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THE NATIONAL GEOGRAPHIC MAGAZINE

How Canada and the United States, working together, have harnessed 189 miles of mighty river for deepwater navigation and power

New St. Lawrence Seaway Opens the Great Lakes to the World

By ANDREW H. BROWN, National Geographic Senior Staff

EARLY LAST summer the citizens of Morrisburg, Ontario, watched the St. Lawrence River flow up the main street of their village. The water deepened where teen-agers had whistled along sidewalks and where gardeners had cultivated their backyard plots. It washed over the sites of familiar landmarks like McNeely's Drugstore and flooded half the business district.

When at last the water leveled off, the onlookers turned away and went back to work in the new part of town they had helped build on land safely out of reach of the river.

This spring the same people will stand at the water's edge and watch one of the reasons for all this glide up the river. It will be gay with flags and bright ribbons. A big seagoing ship will steam by, bound for the Great Lakes —the first vessel of such size to sail into the heart of North America.

Officially, the passage of this ship will celebrate the opening of the St. Lawrence Seaway —with its linked power development one of the most incredible engineering and construction jobs men have ever attempted, and in some ways the hardest. Unofficially, the day will mark much more: It will begin a major reshaping not only of America's but of the world's geography, and of its economy as well.

The great locks and channels of the Seaway replace the old, much smaller ones that could handle only the small fry of ocean shipping.

For deepwater ships out of world seaports like Liverpool and Hamburg, completion of the Seaway means that Cleveland is suddenly closer than Baltimore; Chicago, Milwaukee, Detroit, and Duluth are now as handy to Europe as Miami and New Orleans. To shippers and manufacturers in the United States and Canada, it means the sudden addition of 8,300 miles of coast accessible to large ocean vessels—a stretch longer than the whole U. S. Atlantic seaboard.

22,000 Men Remake a River

Last summer I spent seven weeks traveling every foot of the made-over St. Lawrence by ship, boat, car, and plane. I watched scores of engineers, armies of workmen, and hundreds of giant earth-moving machines working around the clock to get mammoth locks and miles of dikes and channels ready for this year's April opening.

Not since the Panama Canal have men attempted so ambitious a construction venture as the St. Lawrence Seaway and Power Projects. Together, Canada and the United States poured more than a billion dollars into the four-year undertaking. At peak effort, 22,000 men worked on it.

St. Lawrence Ships in a Traffic Jam Crowd the Heart of the New Seaway

This spring the United States and Canada will open the St. Lawrence Seaway, a mighty maritime highway giving large ocean-going ships their first

ROADSHOW BY ALLEN A. BROWN, NATIONAL GEOGRAPHIC STAFF © N. G. S.

access to the Great Lakes. These bathtub-shaped canallers, shallow enough to navigate the old 14-foot-deep locks, waited last summer at Pilon Island for the opening of the 44-mile-long International Rapids section (map, pages 306-7). Lock operators broke the 144-ship jam in two days.

Men marshaled along the river the most fantastic array of excavating, hauling, and construction equipment ever brought together for a peaceful enterprise. With $70,000,000 worth of machines, they cut canyons through earth and rock and moved whole villages to make way for a broad new lake. They raised great bridges while traffic flowed over them without halt. They pumped raging rapids dry and dredged mountains of muck and glacial till.

And when they were finished, what had they produced?

To understand the Seaway, you must look first at the geography of the St. Lawrence River itself and of the five lakes, each as big as a sea, that it drains.

Water flows into the Great Lakes from all directions, draining almost 300,000 square miles.* But virtually all this water, 246,000 cubic feet a second, flows out to sea through the St. Lawrence. A clean-minded statistician has figured this is enough water to give every man, woman, and child in the United States 61 large baths a day.

French Priests Dug First Canal

To unload this awesome burden, the unfettered St. Lawrence raced 400 miles from Lake Ontario to salt water below Quebec (color map, pages 306-7). Much of the way its bed was broad and deep, and though the current was swift, it flowed smooth and straight and was navigable even for sizable ships. The St. Lawrence has the most unvarying flow of any of the world's great streams. But in three stretches the river narrowed and roared over rocky cascades. Men ran these rapids in canoes and small boats, but for cargo ships they would have been suicide.

The St. Lawrence Seaway now bypasses these turbulent stretches with deep canals and enormous concrete locks, or buries them in quiet water backed up behind steel-and-concrete power and control dams. Thus the river's flow has been calmed, its channels deepened, and much of its irresistible force trapped to run Moses-Saunders Powerdam, one of the half-dozen largest hydroelectric plants in North America.

Around 1700, French priests built a ditch-like canal to help canoes and small boats around the Lachine Rapids, at Montreal. In time, Canada added shallow canals and locks (page 310). By the early 1900's a small ship could go from the Atlantic to Lake Ontario and, using the early Welland and Sault Ste. Marie Locks, reach the other Great Lakes.

Millions of tons of cargo did move this way. But when a freighter, say, of 9,000 tons capacity crossed the Atlantic with a cargo for the Great Lakes, it had to stop at Montreal and transfer the load into shallow-draft canalboats, a slow and costly routine.

This year that same 9,000-ton ship can sail right up the river. Two brand-new locks, each about 900 feet long, 80 feet wide, and with 30-foot minimum depth, will lift it gently up the 46-foot fall of Lachine Rapids (diagram, page 311).

Lock Named for President Eisenhower

Twenty miles farther upstream two locks at Beauharnois, Quebec, climbing past the great Beauharnois Powerhouse, will boost the vessel another 84 feet to the level of Lake St. Francis. Then, after clear sailing for 35 miles, two huge dams serving the Moses-Saunders power plant will block its way.

Two more locks, named for Dwight D. Eisenhower and Congressman Bertrand H. Snell, and a 10-mile canal, the Wiley-Dondero Ship Channel, bypass the dams and put the ship in 28-mile-long Lake St. Lawrence, which first took shape last year. There the vessel floats on a deep lake that drowns what once were the wildest rapids in the river, the Long Sault (page 318).

The freighter now has only one more step to climb in the St. Lawrence, a lock that lifts it around the Iroquois Control Dam far upstream and leaves it free to push on unimpeded into Lake Ontario, only 78 miles away. It can make the whole trip in about 30 hours.

What the Seaway has done is to replace 22 small locks with a water stairway of seven big ones in even steps. Canada built five of them; the United States two. A long stairway, true, and an expensive one: The two nations spent $470,000,000 to build it.

Seaway to Handle 25,000-ton Tankers

The purpose of the Seaway, and its promise to seafaring peoples everywhere, came clear to me when I talked with Harry C. Brockel, Port Director of Milwaukee and a stanch advocate of the project.

Four-fifths of the world's ships, Mr. Brockel pointed out, will be able to use the new route.

* See "Sea to Lakes on the St. Lawrence," by George W. Long, National Geographic Magazine, September, 1956.

PHOTOGRAPHED BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON © N. G. S.

Gantry crane at Lauzon, Quebec, loads a 45-ton gate for the powerdam at Beauharnois. Newly launched, the Saguenay line's freighter *Sunrise* carries an all-aluminum superstructure.

It will handle general-cargo ships of 9,000 tons capacity and tankers and ore and grain carriers up to 25,000 tons, provided they draw no more than 25½ feet.

"Goods moving with no special hurry will always go by water, if they can," he added. "And the volume of traffic on sea, lake, and river keeps climbing. Since World War II, trade on the inland waterway system of the United States has soared to surprising new records.*

"Remember, too," Mr. Brockel said, "this heartland area—the Great Lakes and the Midwest—produces two-thirds of United States export trade by volume.

"Tolls will be reasonable on the Seaway—considerably less than Panama or Suez. Bulk trade in grain, iron ore, coal, petroleum products, chemicals, wood, wood-pulp, and newsprint will be the bread-and-butter business.

"But lots of manufactured goods, the blue-chip cargoes, will travel economically, too. For example, a Milwaukee manufacturer recently exported a knocked-down cement mill to Spain. He saved $30,000 by use of ocean vessel direct from Milwaukee, as compared to what the haul overland to the east coast and onward by ship would have cost.

"A single excavating shovel took the all-water route from Wisconsin to France at a saving of more than $5,000 in freight charges. The average cost advantage by this route, even in very small ocean ships, ranges from 12 percent to 15

* See "The Upper Mississippi," by Willard Price, National Geographic Magazine, November, 1958.

Canallers in tandem find room to spare in two-block-long Snell Lock (page 329). Derricklike booms at the ends of the reservoir support cables to keep ships from ramming the lock gates. Pit beneath crane at right holds stop logs, prefabricated panels that dam the lock chamber during repairs and winter shutdowns.

NATIONAL GEOGRAPHIC PHOTOGRAPHER
ROBERT F. SISSON

JAMES BLAIR, 1958

Builders raise 3,300-foot-long Moses-Saunders Powerdam (page 339), one of the continent's largest producers of hydroelectric current. Howard L. Ross and Jesse Crawford work above the stream's dry bed as cofferdams keep out the water. "We've shoved the river this way and yanked it that," an engineer told the author, "but in the end we know the St. Lawrence is still the boss."

percent, as compared to land-and-ship movement.

"Savings like these, possible with little vessels, surely will be greater as bigger and more economical ships start to use the deep-draft Seaway."

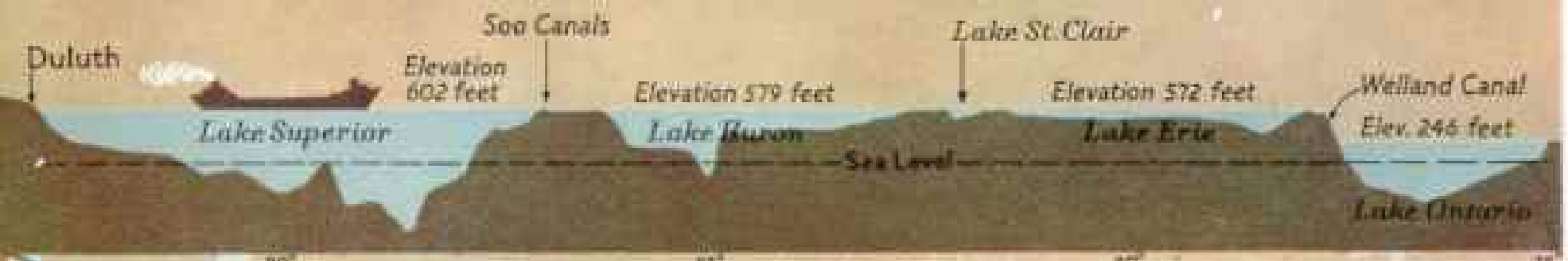
International Rapids Tamed for Power

Even from the air it is hard to grasp the full scale of the Seaway and its associated power structures. I learned this on a flight last summer over the International Rapids section, now dominated by a vast new hydroelectric-power complex.

Our light plane scooted up from the airport at near-by Massena, New York. The St. Lawrence swept below us, clear and green as glacier ice, through a tranquil landscape of grain and grass and grazing cattle.

Then we tilted forward, and the pilot jabbed downward with his thumb. A great dam came into view, water boiling from its curved rank of spillways. We dropped lower and buzzed the slots of two new locks. Off to one side appeared the huge new powerhouse, a tremendous rampart of concrete that walled off one channel of the stream. The river coiled, foam-flecked, through a narrow pass beneath us.

"You can see how they've gone about hog-tying this river," the pilot shouted as we skimmed above a thicket of transmission towers. "They've got her strapped down now, but it sure hasn't been easy!"



Dredging, channel cutting, and lock construction by the United States and Canada will allow deep-draft vessels to navigate between the Great Lakes and the Atlantic. The new waterway will handle ships of 5 to 10 times the capacity of those that used the old canal system.

ONTARIO | QUEBEC

Electricity from the U.S. half of Moses–Saunders Powerdam will serve New York homes and industries as far away as the Mohawk Valley and will cross Lake Champlain into Vermont. Current from the Canadian powerhouse feeds into transmission lines serving southern and eastern Ontario.

CANADA
U.S.A.
Port Arthur
Fort William
Lake Superior
Duluth
Superior
MICHIGAN
WISCONSIN
Soo Canals
Sault Ste. Marie
Sudbury
Calcite
Lake Huron
Ottawa
Massena
Green Bay
Lake Michigan
Milwaukee
WISCONSIN
ILLINOIS
Bay City
Port Huron
Lansing
Sarnia
Toronto
Lake Ontario
Kingston
Hamilton
Welland Canal
Selkirk
Chicago
Gary
Detroit
Windsor
Lake Erie
Erie
Buffalo
Syracuse
MICHIGAN
Toledo
Ashtabula
NY
PA
Illinois River
Peoria
ILLINOIS
INDIANA
Ft. Wayne
Sandusky
Cleveland
INDIANA
OHIO
Springfield
Indianapolis
Columbus
Cincinnati
Mississippi River
Ohio River
Louisville
KY
TENN
St. Lawrence River SEAWAY AND POWER
Morrisburg
Iroquois
Cardinal
Seaway Channel
Prescott
Ogdensburg
Brockville
Morristown
North
National
CANADA
U.S.A.
Canton
STATUTE MILES
Canadian
Seaway Channel
Gananoque
Alexandria Bay
Jewel Island
Kingston
Thousand Islands
Clayton
Wolfe Island
Lake Ontario
Cape Vincent
Thousand Islands Section, 68 miles
VA
NC
NC
SC

SEAWAY PROFILE

A DEEP WATERWAY, ATLANTIC TO GREAT LAKES — ELECTRIC POWER FOR TWO NATIONS

Montreal
St. Lawrence R.
Sept Iles
Railroad to Quebec-Labrador Iron Mines
Northern Europe
Anticosti Island
Newfoundland
St. Lawrence River
Gaspé
Matane
Eastern Seaboard and Gulf Ports
Southern Europe and Africa
Gulf of St. Lawrence
Lake St. John
QUEBEC
NEW BRUNSWICK
Laurentides Provincial Park
Riviere du Loup
Cape Breton Island
Quebec
Ile d'Orleans
Lauzon
Lotbinière
Trois Rivières
Lake St. Peter
Sorel
Contrecoeur
Montreal
CANADA
STATUTE MILES
Compiled by H.L. Peacock
Drawn by J.W. Luthers and I.E. Affeman
©N.G.S.
Cornwall
Rouses Point
Lake Champlain
Plattsburgh
U.S.
MAINE
Ottawa R. River
Jacques Cartier Bridge
Montreal
St. Lambert Locks
Lachine
Caughnawaga
Côte Ste Catherine Lock
Dorion-Vaudreuil
Soulanges Canal
Coteau du Lac
Coteau Rapids
Beauharnois
Beauharnois Locks and Powerhouse
QUEBEC
ONTARIO
GLENGARRY
Valleyfield
Seaway Channel
Lake St. Francis
Huntingdon
Canadian Section, 77 miles
Long Sault
Cornwall
St. Lawrence R.
Pitou Island
QUEBEC, CANADA
NEW YORK, U.S.A.
Hogansburg
Massena
ENLARGEMENT BELOW
International Rapids Section
International Rapids Section, 44 miles
Old river course
Flooded areas
Flooded towns
St Andrews West
Lunenburg
Ornabruck Centre
Long Sault
Moulinette
Ile Perrot
Williamsburg
Ingleside
Farran Point
Dickinsons Landing
Wales
Moses-Saunders Powerdam
Barnhart
Cornwall
Long Sault Spillway Dam
Eisenhower Lock
Snell Lock
St Lawrence State Park
Wiley-Dondero Ship Channel
Seaway Channel
Massena
Morrisburg
Old Morrisburg
Iroquois
Old Iroquois
Waddington
Iroquois Control Dam
Chrysler Mills
Industry's abandoned Massena will use 50 percent of the current from the U.S. powerhouse. Principal buyers are ALCOA, Reynolds Metals, and General Motors.

Gunman draws a bead on classmates at flood-doomed Mille Roches School, Ontario. Creation of a lake above Moses-Saunders Powerdam forced the relocation of seven villages and the partial shifting of one more. The builders of the dam paid the $28,000,000 moving and housing bill.

This view shows the building before wreckers toppled it (opposite). The monument honors the school's World War I dead.

Scattered rubble clogs the school's foundations. Today water covers the spot, and a new school on high ground replaces the old building.

In the distance, engineers on the causeway salvage a bridge. Barges lift the structure as the water rises, permitting the span to be towed away.

One St. Lawrence pilot likened the changing waterway to an "old friend who shaved off all his hair so you don't know him any more."

PAUL L. TURNER (ABOVE AND RIGHT)

It was anything but easy. The Seaway builders faced and overcame obstacles that at times seemed almost insurmountable.

Consider, for example, the "blue goop." A greasy clay that sometimes contained almost as much water as solid substance, it sloshed out of dredge buckets and oozed through truck bodies. Exposed to sun and air, it turned rubbery or even brittle, until a shower changed it back to soup again. One desperate engineer even considered spreading tarpaulins over it during rain. Technically, it was called "sensitive"; the workmen had other names, all unprintable.

Southern Gentleman to the Rescue

There were millions of tons of clay to remove from the Wiley-Dondero channel, which required a cross-country cut 442 feet wide at the bottom and as much as 50 feet deep. Seaway builders called to the job monstrous earth-moving machines, one of the biggest a 650-ton walking dragline excavator named "the Gentleman." It belonged to the Badgett Mine Stripping Corporation, and was busy digging for coal near Madisonville, Kentucky.

When it heard the call from the north, the Gentleman put down its flat steel feet and crawled like a centipede 18 miles to Pond River. On barges it rode the Pond, Green, Ohio, Mississippi, and Illinois Rivers. Unable to pass beneath one bridge, the Gentleman lifted the span from its piers, floated through, and then set the bridge back in place.

From Chicago the big dragline traversed four of the five Great Lakes to reach the St. Lawrence. The 2,000-mile trek lasted 102 days. At journey's end, the Gentleman built itself an earth ramp and walked majestically ashore, where it proceeded to dine on the slushy blue clay and glacial till in a most ungentlemanly way—25 tons to a bite. In six months it removed 2,000,000 tons of earth from the new ship channel.

Not all the earth was ooze, of course. At Quebec's Beauharnois Locks contractors waged an opposite kind of battle, against Potsdam sandstone, rock so hard a foreman said of it: "This stuff takes the teeth off a power shovel every 18 hours. Ten feet of it will blunt a drill bit."

At the upper lock there were 3,000,000 tons of such rock to remove. Dynamite would do it, but first blast holes had to be drilled. A compressed-air drill took as long as a week to sink a 100-foot hole in the flintlike Beauharnois rock.

So the crews turned to a new rig: They shot jets of flame into the stone from a blowpipe at five times the speed of sound. Reaching temperatures of 4,000° F., the jet flame disintegrated rock in its path, burning holes as deep as 160 feet. Jet-piercing sank a 100-foot hole in a single 10-hour shift.

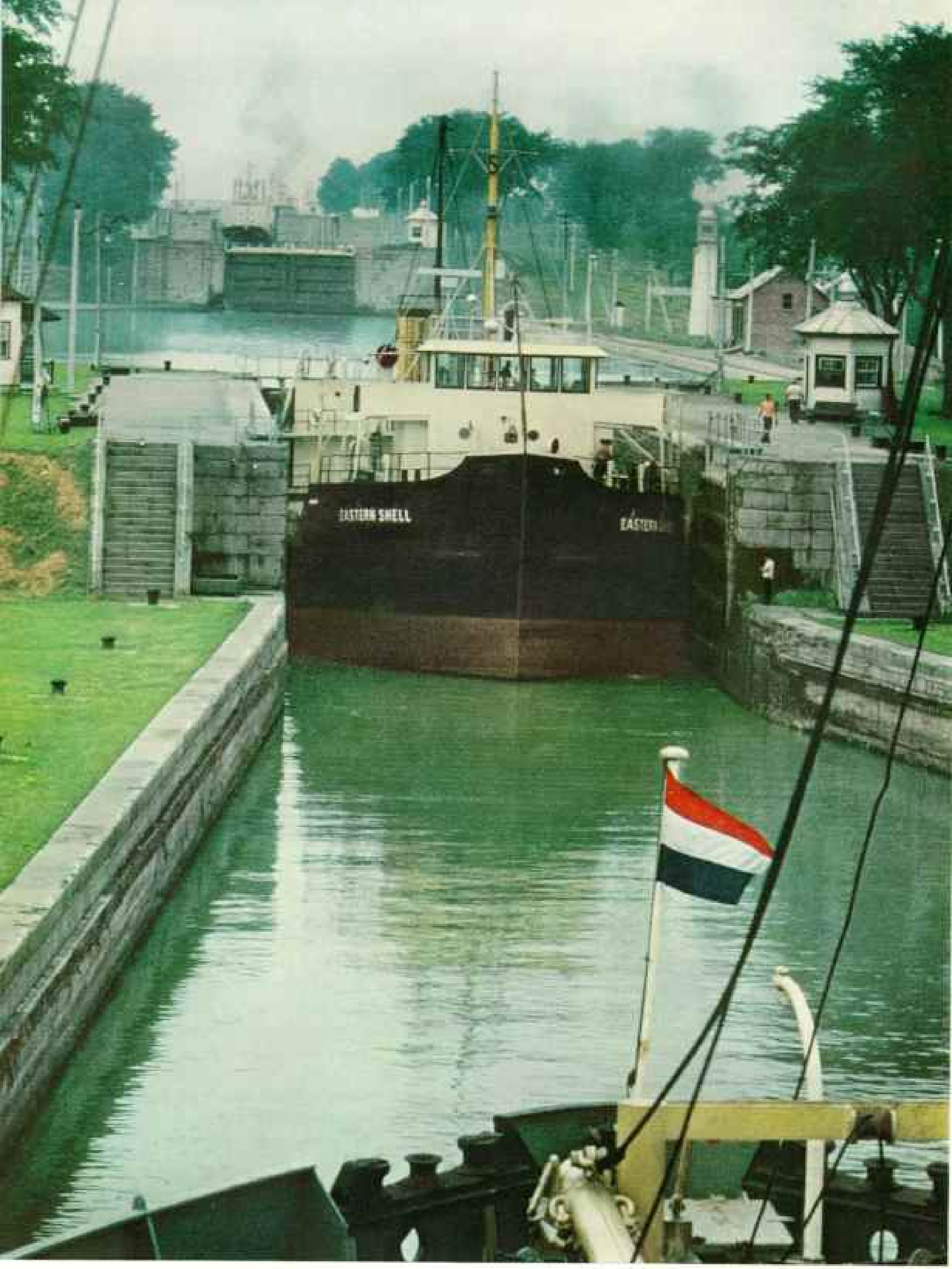
Sometimes, of course, hardness was an advantage. I kicked at a dike slope made of material excavated from a lock site near Massena—and drew back a tingling foot.

"Hard, isn't it?" said a local teacher, showing me around. "The Ice Age spread glacial till all over this valley. It's a compact mixture of pebbles, sand, and clay. They dug it up one place and used it in another. Glacial till is a lot cheaper than concrete or crushed rock; yet it's solid, stable, and stays free of bad cracks even in sub-zero cold."

Gouged out of canals and lock and power sites, the glacial till provided firm, almost impervious fill for twenty-one miles of retaining dikes.

Workers' Hands Froze to Tools

The biggest single enemy of the Seaway builders—aside from the implacable river itself—was winter. Then the St. Lawrence turns to ice, and temperatures in the river valley reach 25 and 35 degrees below zero. Though the intense cold will close the Seaway



PHOTOGRAPHS BY ANDREW H. BROWN, NATIONAL GEOGRAPHIC STAFF © N. G. S.

A Stout Matron of the Lakes Inches Her Bulk Through Old Soulanges Locks

Seven large locks replace the old waterway's 22 smaller chambers, reducing hazards and cutting passage time. This eastbound Canadian tanker leaves the lowest lock in the Soulanges system, which will be bypassed by the 27-foot-deep Beauharnois Power Canal. Freighter in the distance enters the upper lock. The Dutch flag in foreground flies from the stern of a Fjell-Oranje Lines cargo ship.

itself to traffic four months each year, the construction work had to go on.

Bitter temperatures made metal objects burn to the touch. Workers' hands, if ungloved, froze to tools and vehicles. Gear assemblies stiffened and made lubricating difficult or impossible. Drivers freeing tractor treads with blowtorches looked like soldiers attacking tanks with flame throwers.

Earth and gravel shoveled into truck beds froze hard to the steel and wouldn't dump out. To solve this problem, engine exhaust was diverted through heating tubes built into vehicle bodies. Maintenance crews sprayed the trucks with oil, or washed them down with chemical solutions to lay an insulating film between metal and load. When all else failed, they used a small excavator called a back hoe to claw the dirt out.

Concrete, placed when the thermometer was nudging zero, tended to freeze before it set. To prevent this, contractors preheated the sand, gravel, and water used in the concrete mixture. They kept retaining forms warm by spraying with jets of steam. When possible, tents or tarpaulins shielded concrete work, and space heaters warmed the area. For their comfort, the workers set up board or canvas windbreaks and used scores of "salamanders," fire pots made of punctured oil drums.

Sometimes ice refused to move. Above half-finished Long Sault Spillway Dam in mid-March, 1957, the ice jammed up, blocked the river, prevented placing a new cofferdam, and threatened a flood. Borings showed 2½ feet of hard crystal ice on the surface, as much as 30 feet of loose pack underneath.

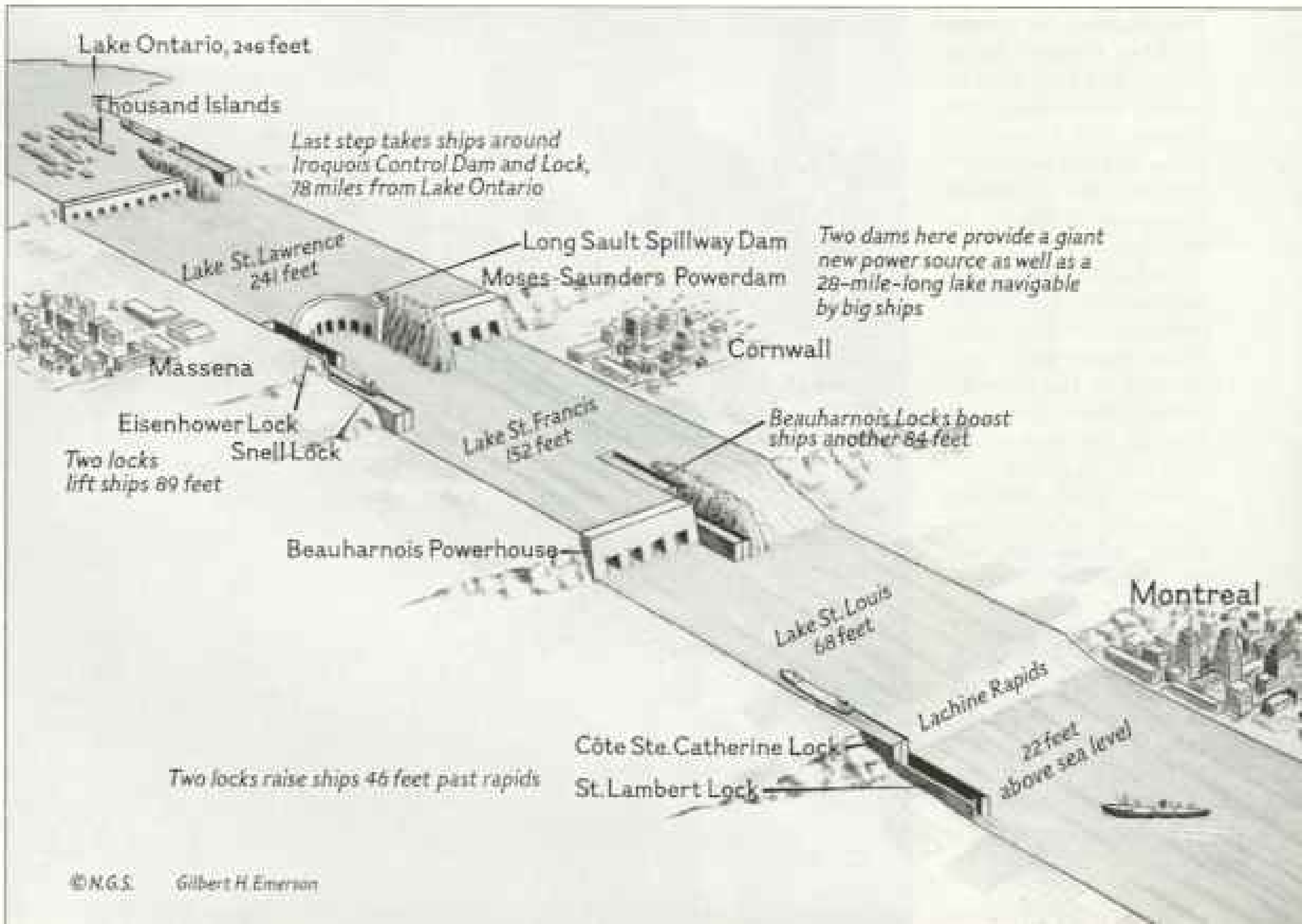
Rocking Water Breaks Ice Jam

Frank Matejka, project manager for the U.S. power engineers, had an idea. In principle, it was the same as rocking the water in a tub by moving your hand back and forth at just the right speed. But his tub was half a mile of flowing channel, and instead of his hand he used two of the dam's big gates.

"I ordered two gates on the dam closed

Ships on the Seaway Ride an Immense Hydraulic Escalator

This schematic drawing telescopes the 189-mile waterway and reveals it as a staircase whose moving steps—the locks—effortlessly lift and lower vessels the 224 feet between Montreal and Lake Ontario.



High on Its Bluff, Quebec Guards the St. Lawrence

Samuel de Champlain in 1608 founded the "cradle of New France" below Cape Diamond, the height overlooking the river. For a century and a half the settlement remained the capital of the colony, falling to the British in 1759.

Though 650 miles from the open sea, Quebec experiences 19-foot tides. Pilots guide ships past the city on the 350-mile journey from Pointe au Père to the Seaway entrance at Montreal.

Castellated Château Frontenac, site of two Allied conferences during World War II, dominates the sky line of Upper Town. Pedestrians from Lower Town reach the heights by the chutelike cable railway. Price Building and spire of Laval University rise at center and right.

AQUACHROMES BY ANDREW H. BROWN (ABOVE) AND ROBERT F. SISSON, NATIONAL GEOGRAPHIC STAFF © N.G.S.

Long-horned Goat Leads the Guard at The Citadel

Summer crowds jam the courtyard of Quebec's 19th-century fortress for the changing of the guard, here conducted by the crack French-Canadian Royal 22d Regiment. High-crowned bearskin headdresses and scarlet tunics call to mind the guards at Buckingham Palace.

Queen Elizabeth II presented the goat, a snow-white billy from Great Britain's royal herd, to the regiment.

The Citadel, 10 years abuilding, never fired a shot in anger.

as rapidly as possible, backing up a third of the river flow," Mr. Matejka told me later. "Then I had them opened again at once, pulling extra water down through the dam.

"I thought I might get waves rolling back and forth and set up motion under the ice that would smash it. Everyone said I was crazy. But sure enough, the first drawdown sucked water from beneath the ice, and set waves running under the ice and upstream of the dam. I opened and closed those gates twice in rhythm, and the ice began to break up. Floes 40 and 50 feet across ground against the sluice walls. Thousands of tons of ice drove through the spillways. In three hours the pack had moved out."

Bridges Raised Without Halting Traffic

In the downriver stretch of the Seaway four bridges reach southward across the St. Lawrence from the island of Montreal (map, page 307). Under the south end of each of them, workers carved a channel for the Seaway.

The highest of the bridges allowed only 40 feet of overhead clearance, while Seaway shipping required a minimum of 120 feet. The bridges had to be raised, but without seriously interrupting rail and highway traffic.

This called for tricky engineering, and it finally cost $45,000,000. Yet the work was so well done that a reporter wrote that "the slick way the bridge improvements were planned and carried out" had robbed Montrealers of what could have been a legitimate cause for complaint.

In elevating the bridges, no short, sharp inclines could be used, because of the danger of steep grades when coated with winter's ice. Engineers staged their fanciest tour de force in the work on Jacques Cartier Bridge. The Dominion Bridge Company had to hump up the whole southern section to provide 80 feet of added clearance over the Seaway channel.

Audrey Adds to Builders' Problems

Thirty feet of this rise was achieved by rebuilding the framework of the bridge itself, by placing the steel trusses above instead of under the roadway. Engineers built the new span on piles beside the old one and slipped it into place in five hours, starting at dawn when traffic was light.

To gain the remaining 50-foot clearance, steel erectors gradually jacked up 13 spans of the bridge, adding new concrete foot by foot to the height of the supporting piers.

The men remaking the St. Lawrence always were glad to see the end of winter. But sometimes summer brought trouble, too. On June 29, 1957, power engineers at Long Sault Dam got word that Hurricane Audrey was heading their way.

Radio messages from Lake Ontario were ominous. A sharp drop in barometric pressure had produced the phenomenon known as seiche: In effect, the whole surface of the vast lake was tipping like a seesaw, and the eastern end was high. It had reached a foot above normal when the hurricane knocked out the automatic gauges that telemetered water levels to the dams downstream.

The lake poured into the St. Lawrence, and the flood—one-sixth more water than normal—rushed down on the construction area at Cornwall and Massena. A 60-mile wind helped it along.

"We had been holding the water at 203½ feet above sea level at Long Sault Dam," Bob Conner, a hydraulic engineer, told me. "If we had let it get much higher, the Cornwall Canal would have become inoperative.

Flood Waters Threaten Canallers

"When we got word of the flood, we started opening gates frantically. But we had 12 of them to open, and only two cranes to raise them. And each gate takes at least 20 minutes to lift. You figure it out.

"With the automatic gauges out upstream, we didn't know just what was coming, or when. So we hustled off two radio-relay cars far enough upriver to give us 15 minutes warning of new water levels.

"In the middle of it all, I took off by jeep from the dam to relieve one radio car. And, wouldn't you know, a police car stopped me and commandeered my help to remove a big tree blocking the road. My jeep pulled the tree away, and I drove on to the radio car.

"The river kept rising, and we kept raising gates half the night. Before we got things under control, the water had come within an inch and a half of the flood point. Skippers of the canallers didn't know how close they came to being stranded where they tied up for the storm!"

Difficult jobs always seem to foster humor and humanity. The Seaway struggle was no exception.

(Continued on page 323)

KODACHROME BY WALAS © NATIONAL GEOGRAPHIC SOCIETY

A Pulpwood Carrier Dumps Its Cargo at Trois Rivières, Quebec

Propellers submerged near shore suck spruce, fir, and jack pine into a newsprint mill. Hinged gates in the log boom let ships in and out. The cylindrical buoy, a part of the boom, bears a navigation light.

AQUACHROME BY ANDREW H. BROWN, NATIONAL GEOGRAPHIC STAFF © N.G.S.

Freighter Slips Past Golfers on a Displaced Green: Massena, New York

New construction and flooding forced the relocation of entire towns along the old waterway. Massena Country Club constructed this course to replace its drowned fairways.

AQUACHROMES BY NATIONAL GEOGRAPHIC PHOTOGRAPHERS ROBERT F. SISSON (ABOVE) AND ROBERT E. GILKA © N. G. S.

Speeding cars duck beneath Dwight D. Eisenhower Lock on the Wiley-Dondero Ship Channel. The derrick on the wall can lower an emergency bulkhead to drain the lock for repairs. The seal above the tunnel bears the insignia of the Saint Lawrence Seaway Development Corporation: eagle, maple leaf, and Neptune's trident.

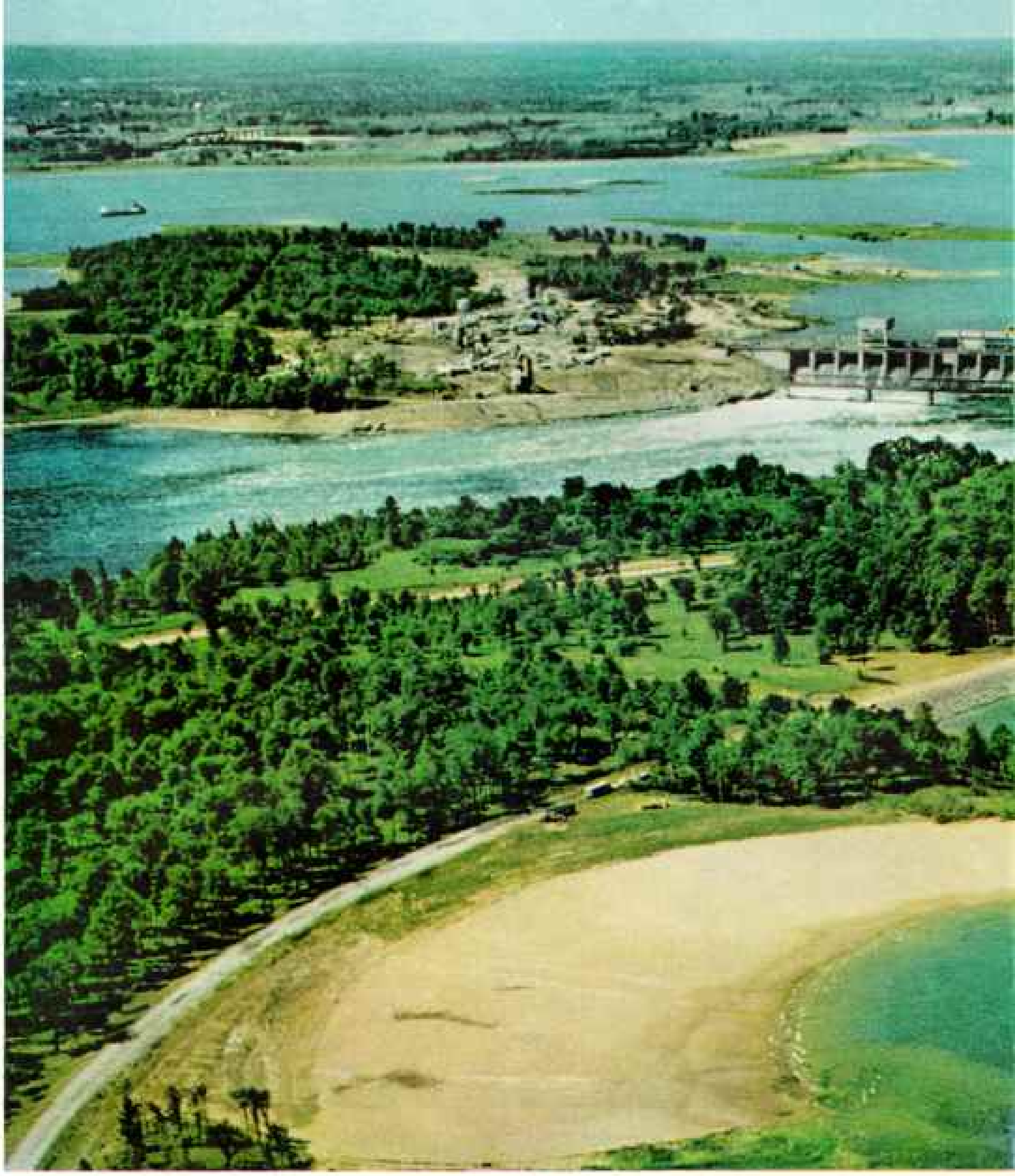
Canalside superintendents gaze through a telescope at construction on Moses-Saunders Powerdam, a U. S.-Canadian project in the International Rapids section. A freighter glides down Cornwall Canal, an old channel built to bypass the rapids (next page). Today water trapped by the dam covers the children's lookout.

Long Sault Rapids Shatter the River; Beyond, a Ship Rides Cornwall Canal's Tranquil Waters

Scourge of the St. Lawrence, rapids have discouraged traffic from colonial times. One 19th-century visitor remarked that he "would rather cross the Atlantic thrice than travel . . . the rapids. . . ." Submerged rocks and waves as high as 15 feet barred all but shallow-draft excursion boats that shot the cascade for thrills.

Engineers began a nine-foot bypass in 1834; others deepened it to 14 feet at the turn of the century. Today rapids and canal lie drowned beneath the 28-mile-long lake formed by Moses-Saunders Powerdam, itself bypassed by Wiley-Dondero Ship Channel. This photograph was taken from Long Sault Island, New York.

Dried-up rapids bare their fangs—jagged slabs capable of ripping the stoutest hull. To build dams below the rapids, engineers temporarily diverted the river (page 320). Long Sault's rocks, after lying exposed for nine months, are now submerged deeper than ever.



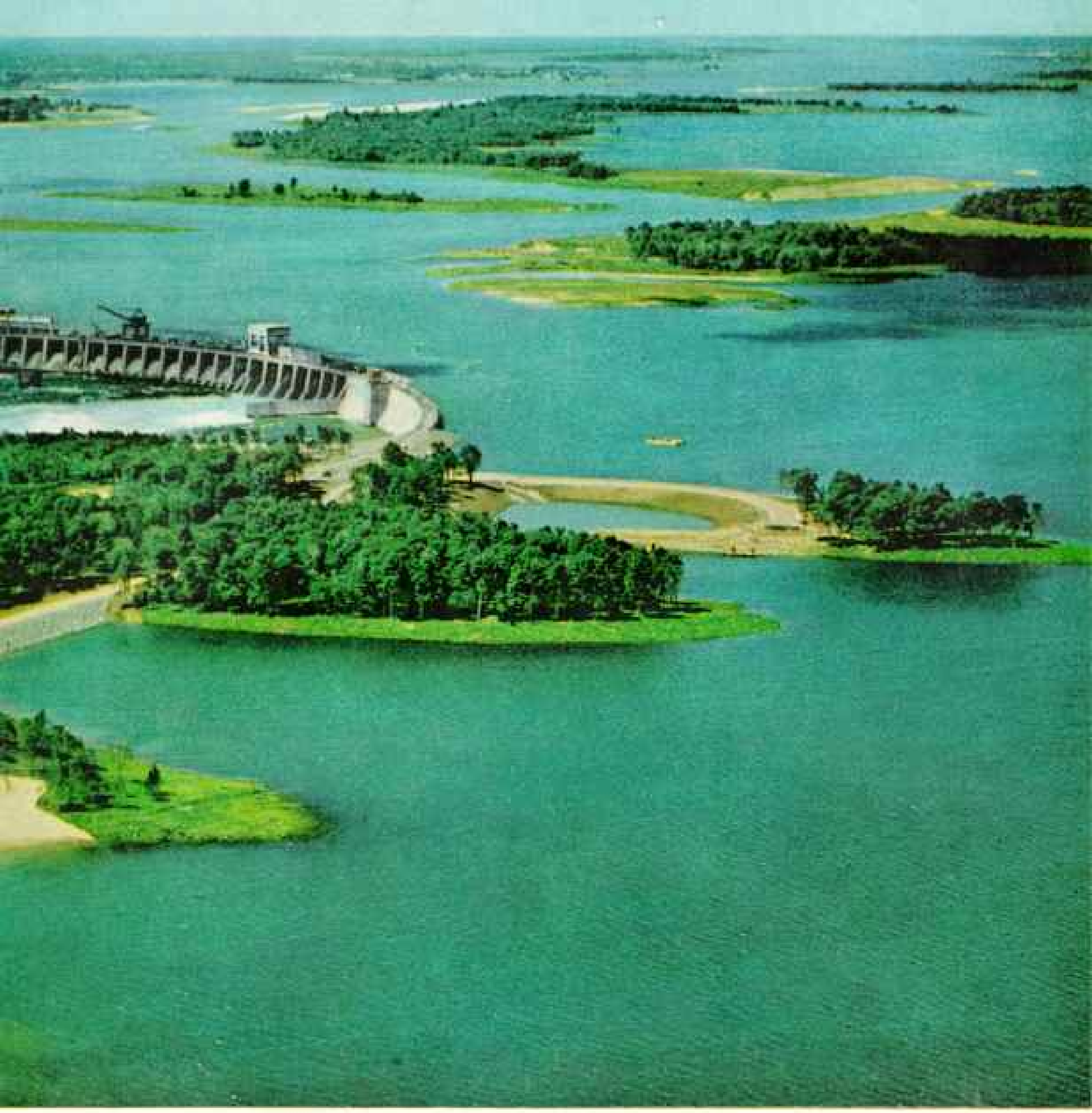
KODACHROME BY AL MELLET (ABOVE), AND E. HORNE © N.G.S.

Long Sault Spillway Dam Arches Its Back to the River

The half-mile-long control dam regulates flow of water to the turbines of Moses-Saunders Powerdam. This view looks west across Barnhart Island to mainland New York. Man-made beach (foreground) and circular boat basin line the shore.

Water rages through a dynamited cofferdam. Moses-Saunders and Long Sault, plus 21 miles of dikes, captured the water to create 38,000-acre Lake St. Lawrence (opposite).

Rising waters block a road near Massena. Motorists stop for a dip.




ROAD CLOSED

At Iroquois Lock, before river traffic started using it, I climbed into the yellow-brick control house one day and watched the lock fill and the upper gate swing open.

"O.K., we'll let this ship go now," said lock superintendent Thomas Henry McCaffrey. "Give it about four minutes to clear the gate."

There was no vessel in the lock and none in sight.

"You act as if a ship is going through," I remarked.

"Can't you see it?" McCaffrey turned puzzled eyes on me, but I caught a gleam of fun. "That's a Canada Steamship tanker. Just painted, too."

I looked sheepish, I'm sure. Of course. A dry run!

Cofferdams Bared River's Bed

Winter or summer, night or day, the builders' most relentless and toughest adversary was the river itself. Near Massena I stood looking at the St. Lawrence with Martin W. Oettershagen of the U. S. Saint Lawrence Seaway Development Corporation. In front of us the water swirled majestically around the head of Cornwall Island.

"The St. Lawrence commands respect," said Mr. Oettershagen quietly. "It's big and strong and single-minded about where it's going, and how fast. Men and machines have shoved it this way and yanked it that—and we've had some reasons for pride in what's been done. But in the end, we know it's the river who's boss."

To build locks and power plants, to dig channels and pile up dikes, engineers often had to shunt the St. Lawrence aside and dry up its bed. Their working tools were dikes and temporary barricades known as cofferdams, made of steel and earth, or just earth.

In widening and deepening the river, new channels slashed across points and through islands. Chunks of dry land up to a quarter of a mile wide were ripped out, not just to water level but to full channel depth. At these places, contractors left earth in a rim around the edges to hold out the water when digging got below river-surface level.

When the excavation was done, shovels and dredges plucked away the rim dikes to flood the hollowed-out areas, and the St. Lawrence flowed deep and straight where capes and islands formerly bent its course (page 320).

Channel Dug, Wells Go Dry

Pumping the riverbed dry sometimes had odd side effects. To dig the Seaway channel opposite Montreal, engineers ran a dike up the stream about a quarter of a mile from shore, and drained the water from behind it (page 331). Promptly they got complaints from householders along the bank: Their wells had run dry. Canada's St. Lawrence Seaway Authority bought each home a tank and started water trucks on regular deliveries.

The naked river bottom had a fascination for visitors—like the attraction of the sea floor for divers. When Long Sault Rapids were drained, people clambered down to inspect huge boulders and ledges of rock worn velvety smooth by centuries of pounding waters (page 319). They found impressionistic sculptures and kettlelike potholes carved by water and gravel. They also found rusted anchors.

A Canadian boy stumbled on a dozen pitted cannon balls, probably dropped early last century from a wrecked supply boat. He gave one cannon ball to a local Highland regiment, and kept the rest.

Helicopter Plumbs the Rapids

Engineers had to know exact river depths in order to sink dam footings and bridge piers. In some areas turbulent rapids made sounding from boats impossible.

Into such rushing waters Canadian engineers dangled a sounding line, weighted with 60 pounds of lead, from a hovering helicopter. Radio-linked surveyors manned three transits spaced alongshore. They made simultaneous readings on a marker placed 50 feet up the airborne sounding line as the lead-weighted end touched the river bottom.

By moving the copter and lead line from

Snell Lock's Wafflelike Gate Holds Back a 75-foot Wall of Water

A miracle of engineering, the four-foot-thick hinged leaves resist pressures of 9,000 tons, yet move with a watch's precision. Just as a dam arches against a current, the gate bows against the reservoir to prevent collapse. During its first month of operation Snell locked 1,006 ships—more than one an hour—in and out of Wiley-Dondero Ship Channel (page 329). The 860-foot-long U. S.-built lock can accommodate two small ships in tandem. Orange and yellow paints resist rust.

Iron ore spouts from conveyer belt to ship at Sept Iles, Quebec, shipping point for vast fields developed since World War II. Canal authorities believe high-grade ore for Great Lakes furnaces will account for a third of all Seaway tonnage. The conveyer moves from hold to hold on dockside rails.

Molten aluminum streams from crucible to pig molds at Aluminum Company of America's Massena smelting works. Men sweep skim from the silvery liquid, which reaches temperatures of 1,600° F. Alcoa and neighboring U. S. industries will absorb a quarter of Moses-Saunders Powerdam's output.

place to place, successive readings were obtained that gave an accurate profile of the riverbed in the rapids area.

From the Thousand Islands' tiny Jewel Island, cut in half for channel widening, downstream to the metropolis of Montreal, floating dredges bit, sucked, and plucked at riverbed shoals and at islands and capes that were in the way. Like atomic submarines, the big dredges stayed "at sea" on the river for months on end. Rotating crews worked them 20 hours a day. Lighters and tugs brought out supplies and shuttled operators to and from shore.

To hold themselves in place, the dredges lowered vertical steel pillars, called spuds, into the riverbed. This gave solid, immovable support that anchors alone couldn't provide.

The present tense would be more appropriate, in a way, to tell about the slow-seeming but miracle-working dredges. Many of them are still at work and won't leave the St. Lawrence until 1960.

Dam Built Half at a Time

The most colossal piece of river juggling took place in the International Rapids section of the river during construction for the hydroelectric plant.

"Fortunately, right here where the St. Lawrence makes its steepest plunge, the river flows around Barnhart Island," Frank Matejka pointed out, as we stood atop Long Sault Spillway Dam (page 320).

"The north channel was blocked off with temporary dams while the power plant was built there," he said, pointing past the head of Barnhart Island (map, page 307). "That sent the whole river crowding through this south channel.

"To build Long Sault Dam here with all that water flowing through took some ingenious engineering. We shoved the river to one side with cofferdams, while we dug for bedrock and built half the dam. Then we sluiced the water through gates in the erected portion and went to work on the other half."

Meanwhile the 2½-mile reach of the north channel was emptied between its two cofferdams. The downstream one, of earth and steel, stretched out for four-fifths of a mile and rose 75 feet from its deepest foundations—the greatest cofferdam of its type ever built. Pumps drained millions of gallons of water from between the dams.

"Then," Mr. Matejka explained, "on the dry ground we erected the Moses-Saunders powerhouse dam, a single structure, but built half by Canada and half by the U. S."

All the International Rapids power work was shared by the Hydro-Electric Power Commission of Ontario—Ontario Hydro, for short—and the Power Authority of the State of New York.

On the first of July last summer—Canada's Dominion Day—I was invited to see the ceremony that officially marked completion of the first stage of the new power plant (page 339). It was to be a noisy affair: 30 tons of explosive would blast out the upstream cofferdam—the lower one was already half removed—and unleash the flood that would start the generator turbines spinning.

New Lake Created in Three Days

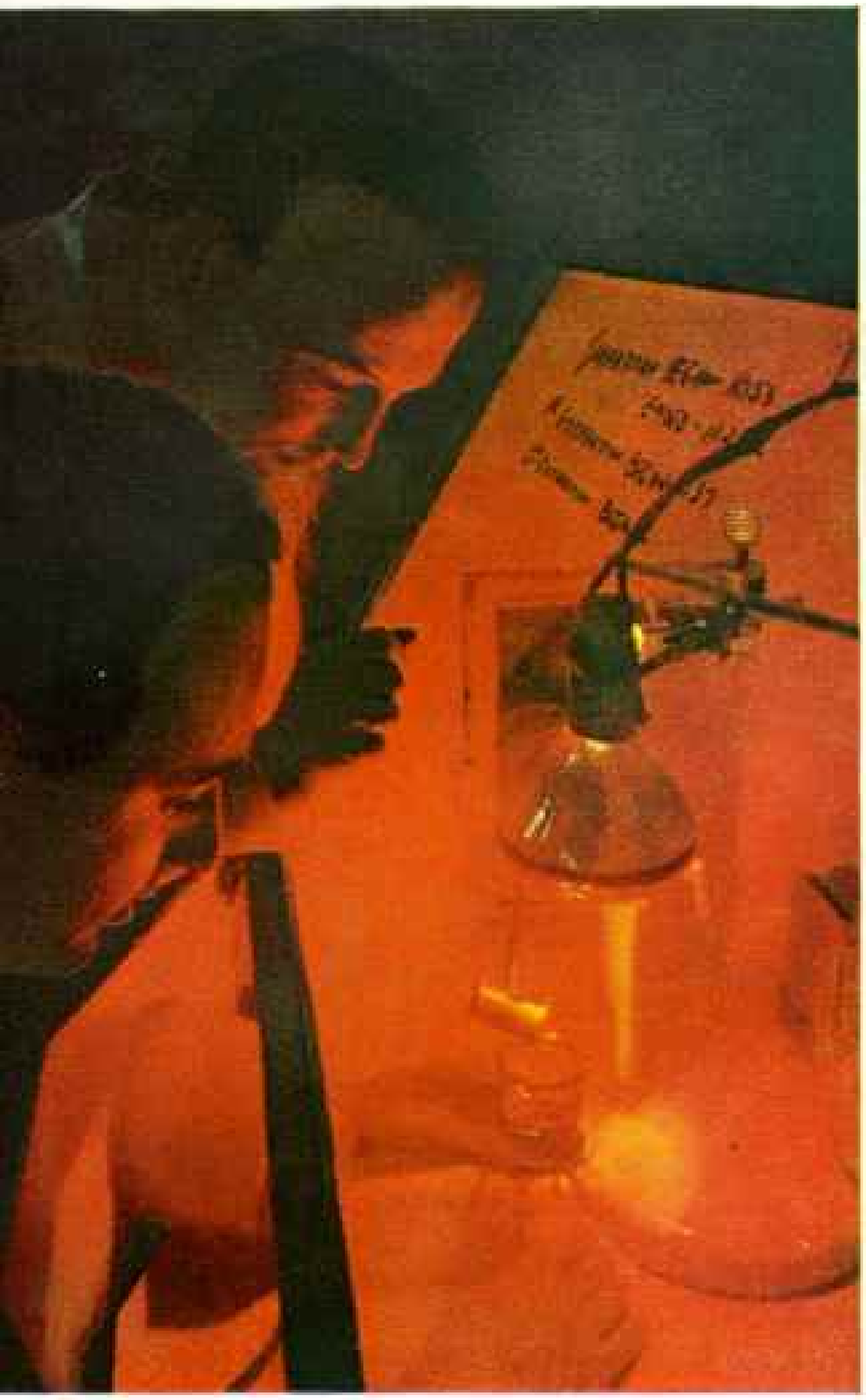
On the morning of the blast crowds blackened the dikes on the Canadian side of the barren basin. At the Canadian-U. S. border in the middle of the powerdam, officials of both countries exchanged compliments. Then, precisely at 8 a.m., the broadcast countdown reached "Fire!" Geysers of mud and sand erupted as the blast ripped wide gaps in the temporary earth dam. The river, surging through the cuts, soon washed out the rest of the dam (page 320).

An hour passed before the swelling, debris-laden torrent reached the wall of the power-plant dam. The pool deepened swiftly. Within three days new Lake St. Lawrence backed up over a total area—former river surface and erstwhile dry land—almost as big as the District of Columbia. New islands took permanent shape; waves washed virgin shores. And finally, at the end of the third day, the gates were opened and the generators started spinning.

Nations Make a Mighty Investment

Today Moses-Saunders Powerdam, spanning the river between the United States' Barnhart Island and Canada's mainland, already is delivering about half its total planned output of power. When all generating units are installed, it will normally drop the whole flow of the St. Lawrence through 32 turbines. At a head of 81 feet, this intricate fabrication of steel and wire, throbbing conduits and whirling turbine runners will develop up to 1,880,000 kilowatts of electricity (page 338).

To reshape the St. Lawrence in this grand manner has eaten up vast sums of money. The



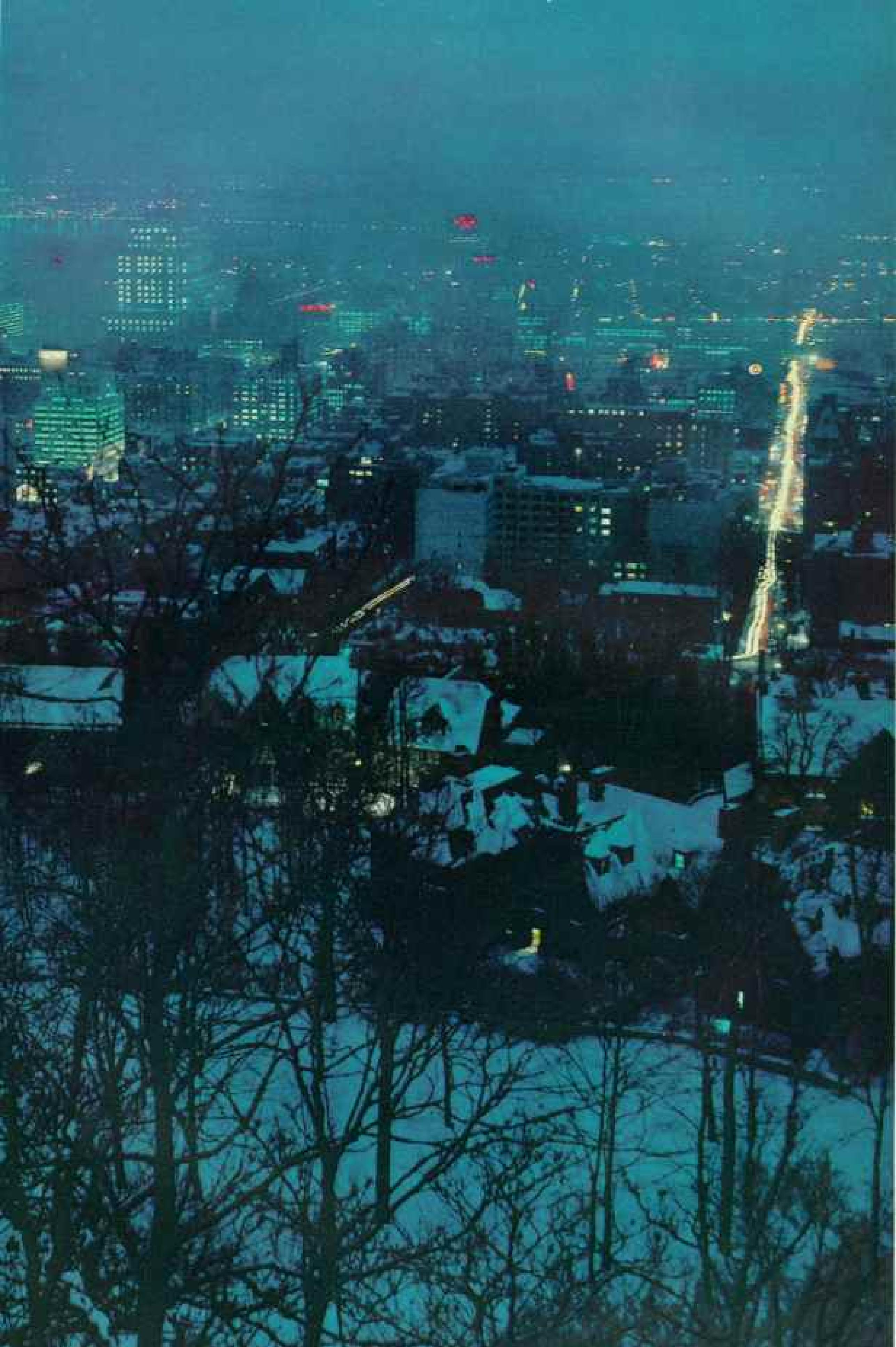
Infrared rays' eerie glow bathes scientists studying radioactive materials. Prof. Leo Yaffe (background) of McGill University's Radiation Chemistry Laboratory, Montreal, shows a student how to use a dry box, a miniature laboratory that reduces contamination. Infrared rays rapidly dehydrate the materials. Symbols penciled on the glass shield record steps of the experiment.

Montreal Spreads a Mosaic of Light Beside Its Lifeline, the St. Lawrence

More than 800 miles of river separate Canada's largest city and chief port from the sea. For years large ocean-going ships, barred by the Lachine Rapids immediately above Montreal, unloaded cargoes in the harbor for transshipment to the Great Lakes. Residents predict that the Seaway, far from diminishing Montreal's role, will bring more trade.

This wintry view from 763-foot-high Mount Royal looks toward Victoria Bridge. Sun Life Building towers in center. Royal Bank of Canada and Bell Telephone buildings rise at far left. Guy Street traces a bright streak at right.

ANSCO FILM BY MALAK (RIGHT) AND KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER HARRY E. RIESER © N. G. S.



power construction, evenly split between the Ontario and New York power agencies, cost $650,000,000. Interestingly enough, this outlay surpasses by $180,000,000 the total cost of all the rest of the Seaway work combined.

"What's divided between Canada and the United States is not the power but the river itself," an engineer reminded me. "At full output, the 16 turbines of each nation's power plant will get exactly the same amount of water. If one country gets more juice out of its share than the chaps across the line—why, more power to them!"

Last Fourth of July, the first cargo ships passed upbound through Snell and Eisenhower Locks, overcoming the powerdam drop and entering Lake St. Lawrence. Scaled to fit the old shallow-draft canal system, they lifted through the locks in pairs, dwarfed in these concrete canyons built to hold ships many times larger (pages 304 and opposite).

At the lower guide wall of Snell Lock I stood with Lewis G. Castle, Administrator of the Saint Lawrence Seaway Development Corporation. We were watching ships awaiting the green light to make first passage through the new Seaway section (page 300).

Dwellings Moved from Drowned Villages

"This is truly a day of gratification," said Mr. Castle. "After four years of work and frustrations—and successes, too—we are seeing our dreams and hopes fulfilled.

"Now we'll know how well we've done our job. Ships will move through the new locks and channels 24 hours a day, until the navigation season closes early in December. Maybe 5,000 vessels will go past in that time."

Mr. Castle was right. In the five remaining months of St. Lawrence navigation in 1958, the new facilities handled 5,289 ships.

When the course of a great river is changed, so, inevitably, is the course of life along its banks. The impact of the Seaway on the people who live near it has scarcely begun to be felt. The growth from a peaceful pastoral valley to an industrial complex will require years, but it will come; abundant electric power and easy access to world shipping assure the long-term change.

But part of the impact was immediate. On the Canadian bank above the powerdam, Lake St. Lawrence obliterated seven whole villages which once had houses and churches and stores, and rather picturesque names: Aultsville, Farran Point, Dickinsons Landing, Wales, Mille Roches, Moulinette, and Iroquois. Morrisburg was partly inundated. In all, 6,500 people and 525 homes were moved.

Most single dwellings were moved, before inundation, from the doomed villages to the orderly blocks of Long Sault, Ingleside, and new Iroquois, built from scratch, and to Morrisburg. In addition, Ontario Hydro built rows of new duplex home units.

Morrisburg lost its fine old waterfront; in fact, the entire business section made a fresh start on the north side of town, where I called on Mrs. Florence Casselman. Her half-timbered brick-and-stucco home had been moved a quarter of a mile (page 330).

Old Residents Learn New Directions

Brisk and busy at 87, Mrs. Casselman served me tea in a cup banded with gold, china used at her mother's wedding in 1854.

"It really hasn't been bad, being moved," said Mrs. Casselman cheerfully. "You can't expect the world to stop changing just because you're getting old."

Morrisburg's shopping center is shiny and new. At the Crest Hardware Store I talked, between customers, to salesman Roy W. Geach. I asked him if I might see his house in its new location.

"You'll have trouble finding it, I guess." He smiled as he spoke. "I keep forgetting the name of the street. Beckstead, yes, that's it. Beckstead Road.

"We still don't have many road signs, and there are no permanent street numbers yet. But you take the first left and the third right and the first left . . . or is it the second right? The place is so new, sometimes I get lost myself!"

Buoy Floats Above Indian Graves

Before riverside lands went under for the last time, salvage went beyond the saving of dwellings and possessions. Graveyards were dug up and removed to new consolidated cemeteries. An archeological party led by Dr. Norman Emerson of the University of Toronto raced rising water to explore ancient Indian sites at Ault Park on Sheek Island. Ontario Hydro loaned loaders and tractors to speed the work. Dr. Emerson found decorated pottery, domestic utensils, and tools. He uncovered, too, 40 cremation burials sprinkled with red ocher by the Point Peninsula people who lived here 3,500 years ago.

"Now there's 14 feet of water over our

REDACTIONNE BY ANDREW H. BROWN, NATIONAL GEOGRAPHIC STAFF © N. G. S.

Pennants on a Snub-nosed Pulpwood Boat Salute the Opening of Snell Lock

Proposed tolls, scaled to pay for the Seaway in 50 years, favor bulk cargoes such as coal, iron ore, pulpwood, and grain. Owners will pay their bills after ships pass through the waterway. *Manitoulin*, second customer at Bertrand H. Snell Lock, "hangs out the wash," a seaman's phrase for flying bunting.

digs," Dr. Emerson told me. "Only a floating buoy marks the site."

One day Edward Place of the Saint Lawrence Seaway Development Corporation took me to a lonely spot on the New York shore north of Massena.

"Under that bay lies the Tracy farm that gave its name to Tracy Landing," Ed said, "and over there is what's left of Long Sault Island.

Swinging a Bridge of Ice

"The river was so swift here it didn't freeze over in mild winters, but heavy ice formed alongshore. On a real bone-chilling day, a gang of men would cut loose a strip of shore-fast ice, a piece just long enough and a bit more to span the channel to Long Sault Island. They'd moor the lower end by posts and ropes to the mainland, and then let the current swing out the upstream end.

"When the far end of the frozen raft struck the opposite bank, it would freeze solid to the shore ice," Ed told me. "Then, as long as thick ice stayed, horses and sleds could go back and forth between the island farms and the mainland. They called it 'swinging the bridge.' "

Towns and factories on both sides of the border already have put to work the kilowatts pouring from Moses-Saunders Powerdam. Some of the U. S. power will go as far as the Mohawk Valley and Vermont.

Industries in Massena and its vicinity will use half the U. S. share of Moses-Saunders power, mostly to make aluminum. The people of Massena, incidentally, have a particular interest in the dikes along the edge of Lake St. Lawrence. Their business section is as much as 33 feet below the surface of the newly created lake.

Aluminum making seeks out sources of abundant, inexpensive electricity. It takes 10,000 watts to smelt a pound of the metal.

The Aluminum Company of America built this country's oldest operating aluminum smelter in Massena in 1903. Today Alcoa has two plants there and is producing aluminum ingot; wire, rod, and cable; and a wide range of structural shapes (page 324).

Don E. Paro of Alcoa handed me a bunch of gossamer-thin aluminum filament 1/2500 inch in diameter. A single foot of aluminum rod only three-eighths of an inch thick yields four and three-tenths *miles* of this spider-web wire, mostly used for one-ampere fuse wire and cross hairs in military and scientific optical equipment.

Ed Place took me to see Reynolds Metals Company's new $88,000,000 aluminum smelting plant on the riverbank seven miles east of Massena. Soon the smelter will be trucking liquid aluminum hot from the pot lines to a new Chevrolet foundry next door for casting into aluminum pistons and transmission parts.

The industrial and trade giant of "Seaway Valley" is, of course, Montreal, eastern gateway to the new waterway (page 326).

House on wheels, the last of 525 Canadian homes to escape the new waterway, rolls through Morrisburg, Ontario, on a mammoth trailer. Moving was done so smoothly that some householders left their china safely on kitchen shelves.

A newly dug channel bypasses Mission St. Francis Xavier on the Caughnawaga Indian Reservation, Quebec. Seaway surveyors took pains to spare the 232-year-old building behind Father Henri Béchard.

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

Water-borne Congregation Jams Half Moon Bay's Open-air Church

Boaters from near-by Gananoque throng an inlet scalloping Yorke, one of Canada's Thousand Islands. An organist plays beside the pulpit, a rock facing the bay.

Montreal is getting set for a trade boom, despite the obvious fact that many cargoes formerly transshipped there for forwarding to Great Lakes ports now will be carried right on past.

Part of the new business will be natural growth, Montreal's commercial experts say, but part will reflect the stimulus from burgeoning Seaway traffic.

"Salt-water shippers declare that the Seaway will bring the ocean to the Lakes," Raymond Vaillancourt of the city's St. Lawrence Municipal Bureau told me. "True, but some of us think its biggest success will be in bringing the Lakes to the sea. Montreal will be a natural turn-around point for big lakers and ocean vessels."

Canada's National Harbours Board is spending $57,000,000 to extend the port's wharves, dredge a new turning basin, build new grain elevators, and enlarge present grain-handling facilities. The Seaway will mean tremendous savings in grain shipment, perhaps four to five cents a bushel or more, between Lake Superior and Montreal.

Europeans Eying Seaway Shores

From the Panorama Room atop Montreal's new Queen Elizabeth Hotel, Mr. Vaillancourt pointed southward across the St. Lawrence, beyond the new Seaway channel, to riverside land that up to now hasn't supported much but cows. "There's our new industrial frontier," he said.

He told me of a French financier and developer, Joseph C. Pardo, who bought thousands of acres of south shore property a few years ago, and now has sold big tracts of it to such industrial giants as the Dominion Steel and Coal Corporation, Ltd., the Steel Company of Canada, Ltd., and A. V. Roe (Canada) Ltd. French, German, Belgian, Italian, and Swiss interests, I was told, also are digging in.

Not all the riverside development is industrial, of course. I joined a party on a cook-out one night in New York's new St. Lawrence State Park, centered on Barnhart Island. Robert Moses, of New York City park-development fame and now Chairman of the Power Authority of the State of New York, personally directed laying out its picnic groves, swimming beaches, and boating marina (page 320).

A constant procession of visitors came to see the new dams, locks, and power plants in Seaway Valley during construction. Fine recreation facilities, Mr. Moses believes, will increase the valley's appeal to tourists.

Upstream, Canada's ambitious park program features relocated old homes and farm buildings in Crysler Memorial Park, and a scenic highway, Long Sault Parkway, that leapfrogs along a chain of new islands.

As the Seaway has been difficult to build, so will it require experience to navigate. Trained pilots will be available to guide ships past the hundreds of channel markers and range lights leading like signposts to Lake Ontario.

Pilots Serve 5-year Apprenticeship

Wilfrid Ménard, Secretary of the Association of Licensed Pilots for the Harbor of Quebec and Below, told me that all ships larger than 2,000 net tons will normally employ pilots on the lower river. Four associations share river pilotage duties between Pointe au Père, Quebec, 200 miles up from the St. Lawrence mouth, and Kingston, Ontario, at the river's outlet from Lake Ontario.

"Some lines, like Cunard, Canadian Pacific Railway, and Canada Steamship Lines, have their own pilots," Ménard told me. "Pilotage for ships on the St. Lawrence isn't required—but on the lower river payment for pilotage is compulsory, so you might as well accept the services of an experienced man!"

Ménard said that the typical pilot rarely achieves full status until he's 30. To qualify as an apprentice, a candidate needs to show first mate papers in coastwise shipping, or a second mate ticket on an international run. During his five-year apprenticeship, he must make at least 40 trips a year with a qualified pilot. Once accepted as a pilot, he makes as many as three or four runs a week.

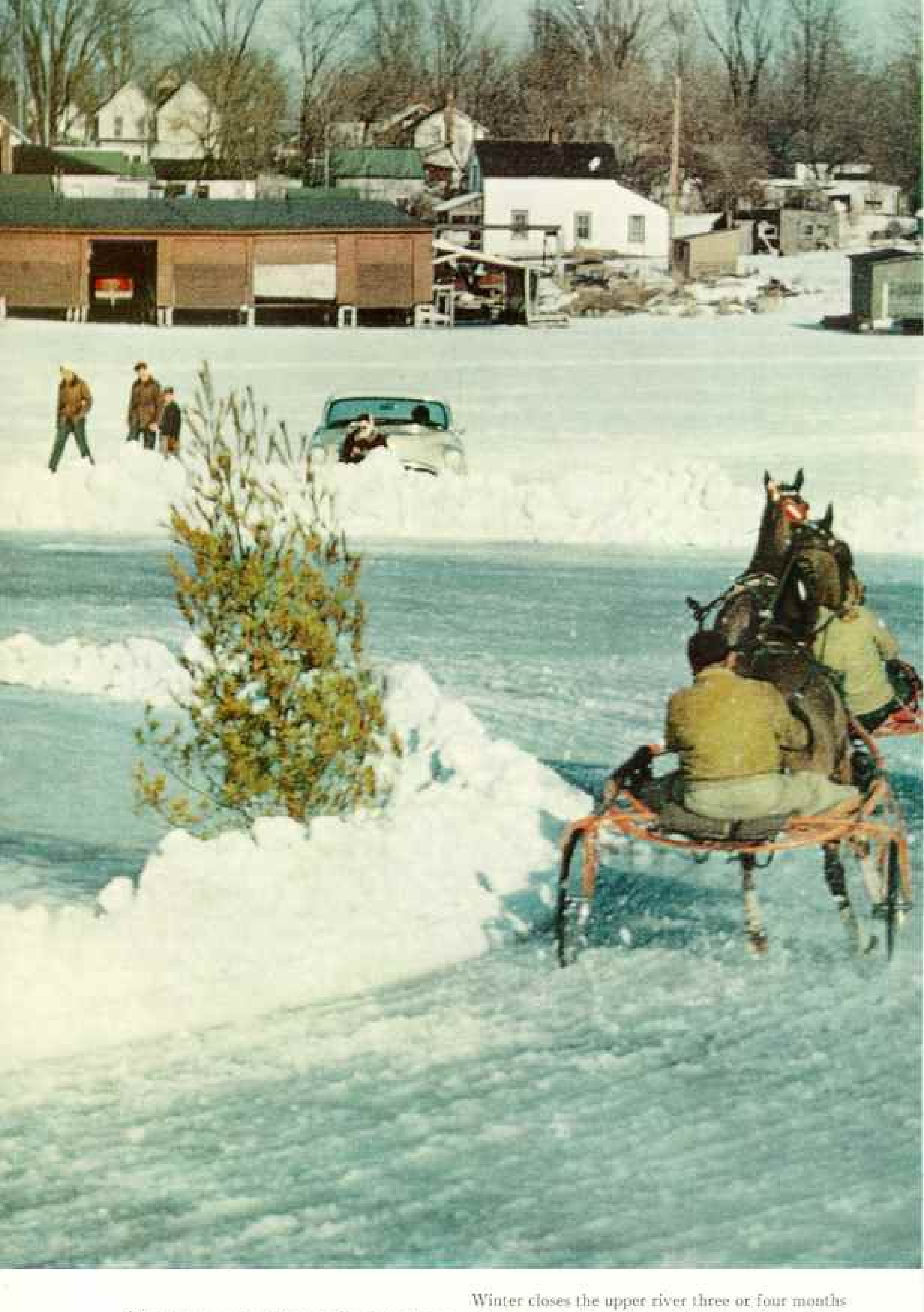
"Does the ship captain stay on the bridge with the pilot?" I asked.

"He doesn't have to," Ménard answered, "but generally he does, most of the time. You see, the ship's captain always has the final responsibility, pilot or no."

Father and Son Both Pilots

I visited a veteran pilot, 63-year-old Charles-Auguste de la Chevrotière, at his home in Lotbinière. It was Sunday, and a score or so of children, husbands, wives, and grandchildren were having a family get-together.

Being a pilot obviously was good employment: Mr. de la Chevrotière's clapboard



Trotters on the Frozen St. Lawrence Raise a Hail of Slush and Ice

Winter closes the upper river three or four months of the year. Residents of Clayton, New York, lay out an offshore track in February, when ice

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

usually lies several feet thick, and bulldoze away snow. For a close-up view, spectators nonchalantly drive cars to the track's edge. Contestants come from miles around to match skills on the slippery course. Horses wear shoes with needlelike cleats. These sulkies bunch at the turn.

home was spacious, comfortable, and modern. Son André left in the middle of tea. He, too, is a pilot, and his next ship was getting close to Trois Rivières, where he was to board her.

I took a trip with Mr. de la Chevrotière on *Prins Willem V*, a Netherlands freighter-passenger ship of the Fjell-Oranje Lines. Inbound from Rotterdam, she was carrying, among other cargo, bicycles and hardware bound from Hamburg to Chicago; baler twine and machinery for Cleveland; textiles and steel ropes to Toronto. In a refrigerated section of the hold was frozen fish—caught in Denmark and then transported to Hamburg, Germany, for shipment in a Netherlands vessel to Toronto, Canada!

Though I was too early to ride a large ocean vessel through the Seaway, my trip on *Prins Willem V* gave me a preview of what 1959's much bigger ships will find. When I sailed through, only three of the new locks were in operation; so Lake-bound traffic still was limited to ships built for the old shallow-draft canals.

Between Quebec and Montreal our trim little gray craft with its yellow stack passed through the heartland of French Canada.* Bluffs walled the river at first; then shores flattened and fields led away from the banks to farms half-hidden among elms, firs, willows, and maples.

Pilot Whistles Message to Wife

The *Willem* crept abreast of Mr. de la Chevrotière's home town of Lotbinière. The pilot yanked the ship's whistle. Two long blasts and two shorts. A pause, then the same signal. Charles-Auguste looked intently at the village, and smiled.

"You see the yellow house?" he asked. "And the red flag waving at the upstairs window? That's my wife. She knows I come by this afternoon. She answers my whistle with the flag.

"I can let her know my plans with the whistle," the pilot said. "When I'm coming home, I give one long and one short blast. If I want my wife to drive to Quebec and pick me up, I make it one long and two shorts.

"The signal I blew today? It just says 'hello.'"

We passed ships of all shapes and sizes, from chunky little coasters stacked high with pulpwood to the gleaming black-and-white Cunarder *Carinthia*. Big ore boats plodded upriver, deep-laden with iron ore from the new Quebec-Labrador mines (page 324). At Contrecoeur, below Montreal, we saw one of them being emptied of its load. Conveyer belts transferred the ore to little canallers for passage on up to Hamilton, Cleveland, or Ashtabula.

Ships Less Buoyant in Fresh Water

This year many of the large ore carriers will be able to sail right on up the river, to discharge directly to steel mills with furnaces beside the Lakes.

At Montreal *Prins Willem* discharged 543 tons of cargo. The Seaway locks on the south shore of the St. Lawrence were not yet finished; so our early-morning departure upstream was through the five locks of the old Lachine Canal. Similarly, at the head of Lake St. Louis, we stair-stepped up the five old Soulanges Locks (page 310), for the new pair of Beauharnois Locks still were being blasted and cast into being.

As we sailed, Capt. Jan Leer told me the changes a seagoing vessel faces when it enters fresh water.

"Rivers and lakes are less buoyant than the ocean," he said. "A ship settles one foot deeper in fresh water than in salt for every 36 feet of draft.

"For my little ship, drawing only 14 feet, this means we float only five or six inches deeper. But, when the Seaway opens, a large ship sea-loaded to 25½ feet and going beyond Montreal will have to lighten cargo, or it won't get through the 27-foot-deep channels."

* See "Quebec's Forests, Farms, and Frontiers," by Andrew H. Brown, National Geographic Magazine, October, 1949.

Forests Moored in Midstream, New York's Thousand Islands Clog the River

More than 1,700 islands, ranging from 50-square-mile giants to uninhabited specks, stretch 50 miles along the St. Lawrence below Lake Ontario. Here engineers removed scattered shoals and sheared an entire promontory from one obstructing island. This air view surveys the Manhattan Group. Unfinished Boldt Castle, named for its builder, rises on Heart Island. Thousand Island dressing was reportedly developed by Boldt's chef. An excursion boat swings past the triumphal arch (near side) and watchtowers (far point). House in foreground perches on a rock the size of a tennis court.

AEROCHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON © N. G. S.

POWER AUTHORITY OF THE STATE OF NEW YORK

Gantry Crane Lowers a 155-ton Turbine Runner at Moses-Saunders Dam

The runners, actually propellers in reverse, convert the energy of rushing water into electricity. Workers guide the assembly onto the runner cone before lowering it into place 45 feet below. Crane operator in glassed-in cab (upper right) follows their signals. Driven by 32 such units, the dam's generators will produce 1,880,000 kilowatts.

The night before we entered Snell and Eisenhower Locks, *Prins Willem V* anchored; Captain Leer wanted daylight for his first transit through the new ship lifts (page 304).

At dawn we moved up, flying an American flag for the passage through U. S. waters.

As the lower gate of Snell Lock opened, a steel boom holding a heavy cable lifted ahead of us. It was one of the fenders that protect lock gates on both sides.

A ship out of control approaching a gate would strike the fender first. The steel carrier arm would shear apart, but the wire rope, anchored on both sides of the lock, would hold. Fender cables, three and a half inches thick, run down through bollards to a hydraulic braking mechanism in the lock walls. Each fender can absorb the shock of a ship up to 20,000 tons moving at 4.5 miles an hour. Costly but essential insurance for the gates.

In just eight minutes 22,000,000 gallons of water, fed in by gravity from upstream, raised us 45 feet. Then the upper lock gate opened, and we steamed through the Wiley-Dondero Ship Channel and Eisenhower Lock.

We overtook the ore ships *Edwin T.*

Douglass of Toronto and *Frank H. Brown* of Montreal. Downstream went the grain carrier *George M. Carl*, the tanker *Redriver*, and a trim German cargo carrier, *Transontario*.

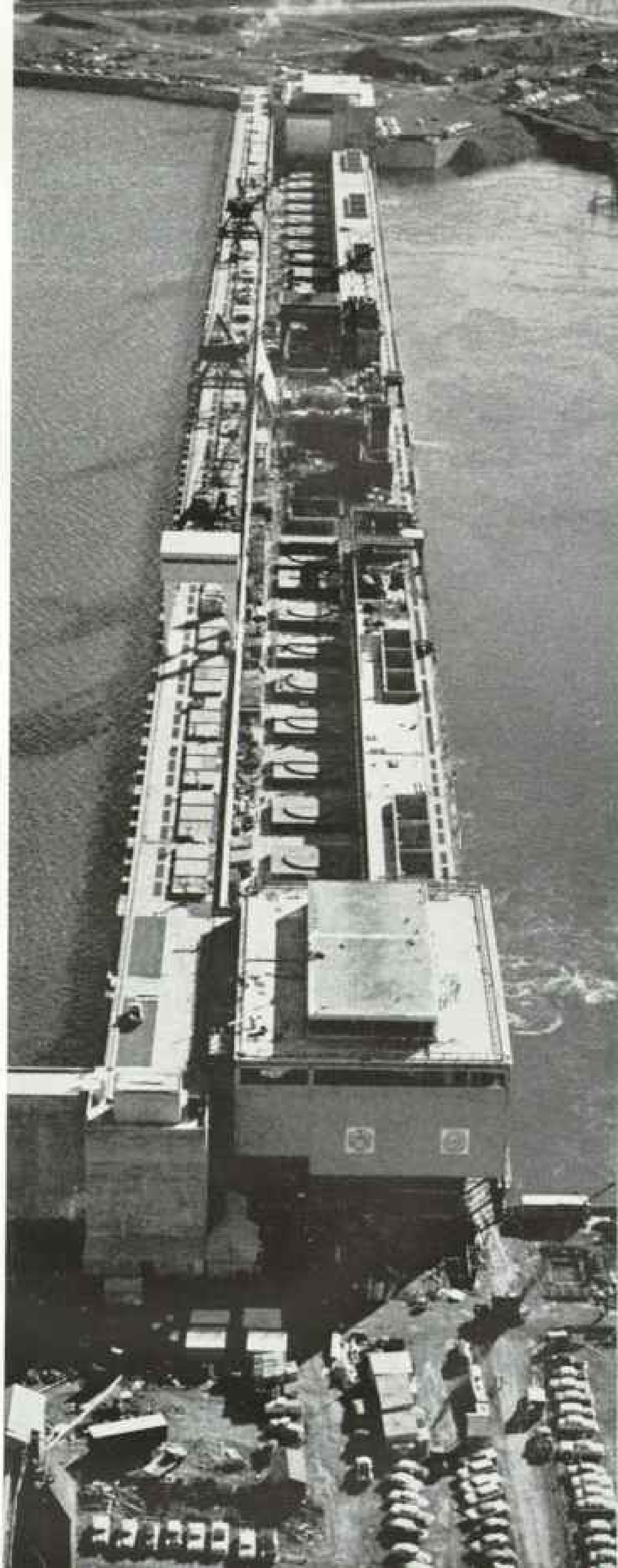
These were all ships of about *Prins Willem V*'s size, 2,000 to 3,500 tons. This year they will look small compared, say, with the Fjell-Oranje Lines' new 8,000-tonners, the first two of which are already being outfitted in Netherlands yards.

Prins Willem V escaped the last pull of the St. Lawrence current. We dropped our pilot, turned into Lake Ontario, and watched the land disappear behind a horizon as wide as the open sea.

Queen to Open Seaway

This June, residents along the Seaway shore hope to see a gleaming yacht lead a procession of ships into the new waterway at Montreal. Aboard *Britannia* will be Queen Elizabeth II and Prince Philip, on their way to the international section of the St. Lawrence. There the Queen plans to join with President Eisenhower and Canadian Prime Minister John G. Diefenbaker in celebrating completion of North America's newest deep-sea portal.

The ceremony will celebrate the first season of business-as-usual on the new sea route between the Atlantic and North America's own Mediterranean, "in the middle of the lands" of two nations which have put to better use these shared waters and, in doing it, have strengthened a fine old friendship.

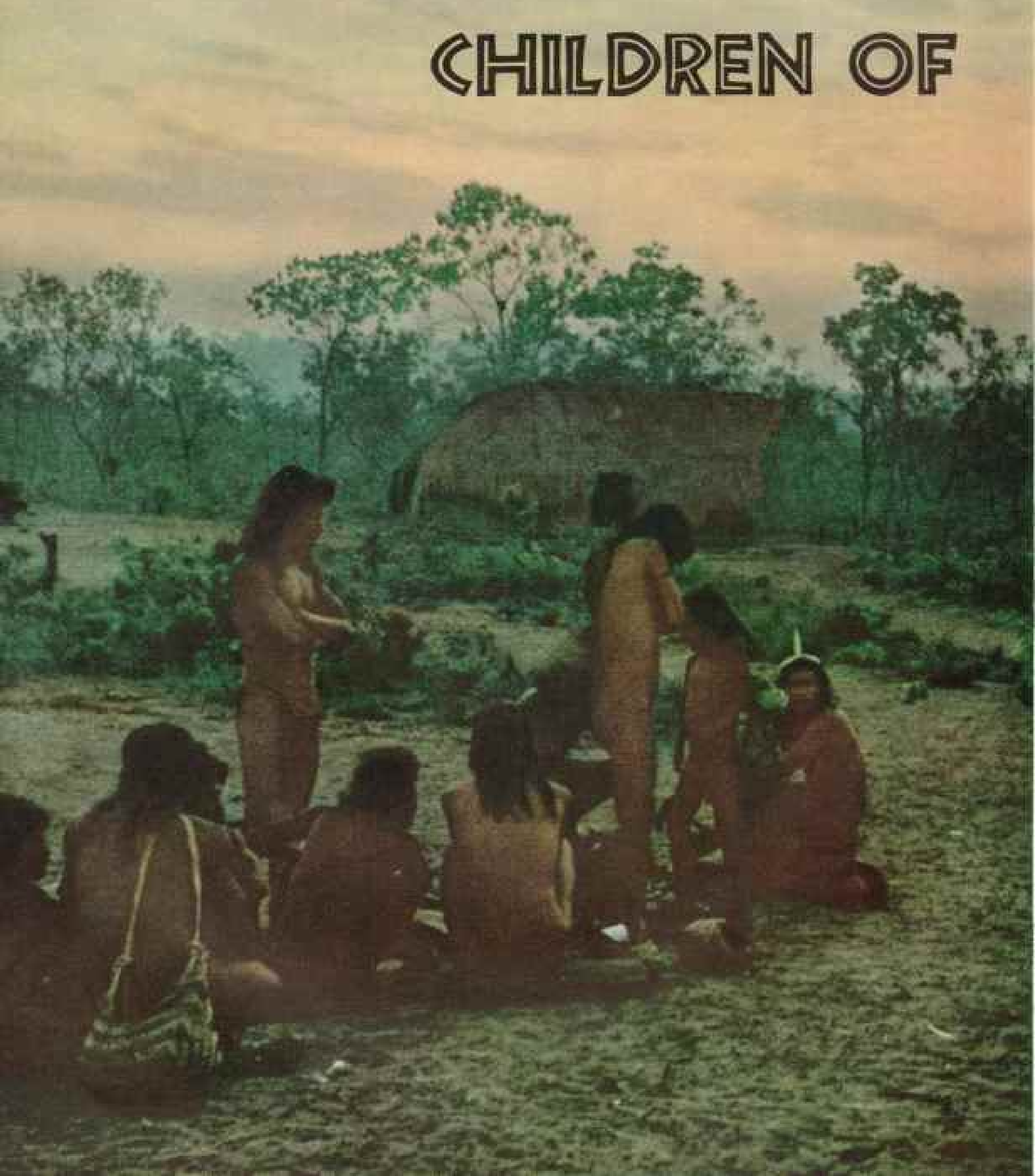


Barricading the St. Lawrence. Moses-Saunders Powerdam backs up water (left) for its 81-foot drop. This aerial view from the American shore shows round-capped hatch covers of the generating units, which the United States and Canada divide equally. Construction cranes add finishing touches. Permanent gantry cranes, riding rails set in the concrete, open and close intake gates and lift machinery. Administration buildings rise beside both shores. The international boundary splits the dam in midstream.

BRUCE HARTMAN, MAGNUM

Primitive Kraho Indians, living deep in Brazil's savanna, dance all summer, singing of nature's gifts. To train for chasing deer afoot, they run relay races with heavy logs

CHILDREN OF



ARTICLE AND PHOTOGRAPHS BY HARALD SCHULTZ

THE SUN AND MOON

Kraho Indians greet the dawn at their isolated village in Brazil. These seldom-visited aborigines wear almost no clothing, and hunt jungle game to supplement their crops of corn and manioc.

WE ARE in the heart of Brazil. It is midsummer, and the heat of the sun-soaked ground penetrates the soles of our shoes. It is now the fifth day that we have traveled on foot through the endless expanse of the savanna, always toward the east, toward the rising sun, ever farther from the fertile banks of the Tocantins carrying its turbulent waters to the Amazon (map, page 345).

Rugged rocks, coarse gravel, and fine sand alternate with rare spots of fertile land, found only where the succulent green leaves of the buriti palm, rustling in the wind, indicate that there is moisture—yes, perhaps even refreshing water from springs that never go dry.

At such places settle small cattle raisers, farmers of Goiás, immigrants from Maranhão. A scant growth of grass provides meager nourishment for the widely scattered herds of grazing cattle. The gnawed bark of stunted trees and shrubs bears witness to their hunger.

It has not rained for three months. But when the hot, dry summer ends, the heavy downpours will come, and the scorched, yellow land will be decked out in fresh green.

Here, deep in the savanna, live the Kraho Indians we would visit.

Their village, called Kenpokrekateye, has a peculiar shape. From the air it looks like a wagon wheel lying in the sand. The dwelling houses are connected by a broad boulevard, the rim, leading around from house to house. At the hub lies the village square. Straight paths leading to it from each house form the spokes of the wheel.

Raccoonlike coati-mundis slung from their shoulders, a Kraho father and son return from the hunt. Accomplished archers, the Indians use no poison on their arrows, relying on skill alone to bring down game as far away as 40 yards.

THE AUTHOR

Harald Schultz, son of a German physician and a noted Brazilian singer, was born in Brazil 50 years ago. Educated in Germany, he returned to South America to specialize in anthropology.

When not deep in the Brazilian hinterland with little-known Indian tribes, Mr. Schultz and his wife Vilma live in São Paulo, where he is Assistant Ethnologist and Chief of Expeditions for the São Paulo State Museum.

Mr. Schultz's penetrating account of the remote Kraho Indians was written for the National Geographic in German. Curtis T. Everett made this sensitive translation.

ALL KODACHROMES BY HAROLD SCHULTZ © NATIONAL GEOGRAPHIC SOCIETY

Hunter tosses a monkey onto the fire to singe off the fur before roasting the carcass. Kraho hunters turn the kill over to the tribe for distribution. Orphans, widows, the ill, and the aged share equally. Game, once plentiful, has become scarce, forcing the Kraho to turn to farming for additional food. A palm strip on the man's back proclaims a lucky hunt.

Grilled carcasses pass inspection. Indians smoke the meat over a slow fire until it becomes as hard as wood. Repeated smoking preserves it for weeks. Cooked game and a tortoise hung above the reach of dogs.

Just as a wheel is a closed structure, so is the village of the Kraho, and the village square is the true center of everything that happens. A strongly marked community life prevails in such a village, and an extraordinary sense of fairness is displayed toward every resident.

About 120 Indians live here, but at midday the village seems dead. No one is to be seen, either in the village square or on the boulevard. Soon an old woman sticks her head from a door. Seeing us, she draws nearer. She is blind in one eye and has a goiter.

"Is it thou, Vuvu?" she asks. "Hast thou finally come back? Thou hast been away so long and hast not forgotten us?"

The old woman embraces me and caresses me tenderly, then weeps loudly and plaintively—so many have died during my absence, so much has happened. It is Tui, my grandmother, who adopted me eight years ago.

"Look, Tui, little grandmother, I have brought my wife. Her name is Vilma."

Hunters Sleep Under the Stars

The men are not at the village. For days they have been hunting on the savanna. Vilma remains with the women, and I go to find the men camping near a crystal-clear spring surrounded by a grove of buriti palms.

The hunters have not built huts of leaves and branches, as they do when they bring women and children on long hunting-trips in the summer. They sleep in the open on straw mats.

Nearly every hunter has a fire under a barbecue frame of poles, on which the meat lies for smoking. At night it is stowed away in little hammocks made of two fan-shaped palm leaves tied together and hung between posts driven into the ground. In this way the meat is safe from the plundering, especially at night, of the ever-hungry Indian dogs.

Mornings, the hunters go into the forest on the banks of a stream. Others roam dry, prickly bamboo thickets.

There is game here, far from the village: monkeys, tapirs, golden hares, sloths, porcupines, anteaters, and, on very lucky days, even a wild pig or deer.

Almost all the hunters have muzzle-loaders. A few still use bow and arrow.

But the game is now too rare and shy for primitive weapons.

Formerly the Kraho hunted with long clubs. Tribal myths tell of a hero who overtook deer on the run and slew them with such clubs.

Even today the Kraho still hunt in a similar way. They drive deer over the savanna, from one small wood to another, until the animals grow weary and are easily killed. This type of hunting requires great speed and endurance on the part of the hunters.

After a fatiguing hunt in the summer sun, the hunters return to camp in the afternoon. My friend Kratchet, in whose house I shall live, has shot a tapir. Others bring in ant-eaters and monkeys.

Villagers Share and Share Alike

The animals are simply thrown into the fire to burn off the fur (page 343). Only the deer and wild pigs are skinned, because their hides may be exchanged for powder and shot.

The game belongs not to the one who killed it, but to all in common. Each hunter lays the animals killed by him on one of two great piles. Two young fellows are charged with the distribution. If a deer or wild pig has been killed, it is cut lengthwise and each half placed on a separate pile. An equal number of all other animals is also placed on each heap.

Why is this done? Well, that is very simple: the Kraho village is divided into two halves. One half comprises descendants of the sun, the other those of the moon.

According to Kraho mythology, Sun, or Pud, and Moon, called Pudlere, were two men, friends and companions, and the first human beings on earth. All Kraho are descended from them.

Each village half has a name. The sun half is called Koigateye and the moon half Harangateye. The Koigateye are also called the Stronger Ones, but that is merely symbolical. Indeed the sun was a strong and wise man, the moon stupid and sickly, but the two village halves are equally strong.

When the two young men have cut up the meat and laid it out in piles, the further distribution to all begins. The ground is covered with fresh palm leaves. Two men, one from each village half, cut up the game into small pieces. A count is made of the number of persons to share in the meat, and a like number of small piles is laid out.

Each hunter has the right to express his opinion about the division of the meat, whether one pile comes out too small or another too big. The divider heeds the criticism and corrects possible errors.

Now the real distribution begins. First, the visitor receives his share, then the oldest Indians, then the grown men, and finally the youngest. Some of the game is reserved for the sick, widows, and orphans.

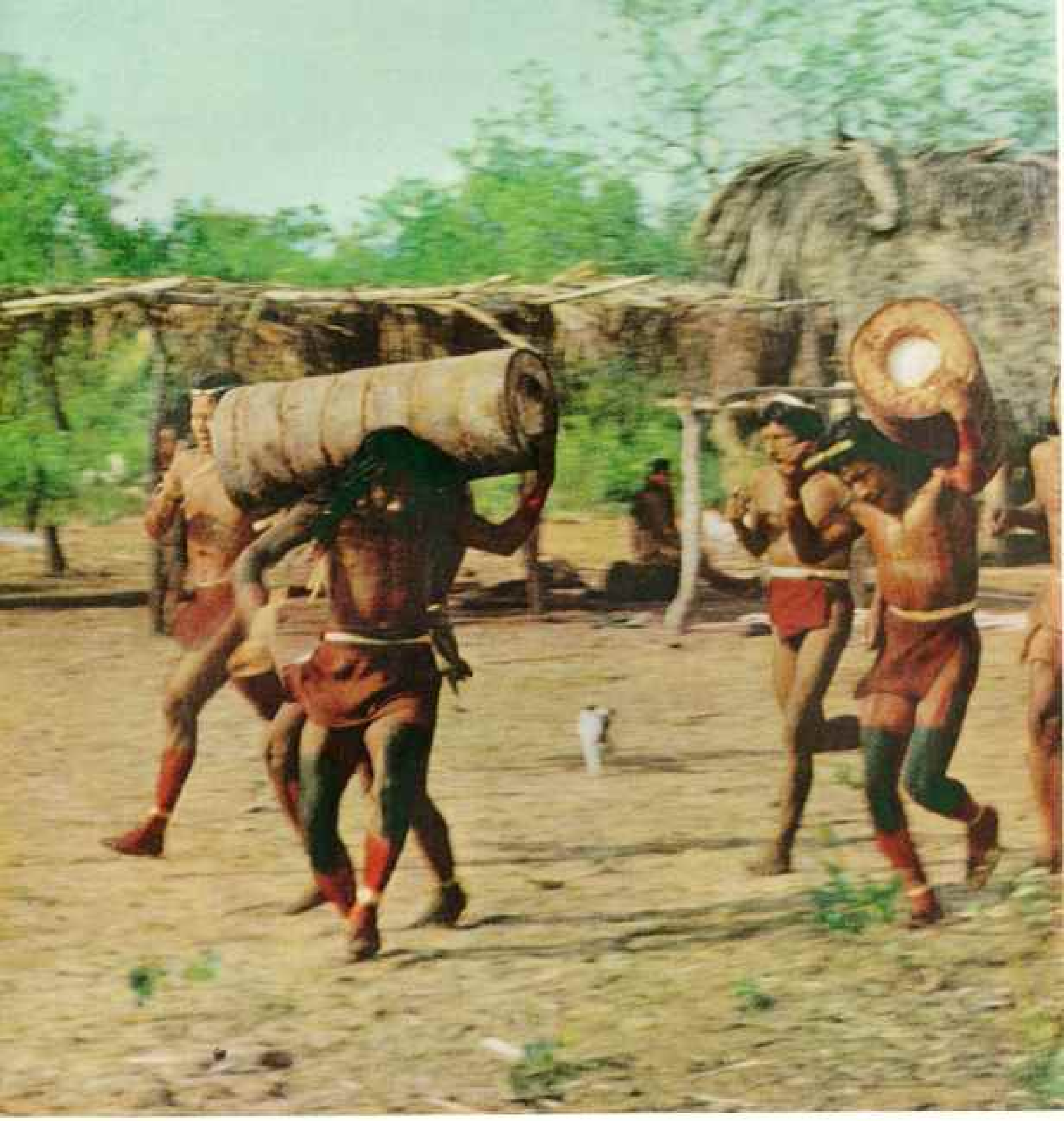
The smoked meat is stowed in hampers woven by the men. Then we head back to the village in a long file, one after the other, according to the old Indian custom.

We halt about a mile from the village. Here two young fellows go ahead. They have hewed two logs out of buriti palm and placed them on the ground beside each other.

The hunters now approach these logs. Two men place them on their shoulders, then run at top speed across the savanna toward the village. The older men carrying the baskets of meat follow shortly.

Yelling encouragement, all the boys and young men follow the log bearers in a wild dash (next page). If one becomes fatigued, another immediately takes the heavy burden upon his shoulders. He endeavors, with redoubled energy and speed, to regain the time lost in changing the log.

All the runners stake their honor on overtaking the others as many times as possible.



Indians Pass Palm Logs as Batons in a Ceremonial Relay Race

In the village they run around the clean sandy boulevard, once, twice, always counterclockwise, until the winning team throws down the log before the door of a house in which a young maiden dwells. She is the team's patroness. Many logs lie in front of her house.

The race over, the perspiring runners go to bathe in a near-by brook.

Relay log racing is the sport of the Kraho Indians: without it, life would be unthinkable. It would be equivalent to the social and economic collapse of the tribe; this sport, in competition between various groups, is a constant incentive to an animated social life.

The Kraho believe that the sun and moon invented the log race, a semireligious sport practiced on holidays and at the end of hunts. Teams

How the Log Racing Began

"Javu," I ask, "who introduced log races to you Kraho Indians?"

"Ah, Vuvu, that was a long time ago," he replies. "Our first ancestors, the sun and the moon, did that when they were the only human beings on earth. Pud and Pudlere went hunting daily, and when they met on the savanna after the hunt, they left the game be-

carry ponderous logs two and three miles, each man taking a turn as the previous bearer tires. Villagers sometimes shoulder hollowed timbers representing souls of the dead. Here two teams sprint for the finish line. Each will drop its log at the door of a patroness, a young girl.

hind in baskets. They hewed out buriti logs and ran a race with them to their homes. At that time there was no one but them. Hence, as they ran over the savanna they encouraged each other: 'Hey! comrade, run!' That was silly, but there was no one else there who might call out to them. Then they went back to fetch their baskets.

"That is the way they ran then, and that is how the Krahó do it even to this day."

Every day, after work in the fields, after a hunting trip, or on holidays, racing with the palm logs is organized. The weight of the logs ranges between 20 and 200 pounds.

If the Koigateye take a notion to anger the Harangateye, or vice versa, they say mockingly: "Hey, you weaklings, you are not good enough to run with a heavy log!" Then the others answer: "You'll see, all right!" On the following day two especially heavy logs are hewed out. Frequently they have to be dragged along by two bearers.

Then when the supple young runners whiz around the boulevard with their heavy logs,

the girls peer through the straw of the houses. Mothers and aunts stand at the entrance. They rejoice over their young men and speak with pride of their athletic prowess.

No one is the champion of log racing. Each youth is merely expected to be capable of athletic accomplishments. Indeed this goes so far that sickly youths who cannot take part in the village's athletic events are brushed aside by the others with biting scorn: "Look at that fellow—he is a weakling!"

The smallest boys are not allowed to run with the others, though that is certainly their greatest desire. As soon as the older youths have finished running, the youngsters pick out small logs and away they go around and around the village.

Youths are first permitted to log race at 12 to 15 years of age. When a man has passed 35, he is eliminated. Then he must help carry the baskets of game from the hunt.

The chief purpose of log racing is the physical training of the young Indian. Living on the broad savanna, the Krahо must journey far to hunt. Large game must often be rushed back to the village in a single day, to prevent spoilage.

Log racing is also associated with Krahо religious beliefs. On certain occasions the Indians carry small hollow logs which weigh no more than 20 pounds and are said to represent the souls of the dead.

Even Women Race with Logs

At the beginning of the summer and winter log-racing cycles, two unusually large but hollow logs are laid side by side in the center of a square far out on the savanna. Two masters of ceremonies dance around them, singing songs and ritual formulas known only to them, as if charming spiritual forces into the logs. Then the men start running to the village with the logs.

Shortly after the men have arrived, the women leave from the same great distance, but they carry smaller logs. The women's races take place only on special social or religious occasions. At the close of a race cycle, impressive ceremonies are performed. The honor girl of the teams is the principal personage on these occasions.

In addition to sports, the Krahо like singing and dancing.

It is dawn in the village square. The little fires, near which unmarried males are lying nearly naked on straw mats, have burned low. Shadowy figures move about. The horizon is just beginning to grow gray (pages 340-41). Now the beat of the dance rattle begins to resound and a melodious voice rings out. The sandy ground trembles with the stamping of feet. At first the beat is slow, dragging, and the voice soft and hesitating, gradually becoming faster and faster, until song and rhythm fill the growing morning.

The voice is that of the village song leader and choir conductor. He dances with leaping step in the village square. A deep contralto comes in, the voice of the best singer of the village. She is a young woman, famous because of her beautiful voice. She wears a wide red sash diagonally across the breast and back, a badge of honor. Soon the village's second best singer, another woman, joins in.

As soon as the song leader's first notes are intoned, the two women must come, arising from warm beds or interrupting their housework, for their presence is an incentive to all

women and girls to come to the singing on the village square. Soon the many-voiced five-toned chorus swells forth in the coming morning or the falling night. The young men dance with a hopping, running step back and forth in front of the women and girls in a long row facing east.

The singing ends with the first rays of the sun. The women singers return to their houses. Then the whole population proceeds in groups to the bathing place. The Koigateye bathe downstream, the Harangateye higher up, and the women still farther upstream. All wash themselves thoroughly, rubbing bodies and hair with clean sand and then splashing about in the cool, clear water.

A gentle breeze blows over the savanna. Some boys have brought dry palm leaves taken from the roof of an abandoned house. Fires flare up briefly and die down. Naked groups stand around the flames with raised arms, warming themselves and drying their bodies.

The day wears on with work in the fields, with hunting and log racing, with dancing and games in the village square, until evening comes. The song leader dances to his own singing in wild leaps to the rhythm of the gourd rattle. Soon the women and girls form a long row. They swing their arms and rock their knees in time to the music, and their beautiful singing fills the solitude of the spacious savanna night.

Singing in the Wilderness

The songs of the Kraho are beautiful even to our ears. Some resemble medieval religious songs in cadence and melody, others are like love songs, and still others have the quality of a marching song.

One song after the other is sung without interruption; an outsider might not understand what is taking place. The conductor

Unmarried Males Sleep in the Village Square. A Campfire Warms Their Feet

Builders Prepare a Thatched Hut for the Author and His Wife

Villagers housed Mr. and Mrs. Schultz in a hut temporarily abandoned after a death in the owner's family. Fresh palm-leaf siding will turn its weathered walls a brilliant green.

The Krahó once built homes of palm-frond screens laid together tent fashion. They borrowed the principles of walls and gables from neighboring tribes.

Huts have a single room; a platform suspended near the roof provides a bedroom for unmarried girls.

Homes form a circle about the central plaza, giving the community a wheel-like appearance from the air.

Basketmaker weaves a game pouch. Strangers to most crafts, the Krahó make no pottery. Usually they broil food or bake it on hot stones, but occasionally boil rice or beans in iron pots.

merely changes the beat of the rattle. The practiced singers recognize immediately from the rhythm what song is to follow.

The song leader is both composer and poet. Generally the profession is handed down from father to son.

When a choir conductor has composed a new song, he must introduce it to his singers. He takes a position in the middle of the village square, and the singers form a circle around him. He divides them into groups of four or five, places himself in front of one of the groups, shakes the rattle in the rhythm of the new song and sings the verses. He repeats once, and then they sing with him. He teaches the song in this way to group after group. The circle opens out again and all sing together.

"Little wild dove! Thy flight is so swift. Thy feet trip rustlingly on the savanna floor. Little wild dove, thou flyest like an arrow. . . ."

The verses are repeated countless times. They sing of nature, of the fruits of the field, and of the wild life of the broad, hot savanna.

The singing lasts until late. Married couples or older men in pairs sit in the soft sand, still warm from the summer day. They look on, converse, rest.

As the night advances, families withdraw, one by one. Small children and grown girls are taken along. Only some young men, still dancing, remain in the village square.

Soloist Serenades Village at Rest

Small fires are lighted. Boys and young men spread out their sleeping mats, which reach down only to their knees (page 349). They lie down naked. Some whispering is still going on, and then something remarkable happens:

The evening quiet is broken by loud coloratura singing. It is a male soloist. The melody is extraordinarily pleasing and his voice enchanting. The beauty of the song lingers in the memory of everyone who has heard it. It is one of the village singers bringing an evening serenade to those who have gone to rest. . . .

The Kraho are reputed to have been a warlike people. They have never been defeated in battle. Their fighting strength was broken only by the creeping in of epidemics.

What fortified their warlike resistance in particular is their pronounced tribal consciousness and especially a kind of political tribal organization, not common among Brazilian Indians, which seems to combine all tribes of the same language group. Among them are included the Chavantes and Kayapo and the friendly neighbors of the Kraho, the Cherentes and the Apinaye, the Krikati, and the cousins of the Kraho, the Canella.

In most Brazilian Indian tribes the witch doctor, or Paye, is the most important personage. His power usually exceeds that of the tribal chief. Not so with the Kraho. Here the village chief with his governing assistants has absolute authority. The witch doctor occupies a subordinate position, with no political power. Among the Kraho he is generally considered a social outsider, who uses his connection with the spirit world to prevent epidemics and heal the sick.

Woe to the Hapless Witch Doctor

If the witch doctor is successful, he is a welcome guest. If he fails to cure, he may be accused by his envious colleagues of evil witchcraft, and he may be condemned by a secret council. An executioner specially chosen for the purpose will then lie in wait for him and slay him from behind.

With the Kraho there are two governments of the village. One governs in winter, here the rainy season, and the other in summer, the dry season. Summer is the season of ceremonies and festive events.

With the first heavy rains, the herald of the winter government appears at dusk on the village square. He leans on the ceremonial spear and proclaims to the people in a loud, singing voice that the time has come to submit to the government of the other half. The season of feasts and ceremonies has passed; now begins the season of work in the fields.

The seasonal Pahi, or chief, does not make decisions arbitrarily. The will of the people is ascertained and finally proclaimed by the chief. The Pahi's main task, however, is to act as peacemaker in the village.

A Kraho is born into one of the village halves and remains a member throughout his life. Boys are promoted, during the course of their lives, to the various age groups. Those from 5 to 15 years old are grouped together. The next group comprises youths from 15 to 25, though the range of years may be shifted. Then come the mature men, who take the principal part in the log racing. The very old constitute the council of elders, and the chief is chosen from among them.

The younger age groups each have two in-

Hunters baking manioc pie for the trail heap the grated root on broad leaves (upper), which they tie with palm strips to form a package (center). Man at left smokes a corn-husk cigarette.

Afternoon social hour attracts women and children to the door of a hut. The Kraho trace lineage through the mother, and her brothers must share responsibility for training the children. Women in center prepare the evening meal in punch-bowl-sized calabashes. Wife at right, sitting on a palm log similar to those used in women's relay races, plaits a girl's hair.

The baked pie and broiled meat (lower), now ready for the hunter, attract a puppy.

Manioc, or cassava, when cleansed of its deadly sap (page 362), provides an all-purpose flour.

structors, or leaders, carefully selected by the elders, who represent the two village halves. They initiate the boys in the tribal culture, with a program of instruction in accordance with their age.

The various age groups sit in the village square in separate classes, the younger on the north and the older ones on the south. The elders sit in the middle.

Only men take part in Krabo government. Women have enough to do at home.

When produce must be brought home from the fields, a few women and one man go out together. The man carries his weapons for protection; the women carry the heavy baskets of tubers and fruits.

A code of honor has arisen from this in the course of time. It used to be shameful for a man to carry a burden. But under present circumstances, he no longer plays the role of protector as formerly, when hostile attacks were still to be feared and wild animals might lie in wait for the women. Today a reasonable husband helps his wife bring home the heavy baskets of sweet potatoes, corn, or manioc roots.

Among the Krabo, women do not play the leading part, as they do in some other tribes that live in the Brazilian forests. Indeed, men were first on the wide, lonesome earth; they lived alone, entirely without women. As legend has it:

Pud and Pudlere felt lonesome in the world. So Pud decided to create a woman. It was toward midday. The log racing had terminated. The sun shone hot. Pud went down to bathe. He took a calabash with him and dipped into the water. He then went to the house, leaving the calabash in the water.

Krabo Eve Rises from a Brook

It was not long before a peculiar clapping sound was heard coming from the water, and immediately thereafter a beautiful young woman came up out of the brook.

When Pudlere saw her coming, he asked in astonishment: "Who art thou? Where goest thou? Come here to me; here is my house." But the woman answered merely: "I am Pud's woman!" and continued past the house of the moon and straightway into the house of Pud.

Pudlere was much impressed by the woman's beauty. He would have liked to have a companion. But he was not as clever as the sun and did not understand magic. He could not create a woman!

The following day Pud came to Pudlere to invite him to go hunting. But Pudlere lay on his straw mat in the dark of the hut and groaned: "Oh, I am so sick. I have such pains." While saying this he held his hand over his left eye.

"Let me see what is the matter with thee," said Pud.

Pudlere wailed even louder: "I cannot go hunting with thee today."

When Pud went to him, Pudlere quickly spat into his hand and smeared his eye with saliva: "See, my eye is sick. It hurts so, oh, oh!"

"Yes," said Pud, "thou must remain at home today. I shall go hunting alone."

When Pud had left, Pudlere cleaned his eye and went into Pud's house. The young woman was crushing corn in a mortar. She was friendly with Pudlere. He said to her: "Come to me. Thou art so beautiful. Come, let's be married." For she was not yet exactly married to Pud. But the young woman did not wish to. Pudlere pleaded with her so long, however, that she finally yielded and went into the house of Pudlere.

When Pud returned from the hunt, his house was empty. He knew at once what had happened. He went over to the house of his friend and found them there truly married.

But he was not angry, and simply said: "Good, thou likest Pudlere better than me; so thou must stay with him. I do not want thee any more!"

Pud Creates Another Woman

Pud went bathing again. He dipped a calabash into the water. Again the strange clapping sound was heard, and soon a woman came out. She was even more beautiful than the first!

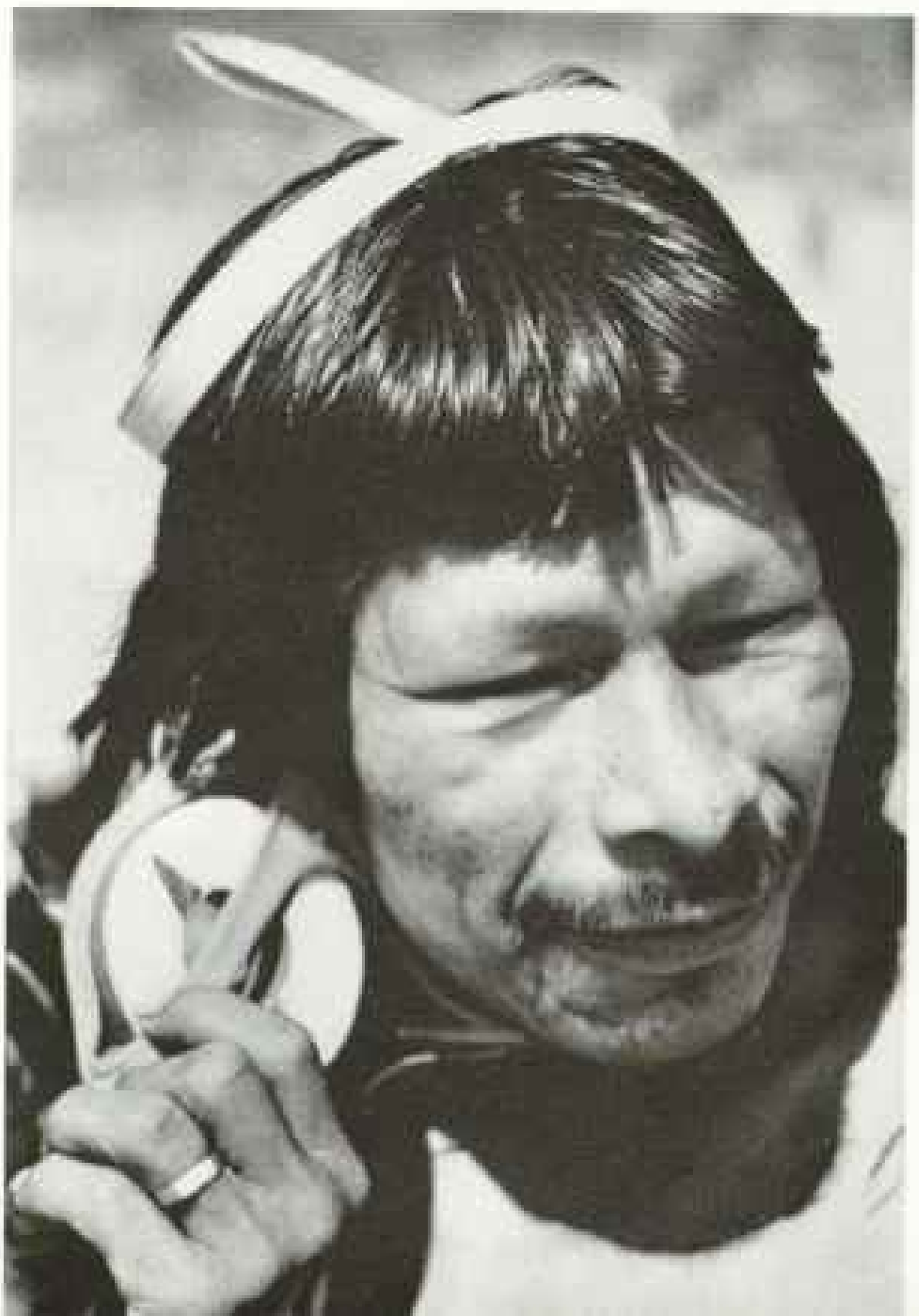
As she went past Pudlere's house, he saw her and said: "Thou, come here, here is thy house!" but she went into Pud's house and became his wife.

Soon there were children. The Kraho became numerous. They are all descended from Pud and Pudlere.

The clapping which was heard every time Pud created a woman came from striking the water with cupped hands, just as the Kraho maidens do today for fun while bathing.

Thus came life. There is also death.

The summer will soon be over. Quiet reigns in the village during the hot midday hours. All the Indians are in the shade of their houses. Some are resting, lying on straw



Wife cuts husband's flowing hair. Kraho men and women often wear a special hair style, double parted to give a white streak on each side. Villagers dressed the author's hair in Kraho fashion and painted his body with ceremonial dye when they initiated him into the tribe. This woman snips with scissors bought from a trader.

Ear-lobe plugs the size of a teacup, a vanity reserved to males, give the wearer romantic appeal. The Kraho believe that the larger the disks they wear in their ears, the greater their success with the girls! Young men begin by inserting sections of arrow shafts and gradually increase the size. Palm-strip headband denotes high office or salutes a feast day.

mats. Others are braiding little baskets, mats, and carrying bands. The women are scraping manioc roots, boiling, or baking.

Then a loud wailing pierces the stillness. It is like a cut through the compact, heavy heat. All listen. Work is suspended. Someone whispers and springs to his feet: "Come, Vuvu, a boy has just died!"

He had been sick for a year and had never been quite healthy. It is the second child who has died in the family within a short time. Like his brother, he had suffered from attacks of epilepsy. Lately a severe case of anemia had developed. A year before, the boy had fallen into the fire during an attack of epilepsy, and since then an arm and a leg were lamed. Now his suffering has ended.

Requiem for an Indian Boy

Relatives and friends come from all houses. They bend over the dead boy and lament loudly. The house of mourning is filled with weeping and sobs. But in this mourning there is order and rhythm, no chaos of unbridled grief.

The weeping is suddenly interrupted by a speech addressed to the child by the mother in a chanting tone. The impression made as she speaks to her dead child is almost poetic. The words, in modulated voice, issue in measured sequence. It is unspeakably beautiful. And then she again breaks into weeping and lamentation (opposite).

The boy is lying on a straw mat on the floor of the hut. A feeble light strikes his almost white body. The mother and an aunt on the mother's side wash the body and wipe it dry. They partly wrap the boy in cloths. The face and upper part of the body are painted over with a yellowish-red stain called annatto.

Only the children take no part in the general mourning. They are playing as usual, laughing and leaping happily.

Two men come into the house, carrying a long pole. They then spread out a new mat, on which they lay the dead child. The body is rolled up in the mat, through which they stick the pole lengthwise. The bundle is tied up with woody fiber. Now they take the ends of the pole and lay them on their shoulders and carry the dead out.

At this moment the house is filled with lamentations.

Only a few follow the funeral procession. Some children go along out of curiosity, laughing and chattering unconcernedly. The dead boy had indeed been neither friend nor playmate. He lay lonesome in his hut as healthy life streamed by outside.

The small cemetery is situated not far from the village, hidden in the savanna. There are few graves, recognizable by the mounds of earth thrown up. No decorations, no flowers. One grave is open. It is not much more than three feet deep.

The two pallbearers climb into the grave. Others assist them to lower the body, carefully, tenderly. Strong, straight branches are laid lengthwise over the grave and firmly anchored at both ends. They are to prevent digging animals from gnawing at the corpse.

While we are in the cemetery, all those in the house of mourning undergo a ritual ablution. Great calabashes full of cool, clean water are poured over their bodies, and they wash themselves with great care.

Now heavy rains are falling ever more frequently. The temperature during the day is becoming more pleasant. The morning usually begins with radiant sunshine. The sky becomes cloudy toward noon, and at any time in the afternoon the heavens fall and everything is flooded. The sand quickly soaks up much water, while the remainder runs off in the near-by brook, which rises rapidly. Soon there is beautiful sunny weather again.

Fish a Rare Treat for Inland Indians

There were no fish in the brook during the dry summer, but now they are ascending the stream. The Kraho kill them with poisonous herbs which they have planted in the vicinity of their homes. Eating fish is a rare pleasure for inland inhabitants.

While I was bathing with the Indians, they had some news for us.

"Vuvu," called Kratchet, splashing in the clear water, "a long time ago our neighboring village made you their Pahi. Now there is talk on the village square that our village also wishes to have you, and that Vilma should become Sartom!"

Grief Overwhelms a Kraho Family Preparing a Son for Burial

Mother holds the child's head while the grandmother and an aunt arrange the shroud. Father bows his head. The Kraho, who believe vaguely in immortality, have never been defeated in war but succumb to pneumonia, tuberculosis, and dysentery.

Ceremonial Feathers Adorn Author and Wife After Ritual Bathing in a Forest Stream

Villagers shoulder Mr. and Mrs. Schultz at their investiture as tribal ambassadors. Women wash Mrs. Schultz (below), here photographed by her husband. He bathed in another pool with the men.

"What is Sartom?" Vilma asks him later.

"That is the same as Pahi, only it is a woman," Krutchet tells her. "Pahi is the man who takes care to see that there are no quarrels among us. When two persons in the village begin quarreling, he goes to them and sets things right again. He is our chief. It has always been so with us."

The following morning shortly before sunrise, someone shakes our hammocks. "Get up, it is time!" Almost the whole population has assembled in front of our house. We go down to the brook. The water is deep and cold.

"You, Vuvu, must undress yourself completely." They lead me by the hand into the water. Four young men come to me and pour and splash water over me. I must wash myself. Vilma is bathed at another place by the women and girls (page 359).

"Now come out and wait here, Vuvu."

Villagers Initiate Author and Wife

I shiver with cold. Slowly the sun warms the morning air. Vilma comes also. All the others are still bathing.

A group of men approaches us. They lift us and put us on their shoulders, then go with us up the slope to the village. The crowd follows us, shouting loudly and shooting their muzzle-loaders, charged only with powder. We are trotted to the village square and then set down on straw mats.

Women come with leaf bags. From them they take sticky, whitish-gray rubber juice and smear it all over our bodies. Trunk, back, shoulders, arms, and legs are entirely covered. Only the face, neck, hands, and feet are left free.

In response to a nod, other men and women bring little baskets filled with down. They begin feathering our bodies by dabbing the down into the liquid rubber.

"You are big as a *prykok!*" says one of the women. Everybody laughs. "Prykok" means ox. She means to say by this that there will hardly be enough feathers to cover my whole body.

Again girls come with small leaf packages. Palm oil is poured from the calabashes into their hands. They rub annatto balls in their palms. The color mixes with the oil. Then they paint our necks, arms, and hands with their red-smeared hands. We get red dabs and stripes on the face.

The whole population of Kenpokrekateye is gathered on the village square, men and women, old people and children. All have come to greet their new Pahi and Sartom. Today is a great holiday.

Two men lift us to the shoulders of others. My bearer groans under the burden, and the triumphal procession begins on the boulevard around the village. The people follow us with yells, cries of delight, and joyful shots from their muzzle-loaders (page 358).

If one of the bearers gets tired, another takes over. With the cooperation of several, we are lifted from one pair of shoulders to another without touching the ground.

But now I am aware of something different. This time the gait is more elastic. I perceive that I am being carried by a woman, and this makes it all the wilder. She runs playfully out ahead with me on her shoulders, turns quickly around and passes through the Indians following, who now break out into loud cries of enthusiasm and fire their guns.

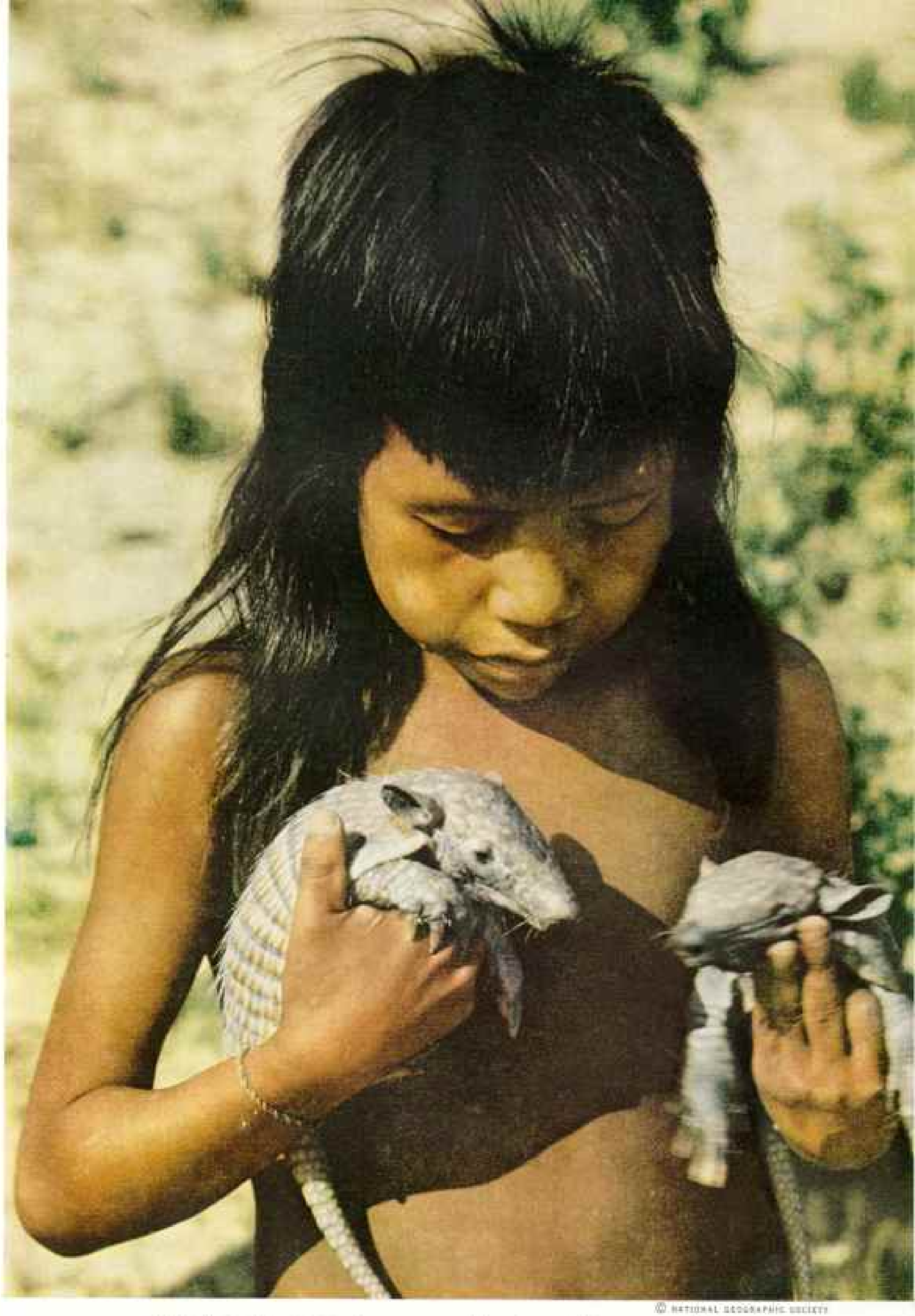
The distance around the village is about 650 yards. We complete one lap. Then they set us down on the straw mats again. A pause. Robkucho, the master of ceremonies, has come. He is one of the elders of the village, who still knows well the ritual and songs. When he dies, many an old tradition will vanish forever from the life of the Kraho.

Neophytes Receive Many Names

Men and women form a double row. We stand at the end, between them, with Robkucho in the center. He looks at them all for a long time, then begins to walk with rapid stride back and forth along the rows. He approaches us, then again withdraws. While doing this he delivers a speech, the sense of which is somewhat as follows:

"The Kraho nation, and in particular our village, Kenpokrekateye, has decided to receive our two friends, Vuvu and Vilma, as members of the tribe. Henceforth you shall have the following names." He enumerated about ten names for each of us, of which only the first names remain in our memory. Vilma is called Tshiki and I, Tshotere. "We are your friends and we know that you are our friends, for we have looked into your eyes and have seen that you have good eyes.

"From now on you are our Pahi and our Sartom! And when this ritual has ended, you can try out the power of your office. You shall see that everyone in the village will lend obedience to you when you seek to establish peace, as it is your office to do.



Mail-clad pets, a brace of young armadillos, charm their master. Indians eat armadillos but sometimes tame the young, which are born identical litter mates. This pair, spared when their mother was taken, romped with children as happily as puppies.

"We have a special request and mission for you. You know that we Kraho are a peaceful and industrious people. We cultivate our fields and hunt on the savanna. But never do we harm anyone. We are honest people and not thieves.

"Our region has grown poor, and our children often cry for a small piece of meat to eat with their sweet potatoes or manioc cakes. But our men return from their hunt with empty hands.

"Formerly, when we went out from our village, the savanna floor was furrowed with the tracks of many wild animals. There were many stags and roes, wild pigs, anteaters, foxes, armadillos, tapirs, monkeys, tortoises. But then the civilized men came. They brought horses, dogs, and firearms and drove off or killed our food. Instead of game tracks, we saw only the great hoofprints of their cattle in the sand.

"We have always respected the property of our neighbors, even when our children hungered.

"Yet our neighbors have accused us unjustly of hav-

Wicker press rids manioc of its poisonous sap. A common staple of South American Indians, the tuber contains prussic acid.

Cooks grate the pulpy root and place it in a woven straw basket that contracts as its ends are pulled. Attaching one end of the cylinder to an overhead beam, the worker fits a log through a loop at the other end and applies pressure, forcing the toxic juice through the basketwork.

This Kraho cook squeezes the bottom of the press to remove the last deadly drops.

ing stolen their cattle, when their cattle wandered away into the savanna or had been killed by poisonous snakes. And one day our village was attacked by an armed band while we men were hunting. Women and children died under their bullets.

"For this reason we have made you our Pahi! You must never forget us when you are again living in the great city.

"And should you one day hear that we are going to be attacked again, come to us in time to warn us. When you come to us again, you shall always be received as friends with the honors of your office. All the Kraho will lend obedience to you as a village chief!"

Robkucho ended his speech. We were again told to wait. Then many came from their houses with presents. They laid them in silence before us: feather adornments, ceremonial spears, little straw baskets with covers in beautiful braided work, sleeping mats, and, finally, a bright-green tame parrot.

"All these are presents for the new Pahi and the Sartom," said one, and added that no gifts in return were necessary, as otherwise is customary when someone gives a present.

"But you should give a small remembrance to all those who carried you and decorated your bodies."

Five-day Walk to Wave Farewell

Summer is at an end. We must go back through the savanna before the watercourses are filled and difficult to cross.

When we head back toward civilization, many of our friends accompany us for hours; some even walk the whole five days under the burning sun and pouring rain to the next locality, in order to wave to us as the airplane takes us from their sight.

It is true that the Kraho were attacked some fifteen years ago by irresponsible elements because of their fertile grazing grounds. The late Marshal Candido Rondón, who dedicated himself to the protection of Brazilian Indians, sent officers of the army into the area and had the guilty persons arrested. They were kept in prison for many years.

A reservation was created for the Kraho Indians and a protection post established. Since then they have had peace and safety from attacks. But they have never forgotten the unjust attack.

Their homeland, the savanna, was formerly a region rich in game. The stock has declined so greatly, because of ruthless hunting by cattle raisers who have invaded their country, that any adequate supply of meat through hunting is no longer possible.

It is necessary quickly to find a change of course for the Kraho. The natural evolution would be from hunters to cattle raisers.

That is also their fondest wish. And that they are already suited to become cattle breeders is shown by their treatment of the few animals which some of them already own. Under no circumstances will a Kraho be induced to slaughter his only cow, even if the children beg ever so hard for a piece of meat. Their purpose is to increase the stock of cattle in order, in the distant future, to have their own herds like their civilized neighbors.

Four Hundred Kraho Survive

But the road leading to that point is long. It endangers the very existence of the Kraho. Serious indications of malnutrition are already noticeable among them.

We discussed these problems during our long evening conversations on the village square. The Kraho were enthusiastic about the following suggested solution:

"In accordance with your tribal customs, a herd of cattle should belong to the village community and not to separate individuals. For by introducing the concept of personal ownership, the life of the Kraho as a community could be easily disturbed. Your culture is too strongly rooted in community work and observances."

Today there are still about 400 Kraho Indians living in three villages. To give them a good start, it would be necessary to provide them with about 1,000 head of cattle, and, in addition, the necessary instructors.

In a few years the Kraho Indians would be in a position to care for their cattle and increase them by themselves; then the "wild Indians" would become useful cattle raisers, who would contribute to the economic development of the whole of Brazil without sacrificing their own ancient culture.

Portugal's Gem
of the Ocean:

MADEIRA

By DAVID S. BOYER,
National Geographic Staff

TOBOGGANING is an unlikely sport for Madeira, a subtropical island 400 miles off the African coast. Vineyards bank the terraced slopes of this Portuguese outpost, flowers border the roads, and languid waters from the Gulf Stream lap its shores.

But one clear spring day, National Geographic photographer B. Anthony Stewart and I stepped into a wooden-runnered *carrinho de cesta*—a basket cart—at the crest of the Monte that soars above Funchal, the Madeiran capital. Our course—2,000 precipitous

feet of cobbled roadway cutting through the heart of the city—yawned before us like a weird, snowless bobsled run.

Our two drivers were equally incongruous; their white outfits, topped by straw boaters, gave them the air of Edwardian dandies on a summer outing. Carefully they tested the ropes used to steer the sled. Then, as they shouted "*Afasta!*"—Out of the way!—we were off.

We shot with ever-increasing speed across the smooth cobbles, the drivers alternately

A Cloud Cap Overhangs the Peaks Above Funchal, Capital of Madeira

In the early 1400's this phenomenon frightened superstitious seamen who came to the island, for in the omnipresent mist they sensed a mysterious evil force. A Portuguese fort (right) straddles the breakwater's protecting finger. When seas grow choppy, fishing craft take refuge behind the jetty. Atlantic (extreme left) and Savoy are resort hotels.

riding the rear extensions of the tallow-greased runners and sprinting alongside. Down, down we rocketed, past garden walls aflame with tropical blooms, past blurred patches of sugar cane and flickering doorways.

Expert yanks on the ropes threw the sled into sickening sideslips to negotiate the twists and turns of the descent. At one intersection I closed my eyes as a bullock-drawn cart blocked the route. But almost at the last second—in response to a sharp "Afasta!"—the bullock quickened his pace and we hurtled past, avoiding disaster by a matter of inches.

Sliding to a tranquil halt at the foot of the hill, we dismounted. I paid the drivers with trembling hand and watched in wonder as they placidly shouldered their sled for the long climb back up the Monte.

Off-course Sailors Claimed Madeiras

Though this exciting descent is a traditional initiation to Funchal, Tony and I soon learned that speed and bustle are alien to Madeira. Life on the isle moves to the stately rhythm of tides and seasons. Even the principal exports, wine and embroidery, are products of a patience that scorns time's pressures.

We had arrived at Funchal by ship nearly five and a half centuries after the first Portuguese settlers of Madeira (map, page 375). While Prince Henry the Navigator dreamed of empire in his struggling kingdom by the sea, one of his loyal captains, João Gonçalves—called Zarco, "the blue-eyed"—was steering his caravel on a daring course around Africa to the fabled East.

But angry seas cuffed Zarco far to the west before at last, by the grace of God, they tossed him up on a strange island. Zarco and his storm-weary crew knelt to offer a humble prayer; and, grateful for their salvation from the terrors of the deep, they named the island Porto Santo, or Holy Port.

These same Portuguese sailors were the first to claim the island of Madeira which, like Porto Santo, belongs to the group of mountainous isles that would serve later as stepping stones for Christopher Columbus on his way to the New World. The islands also became a key link in Portugal's chain of empire that stretched from Brazil to Macau on the China coast and brought the court of Lisbon to the dizzy summit of world power.

From our Madeira-bound ship, Tony and I had watched Porto Santo grow on the horizon; we passed close enough to see windmills crowning its hilltops. Farther to the south lay the barren, uninhabited trio of the Desertas. Ahead loomed the largest of the Madeira Islands, Madeira itself.

The island greeted us with a frown; its mile-high peaks wore their characteristic cap of dark clouds (page 364). A similar gloomy mass, seen from afar, had frightened Zarco's superstitious shipmates. But the ominous shape had only beckoned their blue-eyed leader on.

As we drew near Funchal, we knew the awe that must have gripped the quarterdeck of Zarco's tossing caravel. For now, under the clouds, we saw the island in all its Arcadian splendor.*

Zarco had sailed past this panorama of mountains buttressed by cliffs against the sea and marveled at drifting mist and gorges splashed by waterfalls. Hanging valleys glowed in green and blue, and tropic vegetation grew wild and pine-tree deep.

He planted his country's flag on what he called Madeira—"mah-day-rah" to the Portuguese. They pronounce it with affection, with a lilting accent on the middle syllable, and with a rolling *r*. The name, meaning wood, was Zarco's tribute to the island's thick forests of giant laurel.

Cannon Corrected Wayward Ships

Finally we reached Funchal, Portugal's third busiest port, curving like an amphitheater against a hollow in the hills. Pink and yellow houses mounted in a terraced crescent toward the summit.

A crumbling 17th-century fortress guarded the harbor entrance (page 365). From this rocky stronghold, in days gone by, irate harbor masters had fired cannon balls at ships that disobeyed harbor regulations.

In the 400-year-old customs house, we found an aged, treasured copy of the four Gospels upon which the traveler, if so inclined, could swear that he had no contraband to declare. After so swearing, we boarded a bright blue Hudson touring sedan that had been the last word in transportation the year the stock market crashed.

Funchal—named for the wild fennel that once grew profusely on its site—is a serene city where old ways still prevail. The outdoor flower market, with its riot of color, could

* See "Madeira the Florescent," by Harriet Chalmers Adams, National Geographic Magazine, July, 1924.

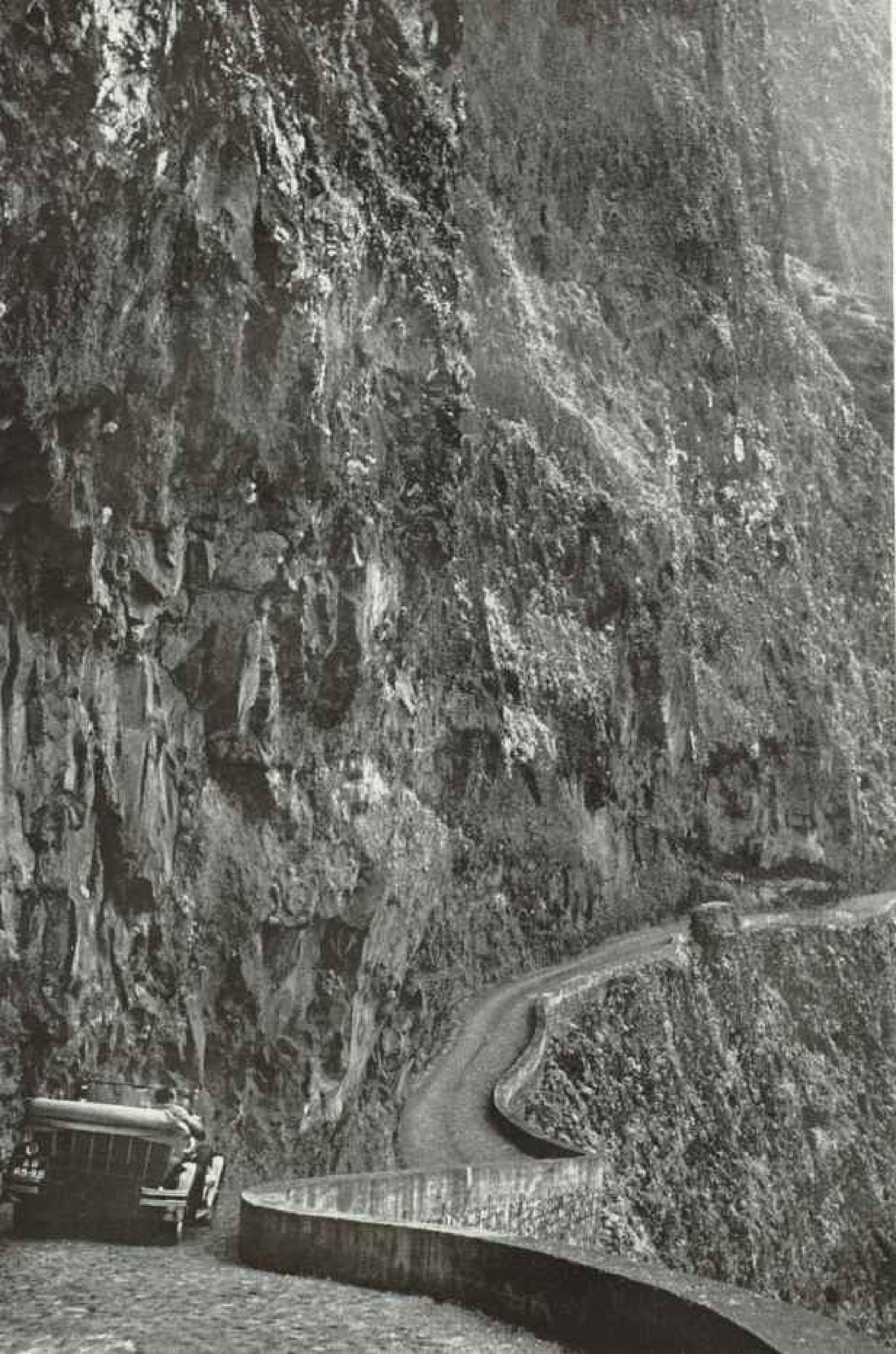
Funchal Visitors Slide Downhill in Sledges

Excursionists in antiquated taxis climb 2,000 feet up a steep slope at the city's back door. After appraising the view, they return in swifter, more exciting fashion by tobogganing down a cobbled roadway.

The Madeira sledge looks like a Ferris-wheel seat. Two attendants riding the rear running board kick with one leg to build up speed as they shout "*Afasta!*"—Out of the way! Desperately braking with feet and ropes, they bring their passengers safely to the foot of the hill. Although greased with tallow, the toboggan's hardwood runners scream and occasionally smoke.

Cruise-ship passengers on the Funchal quay try a canopied ox sledge. Wheelless drays still haul wine, baskets, bananas, and sugar cane over Madeira's cobbles.

SUPERIMPOSED BY B. ANTHONY STEWART
(RIGHT) AND DAVID S. BOYER
NATIONAL GEOGRAPHIC STAFF © N.G.S.



have been part of another century. The car nosed between banked begonias, roses, hibiscus, and geraniums that dazzled the eye and intoxicated the nostrils.

The women who hawk the blooms lend a chromatic touch of their own, for they still wear the island's traditional costume—full red skirt, white blouse with puffed sleeves, gaily colored cape, and a pigtail cap called a *carapuça* (page 386).

Madeirans Use English Names

As our car churned up a cobbled hill, it swerved to pass a creaking, wooden-runnered sledge powered by a plodding ox. A barefoot boy in patched and repatched trousers tugged at the animal's horns, while an old man pushed and hammered against the beast's withers, calling down fierce Portuguese curses on its slowness.

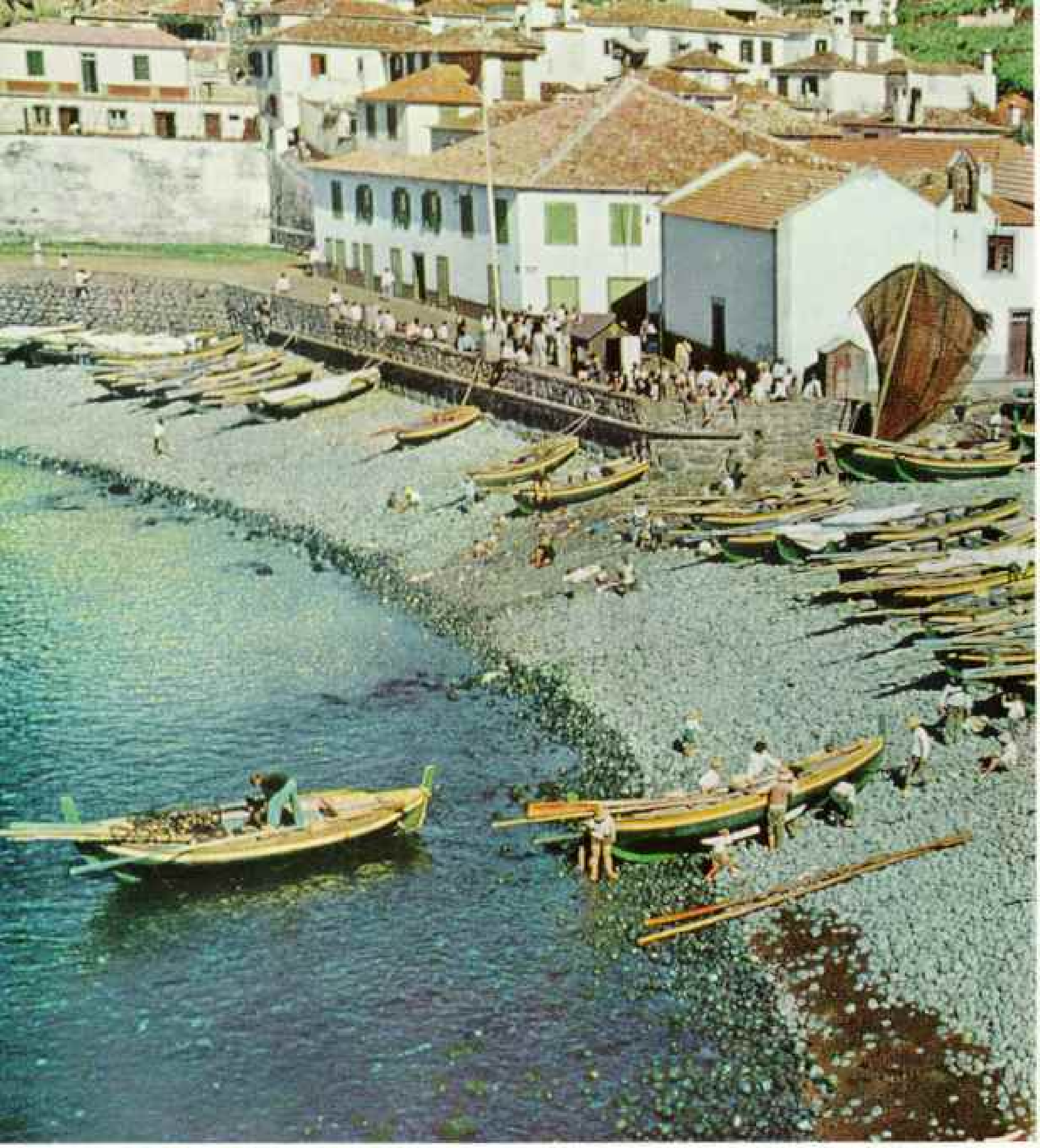
At the top of the hill leading to our hotel, we glided beneath blue-flowering jacaranda trees. A dash across the high stone bridge (with a glimpse of tangled trees and flowers in the ravine below, and a breath of air scented with jasmine and honeysuckle) and we squealed to a halt at our destination—Reid's Hotel.

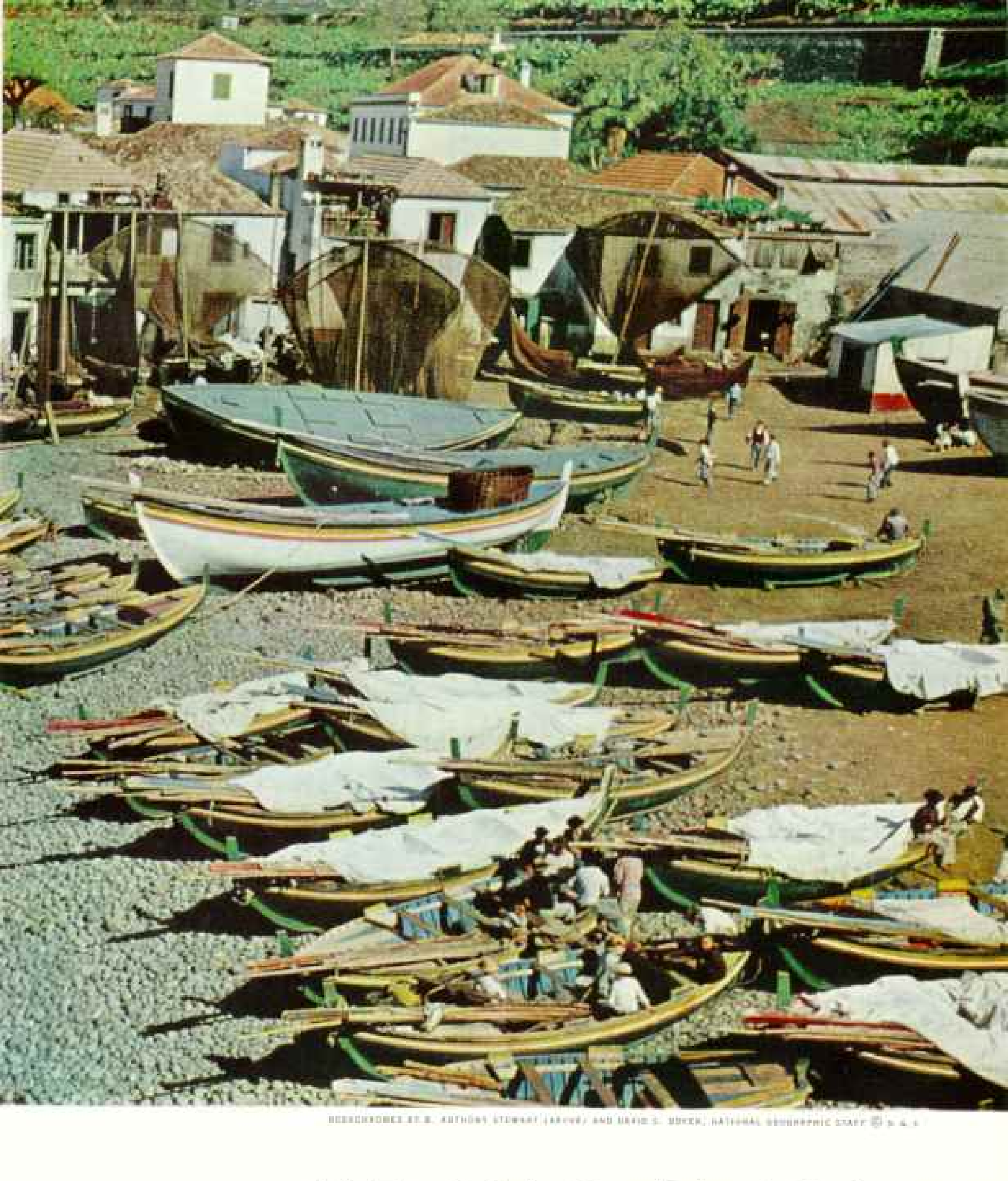
The English name of this famous hostelry reflects the long-standing enchantment Madeira has held for generations of sun-starved Britons. Many, smitten by the otherworldly beauty of the island paradise, have settled there. As a result, several of the grand old families of Madeira bear such non-Portuguese names as Leacock, Blandy, Grabham, and Gordon. Prices are invariably posted in

An up-and-down island, Madeira all but leaps out of the ocean. Its awesome sea cliffs, among the world's highest, jut as much as 2,000 feet above the Atlantic's rollers. Views such as this led English novelist Frederick Marryat to write: "I do not know a spot on the globe which so astonishes and delights upon first arrival."

Here, on the north side, a cobbled road clings to the precipice and tunnels behind a waterfall. Such roads are comparatively recent; old-time trails are too narrow for cars.

NATIONAL GEOGRAPHIC PHOTOGRAPHER
B. ANTHONY STEWART





Photographs by B. Anthony Stewart (above) and David S. Boyer, National Geographic Staff © N. G. S.

Keels grate on the shingle at Câmara de Lobos as the fishing fleet prepares to sail. By late afternoon the craft will be under way; after dark their flickering lights will encircle the island. The catch may be heavy with *espada*, the eel-like scabbard fish, caught on 150-hook lines dropped half a mile deep. Arched nets dry in the background.

Hake, sea bream, bigeye, and sea bass vary the catch and bring a smile to the face of a lucky fisherman. Island diet relies on sea food.

Needles fly as Porto da Cruz women gather in the sunlight to do embroidery, a leading island industry (page 393). Fine linens, intricately stitched in this cottage yard, may grace a princess's trousseau or a statesman's table.

sterling as well as escudos; afternoon tea is a custom at the larger hotels; and, to the despair of garlicky gourmets, the tourist cuisine is thoroughly English.

Madeira was also a favored resort of royalty. Empress Elizabeth of Austria and Queen Adelaide, consort of King William IV of Great Britain and Ireland, were 19th-century visitors. In 1852 the young Princess Maria-Amelia, betrothed to Austria's Archduke Maximilian, came to Madeira to recover from tuberculosis. But instead she died. Her mother and fiancé built a sanatorium in Funchal as a memorial to the dead princess. And the grieving Maximilian made a certain provision: To this day, in the shadowed chapel of the Hospício Maria-Amelia, a candle always flickers in her memory before Our Lady of Sorrows.

After hurrying out of the hotel for our swift, thrilling sleigh ride down the Monte, we returned for dinner. But the meal was too long and formal to suit our mood. Some sixth sense keyed us to an expectation of magic on this island. Without taking coffee, we slipped out to the hotel veranda.

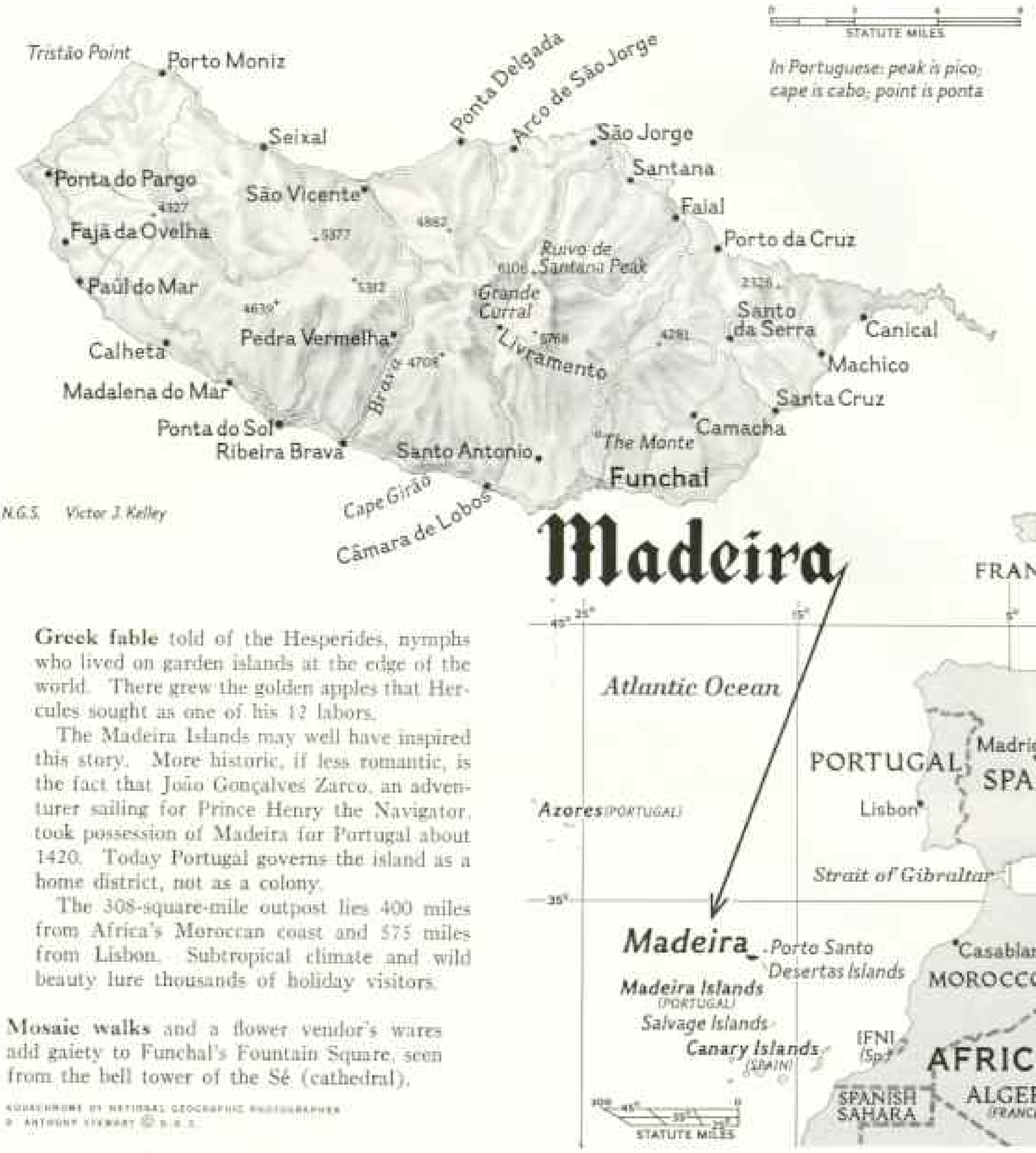
There, across a chasm where breakers rolled over rocks and echoed from a cliff, the city sparkled against dark-blue hills. Lamplighted streets fanned upward from the port, and horizontal avenues threaded them into a beaded network. The lights flickered in the water below like a dewdropped spider web.

Out to sea, in the direction of the distant Canaries

Children of five or six learn the embroiderer's art in a government school at Machico. As they gain proficiency, they join their elders in home piecework that keeps thousands of Madeira's women busy when they are not performing field or household chores. A government agency imports the fabrics from Ireland and Switzerland, stamps them with designs, and sets standards of excellence for the piece-workers. A single fine tablecloth may consume months of work for an entire family.

DAVID L. BOYER (BELOW) AND B. ANTHONY STEWART, NATIONAL GEOGRAPHIC STAFF

BAZAR DO POVO



Greek fable told of the Hesperides, nymphs who lived on garden islands at the edge of the world. There grew the golden apples that Hercules sought as one of his 12 labors.

The Madeira Islands may well have inspired this story. More historic, if less romantic, is the fact that João Gonçalves Zarco, an adventurer sailing for Prince Henry the Navigator, took possession of Madeira for Portugal about 1420. Today Portugal governs the island as a home district, not as a colony.

The 308-square-mile outpost lies 400 miles from Africa's Moroccan coast and 575 miles from Lisbon. Subtropical climate and wild beauty lure thousands of holiday visitors.

Mosaic walks and a flower vendor's wares add gaiety to Funchal's Fountain Square, seen from the bell tower of the Sé (cathedral).

KODACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER
© ANTHONY STEWART © N.G.S.

and the uninhabited Salvage Islands, orange lights bobbed on the black water. By the glare of kerosene lanterns, Funchal fishermen were beginning their nightlong labors.

As we watched, a steamer crept through the dancing harbor lights below us like a seagoing glowworm, her portholed sides agleam. Tethered to a buoy, a silver seaplane cast back a wavering image.

Later Tony and I discussed our plans. Madeira, its very essence, I suggested, meant wines, baskets, and embroideries. We should want to investigate these first. But Tony had other ideas.

"What about the peasant's life?" he asked. "The struggle to wrench a living from this upended landscape must be an epic in itself."

Tony was right, of course. How could we expect to understand Funchal, Madeira's hub of industry and commerce, until we had explored the countryside that supports it? We would trace island activities from the capillaries to the heart, I agreed, and not the other way around.

"After all," Tony reassured me, "Madeira is only 35 miles long. A little world. In a day or two we can get a bird's-eye view."

True, a bird might explore the length and breadth of this fascinating island in a couple of days. But we soon found that such speed was out of the question for two photographers with a carful of equipment and a determina-

Incredible Labor Carved This Mountain into a Staircase of Tiny Farm Plots

Overpopulated Madeira uses every foot of arable land, most of it lying on precipitous slopes. Mortarless stone walls, some of them 25 feet high, enclose patches as small as a tabletop. Cabbages or sweet potatoes planted beneath high-trellised vines give growers an extra crop.

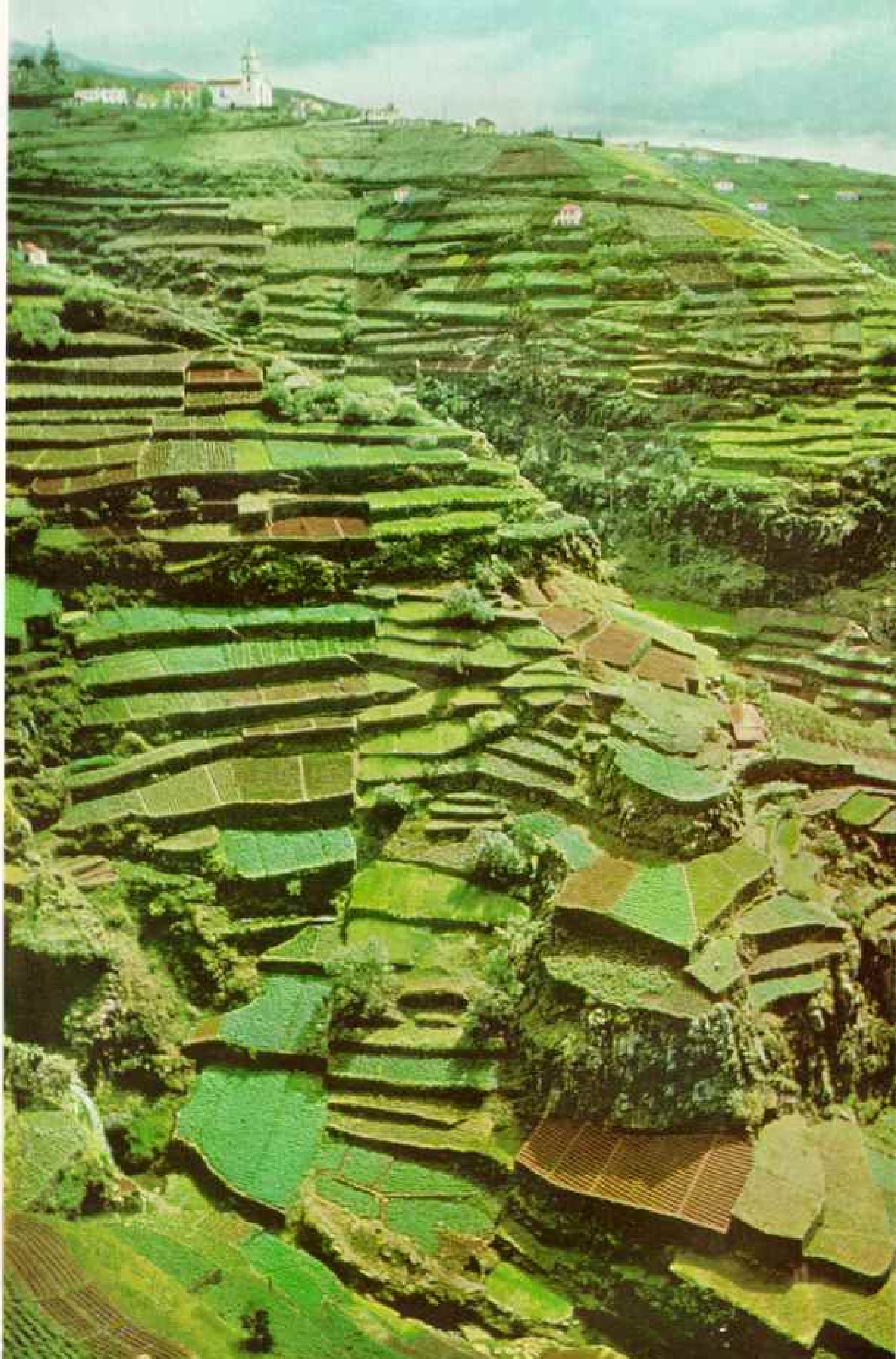
Carving the terraces by hand, Madeira's farmers scrape away the topsoil, level the bedrock, and build a retaining wall. Finally the soil is spread back.

Steep slopes rule out the use of mechanized equipment; the standard tool is a heavy mattocklike hoe.

Farm wife carries a sickle to cut grass for her cow. She imprisons the beast in a thatched stable (page 382) lest it eat her cabbages or fall off a terrace.

Farmers convoy a heifer fore and aft to a vaccination center near Câmara de Lobos.

PHOTOGRAPHS BY B. ANTHONY STEWART (TOP AND OPPOSITE) AND DAVID S. BOYER, NATIONAL GEOGRAPHIC STAFF



tion to probe beneath the surface of Madeiran life.

The next morning we set off to the southwest, accompanied by Celso Silva, a Funchal man who knows his island and its people. Francisco, our driver, plucked from a garden wall a fresh spray of bougainvillea for the vase on the dashboard of his venerable Packard. Then he bore down simultaneously on the horn and accelerator.

By American standards, the five miles from Funchal to Câmara de Lobos is a narrow, winding lane. But to Madeirans, who measure their angles vertically, it is a Pennsylvania Turnpike; indulging his thwarted passion for speed, Francisco went all out on comparatively level stretches of macadam highway. The rest of the day we twisted over harrowing hairpin turns in second and low gear.

"These roads are made of volcanic stone," Francisco told us regretfully as we bumped over a choppy roadbed at 15 miles an hour. "Wears tires to the cords in 8,000 miles."

The Portuguese Government plans in time to macadamize all the island's main roads. But time, in Madeira, must be reckoned by Madeiran standards. Nature has imposed obstacles that discourage haste in any form.

Great volcanic convulsions in eons past lifted Madeira three miles to the surface of the sea and more than a mile farther into the air. Streams and winds for countless centuries carved its basaltic stone and ash into deep and dangerous ravines. Dynamite, machinery, and the slow, painful manpower of Madeira have recently completed tunnels through the cliffs of the formidable north shore, making it at last possible to encircle the island by car.

Fish Caught at Half-mile Depths

Francisco's battered Packard lurched over a hill to give us a sudden view of Câmara de Lobos, the home port of Madeira's largest fishing fleet. Here village and boats shelter behind rock barriers that form a great blue bathtub, with one end open to the sea (page 370).

Swarms of naked boys dashed over a crescent stretch of stony beach and dived into the surf. We watched grizzled, shoeless fishermen drying their nets and mending the lines they use to catch tunny and the black eel-like *espada*, or scabbard fish.

These saw-toothed horrors are deepwater members of the cutlass fish family; as many as 50 are caught at a time on one long and expensive line. Reduced pressure kills the ugly creatures as they are hauled up from half-mile depths. Once dead, they float to the surface to become a staple for Madeira's poor and a delicacy for the well-to-do citizens. Madeira's commercial fishermen are thus in the unique position of grinning rather than grumbling when the tension on their lines goes slack.

Flood Sweeps Houses into the Sea

Westward from the fishing village with its orange-tiled rooftops ranged about the harbor, we began the snakelike ascent of Cape Girão. It is, islanders assured us, one of the highest sea cliffs in the world.

The descent to Ribeira Brava, only five miles by sea from Câmara de Lobos, is a tortuous route. In an hour the odometer recorded 14 grueling miles of climbing, twisting, and ravine crossing.

Ribeira Brava—"wild river"—lies at the mouth of a panting little stream. Barely enough water trickled into its pools that day to allow the kerchiefed townswomen to soap the family wash. During the rainy season, however, the village must sometimes cope with rushing, murderous torrents. Great boulders everywhere testified to that.

The people of these canyon villages have tamed their streams by building massive stone dikes down their central riverbed. Before these retaining walls were built at near-by Madalena do Mar, Celso Silva told us, one winter deluge swept 39 houses into the sea.

Dams, terraces, water channels, and reforestation are gradually checking erosion and guarding against future calamities. But it has been an uphill struggle in more ways than one, ever since the infamous, half-legendary fire set by Zarco's early colonists. Clearing land for agriculture (and also, they say, to kill imaginary reptiles and wild animals), his men lost control of their brush fires. Blazes smoldered on island slopes for seven years.

Today the peasant's main crops—potatoes, onions, tomatoes, grapes, sugar cane, and French beans—lend distinctive shades of green to the patchwork hillsides (page 377). So do groves of mangoes, avocados, passion fruit, and custard apples. Agricultural products are myriad. Yet the cash revenues of most farmers flow from "invisible" sources.

Some 280,000 inhabitants make Madeira

(*Continued on page 387*)

Youthful Porters Wear Burlap Hoods as Pads

Madeira children often eke out the family income. By the age of six, many boys transport their own weight in firewood, fodder, or produce. Half hidden under burdens, they shuffle with rapid little steps up and down steep trails. Seen through the mountain mists, they suggest the gnomes of fairy tales.

These youngsters stack firewood they have portaged from the heights of Cape Girão. Trucks will pick up the fuel.

Young harvesters near Machico peel sugar cane and cram their mouths with its sweet delights.

Though some 10,000 farmers grow cane on the island, Madeira must import sugar to meet local needs.

Until its abolition in 1768, slave labor worked the fields. The first sugar plantation operated on the present site of Funchal's cathedral (page 374).

Priest and flock near Faial tread a path strewn with flowers. Periodically the clergy carry communion to the valley's sick and aged. To show them the way, farm families adorn the roads. Cross and bell precede the priest.

To leave this pit, men must climb 1,200 feet. Madeira's yawning Grande Curral, the crater of a dead volcano, bespeaks the powerful forces that thrust the island's peaks out of the sea.

Long ago a convent used the hollow as a cattle pasture. When pirates threatened Funchal, nuns fled to this spot for safety. Thus islanders call it the Curral das Freiras, or Corral of the Sisters.

Livramento, the toylike village on the crater floor, was built entirely of materials carried down on men's backs. Each round trip took five hours.

Thatch to the ground protects a home against fierce Atlantic winds. The cow, kept in the shed at left, seldom sees the light of day.

A pet lamb goes to church as an offering. It will be raffled at a *festa*, or celebration, to raise money for the poor.

Countryfolk use their many saints' days as a sort of calendar. "I'll see you a week before Sant' Antonio's," they say.

A boy sets out for the fields with lunch baskets for his father and brothers.

One specialty of the island is wickerware. Like wine and embroidery, Madeira's woven baskets and chairs go to many parts of the globe. Willow saplings for their manufacture, gathered from osier beds in ravines, are stored in water to keep them pliable and later stripped of bark. The industry centers around Camacha, in the mountains northeast of Funchal.

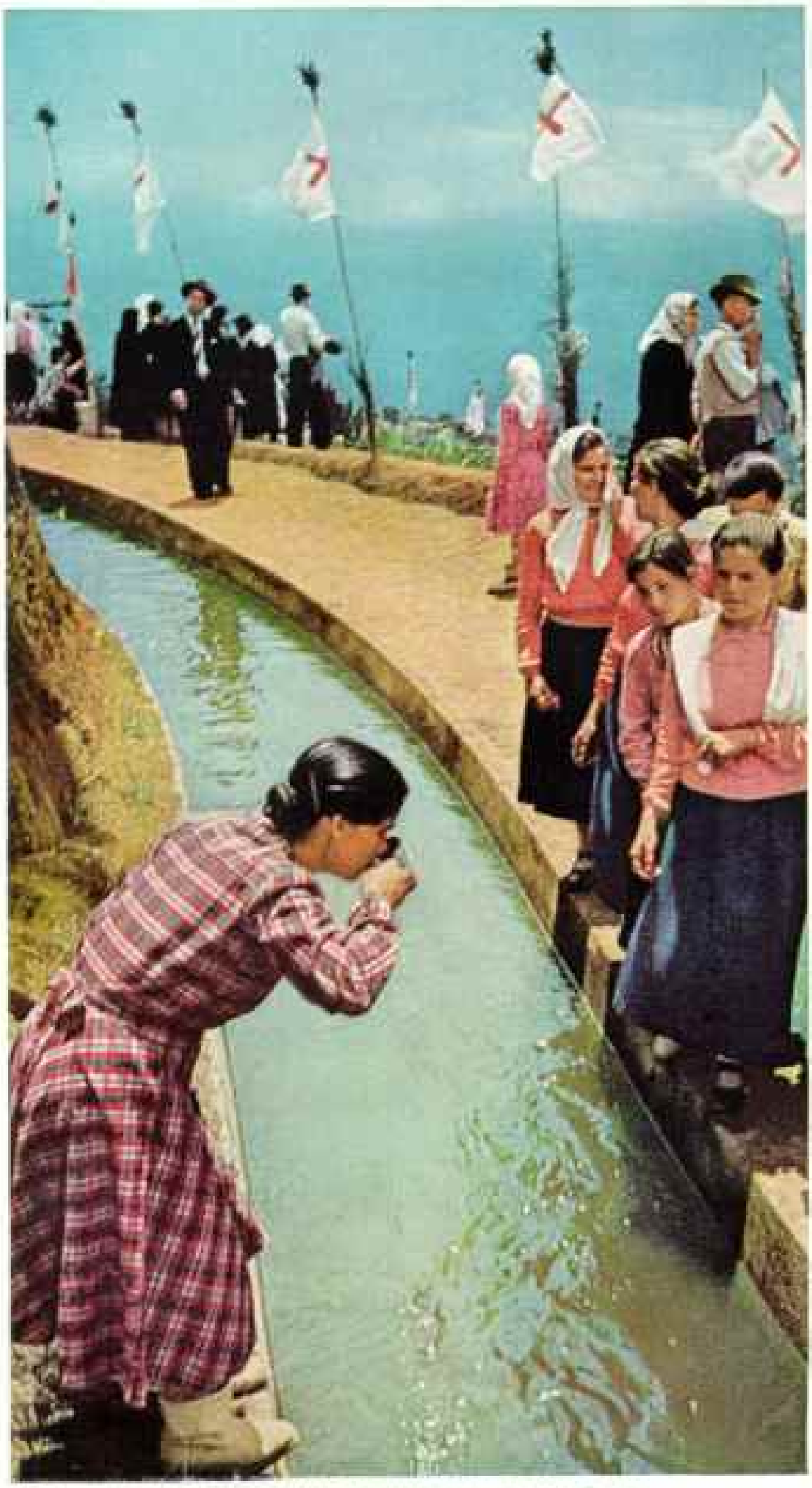
Camacha's sturdy porters still carry tremendous loads down the mountain on heads and shoulders. The Madeiran countryman, accustomed to climbing since childhood, seems tireless. A 200-pound load for a man or a 150-pound one for a woman is not uncommon.

Happy Madeirans Cheer the First Trickle in a New *Levada*, or Watercourse

Lush vegetation deceives the visitor, for it suggests an abundance of rainfall. For the most part, only the uplands are well watered; lowland slopes support luxuriant growth by a tremendous canal system that brings water from the mountains.

For hundreds of miles the stone-and-concrete channels creep along sheer rock faces, traverse ravines, and tunnel through mountains. Engineers marvel at the ingenuity and bravery that made them possible.

Here, near Ribeira Brava, farmers and Funchal officials join in the dedication of the island's largest levada. Its 33-mile length, passing through 31 tunnels, cost the lives of 35 men.



Farmfolk sample their new water supply.

When a man buys farmland, he also acquires the right to irrigate with levada water on certain days. Arguments about such rights cause most of Madeira's litigation.

Untold water power lies untapped in the levada system. Hydroelectric stations along a series of new channels are bringing electricity to every part of the island.

Hikers who can stand dizzying heights find the levada pathways a magnificent challenge. Flower-banked walks, sometimes no more than a foot wide, lead to scenery of the wildest variety (page 388).

Village girls do the family wash in a levada branch that waters their garden.

Men dance in old-time pigtail caps and yellow boots. Today's islanders prefer black for ceremonial dress, but these performers cling to the more colorful national costume: striped skirts and capes for women, baggy pants for men.

Singers sit beneath a tasseled instrument resembling a parasol. Made of wood and paper, it is called a *brinquinho*. The pull of a string claps its castanets and jingles strips of metal. Red ear patches ornament the men's skullcaps.

one of the most thickly settled agricultural areas in all the world. Every year a large crop of emigrants must be skimmed off. Otherwise it would soon become impossible for all to scratch even a poverty-level existence from the island's steep mountainsides.

Thus, impelled as much by necessity as by inclination, Madeirans have become inveterate travelers. Emigrants flock to South America, Africa, the United States, and Canada. Sometimes they come home again to a leisurely retirement in their native villages; it is not unusual to hear the broad *a* of a Massachusetts accent in a remote Madeiran hamlet. But more often their tie to the island takes the form of money sent regularly to stay-at-home members of the family.

Thatched Huts Guard Cows from Evil Eye

Invisible income number two is even less in evidence to the casual visitor. It was not until we met Alberto Relva, Ivo de Costa, and Antonio Monteiro of the Government Dairy Board that we learned of the key role played by the Madeiran cow.

And no wonder. You can drive for hours in Madeira without seeing one. Yet there are thousands of cows on the island, producing nearly five million gallons of milk annually. Most of it becomes canned butter, eagerly sought in European markets.

Land in Madeira (sold for as much as four to eight dollars a square yard) is far too valuable to be used as pasture. More important, the family cow must not walk alone, or she might fall off the family terrace. And, finally, if she is a good cow, she must not be exposed to the envious glances of neighbors. The evil eye still lurks in Madeira.

So this prize source of pocket money covertly chews her cud in a little thatched hut near the peasant's house (page 382). She is attended like a queen. Her food is cut for her on the cliffs, and all too often a member of the family loses life or limb while foraging for the cow's supper.

Three centuries of British influence upon Madeira have made the English language almost as common as Portuguese. But Ivo de Costa, like many another educated Madeiran, often lapses into French when he talks with foreigners. It is, he explained, more compatible to his Latin tongue.

Turning from the main road, Ivo stopped to shift his new jeep into four-wheel drive.

"*Une merveille américaine,*" he commented, patting the top of the dashboard affectionately.

It was not surprising that Ivo thought his jeep an American marvel. The road ahead, built of chipped chunks of basalt hammered tight into wavy steps, went up like a stairway into the Madeiran clouds.

We passed porters trudging up and down beneath gigantic baskets loaded with potatoes. Madeirans, Ivo told us, are trained to carry from childhood. Boys from six to fourteen, and girls too, proudly inform you that they can shoulder their own weight in firewood, fodder, soil, or vegetables, and they do it half a day long (page 379). The other half day most of them are in school, in conformance with compulsory education laws of recent vintage.

Madeirans work from dawn to dark. Their labor is hard, and their material possessions meager. Yet I found them nearly always ready with a smile and a greeting, nearly always contented, and sometimes even happy. They have discovered some great secret about life, these Madeirans.

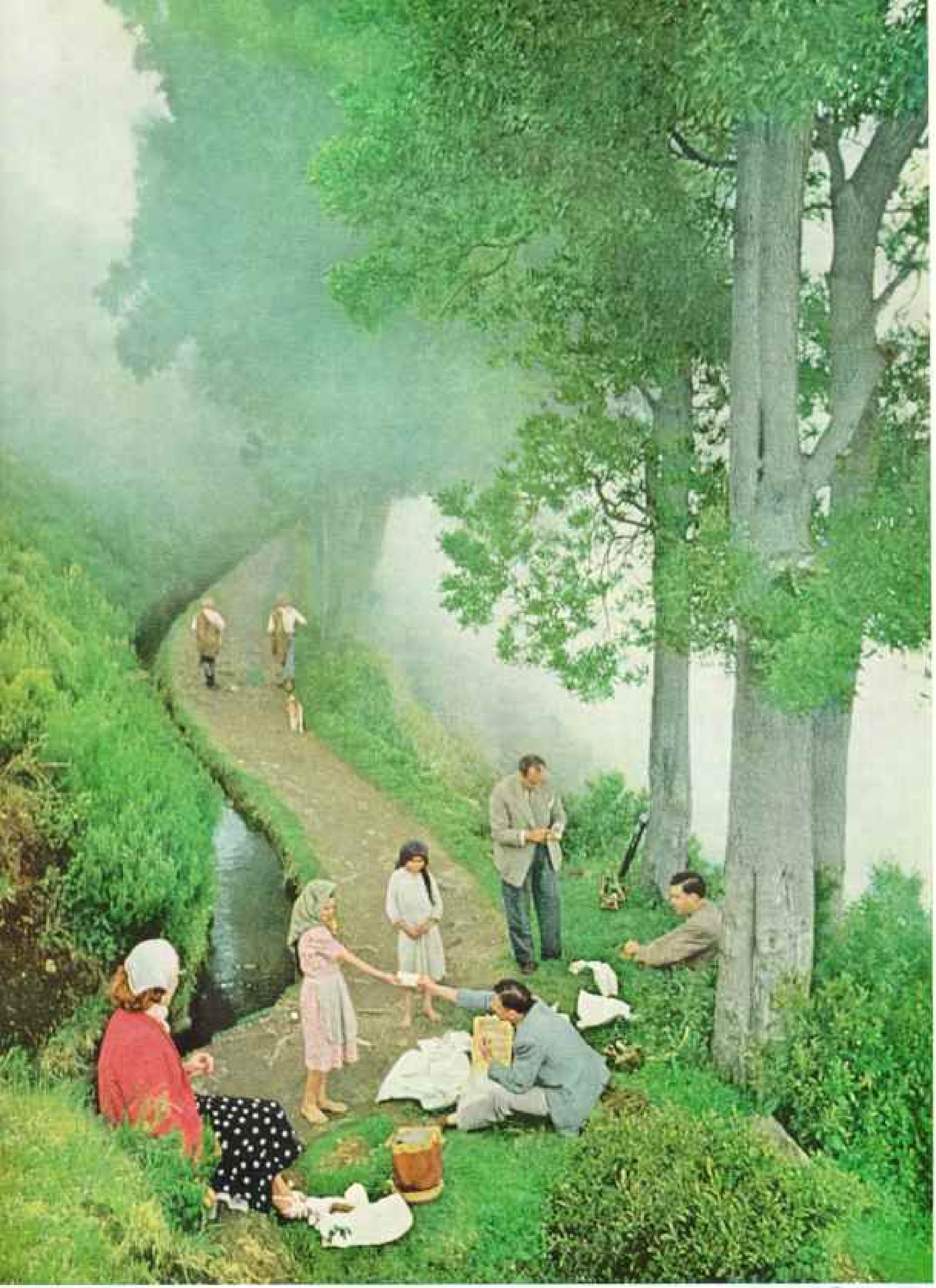
The island's blue-gray volcanic rock provides material not only for steps and roads, but for houses, barns, canals, and the terrace walls that make it possible to bring Madeira's steep mountainsides under cultivation (page 380). Farmers first scrape away the surface soil, then break away the rock beneath it. When the retaining wall is finished, they laboriously carry the soil back up, basketful by basketful.

Canal Builders Swing by Rope Harnesses

Even then, the work remains incomplete. Irrigation of the terraces is a project so ingenious and painstaking that it ranks as the greatest achievement of these hard-working islanders.

Honeycombing the land, from the mountain springs to the lowest farm lapped by the sea, run Madeira's famed *levadas*, or watercourses. Hundreds of miles of these canals, built of cement and stone, collect precious water from sources in the mountaintops and distribute regulated portions to each terrace and each farmer.

We walked through levada tunnels cut for nearly half a mile through solid rock, or winding along the faces of perpendicular cliffs (page 388). Many of these hard-won arteries were chiseled by workmen swinging perilously from the heights in rope harnesses. Others were built by untied daredevils who,



GOUACHROME BY NATIONAL GEOGRAPHIC PHOTOGRAPHER B. ANTHONY STEWART © N. G. S.

Watteau or Fragonard Might Have Painted This Misty Landscape

Clouds that so often settle on Madeira's heights obscure the scenery but condense into irrigation water. The author shares his lunch with hikers along a levada trail.

for less than a dollar a day, cut a 24-inch work path as they advanced the channels along the cliffs.

"You'll get over your fear," a young levada engineer assured me when I swallowed hard at the thought of walking along one of these dizzying paths. "Always look up," he warned. "The real hazard is not dizziness, but the danger of being hit by falling rocks.

"New levadas are a boon to Madeira in another way," the engineer told me. "Spillways and power plants are ending the necessity for Funchal's importing oil to produce its electric power. Small hydroelectric stations along the levadas are already in operation."

Time Reckoned by Saints' Days

The islanders, I am sure, could not live without fireworks. Every *festa*, every happy religious occasion, is machine-gunned with explosions. Madeirans, in fact, seem to survive only for the joy of the next feast day; their lives revolve around the great ceremonies and celebrations of the Catholic calendar.

Time itself bows to this preoccupation with saints' days. "I will come to see you in Funchal during Sant' Antonio's," an islander promises, and his friend knows that he must not expect his visit until June. Even the past is ordered and remembered by saints' days.

"How old is your baby?" I asked a smiling fisherman one day in Câmara de Lobos.

"He was born just after Santo João," the man said proudly.

As though defying the harsh realities of everyday life, the islanders cling stubbornly to the last minute of their beloved festas. On Monday, though a celebration may be officially over, not all Madeirans recover sufficiently to go back to work. The holiday is consigned to history with reluctance. Leftovers must be finished, and, of course, more wine consumed. And toward late afternoon, when it has become clear that the feast has been wrung dry of its last drop of excitement, there remains one more excuse for a procession.

I ran across it quite by accident after a feast in Camacha. Our car rounded a turn in the mountain road to be stopped by a parade of disheveled men in funeral step. Accordions and guitarlike *machetes* wailed a lugubrious march; the clean-picked bones of cattle eaten at the feast rode on a plank among a dozen pallbearers.

One final gulp of wine, they told me, would see the bones into the grave. Tomorrow would be time enough to go back to work!

Madeira's fame, first and last, has stemmed from wine. As long ago as 1478, George, Duke of Clarence, received a death sentence for plotting against the English Crown. Not long after his demise, rumors circulated that he had paid for his crime by being drowned in a butt of Madeira's mellow malmsey—not too sad a fate, in the view of some connoisseurs.

Today the island exports nearly three million quarts of its famed apéritif and dessert wines annually. While America and the British Empire were at one time the main markets, today the largest share of Madeira wine goes to Scandinavia.

For those who have tasted the wines of Madeira—the rich, sweet malmsey, the bittersweet bual, the fruity verdelho, the dry sercial—it must be explained that Pedro, the Madeiran villager, does not drink these heady draughts. Pedro gets the cheap *vinho claro* or, for a little more money, wines to which a minimum of alcohol has been added.

Madeira Wine Improves with Travel

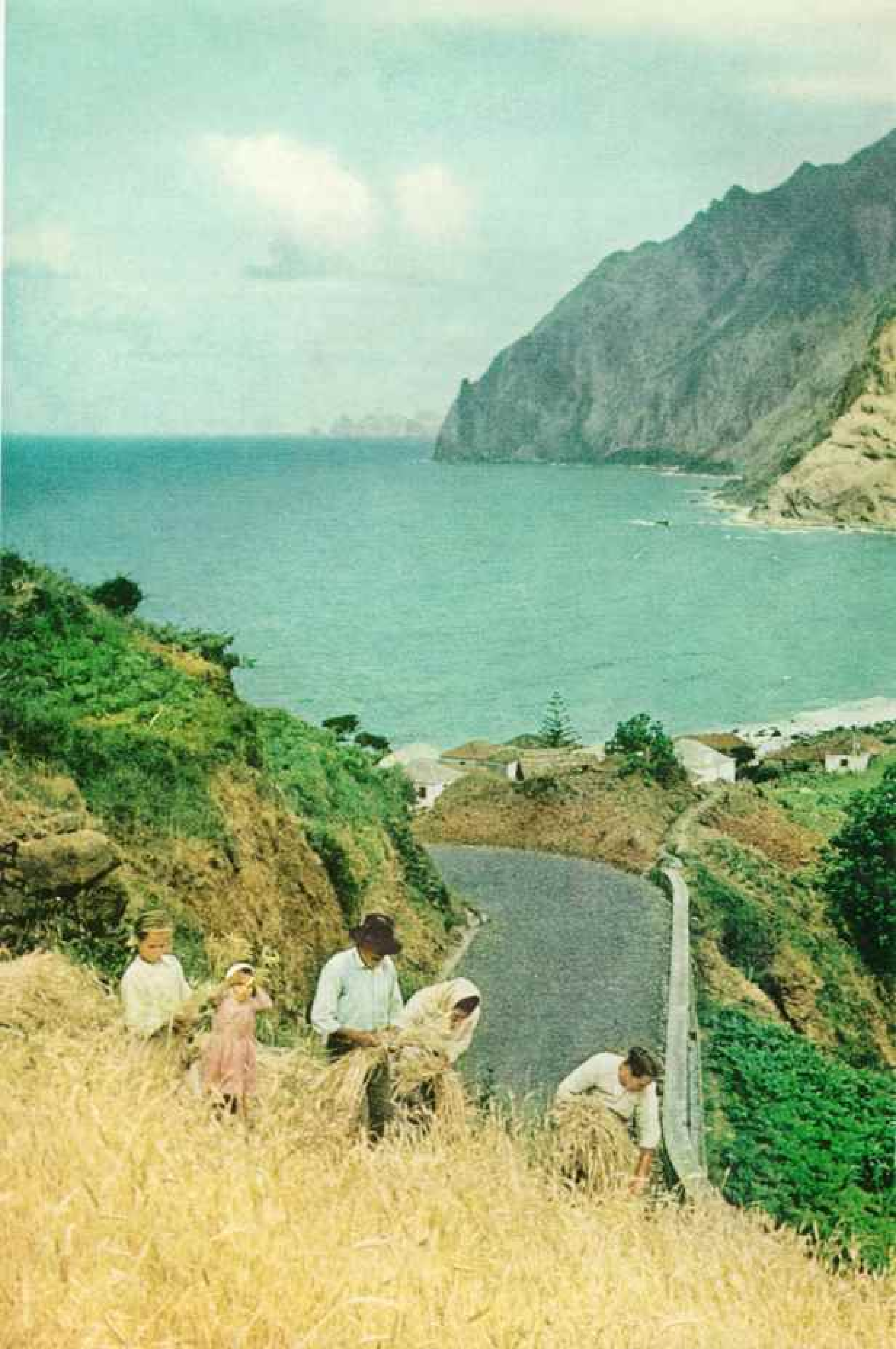
But the vintages that go abroad to represent Madeira are another matter. Ferdinando Bianchi of the Madeira Wine Association invited me to sample some of his best. They had undergone treatment and aging and blending far beyond the average islander's pocketbook.

Early in the history of Madeira a great discovery was made. Trading ships carried wine around the Cape of Good Hope to the East, and some of it came back unsold—after a year or more in the stifling holds of the vessels. Surprised bibbers found it better than ever.

Today Madeiran wines are subjected to the same high temperatures and humid atmosphere in incubating chambers, or *estufas*. In addition, they are fortified with cane-sugar alcohol, a product of the island's terraces and of Funchal's sugar factory. The secrets of aging and blending contribute, too, to the distinctive bouquet of Madeira. Each winery is convinced that it alone possesses the formula of perfection.

Wheat Harvesters Above Faial Pay Little Heed to Scenic Vistas

Climate permits three crops a year. This hillside will be resown as soon as it is scythed.



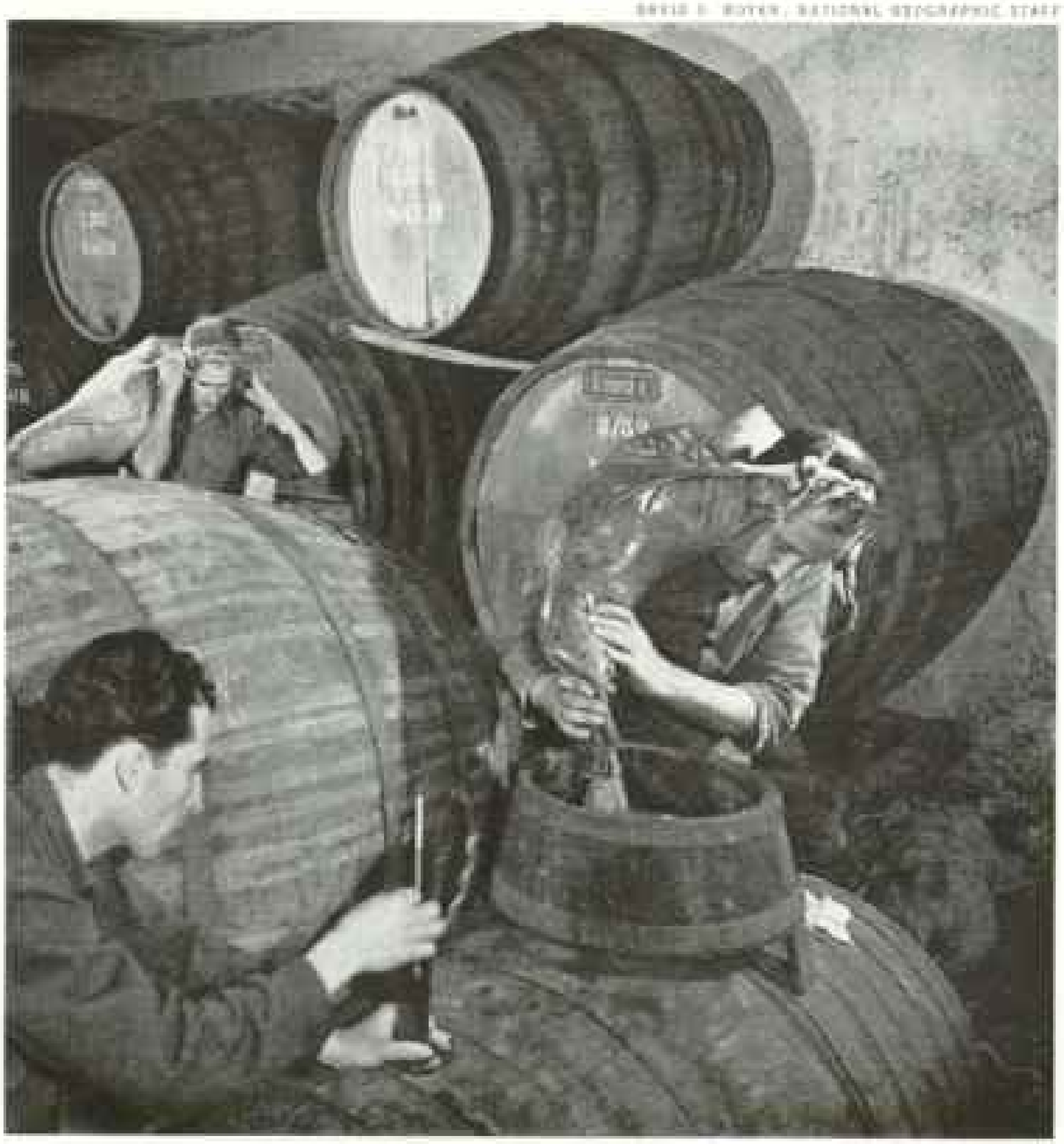
Grape-harvesting time in September is a time of work mixed with merriment. Often all the members of a family, freshly scrubbed and in clean clothes, jump into the wooden pressing tank, singing as they trample the vintage, while a machete plinks out the rhythm for their dance. If a child slips and falls headlong into the mash, it only adds to the fun.

Porters Shoulder 100-pound Wineskins

For centuries, Ferdinando told me, new wine has been transported to the Funchal cellars in goatskins. Wine carriers shuffle single file like sheep down the mountains, carrying skins that weigh more than 100 pounds. Their sons troop alongside with lunch baskets.

Madeira wines keep remarkably well. An occasional lucky visitor may even have the privilege of sampling a 150-year-old vintage from the cellar of a pioneer family.

"Madeira" and "wine" are almost synonymous. Vines transplanted from Crete started the industry, which has flourished for more than five centuries. The island annually exports nearly three million quarts of its rich, sweet dessert wines, chiefly to Scandinavia. In the old days porters trudged many miles carrying goatskins of new wine. The wine still travels on men's backs, but fine new roads now speed its way to the fermenting cellars of Funchal. The man at left checks sugar content.



Madeira's embroidery, like its wine production, is a home industry. We saw it conducted beneath the trellises and on the stairways of peasant cottages throughout the island. There, while the men are in the fields, women gather to gossip and to fashion the island's famed embroidery (page 372).

It is an occupation they learn in childhood and do not relinquish until years later, when their eyes are too tired to see, or their fingers are no longer nimble enough to perform the intricate stitching.

Tony and I visited a school in Machico where peasant girls of kindergarten age studied reading and writing in the morning and embroidery in the afternoon (page 373). The delicacy of their artistic work, produced against a background of poverty by people who love flowers and beauty and color, reveals a sensitivity that seems a part of the very soul of Madeira.

A hundred export firms distribute patterns and materials to the 70,000 embroideresses about the island; their pay is one escudo (3½ cents) per 50 stitches. The finished pieces are collected for shipment in Funchal offices, where we watched inspectors examining the quality of each piece before approving it for sale.

The arrival of a cruise ship diverted Funchal from quiet basking under the sun into a frenzy of movement. Gay-colored taxis drew up at the pier. *Carros*, ox-drawn passenger sledges, joined them (page 367). Flower girls in the island's traditional scarlet costume converged on the port. Souvenir shops hired extra clerks. And everyone with nothing else to do came down to meet the ship.

One morning I joined a fleet of seagoing salesmen to besiege a ship at anchor off Funchal. Dozens of tiny craft like the one I was on—laden with em-

PHOTOGRAPH BY DAVID S. BOYER, NATIONAL GEOGRAPHIC STAFF © N. G. S.

Seagoing Salesmen Offer Embroideries; Excursionists Shout Their Bids

Funchal boatmen, besieging cruise ships, jockey for position to show the island's famed needlework. Cash and linen embroidery change hands by basket (upper right).

PERSEVERANCE PHOTOGRAPHS, LTD.

Flash and Thunder over Funchal Bay Salute the New Year

Madeirans celebrate holidays with massive displays of fireworks. Strings of lights underscore the pyrotechnic display; ships' horns wail a farewell to the old year.

broideries, baskets, fruit, wine, wild canaries, and inlaid woodwork—clustered below the passenger promenades. The hawkers shouted their wares and argued prices in a mixture of Portuguese, French, English, and sign language.

After a few weeks on the island, Tony and I felt that the Madeirans had adopted us. Now we could enjoy the show staged for other visitors with a smug sense of belonging.

Madeira Wants More Visitors

Unfortunately for an island that needs dollars, francs, pounds, and escudos, the flow of tourists has fallen off in recent years. The fault is not with Madeira itself. It is with her inadequate facilities for the berthing and supplying of large vessels.

A new deepwater port is Madeira's primary need. One of the most ardent campaigners for this cause is Portugal's former Ambassador to the United States, Dr. João A. de Bianchi, a native of the island.

An airfield is another touristic necessity. The Portuguese Government, somewhat bewildered—not to say bedeviled—by Madeira's mountainous terrain, has started to expropriate land near Santa Cruz, 10 miles from Funchal, for an airport, but both projects present serious financial problems.

Fortunately, the very pressure of people who want to visit Madeira will almost certainly have its effect. If enough foreigners with pockets full of assorted currencies want to visit this lush paradise of the Atlantic, islanders will find a way to welcome them by boat or plane.

For Madeira *is* appealing, in a way that wrenches the hearts of all who see it. It is an island of dreams—but dreams come true.

I recall a peculiarly Portuguese word, *saudade*, which means "memory imbued with longing." All who have visited Madeira, from Zarco the Blue-eyed, who sought undiscovered continents and seas beyond Portugal's horizons, to travelers who toured Funchal last month, have left this green island with saudade indelibly graven on their hearts.

Cormorants and boobies, most valuable of wild birds, give South America a multimillion-dollar guano industry

Peru Profits from Sea Fowl

By ROBERT CUSHMAN MURPHY, D.Sc.
Lamont Curator Emeritus, American Museum of Natural History

Photographs by the author and Grace E. Barstow Murphy

THERE'S an appropriate noise, I thought, as *Chincha's* whistle split the gray dawn's stillness. It sounded for all the world like Monday morning at a Pittsburgh steel mill.

We had arrived at one of nature's most marvelous factories—Macabi Island. *Chincha's* whistle was not, however, signaling the start of a new shift, for in this factory there are no shifts, no holidays, and production never ceases; yet its workers have never gone on strike or demanded a raise and wouldn't understand a pension plan if they saw one.

Macabi is one of the rocky sea-bird sanctuaries strung like beads along the coast of Peru (map, page 401). These islands are the homes of tens of millions of the birds called *guanayes* and *piqueros*, whose deposits of guano are one of Peru's most treasured assets. Farmlands the world over have been enriched by Peruvian guano, probably the finest organic fertilizer nature provides.

Island Resembles a Pile of Feathers

Now I was to have my first opportunity to visit Macabi. In response to our motorship's whistled summons, a small boat came out from the island to take my wife Grace and me ashore. With us were Dr. Enrique (Hank) Avila, the youthful ornithologist of the Peruvian Government's guano conservation agency, and Dr. Frances N. Clark, an eminent California fisheries zoologist and a leading authority on the sardine.

As we rowed toward its bleakly inhospitable cliffs, Macabi appeared to be a gigantic mound of feathers, so thickly were its resident workers clustered. We glided beneath a suspension dock jutting from a shelf in the sheer cliff, and I reached for a rope ladder that led upward to safer ground and a fascinating spectacle of nature at work.

While scrambling to the landing, we thoroughly soiled our hands with guano. My rubber-soled shoes shot out from under me, and I came down with a hard bump, much to the detriment of my clean trousers. The wardens stopped sweeping the porch of their frame house to greet us with basins of water, soap, and towels. This is proper etiquette in guano land.

Safely aloft and washed, we looked over a compact island of 19 acres, cut in two by a deep channel. A suspension bridge spans the channel and, like everything else on Macabi, lay nearly hidden beneath the bodies of the birds. Like tufts on a wrinkled carpet, at least a million birds covered the ground and the roofs of the buildings. Crude fences kept them from spilling onto the porch of the house and through its open doors and windows. Guano encrusted every surface; its faint, not unpleasant odor of ammonia sharpened the damp, salty air.

"There are probably more birds per square yard here than on any other guano island," said Hank.

"But the government hopes to make room for more," he added, as we waded through a sea of sleepy, sluggish birds toward a cluster of guano sheds and laboratories. "We are thinking of covering the channel with a steel-supported deck to provide nesting space for another 150,000 pairs."

All about us were families of guanayes, or Peruvian cormorants, which rank first among the guano-producing fowl. Guanayes are big birds, 20 or more inches tall. They stand

The Author: Dr. Murphy, who will be 72 years old in April, has devoted his life to the birds of the ocean. As a boy he was fascinated by sea fowl in the vicinity of his Long Island, N. Y., home. For 28 years he headed the Department of Birds at the American Museum of Natural History in New York City.

When a National Geographic researcher asked the Smithsonian Institution to review this article, the Associate Curator of Birds turned to Dr. Murphy's own *Bird Islands of Peru* and *Oceanic Birds of South America*. "If these books don't verify the facts, nothing will," he said. "On South American sea birds, Dr. Murphy's word is it."

Clouds of *Guanayes* Feast on Anchovies off Foggy San Lorenzo Island, Peru

Other cormorants search for fish underwater, but the guanay, South America's chief guano bird, sights its prey from the air like a hawk, and hunts in vast flocks. *Anchovetas*, or anchovies, make up its favorite diet. The fish, weighing less than an ounce, abounds in the Peru Current. A bird colony may eat 1,000 tons a day.

Dried guano lined with moulted quills makes a nest for the guanayes. These nestlings display the birds' salt-and-pepper stage.

Inca terns brighten a rock. Chileans call them *monjas*, their name for nuns, who wear white linen at their throats.

erect, giving an illusion of formal dress with their cloaks of blackish-green feathers and vests of white. But concentric rings of green and red naked skin around their eyes give them a truly bizarre expression (page 396).

No guanay, it appears, ever looks happy at the nest, particularly in dawn's unkind light. His aspect is emphatically dour and morning-afterish.

The Macabí guanayes paid little attention to us. "Generally speaking," Hank explained, "the birds are tame on islets like Macabí. On the big ones, where we live and work in greater numbers, they have developed a natural shyness."

We leaned over the porch rail, our faces within four feet of papas, mamas, and fuzzy chicks. The adults wove their heads back and forth, giving us bored, bloodshot looks. The birds squabbled and bickered with neighbors in a rumbling, grumbling chorus. Whenever a youngster spilled out of its own cradle and trespassed on another family, it was roundly chastised and driven back where it belonged.

The parents picked repeatedly in the throat pouches of their downy young, perhaps to remove the worrisome feather lice that fasten themselves in the mouths of all guano birds. None, however, seemed to be suffering from the parasites. Macabí was inhabited by a healthy and fecund batch of birds.

Feathered scouts were beginning to take off from Macabí to search the sea for silvery ruffles that betray schools of *anchovetas*, their favorite food. Walking in Indian file, the birds shuffled down a shallow gully running from the island's crest to a cliffside retaining wall. Crowded like commuters awaiting a subway train, they leaped onto the wall and launched into flight with a frantic beating of wings. Thus the birds' day began.

White heads and bodies of a few piqueros, or Peruvian boobies, the second most valuable guano-producing bird, gleamed in the hazy glare on the fringes of guanay territory. We often saw piqueros power-diving into the ocean through masses of feeding guanayes. The birds fish together peacefully, though their vastly different techniques appear hazardous to both species. It seems a miracle there are no fatal collisions.

The piqueros are in every way the most dashing and appealing of the guano birds (pages 402-3). These white-bodied boobies with brown-speckled wings and backs circle about looking for prey, then plunge straight down like hissing hailstones. Thousands strike the sea at once, vanishing in spurts of foam that seem to leap up to meet them.

Ashore, the birds nest in such compact bodies that wardens measure rather than count them. Since the guanayes and piqueros require just enough space to defend their homes, three families normally occupy each square yard. Each pair, as a rule, produces a clutch of three eggs.

More Precious Than Gold to Peru

Our stop at Macabí was part of a serious and somewhat hectic quest. By ship, launch, car, truck, and plane, I was making a 3,000-mile reconnaissance of Peru's islands and desert coast for the Peruvian Guano Administration, in order to assess its program of conservation and to make recommendations for the future of the guano industry.

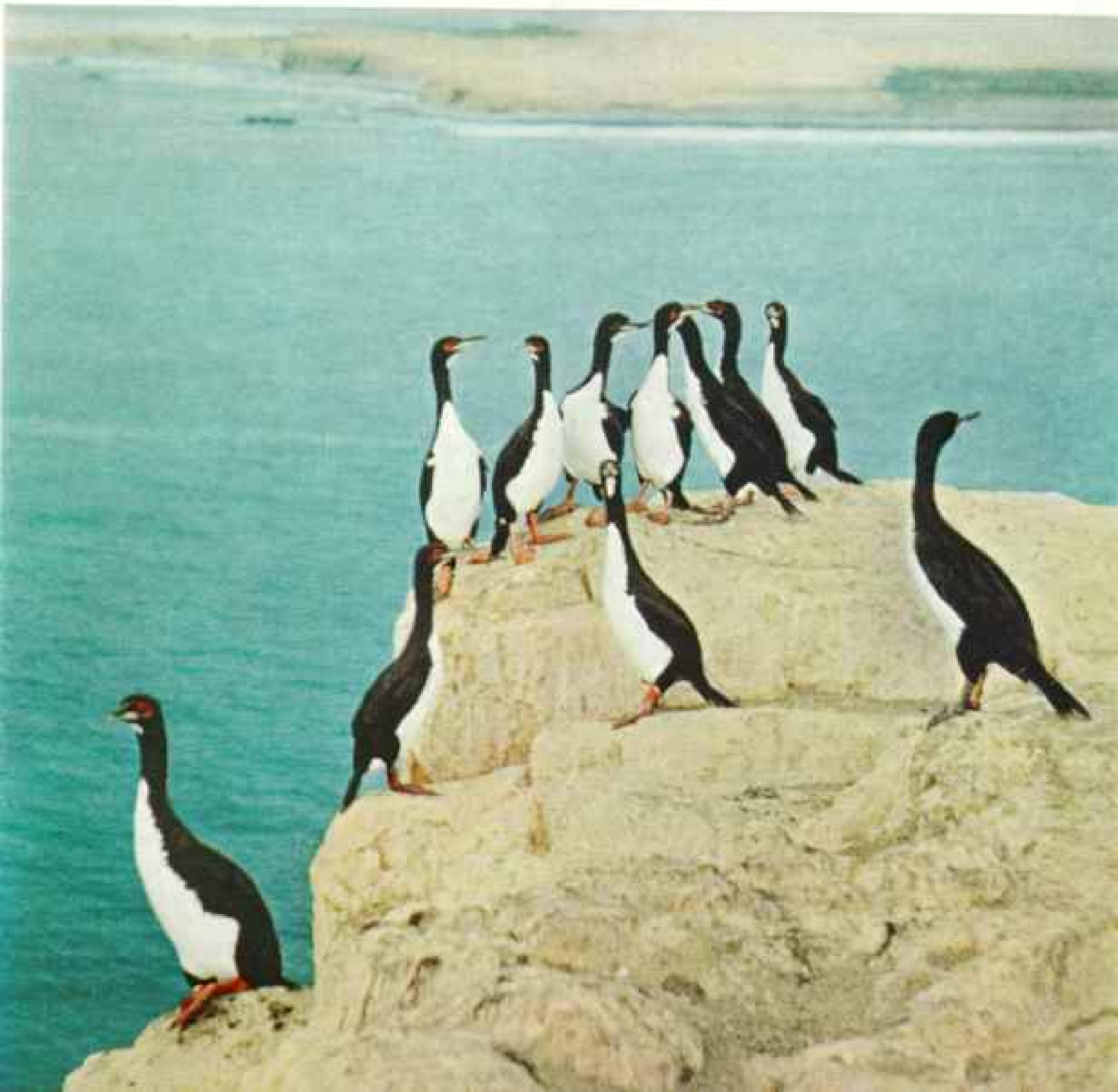
Many sites were familiar to me, for I had studied birds and guano production on dozens of isles in 1919-20 and 1924-25.* Now I was covering the entire guano coast from Máncora in northern Peru to the Chilean coastal city of Antofagasta.

This chain of islands—some of them mere platforms of low-lying rock, others jagged mountains leaping from the Pacific—supports the greatest guano industry in the world. Guanayes and piqueros exist in tens of millions—a winged population without equal elsewhere in the world. All along Peru's coast

* See, in the National Geographic Magazine: "Most Valuable Bird in the World," by Robert Cushman Murphy, September, 1924; and "Peru's Wealth-Producing Birds," by R. E. Coker, June, 1920.

One of millions, the guanay above streaks to its nest with craw crammed with anchovies. Nestlings tease the home-coming fisherman until it opens its bill. Two or three may dive together into the well-stocked gullet. Champion aerialists of the cormorant family, guanayes press against brisk southerly winds for hours on end.

White vests and swallow-tailed coats dandify guanayes on Don Martín Island. Because nature preserves their voluminous waste as guano, these are the world's most valuable wild birds. Peru harvests thousands of tons of the rich fertilizer each year.



Harvesters on Asia Island, Peru, break the crust with pickaxes. Each bowl-like mound is a guanay nest. Sacked guano slides down the distant chute. These Indians possess the burly chests of mountaineers. Inured to the mainland's altitudes, they work at the sea-level guano stations for only two or three months in the year.

I found growing bird colonies, modern guano stations, and fresh ideas at work. Guano is big business, and more precious to Peru than gold.

Laboratories stand at strategic stations. Thanks to research, the industry distributes a pulverized and stable form of guano. The improved product and better methods of spreading it represent notable advances.

The use of organic refuse to improve crops is probably almost as old as agriculture. Primitive peoples fertilized their fields with fish, seaweed, wood ashes, and crude chemical salts. But the droppings of fish-eating birds, when found under the dry climatic conditions that preserve the chemical properties of the guano, have long been recognized as the best of all natural organic fertilizers.

No Rain for 20 Years

The barren coasts of Peru and northern Chile are ideal for the production of fine guano, offering bone-dry weather and ample food for the birds. I once asked a guano worker when it had rained on his village.

"Rain?" he replied blankly, as if puzzled by an unfamiliar word. "Why, señor, I have felt no real rain on my back in 20 years."

The Andean barrier protects the west coast from rains that drench the eastern slopes. Thus no guano is washed into the sea, and the mounting deposits retain nitrogen, potassium, and phosphorus—the valuable elements of fertilizer.

The production of guano depends upon the Peru Current. Its cool northward-flowing waters are further chilled by upwelling that supplies food for countless anchovies. These small fish support the myriad birds specially equipped by nature to convert them into superb fertilizer.

Inca emperors valued the birds and protected them; it was unlawful to kill a guano fowl. Indians were forbidden under threat of death to land on the islands during the breeding season.

Guano 150 Feet Deep—2,500 Years Old

Gold and silver ornaments, stone carvings, wood figures, pottery, and textiles have been found embedded as deep as 60 feet in guano on Macabi and other islands. Comparison with similar artifacts from mainland sites suggests burial of the oldest of these relics in the ninth century. We do not know precisely when the Indians started mining guano, but we may be sure they were working the islands when Alfred the Great ruled in England. Since guano accumulates at a rate of about six

feet a century and the thickest beds had grown to heights of 150 feet before being removed in the 19th century, some deposits were made at least 2,500 years earlier.

Guano, however, is a relatively young commodity in international trade. About 120 years ago the world became aware of the magic stuff and demanded it, touching off an orgy of exploitation in Peru. Intoxicated by prosperity, the Peruvian Government pursued a single goal: Dig up the guano as fast as possible; ship it to the United States, Europe, and other parts of the world; count the profits.

No thought was given to the welfare of the birds that produce guano; no thought for the enormous time required to amass deep, rich deposits. The beds were regarded as an inexhaustible means of eliminating taxes.

No one knows exactly how much guano vanished. In the third quarter of the 19th century alone, the peak of mass exportation, Peru shipped an estimated 20,000,000 tons, worth two billion dollars.

With guano reserves depleted, Peru faced agricultural disaster—for the rich fertilizer is absolutely essential, together with irrigation, to support its farms. The fresh guano crop dipped in 1909-1910 to 48,809 tons, a minute fraction of the country's own yearly need.

A generation of alert and wiser Peruvians, lamenting the folly of uncontrolled exploitation, formed the Guano Administration in 1909 to restore, increase, and conserve one of their most precious natural resources.

Bird Cities Created on Mainland

Most guano islands lie within a dozen miles of land; so it was no problem for us to shift from ship to shore, from launch to truck.

At Callao we inspected a new guano laboratory with Hank Avila and Dr. J. A. Ocampo Rivas, Assistant Manager of the Guano Administration. The familiar ammoniac aroma from grinding mills filled the laboratories and an experimental plant where serious young men and women in white smocks sought ways to preserve the high nitrogen content of guano by desiccation and other techniques. Nearly naked workmen in sacking sheds looked as if they had been sprinkled with saffron.

With Dr. Ocampo we motored north along the coast to Colorado Point, where the agency

Moving north, the cool Peru Current provides plankton for the anchovies that nourish guano birds. Flowing east across the Pacific, the warm Equatorial Countercurrent branches north and south near the coast. Occasionally the southern branch, called *El Niño*, penetrates far to the south, killing billions of fish and the birds they support.

A living blanket of birds, *piqueros* cover lonely Hormigas de Afuera, Peru.

Piquero's Spanish name means pikeman, an allusion to the way it plummets into the water like a hissing spear. Known in English as the Peruvian booby, the bird ranks as the second most valuable guano fowl.

Ships shun these rocks, which lie 38 miles west of Callao. Small fishing craft use Hormigas de Afuera as a landmark. The name means Ants Offshore.

Dr. Murphy took the picture from a tossing lifeboat. Boisterous seas prevented his landing. Only on calmer days can Peruvians remove the guano.

Massed like Coney Island bathers, piqueros nest just beyond pecking distance of one another. More than a million birds crowd Peru's South Guañape Island.

Male and female piqueros look exactly alike to ornithologists. The birds find their mates and young with clucks, chatters, and horn-like notes.

This evening view of Guañape, in the author's words, is one of the "beautiful and spectacular remembrances of a lifetime."

has established one of the new bird cities. These mainland colonies are an original idea of the agency's second manager, Señor Carlos Llosa Belaúnde.

Normally the birds shun the mainland. On bare Pacific islands they can breed without fear of rats, feral cats, and *zorros*, the wild foxes of the coast. But since neither guanayes nor piqueros spend the night on the ocean, they must roost at mainland promontories if stranded far from their home islands.

Eight-foot Walls Protect New Colonies

Finding that guanayes often spent the night on a certain peninsula, Señor Llosa in 1946 ordered the construction of an eight-foot-high concrete wall to seal off the neck of the point and protect them. Wardens were stationed in the pen as an added precaution.

His experiment—simple yet ingenious—has had astonishing results. At mainland sites where birds once rested only in emergencies, they now live and breed in increasing numbers behind high walls. Some colonies contain millions of birds. Mounting guano harvests leave no doubt as to the brilliance of Señor Llosa's scheme (page 408).

To reach the mainland "island" of Colorado Point, our car sped over stark, hot desert under a burning haze. We looked across empty miles to the dim Salinas marshes and the vague expanse of ocean beyond. The auto churned up dust as red as blood. Weird hills seemed to tumble upon themselves, their hues of umber, buff, and brown veined by the limp, somber streamers of air plants and patches of gray-green lichens.

"This is the Desierto Colorado," said Dr. Ocampo. "Punta Colorada lies ahead."

Our driver braked at a high, overhanging concrete wall and sounded the horn. Strong timber gates swung open. The warden, who lives with his wife and children in a new cottage just inside the enclosure, waved us in and closed the gates.

The wall starts at the edge of the cliff and encloses more ground than we could see from our hilltop vantage above the sea. Dark clouds of guanayes fished in packs offshore, fanning out low over the waves. In the past four years the population of this bird city has increased from 61,000 to a million or more.

When we returned to *Chincha*, Capt. Roberto Garcia Trindade insisted upon giving Grace and me his cabin on the trim 800-ton guano freighter. The ship headed for an apt destination, the Chincha Islands at the outskirts of the Bay of Pisco.

Men and Birds Compete for Anchovies as Hungry Guanayes Besiege a Seiner

In peak years the Peru Current feeds an estimated ten trillion anchovetas off the Peruvian coast—more fish than all the stars in the Milky Way. In the rare year when the current is interrupted, sea fowl die by the millions.

Modern fisheries, grinding the anchovies for animal food and fertilizer, threaten to kill off the guano birds' staple diet, the author writes. Species of extreme gregariousness among both birds and fish, he says, must maintain their numbers or risk extinction. For instance, Dr. Murphy cites the passenger pigeon, which was doomed even while its flocks still seemed tremendous.

This boat, operating out of Ilo, Peru, uses nets instead of dynamite, which kills many more fish than necessary.

Some ships of the Guano Administration's extensive cargo fleet are named for guano islands, others for familiar birds. I recall the vessels *Alcatraz* (pelican), *Chuita* (red-footed cormorant) *Danzarin* (storm petrel), *Pinguino* (penguin), and *Terrecle* (tern).

The clusters of guanayes on North Chincha were fussy and shy, having just laid thousands of eggs. They are not noisy birds, individually, but the babel of their grunts and calls suggested the rumble of a distant subway train. We were cautioned not to disturb the brooding birds. If they were frightened away, gulls would rob the unguarded nests.

Chincha delivered us next day to Las Viejas Island, once a place where no guano birds bred. Now, protected by wardens, guanayes blanket the slopes of the island up into the cloud zone. The birds keep house in such tight quarters that pairs often appear to be one body with two heads.

A grizzled old man approached us. Unmistakably he was España, the head guardian, whom I had seen 35 years before on another isle.

"España," I asked, "how many guanayes here?"

He looked me boldly in the eye and said, "Eight million, señor."

I had no intention of arguing with that tough old customer. There probably are no more than a million birds on Las Viejas, but they looked like a billion.

Guanayes Have Their Morning Baths

A few nights later *Chincha* glided along a stark, wild stretch of Peruvian coast made ghostly by a covering of mist. At dawn we anchored in the lee of San Juan Point, the site of another walled bird city.

I was hardly prepared for the magnificence of the colony at San Juan Point. As we

CHARLES PERRY WEIMER

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Guanayes fly across the sunset to bed down on Santa Island. As darkness falls, the birds always return to land. Long after sundown one can hear the swish of countless wings. Clicking sounds announce collisions of wing tips.

Flying in undulating lines, this flock follows its leaders to the nesting colony.

Red tide surrounds the author's ship; similar "seas of blood" plague Florida. One-celled organisms called dinoflagellates sporadically multiply so that they redden the ocean. When tropical waters displace the cool Peru Current, red tide may occur, and fish flee or perish. Many guano birds then die of malnutrition.

tramped on cliffs above the pounding sea, fluttering rafts of guanayes made their morning toilets offshore, plunging into the waves with a violent threshing of wings to clean their plumage. Big Peruvian pelicans came and went, flying in dark files with slow and powerful strokes over the splashing and churning of the guanayes below.

Indians Play *Futbol* in Scorching Sun

Chincha sailed south to Coles Point and anchored on a Sabbath in a rocky cove. Ashore, it was not a day of rest. Guano gathering was at its peak. Rows of barrel-chested Indians swung their picks in rhythm, nibbling at a four-inch crust of white, sun-baked fertilizer. Unlike the deeper beds (page 412), this recent deposit was uncompressed by the weight of centuries. It extended from the water's edge to a distant wall. Sacks of guano covered acres. We were told that the crew of 1,692 men had already shipped 97,000 sacks, each containing 163 pounds.

At harvest time these Indians hurry down from Andean villages, unburdened except for cups and mess tins, to work under contract at standard wages (page 411). They get free food, medical care, bedding, and shelter—brown sack tents that give them ample protection against dew and mist.

Peru's midsummer sun turns Coles Point into an inferno. You can feel its rays biting into your skin. I was not surprised to learn that working hours begin at 4:30 a.m. and end at 11:30 a.m., but I was amazed when the Indians trotted onto the station's soccer field in the afternoon's broiling heat to amuse themselves at *futbol!*

Life on *Chincha* was pleasant. Hospitality of captain and crew was overwhelming. Between meals—formidable banquets in themselves—were sandwiched all sorts of refreshments. It was a problem to respect one's own capacity, yet avoid hurting the feelings of the stewards, who were dedicated to keeping us stuffed with delicious food.

On deck one day, Grace noticed sailors hauling in *lorna*, a basslike fish. She said casually, "They look delicious."

The remark was overheard. Accordingly, the first course at lunch was cold lorna with cucumbers. Very good. The second course was lorna soup poured over a whole lorna. Not too bad. The third course was fried lorna served with sliced potatoes. Discreetly, we skipped the fourth.

Leaving *Chincha* at Ilo, a port in southern Peru, Grace and I toured Chile's mountainous coast from Arica to Antofagasta as guests of the Chilean Fertilizer Society. Chileans, too, are building walled sanctuaries, hoping to profit by founding permanent bird colonies far south of the traditional roosts.

My wife and I flew to Lima for Christmas. I hardly recognized the old colonial capital. My memories were of a remote, sleepy time, of a mosaic of pink tile roofs sheltered by the Andes. Now Lima is a groomed, cosmopolitan city, sending wide new streets and garden suburbs into the valley. Fine new buildings stand at every turn.

The chambermaid at our hotel took for granted that we were vacationing and had the kindest concern for our welfare. "How did you enjoy the Inca ruins at Cusco? It's a fine season at Ancón, yes?"

"Well, actually," I said slowly, "we're touring the guano islands."

The maid gave us a dark, uneasy look. She was aware of the guano islands, but she had never heard of vacationers going there.

In Peru, a land that loves fun and laughter, even the guano service has fiestas. Just after the official holidays, Señor Llosa invited us to the agency's big outing of the year—a *pachamanca* on San Lorenzo Island for its Lima and Callao staffs. The pachamanca is somewhat like a clambake with a Latin accent—but no clams.

The party was going at full tilt when we boarded a launch and crossed to San Lorenzo. We could see pretty dark-eyed stenographers, clerks in shirt sleeves, and portly factory supervisors.

Hot Stones Cook Pachamanca Foods

We stepped ashore on the bunting-decked island just in time to see the food pit prepared. Wood fires blazed in a deep trench lined with bricks. Stones were heating on grids. Chefs cleared the pit, lined it with a mat of corn husks and coals, and tossed in yams, potatoes, corn, manioc, fish, chickens, ducks, and pork. Hot stones were tucked among the foods, and the potpourri vanished under a covering of more husks, overlaid with burlap bags and loose earth.

Everyone was in a sunny, expectant mood. The agency's guitarists struck up a twanging folk tune, and dancers swirled about them. A placard on a pavilion announced in Spanish, "Spitted guanayes, with unlimited helpings."

Punta Colorada's Eight-foot Walls Protect Nesting Sea Fowl from Wild Animals

Sea birds did not breed on the mainland until Peruvians in 1946 built barriers to protect them from rats, feral cats, and foxes. Walls open new

The sign was a joke, of course, lampooning the inviolability of guano birds.

While the food cooked, Señor Llosa gave employees of the Guano Administration an eloquent pep talk, all the more impressive because he spoke in melodious Castilian:

"*Amigos*, the key to the success of any *compañía* depends not alone upon leadership, but the spirit of all the people who work together. We are gathered here on this glorious sunny day, honored by the presence of distinguished guests, to have fun. . . ."

The throng shouted, "Bravo!"

The speech continued, "And now we must say farewell to two members of the Compañía Administradora del Guano, men who have given 35 years of loyal service, men whom we shall miss more than words can say."

The fiesta coincided with the retirement at full salary of two aging employees, who were swollen with esprit de corps and tearful pride. Señor Llosa presented each with a wrist watch, an alligator purse, and a scroll.

Waiters, meanwhile, had opened the pit and were carrying platters of steaming, mouth-watering food to a long table on a porch near the beach. A bottle of wine stood beside each plate.

The feast was prolonged with toasts, more speeches, and jokes, especially about the flurry of fine feathers that drifted from the guanay colony on the hills above like airborne soap bubbles. They speckled our hair, floated lightly on the wine, changed the tablecloth from starch-white to gray.

Rough Seas Pound *Chincha*

The following dawn found *Chincha* wallowing in heavy swells near the island cluster called Hormigas de Afuera—Ants Offshore. Piqueros tufted the crown of the main islet (page 402). Flights threaded in and departed, mostly toward the mainland. Less numerous flocks of Inca terns huddled on rocks in the boiling surf, popping up like puffs of gray smoke when a roller threatened them (page 397). Rough seas precluded our putting a party ashore.

On Don Martin Island (page 399), a major research center directed by Hank Avila, we observed a tedious job with far-reaching effects. Wardens, performing a daily chore, herded a thousand shrilly protesting guanay chicks into a corral and snapped a numbered aluminum band on a leg of each.

The banding of birds, commenced in Peru by the American ecologist Dr. William Vogt, has given science vital, often surprising, facts about guanay movements and life span. Marked birds have appeared, unexpectedly, all along South America's Pacific coast.

A decade of banding indicates guanayes are short-lived. Various other species of the normally long-lived cormorants have survived in aviaries 20 years or more. But most guanayes die within three years.

The brief lives of these gregarious birds and their extravagant success at reproduction seem to be related—a point that requires further research, however. A guanay lays three eggs in a clutch and rears an average of more than two young. Individual pairs are believed to raise two broods a year.

Fish and Fowl Feed in Green Sea Pasture

Wardens of guano islands and mainland preserves keep records of birds' seasonal activities. They note movements of other creatures in coastal waters. This information is correlated with records of changes in ocean currents, winds and clouds, barometric pressure, and sea and air temperatures for planning guano operations seasons ahead.

Obviously, the present solid footing of the guano industry rests on much more than the mere protection of birds. I found that it has grown through the greater understanding of such natural factors as weather, oceanic conditions, and the interdependent life of the sea. All these affect the birds.

Guano fowl remain healthy and productive only as long as normal weather prevails. On the littoral of Peru and northern Chile, this means little or no rain.

In normal times the belt of cool ocean water known as the Peru Current streams northward with abundant food (map, page 401). It is a lush pasture of minute plants and animals that support larger organisms, including anchovetas, the birds' staple food.

At intervals, frequently in cycles of seven years, the weather may change. Rains spat-

A Gunny-sack Army Breaks, Bags, and Totes Guano on Las Viejas Island

Because the slope is too steep for rails, Indians carry the fertilizer to a seaside loading platform. A sack draped over the head cushions the burden and prevents its slipping. Centuries ago these men's ancestors performed a similar task under the Incas.

GONZALO DE REPARAZ

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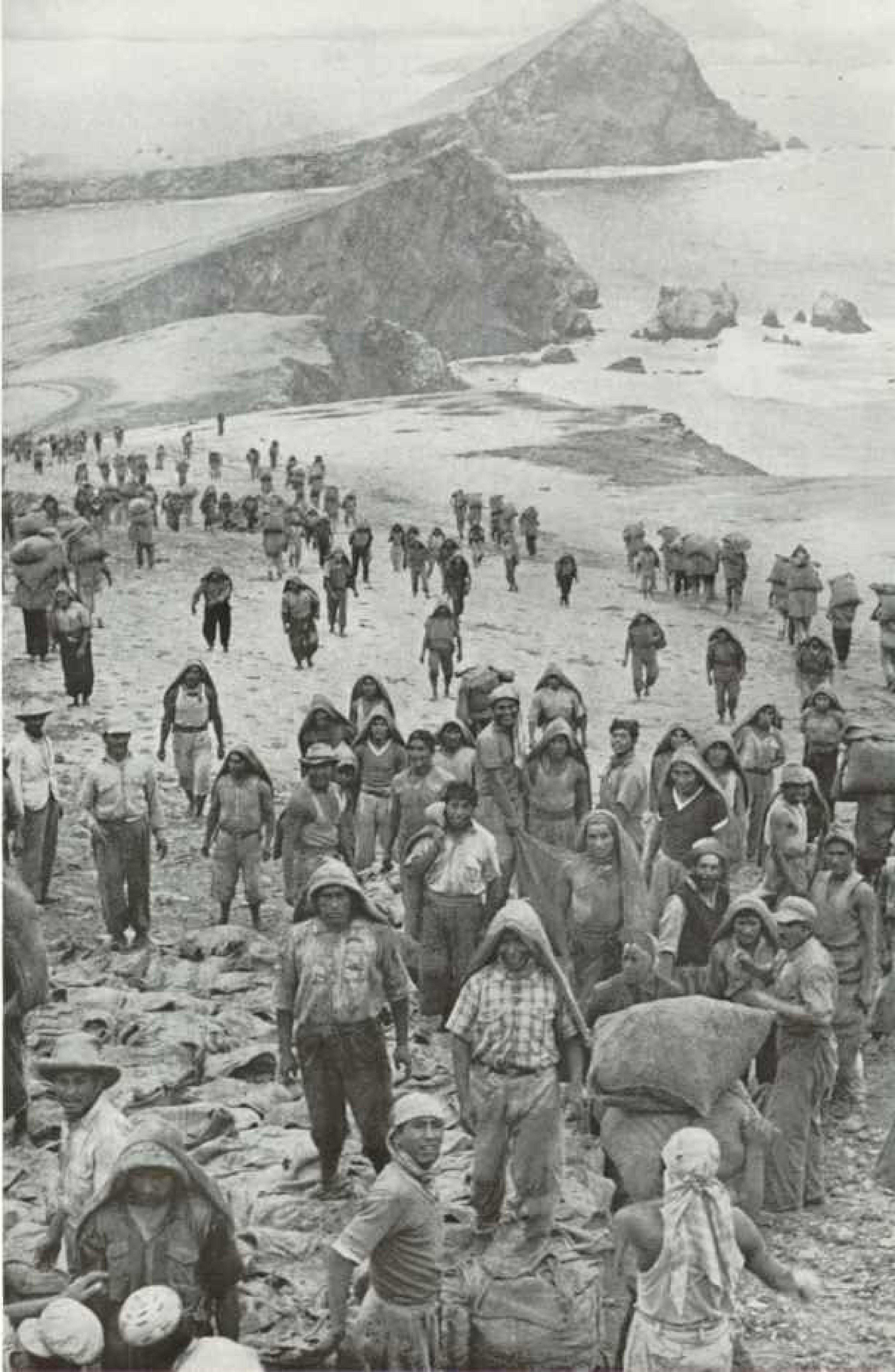
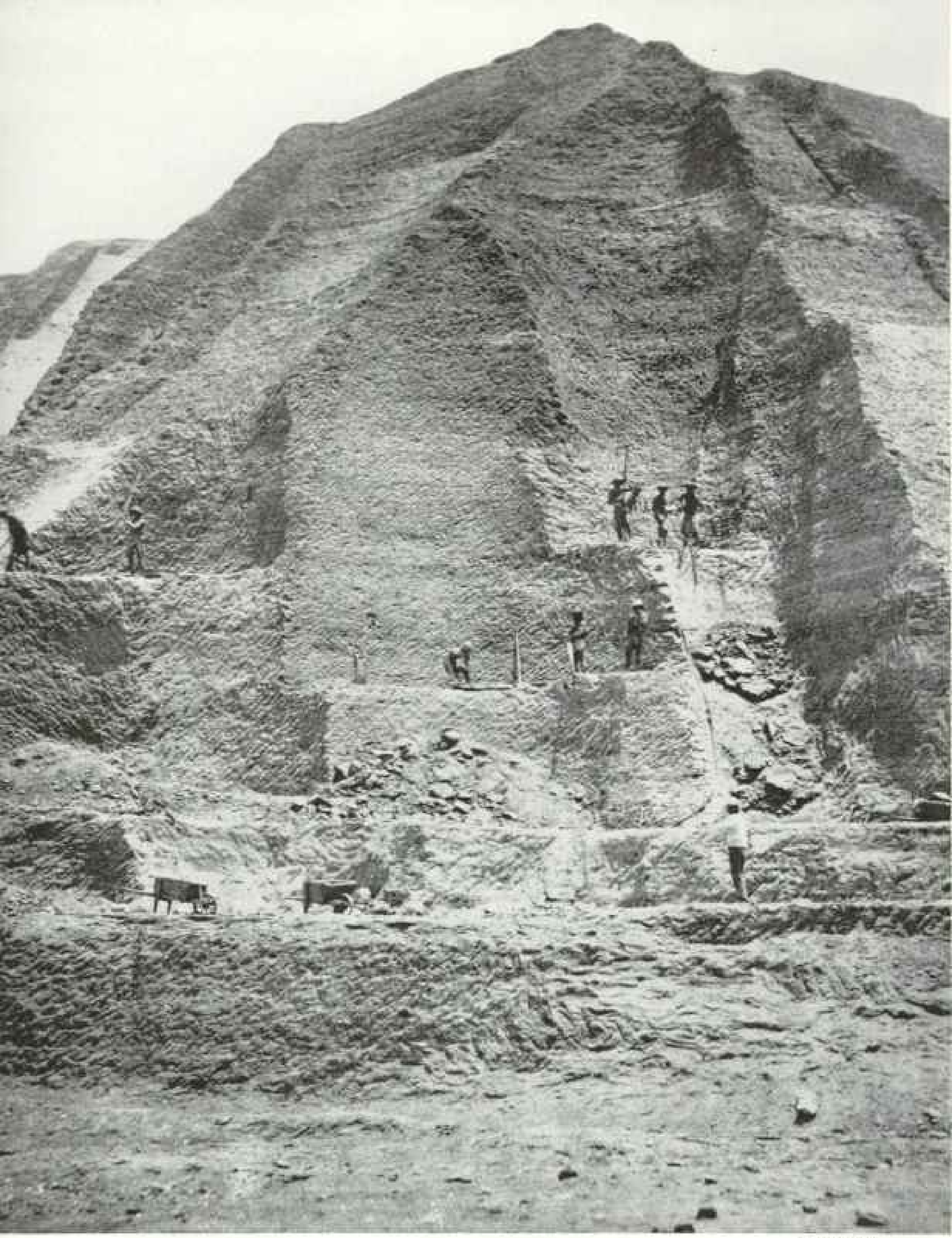




C. B. KEEHNEN

Birds built a mountain of guano on Central Chincha Island in two and a half millenniums; men carted it away in a few years. An orgy of exploitation in the 1860's stripped Chincha of its valuable cover. Measured against the workers, the heap exceeds 65 feet. In some places the guano rose twice that high above bedrock; earlier digging reduced this pile. This old photograph shows Chinese laborers at work.

ter north and central Peru. A warm and deadly current from the tropics, called *El Niño* —The Child—because it usually appears near the Christmas season, surges southward along the coast, heating the cool ocean waters and searing the green pasture.

Havoc results. Marine life perishes. Hydrogen sulfide bubbles as a putrefactive product from the sick sea. Mariners call the phenomenon "Callao Painter," because it turns white paint on a ship to an ugly brown.

Warm Current Deranges Guano Birds

I saw this tragedy strike Peru on an earlier trip. The whole pyramidal structure of sea life toppled like a house of cards. Decaying fish littered the beaches; the stench drifted to distant villages. Bodies of countless guano birds washed ashore. Their deaths were not necessarily due to starvation but rather to infections that overtake wild creatures whose vitality has been sapped.

Survivors or temporary survivors acted strangely, exhibiting a mass hysteria that drove some of them northward beyond their proper range into the humid equatorial region and even far inland along forested rivers of Ecuador. Such ecological disturbances have caused Peru's guano harvests to drop sharply six times in the 20th century.

Since the Painter occurs only at rare intervals, the extension of bird colonies, particularly out of its range in southern Peru, will multiply annual deposits of guano and ensure the supply. Crops should increase in direct ratio to the addition of nesting sites, as long as guano birds can find the enormous amount of anchovetas they require—now estimated as high as 3,000,000 tons a year. Food is not a problem—yet.

Anchovetas, however, are vanishing into a vast new maw, factories that grind them into fish meal for cattle and poultry food. As most of this is exported profitably, fishing companies have exerted pressure on the government to regard the industry as a valuable off-season source of revenue.

This exploitation threatens both the guano business and the regular food fisheries, for anchovetas support large food fish like bonito and tuna, as well as birds. Nature does not allow animals to overeat their prey, but no such margin of safety governs the taking of anchovetas for fish meal.

Since our voyage to Peru's paradise of birds, I have learned that the Peruvian Government has imposed curbs on the industrial use of anchovetas to "guarantee the exploitation and perpetuity of the marine riches."

The Guano Administration is not engaged solely in exploiting guano; it is working hard to build up the supply. Crop removals never exceed the limitations imposed by nature. Guano officials realize that the annual yield cannot remain steady; they know that operations must be attuned to climatic periods. Therefore, they keep watchful eyes on any circumstances which might disturb the rhythm of the guano birds' life cycle and reproduction.

The export of guano was halted in 1942, for instance, after the Painter had struck and killed many birds. As the populations of guanayes and piqueros recovered, guano reserves built up.

Since the agency took the guano birds back into partnership with man in 1909, their place has remained secure. Out of the wreckage of the past, out of lessons bitterly learned, a great and constructive industry has fully evolved. Today Peru's guano islands and walled cities are by far the most impressive bird sanctuaries of their kind in the world.

Chincha Rides the Red Tide

Our trip was nearly over. *Chincha* nosed into crowded ports, sailed on landless tracts of shimmering green sea. Counting earlier excursions, my roster of personally inspected isles rose to about 50.

Near Lobos de Afuera Island, the vessel cut through patches of red tide (page 406). Occasionally seen in northern Peruvian waters, this tide occurs along with the Painter.

The last day aboard *Chincha* was perfect. We made a sentimental journey to South Guañape Island, most striking of the magnificent piquero strongholds. Memories of it had lingered with me since 1919 (page 403).

We tarried on the cool heights of South Guañape until sunset. The darkening sea framed the larger island of North Guañape and beyond that a dim, mountainous promontory of the Peruvian coast. All about us, the afterglow warmed the gleaming white plumage of hundreds of thousands of birds to pink and finally made each body a glowing spark.

The scene stands out in my mind as one of the most beautiful and spectacular remembrances of a lifetime. I doubt whether there was another scene in the world, on that January evening, to match it.

A Geographic writer and photographer visit Nationalist China's battered but defiant fortress five miles off the Communist coast

LIFE UNDER SHELLFIRE ON Quemoy

By FRANC SHOR, Senior Assistant Editor, National Geographic Magazine

Photographs by WILBUR E. GARRETT
National Geographic Staff

THERE WAS something almost frighteningly familiar about that flight: the war-weary old C-46 in the predawn darkness, the piles of cargo lashed down on one side of the cabin, the ammunition cases stacked in the rear, the row of stoic-faced Chinese officers in the bucket seats beside me.

Someone has turned the clock back 15 years, I thought. I have flown in planes like this before; my companions have been men like these; we have shared the cabin with cargo stacked in this manner. But time does not stand still. Something must be different.

Something was. A number of things were, in fact. Over my shoulder, instead of a carbine, M-1, hung a Leica, M-3. The cargo cases were painted with the clasped hands and United States shield of the International Cooperation Administration. Next to me, instead of a Chinese companion, rode photographer Bill Garrett.

There was, of course, the far from comforting thought that this airplane might well be one I had ridden 15 years before, since no C-46's were built after World War II. And there was the disquieting realization that we were flying again into a war, a very little one, to be sure, but one where shells burst and men died and women and children saw their homes crumble and moved into caves to live like animals.

We were flying from Formosa's Taipei airfield to Quemoy, Free China's outpost only 9,000 yards off the Communist-held mainland. Bill and I were not concerned with the politics of the situation: our job was to find out how the people of that beleaguered island were living in this strange on-again-off-again war.

Children ride their mothers' backs across a sun-drenched street in Quemoy city, shell-battered capital of this island outpost of Free China (map, page 418). Women wear the quilted jackets, slit gowns, and trousers common to most of China.

In size, Quemoy isn't much of an island. It's 13 miles long and eight miles at its widest point, shaped like a badly made dumbbell. The 1956 census showed a population of 45,081 inhabiting its 50 square miles. What makes it important, of course, is the fact that it lies so near the mainland of Red China (map, page 418). The Communists want it. The Nationalists, based 120 miles away on Formosa, don't want to give it up.*

Shells Fall Only on Odd-numbered Days

Late last August the Communists lashed the island with an artillery barrage that many observers thought was a prelude to invasion. The intensive shelling continued into October, with as many as 55,000 high-explosive shells falling in a single day.

The United States Seventh Fleet, packing what has been called the greatest concentration of fire power in history, gathered in and near the Formosa Strait. The invasion was never attempted. In late October the Communists announced that henceforth they would shell only on odd-numbered days. As of early January, they had adhered to that program.

Bill Garrett and I landed on an odd-numbered day. Our escort, Lt. Col. Chang Chang King of the Free Chinese Air Force, hustled us into a waiting jeep and drove us through fertile fields of vegetables and small grain to the island capital of Quemoy, or Kinmen.

These words Quemoy and Kinmen (or Chinmen) are confusing. They are really the same word in different dialects. The Chinese characters mean "Golden Gate." "Kinmen" is the Mandarin pronunciation. In southern Fukien, the province opposite the island, the same characters are pronounced "Quemoy."

An irregular drumming of shellfire serenaded our journey. The bursts reminded me that I had read press reports of the number of shells rained on the island on each "business" day. I thought it would be interesting to meet the man who did the counting, and asked Colonel Chang if that could be arranged.

"Very easily," he smiled, "but he works on the most exposed point of the island. Wouldn't you rather wait and interview him tomorrow, when there will be no shelling?"

"Much rather," I admitted. "Unfortunately, it will make a much better story if I see him actually at work. Let's go today, and hope the Reds are short of ammunition."

Unhappily, they weren't. We gulped a quick breakfast of rice gruel, small baked loaves filled with onions and spices, and preserved pork. Then we set off for Peit'aiwu Mountain, highest point on the island and site of the Kinmen Defense Command's forward observation post (page 422).

Shells were exploding near by as we left our jeep and scrambled the last 50 yards up the rocky summit of the 830-foot hill. The words "near by" are, of course, relative. A bus stop 400 yards from your front door may be quite a distance. But a high-explosive shell, screaming its menacing warning of death and bursting with an earth-shaking crash 400 yards away—that's near by. These were near by.

Watchers Tally Red Artillery Fire

In a deep and heavily sandbagged dugout we found two Chinese enlisted men and a young officer, all staring intently through high-powered glasses at the haze-obscured mainland coast. Lt. Tung Wei Nee courteously offered us a look through a powerful telescope. A scant hundred yards inland we could see an occasional puff of smoke. Seconds later we could hear the explosion in our own area.

Lieutenant Tung is 29, a native of Fukien Province. While we talked, he made check marks on a large sheet of paper. When the firing ceased, he explained his system.

"The Communists have three sizes of guns," he told us. "These tables show the speed at which each can fire.

* See, in the National Geographic Magazine: "Changing Formosa, Green Island of Refuge," by Frederick Simpich, Jr., March, 1957; "Patrolling Troubled Formosa Strait," April, 1955; "Eyes on the China Coast," by George W. Long, April, 1953; and "Formosa—Hot Spot of the East," by Frederick G. Vosburgh, February, 1950.

Bay Blasted from Rock and Ringed with Sandbags Shelters a C-46

This report by a Geographic writer-photographer team gives a telling picture of Quemoy under siege in January, 1959. Some 80,000 troops and 45,000 civilians occupied the 50-square-mile island bastion, which lies only five miles from the enemy shore. The soldier hefting homemade dumbbells overlooks one of two airstrips providing a link with the Nationalist stronghold of Formosa, 120 miles to the east. The plane, a veteran of World War II, bears the sun insignia of the Nationalist Chinese Air Force. It shuttles between Formosa and Quemoy.

Like a Moored Battleship, Quemoy Pickets the Port of Amoy

Besides the main island, Nationalist China's offshore fortress includes Little Quemoy and the Tan Islands, only 3½ and 2½ miles respectively from Red territory. Shelling them from three sides, mainland Communists sought to wear down resistance.

"I can tell the size from the sound. By noting the time each piece is in action and using my tables, we figure the number of shots into this area. Other officers count the rounds in their own sections of the islands, and at the end of a day we add the totals."

A new barrage opened up, the bursts coming from over a near-by hill. I found the distance comforting, but Bill was dissatisfied.

"We might be able to get some good pictures if we got closer," he urged. "Let's get over on the side where they're landing."

Unable to think of any reasonable excuse except the real one—and I didn't want to admit that to my eager colleague—I went along. The whine of shells passing overhead didn't do anything to help matters. But minutes later we were across the exposed valley, looking down at the target of the moment.

For half an hour we watched the big shells plow up the flat terrain a few hundred yards below, probing for the well-concealed Nationalist gun positions (page 423). While we watched, they fell harmlessly. Later, however, we learned that one of the more than 4,000 rounds fired that day scored a chance hit on a group of soldiers digging a new gun pit. Two men were killed, three injured.

BLACK STAR

Eyes on the Enemy Shore, Artillery Spotters Watch for Telltale Flashes

Nationalist and Communist positions lie so close that soldiers can watch one another riding bicycles or strolling beaches. Loud-speakers blare propaganda across the strait, and balloons carry political slogans. These men scan the mainland for puff of smoke or wink of flame betraying a Red battery. Brush camouflages their dugout.

"While you're in this part of the island," Colonel Chang suggested, "you might like to call on the only foreign civilian who lives on Quemoy. Father Bernard Druetto is a Catholic priest who has lived here since 1955. His church is just a mile away, near where the shells were falling."

Father Druetto, wiry, smiling, and heavily bearded, is a man of remarkable fortitude and considerable persistence (page 433). After years of service as a member of the Franciscan Order in China's remote Hunan Province, he was arrested by the Communists and held without trial for eight months.

His captors finally brought him before a court on trumped-up "enemy-of-the-people" charges. To their chagrin, so many of those same people appeared voluntarily in his behalf that the embarrassed judges hustled him out of the country.

The French-born missionary reached Hong Kong sick, emaciated, his clothes in tatters. He stayed just long enough to get a bath, a haircut, and a decent suit.

"There was work to be done in Quemoy," he told us, "and I knew I could do it.

"The Communists called me an 'enemy of the people.' Well, I'm doing here exactly what I did in Hunan, and no one seems to regard me as an enemy!"

What Father Druetto is doing might shame a man half his age and twice his size. He supervises the spiritual welfare of the sizable flock in his attractive little church and distributes thousands of dollars worth of relief supplies every month. He makes a daily round of calls on the sick in the surrounding countryside and holds an outpatient clinic every morning in his little dispensary. In his spare time he tends a tiny garden, makes a little wine, and digs his shelter tunnel deeper into the neighboring hillside.

On-the-job training occupies a U. S. Army officer and a Nationalist gun crew. Col. Gordon A. Moon 2d (right), an observer with Free China forces on Quemoy, lectures on shell fuses to a captain and two artillerymen beside their American-made 155-mm. piece. Massive earthworks and sandbags protect the emplacement. One Nationalist battery lost six men to a direct hit from a Communist gun but resumed firing within three minutes.

I was thinking fond thoughts of that tunnel as we sat at a bare wooden table in his sparsely furnished living room, listening to the crash of artillery shells. The Communists were using their big guns now; the flimsy walls shook with each explosion, and the noise was interrupting our conversation. Father Druetto disappeared into an adjoining room. I hoped he had gone for his hat and would suggest an adjournment to the shelter.

Instead he reappeared with a bottle of homemade wine and a handful of tiny glasses. As he opened the bottle, a big shell whined home very near by indeed, and the explosion literally rocked the house.

"That's very good for the wine," Father Druetto laughed. "It ages it."

I didn't tell him, but it was aging me, too.

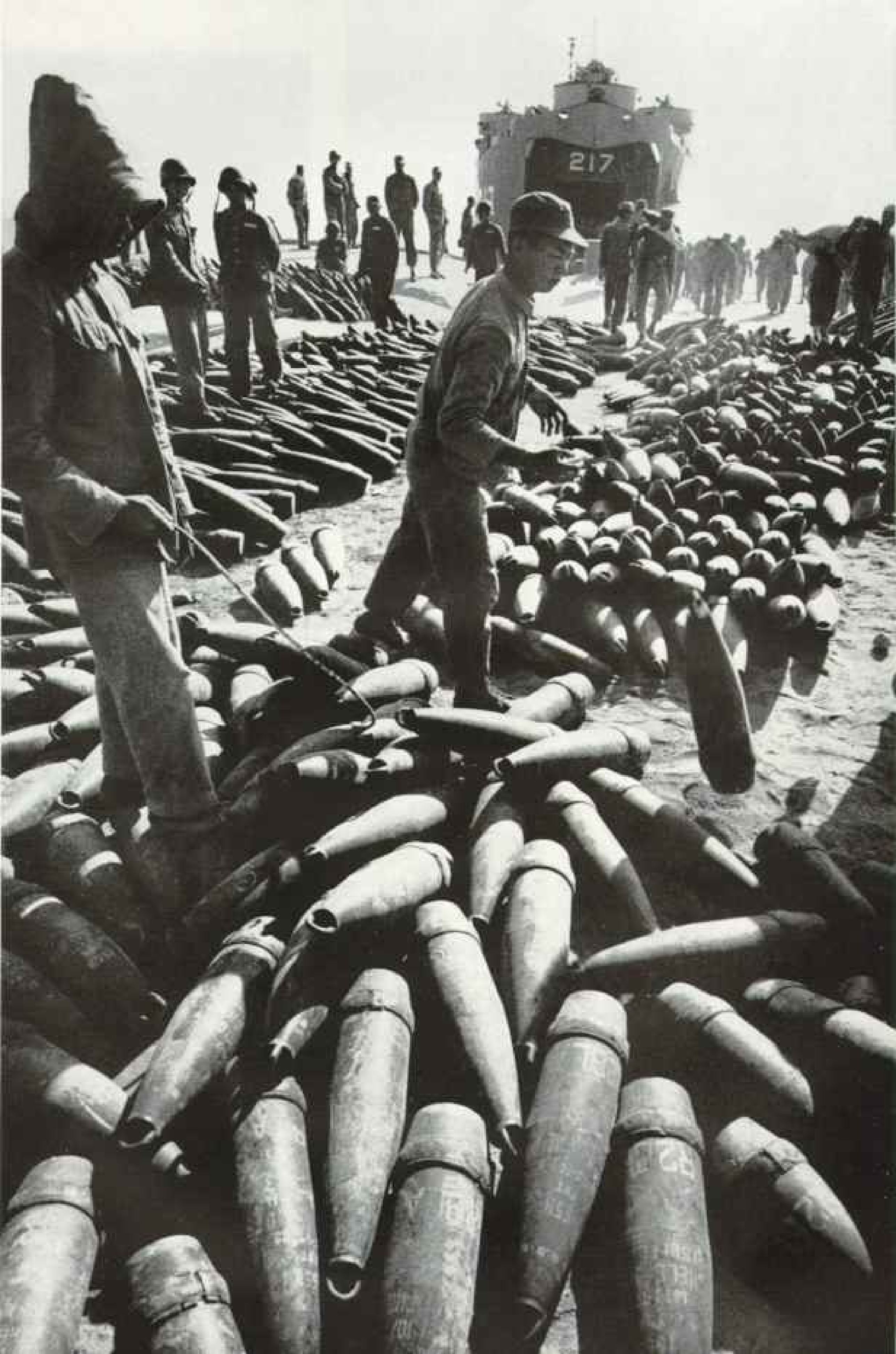
"Kitty Cat" Team Coaches Chinese

There are Americans on Quemoy, too, a handful of officers and enlisted men who make up "Kitty Cat." Officially, it's KDCAT—Kinmen Defense Command Advisory Team. They don't take a hand in the actual fighting, but their expert advice and technical assistance play a big role in the excellence of the Nationalist counterfire (left).

Bill and I visited some of the Kitty Cat team members in action. We sat on sandbags in their 155-mm. gun position and saw them patiently training Chinese officers and men in the delicate art of laying the big weapon. Some of the

Piled Like Cordwood, Howitzer Shells Litter the Beach Beside an LST

Quemoy gobbles 1,000 tons of military and civilian supplies a day. Convoys from Formosa brave the enemy barrage or capitalize on lulls in the firing. These soldier-stevedores laboriously unload 155-mm. shells by hand from the hold of a beached landing ship. "They tossed the unarmed projectiles around like chunks of pig iron," reported photographer Garrett. Man in foreground arranges the shells with a hooked rod. Eyelets on projectile tips unscrew at firing to make way for fuses. Protective grommets encircling the shells guard rotating bands, soft metal rings that engage rifling in the gun barrels and set the projectiles spinning.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Counting enemy shells, a spotter scans Quemoy from 830-foot-high Peit'aiwu, the island's highest mountain and nerve center of its defenses. Observers divide the territory into sectors, identifying the size of each shell by its sound. Nationalist authorities estimate that tiny Quemoy in five months endured more high explosives than Japanese forces fired in China between 1937 and the close of World War II.

Smoke from a Bursting Shell Drifts Away

Examination of shells that failed to explode reveals that most are of Chinese or Russian manufacture. Disposal crews occasionally unearth American projectiles, presumably seized in China and Korea. Communist gunners here drop a shell near a highway. Traffic avoids the pavement by driving in sheltered trenches.

training goes on under fire, and it takes a very near miss to interrupt the work.

We lunched in the Kitty Cat mess with Lt. Col. Niels M. Dahl of Denver, the team's solidly built executive officer. Colonel Dahl reached Quemoy in September and has gone through most of the heaviest shelling.

"The advisory team personnel have a very warm feeling for the Chinese soldiers we work with," he told us. "The gunners serve their guns, military police direct traffic, and laborers continue unloading cargo on the beach, even under the most intense bombardment."

A few days before our arrival Colonel Dahl had visited a Chinese gun position which had sustained a direct hit. Six men had been killed.

"I asked the battery commander how long his piece had been out of action," Dahl went on. " 'Three minutes,' he replied. He had replaced his casualties with personnel from a near-by shelter and resumed firing.

"That's typical of the Chinese spirit here."

Members of the advisory team have suffered a few shrapnel wounds, but up to the time of our visit none had been seriously injured. A Chinese installation only a few hundred yards from the KDCAT barracks was wrecked in October's heavy shelling; some Chinese generals were killed, but only a few stray shells fell in the American compound.

"I think the worst injury any of this team has suffered was to his pride," Colonel Dahl laughed. "It happened to a very young second lieutenant who was flown out here."

The fledgling officer's plane landed on a Quemoy airfield which was under heavy shell-

fire. Before the craft came to a halt, the passengers threw the door open, leaped to the ground, and dashed to the nearest trench.

There had been recent rain, and the trench was a mudhole. When the firing ceased, the lieutenant's new uniform was a sodden mess. He hailed a jeep, was driven to his quarters, and jumped into a shower.

"He had just gotten thoroughly soaped," the colonel continued, "when the Reds opened up again. The shells were uncomfortably close, and everyone was ordered out to the shelters. Our newcomer raced out of the building, struggled a hundred yards up the hill, yanked open a door, and plunged into our communications cave.

"Wearing only a few bubbles of lather, he found himself face to face with a colonel, two lieutenant colonels, and three majors, none of whom he had ever seen before. He saluted, gasped, 'Lieutenant ———— reporting for duty, sir,' and spent the rest of the bombardment trying to keep out of sight.

"I doubt if anything in the rest of his military career will ever be as painful as those few minutes."

Gunfire Severs Trees Like Giant Ax

The next day was an even date, promising a respite from gunfire. While Bill photographed Nationalist cargo vessels unloading ammunition and supplies on the beaches (page 421), I took the dusty road to Nanshan village, on the northwestern tip of the island. With Lt. Thomas Chen of the Chinese Army, I rode through rows of jagged stumps which

BLACK STAR

Salvage party searches rubble for belongings after a hit. Few houses stand unscarred. Barrages saturate the island, shattering hospitals, schools, and temples (opposite), as well as military targets. Dispossessed families live in caves (page 429).

Boys in a Ruined Temple Roll Hoops Beneath a Battle-scarred Idol

Centuries-old shrines and landmarks disappear overnight. This temple on the island's once-sheltered south side crumbled when Communist artillery increased its range. Ironically, the statue represents a god who transports souls of the dead to heaven. Villagers, desperately lacking wood, salvaged the lumber at right.

had once been healthy young trees. The gunfire had cut them as effectively as a giant ax.

Nanshan, directly opposite the Communist shore batteries, has the unhappy distinction of being the most shelled village on Quemoy. Once a prosperous community of 600 people, it has been transformed into a heap of rubble in which not a single building remains intact.

Lieutenant Chen and I picked our way through the narrow streets, climbing heaps of broken bricks and shattered roof tiles. We paused in front of what had been a temple, its roof and walls shattered, its huge hand-hewn beams splintered by Red gunfire.

"This temple was built in the first half of the 16th century," my companion told me, scanning the gilt characters on a wooden dedicatory tablet lying in the rubble. "It was dedicated to ancestor worship. For four hundred years the people of Nanshan have come here to pay homage to their forebears. Now, in a single day, it is gone."

The stillness of death lay upon Nanshan as we walked its deserted streets. The only sound was the crunching of broken roof tiles beneath our feet. Then, near the edge of town, we came upon three figures hard at work in the ruins of what had been a home.

Quemoy's Fishing Fleet, Immobilized by War, Rots in Its Seaside Graveyard;

An old man with a heavy mattock was carefully spreading the broken stones and tiles heaped among fallen beams. A younger Chinese worked beside him with a rake. A young woman with a woven basket sorted the refuse by hand. Occasionally she would come upon some small piece of household equipment and carefully place it in the basket.

I introduced myself to the older man. "What is your honorable name?" I inquired in Chinese.

"My humble name is Lu," he replied, putting down his mattock. "Lu Pao Hsu. This is —" he hesitated, "this *was* my home. Here is my son Lu Sze Nan and his wife."

The couple bowed, then went on working while their father answered my questions.

"For 22 generations my ancestors have lived in Nanshan and farmed our fields," he said. "This house had stood for 12 generations."

He looked ruefully about him, prodding a pile of debris with a calloused bare foot.

"It was a good house," he said. "My sons and their wives lived here with us, and my grandchildren. There were 14 of us. We have 12 *mow* [about 2 acres] of land, and it is good land. We grew wheat and peanuts and winter potatoes.

"Then on Number Eight month, 23 day, the shells came. Every day through Number Ten month, 5 day, they came. Our house is hit and broken. In the fields the crops are destroyed."

The elder Lu's wife was killed in the first bombardment, and one of his sons died in a September barrage. Two of his grandchildren were wounded. The surviving members of the family live with relatives in Kinmen city.

"How do you fill your rice bowl now that you cannot till your land?" I asked him.

"It is very badly filled for all of us now," he replied. "I had a crop of winter potatoes ready for harvest, and we eat some of those and sell a few to buy other things."

Children Race to the Moldering Hulks to Play Pirates and Merchantmen

The irrepressible humor which is China's heritage welled up, and his weathered face broke into a wry smile.

"In one field the shells saved us much labor," he said. "They dug all the potatoes for us. We had only to pick them up."

A government relief agency keeps the Lu family from starvation. Each member receives a weekly ration of rice, milk powder, and fuel. It is not much, but it sustains life. And now that the Red shells fall only on alternate days, the family works from dawn to dusk on the days of blessed calm.

I asked Mr. Lu if he planned to rebuild his house.

"It will be rebuilt," he replied determinedly. "It must be rebuilt. This is our family home. I do not know how we will do it, for we have no money, and this house took many generations to complete. But I will start the rebuilding, and my sons will continue it, and their sons will take up the task.

"The temple of ancestral worship will be rebuilt, too. My tablet will be there. And my grandsons and their grandsons will worship there, and tend to the needs of my spirit. It has always been so, and it will always be so."

He picked up his mattock and attacked the rubble with renewed vigor. The pile of unbroken bricks grew steadily higher. The House of Lu, I am sure, will stand again in Nanshan, and the shade of Lu Pao Hsu will be honored in the temple with those of 22 generations who labored here before him.

Villagers Tunnel to Safety

On another shelling day Bill and I visited Chinmenchiuch'eng (Old Golden Fortress) near the southwestern tip of the island. Less battered than Nanshan, this village has nevertheless taken a heavy beating, and many of its homes lie in ruins.

Everyone had a smile for us as we wandered through the streets. The inevitable crowd of

children gathered, and we felt like Pied Pipers as they trailed us. Bill photographed a group of devastated houses around a single courtyard, and a handful of their former residents invited us to visit their present quarters.

"We are cave dwellers now," said Elder Ku Su Yuan, tugging open a wooden door set in the hillside. "Be careful. The tunnel is not large" (opposite).

It wasn't, either. Bill, garlanded with cameras, had very little clearance. I, even without cameras, had none at all. Our crowd of youngsters followed us in, and there were times, squeezing into a particularly narrow space, when I had visions of becoming a permanent part of the village's real estate.

The tunnel was about 120 feet long, seldom more than five feet high. Half a dozen little cubbyholes were scooped out of the walls, none more than five feet square.

"Five families—about 50 people—sleep here," Mr. Ku told us. "Two people sleep in each of the rooms, although they must curl up. The rest stretch out in the tunnel. It isn't very comfortable, but it is safe."

Two men died in the bombardment which wrecked our friends' homes; half a dozen women and children were injured. The survivors race from their fields to the tunnel at the whine of the first shell.

Ball-point Pen Wins a Friend

A tiny girl, not more than four years old, was fascinated by Bill's many cameras. Gingerly she extended a finger to touch them, then gained confidence and climbed into his lap. Pleased by his conquest, he presented her with a ball-point pen. A Tiffany bracelet couldn't have been more successful.

Screaming with delight, she raced around, showing everyone her new treasure. Someone produced a piece of paper, and she plopped down, scribbled intently for a couple of minutes, and then presented Bill with a page of meaningless doodles which were, I am sure, meant to be a love letter (page 430).

Her mother had to hold her when we left. She was determined to go with Bill. She was still crying when our jeep drove away.

On another day we were rolling across Quemoy's fertile central plain when a dozen girls, neatly uniformed in white blouses and black skirts, crossed the road in front of us, each carrying a little wooden stool. Lieutenant Chen identified them by their uniforms as members of Quemoy's Women's Civilian Defense Corps.

"Why the stools?" I asked.

"They must be coming from a training class," our guide explained. "This is a poor island, and few houses would own that many chairs. So each girl brings her own."

Girls Aid Wounded During Barrage

We stopped to ask one of the girls about the work of the corps. Shy at first, she thawed when Lieutenant Chen explained that we wanted to write about her group for an American magazine. She invited us into her single-storied, tile-roofed home with the curving eaves typical of the island.

Her name was Hsu Yuen Yue—Miss Cloudy Jade Hsu. We sat at a wooden table scrubbed white by many generations of use while her mother brewed tea and a younger brother raced to a near-by field to call her father. The family altar filled one end of the small room, and four household gods, fierce of face and brightly painted, glared down at our conference from their glass case.

Cloudy Jade Hsu is 22, slender and graceful, a graduate of Kinmen Primary School. She joined the Civilian Defense Corps two years ago, before the present heavy shelling began. Her group studies first aid in two-hour sessions three times a week.

Chiempan, Cloudy Jade's village, was one of the first to suffer when the heavy fire began. On a single September day nearly a thousand high explosives smashed into its narrow streets. A score of villagers were killed, more than fifty injured.

"I ran for my first aid box when the first shell landed," Cloudy Jade told us. "Wounded people were everywhere. As soon as I bandaged one, someone would lead me to another. I don't know how long we worked. It was like a terrible dream."

Hsu Su Yuan, Cloudy Jade's father, hurried into the room. At first he was disturbed to

Ghostly Candlelight Bathes the Residents of a Quemoy Tunnel

Forced by the bombardment to live in caves, these islanders dash into the hole at the first whine of a shell. They bed down in cubicles carved out of tunnel walls. Electricity and running water are unheard of, and ventilation is poor. This scene calls to mind the ordeals of Corregidor and Malta, besieged islands of World War II.

FRANK GARRETT

Photographer and Camera Draw an Envious Crowd

Few luxuries adorn shop windows in Quemoy. Photographer Garrett's two Nikons caused a sensation. "When the people saw them," he reported, "every kid in town wanted to be in the picture." Girls at left, spying the author's own cocked camera, defect from the ranks. One carries her brother piggyback.

Smile lights the face of a 4-year-old girl from a cave family. Photographer Garrett gave her his ballpoint pen. Scribbles on the paper represented a love letter to the donor.

The All Clear Sounds. With Candles Snuffed, Cave Dwellers Quit a Bunker

Villagers sometimes must spend entire days in shelters. This young woman enjoys a breath of air between attacks. The wedding ring follows Chinese custom.

find his daughter talking to strange men. Reassured by Lieutenant Chen and the venerable village leader, he answered our questions about a farmer's life on Quemoy.

Father Hsu is old-fashioned and measures his land in neither mow nor acre. He calculates by the number of plants it will support—in his case, sweet potatoes. He owns "will-grow-9,000-sweet-potato-plants-land."

He doesn't plant it all to sweet potatoes. Some of it is in wheat, some in peanuts. He keeps a few chickens and a pig and grows most of the family's food.

"Last year was good," he told us. "I sold nearly $20 worth of potatoes, and half that much in peanuts and wheat. My wife got about $10 for her eggs. And that was after we had all we wanted for ourselves."

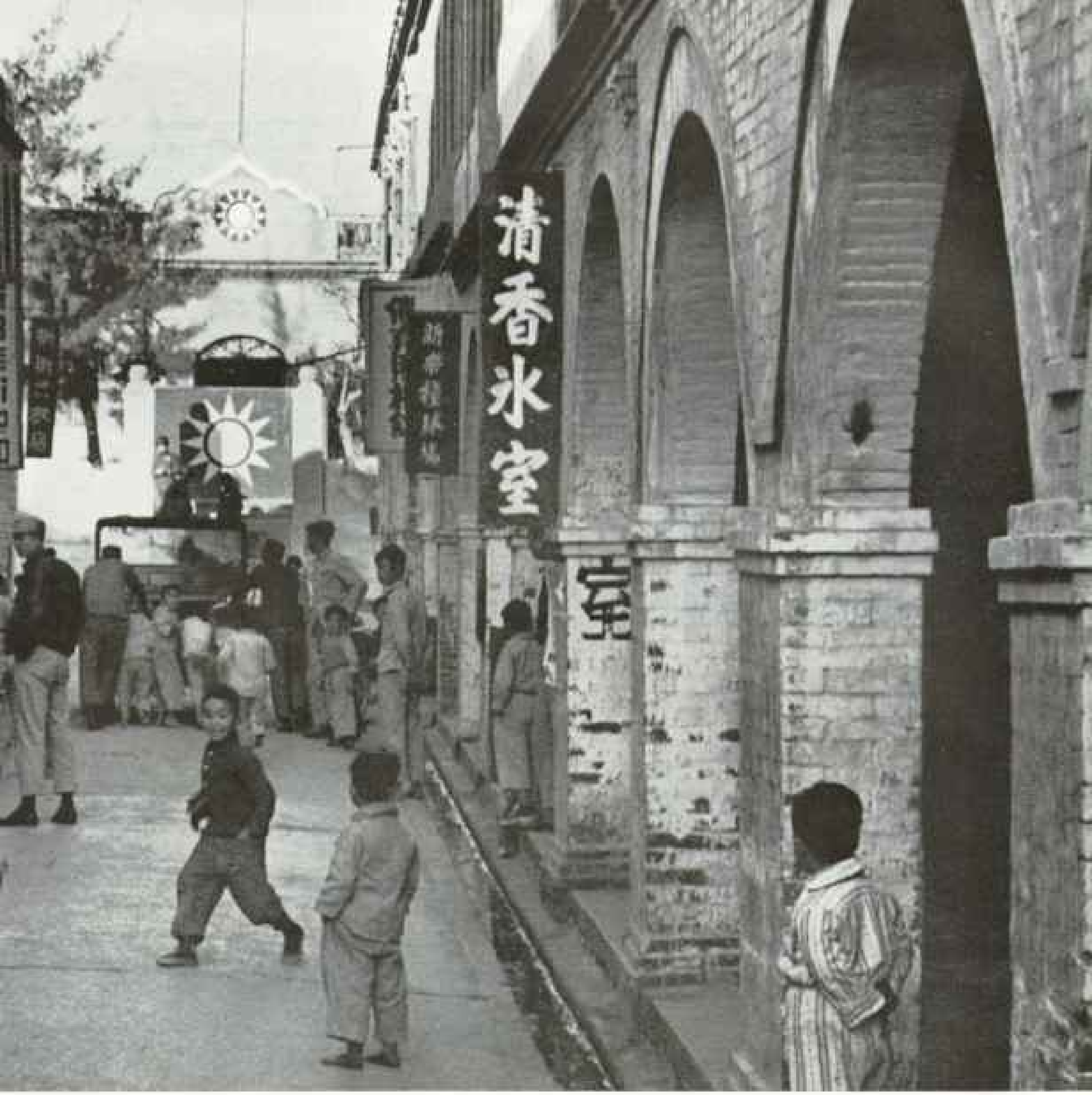
What the Hsu family want for themselves is very little. They eat three meals a day—each one the same. Sweet potatoes, noodles, peanuts boiled or fried, and a bit of green vegetable. Perhaps once a week they will feast on a little pork, and as often have a bowl of rice. It is meager fare, but the four Hsu sons

When Guns Fall Silent, a Game of Tag Enlivens a Street in Quemoy City

Men and boys push a stalled jeep. Signs on the arcade advertise the Clear and Fragrant Iced Drink Shop and New Happiness Billiard Parlor.

Shopkeeper weighs oranges on her hand scales for Nationalist officers. Quemoy imports its fruit.

Helmeted priest, Father Bernard Druetto, feeds a parishioner in a streetside shelter. He spent eight months in a mainland prison, emerging almost a skeleton in rags. Banished by the Communists, Father Druetto chose Quemoy, where he built his church with his own hands. The Republic of China has awarded him the Brilliant Flower Medal for his "untiring efforts in rescue work" during the Communist bombardments.


清香冰室

Homemade Sprinkler Waters a Field of Grain

Arid soil and lack of rivers prevent Quemoy from growing rice. Sweet potatoes, grain, and peanuts form the islanders' staple diet. This man waters his crop with perforated bamboo tubes attached to buckets.

Communist guns give Quemoy villagers a fourth crop—shrapnel, which they sell to the Nationalist Government as scrap metal. Farmers call the harvest, which brings more money than conventional crops, "iron potatoes."

Soldier tends garden below a camouflaged gun and a dome-shaped pillbox. In off-duty hours, officers and men cultivate small plots of their own and help civilians work their farms. The Joint Commission on Rural Reconstruction, a United States-Nationalist China agency, gives technical advice and aid. Hog cholera, scourge of pork-loving Quemoy, no longer plagues the island's herds.

Ceremonial gate to a shrine looks across plowed lands to the sway-back roofs of a village. Stone lions cap the gateposts. A tethered donkey browses the terraced field.

Land reform and improved farming techniques have made Quemoy nearly self-sustaining. Millions of seedlings flown from Formosa have given the island its first sizable stands of acacia, casuarina, and pine.

and two daughters seemed healthy and happy, and their 80-year-old grandmother, smiling in her corner, was a picture of well-being.

We left Chienpan with hearty admiration for Cloudy Jade Hsu's courage and with the fervent hope that she would not have another occasion to prove it.

The majority of Quemoy's 45,000 population lives by farming, and lives very much as the Hsu family lives. It is not an easy life, but the people on the island live far better than they did 10 years ago. And many of those with whom we talked were anxious to give credit to a Sino-American organization called the Joint Commission on Rural Reconstruction.

I called on Mr. Hsu Woo Ping, the JCRR's representative on Quemoy. This smiling Mr. Hsu is a native of Fukien Province, where his family owns 600 mow (about 100 acres) of land. For six years the JCRR has worked on Quemoy, teaching modern

Outbound C-46 Stirs a Cloud of Dust

Shuttling wounded from Quemoy's military hospital, the plane wheels for take-off. A gallery of onlookers atop the bank watches as the mechanics sprint out of the way.

Admirers crowd the author (opposite, below) for a lecture on photography. Mr. Shor, a veteran of World War II in the China-Burma-India theater, speaks Chinese. His escort, a first lieutenant, listens in.

Ready hands load a wounded comrade aboard a plane for evacuation (next page).

farming methods, encouraging the use of fertilizers, supervising plague control, testing new crops.

"The two most important things we have done here," he told me, "are to wipe out plague and to introduce pest control. Ten years ago no one wanted to come to Quemoy—it was notorious as a breeding spot for bubonic and pulmonary plague. There hasn't been a death from either in six years. Rat control and inoculation are responsible.

"With pest control, improved farming methods, and the digging of 3,000 new wells, we've had fantastic increases in production. Sweet-potato yields nearly doubled in six years; peanuts did the same. Wheat and barley harvests are ten times what they were—with increased acreage, of course. The important thing is that people are eating more and living better."

It is satisfying to an American to know that our foreign-aid dollars

FRANK SIEGEL

Wounded Soldier Grimly Endures His Pain

Stolid courage, the quality of Quemoy, shows in the face of a man flying to a rest camp in Formosa. Hospitals and a blood bank await eight stretcher cases aboard the same plane. Nationalist China's 600,000-man armed forces share duty on Quemoy. They also garrison Matsu Island and the Pescadores. Twice a year married troops get a two-week furlough to Formosa to visit their families.

have been responsible for this. But what, I wondered, would happen now that Quemoy was under fire. Would the program be wasted?

"Wasted? Certainly not," insisted Mr. Hsu. "Look at it this way. If a weak man receives a blow in the face, he may collapse. A strong man can take that same blow and stay on his feet. The strength this program has given the Quemoy farmer in the past six years has made it possible for him to survive."

It was another shelling day when Bill and I left Quemoy, and another predawn departure. The Communists were already lobbing a few scattered shells into the island when we drove through the dark to the airport. Somehow, though, it seemed unreal. There was no longer any portent in the screech; the blasts held no menace. They might wreck houses, but they couldn't touch people, particularly us. We were detached.

Plane Removes Wounded

We arrived at the airfield as the familiar C-46 landed. Another crowd of Chinese officers debarked. We started toward the plane, but Colonel Chang touched me on the shoulder.

"Wait just a moment, please," he said. "This is an evacuation plane. We have some other passengers."

We watched silently while a line of ambulances discharged their cargo. When we climbed the steep ladder, eight stretchers lay on the cabin floor, each holding a bandaged, silent soldier. Another 21 walking wounded occupied the bucket seats (page 437 and left).

Bill and I found seats on the bedrolls piled at the rear of the cabin. The plane struggled into the air, roared low over the water. Dawn filtered through the dusty windows, and Bill busied himself with his cameras.

We said little to each other. Suddenly the detachment was gone. This was not a game men were playing on Quemoy, not a gambit in international politics. This was a war. A little one, true, but a real one. And these men we were riding with had played it for keeps.

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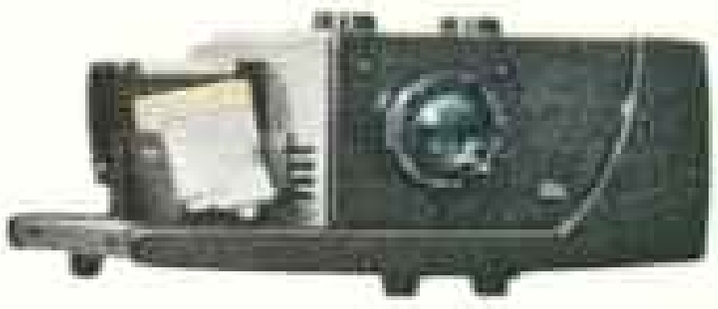

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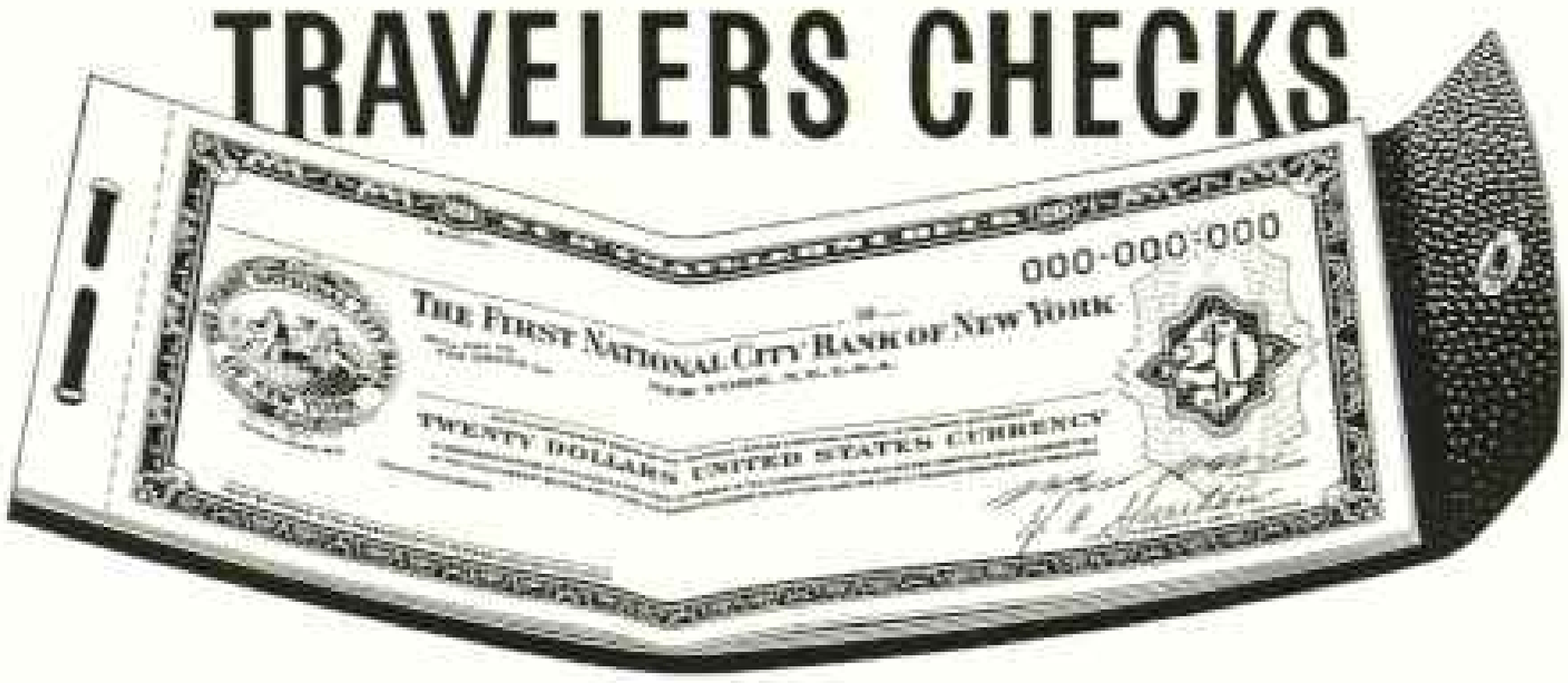

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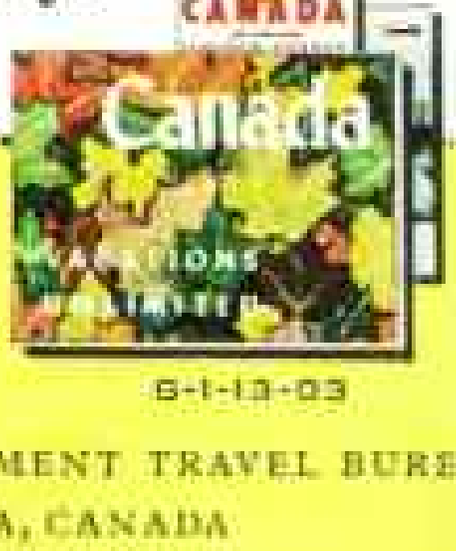

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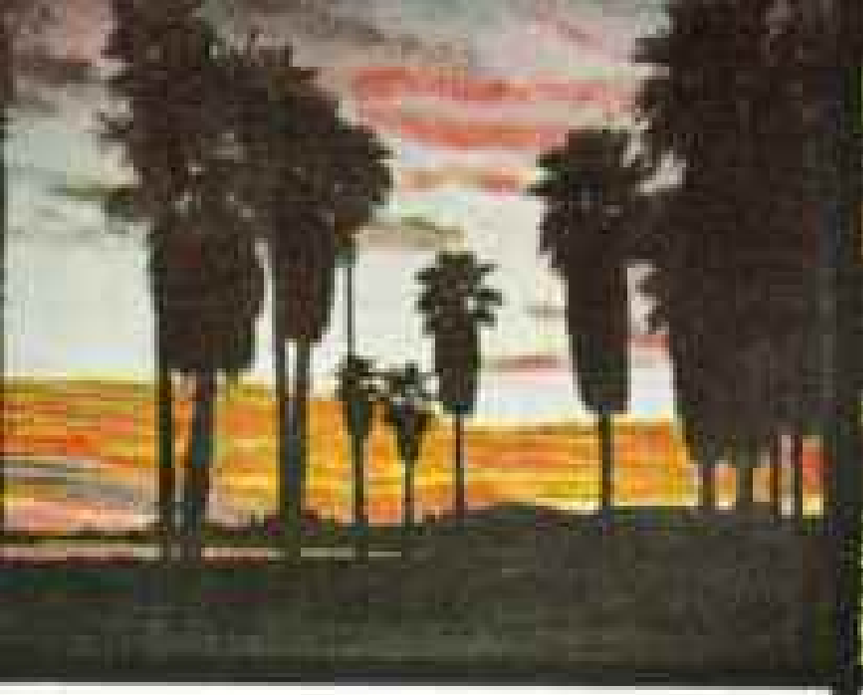

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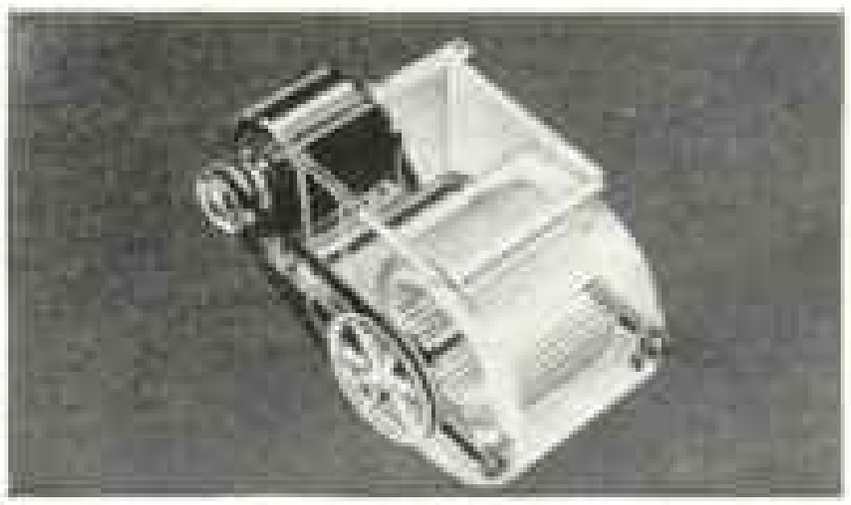

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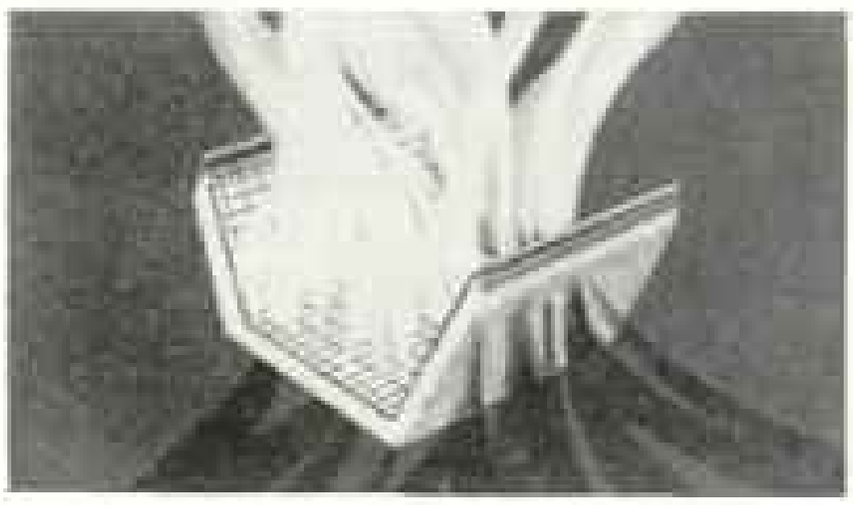

Blue Shield Filter has twice the air-filtering capacity, seals more snugly at all edges to remove more atmospheric soot, dust, pollen than conventional filters.

A completely new way to cool, heat and circulate air —with quiet, comfort, economy never before achieved!

Look at the design of this unique all-year, whole-house comfort system: individually sized components for heating, cooling, circulating air—so your Lennox Comfort Craftsman can custom-balance your cooling, heating with the one right combination for your home, climate, family.

So advanced is the Landmark, so skilfully installed, you'll hear no annoying sounds, feel no drafts, notice no difference in room temperatures. Air is delightfully clean: less dusting, cleaning; less trouble with allergies.

Throughout the handsome Landmark, find the quality you seek: doors, cabinet heavily insulated, solid as a superbly crafted car; heat exchanger of aluminized steel, with "accordion" connections for silence, durability; automation carried to the ultimate; many more quality features.

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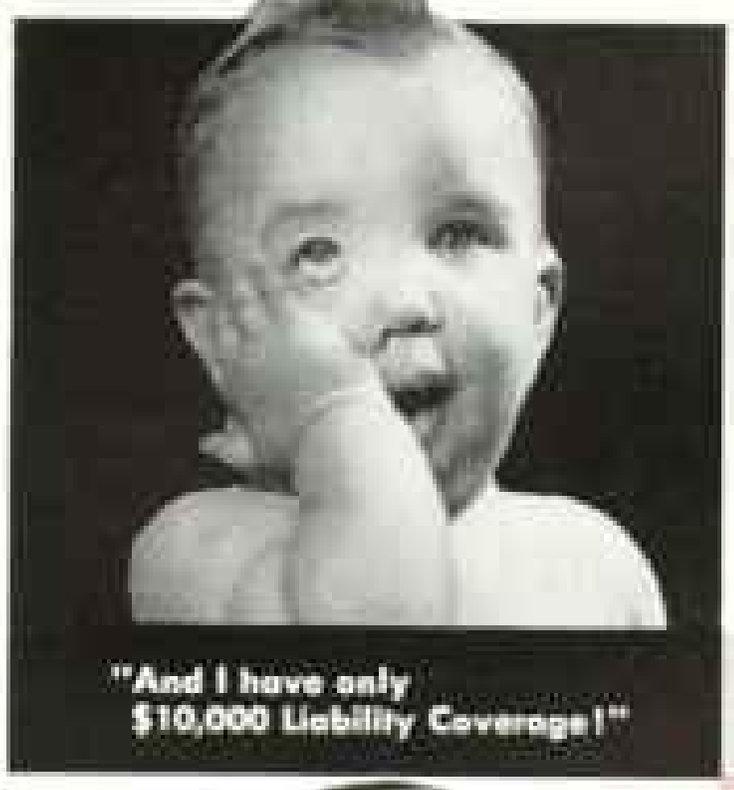
LANDMARK *by* **LENNOX**
AIR CONDITIONING • HEATING

World leader in indoor comfort for homes, business, schools

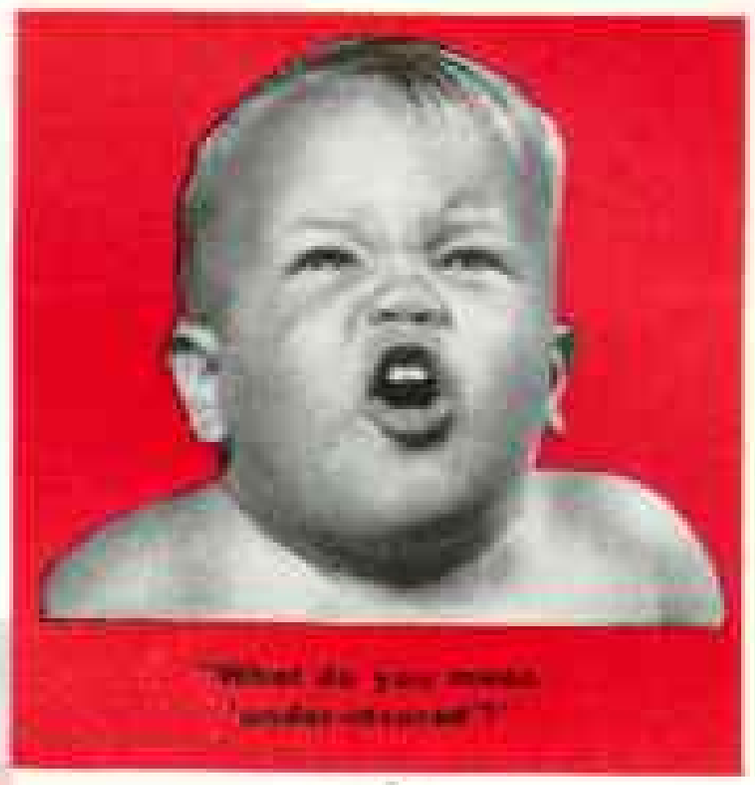
*T. M. Patents Pending

Who is "the most happy fella" AFTER A LOSS?



"And I have only $10,000 Liability Coverage!"

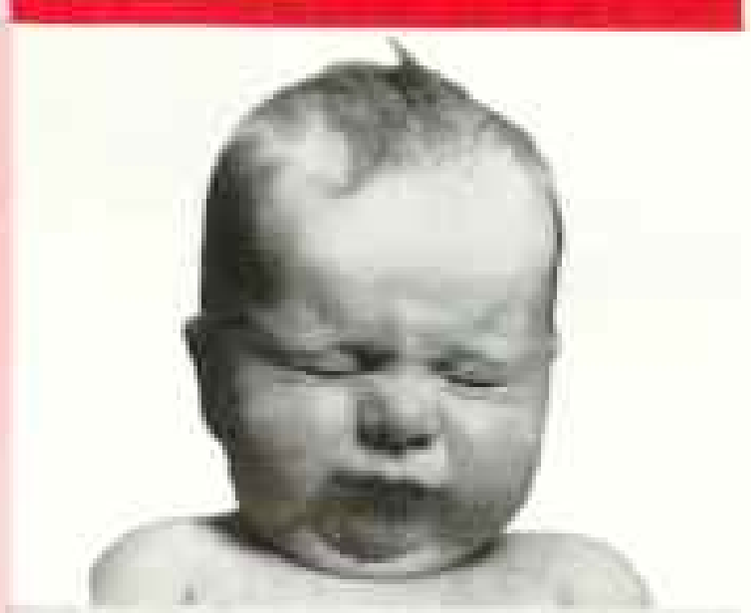
"Suing me? I didn't put ice on the sidewalk!"



"What do you mean, underinsured?"

"After this, I'll buy the best insurance."

"But Myrtle, I didn't think we needed an independent insurance agent."



"I didn't keep my insurance up to date."

"My Independent Insurance Agent had me well insured in a company of the America Fore Loyalty Group."

You too will be the most happy fella if you consult an INDEPENDENT INSURANCE AGENT about your insurance matters. He is a professional who knows the kinds and the amounts of insurance you should carry. Because he is not affiliated with any one company, he can select the best capital stock companies in which to insure you and he is always nearby to help you should you suffer a loss. He can arrange for you to pay all your fire and casualty premiums on a monthly, quarterly, semi-annual or annual basis if you desire.

For the name of a nearby America Fore Loyalty Group insurance agent, call Western Union by number and ask for Operator 25.

Photos by Constance Bannister

America Fore Loyalty Group

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NIAGARA FIRE INSURANCE COMPANY • THE FIDELITY AND CASUALTY COMPANY OF NEW YORK • NATIONAL BEN FRANKLIN INSURANCE COMPANY
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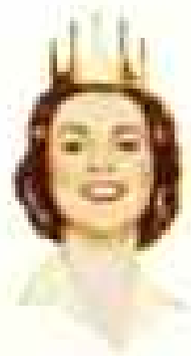
Elegant? Indeed they are! But just as important, Frigidaire Built-Ins have every modern feature—plus the quality you expect of an appliance that becomes an actual *part* of your home. And while, admittedly, Frigidaire Built-In Appliances *look* richly expensive, they are priced to meet every pocketbook. So for beauty, for efficiency, for quality, for thrift—when you buy a home or modernize—let nothing tempt you from the finest Built-Ins of all—by FRIGIDAIRE. See them in model homes and at your Frigidaire Built-In Appliance Dealers, or write Frigidaire Division, General Motors Corporation, Dayton 1, Ohio.



Five matching Rainbow Colors. Many models available in Mayfair Pink, Sunny Yellow, Charcoal Gray, Turquoise, and Aztec Copper. Also models in White and Satin Chrome.

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EVERY family should select and become acquainted with a doctor before illness strikes. Yet, many families wait until sickness or emergency requires a hasty decision about the doctor they will call.

A family doctor, usually a general practitioner or an internist, can care for about 85 percent of the illnesses your family is likely to have. Further, if you should need specialized care, the family doctor can arrange it.

One way to select your doctor is through your local medical society or community hospital. They will give you the names of several physicians. You may choose one of them with assurance that you will be in good hands.

Then, call the doctor and see him for a friendly talk—about fees, night calls, the hospitals he's associated with, and whatever else is on your mind.

Then ask yourself these questions: did you like him . . . feel at ease with him . . . would you trust him during those critical situations which illness often creates?

These questions are important, for without mutual friendship and understanding a warm doctor-patient relationship can never exist.

What are the advantages of having a regular doctor? For one thing, he will get to know you and your family intimately—your "medical history," your response to certain drugs, your normal blood pressure, your emotional reaction to illness, and other facts which may be very helpful whether your trouble is minor or serious.

He can also give you the benefits of preventive medicine. For example, if you have young children, he will want to see them at intervals to check their growth and development—and to keep their protection against communicable diseases up to date.

For others in your family, he can be a health counselor. For instance, if you're bothered at times by seemingly trivial complaints—indigestion, headache, nervousness, or fatigue—you might hesitate to go to a doctor whom you do not know. But with a family doctor, you'd feel free to talk over any condition that upsets you.

Select and become acquainted with a doctor now. Keep his name, address, telephone number and office hours posted in a spot known to everyone in your family. His continuing supervision can help your children grow up strong and well—and help you live a long and healthy life.

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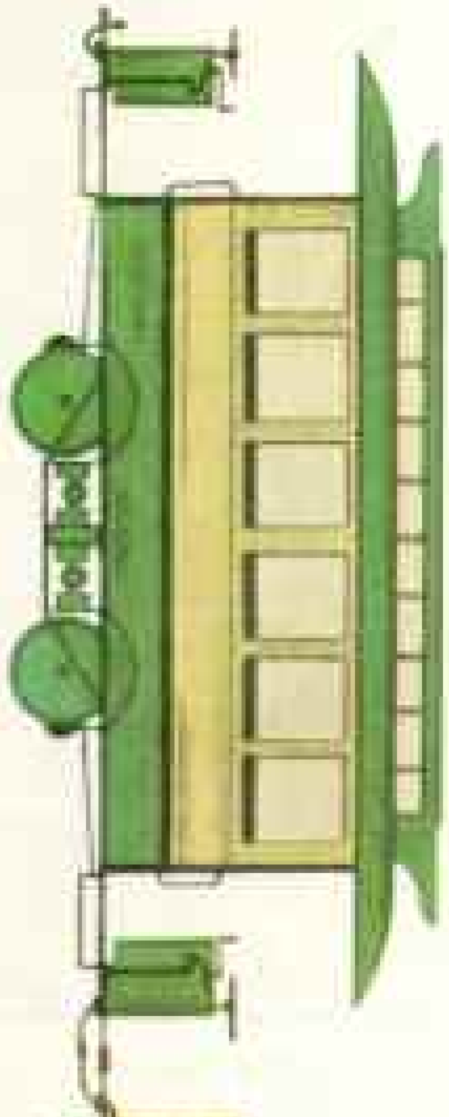

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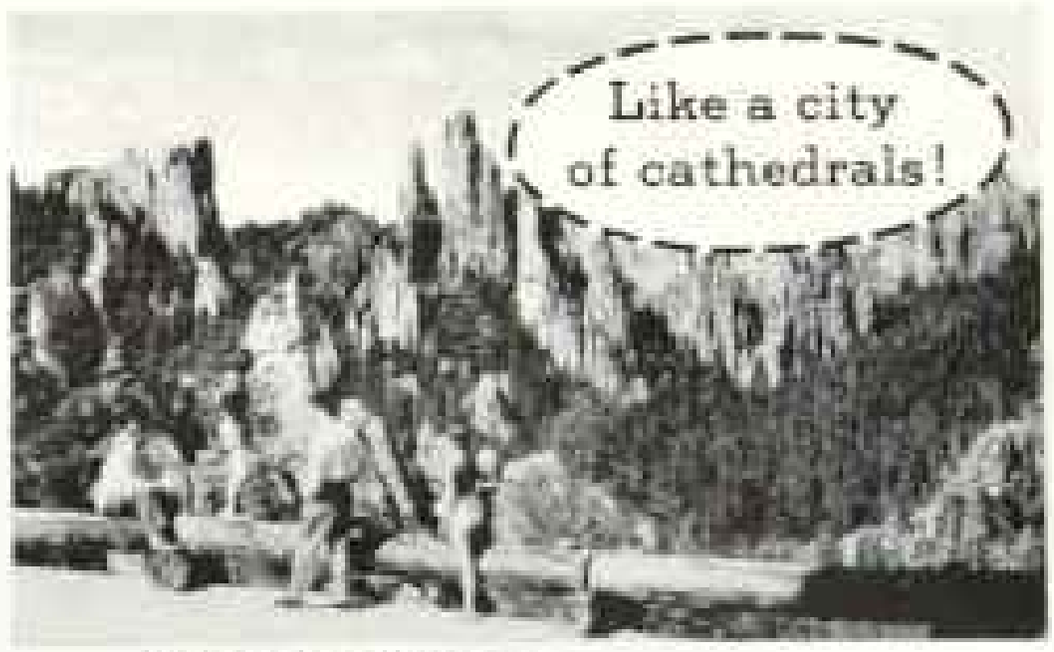

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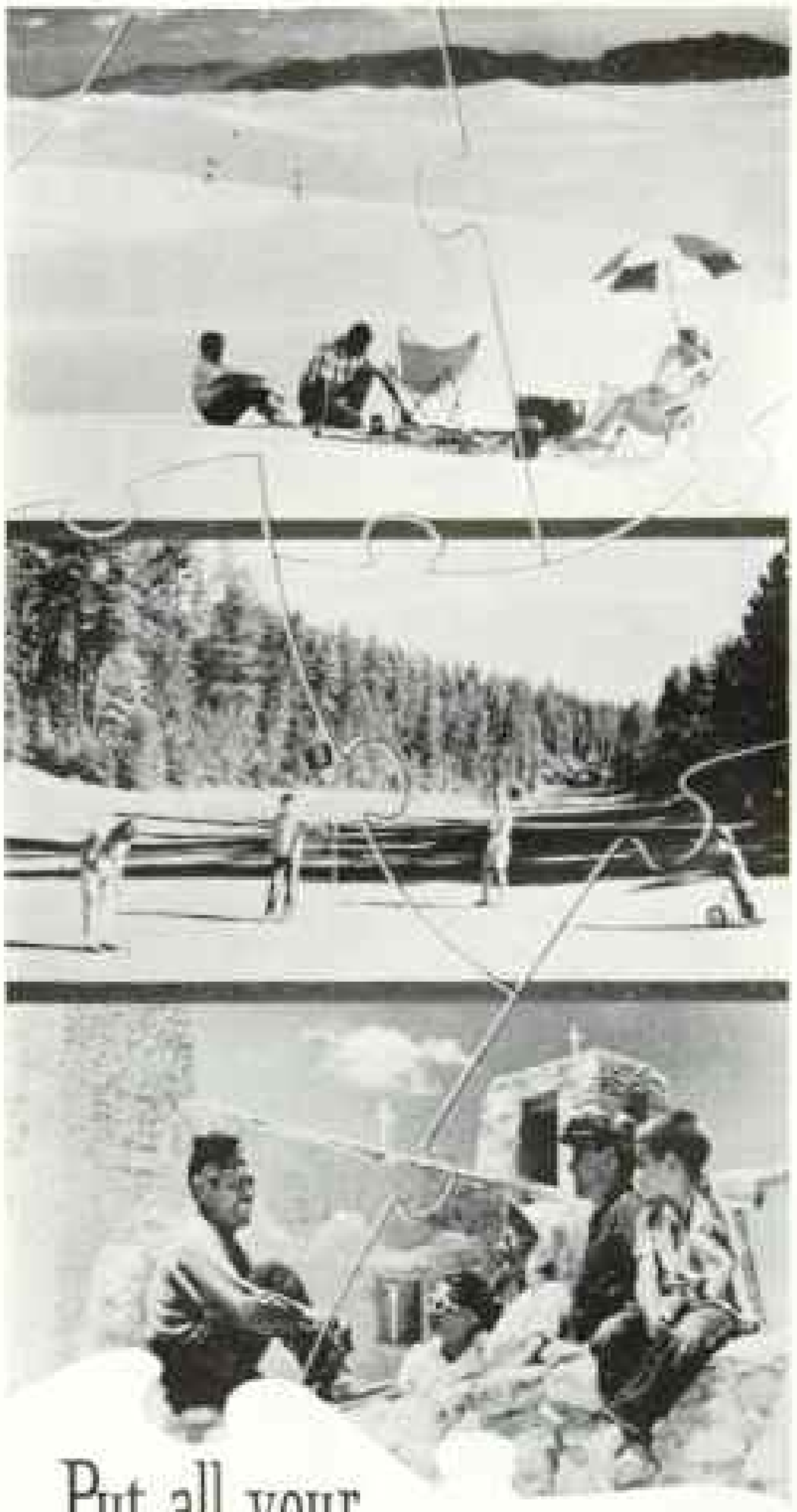

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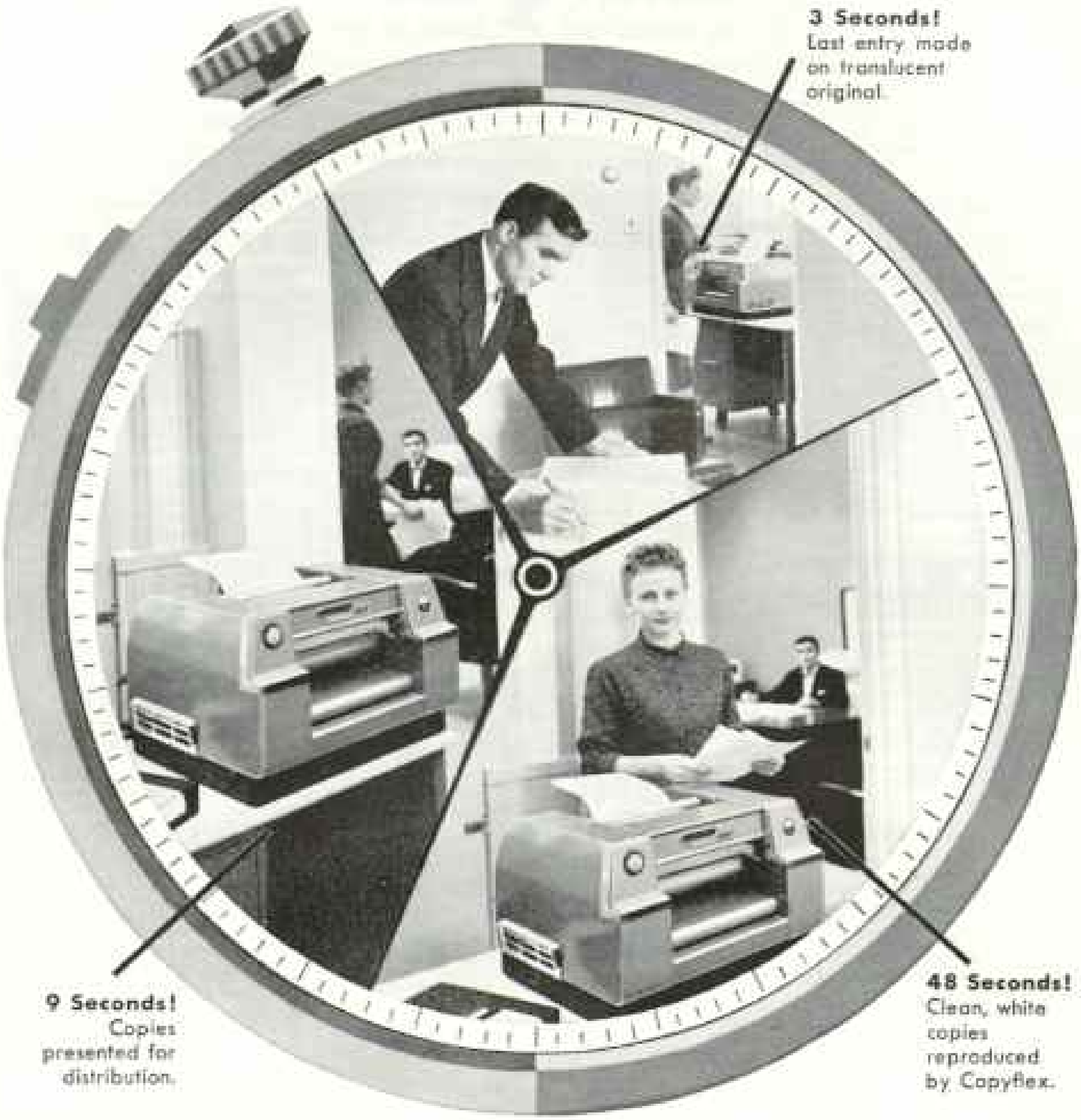

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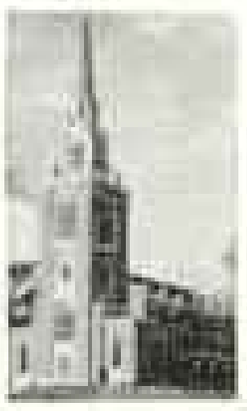

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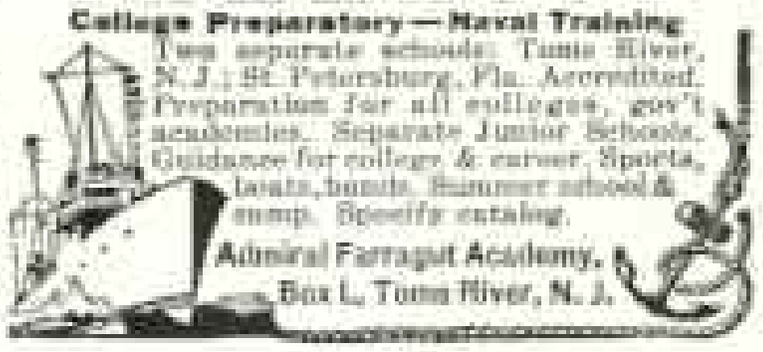

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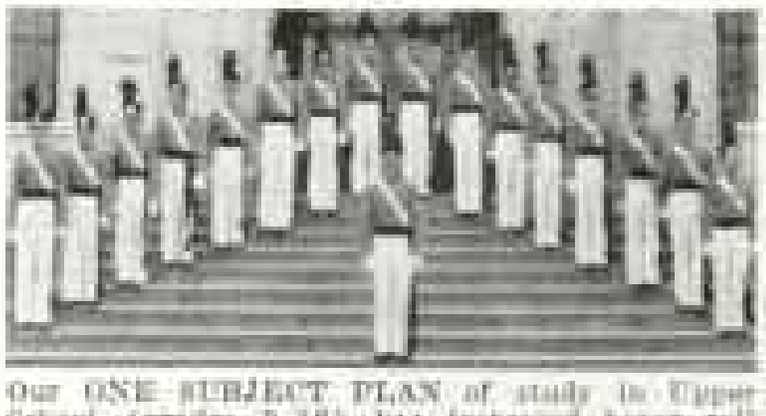

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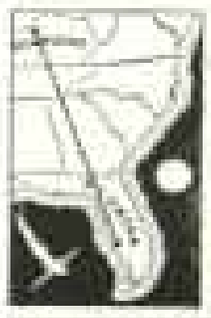

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