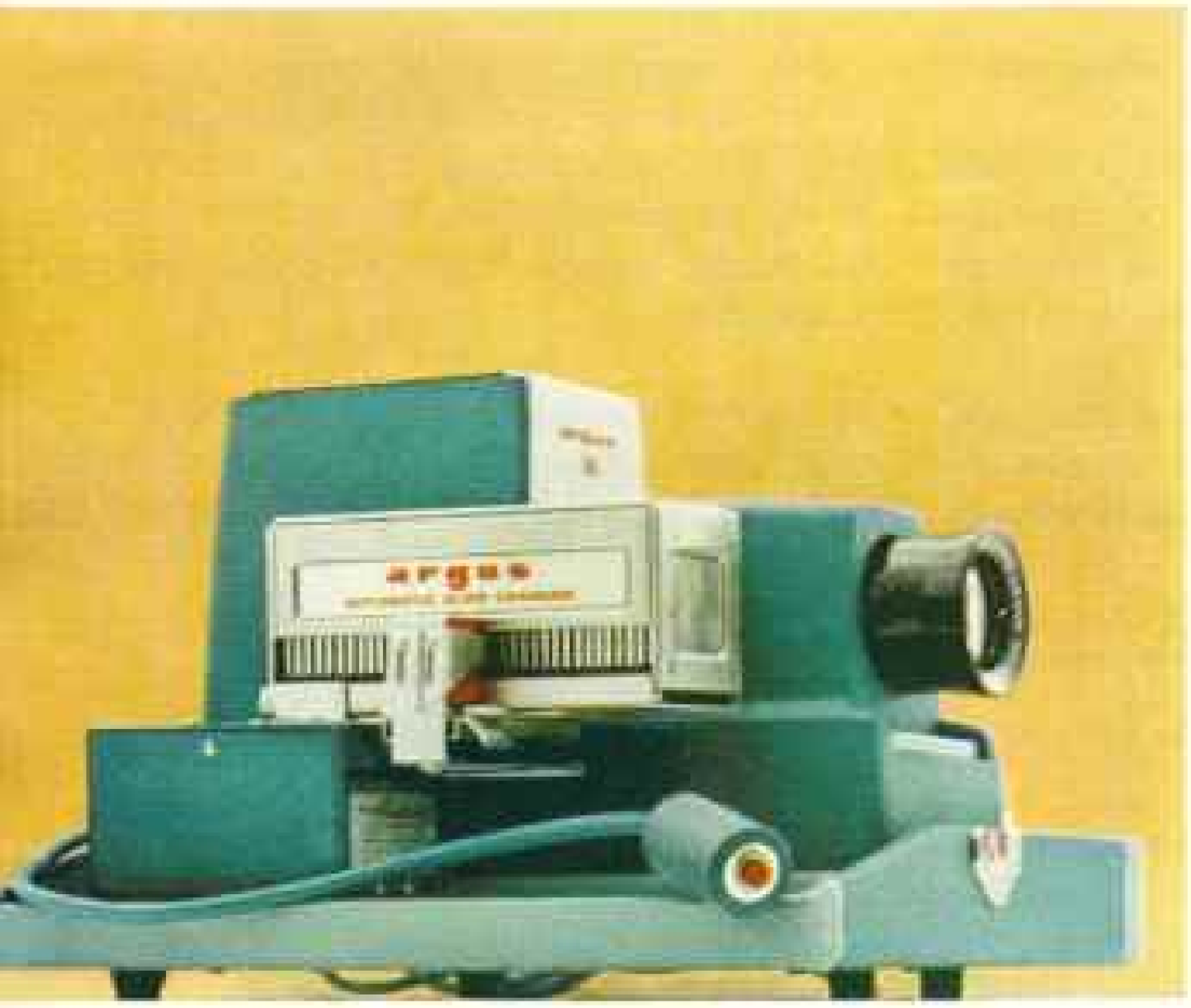

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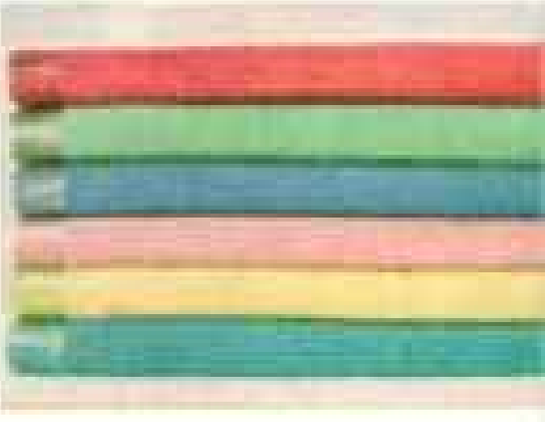

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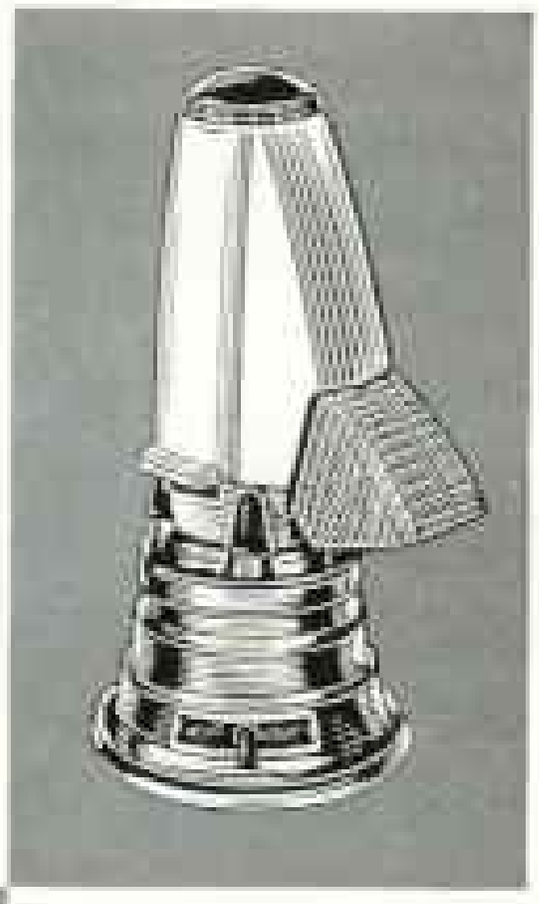

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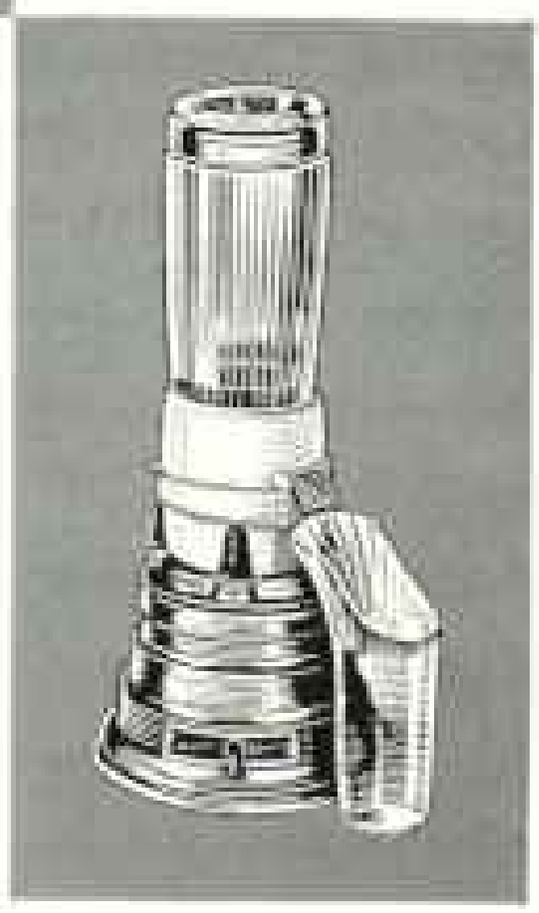

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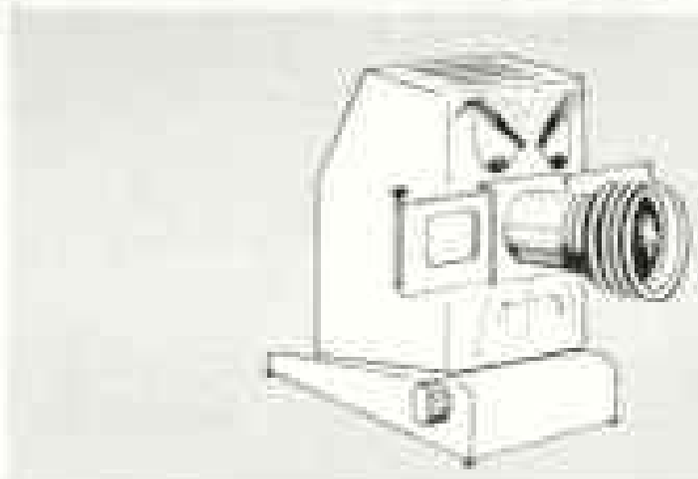

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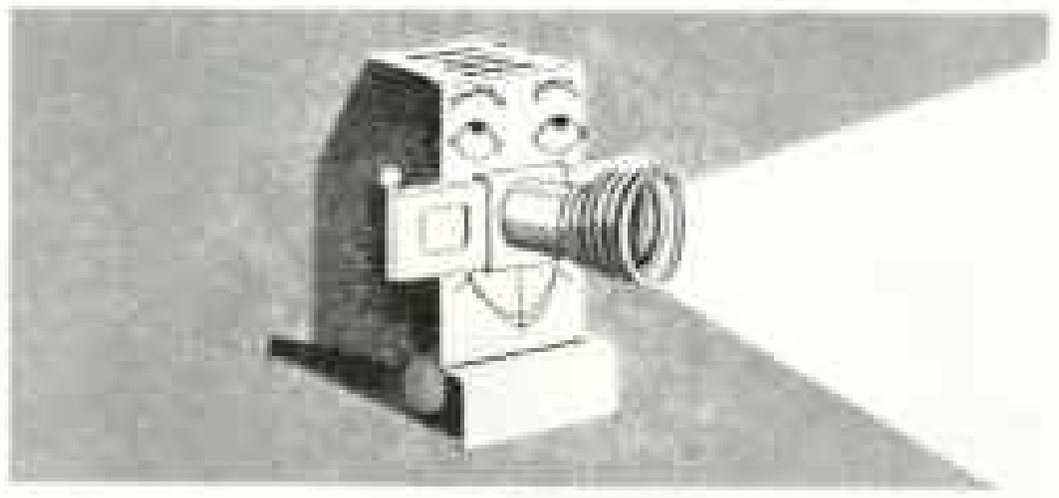

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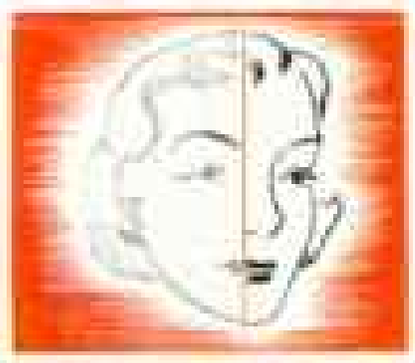

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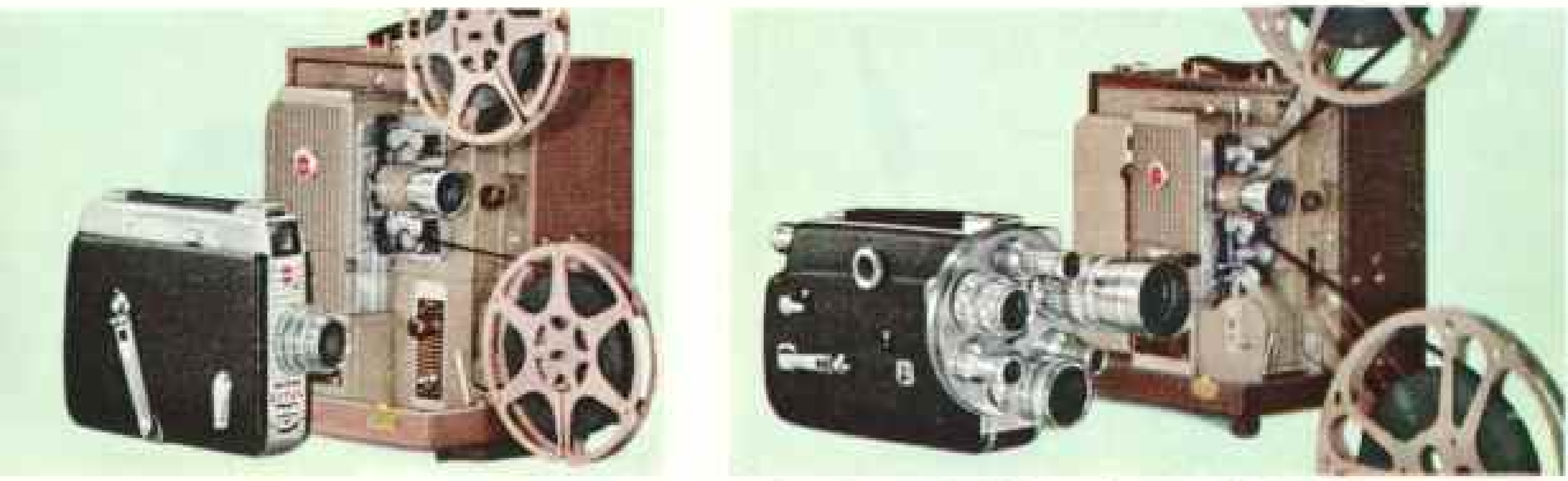

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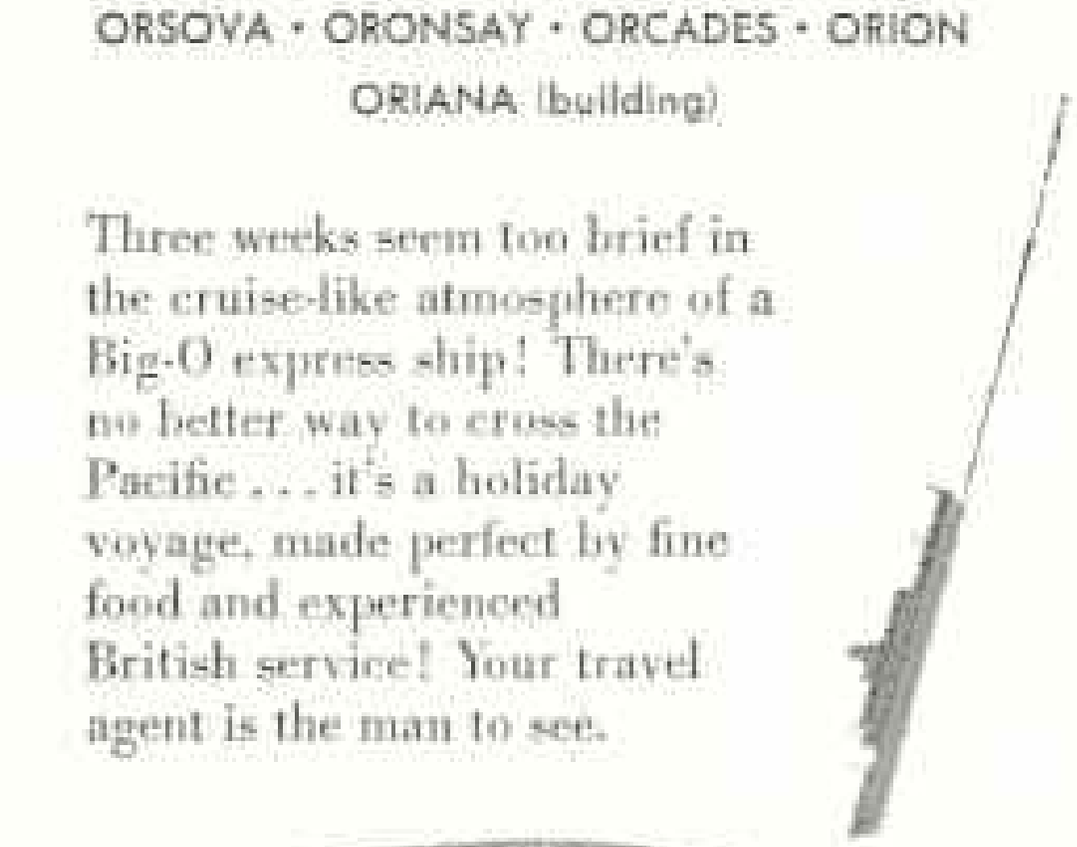

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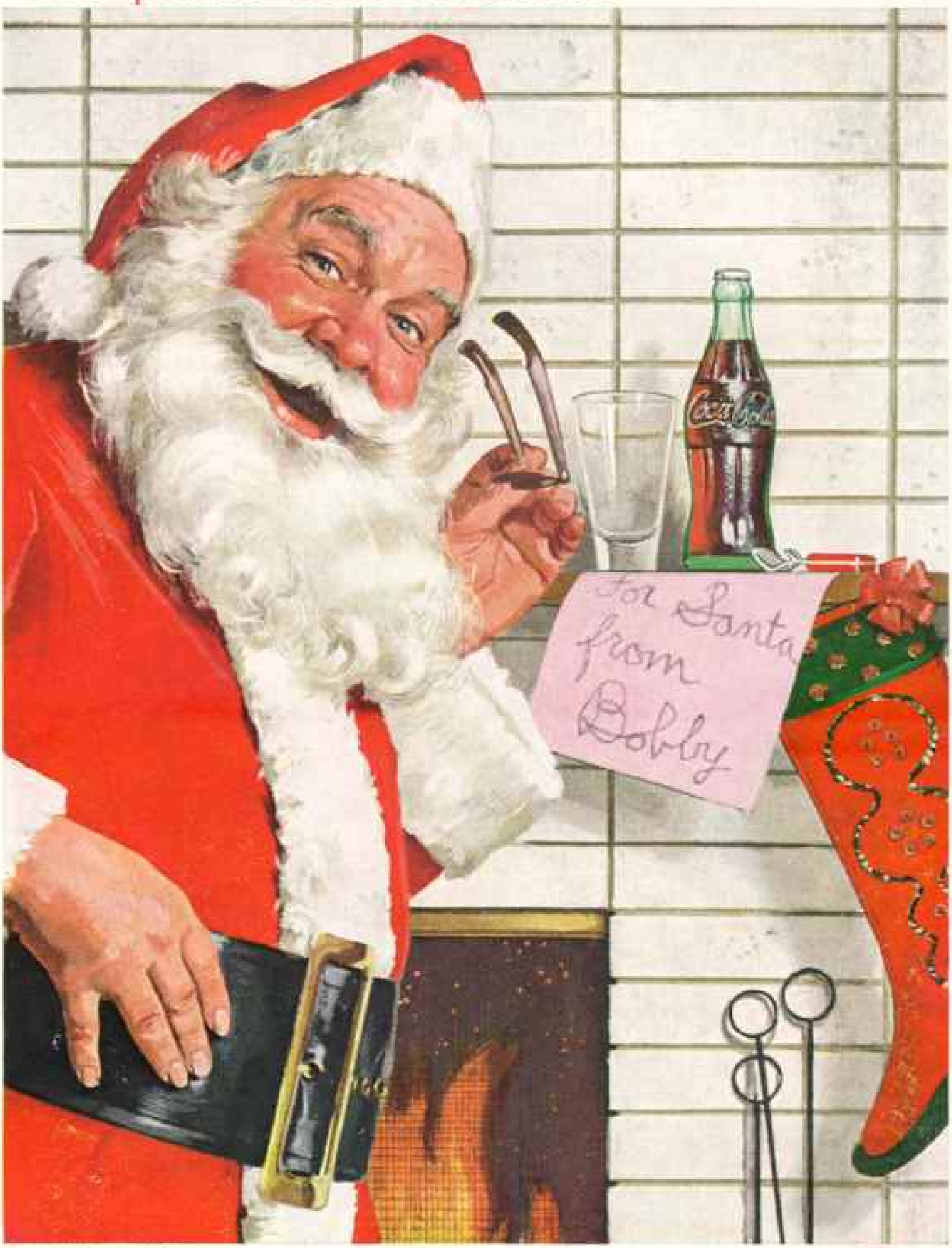

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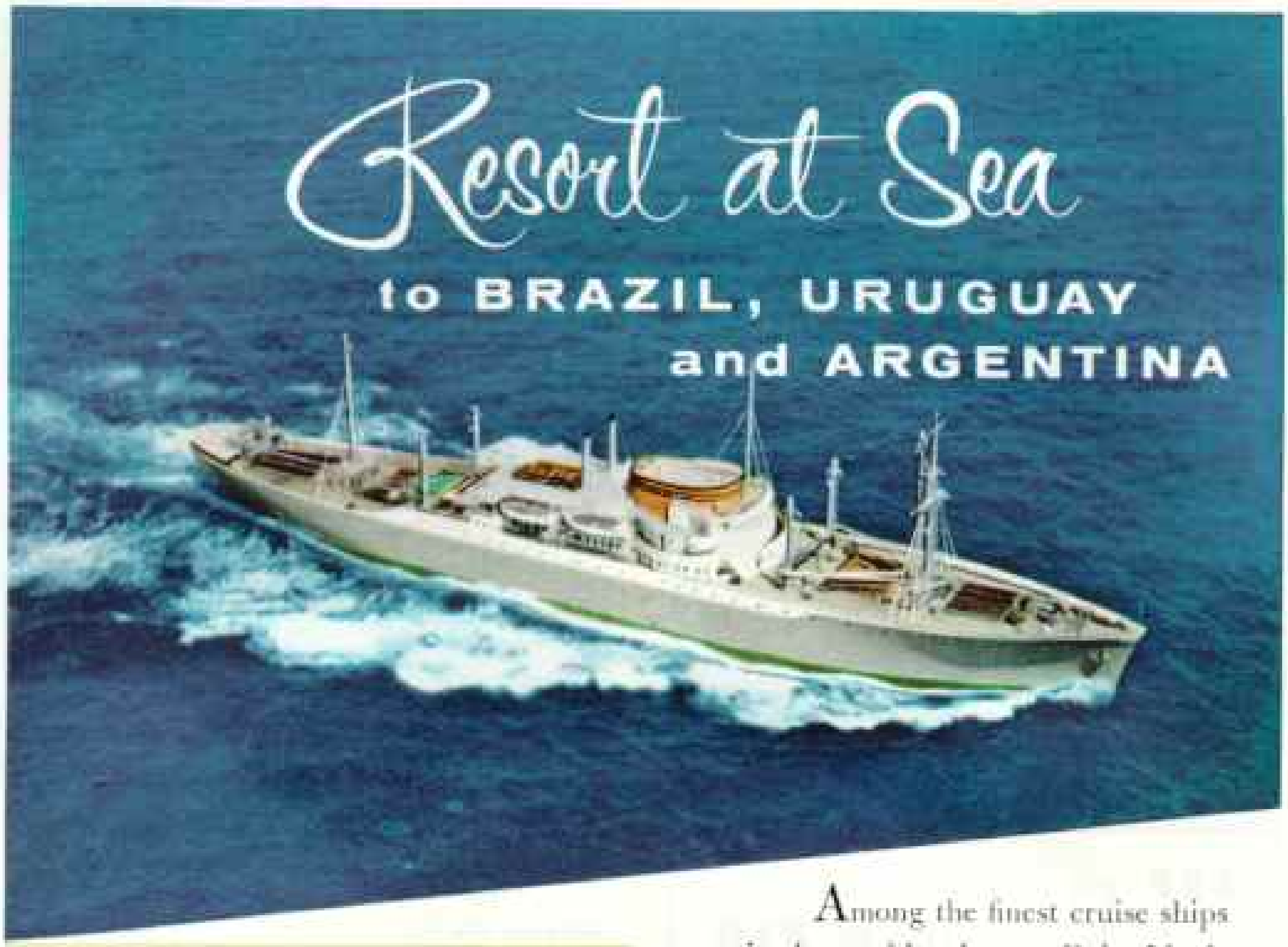

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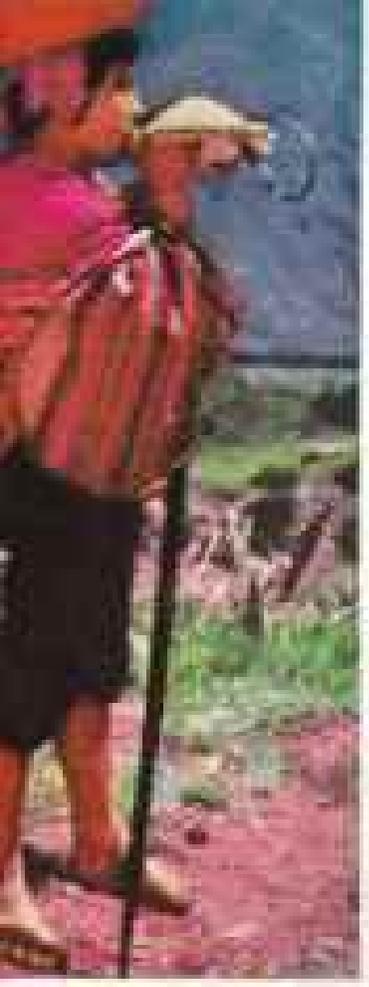

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