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AUGUST, 1957

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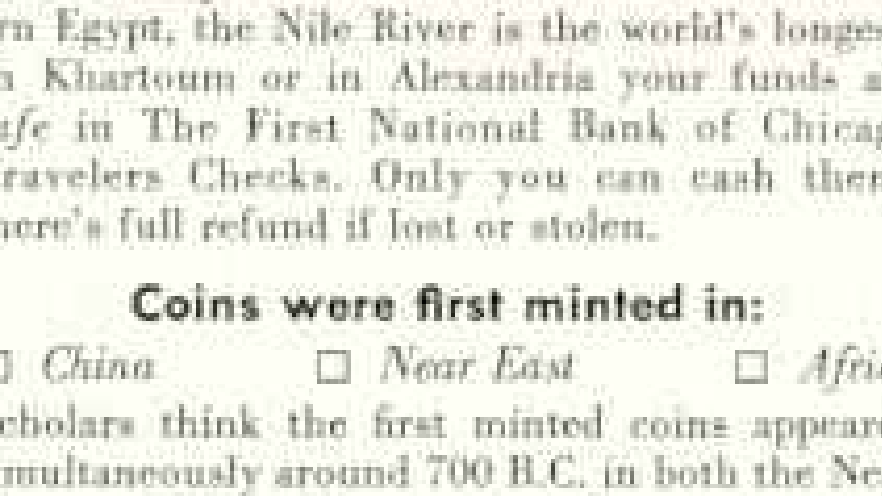

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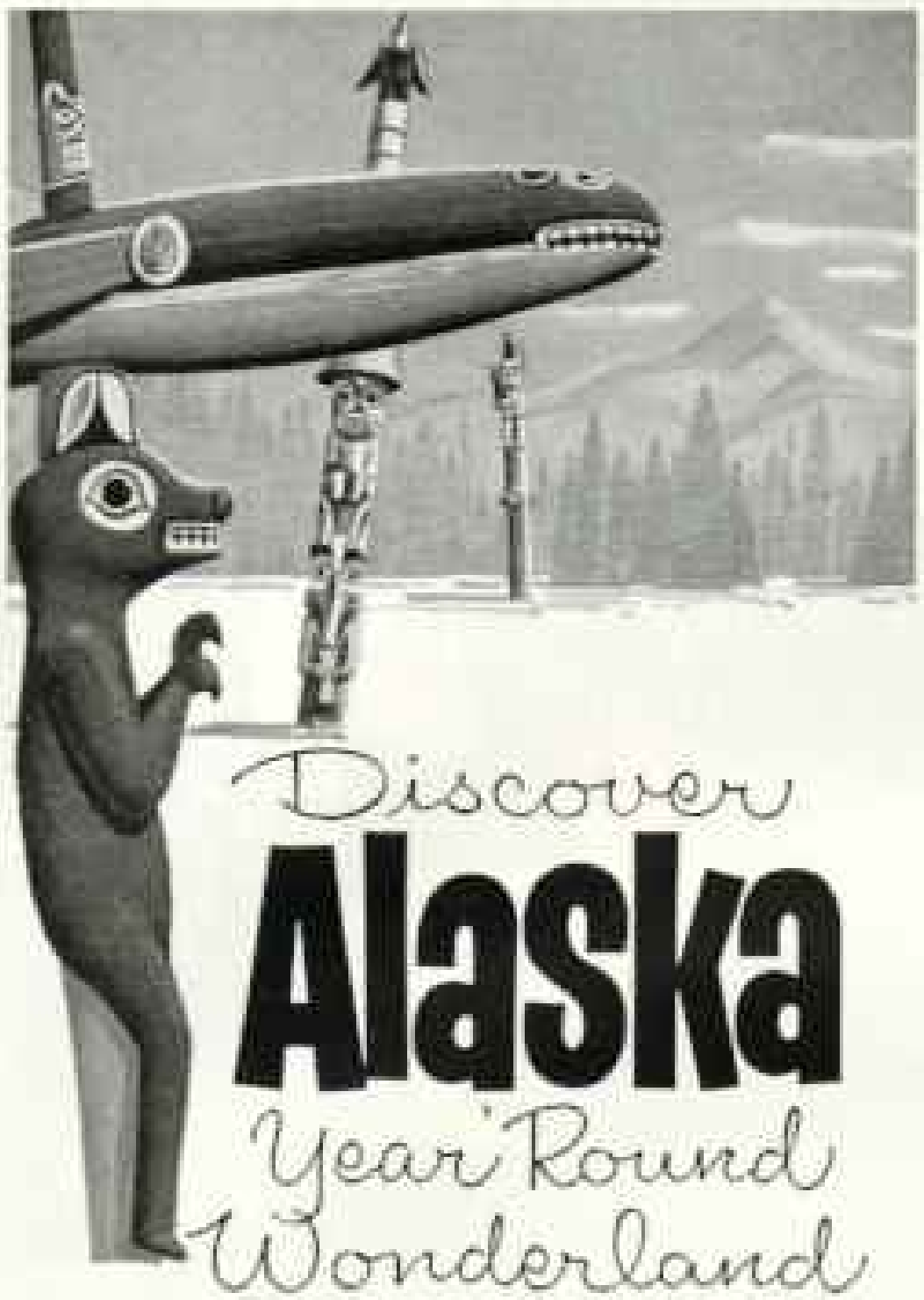

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To treat minor cuts: most cuts heal quickly if cared for promptly, but can become serious if infection develops. The first and most important thing to do is to wash the cut under warm running water. Then apply a mild antiseptic and sterile compress.

If iodine is used, remember that it becomes stronger with age and old solutions should not be applied.

To treat more serious injuries: falls cause many serious injuries, especially among young children and people age 65 and over. If you suspect a fall has caused a broken bone, do not move the victim unless absolutely necessary. Keep the patient as warm and comfortable as possible and get medical care promptly.

If an accident occurs and you cannot determine its extent or seriousness, call a doctor. Describe the injury, tell him where the victim is, what you have done and the victim's apparent condition.

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Note: For the topping, combine ¼ cup nonfat dry milk solids, ¼ cup ice water and ½ teaspoon Sucaryl in small bowl. Beat at high speed until consistency of whipped cream.

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VOL. CXII, No. 2 WASHINGTON AUGUST, 1957

THE NATIONAL GEOGRAPHIC MAGAZINE

The Giant Tides of Fundy

A Naturalist and His Family Explore the Shores of a Restless Bay Where World-record Tides Wash Canada's Maritime Provinces

BY PAUL A. ZAHL, PH.D.

With Photographs by the Author

THE famous tides of the Bay of Fundy move with deceptive quiet. Sheltered from the open sea, they ebb and flood to a recorded range unequaled in the rest of the world, relentlessly, swiftly, sometimes even dangerously.

Our first intimate brush with these tides came one noontime a mile from the bay itself. Soon after we drove into green, rolling Hants County, Nova Scotia, we stopped our car to picnic beneath a roadside maple. Eda Kristin, our eight-year-old daughter, newly possessed of rubber boots, rushed off to explore a shallow stream that meandered at the bottom of a ravine near by.

Soon a cry of alarm drew us up sharp: "Help! I'm stuck!"

Red Mud Mires Unwary Feet

Leaving five-year-old Paul to guard our sandwiches, my wife and I rushed toward the ravine. Halfway down a steep, slippery, 30-foot embankment stood Eda, her boots buried in red mire.

"Easy now!" I cautioned, as I picked my way down the gluey incline. Eda reached out with the desperation of someone drowning.

"First we'll get your feet free," I told her. "Then we'll just have to inch our way up."

Crouching, teetering, knotting our toes to keep shoes and boots from pulling off in the ooze, we struggled to higher ground.

It took Eda and me only a short while to wash and change clothes at the well of a neighboring farm. Returning, we again peered over the bank. Our ravine, actually a tidal vein, was now a full-sized salt-water river! The muddy tracks we had made were already submerged beneath a good six feet of the inflowing tide.

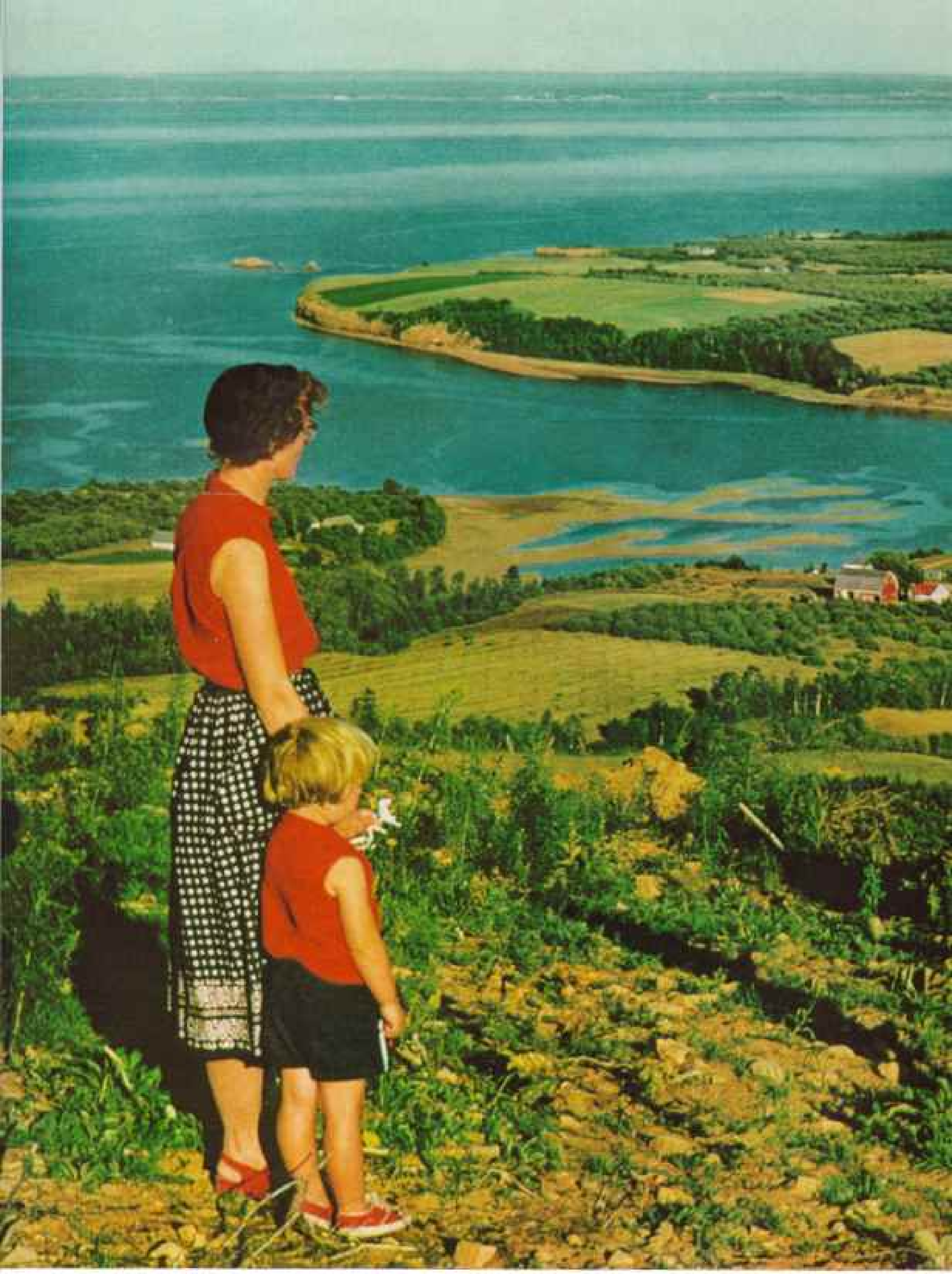
Tragedy Rides on Fundy Tides

Though my daughter viewed her narrow escape with a child's unconcern, her mother and I did not. "What if Eda had been alone?" we wondered.

Her fate could well have been that of a woman I lately read about. A resident of this very county, she had been riding horseback on an open beach when the fast-rising tide overtook her. The horse swam ashore, but the woman drowned.

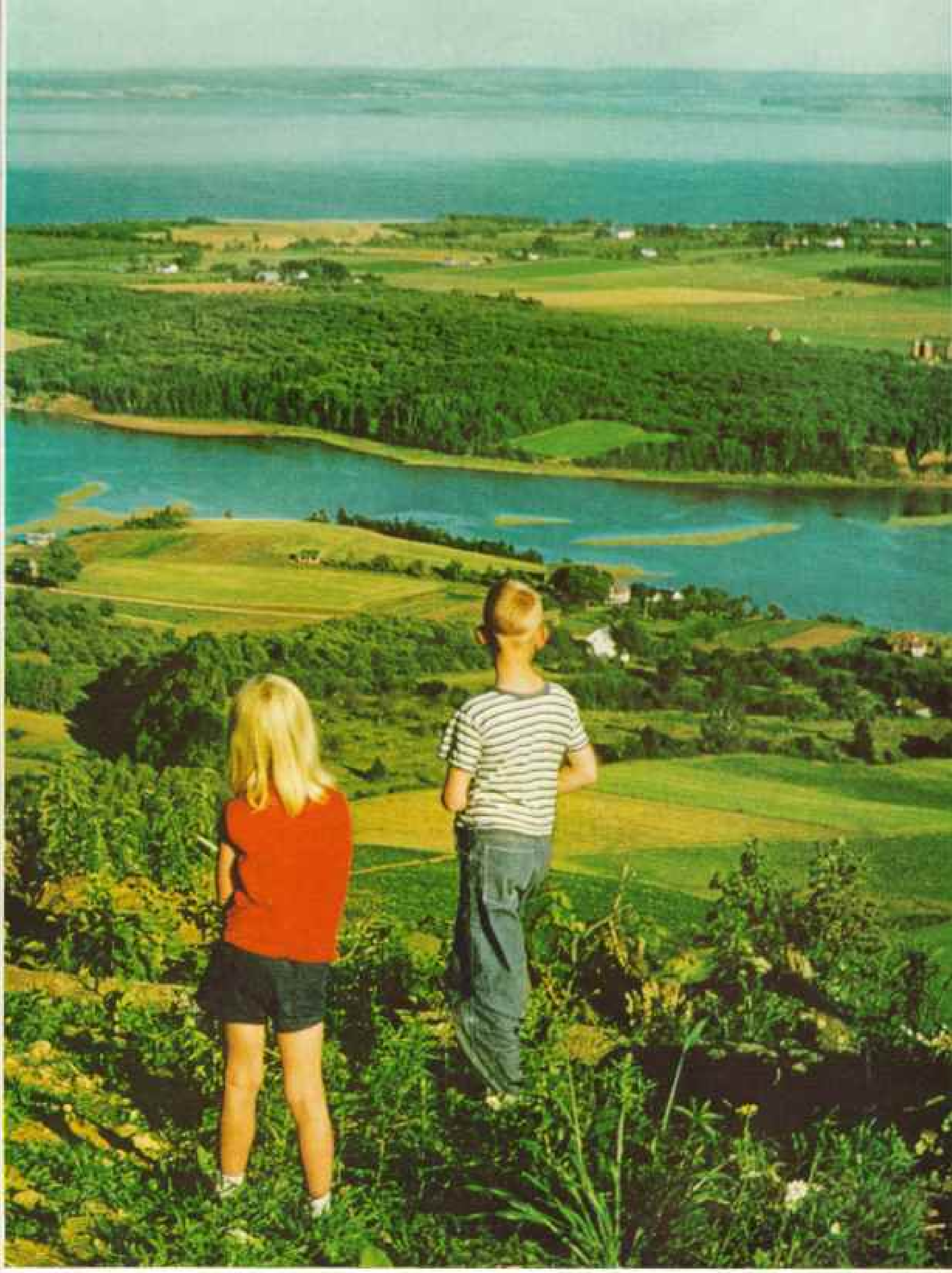
Fundy people had given us a deadly serious warning: "Unless you know these tides and currents, don't take chances." Eda's experience with the bay's swift movements served to underscore their hazard.

Just the day before, we had crossed from Saint John, New Brunswick, to Digby, Nova Scotia, a distance of about 45 miles. But fog lay heavy over Fundy. Aboard the ferry S.S. *Princess Helene* we had spent four hours listening to the moan of foghorns and the clank of sea buoys. We watched the ship's radar antenna sweeping high on the bridge, but saw little of the bay itself.



Bay of Fundy Tide Sweeps in Mighty Flood Along Nova Scotia's Inner Shore

Twice daily the world's highest tides funnel into Minas Basin, Fundy's eastern branch (upper). Waters may rise 53 feet. These visitors atop the Lookoff, a high point near Blomidon, see Pereau Creek swollen into a broad river (center). When tide runs out, the channel becomes a vein of red mud. Hants County meets the horizon.



Kodachrome by Paul A. Zahl

"This Is the Forest Primeval," Wrote Longfellow of the Acadian Land He Never Saw

In *Evangeline* the poet described this "happy valley" with its "murmuring pines and . . . deep-voiced neighboring ocean"; its "vast meadows . . . and orchards . . . spreading afar"; its heights where "sea-fogs pitched their tents." Then, as now, "dikes, that the hands of the farmers had raised with labor incessant, shut out the turbulent tides."

Our enforced blindness was tantalizing: we wanted to see these extraordinary waters. Into this 170-mile-long sea pocket northeast from the Gulf of Maine, more than 100 billion tons of water swell and recede twice daily—a weight roughly 70 times the daily discharge of the Mississippi River.

When the moon exerts its maximum pull, tides at the head of the bay may rise and fall as much as 53 feet. Even a "normal" tide exceeds 40 feet.

Yet from the deck of *Princess Helene* we could see next to nothing of our surroundings. Finally, at the dock in Digby, the fog lifted just a bit. Eda peered in all directions.

"But, Daddy," she asked, "where *are* those high tides?"

I explained that at this point, where the bay begins to flare out into the Atlantic, the tides are not phenomenally high. Here in the lower bay the range is 20 to 30 feet—considerable, to be sure. But these figures can be matched or exceeded at a number of widespread spots on the globe: at Cook Inlet, Alaska; Chepstow, England; Puerto Gallegos, Argentina; Penzhinskaya Bay in northeast Siberia; St. Malo, France; and at several other localities.

Minas Basin Holds Tidal Record

"For the real whoppers," I told Eda, "we have to go 60 miles upshore." I showed her on our road map how the Bay of Fundy forks into two branches, Chignecto Bay and Minas Basin. "Minas has the highest tides in all the world," I said (map, page 162).

I half expected my inquiring daughter to press the point still further: *Why* are these the world's highest tides?

It is an intriguing question.

The same moon and sun tug everywhere at the earth's watery blanket. But depth of the sea, configuration of the bottom, and the shape of the coastlines affect the tidal movement, causing marked differences in various parts of the world.

In areas of the South Pacific, as at Tahiti, the daily tides rise and fall less than a foot. The canals of Venice, responding to tides in the Adriatic, remain faithfully within a range of one to two feet. At the Atlantic end of the Panama Canal the tide is almost negligible; but on the Pacific side, a mere 40 miles away, the sea lifts and drops as much as 16 feet.

Oceanographers, using complex equations and charts, divide the oceans into a number of distinct tidal areas. The region to which the Bay of Fundy belongs has its center in the Gulf of Maine somewhere off the Massachusetts coast. Near this center, as at Nantucket, tides rarely exceed three feet. But as one moves northward the range increases dramatically. At Gloucester the tide may attain 13 feet; at Bar Harbor, Maine, 15 feet; at St. Andrews, New Brunswick, at the mouth of the Bay of Fundy, 27 feet; and in the Minas Basin, at the upper reaches of the bay, it reaches more than 50 feet.*

Sea Funnels into a Dead End

Several peculiarities of nature combine to cause the spectacular rise and fall of Fundy's waters.

First, there is the funnel shape of the bay. Its shorelines converge and its bottom slopes upward continuously from mouth to head. Thus the insurging sea has no place to go but up.

Second, and even more important, is the particular wave motion with which the tides rise and fall in this finger of the ocean. It is like one end of a seesaw, balanced against outlying forces of the open Atlantic. Oceanographers call this a "stationary wave," the sort produced by tilting a tub and letting its water slosh back and forth.

Physicists know that the length and depth of a body of water determine the size and frequency of such waves. The dimensions of the Bay of Fundy give its tides a definite rhythm. By geographic chance, Fundy's depth and length produce a pulse attuned to that of the outlying ocean.

Thus the two forces—ocean tide and wave motion within the bay—move at the same time, cooperate, and push the waters to phe-

* See "Down East Cruise," by Comdr. Tom Horgan, National Geographic Magazine, September, 1952.

These Fish Swam Above Eda's Head ➔ At High Tide on Chignecto Bay

The author's daughter stands on the muddy bottom of the sea during the few hours of low tide. When waters rush back, they will rise 30 feet.

On her first day in Nova Scotia, the youngster was trapped in a low-tide quagmire and had to be rescued by her father. An hour later, water swirled over the spot.

This gill net, one of the few remaining in the area, stretches a wall 10 feet high and some 70 feet long. Sturgeon (left) and goosefish hang helpless, snared by gill and jaw as they swam seaward.

nomenal heights. It is much like a child in a swing: even a small push, timed at the right moment, sends the swing higher and higher.

The result is a force of gigantic proportions. An estimated 200 million horsepower is at work in Fundy's daily surges, a tempting prospect for engineers who dream of harnessing this enormous energy. Schemes for a tidal power plant on Passamaquoddy Bay, between Maine and New Brunswick at the mouth of the Bay of Fundy, have been discussed since a far-sighted summer resident, Dexter P. Cooper, conceived the idea in 1919.

Sea Gates May Trap Daily Floods

At Passamaquoddy, if a continuing United States-Canadian study proves the plan practicable, huge gates swung by the sea may someday trap tidal waters in a natural island-studded reservoir. Channeled through great penstocks to an adjacent basin, kept at low-tide level by other gates, the water would power hydroelectric generators with an output a third that of Hoover Dam.

Driving northeastward from Digby, we got only occasional glimpses of Fundy's waters. Through miles of green forest and rich Nova Scotia farmland the road offered us no trace of seascape. Then suddenly we would cross a weathered bridge and see an inlet below.*

At the port of Windsor we found that ebb tide had created a great waterless harbor. Wharves towered high and dry above mud flats that denied all kinship with the sea.

We stopped at the Canadian customs house to check on the arrival of some scientific equipment I was expecting. As a biologist, I was eager to gather specimens of mud from these shores, since the microorganisms here, exposed alternately to sea and to air, were adapted to an environment I had not previously examined.

Farther along, at Walton, we saw two cargo ships tied up to the wharf by sturdy hawsers. But not a trace of water was there to support their strangely tall hulls; their keels rested bare upon a wooden platform. The port was a basin of mud (page 163).

"Bremen, and Bergen," said my wife, reading the German and Norwegian home ports lettered on the ships' sterns.

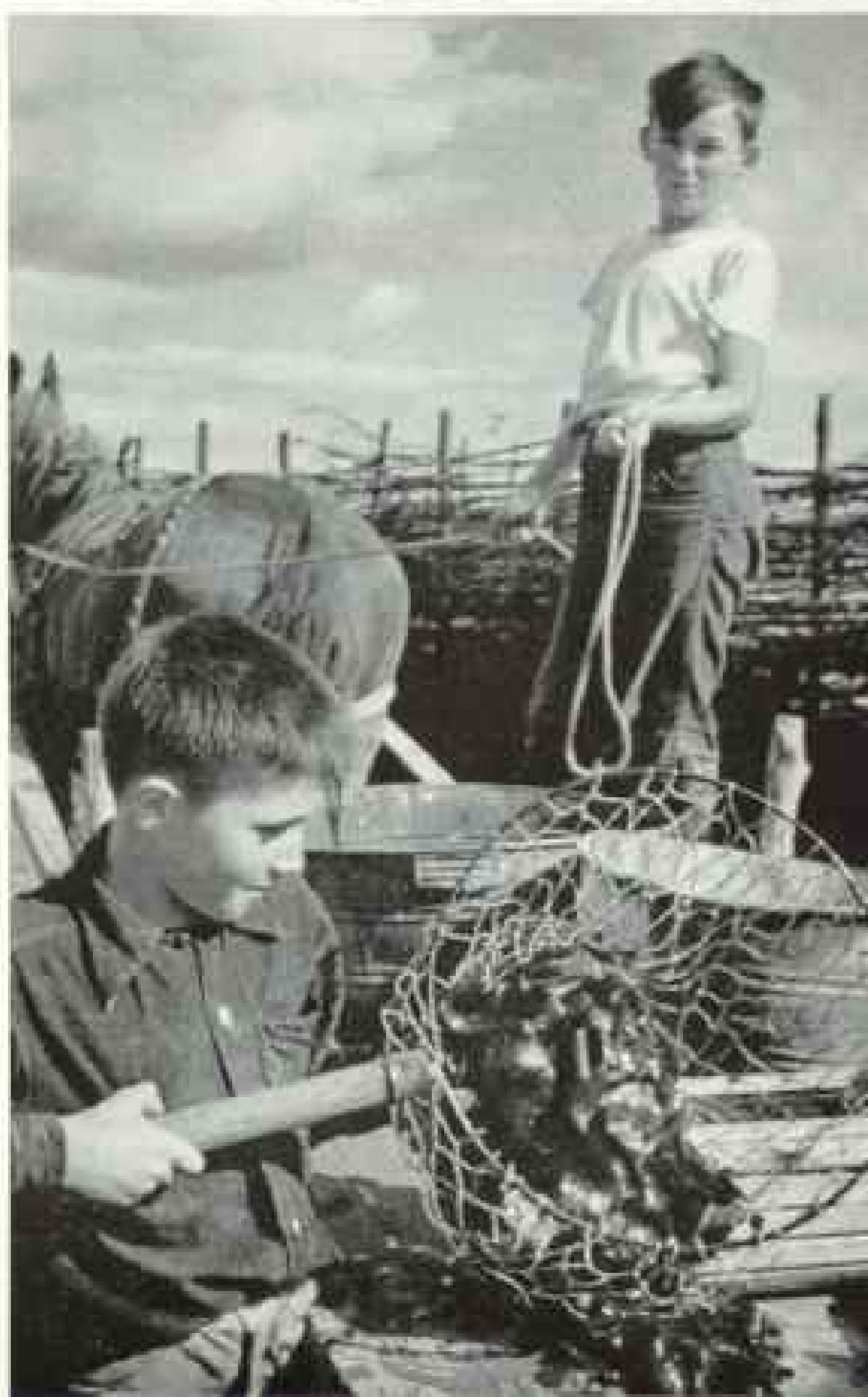
* See "Salty Nova Scotia," by Andrew H. Brown, NATIONAL GEOGRAPHIC MAGAZINE, May, 1940.

Minas Basin at Ebb Tide Offers a Bounty of Seaweed and Clams

Much as he might pause to feast on blueberries, a lad stoops to pick a mouthful of seaweed called dulse. Eaten fresh or after drying, the plant is prized as a snack on the order of peanuts or potato chips. Clam beds here are among the finest along Fundy's shores.

These youngsters return from their father's weir (left) along a course marked by stakes, a safeguard against getting lost at night or in fog.

Dip net proves handy for seaweed as well as fish.



"Landlubbers now," commented a workman near us on the levee. "But come back in a few hours and they'll be afloat. Forty-two-foot tide last night."

The children wanted to know why these ships had come so far.

"Barite and gypsum," said our friend. "They're mined near here. You ought to come back when a ship pulls into port." He grinned with admiration. "Not everybody can bring one in."

Fundy Tide Tricks French Explorer

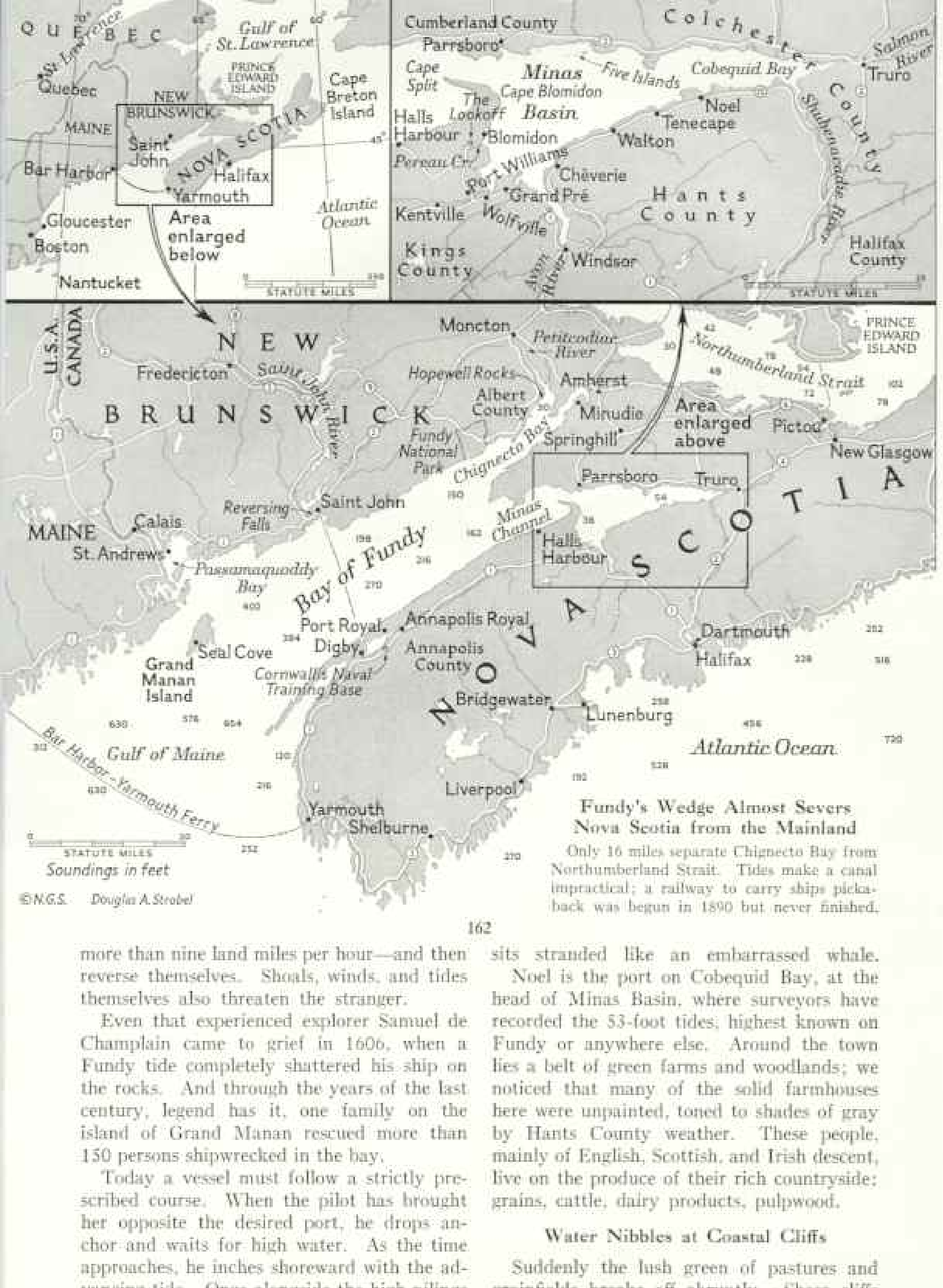
Maneuvering large vessels in and out of Fundy ports requires masterful navigation. Currents sometimes run at a speed of eight knots—slightly

↑ A Trickle of Fresh Water Rinses the Empty Tub of Halls Harbour.
← Salt Baths Fill It Twice Daily

Some fishermen go to work by dawn's alarm; those along the shores of Fundy follow a time-table set by the sea's pulse. With each tide a hundred billion tons of water pour into the bay. Forced into ever-narrowing and shallowing channels, the flood rises dramatically, then falls back as if a plug had been pulled from a drain. Wave rhythms of the bay coincide with those of the Atlantic, reinforcing the tremendous surge.

Because of this extreme tidal pattern, Halls Harbour runs dry twice each day. At lowest ebb (above) boats lie marooned on the harbor floor. Overflow from a dammed pond near by feeds the fresh-water rivulet. When silt clogs the harbor entrance, villagers open the pond's sluice gate and wash their channel clean.

During the early 1800's a pirate named Hall sailed into Minas Channel (horizon) and raided a settlement here. He left behind his name and a legendary treasure, buried but never found.



Fundy's Wedge Almost Severs Nova Scotia from the Mainland

Only 16 miles separate Chignecto Bay from Northumberland Strait. Tides make a canal impractical; a railway to carry ships piggyback was begun in 1890 but never finished.

more than nine land miles per hour—and then reverse themselves. Shoals, winds, and tides themselves also threaten the stranger.

Even that experienced explorer Samuel de Champlain came to grief in 1606, when a Fundy tide completely shattered his ship on the rocks. And through the years of the last century, legend has it, one family on the island of Grand Manan rescued more than 150 persons shipwrecked in the bay.

Today a vessel must follow a strictly prescribed course. When the pilot has brought her opposite the desired port, he drops anchor and waits for high water. As the time approaches, he inches shoreward with the advancing tide. Once alongside the high pilings of the wharf, the ship ties up with extra-stout lines. By then the tide may have already begun to ebb. Soon the vessel sits stranded like an embarrassed whale.

Noel is the port on Cobequid Bay, at the head of Minas Basin, where surveyors have recorded the 53-foot tides, highest known on Fundy or anywhere else. Around the town lies a belt of green farms and woodlands; we noticed that many of the solid farmhouses here were unpainted, toned to shades of gray by Hants County weather. These people, mainly of English, Scottish, and Irish descent, live on the produce of their rich countryside: grains, cattle, dairy products, pulpwood.

Water Nibbles at Coastal Cliffs

Suddenly the lush green of pastures and grainfields breaks off abruptly. Sheer cliffs of red sandstone or shale plunge into the bay, intercut with grottoes and eroded into dramatic arches, saddles, and pinnacles.

Twice a day the waters of Fundy rise high on these sculptures, there to continue their age-old nibblings. Receding, they drag along and scatter cliffside material, creating the second wonder of these shores—far reaches of red-brown mud flats.

Noel itself, well off established tourist routes, is a village consisting of one general store, a church, a school, a community hall and post office, and perhaps two dozen comfortable dwellings. One of them displayed a sign welcoming overnight guests. We stopped, knocked—and thus met the A. R. Scotts.

"Come right in," said Mrs. Scott, an energetic woman with a quick smile. We stepped into a sun porch where stood the racks and stretchers for a gaily colored, half-finished quilt, then through a front parlor into a large kitchen filled with the fragrance of baking bread. A buzzing sound interrupted us.

"Excuse me," said Mrs. Scott. "I have a call."

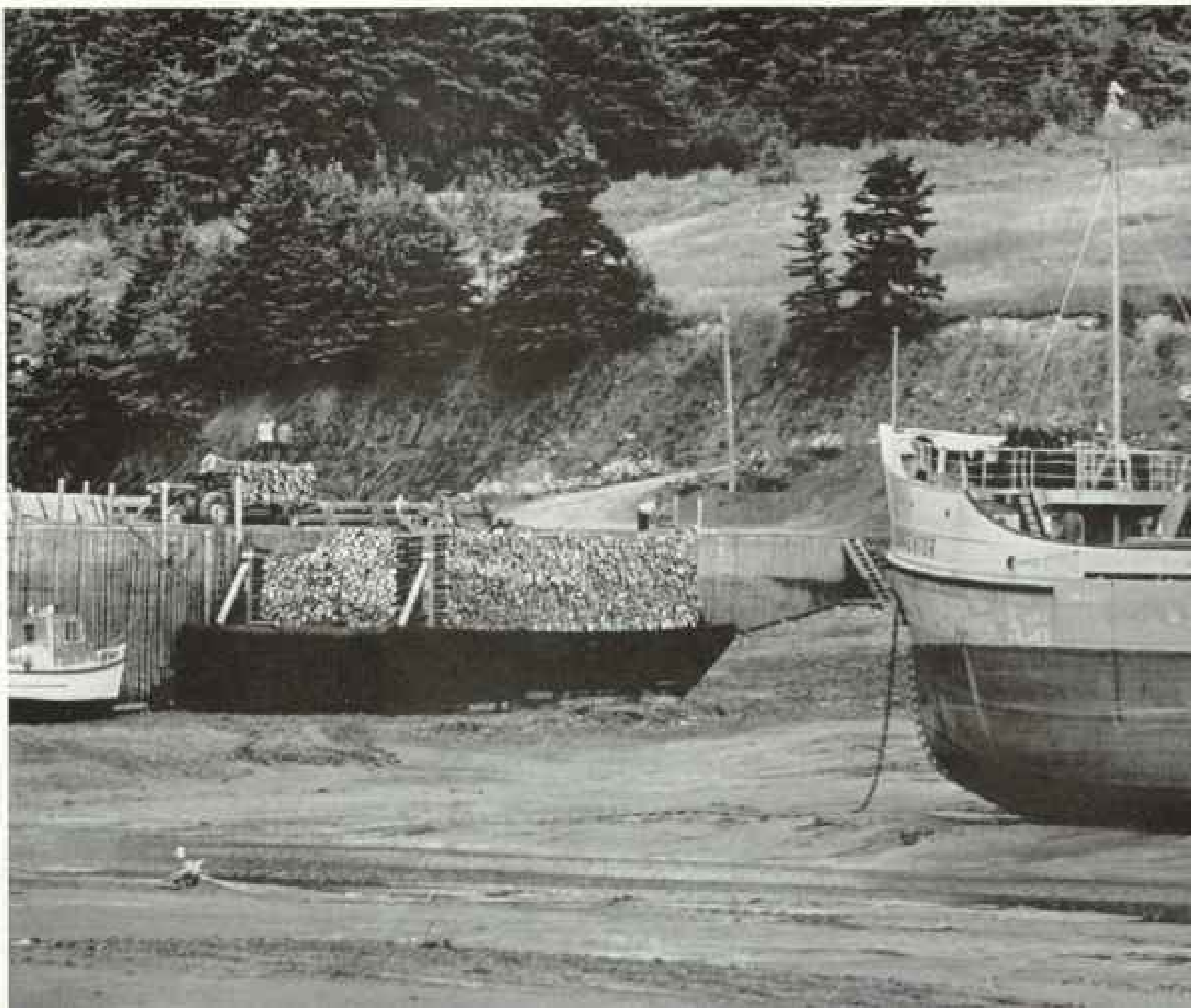
She turned to a corner of the kitchen. There stood the switchboard for the Noel telephone exchange! Deftly Mrs. Scott plugged in a line. By happy accident we had come upon the very nerve center for this part of Hants County.

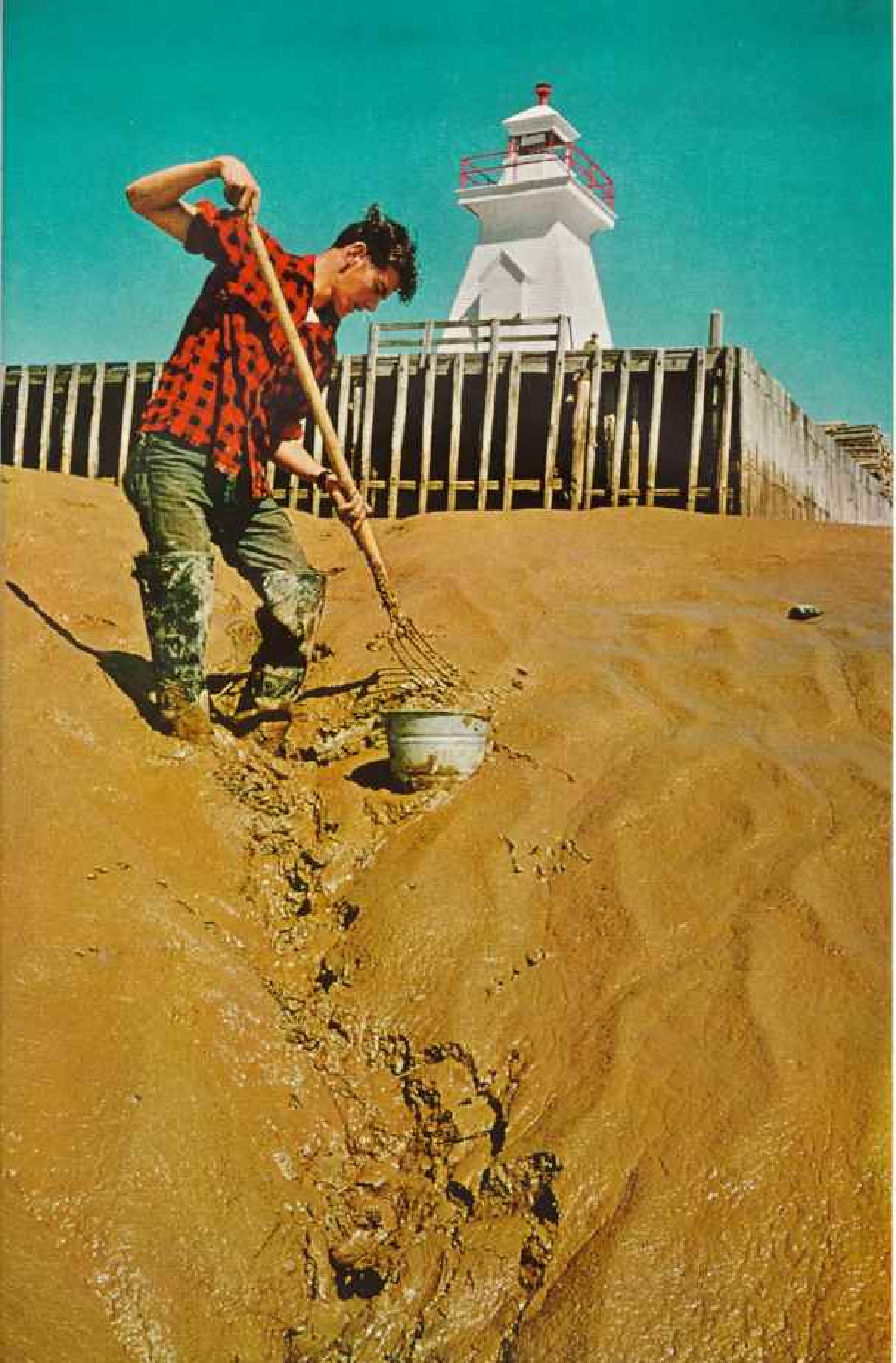
Mr. Scott, a hearty man, also worked for the telephone company. Son Ralph, a sophomore at Acadia University, had a summer job in the Walton mines. Then came Margaret, a teen-ager, and Ruth, a blond child of seven and a half, who helped their mother in the kitchen's many activities.

Next morning, from our bedroom window, we looked out to find a startling change. Where before had been endless water there was now endless land. As far as we could see stretched glistening mud—a gushy, red

Timber Barge and Ore Ship Await a Tidal Rendezvous on Walton's Mud

The freighter's anchor and chain sprawl on the exposed bottom; hawsers hold the ship to pilings on its starboard side. As tide ebbs, workmen loading pulpwood on the scow keep the logs level with the wharf.





bay bottom cut by twisting ravines through which rivulets of water still trickled.

At breakfast we asked how we might see some of Fundy's marine life out on the flats. Mr. Scott made all our arrangements over the kitchen switchboard.

"A young farmer named Ralph Laffin keeps a fishing weir near Tenecape," he said. "He'll be glad to have you go along when he makes his run."

Farmer Doubles as Fisherman

So we left Paul with Mrs. Scott and set out for the Laffin farm. Fishing, we discovered, is distinctly a side line for the Laffins. Ralph regularly helps his father on the land, but on the ebbing tide twice a day, regardless of time or weather, he goes to his fishing weir and gathers its yield for the family freezer.

Hitching his horse to a buggy, Ralph joined us. "Guess we're ready," he said.

The bottom here was firmer than at Noel, the mud less deep and sticky. In the light wagon we set out for the weir, nearly a mile from shore. As we jogged along, Ralph surveyed the retreating water.

"Tide's going fast. Be out by the time we get to the weir." We bumped across a bed of rocks covered by weeds and algae, then onto a prairie of partly drained mud flats.

In the distance ahead I could make out a long line of poles emerging like an upturned comb from the ebbing waters.

"Watch those stakes," Ralph said, as the horse stopped at a gentle tug on the reins. Before long we perceived the stakes rising higher and higher as the water slipped away. I jumped out of the buggy to get some photographs.

"Don't tarry," advised Ralph, amused at my struggling walk in the sticky muck. "The tide won't wait."

At length we came to the weir. Ralph's was only one of many types used in the Bay of Fundy. The varying nature of the shoreline and currents leads individuals to construct weirs of original design—circular fences, curves, angles. This one was a wide V opening shoreward, a pen built of twigs and branches hauled from the shore, supported by 10-foot poles stuck in the mud at close intervals for a hundred yards or more and tightly interlaced with branches and underbrush. As the tide drops, the weir traps retreating fish and leaves them stranded (pages 159, 185, and 188-189).

"Not much of a catch today," Ralph said.

He hopped from the buggy and proceeded to gaff some skates, eels, and a few shad that were flopping helplessly on the mud. My womenfolk helped him gather buckets of smaller fish for sale as line bait.

Bounty Paid for Trapped Seals

"Bass and shad'll be running in a few weeks," Ralph said. "Not long ago we found a 50-pound sturgeon out here. Even seals sometimes get caught in the weir. That doesn't hurt our feelings: the Government gives us a bounty because they prey so much on fish."

With practiced awareness, Ralph kept an eye on the outer bay. At the first sign of a switch in the tide he called out, "We'd better start back now."

Old Dobbin had a free rein on the return. Shoreward, far ahead, lay a sunlit checkerboard of grainfields, meadows, and woodlands. Behind us a noiseless 40-foot tide pulsed in, rising swiftly to engulf the stakes and fencework, a movement of surprising speed and gentleness.

Small wonder, I thought, that livestock are sometimes lost or that strangers can get a fright. Weir owners such as Ralph Laffin can take their danger lightly, yet with a respect based upon lifelong association with the treacherous tide. It is remarkable how few Fundy people have lost their lives in the surging waters.

At Noel, nearly every day, our children went swimming beside the 30-foot pilings where barges tie up to receive their loads of pulpwood (opposite). Swimming is a matter of careful timing here, and mothers are quick to warn their children of the danger.

← **Digging Against Ocean's Deadline, a Summer Resident Looks for Marine Life**

The town of Noel regularly sees world-record tides. On an October night in 1869 a gale helped push waters a monstrous 56 feet above low-tide level, enough to submerge a five-story building.

Normally the tide rises 8 to 11 feet an hour. Three hours after this picture was taken, water lapped far up on the pilings.

The author, a research biologist, sampled mud along Fundy's shores in search of animal life. To help him, David Corkum digs for specimens by Noel's navigation light.

Atop the wharf a load of pulpwood awaits transport by barge. Appropriately, Noel exports Christmas trees as well.

← A Wall of Water, the Tidal Bore Roars Up the Petitcodiac River

Shoals at the river's mouth temporarily dam the fast-rising tide. Oversweeping the obstacle, the crest drives inland like surf on a beach. Height of the bore, Fundy's largest, varies from a ripple to five feet, depending on the moon. Gulls hover for worms churned up by the turbulence.

↑ Tide Reverses This Waterfall, ↓ Then Drowns It in a Calm Lagoon

French explorers in the early 1600's came upon Reversing Falls near Saint John, New Brunswick. "The river takes a fierce leap . . . with a wondrous noise," they wrote; "at low tide outward; at high, inward." The Zahl children and a guide see words come true as the river moves seaward (above), then inland (below).

"My boy almost drowned right here a few years ago," Mrs. Scott told us. "A girl was swimming when the tide changed, and the current caught her. She called for help, and Ralph went in to get her. Both of them might have been lost if an older youngster hadn't jumped in to help them out."

Swimmers' Water Vanishes

During mild summer weather, when a high tide comes in the afternoon, bathers gather near the wharf for a dip in the bay's turbid red-brown water. But while they splash, the moon and sun are quietly at work, and inevitably the ebb begins. Within an hour or two the swimmers' water has disappeared, as if down a drain.

Here, as along most of the Atlantic coast, the tide arrives twice within every 24 hours and 50 minutes. For 6 hours and 12.5 minutes the sea rises; during the succeeding 6 hours 12.5 minutes it falls. Each day the two highs and two lows arrive 50 minutes later than on the preceding day.

Whatever our family plans, we were always dependent upon the tidal schedule; so, for a dime, I bought a blue-backed booklet: *Bay of Fundy Tide and Current Tables*. The most remote general store carries a supply, since these tables are as important to Fundy life as train schedules are to suburbs. I thumbed the booklet to arrange side trips and consulted it regularly before gathering specimens of mud.

On such scientific forays I filled 200 sterile culture tubes with tiny mud dabs. One specimen might come from the broad red flats;

(*Continued on page 177*)

"Gentle Evangeline . . . Ah! She Was Fair, Exceeding Fair to Behold"

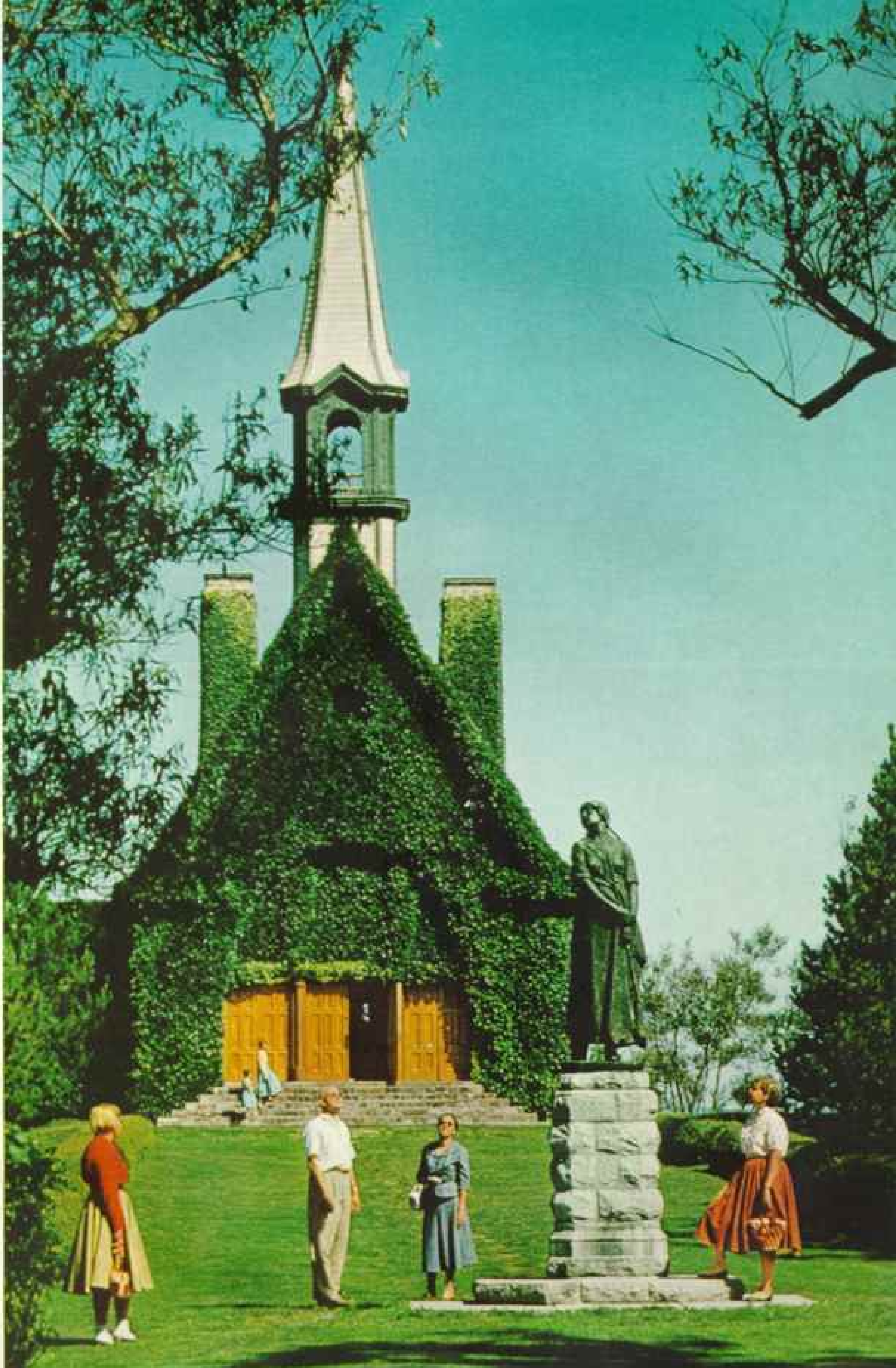
In the first half of the 17th century immigrants from France settled in Nova Scotia, calling their sea-washed land Acadia. When the Treaty of Utrecht ceded this part of North America to England, the inhabitants were ordered to pledge allegiance to the English king. This the Acadians refused to do, and in 1755 some 6,000 of them were shipped away to exile.

Ninety-two years later Henry Wadsworth Longfellow immortalized the exodus in his poetic tale of Evangeline, maid of Grand Pré, who was separated from her lover on the day of expulsion and spent a lifetime in search of him.

➔At Grand Pré Memorial Park, Evangeline stands in bronze before the museum, a replica of the Church of St. Charles where, wrote Longfellow, the Acadians heard their doom pronounced: "All your lands, and dwellings, and cattle of all kinds forfeited be to the crown; and you yourselves . . . transported to other lands."

Visitors who walk clockwise around the statue, the work of Henri Hébert, see the heroine seemingly age, recalling the lines, "Fair was she and young . . . Faded was she and old."

➔On the park promenade a monument honors Longfellow, laureate of Acadia's past.



♠ The Sea Scatters a Treasure in Jewels Before the Eyes of Beachcombers near Parrsboro

In the days of the earliest dinosaurs, volcanoes spewed across the face of what is now Nova Scotia. Gases formed bubbles in the slowly hardening lava. As eons passed, mineral-laden waters seeped into these cavities, depositing agate and amethyst, colored varieties of quartz.

The stormy waters of winter now wash these semiprecious stones from Fundy's cliffs, strewing them on the beaches. Each spring, collectors rush to take first pick.

Micmac Indians believed that their legendary hero, Glooscap, cleaved distant Cape Split in a fight with his enemy, the Beaver.

Upper right: Eldon George, a professional collector, cracks a rock to discover flashing amethyst. Uncut, such stones may bring several dollars a pound.

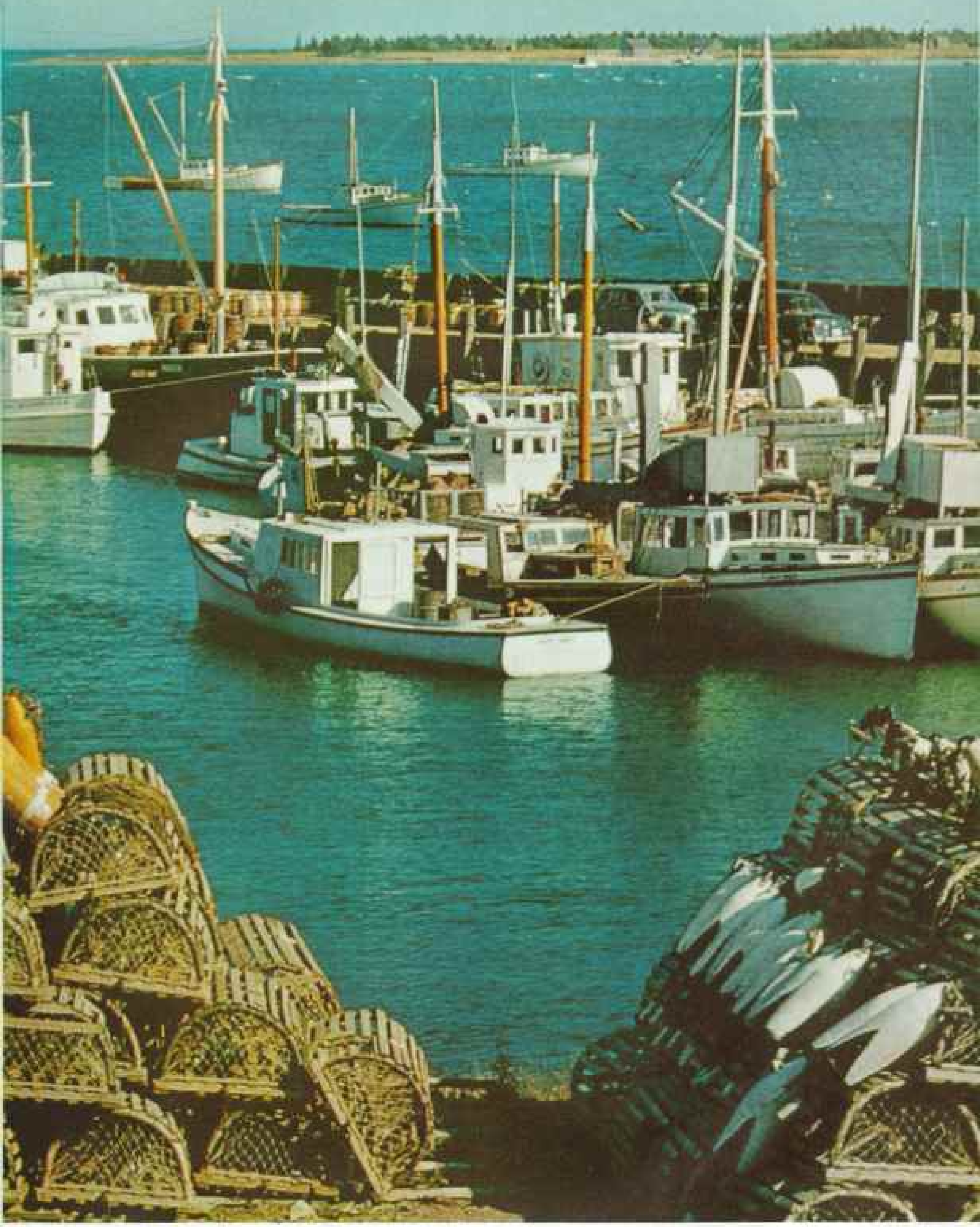
←Mrs. Jean Mosher of Halls Harbour, pursuing a profitable hobby in jewelry making, cuts agate on a diamond-edged wheel. Rough amethyst covers the table.

→Kentville gem cutters Winifred and Harold Fox designed an agate necklace for Princess Elizabeth as a gift from Nova Scotia on the occasion of her visit there in 1951.

Mrs. Fox arranges a display of gleaming agate stones for the family shop; her husband polishes a gem.

Lobster Pots Make a Child-size Mountain on the Island of Grand Manan

Covering 55 square miles, Grand Manan guards the entrance to Fundy. Like the State of Maine, only six miles away, the island is noted for lobster. Bright-colored buoys identify the traps when they are dropped in offshore waters.



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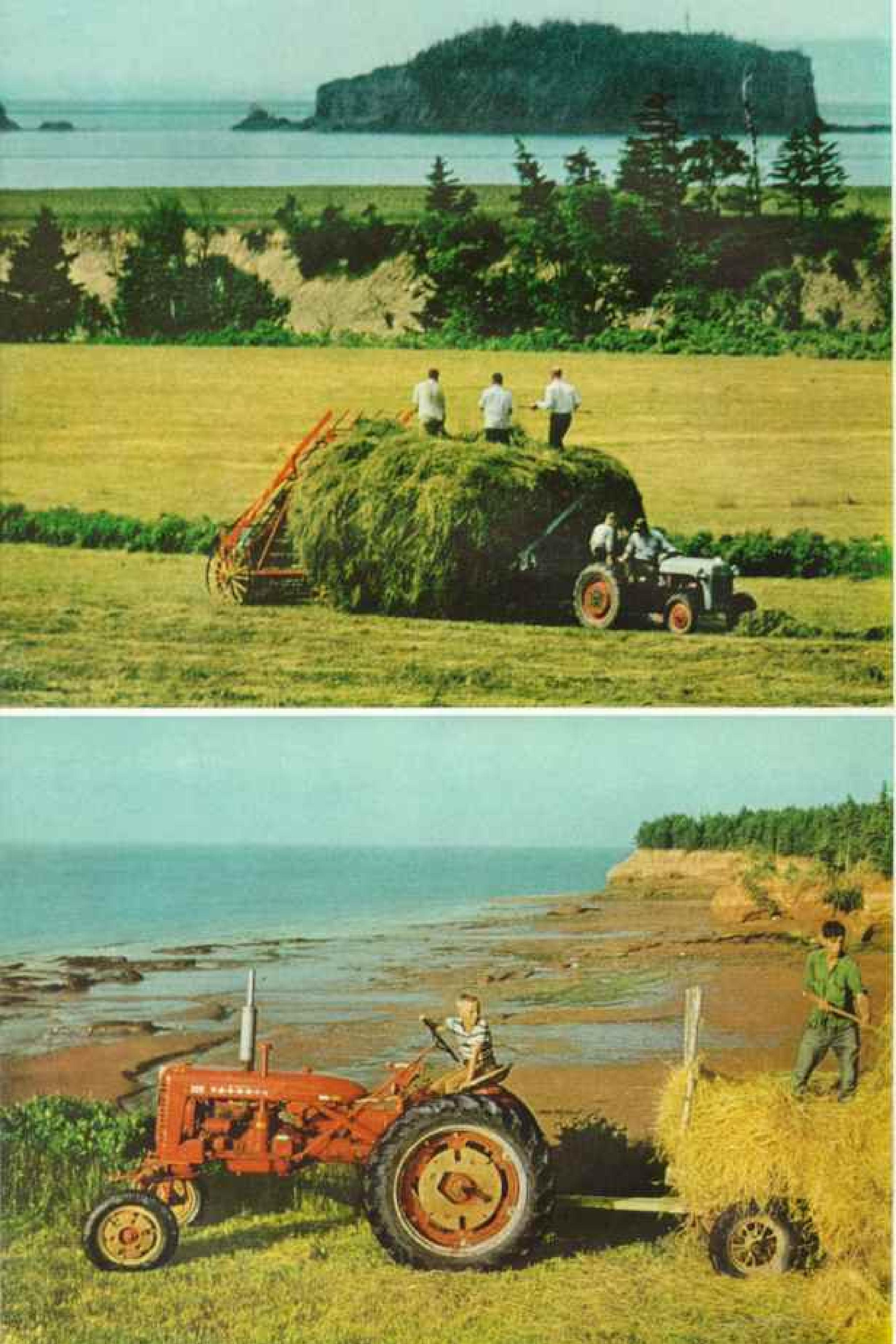
In from the Herring Harvest, the Fishing Fleet Ties Up at Seal Cove

Part of the catch is canned as sardines; part is cured. Smokehouses sweeten the island with an appetizing scent. A coating washed from the herring scales, called pearl essence, is sold for making costume jewelry.



↑ Farms Run to the Water's Edge; Islands Guard the Coast Like Medieval Watchtowers

The Acadians, experienced in farming marshes on the western coast of France, set about reclaiming the coastal fringes of their adopted land with a system of dikes and ditches. "At stated seasons," wrote Longfellow, "the flood-gates opened and welcomed the sea to wander at will o'er the meadows."

The dike system still prevails; upper bay water—far less salty than the sea—irrigates rich crops of vegetables, oats, barley, hay, and clover.

Here Colchester County farmers gather hay. Beyond rise two of Minas Basin's Five Islands—rounded Pinnacle Island and Pinnacle Rock, a formation with Gothic spire and flying buttress.

← A Hungry Sea Nibbles at Forest and Field

This balsam fir forest in Hants County gives up some of its soil and a few trees each year to the growing mud flat. Boys pitch hay on a cliffside field; it, too, diminishes annually.

← Fishing Boat's Gangplank and Mooring Anticipate the Tidal Flood

Nova Scotia's irregular coast is splintered by countless inlets and streams. Seafaring tradition runs strong.

In a rivulet harbor near Noel this homemade vessel uses a specially devised mooring rig. Rock-weighted kegs suspended on the frame keep lines taut over pulleys as the craft rises and falls.

Lower: At high tide the kegs go below water. Gangplank floats on air-filled barrels.

another from an inlet with green algae or brown silt; still another from a spot where tidal currents swirl or where fresh water dilutes the salinity of the bay.

Fundy offers a varied, fascinating ecology for microorganisms. Taken from their surroundings and their sources of food, many of these small creatures die before they can be studied under a microscope. But even a few survivors able to adapt to life in a culture tube may contribute to our understanding of the sea's bioeconomy.

Creatures That Time the Tides

Such work is humbling. Literally trillions of living things depend on the regular pulse beat of mother sea. Think of the sedentary organisms—barnacles, oysters, anemones, seaweeds, and the rest—living in the tidal zones of shores throughout the world. Consider, too, the strange marine species which breed during the full- or new-moon tides and those others that choose the quarter-moon periods.

A classical case is that of the grunion, a small silvery fish that periodically appears in large numbers on the southern coast of California. Its eggs must be deposited in moist sand, in a spot that will be undisturbed by the surf for a two-week period. Adult grunions find such a spot by uncanny use of the tides.

During the breeding season, just after the peak of the highest tides adult grunions purposely allow waves to wash them high on the sandy beach. Quickly, before another wave arrives, the females deposit their eggs in the sand and the males fertilize them. By some mysterious instinct they choose the precise moment when the tide is beginning to ebb. Thus the eggs, buried now in the beach, will not be carried away by the following, less powerful rollers.

Two weeks elapse before another high tide reaches the spot and digs out the eggs, which hatch instantly. The waves sweep the young into the sea, to repeat the cycle.

Fundy's marine life must contend not only with giant tides but with man as well. Besides brush-built weirs, fishermen string up gill nets to comb the surging waters.

"Not many gill nets left," folks told us. "You might try Minudie."

So we drove to Minudie on Chignecto Bay, all the way around Minas Basin. Waiting for the tide to go out, we could see that this sort of weir resembles a giant volleyball net, stretched several feet above the sea bottom on 12-foot posts. Fish swimming seaward catch their gills like ratchets in the netting. An ebbing tide then leaves the fish stranded high above ground.

In old days men filled wagons with shad caught this way and harvested by means of a ladder. But the entire catch from the outgoing tide we watched consisted of only two fish, a sturgeon and a goosefish, angler, or "allmouth," as the net tender disparagingly called it (page 157).

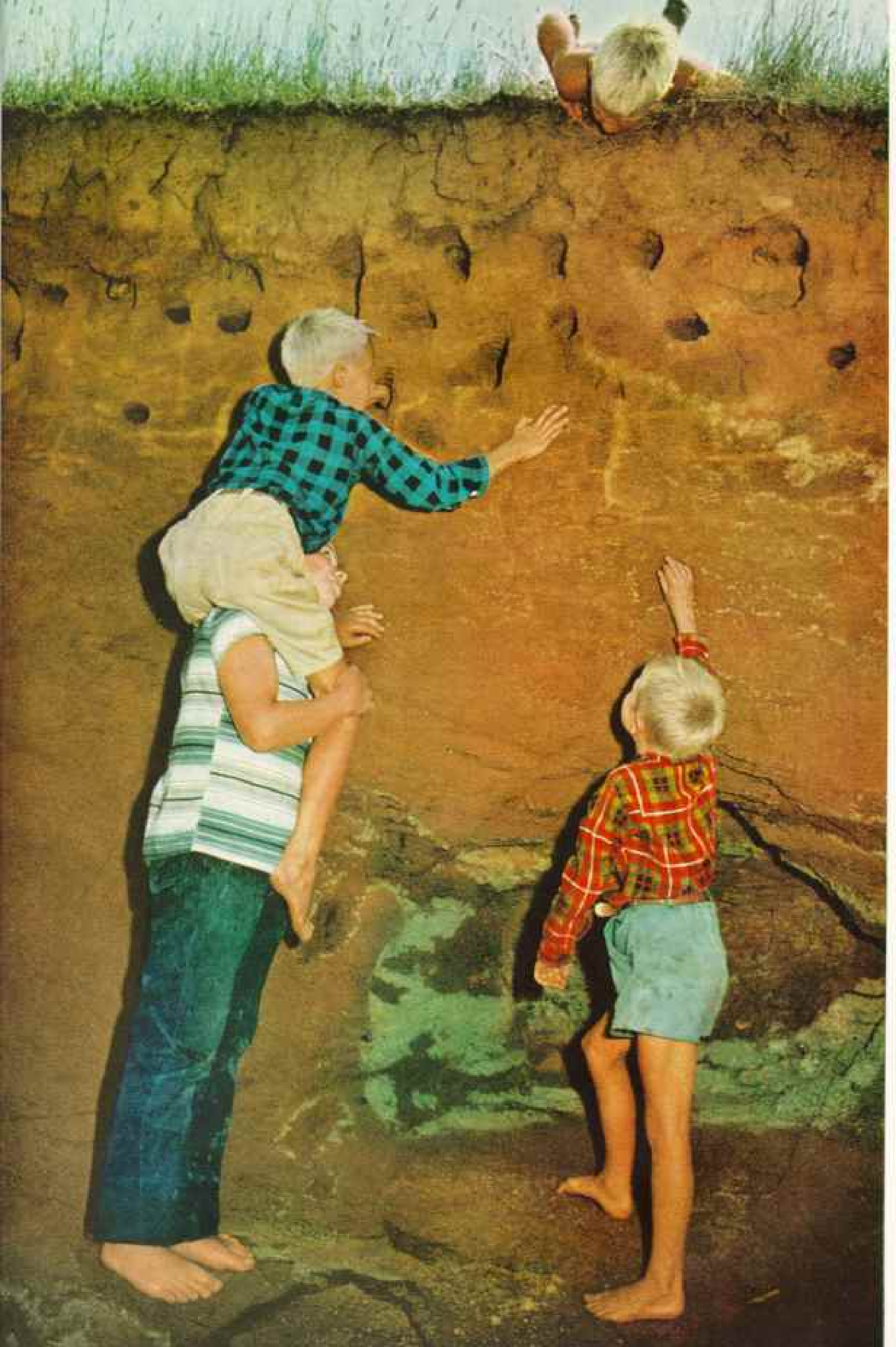
"Why bother to take them in?" he shrugged when I asked him about his business. "Even when shad are running, there isn't much of a market for them around here any more." In addition, he explained, nets have become more and more expensive. They have to be mended frequently, and often the catch scarcely pays upkeep costs.

No Venomous Snakes in Nova Scotia

Almost every day we made side trips from Noel and other temporary homes. We motored hundreds of miles, poking into scores of side roads, relishing scenic spots.

"No need to worry about poisonous snakes along our shores," Mr. Scott had said. Indeed, Fundy's Nova Scotia waterfront has few inconveniences. Even the mud flats have relatively little stench, thanks to frequent submersion and a chill temperature.

Our only requirement in abandoning the main highway was that our lane should lead in the direction of the bay. Such an excursion took us to Halls Harbour, a fishing and lobstering hamlet on Minas Channel. We simply rounded a turn in the road and there stood a picture-postcard vista, an inlet shaped like a horseshoe and lined with pilings. A dozen simple buildings surrounded it. Fishing craft that would bob on high tide now were strewn about a nearly empty gravel-and-mud-bottomed basin (page 160).



We had to stop. While I moved around taking photographs, our youngsters struck up an acquaintance with a small lad standing on the dock. His name was Peter Parker; his parents owned and ran the village store.

"Is it true that Halls Harbour was named for a 19th-century pirate?" we asked Fred Parker when we visited his store.

He laughed. "Captain Hall—yes, that's the story." Looking at the youngsters, he added, "And they say his treasure is still buried around here."

Jewels Borne by a Generous Sea

Obviously Fred put no great stock in this folk tale. But he told us of other treasure that Halls Harbour residents regularly find on their beaches—amethysts and agates, brought down by the great tides from near-by cliffs.

"You might talk to Mrs. Mosher," he told us. "She finds her own gems, then cuts them herself."

Mrs. Jean Mosher is a gracious and twinkling woman who asked us in to see her studio, then showed us the way her diamond-edged wheel cuts stones (page 170). Like scores of other people in Nova Scotia, she has turned this hobby into a profitable home-craft industry.

"Would you like to have some amethyst crystals?" she asked Paul and Eda. At that moment two wide-eyed youngsters, fingering bits of lavender rock, became eager mineralogists. Breathlessly they listened as she talked about her work.

Winter storms bring down landslides along the shore; so, as soon as the thaw comes each spring, mineral collectors hurry to their favorite beaches, trying to be the first explorers of the season. Geologists and amateur collectors come here from all over Canada.

"But we have an advantage," said Mrs. Mosher. "We know where to look.

"Agate and amethyst are really just differently colored quartz," she told the children. She showed them the egg-shaped igneous rocks that had encased these semiprecious treasures until split open.

Later Eda told her mother and me, "I want a geologist's pick for my birthday."

If we were at first inclined to dismiss this request as a whim, Eda's continuing enthusiasm changed our minds.

"Mrs. Mosher says that moss agates don't really have pieces of fern inside," Eda would explain. "The design is just the way they crystallize."

From that day on, the whole family pursued Eda's new hobby. On a beach near Parrsboro we went rock hunting with a professional collector, Eldon George, and his brother (pages 170, 171, and 192).

Eda's bag was soon filled with heavy specimens mined by a generous bay. I can even admit to a personal thrill when I found some pale amethyst crystals. They were of little value, yet I had to keep them.

Visiting the famous Hopewell Rocks in Albert County, on the New Brunswick side of the bay, our youngsters could barely see the boulders for the pebbles. Here 40-foot tides have attacked the soft conglomerate rocks of the cliff, carving out tall islands. At low tide these islands expose their dry feet, slender columns that support the bulky tops like giant mushrooms (page 183). But the children were preoccupied with the smaller stones littering the flats beneath Hopewell's strange islands on stilts.

History Washed Annapolis Royal

The great Fundy tides indirectly aroused another interest for our family. History has moved upon these waters, and its traces remain on the land. At Annapolis Royal we saw the site of the continent's first lasting European settlement north of St. Augustine, Florida—old Port Royal, founded by Sieur de Monts in 1605.

Changing hands repeatedly over the next century, Port Royal was finally won in 1710 by British troops from Boston. The French flag came down, and Brig. Gen. Francis Nicholson renamed the outpost for his Queen: "Town of Anne," or Annapolis Royal.

Just 16 years earlier, a Maryland settlement had also honored the same royal Anne. And, strangely, the name Annapolis grew great in naval tradition at both these distant points. In 1942, Nova Scotia's Annapolis County became the site of the Cornwallis naval training base, one of the largest in the

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←"Anybody Home?" Towheaded Visitors Call on a Colony of Bank Swallows

The birds use short, broad bills to excavate tunnels in soft sand-and-clay cliffs along the Bay of Fundy. Burrowing more than a foot, they hollow out chambers about five inches in diameter for nests.

At Evangeline Beach near Grand Pré, swallows live just out of reach of the highest tides but not beyond the curiosity of barefooted adventurers.

Kodachromes by Paul A. Zahl

At a Port Williams Field Day, Oxen and Horses Pit Tons of Brawn Against Sleds Laden with Stone

Each year farmers near this shipping port gather for an ox-and-horse pull. Above: A driver helps his oxen drag a 4,800-pound load two feet. Below: Dust flies as 5,230 pounds of horseflesh strain to move 8,200 pounds of boxed gravel, the day's record for horses.

British Commonwealth. As guests, we drove through this installation in the jeep of a hospitable commander in the Royal Canadian Navy, to our youngsters' delight.

But for the children, the Acadian country whisked away the centuries more excitingly. Near the tree-shaded university town of Wolfville, we explored the Acadian setting of Henry Wadsworth Longfellow's poem *Evangeline*. In front of the museum at Grand Pré Memorial Park stands a statue of Evangeline herself, as imagined by the Canadian sculptor Henri Hébert (page 169).

Statue Recalls Poetic Drama

"Have you noticed how this statue ages?" a tourist asked us. "Here, walk around it clockwise. She seems to grow older as you move."

We followed his advice and fancied that we, too, could see the young Acadian girl fade and bend with the years.

My wife then told the children the story of this girl, exiled with her people in 1755. With her words, that long-ago era came close to Paul and Eda. It even spurred me to purchase a copy of Longfellow's poem to reread that night.

In a hundred small details the poem called to mind images we were seeing: "the forest primeval," the swallows, the dikes that shut out the bay from rich farmlands, the orchards and meadows. Dramatically the poet used Fundy's pulse to punctuate his story, recording each change of tide—"in haste the refluent ocean fled away from the shore. . . ." Then it returned "heaving and hurrying landward." And finally, "with the ebb of the tide the ships sailed out of the harbor," carrying Gabriel far away from the fair Evangeline.

Acadians' "Happy Valley" Comes to Life

Our excursions in Acadia took us all around Longfellow's "happy valley." We visited the towering Lookoff near the town of Blomidon to photograph a sweeping view of Minas Basin (page 154). On clear days visitors here can count the valleys of six rivers and spot landmarks in five counties.

Another day we noticed a sign: "Field Day —Ox and Horse Pull, Port Williams, N. S." We turned off the main road for a short distance and near an apple orchard found a holiday competition in full swing. Some 3,500 farmers and townsfolk were cheering yokes of oxen and teams of horses as they strained against weights measurable in tons (pages 180 and 181).

Another jaunt acquainted us with dulse, an edible seaweed that grows in abundance along certain sections of the Fundy shore. Coastal dwellers collect it for home consumption to nibble like potato chips. On the island of Grand Manan, near the mouth of the bay, this seaweed is even gathered on a commercial scale.

At Chèverie, a tiny bayside hamlet near Noel, we arranged to accompany a redheaded teen-ager named Donna Murphy and her father on a dulse hunt. Our journey took us well beyond the mud zone to a rock-strewn region where timing is crucial. There the sea can rise in a few hours from eight inches to the height of a four-story house.

"What would happen if the horse went lame or if we broke a wagon wheel?" I asked.

My daughter looked at me for reassurance; I looked at Mr. Murphy. He merely laughed. His hale presence and that of his beaming daughter, both veterans of the tide flats, were good indications that we would come to no harm.

Family Harvests Fundy Seaweed

I was reminded of a story I had heard of a Hants County dory skipper, whom worried ferry passengers often asked, "Do you ever lose people here?"

His invariable reply was, "No, we always find them the next day."

Even sober scholars have sometimes swallowed tall tales of Fundy's tides. An encyclopedia in the last century noted that the bay waters "rush up from the sea with such rapidity as sometimes to overtake swine feeding on . . . the shores." But the local pigs, another story relates, outwitted the hazard. They stationed one of their number on a high bluff. When the tide approached, the sentry would squeal a warning, and the others would scamper to safety.

I could grin at such yarns, yet I couldn't help glancing seaward every few minutes. Within a matter of hours several million

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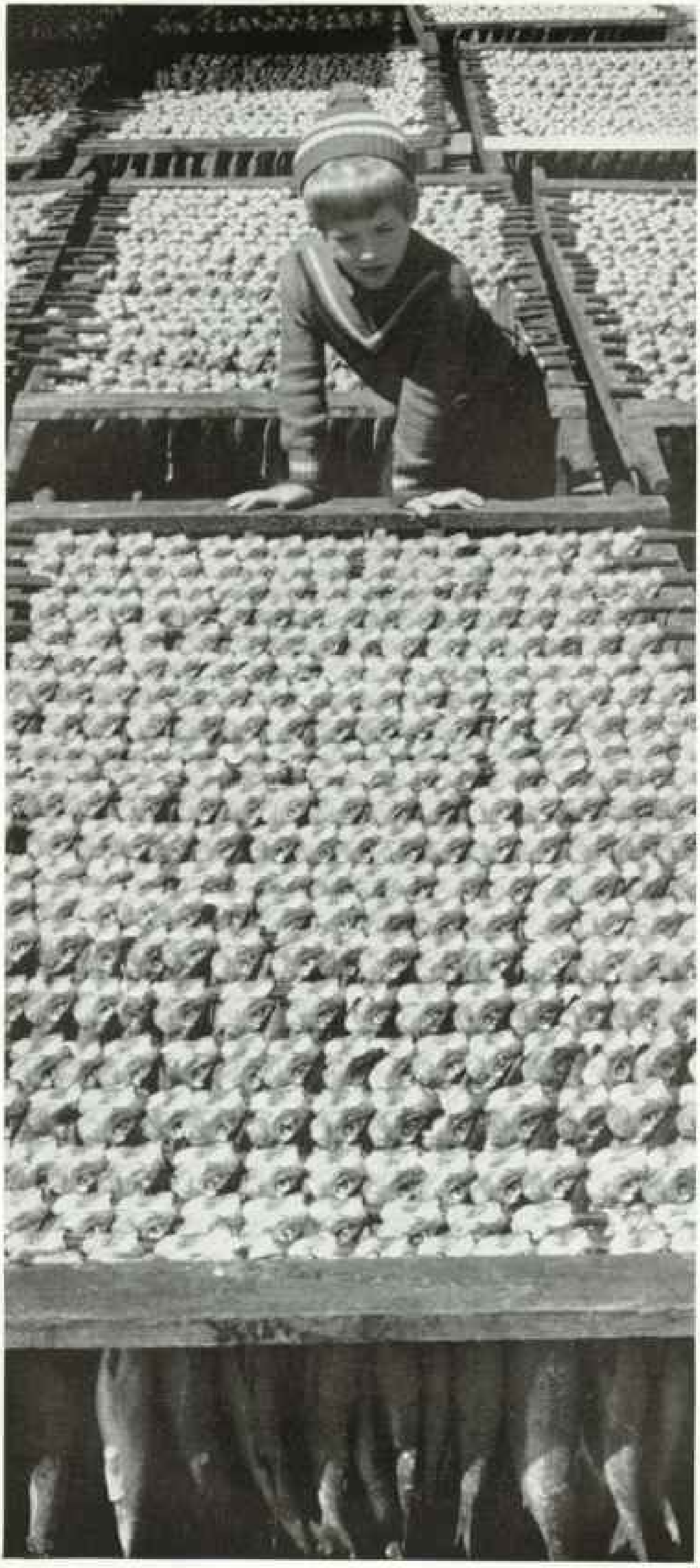
Gnawing the Feet of Hopewell Rocks, ➔ Tides Create Monstrous Mushrooms

Near the mouth of the Petitcodiac River visitors see dramatic evidence of the work of tidal currents and frost. At highest tide only balsam fir and dwarf black spruce show above the flood.



tons of water would slide back over these very flats.

Land was soon far behind, and we jogged through a dimensionless mirror of shin-deep water. Suddenly Mr. Murphy spotted our goal.

"Dulse!" he shouted. "Dulse by the bushel basket!"

He pointed to where seaweed tufts, each attached to a head-size rock, waved gently in the shallow clear water. Mr. Murphy pulled the cart to a halt, and the four of us piled out (page 186).

"When it's this color, it's ripe," said Donna, plucking a bunch that was purple brown. Half an hour later the cart was almost full.

Back on dry land, Donna separated the fronds and spread them to dry in the sun. By midafternoon the dulse looked more like dried tea than seaweed.

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Herring Eyes, Lined Row on Row, Stare from Curing Racks

The day before this photograph was taken, these herring swam in Fundy waters. Now, cleaned and skewered in frames holding 350 fish apiece, they await three months of curing in the smokehouse.

Men Tug at Nets, → but Hose and Pump Pull In the Fish

Inside a Grand Manan weir, fishermen haul in seines to concentrate the catch. Then a hose like that of a giant vacuum cleaner sucks up both water and herring. Pumping process loosens scales, which are caught on screens aboard the vessel at left.

Draining Waters Reveal a Vast Field of Glistening Seaweed

Some families plan vacations to the Bay of Fundy to reap iodine-rich dulse. At Cheverie, Nova Scotia, Eda Zahl helps Donna Murphy and her father with the harvest.

Lower: At Grand Manan a commercial crop of seaweed is spread on the pebbled beach for drying. A subtle darkening in color tells when the sun has baked the weed to a proper turn.

"Have to be careful at this stage," commented Mr. Murphy, as he stuffed a handful of the sun-crinkled fronds appreciatively into his mouth. "If dulse is too dry, it's hard to eat. If you don't dry it enough, it rots when you store it."

I tried a few small fragments. The salty, somewhat medicinal flavor suggested that a taste for dulse must be acquired.

"People who eat dulse are supposed never to have goiter," Mr. Murphy commented. In view of the high iodine content of seaweed, this generally held opinion may have a sound basis.

As our days passed, we realized that the moon phase was changing. Since I hoped to witness another of Fundy's natural wonders, we shifted quarters to the point where Minas Basin tapers into the form of a tidal estuary and meets the Salmon River. Here a striking phenomenon can be observed, especially at the period of so-called spring tides.

Spring Tides Rise Twice a Month

The term "spring tide" has no seasonal connotation; it comes from the Anglo-Saxon word *springan*, to rise. Spring tides come twice a month throughout the year: when the sun and moon are aligned on the same side of our planet, and later when they align on opposite sides of the earth.

Guided by our tide tables, we planned to arrive in the city of Truro, Nova Scotia, at the onset of the full-moon period, to see the bore of the Salmon River.

A tidal bore is a sea surge, sometimes a series of them, passing up a river or estuary at the commencement of rising tide. This surge may take the form of a violently churning wave front, or wall of water, pushed along by a pistonlike inflow of tide.

Tidal bores are caused by some of the same forces that make surf break on a beach. When a fast-rising tide enters an estuary and encounters some kind of obstruction—say a sandbar, a sudden bend, or another kind of bottleneck—its wave front is deformed by shallowing banks and bottom. Readjusting to a new rhythm, the front steepens until it resembles surf. It may start to curl over, then break into foam as it rushes upstream.

I recall the day we stood on the banks of the Salmon River, on the outskirts of Truro, waiting for our first tidal bore to arrive.

"The tables say our tide should change at 11:40," I told my wife.

"What time is it now?" she asked.

"It's 11:38."

The Salmon River, about 150 feet wide at this point, looked like a dozen other tidal channels we had seen along the way—sloping walls of mud with, at ebb tide, a modest stream of quiet brown water. I held my son's hand to keep him a safe distance from the bank.

Sea Roars In Like an Express Train

Suddenly there was a shout from among the group of people who, like ourselves, had been drawn by curiosity. "Here she comes!"

Sure enough, about a quarter-mile downstream we could see a white line across the river and extending out over the bordering flats. It seemed to be moving slowly, an illusion created by distance. As it got nearer, I saw that this bore was, in fact, a thing of great power moving upriver at the speed of a sprinting man. Like the rolling surf, it tumbled relentlessly, dashing along and pillaging the banks, speeding across the flats, a two- to three-foot-high front of hissing water. In the excitement I could feel my son's hand tighten on my own.

The bore moved past us, sweeping under the near-by highway bridge and out of sight upstream. Behind it, pushing, were tidal waters of the rising sea. The Salmon River, which an instant before had been a lazy drainage channel, was now a coffee-colored torrent, rampaging wildly and aswirl with eddies and whorls and floating debris.

Tidal Bore Eerie by Night

Twelve hours later, close to midnight, my wife and I were back on the same bank.

"Eerie, isn't it?" my wife murmured. Under the cloak of darkness we could see only a moving white line; otherwise, the river was black. Then the low sizzle of the monster grew louder. As it passed noisily, the effect was a bit frightening. In such a manner does

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Horse and Cart Replace Boat on a Fundy Fishing Trip; Brush Substitutes for Net

Many bay fishermen use weirs, letting the tides do most of the work. Some weirs, or traps, are made of netting. Others, like this one belonging to Ralph Laffin, a Tenecape farmer, are built of 10-foot poles stuck in the mud and laced with a tangle of branches.

The owner must reconstruct the trap each spring after the violence of winter's storms.

Night or day, Mr. Laffin visits his weir at every low tide. Hitching horse to buggy, he bumps over a rocky mud flat for almost a mile, hoping that a kindly sea has left behind a bountiful harvest.

Mrs. Zahl and her daughter gather small fish for bait.

← Cautioned by her father not to touch unidentified eels, young Eda stands a reluctant but obedient distance from two green specimens.

→ Mrs. Zahl gaffs a skate, relative of the shark and ray. Mr. Laffin inspects his brush work for tidal damage.

the sea twice daily reclaim the Salmon River as one of its own.

The most famous and most dangerous tidal bore in the world occurs on the Fuchun River in China, where a roaring crest may gain a height of 15 feet. At speeds of 10 knots this wall can sweep everything before it. Tidal bores also occur in several rivers near the mouth of the Amazon, on the Severn and Trent Rivers and Solway Firth in the British Isles, on the Seine in France, on several rivers in India and Pakistan, on Cook Inlet in Alaska, and elsewhere.

Sea Birds Follow Speeding Water

We saw bores in four distinct localities of the Bay of Fundy: the Salmon, Avon, and Shubenacadie Rivers in Nova Scotia, and on the Petitcodiac River in New Brunswick.

The Petitcodiac is much broader than the Salmon, so the width of its bore is correspondingly greater. Its speed is about 8 miles an hour; its height at average spring tide, 3 to 3½ feet. Sometimes the speeding bore exceeds 5 feet.

As the breaker rolls over exposed mud flats, flocks of sea birds follow it closely, swooping down to feast on worms and other mud creatures churned and tossed up by the bore's plowing head (page 166).

I was continually impressed by the power and punctuality of these tidal bores. But one day, when I tried to make some photographs from a railroad bridge, the timing of the bore cost me some anxious moments. Tide tables could give no precise information for the bore's arrival at this inland point. So, deliberately early, I left my family parked in the car with a picnic basket and clambered gingerly out over rails and ties to the center of the bridge.

Tide and Trains Race the Clock

My camera held at the ready, I began to wait; I realized uneasily that I knew less about local train schedules than about this tidal bore. Consulting my watch, I listened carefully for the advancing water—or for a train whistle. Time passed, but neither appeared. Mentally I rehearsed a quick retreat in case an express should win this race with the tide.

Actually I need not have worried; no train whistled while I sat there. The tidal bore came through, but not until I had waited a tense two hours!

This experience sharpened my own excitement a few weeks later when I watched a young man risk his life on the timing of a Fundy tide. From the New Brunswick side of the bay we had visited the lobster and herring fisheries on the quaint island of Grand Manan, then had driven through Fundy National Park.*

Approaching the city of Saint John, we caught a fragment of newscast on the car radio: "...a young factory worker will attempt to swim solo through the Reversing Falls gorge...."

The Reversing Falls are just what their name implies, rapids that can leap forward or backward. They are caused by a bulky rock formation at the mouth of the Saint John River. Here rising tides of 28 feet brim over and tumble upriver through the gorge for an 11- or 12-foot drop. When the two levels are equal, the water remains slack for a short period. Then with the ebb it spills outward again for a fall of 15 or 16 feet (page 167).

Swimmer Challenges Reversing Falls

Checking time and date, I joined 10,000 other spectators one evening to watch husky Frank Martin challenge this treacherous gorge. No one else had ever succeeded in swimming it. At slack water the rapids are navigable for sturdy craft during an average one hour and ten minutes. But swimmers have far less time before currents threaten to buffet them over dangerous rocks.

"Look!" yelled someone in the crowd. Martin was off the boat. In the tense, vast assembly I found it difficult to see. But a view was hardly necessary; 10,000 craning commentators on banks and bridge registered the swimmer's progress. Martin had timed his speed meticulously, 45 strokes to the minute as a start.

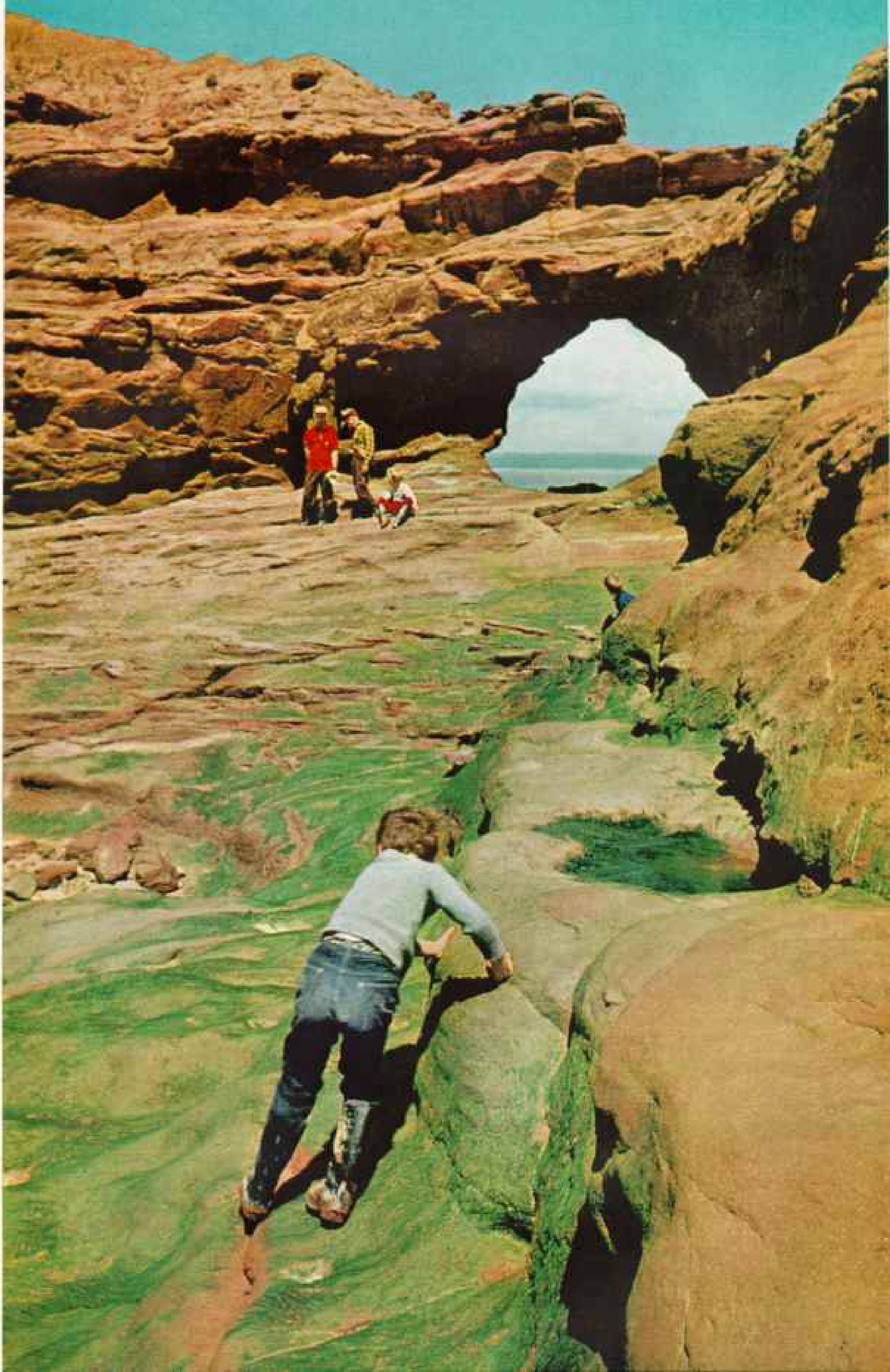
Suddenly he speeded up.

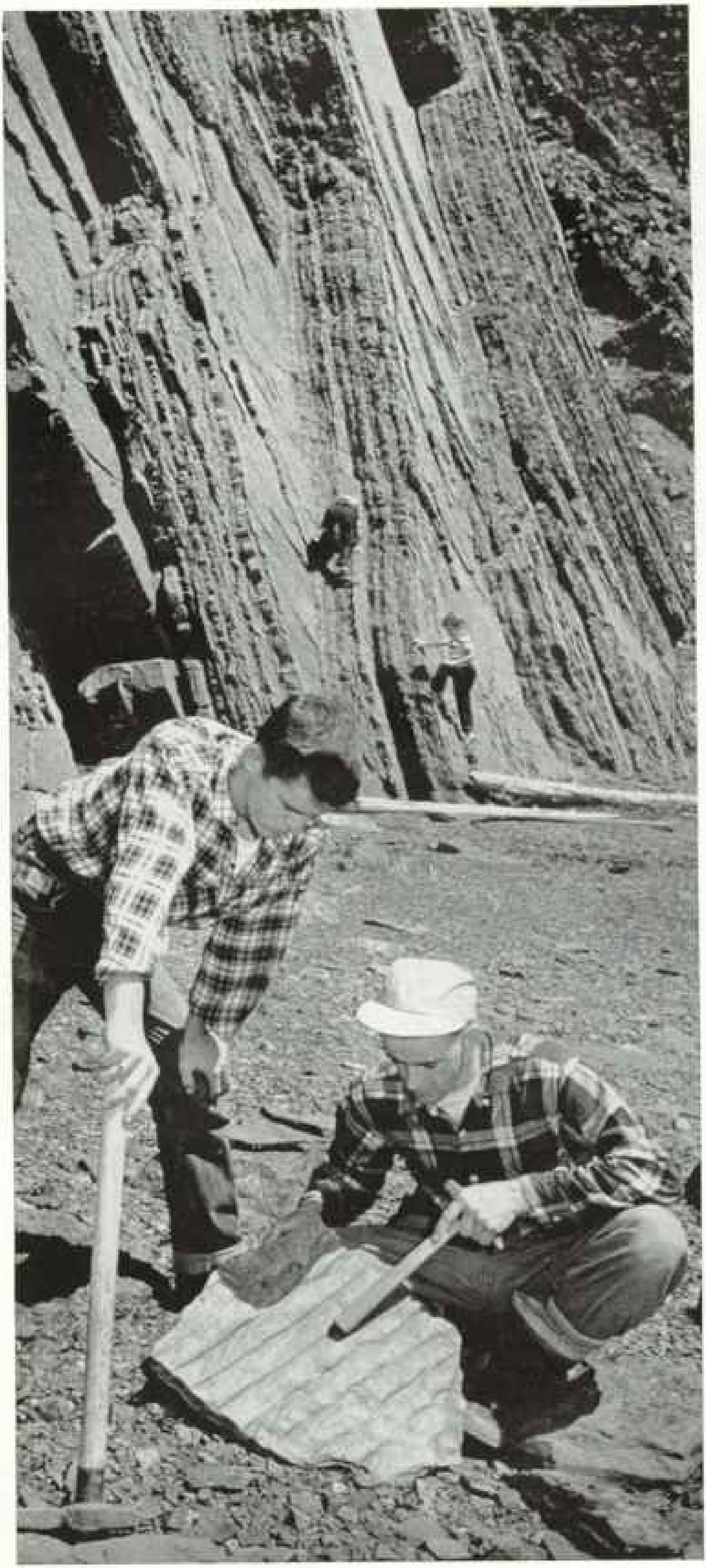
"Look at him go!" a man near me marveled. But would Martin, I wondered, be

* See "New Brunswick Down by the Sea," by Lawrence J. Burpee, National Geographic Magazine, May, 1941.

Mud and Algae Slicken the Footing → Among the Sculptures of a Patient Tide

Persistent as a desert wind, Fundy water carves the rock into endless arabesques. Dissolved, the red sandstone stains the region's mud flats.





faster than the changing current?

A cheer went up. A few moments before the reversing tide would have dragged him upon the jagged rocks, Frank Martin reached the other shore. A man's endurance and careful planning had defeated Fundy's mighty tides.

Our family had a feeling of satisfaction as we prepared to leave this extraordinary part of the world. Our specimen tubes were carefully packed. So were the rubber boots that had measured off so many miles of mud flats. One painful task remained: to winnow the children's rock collection to a wieldy weight.

"We can do without this," I said, discarding a fist-sized fragment.

"But that's my prettiest one!" Paul howled in anguish.

"And these aren't necessary," I continued.

"Oh, no!" wailed my daughter. "*Any* rock but that one!"

So instead of bidding goodbye to the rocky shores of Fundy, we took 10 pounds of them home with us.

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Experts Read a Rocky Autobiography Written by the Sea

Ancient seas built the shores that Fundy's tides now erode. Layers of sediment on the shallow bottom became stone under the water's weight; geological upheavals turned them on end to form cliffs like these near Parrsboro.

Two mineral collectors study ripple marks made by long-forgotten waters.

Keeping House for Tropical Butterflies

Scientists Learn New Secrets of Insect Evolution and Courtship by Building Butterfly "Hotels" in the Trinidad Jungle

By Jocelyn Crane

Department of Tropical Research, New York Zoological Society

With Photographs by M. Woodbridge Williams

A FLOCK of tame butterflies can be as troublesome as a cageful of monkeys—but butterflies are a lot more fun.

For instance, I don't know a better way to start a tropical day than to step out of our laboratory here in the Northern Range of Trinidad, pick a big bunch of yellow lantana blossoms, take them inside our butterfly "hotel," and watch the brilliant-hued guests come rollicking up to feed.

Quickly I'm surrounded by a rainbow swirl of wings—scarlet and black, orange, crimson, iridescent blue and gold. Soon the butterflies smother my lantana, dipping their long tongues into the nectar-laden flowers.

Sentiment ends right there, however, because our studies of butterfly behavior, coloring, and heredity keep us too busy to have much time for simple enjoyment of our fluttering pets.

Jungle Station Probes Insect Behavior

Our laboratory at Simla, in Trinidad's Arima Valley, is a jungle field station of the New York Zoological Society; its director is Dr. William Beebe. Here we are learning things about the private lives of butterflies that have never been known before.*

Perhaps our most fascinating study concerns their complicated courtships. We have found, for example, that in two species the scarlet color of a wing patch is an important recognition sign. A male is most attracted by a female bearing his own colors. We now have proof that orange and blue are vital hues for other species.

We know, too, that hindwing quivers, forewing flutters, and aerial acrobatics are other ways in which butterflies signal one another during courtship. And we have even learned to distinguish four different scents that a single butterfly species can produce to attract the male or female or to repel an enemy.

Our concern with butterfly zoology, however, does not let us live a life of peaceful contemplation. Instead, we often feel as harassed as the manager of a resort hotel. We have to furnish not only the comforts of home and excellent food for our insects, but suitable companionship and nursery space as well. And we go further by supplying a maternity ward and a baby-sitting service. Finally, few hotel men have to worry, as we do, about wild beasts gobbling up the guests.

Lizard "Humbugs" Butterfly

One day in January, shortly after our arrival in Trinidad for the research season, I saw a rare yellow butterfly high in the cage among the jasmine vines, flapping its wings helplessly. A second look showed that the insect was held fast by a large green tree lizard which absolutely had not been in the cage when we went away six months before.

At my indignant yell, Dr. Beebe, the staff, and Ram Dial, our Hindu caretaker, all rushed up to peer through the screening. Meanwhile I climbed on a bench, grabbed the lizard, and released the battered butterfly.

Ram gave a delighted chuckle. "That lizard humbug your butterfly? I watch him grow all the time you been gone!" The reptile must have sneaked in when he was little and found a good living in our lush green insectary.

This year most of our butterflies are living in a big new cage of aluminum frame and netting, provided by the Aluminum Company of America and the Alcoa Steamship Company. Designed by staff entomologist Henry Fleming, it has all the latest improvements (page 198). The cage lets in the sun and air, but keeps the glare out, and stays cooler than our older bronze-wire enclosures.

Best of all, the new insectary cannot rot or be eaten by termites. Its predecessor

* See, in the National Geographic Magazine: "Who's Who Among the Butterflies," by Austin H. Clark, May, 1936; and "Strange Habits of Familiar Moths and Butterflies," by William J. Showalter, July, 1927.

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Butterflies Flock to the Author's Wand Like Farmyard Chickens Coming to Be Fed

At Simla, on Trinidad's jungled slopes, New York Zoological Society biologists study tropical wildlife in one of the world's most unusual laboratories. Inside the wire mesh of Simla's big insectaries, butterflies feed, court, and live out their short lives under the probing eyes of scientists.

To discover the habits of her winged charges, author Jocelyn Crane became a combination hotel manager, dietitian, and flight surgeon. She learned to pacify jittery subjects, mend tattered wings with Scotch tape, and coax ailing patients with special dishes.

These photographs show Miss Crane at work with her brilliant specimens. Left: She drops a net over an escapee. Below (both pages): Hungry flyers flock to lantana blooms fixed on a wand. Above: A *Dryas*, its wings like leaping flames, balances for lunch.

Kodachromes by M. Woodbridge Williams, National Geographic Photographer

literally collapsed one rainy morning two years ago when the resident termites stopped holding hands. We cannot, unfortunately, use preservatives or poisons on wood supports, lest the chemicals also liquidate the butterflies.

The scenery inside the new cage is a cross between a formal garden and a jungle. There are small trees, grass, a flagstone path, a lily pool, blossoming shrubs, wild flowers, vines, wild plantains—even orchids. And the butterflies take to their new hotel with all the nonchalance of seasoned travelers checking in at the Waldorf-Astoria.

Dr. Beebe Starts "Flutter Inn"

Our butterfly housekeeping in Trinidad began in 1950 when William Beebe bought a wonderful old house on a jungled mountainside in the Arima Valley. This, along with 200 acres of surrounding wilderness, he later presented to the New York Zoological Society. In a large flat space originally blasted out of the rock behind the house for tennis courts, Dr. Beebe was able to carry out his long-cherished plans for a butterfly house in the tropics.

My own interest in studying living butterflies—an ambition that has been abundantly fulfilled at Simla—began about the age of ten, when I leaned over a glass case in the American Museum of Natural History to memorize the name of a dazzling morpho from Brazil.

Aside from the observations of a few early naturalists on flight habits and the distastefulness of some butterflies to their enemies, most tropical forms have been known only from dried museum specimens.

Taxonomists, working in museums often far removed from the living insects, still have trouble in accurately separating tropical species. Some kinds, although distinct, resemble each other so closely that a hand lens is necessary to tell them apart. Others vary so much from one individual to another that, without rearing numerous broods of known parentage, it is impossible to tell how many species actually exist.

In our butterfly hotels at Simla, however, we can study the living insects and sort them out under conditions approximating those of the open jungle.

As satisfying as it is to glimpse the flash of bright-colored wings in the jungle, it is downright frustrating to try to study the insects under these conditions. We see only scraps of behavior patterns, hints of the reasons for their colors and of the way their sense organs work. We can learn little of their delicate adaptations to living.

Neither can we learn much by keeping butterflies in small laboratory cages. Geneticists and commercial breeders, it is true, can raise many species that way. But although healthy caterpillars may result, scarcely anything can be learned of the normal habits of the caterpillars' parents. It is like studying the food and table manners of African Pygmies by shutting them up in a New York apartment.

We needed a place where we could keep butterflies under observation day and night, give them plenty of flying space, bring together those whose social activities are of special interest, and perform experiments on them under conditions of ease both to the butterflies and to ourselves. At last, here in Trinidad, we found exactly the right place. In these warm, damp mountains, butterflies are numerous and lively throughout the year.

Trade Wind Demolishes First Guests

At first we had almost as much trouble with our tropical insectary as an Eskimo trying to build an igloo at the Equator.

We started off with a modest cage of bronze netting tacked to wooden posts, measuring 12 by 18 feet and 9 feet high at the ridgepole. After congratulating Henry Fleming on planning the roof with a specially steep slope, to cope with tropical downpours, we dubbed the structure "Flutter Inn," stamped the earth down neatly inside, placed a bunch of fresh scarlet blossoms on a stand in the middle, and hopefully introduced our first tenants—two black-and-red erato butterflies (*Heliconius erato hydara*) and a lone great

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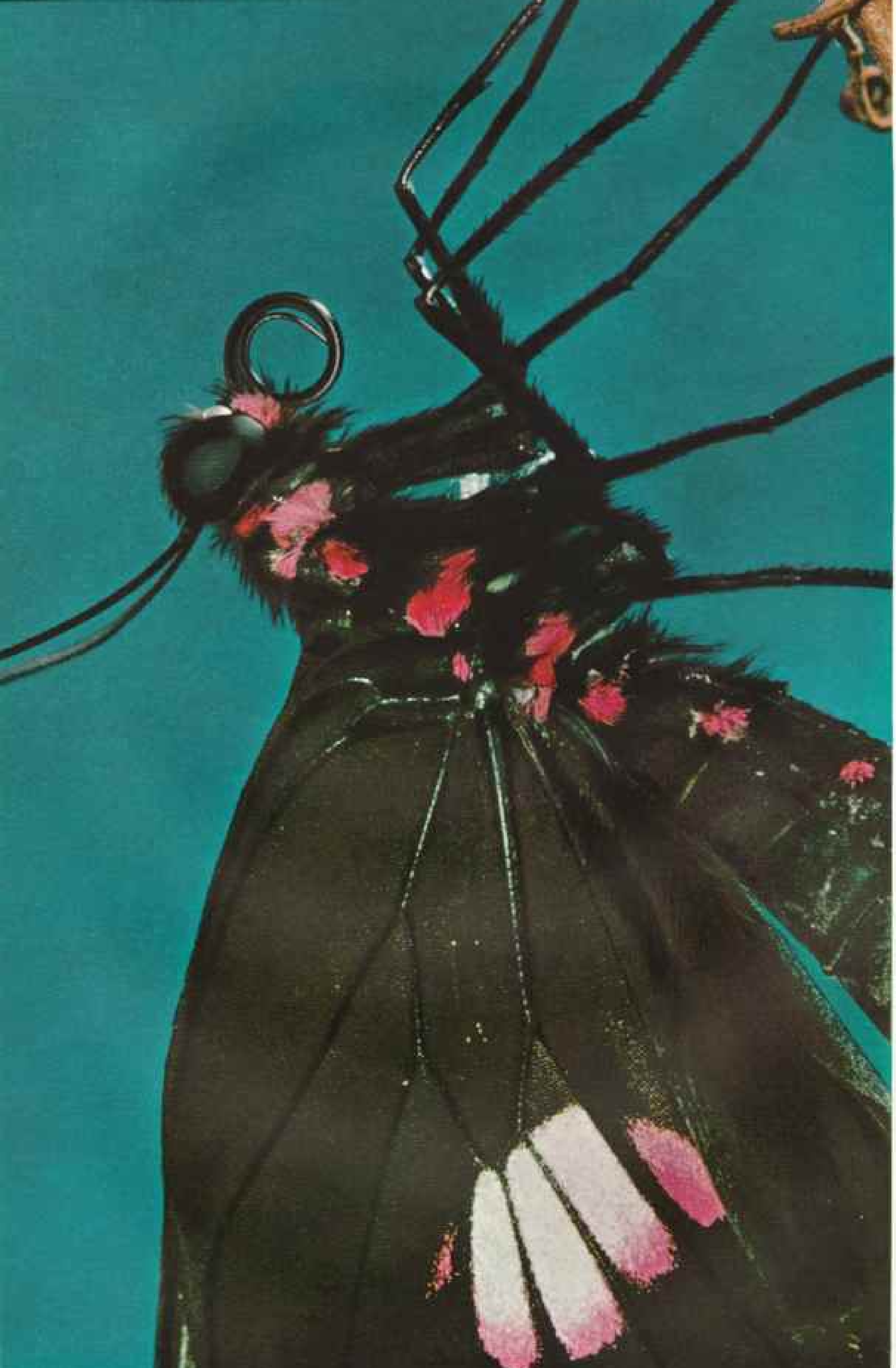
Scarlet-splashed Swallowtail Coils → Its Tongue Like a French Horn

Tiny shinglelike plates that make up their wing surfaces earn butterflies and moths the name Lepidoptera, or scale wings. Sizes vary from the 11-inch wingspan of a giant Atlas moth to the 1/8-inch spread of the tiny *Nepticula*.

This *Papilio anchises*, magnified 9 times, has recently emerged from the chrysalis. Beginning life as an egg, it passed through the stages of larva, or caterpillar, and pupa, or chrysalis, to become a fully developed butterfly (pages 212-215).

The insect's proboscis uncurls for feeding.



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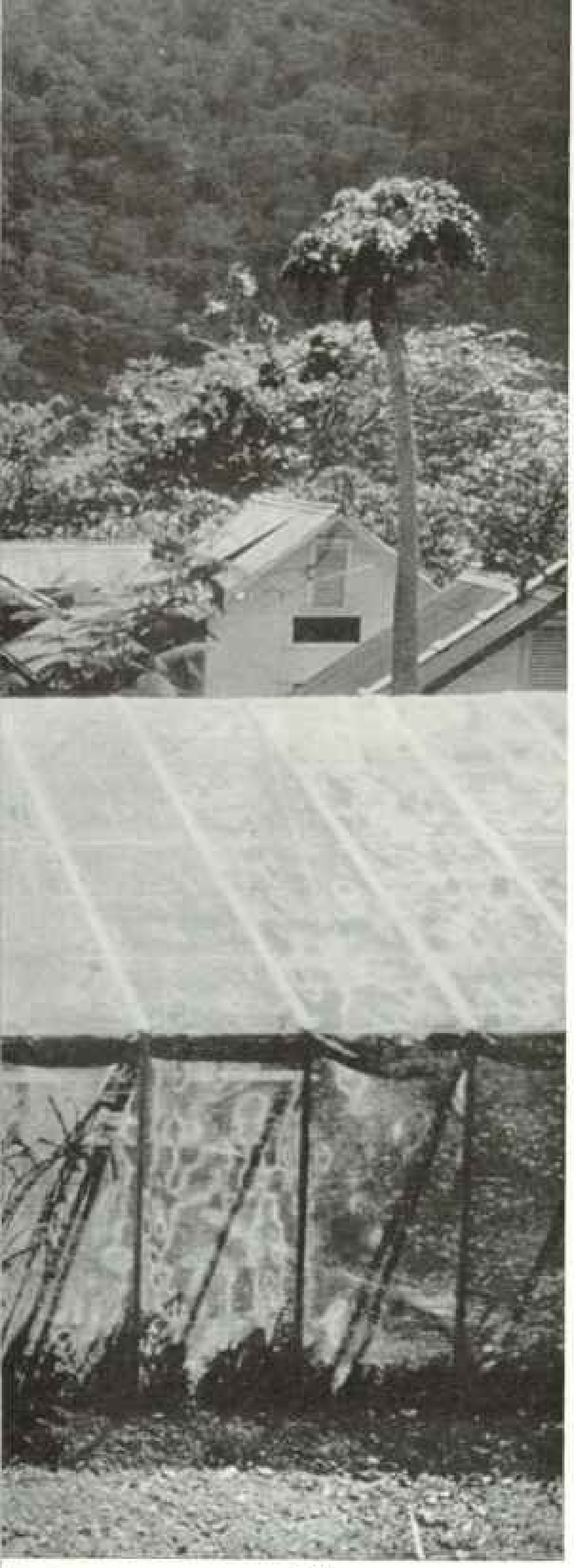
Butterflies in Their Aluminum Bungalow Live Side by Side with Scientists . . .

This view shows Simla's largest and newest butterfly cage beside the living quarters and laboratory. Dr. William Beebe, Director of the New York Zoological Society's Trinidad Field Station, accepts a gift of insects.



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. . . at Sun-drenched Simla

A papaya tree lifts bunched foliage above the compound. Trees cover the slope of Arima Valley in background.

blue morpho (*Morpho peleides insularis*).

Ignoring the flowers, all three flapped wildly against the roof and later were blown flat against the west end by the afternoon trade wind. Next morning there was no sign of them except for a few scattered scraps of blue and scarlet wings.

It took nearly three months to learn how to keep several species of tropical butterflies happily together in the same cage. We found our Trinidad butterflies need lots of deep shade, bright sun, and high humidity—simultaneously. Also, they are as particular about their food as a spoiled child getting over the measles. The morphos, for instance, would much rather eat rotten bananas than sip the sweetest nectar. The heliconiids prefer a diet of nectar from lantana plants.

Enemies Prey on Winged Guests

Most of our guests thrive on sociability, but can't stand overcrowding. And above all, if they don't have a minor jungleful of green growing things around them, neither ample space, nor sun, nor shade, nor the right food or companionship, nor any amount of tender loving care will keep them flying. After we had learned all these things, more and more species settled in successfully.

Meanwhile, our problems with enemies multiplied, and even now they are still with us. Lizards are the least among them, although occasionally a ground-living ameiva will sneak in through a door left carelessly ajar. Inside, he lurks around the edges, biding his time to catch an inmate as it sunbathes carelessly near the ground.

Large praying mantids find their way in now and then and grow fat before they are caught in the net.

Ants are a particular nuisance. Some eat butterfly eggs before I can gather them for hatching in the laboratory. And there is one fierce, solitary kind that will seize a weakened insect and literally devour it alive. Others are scavengers, promptly carrying off dead insects before we can salvage the casualties for our collections.

Worst of all are the spiders. They stretch webs in strategic places and make a good living in spite of our precautions. Every morning the cages are cleared with a broom poked into all the corners, high and low. Good housekeeping is vital.

Just the other day we caught a new enemy at work, one even more difficult to destroy because it spins no web. When I first came upon the tragedy, all I could see was a big

←Roundup Time at Flutter Inn Enthralls Young Visitors

Many tropical butterflies like to wander freely from bright sunlight to dense shade; they thrive on high humidity. To make temperamental charges feel at home, Simla's lepidopterists fill their cages with tropical plants. Wire screening keeps butterflies inside and excludes lizards and birds.

Miss Crane here tempts an insect onto her flower-decked herding wand.

Bystanders from a near-by Hindu settlement watch outside the cage.

↓Golden Pasture Lures Diners

Butterflies, often finicky eaters, recognize favorite foods by color as well as by scent. Faced with paper flowers, new adults instinctively choose colors preferred by their species.

A quartet of *Heliconius erato* flocks to the bright-yellow blossoms of a lantana bush. They ignored the same plant when its gaudy blooms were hidden. Three of these eratos wear paint over their natural red wing spots (opposite).

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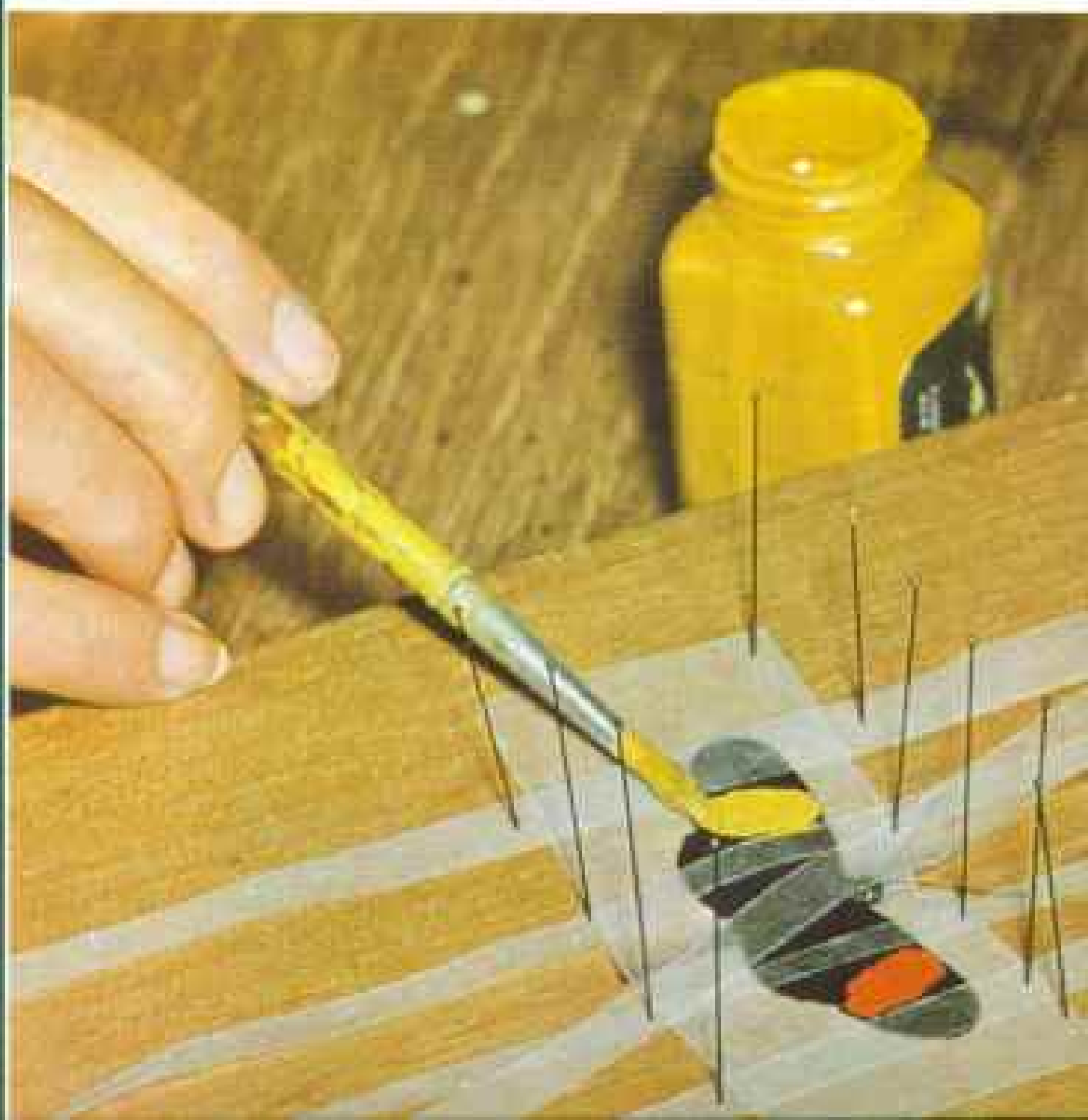
Wing-cuffed Butterflies Get New Colors

To see if color has an effect on courtship, Miss Crane paints wing surfaces of *Heliconius erato*, a common tropical variety. Gently capturing a subject, she anesthetizes it with a carbon-dioxide fire extinguisher and fastens it to a board with wax-paper strips. Patients show no ill effects from the operation.

↓ The butterflies responded to artificial colors most like their own natural orange-red. Saffron wing patches, for example, attracted countless males. A covering of black reduced the female to a wallflower. This subject gets a coat of yellow. The author uses quick-drying model-airplane lacquer.



orange dryas hanging in mid-air, wings folded, swaying gently back and forth. When I looked closer, I found a jumping spider, only a third of an inch long, gripping the butterfly's thorax with fangs sunk in deep and legs clinging. Its hind legs paid out a fine silk lifeline, which led up to the leaf half a foot overhead and from which the spider and butterfly dangled.

I let out a shout, and Woody Williams, making pictures for this article, had time to set up his camera and make a flash shot before the spider moved (page 216).

As we watched, the tiny spider pulled itself and its enormous prey back up the dragline to the leaf. Here it began to suck juices from the butterfly, now quite inactive from poison injected by the spider's minute fangs.

Banquets Planted for Finicky Eaters

Butterfly enemies continue to be our major problem; in comparison, feeding has become a simple matter, after our first mistakes. At the very beginning we planted plenty of flowers liked by butterflies—Spanish needles, lantana, and the local milkweed. Now, in addition, we hang up orchids and other delicacies in season, and every day we bring in fresh-cut flowers.

Little by little we discovered the preferred foods of our more finicky guests. They don't like much variety; each kind goes to its own few favorites, day after day, like a small girl who always orders chocolate sodas while her best friend sticks to vanilla malts.

Different species have definite color preferences. To some, color is even more important than scent; careful experiments with paper flowers have proved it. Newly emerged butterflies that have had no chance to see real flowers will come first to yellow paper blossoms or to blue ones, depending on the family to which the insects belong.

Our eratos, melpomenes, and ricinis—all species of the genus *Heliconius*—will not visit their favorite lantana if the bright yellow-and-orange blossoms are hidden, even though the odor is there. However, if one small petal—fragrant but nectarless—lies by itself on the ground, some hungry individual is sure to swoop down, uncoiling its proboscis as it goes.

The fruit eaters, on the other hand—morphos, caligos, preponas, and some wood nymphs—depend largely on smell in locating their food. In the butterfly houses they suck greedily on bananas, papaws, mangoes, and cashew fruit, all generally too ripe for our own lunch table. Nevertheless, we once scandalized some mango-loving visitors by presenting the very first mango of the season to the appreciative butterflies.

We didn't think that our caged butterflies could get into trouble with their food, but the accident-prone ones can—and frequently do. One troublemaker is the orange-and-yellow-flowered tropical milkweed, closely related to the more familiar milkweeds farther north.

The pollinating system of milkweed blossoms is a tricky business, in which the monarch butterfly (*Danaus plexippus*) often plays an important part. Here in the tropics, as in the north, these strong flyers use milkweed both for food and for laying eggs. The flowers, however, are not convenient for a big butterfly to stand on, being small, slippery, and set at awkward distances from one another. The monarch, therefore, often slips while dining, his foot catches briefly deep in the blossom, and in the struggle needed to pull it free a pollen sac may stick to his leg and be carried off to another blossom.

Many butterfly species that are fond of milkweed nectar, however, are not so strong as the monarch. So they are often caught, usually by the proboscis. They may flap wildly in the trap for minutes at a time. Usually they free themselves, but occasionally I have to come to their rescue. They never seem to learn from their horrid experiences and at the next chance flutter right back into trouble.

Tame Insects Harass Photographer

In our work with butterflies one of the biggest and best surprises has been the astonishing tameness of some species. It is like the differences among ducks. Some of them, mallards, for instance, are easily tamed and settle into a barnyard as if born there. Others never become domesticated.

In the same way, butterflies may make themselves at home almost as soon as they are released inside the cage. Others bat constantly against the screen and refuse to eat.

Even the easily tamed ones, however, may take a long time to settle in. It all depends on whether the cage is already "seasoned" with butterflies of their own kind. Butterfly odors, clinging to screens and plants, undoubtedly make the difference. There is nothing like a whiff of its own scent to make

a butterfly feel at ease.

Once a butterfly has settled in, his tameness becomes one of our big rewards. It makes any pleasure we ever had before from mounted specimens seem trifling.

If you come in with a bunch of his favorite flowers, he will fly to you as you enter. He starts to feed, and you can lift him, still on his blossom, without disturbing his meal. He will even crawl on your finger and let you lift him to another flower. You can pick him up gently by the wings and put him somewhere else. He probably won't stay put, but as he flutters casually away he shows no panic whatever. To remind yourself of the difference, try taking such liberties with the next able-bodied wild butterfly you meet.

When Woody Williams was photographing at Simla, huddled over the feeding bench for close-ups, the butterflies sometimes made nuisances of themselves. They would light on his hand when he was about to release the shutter or tickle the back of his neck at crucial moments. One dryas even started to lay an egg on

Netmen Hunt Specimens Along Bamboo-fringed Arima River

Most of Simla's butterflies come not from open fields and clearings but from the moist and shady Arima Valley forest encircling the station.

Entomologist Henry Fleming and assistants wait beside blossoming arum lilies for prospective cage dwellers.

↑ Whirring Wings Announce a Suitor

Like any girl at a party, the female butterfly attracts males with a distinctive perfume. This female sprays the scent from bulboes glands on her abdomen.

↓ Ardent Wooer Courts a Cloth Decoy

One or two flaps of the crude lure placed on a stick brought *Heliconius ricini* fluttering to the challenge. Color rather than pattern of the model attracted him.

his flash-gun cord, doubtless mistaking it for the stem of her proper vine.

Best of all, I like feeding a winged guest a bit of fruit. If I hold it a foot away from his perch, he walks toward it until his glistening eyes are only an inch from my finger. Then out comes his proboscis, the sensitive tip curling here and there to sample the delectable mushiness (page 207). In a moment he climbs onto the fruit, and I can carry him about without interrupting his meal.

Yet when I free him after a few days, he will zoom out the door, soar up over the towering mahoganies, and be just as wild as he ever was.

Butterflies Mope When Sick

Butterflies are like puppies, canaries, monkeys, and children: you can always tell when they aren't feeling right. A sick beetle or boa constrictor may seem very much as usual to a casual eye, but an ailing butterfly is unmistakable. He hangs motionless against the screen for hours or bats about high up near the ridgepole. He hasn't any appetite, never takes part in the giddy chases of his healthy companions, and may spend the night sleeping alone instead of joining the gang on the twigs or leaves of his particular roost.

If his ailments are due merely to a kind of shock after capture, or after he has had his color changed for experiments, a good night's rest will usually fix him up. Sometimes I sprinkle a bit of honey on a flower and gently slide it under his proboscis. It may have the same swift effect as a piece of chocolate cake offered to a small boy in the dumps.

Incidentally, shooing a butterfly where we want him, whether to breakfast, to bed, or in the direction of another butterfly, just won't work. (*Any* butterfly can be as stubborn as a mule.) We can only stir up a lazy one—lots of species take noontime siestas—and hope that he will flutter in the right direction.

Sometimes a reluctant suitor can be led, by means of a sprig held carrot-in-front-of-nose fashion, clear across the cage to the side of his potential mate. But after that the proceedings are strictly up to the butterflies.

Courtships are usually dizzy affairs, with the male fanning perfume over the female and flying high in whirling-dervish dances. In fact, observing butterfly courtships is as hard on human neck muscles as watching pilots do stunts at a country fair.

As recorded by human eyes and noses, here is what happens during a typical courtship, that of our erato butterflies. The male usually finds the female as she sits on a leaf, gently waving her wings. Sometimes when he starts courting, she takes off, and they do a whirling dance too fast to tell who is chasing whom. And sometimes a female who has been a wallflower for some time will spring into the air and chase a passing male with vigor and enthusiasm.

Whatever the beginnings of the courtship, the female eventually settles, wings closed, and the male zooms up behind. He flutters repeatedly against her, practically touching her hindwings with the tips of his front pair. She then thrusts from the end of her abdomen a pair of bright-yellow scent glands while she flutters her hindwings; doubtless the fanning wafts the perfume, which humans cannot detect, toward the male.

Now the male moves forward and hovers above her and in front, his wings a swift blur of black and scarlet. His fragrant scent scales —these we *can* smell—are uncovered; in this species they are set among a band of silver scales on the front edge of the hindwing. Finally he lands on the leaf beside her, and, if all has gone well, they mate.

Most courtships, however, are casual flirtations only. There is a brief chase, a few flutters of the female's wings, a few swoops by the male, like a pilot buzzing a grounded plane, then each butterfly goes its way.

Females Ignore Wrong Swains

Our most detailed studies are being made of *Heliconius erato lydara* and *Heliconius melpomene*, two slow-fluttering species of the deep jungle. Both are black with scarlet wing patches and extremely difficult to distinguish in the field. However, we found at least one interesting difference in the courtship procedure between the two species.

The melpomene male always starts wafting his scent over the female's odor-receptive antennae while he is hovering in front of her (opposite), while the erato male first fans an unscented breeze from the rear. Neither female is attentive for long to the "wrong" kind of courtship. And, so far, we have no evidence that any of the butterflies we are studying ever hybridize.

When you see two butterflies chasing each other in your own garden, you are not necessarily watching a courtship, even one of these casual affairs. Just as likely it is two males

Magnified 3½ times

Uncoiled Proboscis Serves a Winged Glutton as a Built-in Straw

Forced Feeding Revives→ a Dazed Newcomer

Butterflies often suffer shock at capture and refuse to eat. When this *Prepona* declined to taste an overripe banana, Miss Crane uncoiled the insect's supple proboscis with forceps and dipped it into the fruit. As the butterfly began to feed, she relaxed her hold, leaving it sucking greedily (below).

↓Prisoner Settles Down to a Pipeline Lunch

Twin tubes on the butterfly's head interlock to form a tongue-like proboscis. Alighting on a flower or piece of fruit, the creature uncurls the apparatus and probes for sugars. On contact, powerful muscles in the insect's head create a vacuum, drawing up the fluid.

Magnified 3 times ↓

engaged in a territorial dispute. Possibly it is only a social whirl, or a male mistaking another male for a female. It may even involve an old busybody female who, after her egg-laying chores are completed, spends a lot of time taking off after old and young of both sexes. Nothing drastic ever happens in these mix-ups; the partners simply separate and head for the nearest flowers.

Scarlet Bands Warn Enemies Away

We are specially interested in the significance of butterfly colors to their owners. For example, I wanted to find out what part, if any, colors play in courtship of these brilliant tropical forms.

The first subject we chose for study was, again, our old friend erato. We wanted particularly to learn if the band of flame scarlet across the black velvet of the butterfly's wing was of any use in its social life.

We already knew one use of that band: it is a classic example of warning coloration. The gaudy erato seems to be distasteful to almost every animal which would normally munch a good-sized insect. If a hungry laboratory frog makes the mistake of snapping up an erato for supper, he gags as it reaches his taste buds, then spits it out with bulging eyes and gaping mouth and shakes his head emphatically back and forth.

Lizards and birds reject the butterflies with equal vigor. And a pet monkey, if he picks one up at all, sniffs it fastidiously, makes a face, lets the horrid object go, and spends minutes scrubbing at his small black hands. Only the insatiable spiders and ants of the butterfly houses will make satisfactory meals from unfortunate eratos.

So it seems clear that this insect offers a good example of warning coloration: a butterfly, protected by an unpleasant smell and taste, tells enemies by its bright colors that it is best left alone.

To find out if economical nature had given the gaudy red patches a use in courtship as well, I worked out a way to change the insect's colors. This was a chore, since no butterfly can stand much handling. Also, chemical bleaches not only faded the colors but were hard on the insect. Unlike peroxide blonds, a bleached butterfly has no energy left at all. However, I finally worked out a method using fast-drying lacquer such as boys employ for model boats and planes (page 201).

In painting a butterfly, I always try to work at night. At that time it scarcely wakes up and is less bothered by the messy business. I put it into a small glassine envelope, and that goes into a little glass-topped box. A stream of carbon dioxide from a small fire extinguisher then anesthetizes the insect.

After that it is placed gently on an insect spreading board, just as if it were going to be pinned and dried for exhibition. Its wings are arranged under strips of paper. If I am clumsy, or in a hurry, or somebody comes to talk, the butterfly wakes up and I am in trouble. The result may be rubbed scales, broken wings, or a battered escapee.

However, if all goes well, any giddy color is possible. Scarlet can be covered with blue or green, yellow or violet. Color can be altogether blotted out with black, or an orange sunburst or magenta band added to the plain hindwings.

In a few moments the paint is dry, the board is carried to the cage, and the fastenings removed. Then the faintly stirring butterfly is hung back among its fellows on the roost. Next morning there he is, flexing his newly tinted wings and feeding as usual, none the worse for his experience (page 200).

Felt "Butterflies" Attract Suitors

We have also experimented with imitation butterflies made of floppy felt on a bamboo wand. The stick has a tiny magnet from a kitchen bulletin board glued to one end. A butterfly model of black or colored felt, held by a pin, is laid against the magnet. Live butterflies sometimes dash at it, or flutter their wings in courtship, when we waggle the model appropriately (page 204). The advantage

(*Continued on page 217*)

Winged Acrobats Hang Upside Down ➔ Beneath Their Shattered Husks

The caterpillar, a sluggish pedestrian, enters the third, or chrysalis, stage of its life to be reborn a creature of the air.

Within the shell-like casing the larva of most species exchanges 16 stubby legs for 6 jointed stilts. A sucking proboscis supplants powerful jaws, compound eyes replace simple ones, and wings and antennae sprout seemingly from nowhere.

Transformation complete, the young butterfly bursts restraining walls and steps forth a gleaming adult.

Heliconius melpomene adults, two hours old, stretch wings for their first flight. (Magnified 3 times.)

Kodachromes by M. Woodbridge Williams, National Geographic Photographer

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Butterfly Egg on a Slender Vine Suggests a Japanese Lantern

Sequence photographs on these and following pages record the butterfly's entire life cycle, from egg to adult, with *Heliconius melpomene* as chief actor.

Here the female selects a passion vine for her hatchery. Clinging head down from a furled leaf she deposits a single egg. Two previously laid eggs gleam yellow atop the plant.

Insert shows a *Dryas* egg magnified 26 times.

←An *erato* larva breaches its corrugated eggshell.

↓Half emerged, it strains toward the vine.

→Magnified 9½ times, the *Heliconius* caterpillar assumes the aspect of a crawling nightmare, with spines like a burned-over forest.

↑ Dangling Larva Awaits the Close of Its Earthbound Existence

One of nature's most spectacular events, the transformation of lowly caterpillar into fragile butterfly, comes alive in these photographs of *Heliconius melpomene* and those of *Dryas julia* on pages 214-215.

As the time for change approaches, the caterpillar spins a button of silk from which to hang.

Conversion to the chrysalis begins as the caterpillar sheds its old skin, spines and all (above right). Now the creature is entering the enclosed state from which it will emerge a butterfly. (Magnified 5 times.)

Chrysalis Discards Larval Skin, a Last Link with the Past →

This rare photograph catches the *melpomene* caterpillar in its final stages, just as the old skin flies free in a crumpled ball (left).

Before the old outer layer is shucked off, the insect secretes a new covering of quick-drying material that will serve as shelter during the chrysalis, or pupal, state. Here the new pupal skin covers the developing, upside-down butterfly (magnified 6½ times).

Biologists believe the pupa's leaflike appendages and pointed fringe may be protective camouflage.

Magnified 2 times

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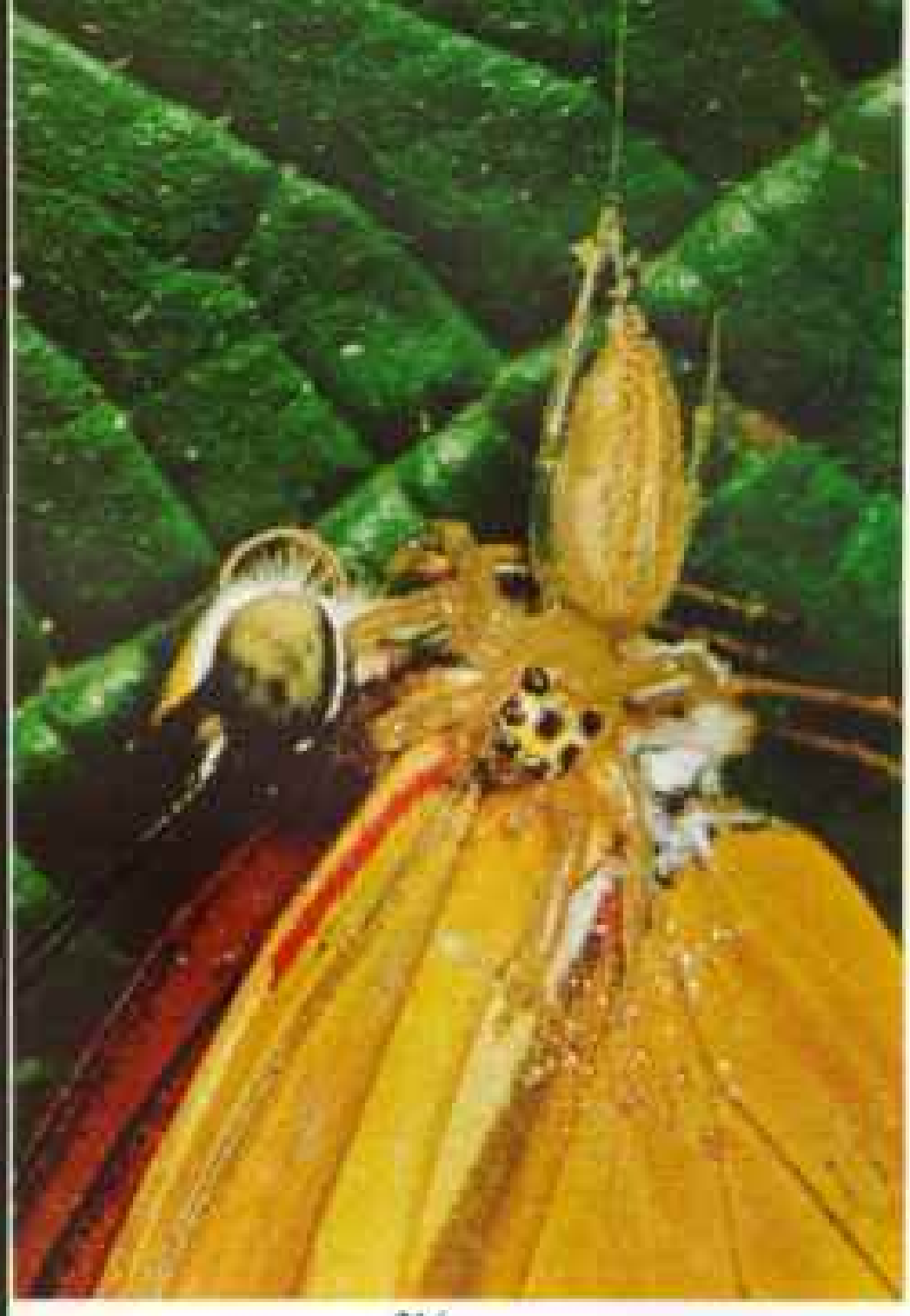
Cinderellalike Beauty Bursts Resplendent from a Drab Abode

The butterfly's life as a pupa varies with season and temperature. Simla's subjects average between one and three weeks. So swift is the emergence from the chrysalis that few people witness the marvelous event.

These photographs of *Dryas julia*, taken within the space of a minute, reveal the entire escape process from breaching of the dry and withered shell to the insect's first free movements.

As the chrysalis splits (upper left), the butterfly thrusts downward with proboscis stretched back and wings folded capelike (left). Then it crawls free (above), pumps body fluid into spreading wings (right), and, fully expanded, prepares for take-off.

Magnified 5 times →



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↑ Unwary *Dryas* Falls Victim to a Spider's Fangs

Butterflies of tropical Trinidad, unlike those of temperate zones, produce broods throughout the year. These cycles permit unusual studies of behavior and heredity.

Tropical surroundings work against the scientists by producing an abundance of butterfly enemies—the monkeys, birds, lizards, ants, and spiders of the rain forest.

Spiders, deadly and elusive, present the greatest threat. Despite daily cage cleanings, the eight-legged marauders repeatedly build traps for careless butterflies.

This jumping spider, *Thiodina*, hugs its prize close while injecting a paralyzing poison. Not a net spinner, the jumper leaps on its prey while the insect rests on a leaf.

← Silken Strand Supports a Hunter and Outsize Quarry

Some species of butterflies enjoy immunity from larger pests because of a bitter taste. Birds, monkeys, and frogs avoid *Heliconius erato* or spit the insect out after a single bite. Spiders, insatiable killers, prey on all species without discrimination.

Miss Crane first discovered this butterfly's plight when she noticed it swaying upside down near the top of the cage. As she watched, the spider reeled in its line and hoisted the captive, many times its own size. Balancing the victim on a leaf, the spider sucked out the body fluids and left the carcass.

Here, atop the butterfly, the spider swings like a trapeze artist. Silky line rises from its pear-shaped abdomen.

of the models over painted real butterflies is that we can eliminate the effects of odor; results here are due to sight alone.

Our findings from all this painting and waggling have taken several seasons to accumulate, but they are unmistakable. In spite of the importance of motion and scent in courtship, true color also means something.

Generally, the closer the color is to the eratos' own orange-red, the more the females respond with courtship flutters, and the oftener the males give chase. Blues and greens aren't popular, and pure-black females are usually complete wallflowers. Sometimes such a black one will waggle her hindwings as a male passes by, or even spring into the air and chase him clear across the cage, while the male goes unconcernedly on his way.

Egg Laying Confined to Certain Plants

When it comes to the fundamental business of motherhood, however, butterflies pay little heed to the color of plants on which they lay their eggs. On the other hand, the odor of the proper leaves is all-important. Every species, too, has its favorite part of the plant—tiny leaves, tendrils, or arching stems (page 210).

Dr. Beebe started our Trinidad butterfly rearing with one of those profitable accidents that can happen in any laboratory. He wanted, just for fun, to have a jungle vine growing on his desk because he likes to watch its tendrils curl. So one day he went out into the green tangle behind the house, dug up the first attractive little vine he saw, put it in a pot with a stick to cling to, and kept it beside his microscope. A few days later he saw a tiny yellow caterpillar gnawing on the topmost leaf. It had obviously hatched from an unnoticed egg, already laid when the vine was transplanted.

For twelve days he let the caterpillar grow, to the detriment of his tame vine. It ate all the leaves, stem, and tendrils, but economically, from the top down, with a nice instinctive regard for not cutting itself off in mid-air. After shedding its skin four times, it was a handsome caterpillar an inch and a half long, white with black spines and yellow polka dots.

Then it molted into a knobbly brown chrysalis, marked with a double row of shiny gold spots like brass buttons. Nine days later, as we gathered round making bets as to the occupant, out came a black and scarlet erato. It was just the butterfly we were most hoping to rear for work in our first little cage.

That particular butterfly, a female, was mated to a wild-caught male in Flutter Inn and started a long line of flourishing descendants. She herself lived to cavort around the cage with her grandsons, and one sunny morning when I left the door ajar, she simply fluttered out and vanished among the mahoganies. At that point she had reached the age of a butterfly Methuselah; it had been three months and two days since she had come from her chrysalis. Most of our tenants live about eight weeks.

For the past several years we have been able to travel afield to obtain highly variable butterfly species from Surinam, thanks to assistance from the National Geographic Society, the Explorers Club, and other interested contributors.

We brought back to Trinidad, by air and sea, living eggs, larvae, and a few prospective parents. Eventually we reared brothers and sisters with markings that once would have labeled them as distinctly different varieties. Wing patterns ranged through a rampant variety of scarlet and yellow spots and bands and often blazed with sunbursts of radiating lines. By breeding these unpredictable insects, we hope to learn more of how characteristics, both of structure and of behavior, are inherited.

Butterflies Lead Adventurous Lives

This evening I've just come in from a checkup on our current butterfly crop. Many are hanging aloof, each under his own green leaf. But 17 of them are roosting companionably on the same dried vines they have used for weeks.

By the paint spots on their wings I know all their past adventures. Yesterday this erato escaped from a spider web, and I had to mend her torn wing with a bit of Scotch tape. The ricini with the single yellow dot on his hindwing got mixed up last month in a swallowtail courtship and was chased away by both the other butterflies. And just this morning the biggest melpomene of all became a grandfather for the third time.

They are a fine lot, and they are teaching us a great deal—about themselves, about insect behavior in general, and even about evolution in the broadest sense. And before we go north for the summer, we shall have the fun of watching them fly out of their cage, sail over the garden wall, and vanish into their ancestral jungle.

Kachinas: Masked Dancers of the Southwest

Messengers of the Gods Mark Spring's Coming with Age-old Rites, Rewarding the Good and Punishing Evildoers

By Paul Coze

With Photographs by the Author

THE Kachinas were coming!

A masked dancer, mounting a rooftop, signaled that the Hopi gods were about to visit the village of Shungopavi.

Cars and pickup trucks loaded with Indians ground to a halt. An expectant hush, broken by the whine of a cruel February wind, settled over the village. Dogs slunk into corners; women gave up their happy chatter and sought vantage points in doorways and on rooftops. The 16-day Hopi Bean Festival was approaching a climax.

Masked Gods Bring Blessings

Out of the desert beyond the village marched 70 figures—weirdly masked, garishly painted, verdantly draped in evergreen branches, and attired in a veritable wardrobe of other sacred symbols. These were the Kachinas, the supernatural ones, incarnate lesser gods, ancestors, messengers of the gods, bringing blessings and happiness to the people. Some marched as solemnly as bishops; others scampered and tumbled, ran or hopped.

A medley of noises shattered the silence. Sleigh bells and shells tinkled on the dancers' bodies, drums beat like magnified hearts, and rattles imitated the clatter of rain. The gentle coo of birdcalls mingled with growls and shrill whistles.

Old men, simple priests in long hair and ceremonial blankets, led the procession, but no two moved in concert; each Kachina danced his own steps and called his own signals. Other Kachinas, serving as policemen, moved into the crowd, pointed yucca-leaf whips at men, and ordered them to take off their hats. Ogre Kachinas directed traffic and cleared the dance grounds. Still others moved in rhythmic procession around the *kivas*, the ritual plaza.

No one dared to speak to the Kachinas or to touch them. But the spectators felt a sense of tremendous emotion, as if a ripple of life had suddenly flooded this dusty village in northeastern Arizona's Hopi Indian Reservation. Ecstasy lit their faces.

My own comfortable white man's world seemed to dissolve. Could this be 20th-century America?

Pueblo People Older than History

The Hopi number some 3,000 of the approximately 22,000 Pueblo people—Hopi, Zuñi, and Rio Grande tribes—who have lived in the Southwest since prehistoric times. These tribes are successors of the primitive Basket Makers, who came into this region before the time of Christ.* All are related culturally, but not linguistically; some speak a tongue akin to that of the Aztec.

They live in Arizona and New Mexico reservations, alongside some 85,000 Navajo and Apache whose ancestors migrated into the Southwest at a later time.

The Pueblo people believe that man's life and blessings—the cycle of seasons, rain, and crops—are gifts of Kachinas (a Hopi word). Archeologists recently unearthed near Monticello, New Mexico, wooden carvings and murals dating the cult back at least 600 years.

The Hopi believe their Kachinas live in the snow and ice of the high San Francisco Peaks near Flagstaff, Arizona. Borrowing the bodies of living men, these lesser gods visit the villages to distribute presents and receive prayers to the gods. He who wears the mask of a Kachina believes he loses his personal identity and assumes that of the spirit.

* See "Indian Tribes of Pueblo Land," by Matthew W. Stirling, National Geographic Magazine, November, 1940.

← Crow Mother, in Crow-wing Mask, Watches Ritual from a Kiva Roof

Pueblo Indians of Arizona and New Mexico venerate a multitude of spirits ranking just below the major gods. They call these supernatural beings Kachinas, from the Hopi words meaning father of life. At festival times the Kachinas make visits to the pueblos, bringing the blessings of rain and fertility, teaching discipline, and rewarding good.

Here the Crow Mother, impersonated by a member of the opposite sex, holds a bough of evergreen, symbol of eternity. The deerskin mask is never doffed during a ritual. Ladder pole clutched in hand leads into a kiva, or ceremonial chamber.

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↑ Hopi Girls in Painted Crests Await Suitors at a Dance

These butterfly dancers, who are not Kachinas, use no masks. They have gathered at a gay social affair where girl meets boy. Each wears a small fortune in turquoise, the semiprecious stone prized by southwestern Indians.

Coarse yarn bangs hanging over the dancers' eyes represent clouds. Thin wooden boards worn as crowns are known as *tablitas*. Cutout figures above the headdress at left show terraced rain clouds, which give life to the ears of corn below. Sun in center rises between thunderheads and lightning bolts.

Opposite page, upper: Zuñi maidens, wearing family wealth around their necks, gather at the annual Powwow at Flagstaff, Arizona, to do the Basket Dance, a nonsacred entertainment given outside the reservation. Flat baskets over the ears imitate the butterfly hair-do often worn by Hopi girls. Colored yarn and eagle down brighten the hair. Facial paint represents bird tracks.

Navajo Medicine Men Rehearse→ a Chant at Flagstaff Powwow

The seminomadic Navajo, neighbors to the Pueblo people, seldom use the skin drum. To keep time, these chanters beat an overturned wedding basket. Kite-shaped standard of sticks and ribbons will be carried in the Feather Dance. Costumes show the classic velveteen blouse, pajamalike trousers, moccasins, silver and turquoise, and Spanish-style handannas of the Navajo.

The Author

Buffalo Bill stories, read as a 10-year-old French boy in Egypt, gave Paul Coze an interest in American Indians that shaped his entire career. In 1919, as a teen-ager, he saw his first Indians; they had crossed the Atlantic to teach woodcraft to the French Boy Scouts, of whom Coze was a founder. In his search for authentic books on Indians, he learned English, read some 300 works, and then with a collaborator, René Thevenin, produced one of his own in French, *Manners and Customs of the American Indian*. He has since written five others.

Mr. Coze first visited North America in 1928; later he directed an expedition to study the tribes of northern Canada for the Museum of Man in Paris. Now a United States citizen, a recognized authority on American Indians, and an established painter whose works hang in 14 museums, he is an honorary member of seven Indian tribes. He serves France as its consular agent in Arizona, flying the Tricolor over his studio and art school in Phoenix.

All the average traveler sees of this cult is the Kachina doll, a masked and painted miniature (pages 226 and 235). Of the thousands sold every year at roadside stands, few are the ritual dolls made by Indian carvers; most are turned out by Indian employees of white men.

As Santa Claus takes gifts to our children, so the good Kachina carries dolls to Pueblo girls and bows and arrows to the boys. Pueblo children study their Kachina dolls as our boys and girls learn the catechism.

For the past five years Violet and Howard Seimatewa, a Hopi couple living in Phoenix, Arizona, have looked out for me like a mother and father. She dusts my studio; he gardens, makes repairs, and sometimes helps me give French visitors a true western welcome. But some days the Seimatewas do not appear; homesickness or a ceremony draws them back to their native land.

Invitation to the Bean Dance

Last winter Violet said, "There is to be a Bean Dance. Are you going?"—her oblique way of inviting me. And then she added, "Sally wants to go, too."

Sally, her 19-year-old daughter, is a high-school graduate and working stenographer. She knows all the latest hit tunes and can sing them with a better accent than mine.

Why did Sally want to go? I have learned not to ask direct questions of Indians. We were halfway to the Hopi country before the reason became clear. Sally, who was devoted to her people and the Hopi Way, wanted to undergo the initiation ceremony; she was offering her back to the yucca-blade scourges of the Whipping Kachinas.

For seven hours we drove through mountains and desert, until finally a dramatic twist in the road carried us up to lofty Third Mesa.

Most of the Hopi villages sit on three templelike sandstone plateaus named First, Second, and Third Mesa, according to the pioneer's point of view as he struggled west. Each has its specialty in pottery or basket-making. In all the villages the men do the weaving.

The fortresslike pueblos, camouflaged against the native rock, cling to the mesa-tops like eagle nests. Some of the villages wear an aura of age. One can guess the century of a house by the style of its windows. Some show antiquity's foot-square openings; others present today's prefabricated millwork. Rooms are piled on rooms with a setback effect, ending in a penthouse. Outdoor ladders lead from one story to another.

Streets laid out like the winding lines of jigsaw puzzles lead into central plazas. There the visitor may find only a lonely burro, a few children at play, or girls carrying water on their heads. A captive eagle may be tied to a pole atop the tallest house, awaiting sacrifice for its magic feathers.

Town Split by Push of War

Our first stop was Oraibi, oldest continuously inhabited town in the United States. It was settled about 1150.*

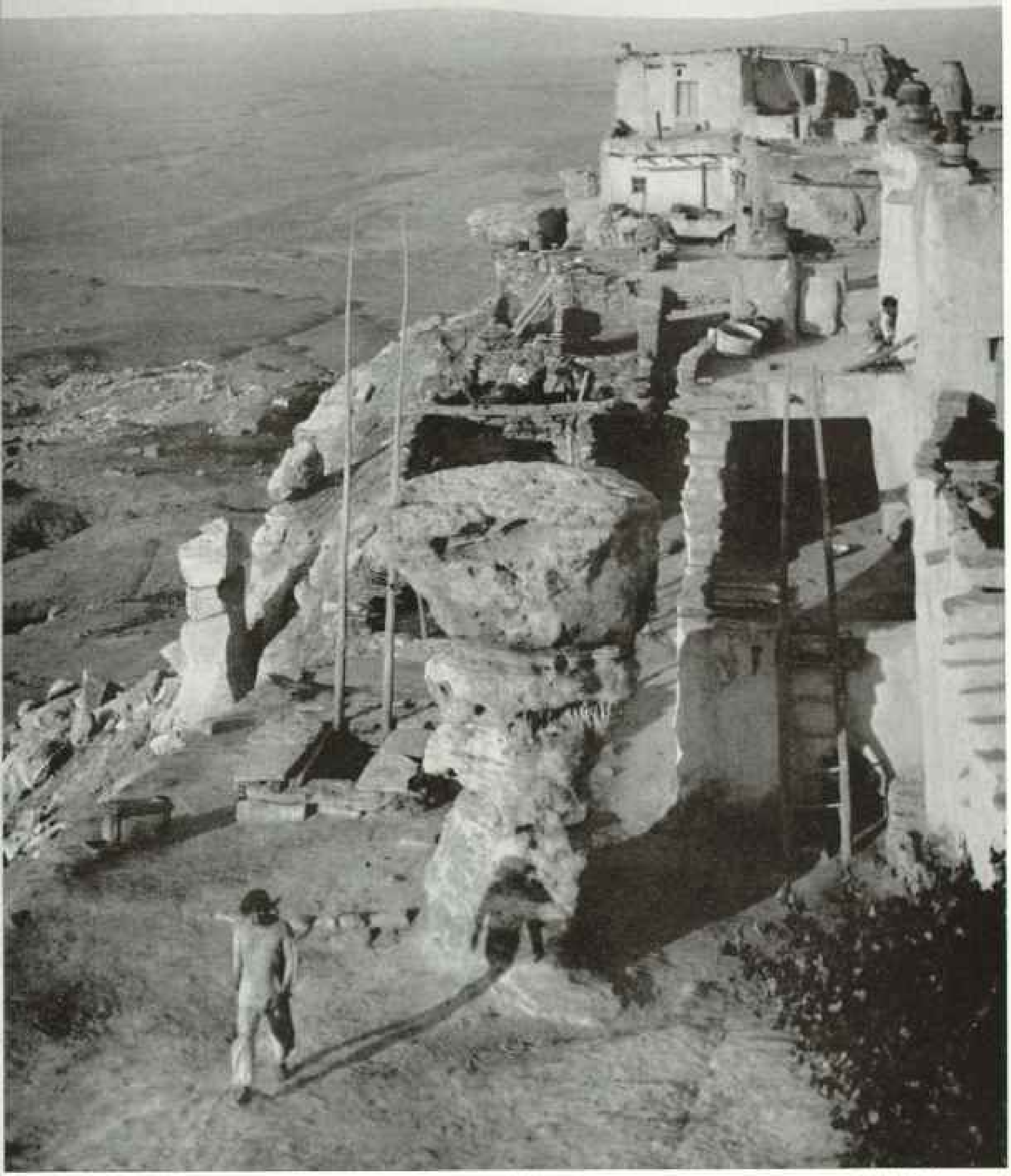
In 1906 Oraibi was split by bitter controversy: whether or not to adopt new ways suggested by the United States Government. The Hopi, the "peaceful ones," settled the issue without bloodshed, on a sandstone platform back of the village. They drew a line on the ground and asked all men to declare themselves, to select one side or the other. Champions of both sides then began a push of war, struggling to drive opponents across the line. The ones favoring change won, and, by terms of the agreement, the conservatives abandoned their homes and farming plots and moved away. Later they founded Hotevilla and Bakabi.

Though the Hopi still live in a little world of their own, they fulfill their duties as citizens: they vote in national elections and

* For an account of the determining of dates of these early settlements, see "Secret of the Southwest Solved by Talkative Tree Rings," by Andrew Ellicott Douglass, National Geographic Magazine, December, 1929.

Snouted Dancer Sets Shells and Bells Tinkling, Yarns and Sashes Swishing

Kachina dances often emphasize rain, life-giver in a semiarid country. The dancer has painted rain symbols on his hands and wears a string sash that prays for showers. Bandoliers of shells imitate the beat of the drops. Sleigh bells, borrowed from the white man, substitute for the rattling deer hoofs of old.



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Frederick L. Monsen

Walpi, a Skytop Hopi Fortress, Surveys the Arizona Desert

Visitors love Walpi's castled setting, twisting lanes, and ancient look. Founded in the valley before 1400, it was moved to the mesatop after 1680. There stone houses merge with the cliff's solid rock. Ladder on left descends into a kiva like the one visited by the author. Poles on right rise to a second-story balcony. Mushroom-like column in foreground is a natural shrine. A solitary Hopi in moccasins and slacks enters the ritual plaza, site of dances. He tends his corn and bean fields, not on the mesa, but on the desert below. Little has changed at Walpi since this picture was made in the early 1900's, or, for that matter, since Spanish colonial days.

send their children to high school. More than 200 of their young men fought on the battle-fronts of World War II.

At Oraibi I made arrangements for two nights' lodging, and we drove on. For dinner that evening we were guests of Howard's relatives, who live in Hano on First Mesa.

We ate by the light of a kerosene lamp while enjoying the warmth of coal mined on the Hopi reservation, a small enclave within the huge Navajo reservation. Gay linoleum covered our hosts' floor; Kachina dolls, calendars, and medicinal herbs hung from white-washed walls; and prayer sticks dangled from the rafters.

These prayer sticks, called *bahos*, are tipped with plumes and blessed during ceremonies. Symbols of the prayers said as they were fashioned, bahos store Hopi spiritual values. Like Buddhist prayer flags, they guard fields, shrines, homes, and even automobiles.

Hopi delicacies covered an oilcloth spread on the freshly scrubbed floor. We had bean sprouts, mutton with hominy, corn pudding, coffee, and *piki*, a paper-thin corn bread made with one sweep of the hand from batter dish to the hot surface of a flat stone. White people trying to make piki invariably burn their hands.

Kachinas Dance in Ancient Kiva

To see the kiva dances that night, we walked by starlight to 17th-century Walpi, following rock trails worn smooth by the footsteps of generations (opposite). Ladder poles sticking into the sky like fingers identified the kivas, the Pueblo underground ceremonial chambers, even in the dead of night. Though these are usually closed to white visitors, we were invited into the small Snake Kiva, so old it must have existed in the time of the Spaniards. It was crowded and hot; we could see why the conquistadors had dubbed the kivas *estufas*, or ovens.

Humbly dressed in tattered clothes, the clan priest tended the fire and welcomed each magnificent group of Kachinas, who shook rattles to gain admission. He blessed each dancer with a pinch of sacred corn meal sprinkled on the right shoulder. Then he laid a welcoming trail of meal, the Hopi "happy way."

Team after team, in masks and costumes, delivered their blessings and sang and danced half an hour to the beat of a drum. Women spectators frequently asked for encores.

Taking leave, the Kachinas handed out oranges and candy to the children and sometimes medicinal herbs to the elders. Then up the ladder they went, to complete their tireless all-night rounds of the other kivas.

Bean Sprouts, Magic of the Gods

The pale-green sprouts of beans growing against kiva walls are an unexpected sight in February. The Hopi call this happy season Powamuya, or Powamu, Moon of the Bean, a traditional time for Kachina visits. The Bean Festival, a portent of spring, asks the gods to purify man and the earth. The humble bean symbolizes future crops.

Before the Kachinas appear at Powamuya, every farmer gathers earth in pots and takes his offerings to his kiva. There the beans sprout in darkness, forced as in a hothouse by the heat of an old-fashioned iron stove. Within 12 days they put out foot-long tendrils. Indians view them as magic of the gods, who make life come out of seeds before weather permits.

Every Hopi kiva has its *sipapuni*, the sacred hole in the floor that represents the womb of Mother Earth, from which Pueblo people believe the first men emerged. Kiva culture may be traced back to the Basket Makers, who protected corn in round cists, or burrows, dug into the ground.

Enlarging these diggings, the Basket Makers created pit houses to shelter their families. Learning to build above ground, their successors, the early Pueblos, erected the first apartment cities in North America, piling four and five stories one atop the other.

Today, as if by a mysterious racial memory, the Pueblo people preserve the cist and pit houses in the kiva, man's birthplace, and the original man in the masked mudhead clown (page 234).

Girl Gets a Ceremonial Lashing

Pueblo people, so named by the Spaniards who found them dwelling in pueblos, or villages, might better have been called kiva people. The kiva is to the Pueblo what a church is to a Christian. What is more, it is his club, dance hall, playroom, art studio, and occasionally his sanctuary from women. The kiva dancer, by custom, turns celibate days before a sacred ceremony begins. Similarly he eats neither salt nor meat.

Late that night we drove to Shungopavi and found Sally had undergone her initiation

↑ Kwaho, the Eagle, Dances on a Cliff; Kachina Doll Stands a Foot High

The Hopi carve figurines of their gods and spirits from cottonwood-tree roots. Dancers at rituals distribute these to little girls. Studying them, children learn to identify Kachinas. The doll spreads wooden wings; a dancer would use eagle feathers.

↓ As Zany as a Circus Clown, This Man Is a Pueblo High Priest

Koshares, or clowns, invoke laughter, an element in many sacred ceremonies. Gesturing like a Balinese dancer, this Koshare describes the fall of rain and cultivation of corn. His unicorn cap, topped with corn husks, bears stripes representing bones of ancestors.

at Hano. She was unusually meditative and did not join in the laughter and singing. The Kachinas, who vary the lashes to suit the individual's needs, must have considered Sally a good girl, for they had treated her leniently.

The Indians' mystic fourth year having rolled around, this was the season for the boys, too, to taste the lash—to prove that a "man" can endure pain, though he be only eight years old. Boys had already fortified themselves by rolling in snow and performing other manly tests. Following the Hopi Way, they had learned self-discipline, obedience to elders, cheerfulness, and humility.

Then, led by a clan uncle, the boys marched into the kiva, removed their clothes, and held hands in the air. Kachinas in frightening black masks danced in and flogged bare bodies with sharp yucca blades. Crow Mother, in her winged headdress, watched the spectacle (page 218). But I did not have the right to see these secret ceremonies.

Such a flogging may be painful, but it is not humiliating. On the contrary, it is considered an honor, a challenge successfully passed by body and soul. I have known Indian men and women of all ages voluntarily to offer their backs as if to purge away guilt. "Ceremonial flogging," one Hopi told me, "is a reminder that life itself will whip us unless we go the Hopi Way."

Kachina Lash Teaches a Lesson

Not only the initiates, but also younger children undergo testing. Once I saw Koshares, as some of the Pueblo clowns are called (opposite and page 231), offer forbidden cigarettes to a circle of boys. Immediately an Ogre Kachina arrived to punish those who had yielded to temptation. Seizing the culprits, he growled and made terrifying gestures. One by one he allowed them to escape, until only two remained. Then a mother ransomed her son with the promise that he would mend his ways. As no one was willing to intercede for the last boy, he got two good lashes. All these events proceeded according to the elders' plans.

The Hopi parent does not spank or slap a bad boy; papa has no woodshed or razor-strop. He simply calls on the messengers of the gods to scare the child who cannot be reasoned with, or, in an extreme case, to apply the lash. A terrifying giant with fanged and snouted mask, yucca whip, and a sack for evildoers wastes no time coaxing; he wallops. The Kachina-spanked child never forgets the painful lesson.

Boys cheerfully gather firewood; girls wash the dishes and tend the babies. Pueblo Indians have very few juvenile delinquents, window smashers, or brawlers.

Other Kachinas distribute presents among the worthy. The Pueblo takes pleasure in giving; he scarcely ever visits friends or relatives without presenting and accepting gifts.

When teen-age Ben Quintana of Cochiti Pueblo, New Mexico, won a $1,000 award in 1940 for a painting, he donated virtually all the proceeds to his village. Later this talented artist gave his life defending the United States in the Pacific.

Frequently I have seen people on rooftops throwing to their neighbors in the plazas all sorts of gifts—Indian baskets, pots and pans, five-and-dime-store chinaware, fruit, and canned goods.

Men and women reach high to catch the favors. For an instant the villagers scuffle over an object, until a single hand holds it in the air, a signal always respected by the losers.

Drum Bestowed for a Song

I have my own token of Indian generosity. A prize showpiece in my studio is a valuable skin drum that was given to me literally for a song 17 years ago.

One day I was driving Tewaquaptewa, leader of old Oraibi, to a pueblo outside the Hopi reservation. In a congenial moment, he began singing a Hopi song.

Now, as any of my white friends can tell you, I croak rather than sing. I could not sing a word of "The Star-Spangled Banner" or my native "Marseillaise" if Franco-American relations depended on it. But for some strange reason I can chant Indian songs.

And so I answered my guest with a Cree melody I learned in Canada. He was so delighted he made me stop the car, get out on the roadside, and demonstrate the Cree dance steps. Navajo families passing in their wagons smiled approval.

When we returned to my friend's home, he presented me with a big fat Hopi drum, and at every reunion we sing the Cree song.

Among Pueblo tribes I have gained some slight reputation for my version of the Yei-bet-chai, a part of the Navajo Night Chant, which I have witnessed more than ten times.

It all started in Walpi, where some friendly clowns dragged me into the plaza and asked,

↑ Ogre with Protruding Tongue Polices the Ceremonial Ground

Moaning and wailing, Ogre Kachinas in fright masks keep children in line and preserve discipline.

This Kachina's buckskin kilt and bow and arrow relate him to the hunters; painted clouds on apron identify him with the rain makers. His cape is bearskin. The pouch on his hip contains "medicine"; lightning on sword gives healing power.

←"Good Dancer" Carries Melon and Corn, Gifts of the Gods

Kachinas at harvest festivals distribute fruit and other gifts among the people as reminders of the divine beneficence.

Good Dancer, so called from his bounty rather than his talent, wears a checkered mask of five colors. These identify him as Zenith, summit of the Pueblo firmament. Two crowning macaw feathers came from Mexico, perhaps long ago.

Painted spots and short breechcloth indicate Good Dancer may be a runner Kachina. As such, he challenges boys to endurance races to keep them fit.

Crouched over a Cane, a Dancer→ Imitates a Wary Deer

Crowned with antlers, this Rio Grande hunter stops, listens, watches, and sniffs the air before grazing. Macaw and eagle feathers are tangible prayers. Skunk fur on moccasins protects the dancer from evil spirits. A head-on view would show a half mask.

"Are you a Navajo?"—an allusion to the mustache that I wear, in common with some Navajo.

"Yes," I answered in jest, "and I am a powerful medicine man."

With that, one of the clowns lay down, groaned in mock pain, swore he was dying, and demanded a Navajo "sing."

There I was, facing an audience on the rooftops, with no magic. I made over my red bandanna scarf into a Navajo kerchief and contrived a rattle out of tin can and pebbles. Then, chanting and uttering coyote yells, I led a dance across the plaza, and six clowns in painted stripes followed in single file.

This was too much excitement for the "dying" clown; he jumped up and joined the dance. When the performance ended, the crowd signified its approval, and the Hopi buffoons said my antics had brought pleasure and happiness, and therefore blessings.

Food Lures Clowns Away

Last year I took a few members of my art classes to a Kachina festival. The head clown welcomed us with the announcement, "The banana clan has arrived"—a pun on the Hopi word *bahana*, an Anglo-American.

"Are all these your wives?" giggled the Hopi, pointing to the female students.

"Yes," I jested, "and you can have them for 50 cents apiece."

With that the clowns—short, fat, crowned with cornhusks, their seminude bodies garishly painted with clay—found stools and compared their height with that of the girls, who towered a head above them.

As the clowns fumbled for the purchase price, I could see my students growing nervous. The day was saved when a clan aunt rushed in with a bowl of food and lured the clowns away.

Everyone still wonders if the act of these Hopi entertainers placed food above love!

To complete my clown act, I made a tumbler's descent from a rooftop, the funmaker's traditional entrance upon the stage. Then, simulating an accident, I fainted in the plaza, where my convulsive leg and arm movements sent my Pueblo friends scurrying for water to revive me. They filled pots and pans, only to lose the contents as they bumped into one another.

Finally one clown made it with a full pail. I knew what was coming, and it did—a cold shower right in the face. I revived, grabbed a pan of water, and soaked the buffoon. The crowd was in an uproar, voicing its approval of the turnabout on the clown.

Notwithstanding the Koshare's obvious resemblance to the court jester and circus clown, he springs from entirely independent Indian origins. The joke-loving clown is regarded as the most sacred of the Kachinas; he always directs the solemn dancers.

Kachina Flogs Lagging Visitor

Years ago, attending a Bean Festival dance, I tangled with the Whipping Kachinas. Indian friends and I watched the public performance until the moment when He-é-e, the war maiden, climbed the highest dwelling and waved her quiver as a signal for non-Kachinas to clear the streets for a secret ritual.

My friends, shouting warnings, ran for ground-floor apartments as if a bomb had dropped, but, loath to miss the climax, I slowed to a crawl.

I had not thought that a Kachina would lash a visitor. Suddenly I realized my mistake. The jingle of bells gave an instant's warning; then a giant black-masked ogre bounded around the corner and brandished his yucca whip.

I took off as if the devil were at my heels. Just as I reached the first door, it slammed shut. The second door was already barred, and, like the boy in a game of musical chairs, I had no sanctuary.

Then the blow struck, a single lash across my thick jacket which startled more than it hurt.

Someone dragged me into a half-open door. "He got you," people laughed. As if it had made me one of them, my misfortune cemented an enduring friendship.

Doors and curtains remained closed until the secret part of the ceremony ended. Only

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Koshare, the Delight Maker, Gulps Watermelon in Gluttonous Fashion →

Before taking part in a sacred rite, this Rio Grande clown swallows medicine that enables him to eat more than appetite dictates. All day he wanders among the people accepting food; his bulging middle shows where it goes.

When leading Kachina dances, he is a model of sobriety; a few seconds later he may make the watermelon feast an epic of buffoonery.

Skeletonlike clay-and-charcoal stripes adorn face and body. Tufts of shredded cornhusks protrude like horns from the rawhide headdress.

one little girl, torn by curiosity, dared to peep out. Instantly an ominous rap rattled the door, and the child ran crying to her mother, certain an Ogre Kachina would visit her soon.

Finally, in some fashion unknown to me, the "all clear" sounded, and everyone walked into the plaza.

That was another year. More recently, at the conclusion of the Bean Dance, I saw sunset's alpenglow touch the distant mesas while a band of initiates marched out of the turquoise shadows. Nineteen boys robed in white and masked in yellow and black carried tender green bean sprouts freshly harvested in the kivas. With this simple act they proclaimed faith that the generations of man, like the life locked up in a bean, would not perish but would endure through eternity.

Dancers Pray for Rain

In historical times the three mesas were green with vegetation. But with the cutting of timber and the increasing aridity, they became virtually bare. Only a few springs flow, and water is precious.

Each year about half the Hopi villages perform the Snake Dance, a prayer for rain. Though it contains mysteries beyond our comprehension, the Snake Dance is not a Kachina ceremony, and its costumes are drab by comparison.

In August the tall white cottony clouds that so often pour rain on other parts of the Southwest may bypass the semiarid Hopi mesas. Then the Antelope Society gathers in its kiva, and the Snake Society goes into the desert to gather all kinds of reptiles.

Face to face with a coiled rattler, the gatherer blesses it with corn meal, strokes its back with an eagle feather, and addresses it with appropriate clan titles. As the serpent uncoils, the Indian grabs it and thrusts it into a sack.

Collected within the Snake Kiva, the reptiles are fed, washed, and addressed with songs —or so I am told, for few white men have witnessed this ritual. The Hopi advise their "elder brothers" to crawl down to the underworld and beg the rain gods to let down their hair, the long gentle streamers from "female" rain clouds, which Hopi farmers esteem above sudden and violent "male" rain.

On the sixteenth afternoon comes the ceremony scores of white visitors gather to watch.

Long ago, seeing my first Snake Dance, I took the precaution of standing on a rooftop. One minute I observed the restless shuffling of feet; next a frozen silence. Into the plaza

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marched the Snake Society, bodies and kilts painted black and terra cotta. Their associates of the Antelope Society were in ash colors. All painted their jaws white or blue and wore hair loose and long. The only sound came from chants and the Antelope dancers' rattles.

Snakes Writhe in Dancers' Mouths

In a corner of the plaza stood a pyramid of twigs. A brown arm thrust out through an opening to deliver the first writhing snake to the head man. Taking it in a bare hand, he made no effort to ward off the fangs. His acolyte, an accompanying dancer, waved an

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As Evening's Shadows Lengthen, Tewa Indians Give a Corn Dance in San Ildefonso

Christian converts in this New Mexico pueblo regularly celebrate the saints' days but hold also to ancestral pageantry. Feathers, fox skin, and sash fly from a kiva banner that purifies the dancers. Men's rattles and sashes imitate the sound and appearance of rain. Women, alternating as a dance team, stand in bare feet to express kinship with Mother Earth. Chorus on right chants songs, beats drums, and carries evergreen boughs.

eagle feather to capture and hold the snake's attention.

Other dancers accepted scaly burdens, danced in a circle, and wheeled back to the snake pit for more. In turn, each snake was carried in the dancer's mouth, then released.

A dozen feet from my eyes, a mouth-held rattler turned and sank its fangs into the dancer's cheek. Losing control, the man seemed on the verge of fainting, but quickly regained his stride and finished the dance. The next day he went about his business as though nothing had happened.

I recognized one painted dancer as a souvenir dealer I had seen wearing white man's clothes the week before in Winslow, Arizona.

After half an hour or so of dancing, the performers released their burdens in the plaza, and the snakes crawled toward the first line of spectators below me. Not a Hopi woman

or child shrieked. Before the reptiles could escape, the gatherers took eagle-wing feathers and steered them into the center of the plaza.

Now a housewife led into the plaza a procession of maidens in their characteristic butterfly hairdos. Bending over the mass of coiled bodies, the girls showered the snakes with sacred corn meal. Momentarily, I had the illusion of a giant dish of living spaghetti sprinkled with powdered cheese.

Four runners rushed in, gathered snakes in their arms, ran off to the four points of the compass, and released them far out in the desert.

"Elder brothers," they said, according to ritual, "crawl down in your holes to the underworld and ask the rain gods to have mercy."

Downpour Follows the Ritual

A Hopi friend beside me turned and remarked, "Everything is fine now." He meant that rain would come within the next four days. Actually, the visiting white men had scarcely left the village before the skies opened up and the dry washes ran wild with muddy water.

Indian faces shone with delight. Everyone

Mixed Kachinas Dance Beside a Sacred Trail of Corn Meal in Zuni Pueblo

Zuni, New Mexico, is a successor to ruined "Cibola," whose sun-gilded walls in 1539 led discoverer Fray Marcos de Niza to believe he had sighted a golden city. Fortune-hunting Coronado exploded the myth a year later. Blanketed mudhead clowns, whose masks suggest the earthborn first men, flank the dancers.

put out pots and pans to catch the precious drops.

If rain does not fall, the priests assume that some dancer has failed to observe all the ceremonial requirements or has harbored a profane thought.

Hopi Rites Remain Secret

At sunset I watched the purification rites of the dancers. Ceremoniously the men drank an emetic tea. Leaning over a cliff, they emptied their stomachs. The following day life had returned to normal.

I have asked Hopi men why they undertake this final ceremony. The only answer I can get is, "Good for the body."

And how do the snake-bitten dancers survive? White men have not unmasked the Hopi magic, but have offered these theories: that the snakes' venom is exhausted by teasing them to strike, that the dancers condition their blood by taking doses of venom, or that yogalike exercises make them immune.

When I ask Hopi friends for an explanation, they give me knowing smiles and allusions to fasts, to mind's mastery over the body, and to secret herbs taken by priests in the kivas. Frankly, I have never heard a satisfactory explanation. Rarely will the Hopi betray secrets, even in the name of science.

Cameras Banned at Snake Dance

One thing is certain: most Hopi lack the white man's fear of venomous serpents, a hysteria that sometimes contributes to the victim's death.

It is worth noting that not a camera can be seen at the Snake Dance. No pictures of that rite are known to have been taken since early in this century. Modern Pueblo, pro-

Demigod Hó-te Stares with Goggle Eyes

This foot-high doll is a perfect portrayal of the real Hó-te dancer, who carries bow and arrow. Mask and kilt are in the classic Kachina style.

Children Keep Watch from Rooftops

Priest at right sprinkles a path of meal, a substance he uses to bless every dancer. This half-century-old picture recaptures the aura of Spanish days.

236 From the Collection of Mrs. R. A. Hall

Snake Priest's Wand Distracts the "Elder Brother" Held in Dancer's Mouth

Rain often follows this ritual; joyful Hopi catch it in pans. Man on left wears a Navajo woman's necklaces. Cameras are no longer allowed at snake dances. This old picture is very rare (page 233).

tecting their religion and privacy, ban photography at sacred ceremonies.

Kachinas shown in the accompanying Kodachromes were photographed under privileged conditions. I gave a solemn promise not to release the pictures for 15 years, now passed, and not to name any individual, tribe, or village. I have never taken an Indian's picture without permission.

We Could Learn from Hopi Way

Theoretically, the United States Constitution protects the Indian's right to his faith. Though the Kachina dances may seem barbaric and pagan to the random visitor, they are in reality part of a pure religion—visible prayers in motion. Without these expressions of faith, the Pueblo would lose their identity.

The Hopi Way deserves our profound respect. From the calm and peaceful Indian we can learn much about the things that are free—laughter and happiness, inner discipline, and the enjoyment of sunlight on vast spaces and starlight on rooftops.

For additional information on the Pueblo peoples, prehistoric and modern, see, in the NATIONAL GEOGRAPHIC MAGAZINE: "Ancient Cliff Dwellers of Mesa Verde," by Don Watson, September, 1948; "Adobe New Mexico," by Mason Sutherland, December, 1949; "New Mexico Melodrama," by Frederick Simpich, May, 1938; "Everyday Life in Pueblo Bonito," by Neil M. Judd, and "Exploring in the Canyon of Death," by Earl H. Morris, both September, 1925.

Also see the color-illustrated volume, *National Geographic on Indians of the Americas*, National Geographic Society, Washington 6, D. C., 1955.

El Morro: Story in Stone

Pueblo Indian, Conquistador, Padre, Cavalry Trooper, and Pioneer Carved Southwest Drama on New Mexico's Inscription Rock

By Edwards Park

National Geographic Staff

A MIGHTY crest of pale sandstone rears like the prow of a giant ship from a rolling sweep of open country in west-central New Mexico. To a fresh-water pool at its base, generations of weary travelers have been attracted as by a magnet. And on its rocky flanks they have left the raw material of history.

Spanish settlers named the 200-foot mesa El Morro (The Headland). But Spaniards were neither first nor last to bivouac in the shade of this remote rock. Centuries before, Indians drank at the pool; two pueblos flourished on top of the cliff. When American wagon trains drove west, the old landmark still offered water and a cool place to bed down.

Haunted by the past, El Morro is now a United States National Monument. I camped in its shade and gazed at the souvenirs it has collected.

Graven Textbook of History

Hundreds of early wayfarers carved the cliff's smooth-grained face. Indian artists etched figures telling of hunts or battles. Conquistadors chiseled reports of journeys in archaic, codelike Spanish. American cavalrymen and wagon-train teamsters hacked names and dates. The whole base of "Inscription Rock" is scarred like a student table at Heidelberg, and each name helps weave the fabric of Southwest history.

The prize leaf of this graven textbook came from the blade of Don Juan de Oñate, Spanish colonizer of New Mexico. His words, cut in 1605, rank as the first inscription by a European in the Southwest (page 244).

"We guard these inscriptions," Monument Superintendent Irving McNeil, Jr., explained, "to keep people from adding to them. And we protect the Indian ruins on the mesa top. There are only three things we want visitors to take—pictures, an eyeful of scenery, and a lungful of fresh air."

Water Hole Lured Adventurers

With Ranger Don Page we walked along the base of the eroded cliff and halted under a heavy scar in its face. Before us spread a broad pool, surrounded by clumps of piñon and juniper (page 239).

"Here's the same water hole that brought travelers to the rock," Don said. "It's fed by runoff. Judging by the number of people who've used it, it has seldom gone dry."

Spanish Governor Oñate placed his inscription on a sheltered facet of the near-by cliff (page 244). Graphite squirted into the carved letters makes them more legible today than when they were painstakingly grooved, three and a half centuries ago:

PASO POR AQUI EL ADELANTADO DON JUAN DE OÑATE DEL DESCUBRIMIENTO DE LA MAR DEL SUR A 16 DE ABRIL DE 1605

("Passed by here the governor Don Juan de Oñate from the discovery of the Sea of the South on the 16th of April of 1605.")

Oñate led his colonists into New Mexico and established a capital at San Gabriel, now Chamita, in 1598. That was nine years before the founding of Jamestown and 22 years before the Pilgrims landed.*

Spaniards in Race Against Starvation

But the colony proved costly and discouraging. In 1604 the governor gathered 30 soldiers and two friars and set out to find pearls in "the Sea of the South"—the Gulf of California. He reached the mouth of the Colorado River, prospected in vain, then backtracked in a race against starvation. By the time he pitched camp at El Morro in April, 1605, hunger had forced his men to eat their spare horses.

Tracing Oñate's delicately carved words, I could almost recapture the scene—the gaunt men shedding their dented armor to rest before a fragrant fire of piñon boughs, the fagged horses tethered and scuffing, the exhausted leader laboriously etching a message that ignored disappointment and immortalized his triumph.

"Plenty of Spaniards were in this area before 1605. Are you sure Oñate was the first to leave an inscription?" I asked.

"We can't be certain of any earlier date," Mr. McNeil replied. "Some of the signatures we know little about may have been left by Coronado's men back in 1540."

Conquest of New Mexico Chronicled

Seeking the legendary Seven Cities of Cibola, Coronado found only the drab pueblos of the Zuñi. Disillusioned, the conquistador turned east. Probably he took the Indian route from the Zuñi lands toward Acoma Pueblo and passed El Morro.

Later inscriptions traced the trials of Spanish settlement. In 1680 the pueblos of northern New Mexico exploded in rebellion, driving the Europeans to El Paso. It took 12 years for the Spanish flag to return north. The man who brought it, Governor Diego de Vargas, camped at El Morro:

"Here was the General Don Diego de Vargas who conquered for our holy faith and for the royal crown all New Mexico at his own expense in the year 1692."

Many Spanish travelers threw modesty aside the moment they attacked the rock with Toledo blades. One governor used several square feet of stone to describe himself as a "most extraordinary and gallant soldier of unending and praised memory." With flourishes and symbolic seals, some signatures must have taken a day or two to complete.

Why such meticulous care? Puzzled, I turned from the cliff to stare out at the vast, silent plateau. How tiny a Spanish explorer must have felt when this same wilderness stretched beyond every horizon! The least he could do was to carve his epitaph.

1857 Signatures Recall Army Camels

El Morro's last Spanish date is 1774. For 75 years thereafter no dated entry remains on the rock. But at least one "Anglo" passed the rock—Ewing Young, a noted trader and trapper who beat a trail from Taos to California in 1829-30. In his party rode young Kit Carson.

Other mountain men almost surely knew of the mesa with its water hole and mysterious writings. But none reported it.

In 1849, U. S. Army Lt. James H. Simpson learned of the inscriptions from a trader. With three companions, among them the artist Richard H. Kern, Simpson explored the

* See, in the NATIONAL GEOGRAPHIC MAGAZINE, "Seeing Our Spanish Southwest," by Frederick Simpich, June, 1940.

Mountain Sheep, Carved by an Indian Hunter, Trail Along El Morro's Face

N. F. S. Woodbury

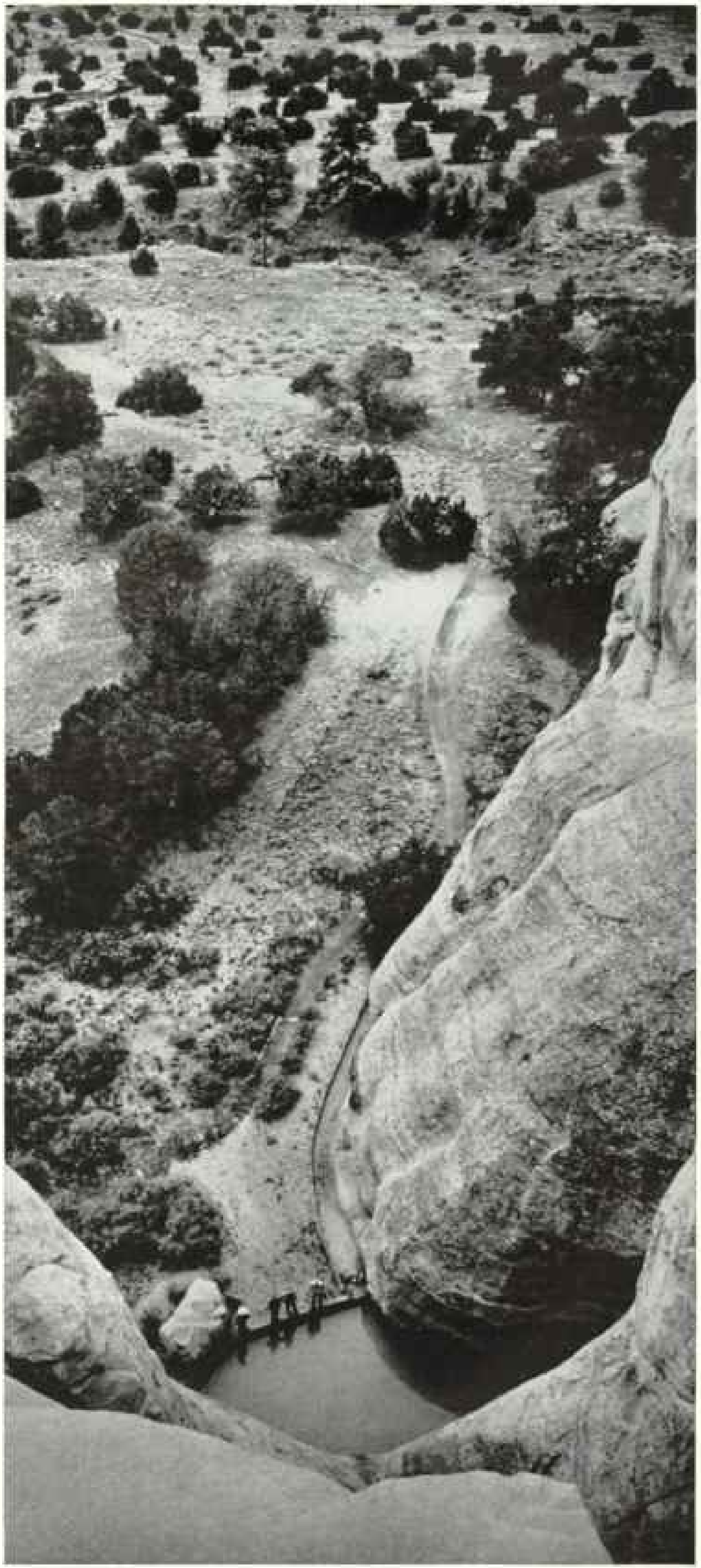
rock. It was, he noted, "strikingly peculiar on account of its massive character and the Egyptian style of its natural buttresses. . . ."

For two days Simpson and Kern copied the Spanish autographs. Then they cut their own in neat, modest letters—the first known American signatures (page 240).

Many of the "newer" messages recall United States pioneering adventures, such as the 1857 party under Edward F. Beale.

"Beale was leading a camel caravan through the Southwest," Don Page recalled. "Secretary of War Jeff Davis had brought camels from the Near East for the Army to try out in our deserts. They didn't pan out—but a good bit of Beale's trail west from Albuquerque did. Today it's called Route 66."

The first wagon train passed a year after Beale, taking the familiar route to Zuni and on into what is now Arizona. Emigrants

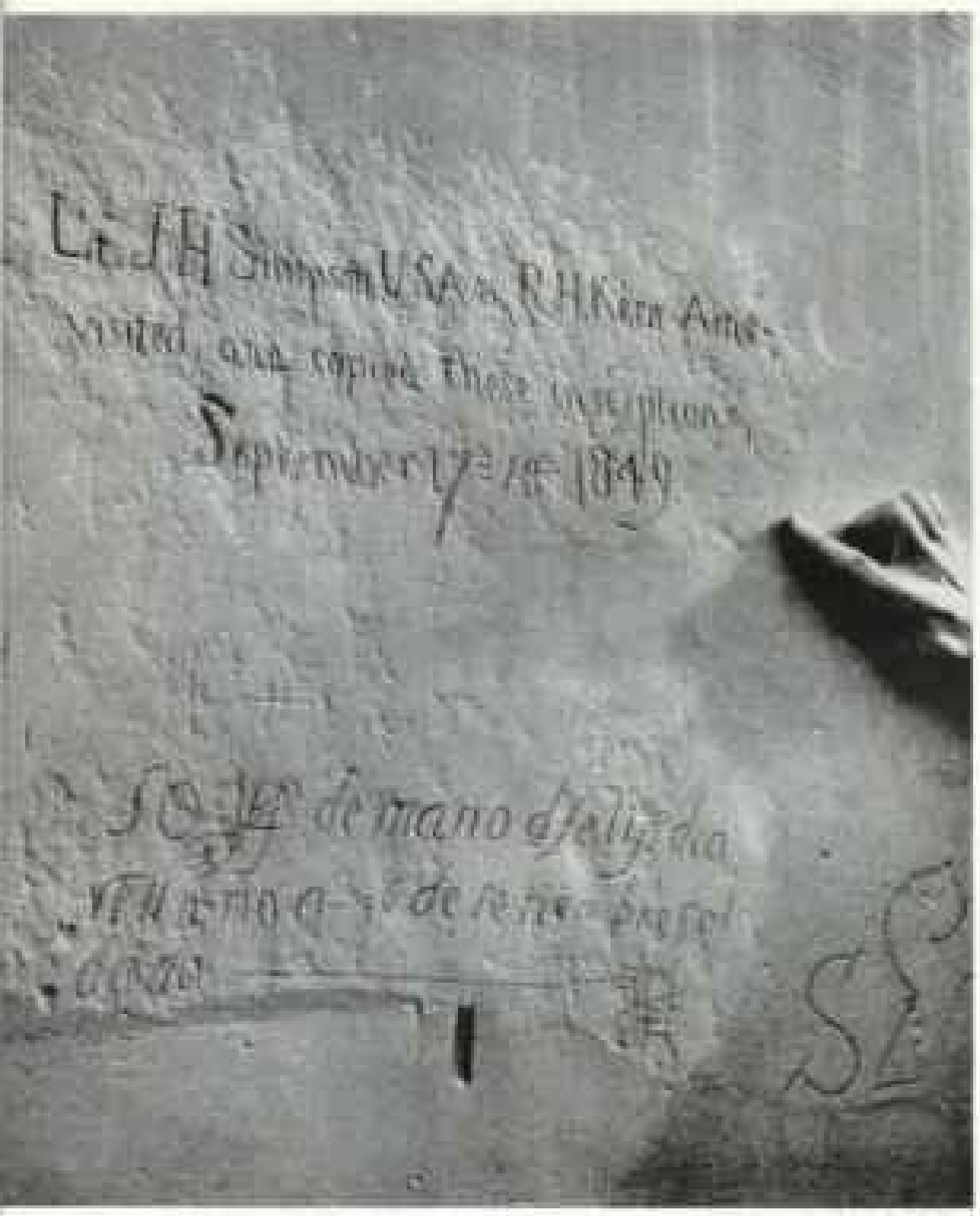


Desert Thirst Led ➔ Countless Wayfarers to This Rock-girt Pool

For centuries parched travelers welcomed the sight of El Morro's towering walls because of the pool of fresh water at its base. Few of those who came to drink could resist scratching a name and date on the fine-grained, easily carved sandstone.

Seen from the mesa top, the catchment of water and the travelers beside it are dwarfed by the elephant-foot-shaped cliff face.

Ralph Gray, National Geographic Staff



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Nature Chiseled El Morro's Buttress; Men Carved History on Its Flank

This weathered butte towers more than 200 feet above the surrounding plateau. Its base bears hundreds of inscriptions, fragmentary records of the primitive history of the Southwest and its exploration and settlement by Europeans.

Long before the time of Coronado, Indians cut petroglyphs—human and animal figures—on El Morro's face. Spanish conquistadors and priests traveling from the Rio Grande to the western pueblos wrote "*Pasó por aquí*" (passed by here) with 17th-century flourishes (page 244). United States Army detachments and westbound emigrants caught the idea and left graven records of their passing.

El Morro (The Headland) came to be known as Inscription Rock. Carvings extend around its tip for more than 1,200 feet, many higher than a man can reach on horseback.

Lt. James H. Simpson and Richard H. Kern, scouting Navajo country for the U. S. Army in 1849, left their autographs on the stone album—the earliest United States signatures now visible (left).

To preserve the mesa and its surroundings as part of America's heritage, President Theodore Roosevelt proclaimed it a national monument in 1906.

 Willard R. Culver (Right), and Ralph Gray, National Geographic Staff

recorded their stopover on Inscription Rock.

"Visitors often pore over the American names looking for great-grandfathers," Don told us. "Some find them, too."

700-year-old Pueblo Crowns Mesa

An easy trail mounts the mesa wall. We followed Don to a point some 200 feet above the surrounding land.

From the ground, El Morro had seemed a solid chunk of rock. Once scaled, it revealed itself as a hollow shell (page 242). A box canyon wedges into its heart, leaving two wide walls of mesa to form a V. Standing at this apex, among castlelike turrets, we gazed on what explorer Simpson called the "circuit of prairie, beautifully tasty."

A sudden shower blew over us, leaving the mesa top gleaming with small pools of captive water. Don reminded us that these natural "bathtubs" supplied water for the two Indian villages that once thrived on opposite walls of the mesa. He led us to the larger ruin. We stared down at roofless dwellings, storage rooms, and kivas of a pueblo that had once held a thriving community (page 243).

Scattered fragments of brightly colored pottery lay underfoot—refuse of centuries ago, now important clues for archeologists.

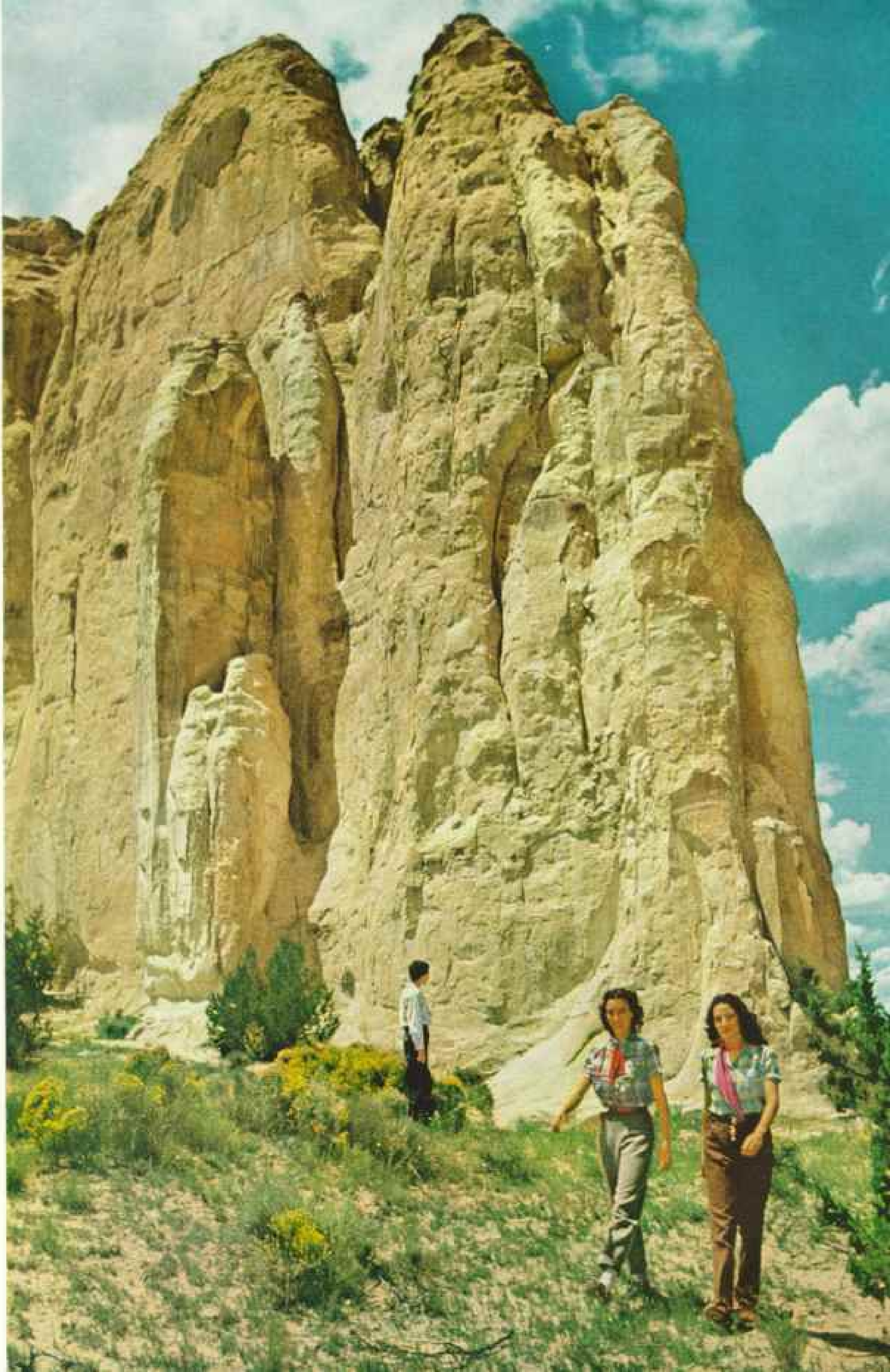
That night we met Dr. Richard B. Woodbury, associate professor of anthropology at Columbia University, and his wife, who teaches the same subject at Barnard College. As a team, they have been excavating El Morro's ruins since 1954.

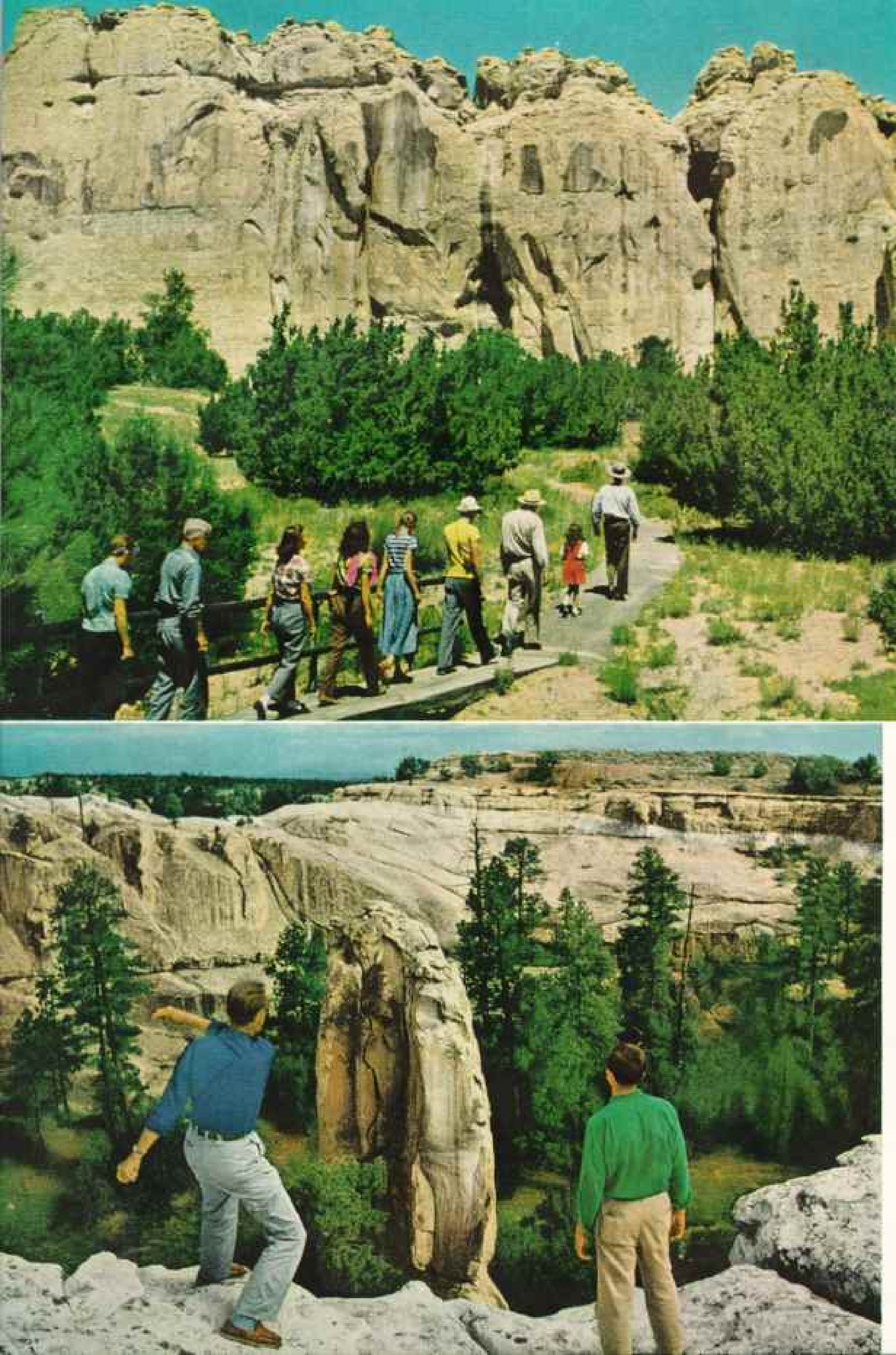
Dr. Woodbury named the large site "Atsinna" at the suggestion of Zuñi workmen. The name, which means "printing," is an apt one for El Morro. We were surprised to learn that the pueblo had risen as high as three stories, with possibly 500 rooms. From their excavations the Woodburys deduce that Atsinna was built early in the 13th century and gradually abandoned late in the 14th.

Mystery Shrouds Earliest Inhabitants

Why did its people leave? Dr. Woodbury suggests that a series of cool summers and late spring frosts kept the village farmers from getting a decent crop of corn. At any rate, Atsinna was deserted when the Spaniards came, and the conquistadors in their turn were gone when the Americans took over. But the three cultures intermingle today in the ghosts that hover about El Morro.

Moonlight shrouded the cliff as I took a last walk along its base. The brooding landmark loomed above me, weirdly pale. It took no imagination at all to hear furtive scraping sounds and to see dim figures at work, leaving brave, flamboyant, wistful marks on this great stone page of history.





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Potsherds Tell of Indian Life

Rangers make sure that El Morro's guests no longer "register" with penknives.

The ambitious may climb the mesa and inspect a pre-Columbian pueblo, now called Atsinna, that rang with life in the 13th and 14th centuries. Columbia University archeologists recently excavated these rooms.

Opposite: A sentinel rock rising from the mesa's box canyon makes a tempting target.

↑ **Antique Shorthand Spells Out the Oldest European Calling Card in the Southwest**

Spain's Capt. Gen. Juan de Oñate passed El Morro several times while establishing New Mexico's first government. The haughty conquistador cut this inscription across a far older Indian carving. The run-together message says that he was returning from "the discovery of the Sea of the South"—the Gulf of California—in 1605.

↓ A century later, in 1709, a traveler named Ramón García Jurado "passed by here on the way to Zuni."

Squaws Along the Yukon

Following the Fabled Gold-rush Route, Six Venturous Young Women and a Lone Man Paddle by Foldboat from Whitehorse to Eagle

By Ginny Hill Wood

MANY a flotilla as strange as ours had sailed the Yukon from its headwaters in Canada to Alaska. Explorers, fur traders, Klondike gold rushers, homesteaders, and adventure seekers before us had braved the mighty river in all kinds of craft. We were not even the first to navigate it in foldboats.

Yet our expedition was different from all the rest: its members comprised six women and a lone man, my husband, Morton Wood.

The reactions of other males could not have been stronger had Woody deliberately planned to herd a harem down the river. "Pretty lucky!" cried some. Others commiserated. Actually, Woody never planned it at all.

Adventure Eight Years in Coming

Our trip sprang from student days at the University of Alaska. Not to be outdone by schemes of others to drive jeeps to Argentina or to bicycle the new Alaska Highway, Woody, a friend, Celia Hunter, and I promised one another we would paddle down the Yukon someday (map, page 251).

"Someday" was almost eight years in coming. By then our number had grown from three to seven: two young geologists with the U. S. Geological Survey in Fairbanks, Alaska, Florence Rucker and Florence Robinson, and two foldboat enthusiasts from Seattle, Susan Hull and Muriel Thurber, who had asked if they could join our adventure.

That fine June morning our jumping-off point above Whitehorse, capital of Yukon Territory, must have resembled a girls' club camp-out. Gear, grub, and tents lay scattered on the riverbank as we assembled our flotilla —three double foldboats and a single—and began stowing our equipment aboard.

As a craft, the foldboat is a simple and ingenious improvement on the Eskimo kayak. Its wooden frame comes apart in a great many pieces. With rubberized canvas hull and deck covers, the whole thing packs into two duffel bags. In a matter of minutes an expert can assemble the numbered parts, locking them together with metal hooks rather than screws or bolts.

Decked over for several feet in both bow and stern, a foldboat affords a lot of space, but it is frustratingly inaccessible. Anyone passing by that day would have seen seven rears of assorted sizes all pointed skyward, with the rest of the owners' bodies burrowed molelike under the decks (page 261).

By 4 p.m. everything was packed and stowed, and our flotilla was ready for launching. One by one the boats slid into the water. Wet paddles flashed in the sunlight, and someone shouted "Hurrah!" as we headed toward Whitehorse.*

In a few minutes we were floating past the town itself. From our boats we could see signs of the new boom this '98 gold-rush center is enjoying, thanks to its huge airport and the Alaska Highway.† Quonset huts, left behind by U. S. forces after World War II, were filled with new families; old prospectors' log cabins had been rejuvenated and occupied. One of these cabins had housed the hero of Robert W. Service's poem, "The Cremation of Sam McGee." Service himself once lived in Whitehorse.

Stern-wheeler Recalls Bygone Era

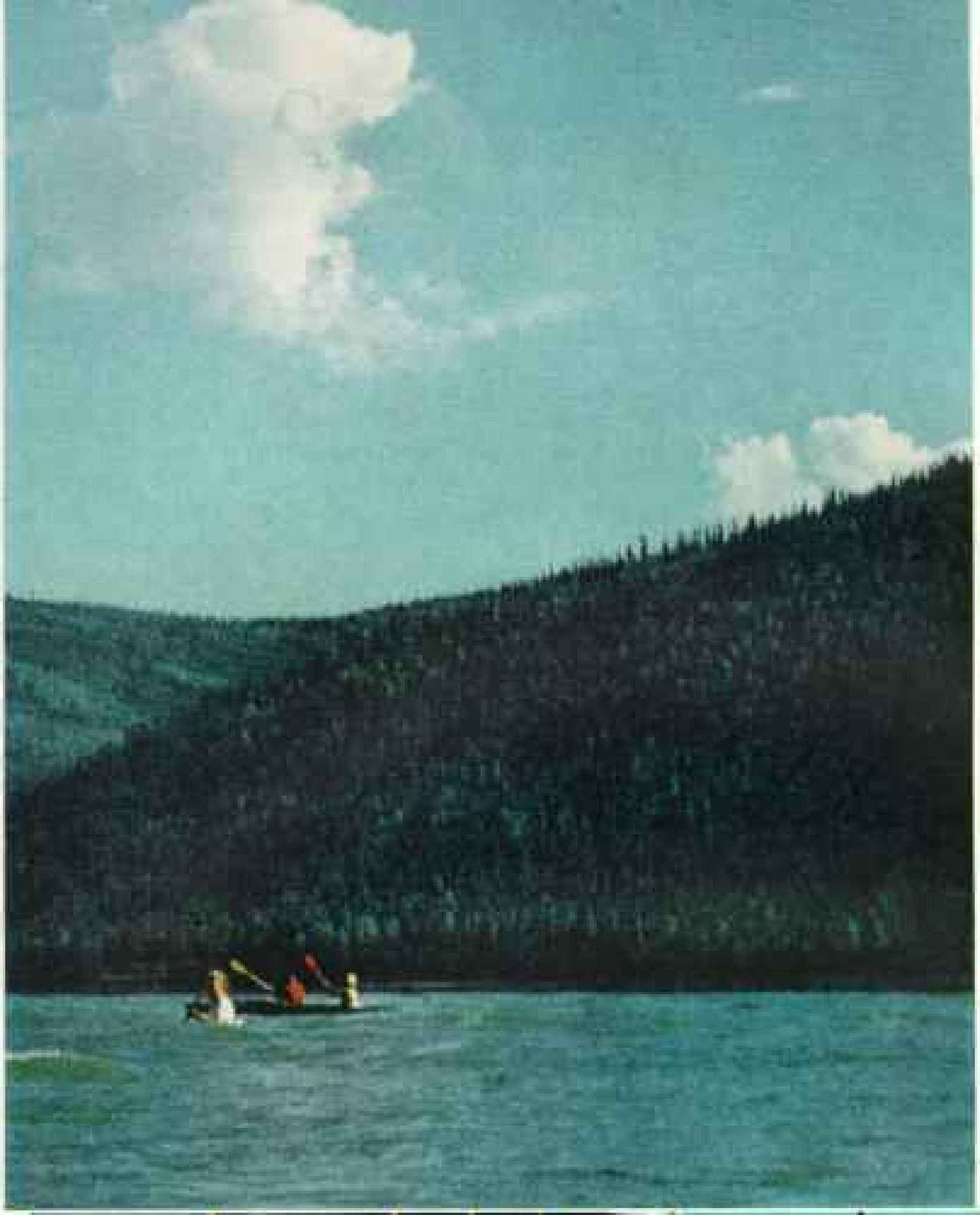
Below the town we passed the stern-wheeler *Whitehorse*, one of the last of the river boats which, for more than half a century, plied the Yukon between Whitehorse and Dawson in the heart of the gold country (page 246). She was loading for her first trip of the summer, the last summer of her active life. As we passed, crewmen and passengers crowded her rail to cheer and wave us on.

Since then the *Whitehorse* has joined her sister ships that we saw sitting like ghosts along the riverbank, silent witnesses to the end of an epoch (page 250). New roads have linked Dawson with the Alaska Highway, and buses, cars, and trucks now are carrying passengers and freight along the Yukon.

We paddled another 20 miles downstream, aided by the river's six-mile-an-hour current. Then, on a grassy bank above a driftwood-strewn beach, we made camp.

* See "Along the Yukon Trail," by Amos Burg, National Geographic Magazine, September, 1953.

† See "Alaskan Highway, an Engineering Epic," by Froelich Rainey, National Geographic Magazine, February, 1943.



← Foldboats on the Yukon Wallow in the Wake of a Stern-wheeler

Sixty years ago this summer the news flashed round the world: "Gold discovered in the Klondike!" Within a few weeks the 1,979-mile Yukon watercourse became a highway teeming with adventurers.

Hundreds of rafts and scores of steamers like the *Whitehorse* carried the frenzied throng to gold creeks near Dawson. Overnight, towns mushroomed. But easy gold soon disappeared and the spruce-banked river returned to wilderness.

To retrace the gold-rush trail in Canada's Yukon Territory, the author, her husband, and five other young women paddled down the Yukon in a fleet of four kayaklike foldboats. Here a voyager appears to sit in the water as her single-seater disappears in a trough created by the stern-wheeler's wash.

Opposite, lower: Mr. and Mrs. Wood navigate past steep banks.

↓ *Whitehorse* crew and passengers watch foldboaters pack gear after the paddle boat gave them a lift across Lake Laberge.

Kodachromes by Glenn Hill Wood (upper) and Muriel Thurber

The two Florences, whom we had speedily nicknamed Ru and Ro to keep them straight, had brought a small mountain tent. The rest of us shared a large tarpaulin lean-to or unrolled our sleeping bags under the open sky. Our first few nights were cool, for we were still at more than 2,000 feet elevation. But the weather warms fast in the Yukon in late spring, and it proved ideal for camping.

It was only 6 o'clock next morning when the *Whitehorse* came churning by and wakened us. We caught up with her again an hour downriver, where she snuggled against a bank near the entrance to Lake Laberge.

One look at the lake, its surface whipped into white lather by a stiff head wind, gave each of us the same idea. Why paddle its 32 miles when we could ride? We descended on the *Whitehorse* like a flotilla of South Sea natives with wares to sell, just as the crew was casting off the lines.

Thinking we had no time to lose, we quickly unloaded our boats and carried hulls and contents aboard. The old steamboat soon lumbered across the river mouth to the opposite shore. There it stopped. And there we sat for the rest of the day—on the "marge of Lake Lebarge," as Robert Service wrote, with more regard for rhyme than for spelling.

River Boat "Walks" Across Bar

Because of a long dry spell, the channel, narrow and shallow under the best of conditions, was unusually low. The flat-bottomed *Whitehorse* drew 3 feet 3 inches; the passage was slightly less than that. Absolute calm would be required to "walk" the craft across the bar on its huge paddle.

Capt. Alex G. Courquin, who had been on the Yukon almost as long as his steamer, seemed undisturbed by the difference between his ship's draft and the channel's depth. But he was much perturbed over the prospect of a Yukon voyage in craft as frail as ours.

"Be careful at Five Finger Rapids," he warned. "Watch out for the eddies and stay in the right-hand channels."

Foldboats, Woody reassured him, had navigated the Grand Canyon of the Colorado. They had even sailed the Atlantic. But the captain's fear was not allayed. We didn't tell him that Ru and Ro had been in their craft only once before and had more experience in light airplanes than in small boats.

The wind subsided that evening and the mooring lines were cast off. The *Whitehorse* moved into the channel stern first so the paddle would pull instead of push. The mate stationed himself with a sounding pole. Slowly we splashed backward. The hull jarred and quivered as we bumped along the silty bottom, the blades churning up more mud than water. For 20 minutes the issue remained in doubt. Then the mate began to call out deeper water. We were through!

The *Whitehorse*, first boat of the season to cross the bar, tied up after midnight at the deserted log cabin settlement of Lower Laberge, at the entrance to the Thirtymile stretch of the Yukon. We tumbled ashore, set up tents, and crawled into our sleeping bags.

Next morning the usual confusion of cooking breakfast and stowing the boats furnished entertainment for the *Whitehorse* crew and passengers, who watched us from the upper deck (page 247). We started down the Thirtymile under cloudless skies. "Whoopee!" shouted Celia and Mu, diving their craft into white water. The rest of us followed, sending mergansers and other waterfowl scampering into the sky.

White Water and Hairpin Turns

The sun was warm, a fragrance of evergreens filled the air, and before us beckoned sparkling shallow water, the clearest section of the Yukon we were to see. It raced over bright-colored rocks, tumbled in stretches of rapids, and wound around hairpin turns between steep banks of lodgepole pine and spruce.

Although Woody and I had explored Alaska's Katmai National Monument in our boat and Celia had sailed hers on Kotzebue Sound, foldboating for us was merely a means of transportation, not an art. Mu and Sue, on the other hand, were members of the Washington Foldboat Club and veterans of many summers running the swift, hazardous waters

Sailors Bathe and Bask in the Sun; Current Sweeps the Flotilla Downstream

For mid-river chores, a floating soap proved best: it could be retrieved with a paddle. Decks served as clotheslines. Wet garments stuck fast; when dry, they sometimes fluttered off into the water. "We lost several good shirts that way," one boater lamented.

Work done, the crew napped under a sun that pushed the temperature to 90°. Rubber balls threaded on ropes usually trailed behind the boats as lifelines in case of a tumble overboard.

Kodachromes by Glenn Hill Wood

of the Pacific Northwest. We Alaskans had to strain every muscle to keep up with them.

Not until we had covered 40 miles and worked our bodies into total numbness did the Seattle experts confess that they too had been straining. They were not going to be outpaddled by pioneers from the North who, they assumed, thrived on feats that would exhaust ordinary Stateside mortals.

"Let the River Do the Work"

Sometime the following day Woody made an announcement that completely dissolved the competition and revolutionized our mode of travel.

"You women can knock yourselves out if you want to," he said, settling back in his boat. "But as long as this river moves along at six or seven miles an hour, I'm for spending a little more time afloat each day and letting the river do the work."

Henceforth, by postponing many of our morning chores until we got on the water, we broke camp in less than two hours instead of the three it had been taking us. Drifting with the current, forward, backward, or sideways, we combed our hair, brushed our teeth, washed clothes, wrote in diaries, loaded cameras, and even took baths (page 249).

When we girls did our laundry, we plastered it on the forward and afterdecks to dry. Woody pretended great disdain for the deckloads of lingerie. "Women! Women!" he'd moan. But he loved us.

A Fleet of Paddle Steamers, Specters of Bygone Days, Haunts the River at Whitehorse

Once these vessels paraded majestically down the Yukon, the only supply line from rail end at Whitehorse to riverside settlements. Now trucks ply the new Mayo Road, and these old veterans face extinction.

Ginny Hill Wood

Eagle
End of trip

Mt. Harper
2000

Yukon River

Forty Mile

Fortymile River

Mt. Campbell
6500

Moosehide Mt.
3270

Dawson

Klondike River

Glacier Creek

Sixty Mile River

Chicken

Taylor Highway

Crag Mt.
5056

Readford

Granville

Clear Creek

McQuesten

Stewart River

Ladue River

230 miles to Fairbanks

White R.

Kirkman Creek

Northway

Alaska Highway

Kirkman Creek

Pyroxene Mt.
4870

Fort Selkirk

Britannia Creek

White River

Snag

Prospector Mt. 6482

Yukon River

Minto

Macmillan River

Pelly River

Tatlmain Lake

Faro

Stokes Lake

Mt. Menzie
5855

Pelly River

Faro Finger Rapids

Truitt Peak
6800

Little Salmon

Little Salmon Lake

Carmacks

Big Salmon

Aishihik

Aishihik Lake

Yukon River
(Thirtymile River)

Lower Laberge

Mt. Black

Teslin River

Little River

Upper Laberge

Canyon

Alaska Highway

Haines Junction

Whitehorse

White Pass & Yukon Route

Whitehorse Rapids
Start of trip

STATUTE MILES

YUKON TERRITORY

ALASKA

U.S.S.R.

Kotzebue Sound

Arctic Ocean

Bering Sea

Yukon River

Arctic Circle

Circle

Fairbanks

Anchorage

YUKON

Area of Large Map

Skagway

Juneau

Katmai National Monument

CANADA

Pacific Ocean

Vancouver

Seattle
U.S.A.

STATUTE MILES

©N.G.S. Victor J. Kelley

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Big Salmon Wears the Lifeless Look of a Ghost Town

To inhabitants of this Indian village, summer signals an exodus. Men depart for road-construction jobs; woman and children move to fishing camps.

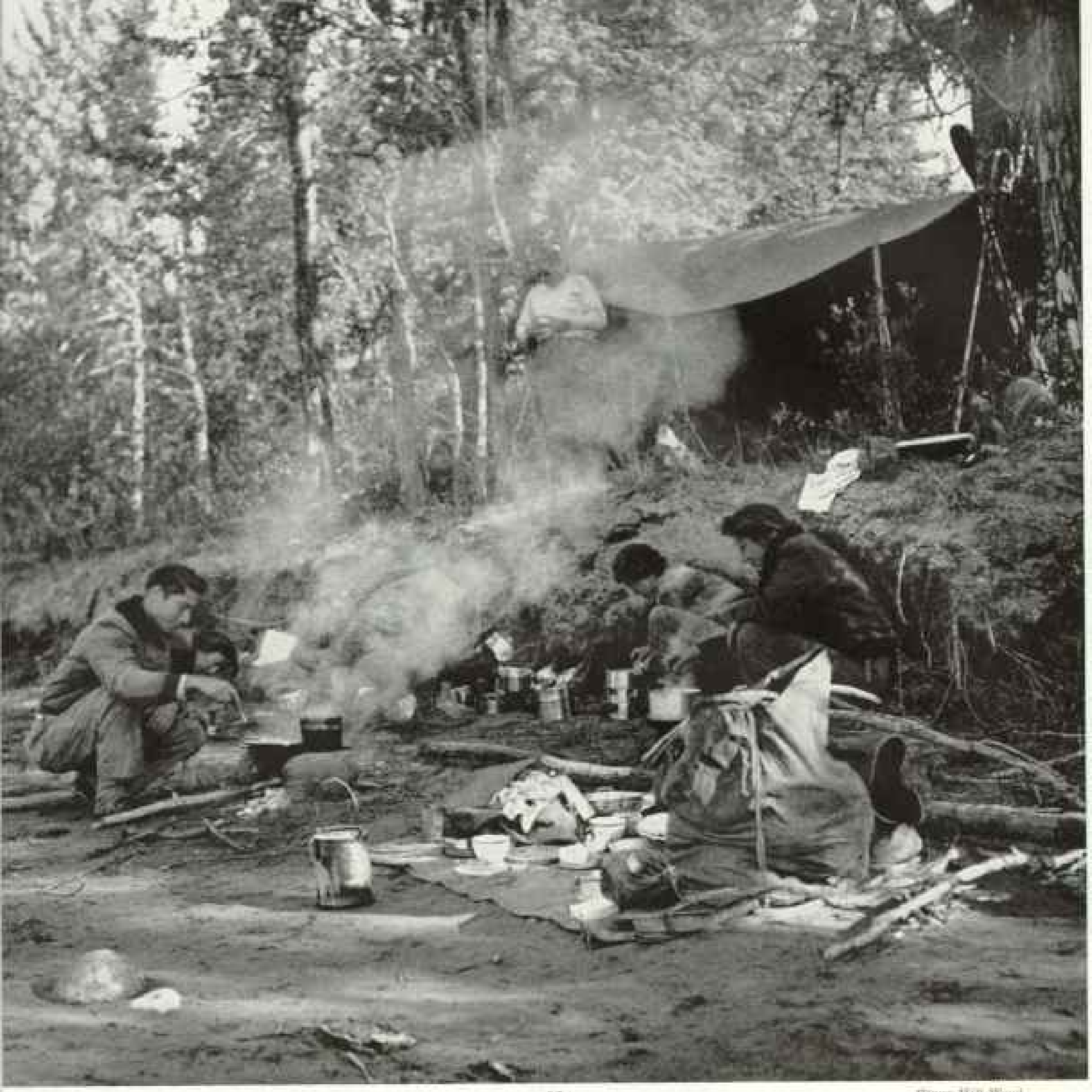
The expedition found sod-roofed log houses deserted but open to visitors. Indians had stored valuables and food in the stilt-legged cache between radio antenna poles.

These foldboaters, both from Fairbanks, fly the Alaskan flag from the stern of their craft.

←At every stop the river supplied driftwood. Midnight sun, here lighting preparation for supper, burned on through most of the night, but tired voyagers slept too soundly to notice.

→The Canadian flag flutters temporarily from Morton Wood's hatband.

Kodachromes by Muriel Thurber and (right) Florence Blatker



Ginger Hill Wood

Breakfast: Pancakes Brown over a Wood Fire; Primus Stoves Cook Oatmeal and Bacon

To avoid transporting large cooking pots, foldboaters split up at mealtime. Three stoves and several chefs saved time, and each group ate what it preferred. Here paddles support a tarpaulin shelter.

At lunchtime, instead of going ashore, we lashed the boats together, continuing downstream while we passed crackers, cheese, sardines, fruit, and chocolates on our paddle blades. Then, still rafted together, we slumped down in our cockpits, legs dangling over the sides or propped up on the thwarts, and let the hot sun and the swish of the water lull us to slumber. All except Ro, that is. She could always be depended on to stay awake to warn of impending hazards.

"I don't want to disturb anyone," she would admonish, "but there's a crisis coming up, and somebody'd better do something."

Someone would cock a sleepy eye at an overhanging spruce, a partially submerged rock, or oncoming rapids and guess we'd probably get through. If catastrophe seemed certain, a short debate would ensue over who should paddle. Then someone would dip a blade, disaster would be averted, and we'd all go back to sleep—all except Ro, the watch bird.

Few Mosquitoes, Too Much Sun

Now and then a summer shower interrupted our siestas and sent us scrambling for rainwear and the spray decks. Fastened to the gunwales and pulled snug, the spray covers kept the cockpits dry (opposite).

We were well outfitted for rain, mosquitoes, and cool weather but least prepared for what we got the most of—sun. Day after day it beat down on us. Gloves, brought along for protection against cold, had to be worn to prevent sunburned hands. And headgear became imperative; cowboy Stetsons for Woody and me, a safari sun helmet for Ru, a scarf for Sue, and a floppy hat for Celia. Ro, who turned redder and redder as the rest of us tanned, had to wear her head net the entire trip, not for mosquitoes—we encountered few—but to keep at least one layer of skin on her face. Mu wore the dishpan (page 264).

Deciding on a camping spot each night had its amusing if not trying moments. Each person had a different notion of the ideal site. Woody was amenable to any place, but would we women hurry up and make up our minds? He was starving!

Ultimately the river made the choice. Because it was impossible to paddle against the current, landing at a particular spot meant heading toward shore a long way upstream, then straining on the paddles until the back eddy was reached, a system used by small cable ferryboats.

If we discussed the merits of a possible campsite too long, the river would sweep us past it. Or one boat on the wrong side of the river would start in too late and beach below the others. Then we would all have to take to the river again until, by trial and error, we all landed at the same spot.

Not a Person in 100 Miles

The campsites always brought us in close touch with history. They never let us forget that the Yukon once was the superhighway to the Klondike and Alaska. In all the 455 river miles between Whitehorse and Dawson we passed only two homesteads and three villages that were still populated.* For long, long stretches in between, we might well have been traversing untrod wilderness. Yet never did we go ashore without finding blazes, rusted cans, rotting shelters, and other evidence,

* See "Family Afoot in Yukon Wilds," by William Hamilton Albee, with Ruth Albee, National Geographic Magazine, May, 1942.

With Spray Decks Zipped Snug, Two Voyagers Slumber Through a Light Rain

Rubberized canvas covers shield the cockpit against storm or rough water. Alone on the river, boaters napped without fear of collision. One expedition member stayed awake to warn of danger.

Glenn Hill Wood

♠ Loaded from a Shopping Spree, Sled Dogs and Mistress Trudge Home

This Indian woman returns from Carmacks to the summer camp where she catches and dries fish for winter dog rations. She speaks little English, but her Athapaskan language is understood by far-flung tribes across interior and western Canada.

♦ Dollhouses for the Dead Mark Indian Graves at Little Salmon

Though accepting the Christian faith, Athapaskans at this village still build cottages to give departed souls an earthly home, an expression of far older tribal beliefs. The neatly curtained window reveals a table set with dishes and food, long since dried up.

such as the overgrown rhubarb patch we raided, that many people had followed this route before us.

We drifted 100 miles downstream before we saw any other humans. A party of Indian women and children, with a long string of pack dogs, came out of the forest toward the shoreline. They stopped and stared at us with shy curiosity.

Indians Build Homes for the Dead

The discovery that nearly all of us were women dispelled some of their reserve, and one of them came down to the shore to talk to us. She told us they were moving to another camp, "many miles." The huskies obviously were doing the bulk of the work. Strapped to the dogs' backs were pots and pans, five-gallon fuel cans, and bedding, as well as a litter of newborn pups.

Farther upstream, at Big Salmon, we had gone ashore to explore a temporarily abandoned Indian village (page 252). Sleds and farm tools lay all around, half hidden in the tall grass. At one of the low log cabins a toy steamboat leaned against the doorway, awaiting the return of its child owner. The Indians would come back in the fall, at the start of the trapping season.

At Little Salmon we found two colorful cemeteries, typical of some groups of Athapaskan Indians of northwest Canada and interior Alaska. On nearly every grave, in addition to a cross, stood a gaily painted little house, filled with the belongings of the deceased. Many of these miniature dwellings must have cost more than the homes of the living.

One house, obviously built for the spirit of a departed male, contained knives, guns, and fishing tackle. Through the curtained glass windows of another we saw sewing equipment, pots, and pans. A tiny table was set with dishes that held real food. The spirits were well cared for.

Village Turns Its Back on the River

The first going community we came to was Carmacks, a village of some 20 cabins and frame houses, two trading posts, a church, and post office. A truck horn blasted for ferry service across the river, and we knew at once that the town's future was assured. The new Dawson highway meets the Yukon here, and Carmacks was turning its back on the quiet river, facing a future of grinding gears, popping exhausts, and dust.

Ever since the start of our adventure we had girded ourselves for Five Finger Rapids. Some people had dismissed them lightly; others had warned of their treachery. Now they loomed before us—five separate channels where the foaming water cascaded around a quartet of rocky buttes.

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Pint-sized Beast of Burden Takes a Rest

On the trail, gasoline in the can sloshed so much that the Indian's dog was barely able to waddle. It sat down at every opportunity.

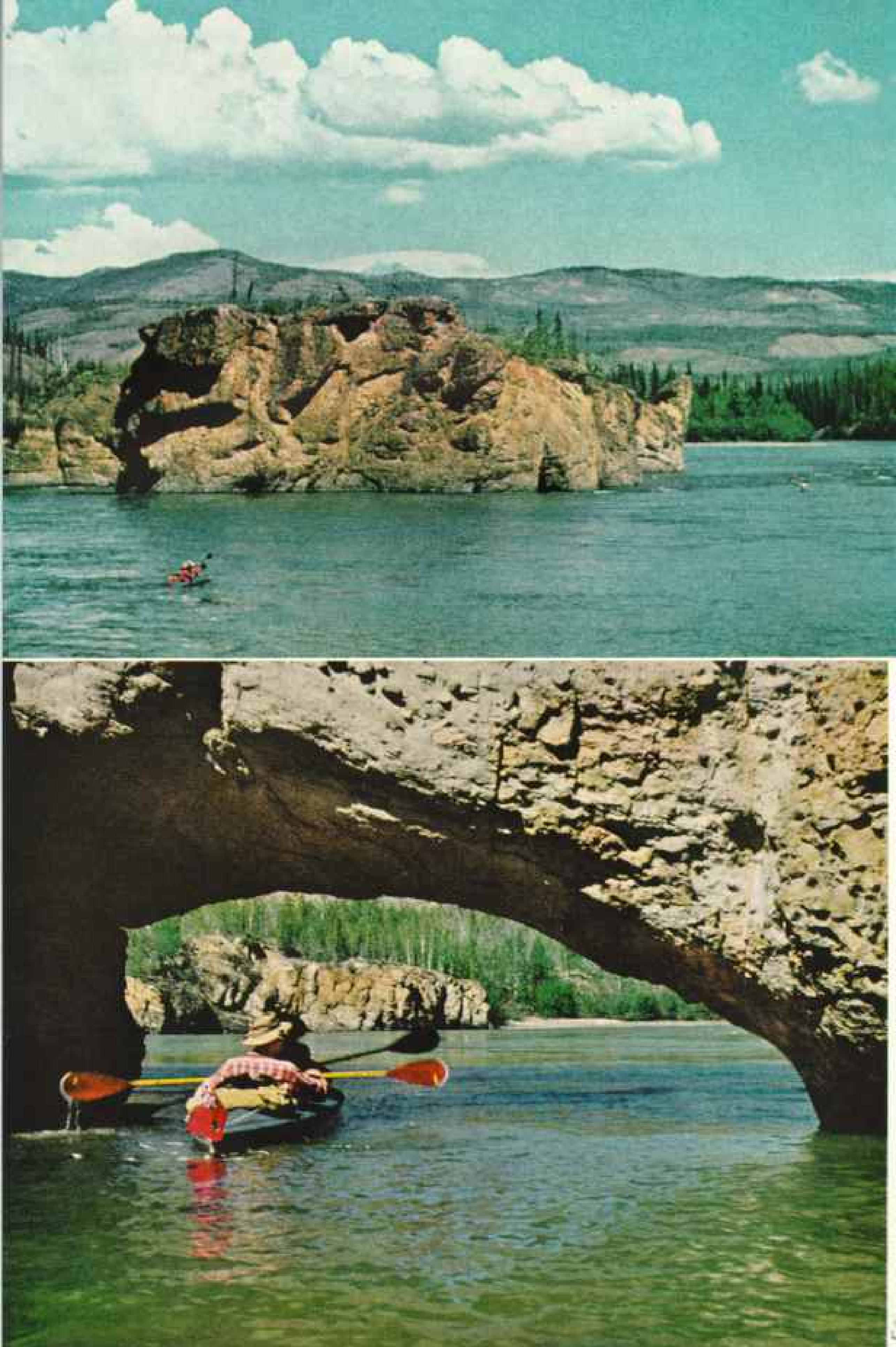
We went ashore to don life jackets and pull up the spray decks. Susan went first in her single-seater. Then Woody and I started through. The hull shook with the first wave. The steep rocky walls fairly raced by us. Whitecaps danced around the bow, but not a drop came into the cockpit.

Suddenly we were in more placid water and paddled over to the back eddy to wait for the others.

"We could have done that with all four boats rafted together," said Woody, almost disappointedly.

The rapids were tame for foldboats, but guiding a big paddle-wheeler through them, we thought, could be worse than dangerous. Along the cliff we could see the cable by which steamers winched themselves through on their way upstream (page 265).

Our next stop depressed us. All along the river we had seen abandoned stern-wheelers, deserted cabins, and stacks of cordwood no longer needed to make steam for river boats.



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↑ Boats Bob Like Corks near the Treacherous Five Finger Rapids

Between Carmacks and Fort Selkirk a broken wall of rock almost blocks the Yukon. The river rushes through five gaps in the barrier, frothing over rapids. During gold-rush days many a prospector met doom here, dashed against the rocks. Only the most skilled pilots dared take a steamer through the passage.

Duly warned, foldboaters approached Five Finger Rapids with caution. Before shooting the course, they slipped on life jackets and pulled up spray decks.

Susan Hull, the most skilled boatman, went first and alone. Here in the river's rocky jaws her tiny boat swirls through a tumult of white water. Another follows at left. All made the passage safely.

← Paddles at rest, a boat glides under a natural arch gouged by the river.

→ Hundreds of swallows, swarming from mud nests on the rocks, greet the adventurers.

Muriel Tourtellotte and (lower left) Florence Rucker

But at Fort Selkirk, once a thriving Hudson's Bay Company trading post, we actually witnessed the death of a town. The last inhabitants—the trader, his missionary wife, and a handful of Indians—were all moving upstream to Minto the following day.

Mrs. Alexander Cowaret, the Episcopal missionary, dressed in a white surplice and mortarboard, was waiting for us at the shore when we beached.

"When I saw your boats," she said, "I thought you were Indians from upriver coming to the church service. This will be the last one here."

She led us to the white-trimmed log chapel. "Wouldn't you like to come inside and sing a few hymns?" she asked. We did, and went away feeling as if we had been to a funeral.

Dawson Survives the Klondike Rush

Our spirits revived again when we spied a tidy cabin and the flower-checked garden of the Malloys, homesteaders at Kirkman Creek. Jack Malloy had mined and trapped on the Yukon since 1913. His hearty, hospitable wife, having learned of our expedition over the "bush phone"—the radio—was primed for our arrival. She wouldn't hear of our leaving that afternoon. We must camp on their beach. We accepted on the condition that they join us for supper around our campfire.

The purr of a distant motorboat interrupted the party. Jack cocked one ear. "That would be J. O. McKenzie from up the Stewart River," he said.

McKenzie landed a few minutes later. Although he hadn't been past here in two years, the sound of his engine—like any other to us—signaled but one boat to Jack.

Ten days downstream from Whitehorse we sighted Moosehide Mountain, named for the shape of the big scar left in its side by a landslide, and we knew we were approaching Dawson. Presently the buildings came into view, street after street of tumble-down false-front stores, houses, hotels, and dance halls. Where 30,000 prospectors once crammed every available structure, now fewer than 800 inhabitants rattle around amid the memories of gold-rush days.

Not prosperous looking, the town nevertheless is picturesque (page 262). And many a man still makes a comfortable living off gold, working the huge dredges that have replaced pans and sluice boxes in the Klondike.

Leaving Dawson, we drifted down the river

Thunderheads Threaten a Storm on a Hot Afternoon near Fort Selkirk →

far into the night, bewitched by the midnight sun which, in this latitude, dipped only briefly below the horizon before climbing back up the sky. Next day at Forty Mile we explored the abandoned log cabins of a gold-rush camp older than the Klondike strike (page 263).

How easily nature changes its mood we were yet to discover. That afternoon the sky suddenly turned black, angry thunderclouds rolled in, and the first real storm of the trip crashed down on us just as we passed the border between Canada and Alaska. Already fooled by several storm threats, we delayed getting ready this time until the deluge hit. All we could do was to lash our boats together and let the wind whip us where it would. Cold and drenched, we huddled as close together as possible, singing "The Sinking of the Titanic" at the top of our lungs.

Late in the evening of that day, our 13th on the Yukon, the sun broke through the clouds again, and we pulled into Eagle. Except for Ru and Ro, who went another 150 miles beyond to Circle, our trip was over.

Change of Tempo on the Yukon

Eagle was once a bustling community of some 400; now its total population numbered about 50, but even that seemed a lot to us, who had come 100 miles from Dawson without seeing another living soul.

At Eagle we sensed again the impact that the coming of a highway can have on an Alaskan or Yukon community. A new road from Fairbanks was just coming through to this remote village, once geared to river and dog-team transportation.

The contrast between road and river life had been forcibly impressed on us by two dif-

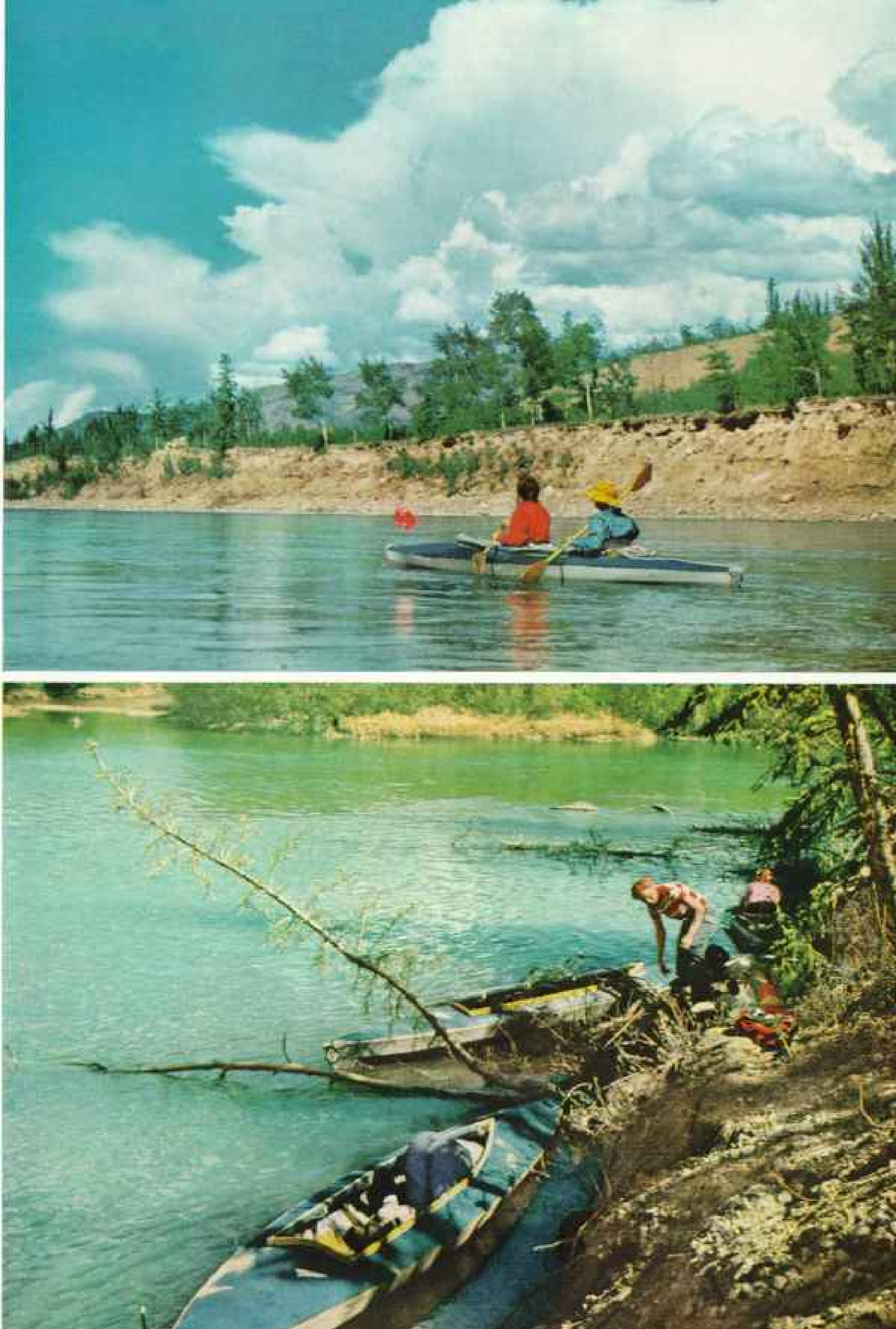
(Continued on page 265)

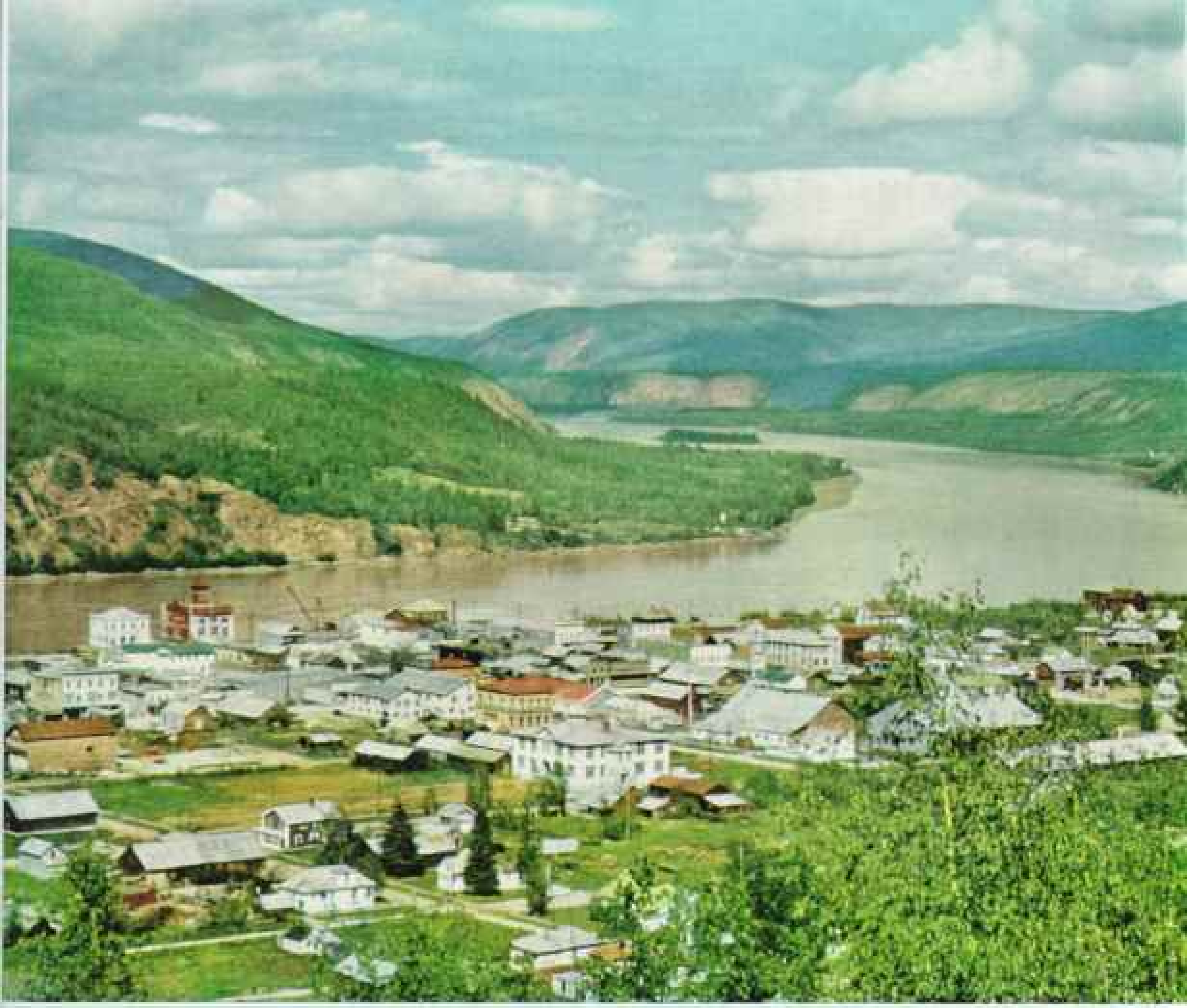
"The Only Way to Pack a Foldboat Is to Act Like an Ostrich" →

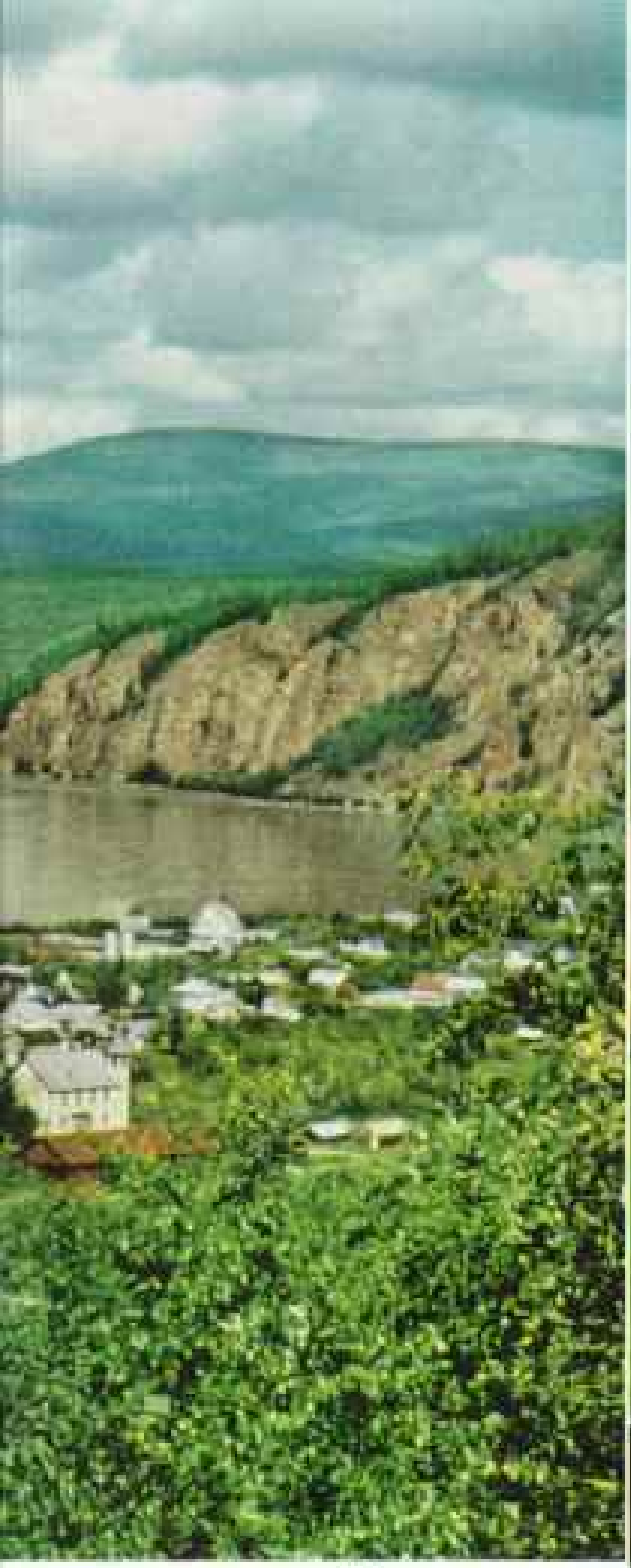
The small craft held an astonishing amount of equipment: tent, sleeping bags, Primus stove, kerosene, pots and pans, clothing, and food for the 535-mile expedition. To balance the boat and keep at hand the most frequently used gear required considerable packing skill.

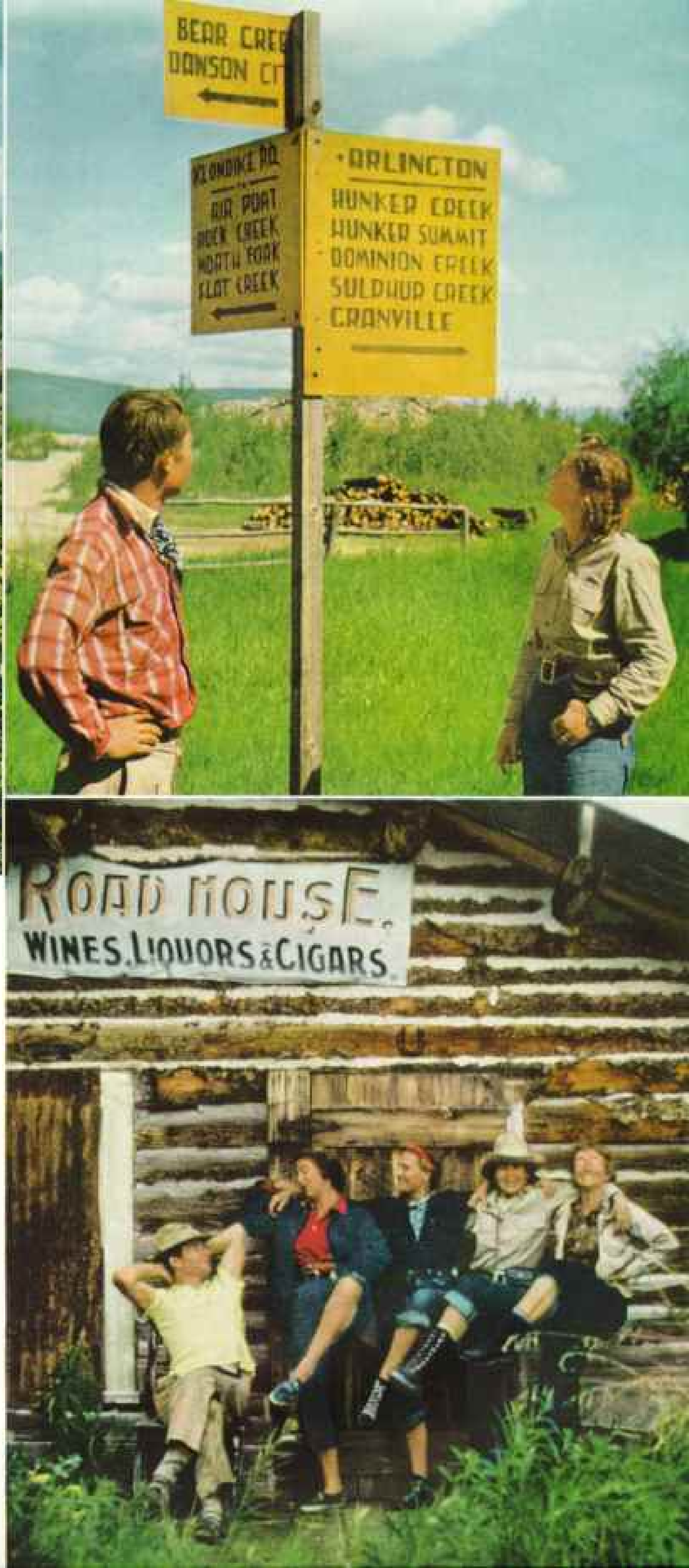
A skipper, bent double and nearly hidden in the cockpit (foreground), stows cargo beneath the deck.

Kodachromes by Glenn Bill Wood (above) and Mariel Thurber









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↑ Born of a Bonanza, Dawson Lives Quietly Beside a Deserted River

In the summer of '98, some 30,000 men surged through the muddy streets of Dawson, jump-off point for the gold creeks.

The town remains a supply base for Klondike gold fields, but power machinery has replaced men. Population now totals fewer than 800.

Upper right: These signs near Dawson point to onetime gold camps—and today's airport.

← Roses and a delphinium plant, gift of homesteaders at Kirkman Creek, decorate the bow.

→ In the ghost town of Forty Mile, Mr. Wood enjoys an echo of gold-rush days as his companions dance the cancan. A calendar gave mute evidence that one person had lived in Forty Mile as late as 1947.

Muriel Thurber (above), Glenn Hill Wood (left), and Florence Robinson

Muriel Thurber and (below) Florence Robinson

Any Hat Is Better than None Under the Hot Northern Sun

The adventurers brought coats but saw little rain; carried netting but met few mosquitoes; packed sweaters and gloves but sweltered in June heat. By contrast, most of the party needed sun hats but failed to bring them. Florence Robinson, a strawberry blond, escaped severe sunburn by traveling like a woman of mystery, swathed in mosquito netting. Gloves shield her hands. Florence Rucker wears a more conventional sun helmet.

↓ Muriel Thurber learned to balance a pan on her head; Celia Hunter relied on a battered rain hat. Lashed together, the flotilla prepares for a lunch afloat.

A Scene from the Past: Cable Pulls *Casca* and Barge Through Five Finger Rapids

Driving upstream, the stern-wheeler faces the swift current that was a boon to the foldboaters (page 259). *Casca* helps herself up the rapids by winching in a cable anchored to shore and stretched along the port side of the barge. On downstream passage the boat raced between the rock walls in a breath-taking two minutes, a run so risky that it was not attempted when the wind was blowing. "If a pilot missed the channel the first time, he didn't get another chance," mused one captain in the now-retired fleet.

ferent pairs of men we encountered earlier along the river. The first pair hailed us ashore at Britannia Creek.

"Have you seen the *Whitehorse?*" they yelled. "We want to get out of this hole."

Dams May Give Yukon a New Shape

We thought at first they must have been isolated there all winter. They turned out to be engineers surveying the river for a large company interested in damming the Yukon to create a head of water for an aluminum-processing plant. They had been on the river only two days and were frantic to get back to their car at Minto, to the speed of highway travel.

Several hours later we beached to talk to yet another pair of men, also awaiting the return voyage of the *Whitehorse*. They were prospectors and had been in the country all winter. They had waited for many a river boat in their lives, through countless freeze-ups and breakups. And they had plenty of time to wait for more. Besides, the sun was warm, the country was beautiful, and what would they do with any time saved, anyway?

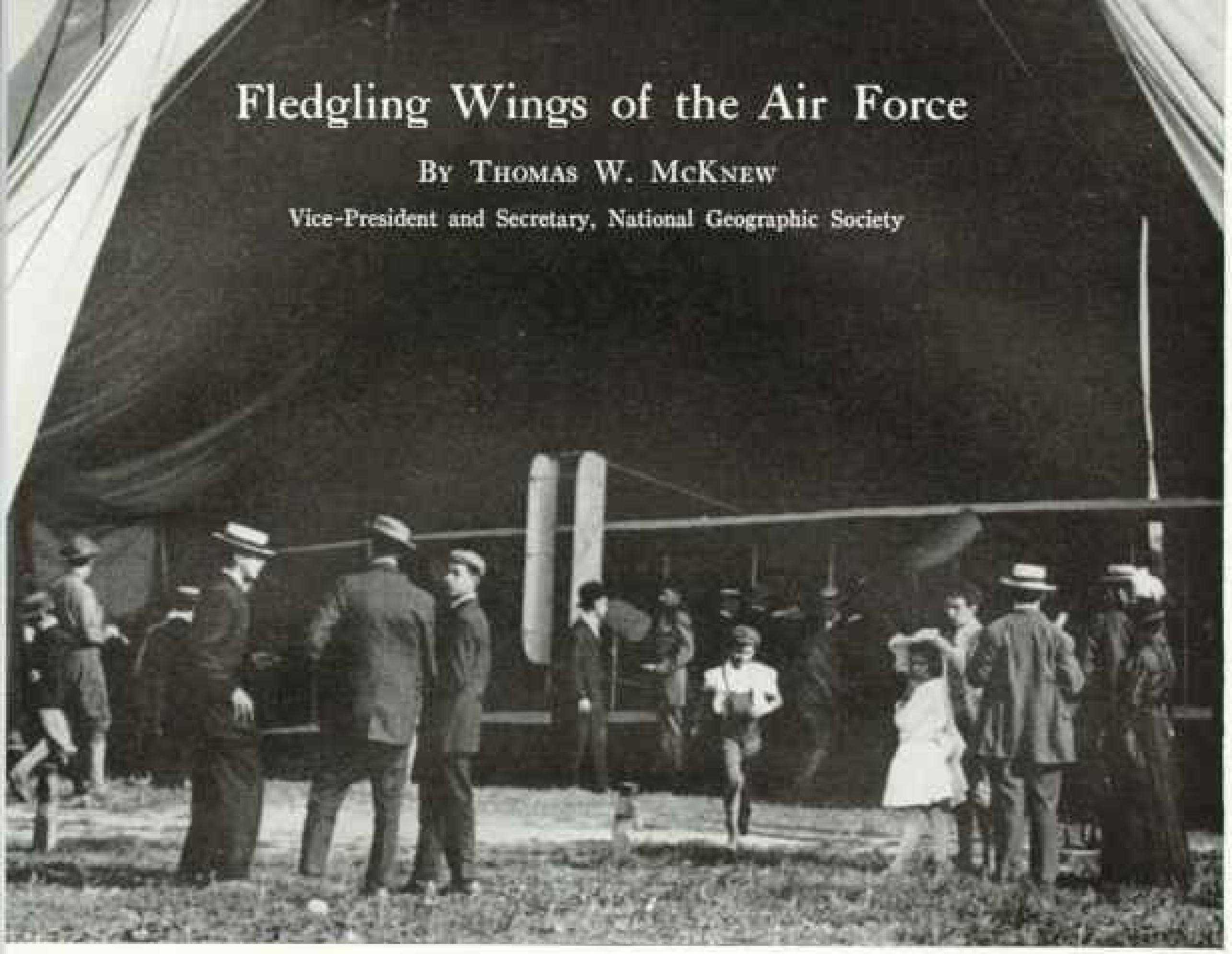
As we flew in a small plane, loaded with duffel and dismantled boats, from Eagle back to Fairbanks, we considered, somewhat sadly, the price of the modern tempo. Should we return again to the Yukon, we might find still more of its towns abandoned, replaced by new settlements along the roadways.

If proposed dams are built, even the water will change. New lakes will crop up and natural ones disappear. The great river may even shrink in places to a mere trickle. We were glad we had seen the Yukon as it was when men patterned their lives around it.

Fledgling Wings of the Air Force

By Thomas W. McKnew

Vice-President and Secretary, National Geographic Society



ENDLESSLY repeated, the phrase swept the Nation's Capital in 1909 until it seemed on the tip of every tongue: "I would rather be Wright than President!" Doubtless no youngster adopted that saying with more enthusiasm than I, a hero-worshiping lad of 13, for I had seen Wilbur and Orville Wright demonstrate their miracle, not once but many times.

A later generation often forgets that in those bygone days there was something akin to magic in the very words "flying machine." Frequently during the summers of 1908 and 1909, those irresistible words lured me from my home in Washington, D. C., to the parade ground at Fort Myer, Virginia, where younger brother Orville Wright astounded thousands by piloting the first military airplane in a series of performance trials.

Crowds See History in the Making

The years have stealthily erased many memories of those historic flights, but vivid mental pictures remain: an awesome, roaring machine tethered on the shadowed parade ground . . . the machine's sudden, plunging release . . . its swift, effortless circles round and round the small field . . . wings sweeping directly over my head . . . shouting, applauding adults.

A year earlier, on August 1, 1907, a three-man division had been established in the Office of the Chief Signal Officer, United States Army, to administer the budding

affairs of military aviation. Today, half a century later, the Nation focuses on that event in celebrating the Golden Anniversary of the United States Air Force.

It was, indeed, a birth, but not until the Fort Myer trials did the fledgling attempt heavier-than-air flight. From that grassy parade ground, where the Army grew a fragile set of wings, the military establishment embarked upon a journey that has brought it to the very threshold of space.

A pictorial tribute following this article tells the story of those first 50 years.

Balloons and dirigibles, not airplanes, first aroused my interest in Fort Myer. In 1907, from a Washington hilltop, I watched manned balloons float lazily above the Virginia countryside. The next summer a strange cigar-shaped craft appeared in the sky. It proved irresistible, and I pedaled my bicycle to the fort for a closer look.

There, on numerous occasions, I saw Capt. Thomas Baldwin and Glenn Curtiss fly the Army's first dirigible. It was Baldwin's creation: a fabric gasbag with a wooden skeleton suspended beneath. The flights were gratifyingly hair raising. Baldwin stood at one end of the skeleton, precariously balanced, and operated the rear controls; Curtiss perched in front, tending the forward elevator and a small engine.

Orville Wright Dispels a Cloud

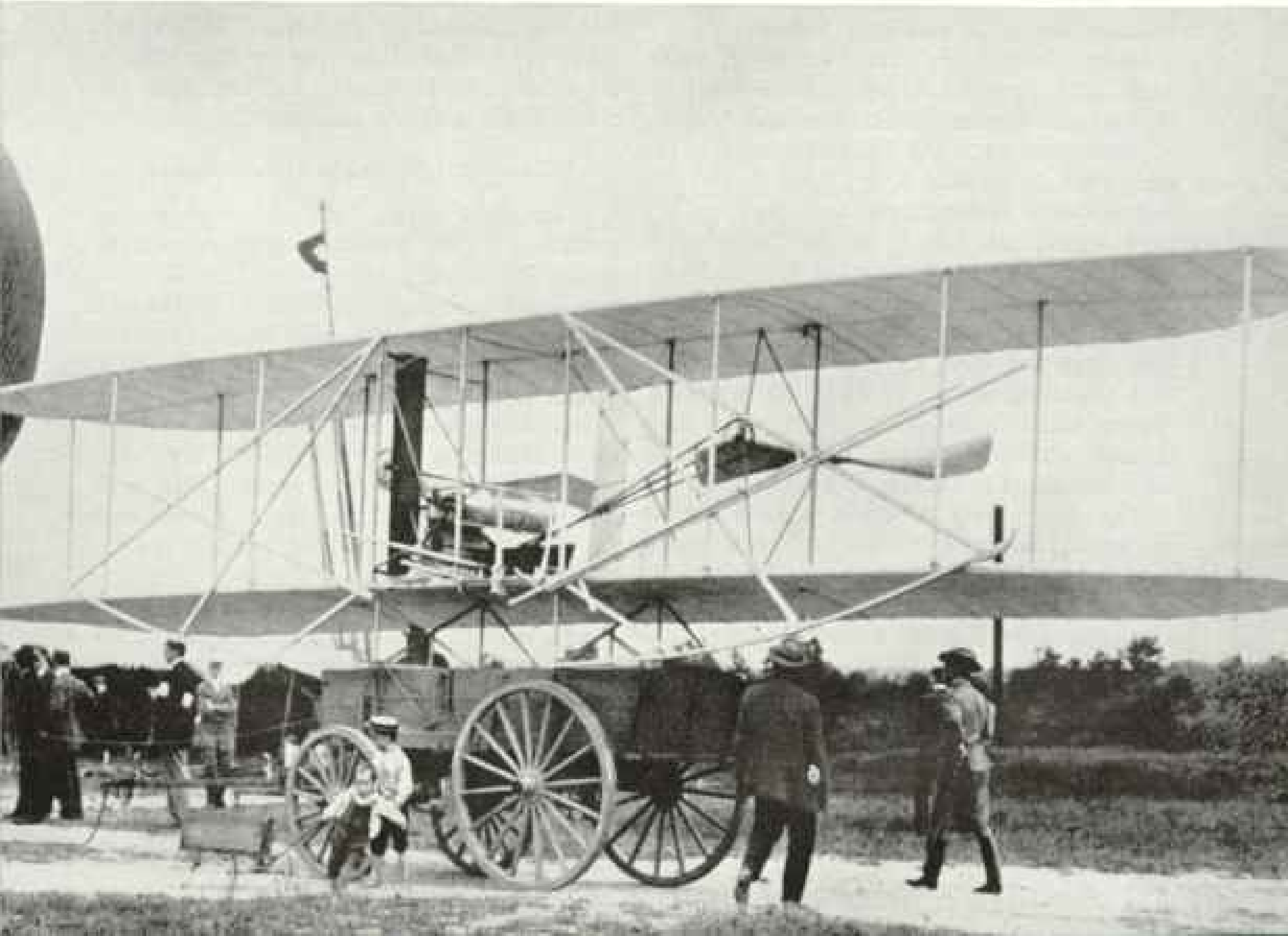
The Army accepted this bizarre airship and in September, 1908, sent it to an exhibition in Missouri. Meanwhile, it had been succeeded in the public eye by an even more curious craft of wood, cloth, and wire called an aeroplane. Wilbur and Orville Wright were the inventors, but only Orville came to Fort Myer that year. His brother was in France, winning the adulation of all Europe

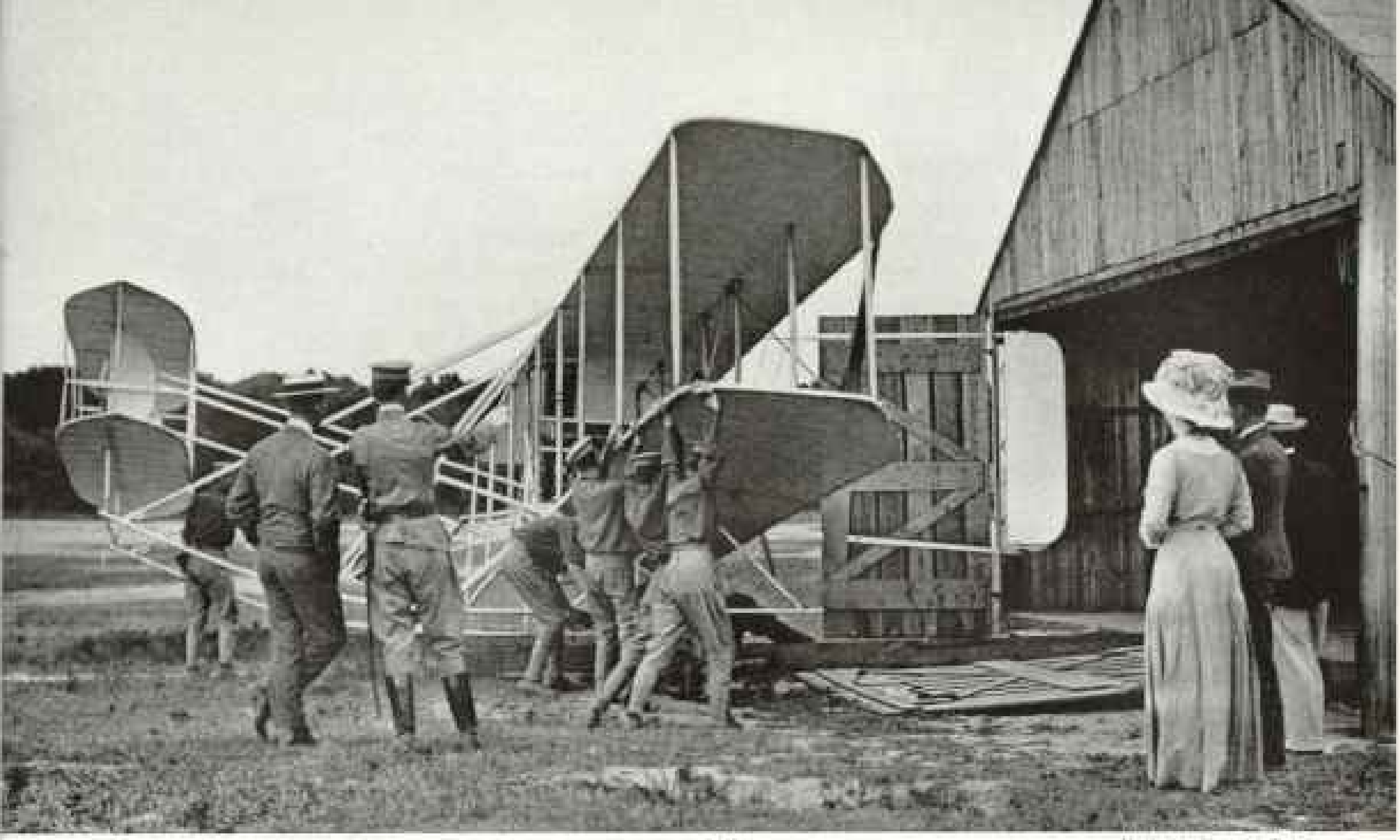
1908: The Wright Flying Machine Draws Admirers and Skeptics to Fort Myer, Virginia

Few Americans in 1903 grasped the enormous significance of the Wright brothers' epochal 12-second flight near Kitty Hawk, North Carolina. For three years the United States Army refused offers by the Wrights to demonstrate their invention. Finally, in 1908, the brothers were invited to present their type A *Flyer* for tests at Fort Myer. A canvas balloon tent (opposite page) served as the first shelter.

Many experts considered the Army's requirements impossible. The Wright machine had to be demountable for hauling in an ordinary supply wagon, carry two men, stay aloft for an hour, and fly 40 miles an hour. Here the *Flyer*, its skids folded back against the wings, meets the first requirement. Orville Wright, the test pilot, rides in the tow car. He wears a straw hat.

U. S. Air Force (MATS)





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U. S. Air Force, official

July 30, 1909: Soldiers Ready the Wheelless *Flyer* for Its Final Test

The 1908 trials ended in tragedy when the Wright airplane crashed, injuring Orville and killing his passenger, Lt. Thomas Selfridge. The brothers returned the next year with a new machine that proved better than Army requirements. Katharine Wright, the inventors' sister, watches from the rear of the *Flyer* as men slide a dolly beneath the skids. Catapulted from a launching rail, the plane flew to Alexandria and back.

with daring flights in a similar air machine.

Orville soon had two shadows—his own plus the person of a small, inquisitive boy. I followed him with cocklebur tenacity.

History credits the first Fort Myer trials with putting an end to American disbelief in the Wright brothers. Skeptics had scoffed at them ever since the incredible reports of their 1903 flights near Kitty Hawk.* Orville demonstrated convincingly that they really *were* flyers, not liars. He flew repeatedly and with great success, until the ill-fated day of September 17, 1908.

Some boyish pursuit following school hours, long since forgotten, kept me from the field that afternoon, but I still recall my heartsick dismay when I heard that the plane had crashed, seriously injuring Orville and killing his passenger, Lt. Thomas E. Selfridge.

The day after the crash, caused by a mechanical failure, I morosely returned to the field for some word of my hero. The wreckage had been cleared, but I grubbed about the crash site until I found a small piece of the wooden frame, then bore it off as a souvenir.

In 1909 Orville returned to Fort Myer with brother Wilbur to resume the trials. Here was a nice problem: how to shadow both. I must have been underfoot everywhere, but the Wrights were unfailingly good-humored. In those days there were no restrictions to keep a small boy from a military reservation, and I had almost complete liberty to make a nuisance of myself. The Wrights could not be free of me even on their trolley-car rides from Washington to Fort Myer, for often I was a fellow passenger.

Wilbur Wright Takes Direct Action

Whenever I could, I engaged them in conversation. Their strikingly different personalities left a deep impression. Orville was quiet-spoken, modest, reserved in thought and action. Wilbur, on the other hand, was more decisive and direct; he instinctively took charge of any situation.

One well-remembered conversation between them illustrates this difference. We were standing in perhaps the world's first, and hottest, military airplane hangar, a wood and tar-paper shed at one end of the parade ground (above).

"If we cut a door in this side of the shed," Orville ventured, "it will give us better access and ventilation. Let's see the colonel and ask permission."

Wilbur replied instantly, "No! We'll put

*See "Fifty Years of Flight" (31 historic photographs with full legends), National Geographic Magazine, December, 1953.

in the door first and tell him about it later. Then he won't have a chance to refuse."

The provisional contract these brothers had signed with the Army seemed rash and difficult of fulfillment in that day. Essentially, it required them to demonstrate an airplane that would average 40 miles per hour and carry, for at least one hour, a passenger in addition to the pilot.

Orville's earlier test flights in 1908 had established the machine's potential. He had flown solo for more than an hour, and for lesser periods he had given rides to Maj. George O. Squier and Lt. Frank P. Lahm.

But his very first warm-up hop, on September 3, 1908, swept away all doubts among casual onlookers in the estimated crowd of only 500. This flight lasted a mere one minute and 11 seconds, ending in a minor crack-up; yet the crowd went wild. Here, it seemed, was a miracle, a physical event transcending the laws of nature as they were then understood.

Said the *Washington Post* in a front-page story: "When the machine finally soared into the air, everyone present became afflicted with a mild form of emotional insanity that externalized itself in cheers, hand clapping, and altogether undignified prancing . . . It was a magical moment, and the spell of it fired the spectators with a common impulse. That impulse was to shout, and shout everyone did, while the great machine circled with an evenness and a quick response that was amazing."

I seem to recall that I "externalized" my own "mild form of emotional insanity" in a series of loud shrieks accompanied by frenzied hopping about.

Though Wilbur was on hand in 1909 in the role of senior planner, Orville made all the test flights. I don't think I missed a single one that year. Usually they took place in late afternoon, when tricky air currents had subsided.

The machine, like all the early Wright models, was equipped with wooden landing skids. At take-off time soldiers trundled the plane on detachable wheels to the launching site, a short length of monorail, and lifted it onto the track.

Early Catapult Launches Plane

Directly behind the monorail stood a wooden tower holding a heavy weight. After revving up the engine, Orville jerked a rope to release this weight, and the impetus of its fall, when harnessed to a system of ropes and pulleys, exerted a strong pull on the plane. It would hurtle down the track, drag its skids for a few moments on the grass, then nose into the air.

This launching by catapult is the same principle as that used today on Navy carriers.

Usually the spectators were too entranced to worry about a crash in their midst, even though Orville never flew higher than 310 feet and generally much lower. He would circle the parade ground endlessly, handling his craft with masterful touch in the relatively confined space.

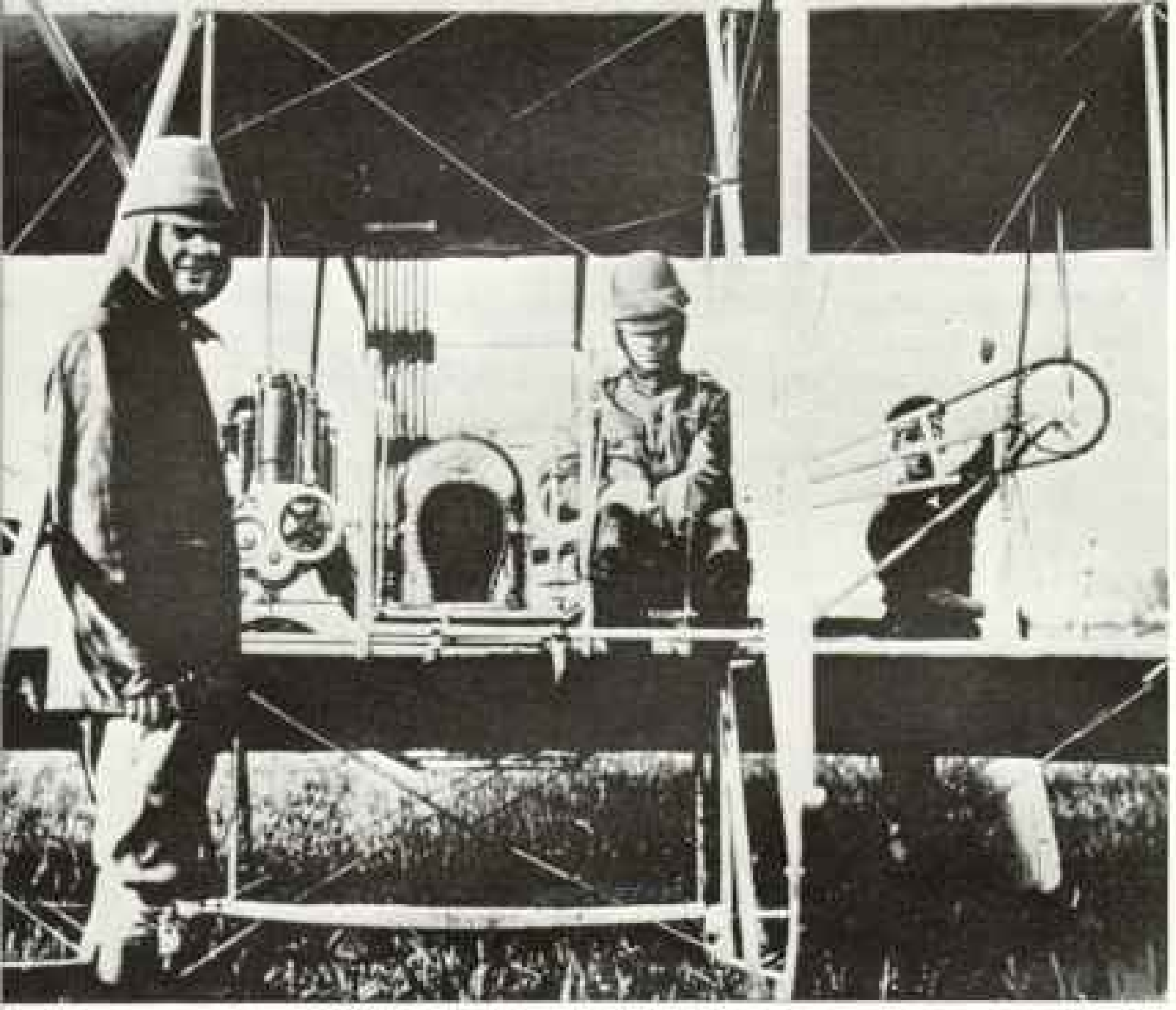
Wilbur, who often wore a derby, stood on

Flightmates Arnold and McKnew Chat Aboard Plane

General of the Air Force Henry H. Arnold more than anyone else epitomized the growth of American air power. A pioneer flyer, much decorated, he rose to command of the U. S. Army Air Forces in World War II.

The author and General Arnold, close friends and fellow Trustees of the National Geographic Society, here share a flight in the General's plane to Rapid City, South Dakota, where Arnold helped dedicate a plaque commemorating the U. S. Army Air Corps–National Geographic Society stratosphere expedition of 1935 (page 281).

U. S. Air Force, Official



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✝ **Pioneer Aviators Test Their Chain-driven Craft**

Flight training was brief in 1911 when 2d Lts. Henry H. Arnold and Thomas DeWitt Milling learned to fly at the Wright school near Dayton, Ohio. Milling took his first lesson on a Monday and soloed the following Friday.

Arnold here stands beside Milling in the improved Wright B at the Army flying school's winter headquarters at Augusta, Georgia. The type B, more stable than the type A, had wheels and a rear stabilizer. Stalling point on the early machines was only a few miles an hour below top speed, giving pilots little warning of approaching danger.

✝ Lt. Benjamin D. Foulois in 1909 commanded the Army's first tactical air force. A dirigible pilot barely acquainted with planes, he taught himself to fly largely through correspondence with the Wrights. At Fort Sam Houston, Texas, Foulois (second from right) stands with his maintenance crew beside one of the Army's two airplanes. He later became Chief of the Army Air Corps (1931-35).

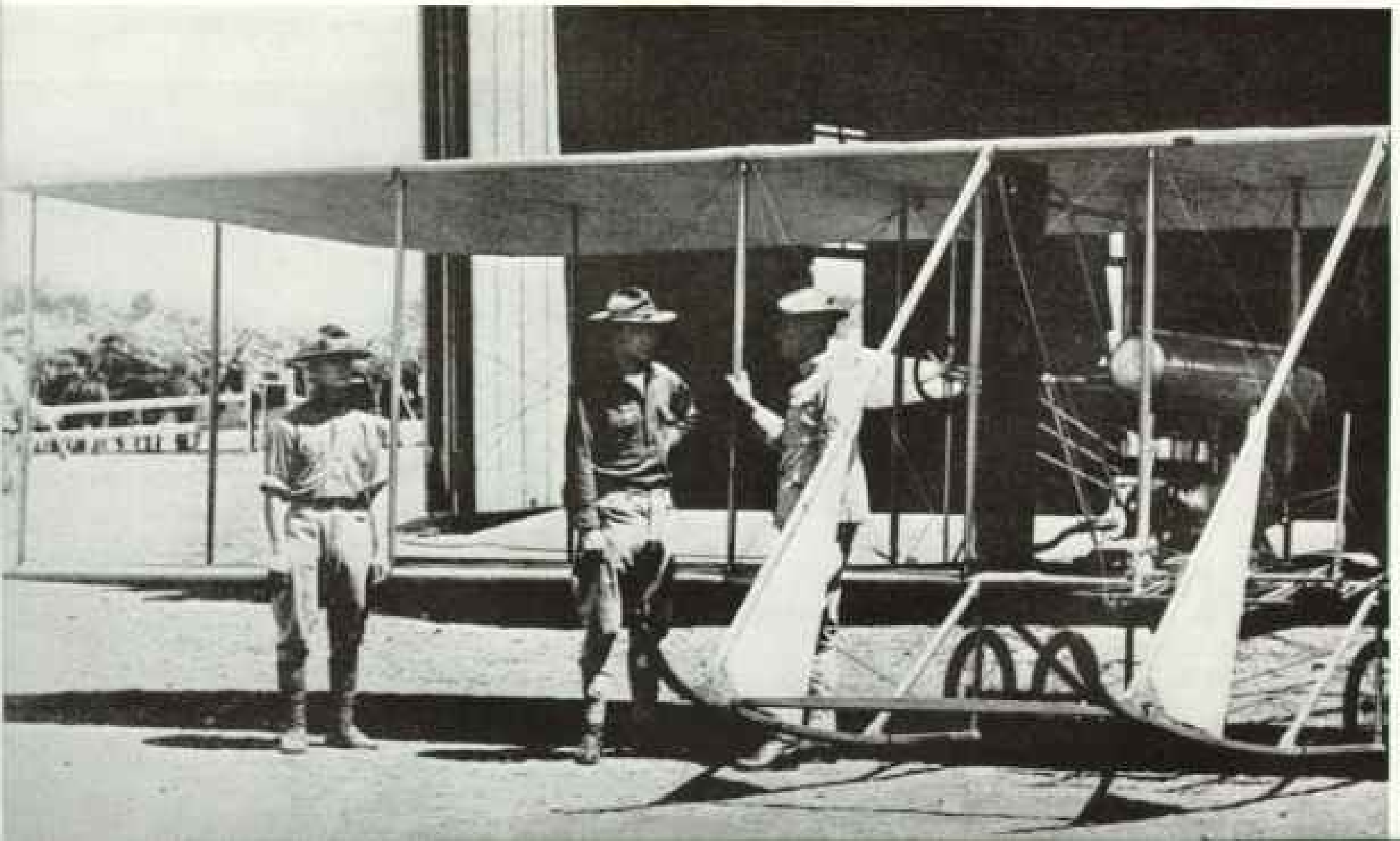
U. S. Air Force, Official

the sidelines with a watch, timing the flights and making rapid speed calculations. Usually Charles E. Taylor, the Wright mechanic, was at his side (page 273).

On July 27, 1909, with Lt. Frank P. Lahm as passenger, Orville flew for one hour 12 minutes and 37 seconds. Three days later he carried Lt. Benjamin D. Foulois on a cross-country speed trial, averaging 42.58 miles per hour.

Conditions of the contract had been brilliantly fulfilled, and a special aeronautical board accepted the plane. The Army paid $30,000 for it, including a $5,000 bonus for extra speed above the required minimum.

Never again was I to see Wilbur Wright. He died in 1912 of typhoid fever. But a quarter of a century after the trials I again met Or-



ville. We were introduced in 1934 at his Dayton, Ohio, home by a mutual friend, Capt. Albert W. Stevens, who was to ascend the next year to a record 72,395 feet in the balloon *Explorer II* (page 281).* Orville's reserve melted in a broad smile when I identified myself as his shadow of Fort Myer days.

Pioneer Pilots Shape the Future

Exposure to the Wrights had given me an incurable case of air-mindedness. When the flight trials ended, I became an insatiable reader of aviation news. Headlines soon led me to new heroes, the pioneer pilots at the first Army airfield at College Park, Maryland.

These men, in 1911-12, wrote in the skies one of aviation's brilliant early chapters. They tested the first successful bombsight, fired a machine gun from an airplane for the first time, set new U. S. altitude and cross-country records, and experimented with aerial photography and wireless. Such projects grew from the flyers' own enthusiasm; their field was designated a training base only.

On summer mornings I would ride a train the seven miles to College Park, marvel at the day's feats of daring, then sit by while the pilots engaged in the new pastime of "hangar flying," or swapping shoptalk. Many of those youthful officers assumed the stature of gods in my teen-age eyes: Tommy Milling, Charles Chandler, Lewis Rockwell, Roy Kirtland, Leighton Hazelhurst, and, above all, Henry (Hap) Arnold (page 269).

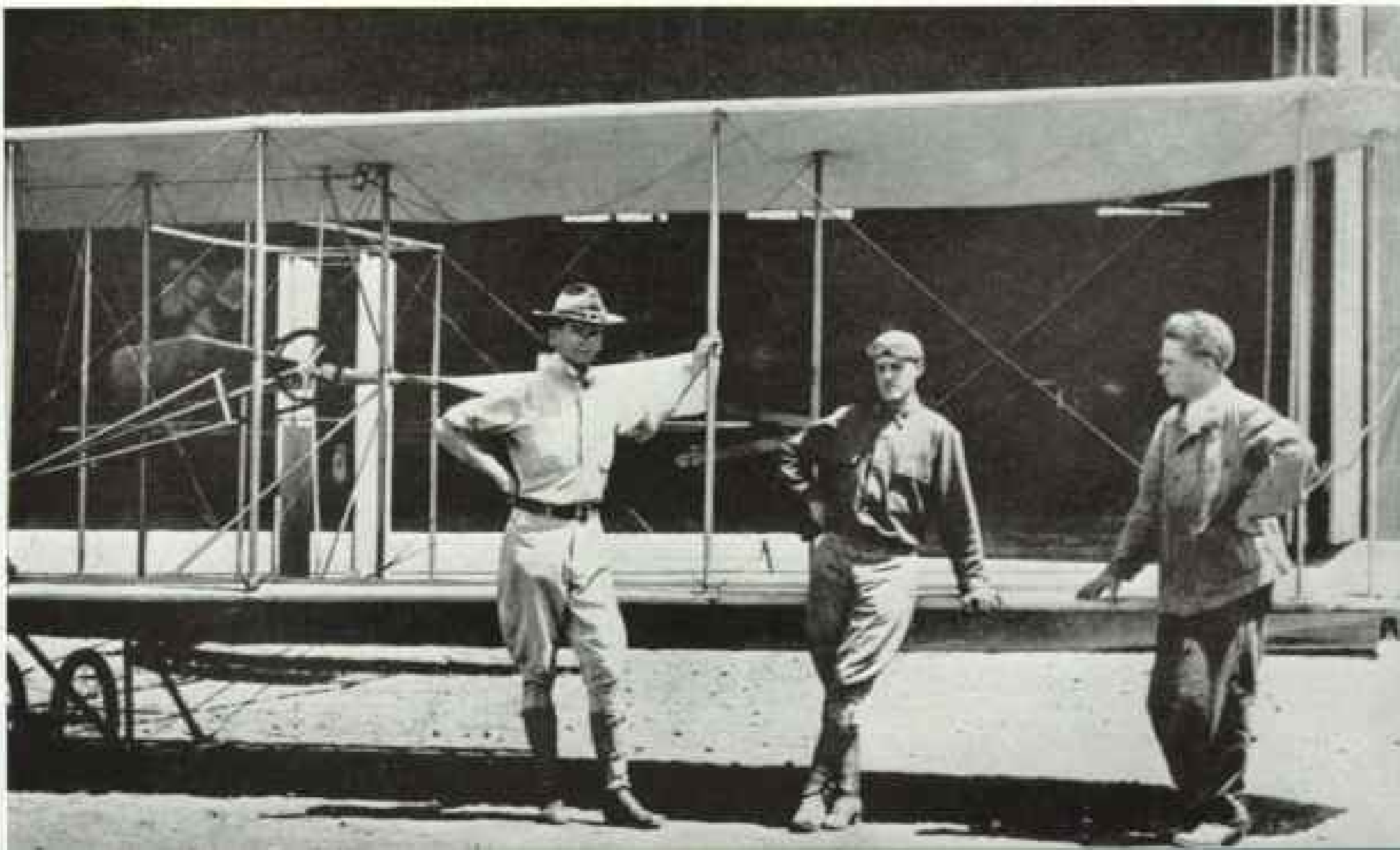
Arnold, the most dynamic personality I have ever known, became Commanding General of the Army Air Forces in World War II. Later, after holding five-star General of the Army rank, he was named General of the Air Force, the only man who has ever held that title. He served with devotion as a Trustee of the National Geographic Society from 1938 until his death in 1950.

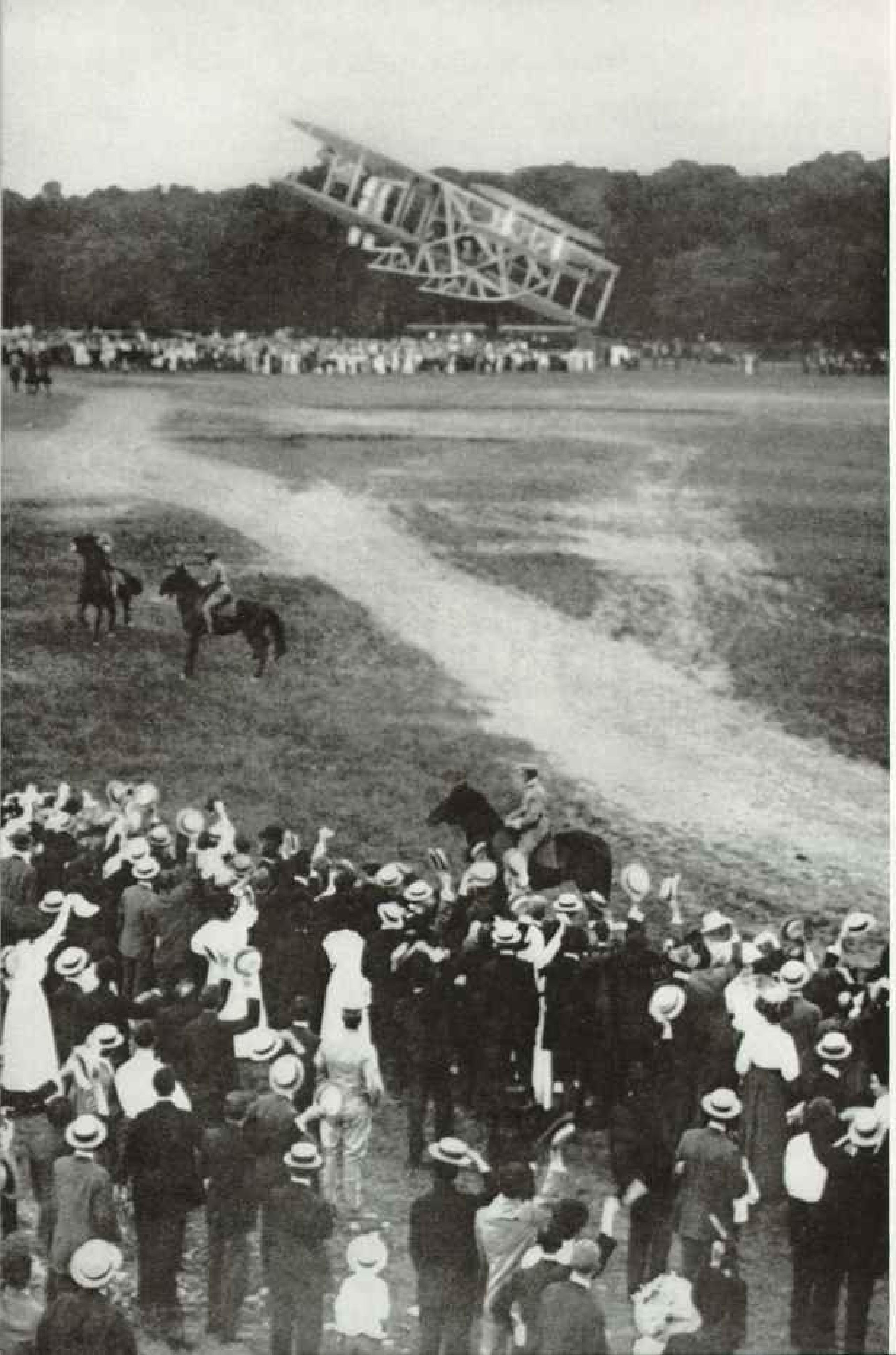
It was during those years that I had the privilege of the General's warm friendship. I often flew with him on trips around the United States, and he recalled the derring-do of the College Park days with nostalgia. His experiences there, he said, marked a turning point in his life, for they gave dedication and purpose to his military career.

In recent years I have flown with the Air Force to Greenland and the North Pole, to Alaska, Africa, South America, and other places that seemed forbiddingly distant before the Air Age.† Frequently, as the giant engines made inches of the miles, I found myself musing over the contrast between past and present. In my own lifetime I had seen military aviation's crude but brave beginning and its dramatic coming-of-age.

* See, in the National Geographic Magazine: "Man's Farthest Aloft," January, 1936, and "Exploring the Stratosphere," October, 1934, both by Capt. Albert W. Stevens.

† See "We Followed Peary to the Pole," by Gilbert Grosvenor and Thomas W. McKnew, National Geographic Magazine, October, 1953.





History Written in the Skies

Pictorial Highlights of the First 50 Years of the United States Air Force

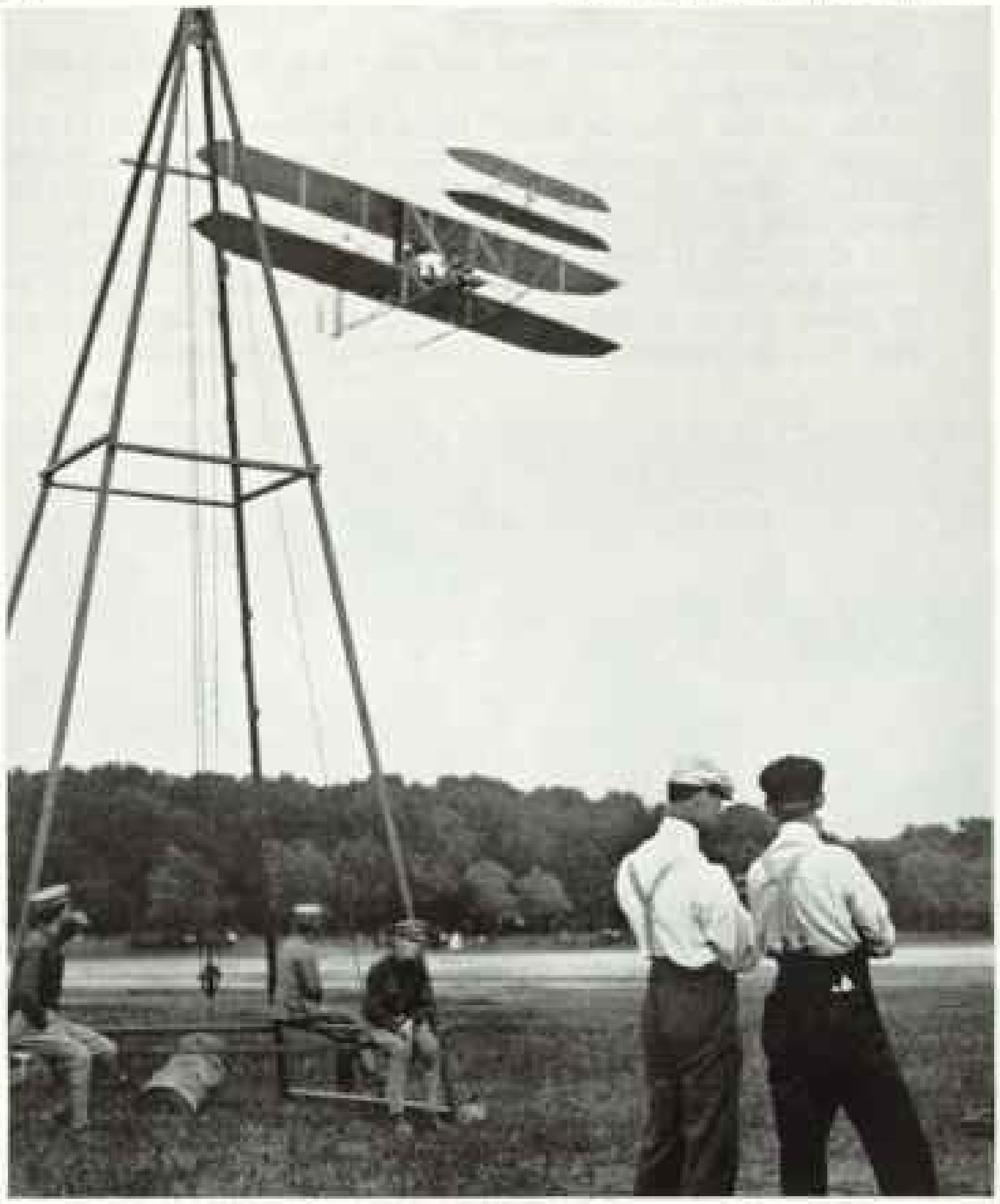
Just 50 years ago, on August 1, 1907, the Chief Signal Officer of the United States Army issued a brief three-paragraph order. Labeled "Office Memorandum," it began: "An Aeronautical Division of this office is hereby established to take effect this date." In an Army long adjusted to the pace of the cavalry horse, the order went all but unnoticed. Veteran soldiers, still swapping yarns of Indian campaigns and the Spanish-American War, found little of interest in an obscure branch with only three men.

Today that small stepchild is the United States Air Force, an independent service with hundreds of thousands of men, planes, and missiles dispersed throughout the Free World. Photographs on these and following pages record highlights in the growth of the Air Force. Many of the historic photographs were compiled from back issues of the NATIONAL GEOGRAPHIC MAGAZINE, which has chronicled the progress of aviation in more than 140 articles.

The world's first military airplane (opposite) was the wood-and-fabric marvel built by the Wright brothers and flown successfully in 1909 at Fort Myer. Here the type A *Flyer* skims over cheering crowds during the July 30 speed trial. Orville Wright flew 10 miles to Alexandria, Virginia, and return.

On another occasion Wilbur Wright (left) stands beside his mechanic, Charles Taylor, as Orville sweeps past the catapult.

Culver Service (left) and Carl H. Claudy, Jr.



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National Archives

Ace of Aces Eddie Rickenbacker Looks Across His Spad

No one symbolized America's aerial role in World War I as did Capt. Edward V. Rickenbacker. Commander of the Hat-in-the-Ring 94th Aero Pursuit Squadron, he destroyed 26 enemy airplanes and balloons, highest official score for any American pilot.

Many of his close friends were shot down, but Rickenbacker seemed to bear a charmed life.

After the war "Captain Eddie" began a brilliant career in commercial aviation. In 1935 he became vice president and general manager of Eastern Air Lines. Three years later he was president. Now chairman of the board, he has made Eastern one of the Nation's most successful airlines.

In World War II Rickenbacker's courage and luck carried him through a harrowing ordeal at sea. While touring Pacific areas on a special Army Air Forces mission, he and seven comrades were forced to ditch their plane. They took to life rafts and drifted three weeks before rescue.

French Bomber Spews→ Smoke as It Falls a German Prey

Early wartime flyers waved casual chivalric greetings as they passed on the way to observe each other's lines. Later they began to carry pistols and rifles, engaging in mid-air duels.

French pilots turned the engagements into murderous affairs by fixing steel plates to propellers so they could fire machine guns forward. Some bullets passed between the blades; others ricocheted dangerously, often smashing props. Germans countered with guns synchronized to propeller revolutions.

In this photograph of World War I combat, the victorious craft (upper right) is piloted by Oswald Boelcke, a German ace.

⸸ American volunteers, eager to get into the war, comprised the Escadrille Américaine, with French officers. When Germany protested violation of U. S. neutrality, the name was changed to Lafayette Escadrille.

Escadrille ace Raoul Lufbery (in cockpit) was born in France but became an American citizen. When his adopted land entered the conflict, he joined the Hat-in-the-Ring Squadron as an instructor, later becoming its commanding officer. Rickenbacker trained under him. Lufbery had 17 kills to his credit when he was shot down.

Here a lion cub mascot perches atop the ace's Nieuport. Plane in back bears a machine gun atop the wing. Pilots disliked the gun's position; reloading was difficult.

Press Illustrating Service, Inc., and (right) Library of Congress

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General Billy Mitchell's Bombers Shatter the Battleship *Alabama*

Air Service officers emerged from World War I convinced that future conflicts would be won in the sky. Most outspoken was William Mitchell.

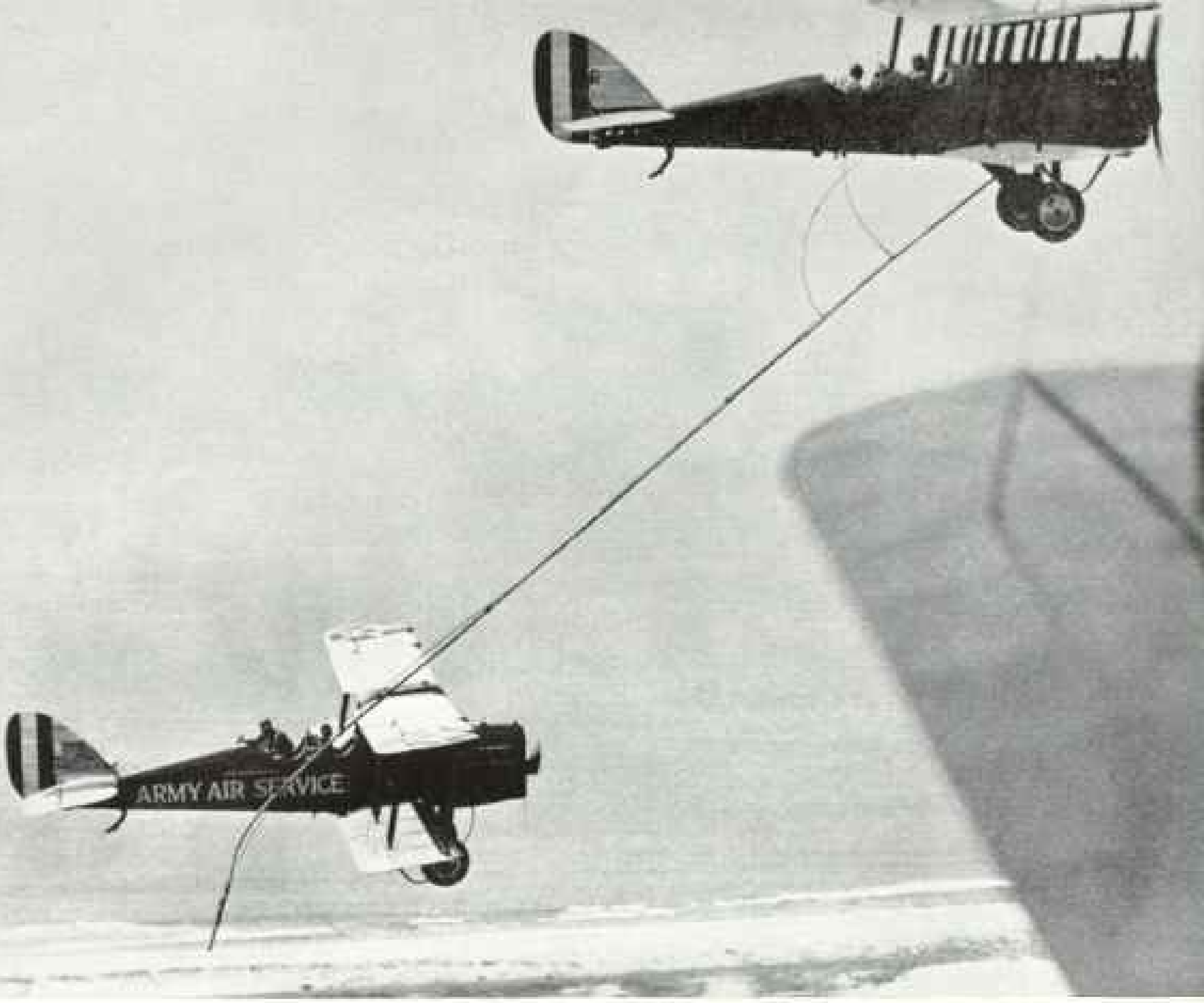
Mitchell argued that air power would shatter traditional sea defenses based upon the battleship. In the National Geographic Magazine (March, 1921), he summarized his theories and forecast future aviation developments. Tweaking the battleship's reputation, he wrote: "Compared to an airplane, these great vessels are very much like the knights in the Middle Ages, encased in their heavy armor, in which they could scarcely move . . ."

At the Navy's invitation, Mitchell took part in bomb strikes testing his views. Taking off from Langley Field, Virginia, in 1921, his planes dropped bombs on condemned warships. Direct hits sank some vessels. Near misses on the *Ostfriesland*, already wounded by the Navy's experimental attacks, produced a fatal "water hammer" effect.

Later he criticized War and Navy Departments for incompetence and advocated an independent Air Force. Continued attacks led to his court-martial in 1925. He died in 1936.

← U.S.S. *Alabama* shudders under the impact of a 300-pound bomb dropped from a Martin B-2. She sank later.

U. S. Air Force, Official



U. S. Air Force, Official

↑ Army Sets an Endurance Record with Its "Pipeline in the Sky"

Endlessly circling Rockwell Field, California, Lt. Lowell H. Smith and Lt. J. P. Richter in 1923 gave the first demonstration of plane-to-plane mid-air refueling with a pipeline. Replenishing the tanks of their de Havilland 4-B2 from a sister plane at 90 miles an hour, the Army pilots risked flaming death had gasoline from the 40-foot hose spilled on red-hot exhaust pipes.

Fog forced a landing after 16 refuelings. But the flyers had spent a record 37 hours aloft and had flown 3,293 miles.

Martianlike Garb Envelops an Altitude Record Holder →

Lt. John A. Macready, pioneer Army test pilot, repeatedly pushed supercharged research planes to heights where man dies without extra oxygen. Taking off from Dayton, Ohio, in 1921, he climbed to 34,508 feet, smashed the world record, and braved —58° F. in an open cockpit. Later he reached 40,800 feet. Orville Wright, as official observer, certified the marks. Called holder of the "icicle crown," Macready described his research in the December, 1926, NATIONAL GEOGRAPHIC.

Here he wears his high-altitude suit.

U. S. Air Force, Official


ARMY AIR SERVICE
NON STOP
COAST TO COAST
AS.84233

← Another "First": Snub-nosed T-2 Spans the Continent Nonstop

Military aviation after World War I suffered from public apathy and meager appropriations. Air Service officers undertook breath-catching experiments to prove the airplane's versatility and win support.

In 1923 Lt. John A. Macready and Lt. Oakley G. Kelly coaxed their fuel-heavy Fokker monoplane aloft on the first nonstop transcontinental flight, 2,520 miles from Long Island to San Diego. The grueling trip, made at an average 94 miles an hour, took nearly 27 hours. Darkness made navigation difficult.

Macready wrote a gripping account of the flight for the National Geographic Magazine (July, 1924). With his article The Magazine published the first comprehensive series of aerial photographs of the United States, made by the Army Air Service.

→ Haggard but jubilant, Macready (left) and Kelly climb from their T-2 at Rockwell Field, California. "The impossible has happened!" exclaimed Maj. Henry H. Arnold, commander at Rockwell.

U. S. Air Force, Official (left), and Harry T. Risbon

↓ Army Planes Warm Up at Santa Monica, California, for the First World Flight

Five foreign nations tried and failed to circumnavigate the world by air in the early 1920's. The United States began planning such a flight in 1923. Air Service officers devoted a year to preparation. They won the cooperation of 15 governments and set up a chain of 40 landing fields and supply depots. The United States Navy promised a sea vigil at strategic points. Douglas Aircraft Company built four specially designed two-place biplanes equipped to carry both pontoons and wheels.

Skeptics suggested that the pilots "might just as well crook a toe in a trigger and get it over with," but the men took off April 6, 1924, from Seattle, Washington. One plane crashed in Alaska, and oil trouble forced another down in the North Atlantic. Two completed the circuit, landing September 28. In 15 days' actual flying time, they covered 26,345 miles. Congress awarded the Distinguished Service Medal to the flyers, all of whom survived the epochal voyage. Three of them, Frederick L. Martin, Erik H. Nelson, and Leigh Wade, later became generals. Here a World Cruiser leaves Clover Field, near the Douglas plant, en route to Seattle. Two others appear at far left and right.

Wide World

← Alaska-bound B-10's Pass the Washington Monument in 1934

In the early 1930's military aviation's capacity for long-range bombing flights was more theory than fact. Two events quickly changed that picture. Martin developed the fast twin-engine B-10 bomber, best of its day, and in 1934 Lt. Col. Henry H. Arnold took 10 of the new planes on a dramatic 7,560-mile round trip from Washington, D. C., to Alaska. Spanning some of North America's most rugged terrain, Arnold demonstrated the bomber's strategic potential. He and his men photographed 20,000 square miles and mapped Arctic airways to Russia.

Explorer II Bids Adieu to Earth →

High as man might fly in his air-breathing machines, the stratosphere—a rarefied layer of the earth's envelope some seven miles up—was largely beyond his reach in the 30's. To attain that unfathomed area, the National Geographic Society and the U. S. Army Air Corps jointly sponsored explorations of the stratosphere by balloon.

Explorer II in 1935 lifted its two-man crew and a ton of scientific instruments 72,395 feet after a take-off near Rapid City, South Dakota. The record stood 21 years. Priceless information was gathered on cosmic rays, radio reception, and the atmosphere's composition. A camera caught the first photograph of the earth's curvature.

Capts. Albert W. Stevens (right), commander, and Orvil A. Anderson, pilot, stand beside the gondola.

J. Baylor Roberts and Richard H. Stewart, National Geographic Photographers (left and below); Master Sergeant H. B. Gilbert and Captain H. K. Bailey (USAF)

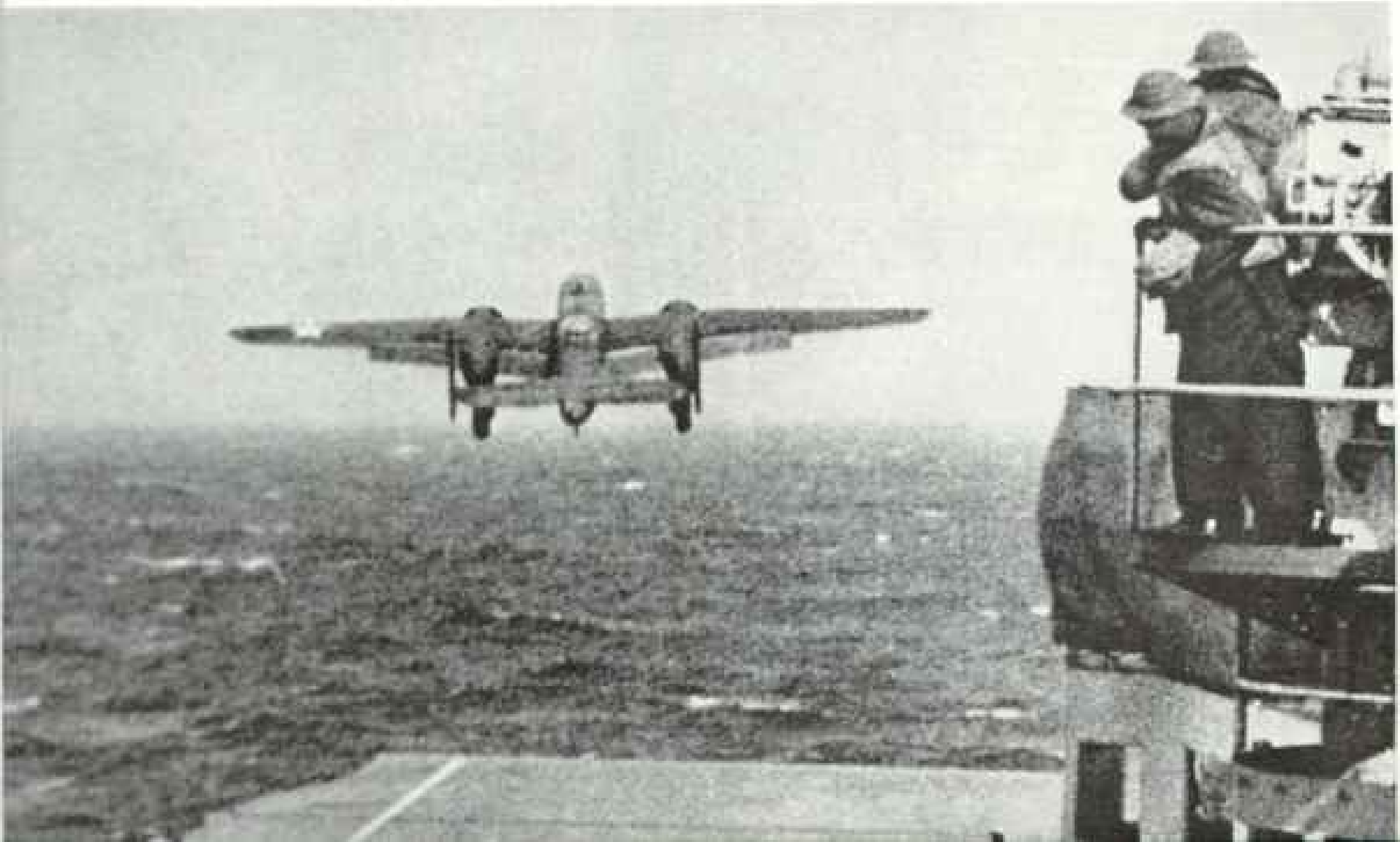
U. S. Army, Official

↑ A Day of Infamy at Pearl Harbor Plunges the Nation into War

Japan's surprise attack knocked out units of the Pacific Fleet and crippled Army air strength—a blow foreseen by Billy Mitchell. U. S. carriers, at sea on December 7, 1941, led American retaliation. Ships and hangars blaze beside Flying Fortresses at Hickam Field.

↓ U.S.S. *Hornet* Launches B-25's for the First Strike at Japan

Four months after Pearl Harbor, Lt. Col. James H. Doolittle led an attack on Tokyo with 16 Mitchell bombers. Pilots flew 668 miles to drop their bombs, then crash-landed or parachuted into China. Of the 80 flyers, 73 survived. Doolittle won the Medal of Honor.



My Girl Is Waved Aloft from Iwo Jima

Originally designed by North American for the British, the P-51 Mustang's speed and long range prompted the United States to order thousands. In Europe its feats as a bomber escort were legendary. Based on Iwo Jima, Mustangs flew cover for bomb raids on Japan.

Deadly Clusters of Bombs Rain from B-29's

Air planners gambled on the Boeing B-29 Superfortress, designed in 1940. Impressed by the plane's potential for long-range bombardment, they ordered it into production before a single model had been flight-tested. Their gamble paid off in the massive fire-bomb raids against Japan's tinderbox cities. B-29's, hauling 15,000-pound payloads, devastated targets 1,600 miles from bomber bases. Here B-29's disgorge 100-pound demolition bombs on a supply depot near Rangoon, Burma.

U. S. Air Force, Official.

↑ Escorts Weave Ghostly Vapor Trails High Above Flying Fortresses

The Boeing B-17 Flying Fortress, first flown in 1935, ushered in strategic bombing. First United States four-engine bomber, it bore gun turrets, carried an unheard-of payload, flew faster than 200 miles an hour, and had a combat range of more than 1,000 miles. So great was its role in the war in Europe that General of the Air Force Arnold declared: "The Boeing Flying Fortress . . . had only one predecessor of equal importance in air history. That was the first 'military aircraft' of the Wright brothers."

Continuously modified, the Fortress served 21 years after its first flight.

← Twin-tailed B-24's Brave Flak Bursting over Romania's Oil Center at Ploeşti

Flying from north Africa, 177 Convair Liberators set out on August 1, 1943, to destroy Nazi oil refineries in Romania. Low-flying wavvs struck through seemingly impenetrable defenses. Some pilots, their machines aflame, stayed in formation to drop bombs, then crashed into storage tanks. The raid knocked out nearly half of Ploeşti's production. Five Medals of Honor were awarded to flyers of this single mission.

U. S. Air Force, Official

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Troop Carriers Sow Provençal Skies with Thousands of Billowing Parachutes

Airborne invasion, planned but never tried in World War I, became standard in World War II. Operation Anvil-Dragoon in August, 1944, sent 1,000 planes and gliders over southern France prior to a seaborne assault.

287

U. S. Air Force, Official

Behind Enemy Lines, Men and Supplies Cascade over Southern France

Some 9,000 Allied paratroopers, flown from Italy, descended between Cannes and Toulon in one of the war's largest airdrops. They attacked enemy coastal defenses from the rear.

Atomic Mushroom Cloud over Nagasaki Heralds End of World War II

← On August 9, 1945, the B-29 *Bock's Car* dropped war's second atomic bomb on Nagasaki. The explosion and aftereffects killed an estimated 35,000. A similar bomb, dropped three days earlier on Hiroshima, took some 80,000 lives.

Appalling as was the damage, the psychological effects were even more devastating. Months of heavy fire-bomb raids by Superfortresses from the Marianas had gutted 66 Japanese cities, destroyed more than two million homes, and killed or wounded more than three-quarters of a million people. The atomic raids added only three percent to the devastated area.

Faced with continued bombing and certain invasion, Japan surrendered unconditionally August 14, 1945.

Here the debris-laden cloud boils to an altitude of 12 miles above Nagasaki. Men aboard the plane, many miles from the blast, reported it felt "as if the B-29 were being beaten by a telephone pole."

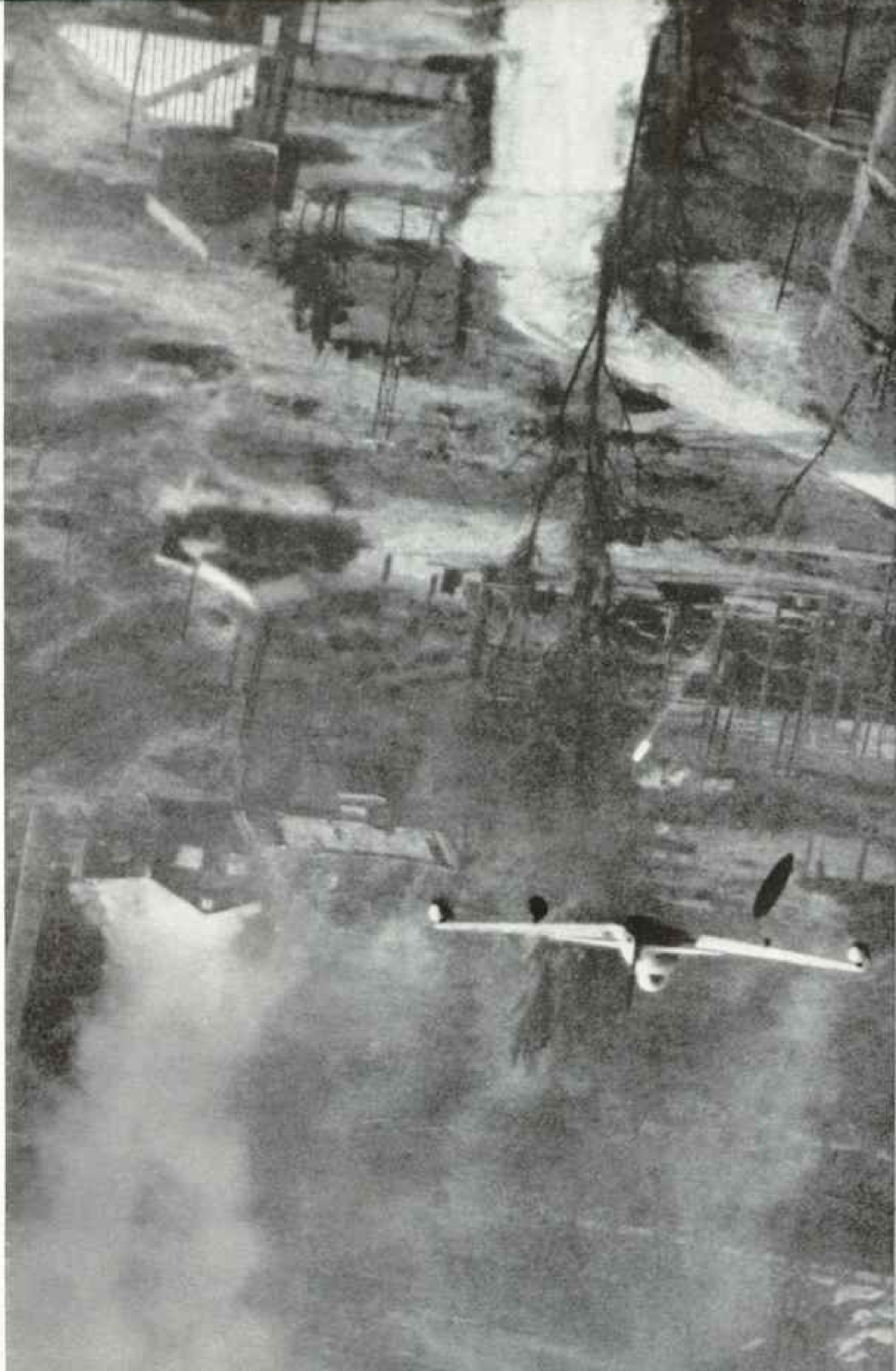
Stratojet Gushes Smoke;→ Rockets Boost Take-off

Jet-powered flight, a vision older than the man-carrying airplane, first became a reality in World War II when Germany flew a jet fighter against the Allies. Great Britain also developed an operational jet during the war, but the United States did not have one until the end of hostilities.

The Boeing B-47 Stratojet, under design in 1945, foreshadowed retirement of piston-driven craft from the bomber class. The new plane, a swept-wing, six-jet medium bomber, flew far faster than the B-29, carried a heavier load, and reduced crews from eleven to three men.

Stratojets are still the backbone of the Strategic Air Command's medium bomber strength.

U. S. Air Force, Official



U. S. Air Force, official

← **Shooting Star Scrapes the Trees to Deliver Fire Bombs in Korea**

So swift are advances of the jet age that planes may become obsolescent after relatively brief operational service. The Lockheed F-80 Shooting Star, America's first combat jet, proved too slow as a fighter in Korea. Pilots used it for ground support.

This remarkable photograph shows an F-80 sweeping at smokestack level to drop a tank of napalm, or jellied gasoline, on a supply dump at Suan. Glowing anti-aircraft shell (left) trails a thin line of smoke.

↑ **F-86 Sabrejets Prowl for Game High Above Korea's Mountains**

Beginning in 1950, the U. S. matched its North American jet against Russia's best fighter, the MIG-15, winning a 14-to-1 score in kills. These F-86's bear tail markings of the 51st Fighter Interceptor Wing.

↓ Dartlike Lockheed F-104A Starfighters, reputedly the world's fastest fighter planes, fly close formation with 22-foot wings mere yards apart.

Stabilizers perch high on tails for precise control at supersonic speeds.

B-36, a Hybrid Monster, Combines Propellers and Jets

First and largest intercontinental bomber, the Convair B-36 marked a transition between piston and jet-powered flight with its six pusher propellers and four pod-mounted turbojets. Its dimensions are enormous—wings stretch 230 feet, almost twice the distance of the Wright brothers' first flight.

For all its size and 10,000-mile range, the B-36 has been relegated to reconnaissance and research by faster all-jet bombers like the B-52 (below). One observer wrote that the B-36 "was designed in the maturity of one air age and flew in the infancy of another."

Stratofortress Takes on Fuel from a Tanker

Greater speed and decreasing range of heavy bombers make refueling essential on most round-trip intercontinental missions.

This eight-jet Boeing B-52 heavy bomber, capable of speeds rivaling that of many fighters, slows down to connect with the flying boom of a Boeing prototype jet tanker.

U. S. Air Force, Official; and Boeing Airplane Company

U. S. Air Force, Official

↑ The Pilotless Snark, a Guided Missile, Spouts Rocket Flame on Take-off

A jet engine drives the Northrop B-62, first intercontinental missile, some 5,000 miles at speeds greater than 600 miles an hour. Unlike the ballistic missile, which follows an unguided trajectory after its rocket motors cut off, the Snark is controlled during the entire flight. Rocket boosters lift this B-62 off the ground.

↓ In Air Force Parlance, the B-58 Is "a Red-hot Beast"

Pilots often refer to a new plane as a "beast." If they like its looks, it is "sexy." Convair's B-58 Hustler earned special respect as the Free World's first supersonic bomber. Now in production, the B-58 may replace the B-47 as our best medium bomber. This Hustler undergoes tests above Fort Worth, Texas.

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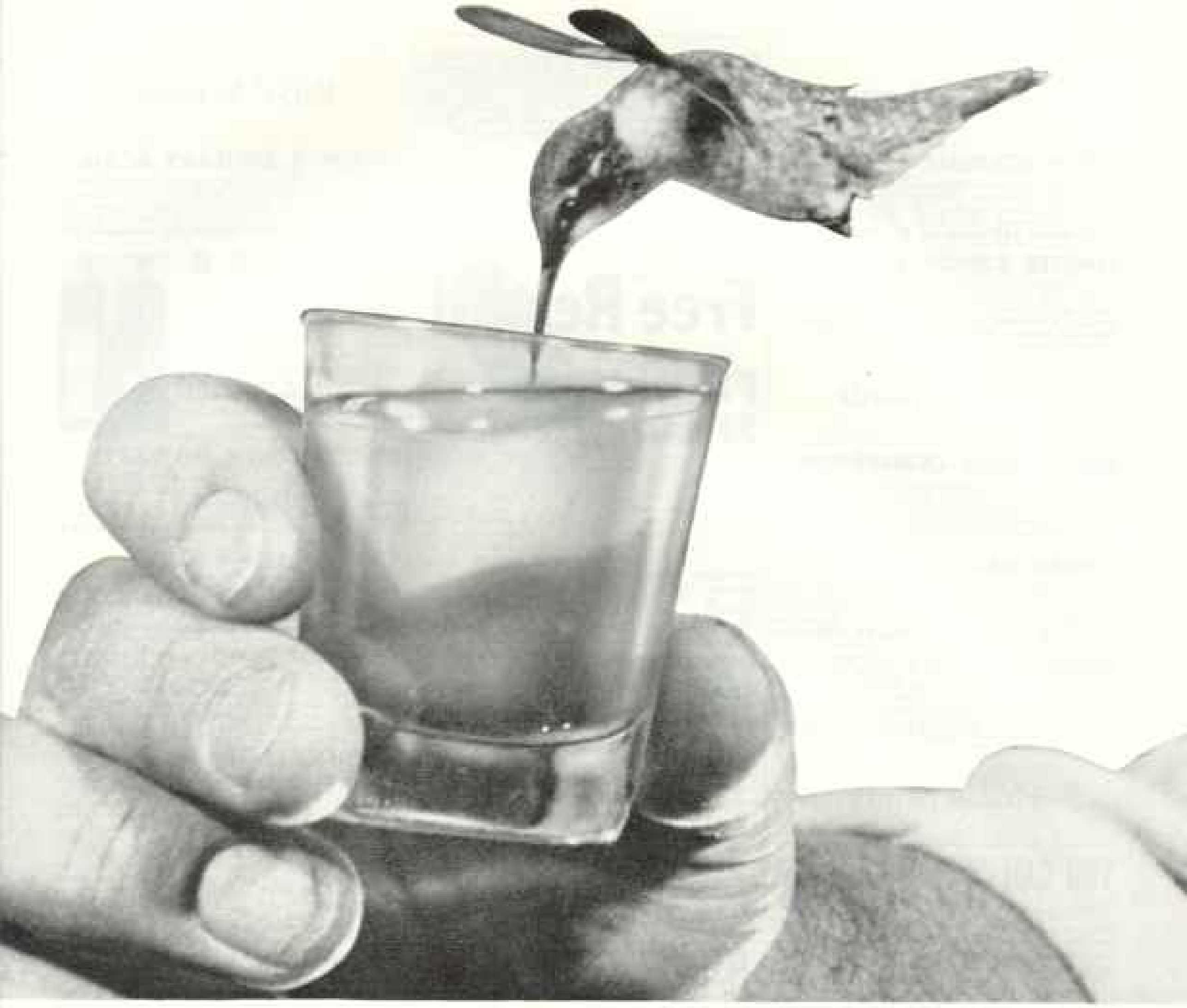

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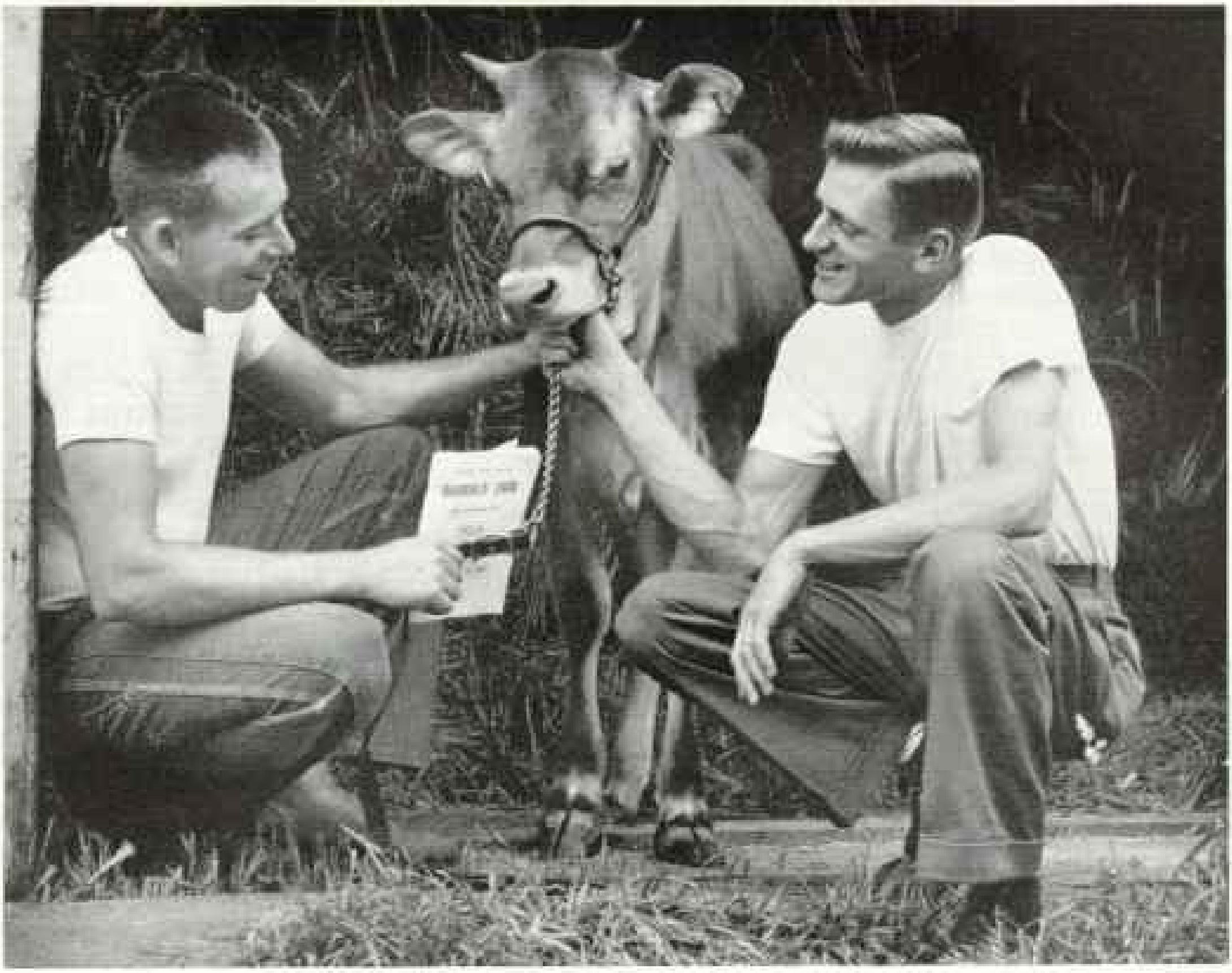

TELEPHONE MAN BOB CROUSHORE, right, stops at the farm of John Rathgeb to discuss entry of Jersey heifer, Wood-Knoll Stillwater Queen, at Harrold Community Fair near Greensburg, Pa. Bob is a director of the fair.

PHOTOGRAPHS BY ANSEL ADAMS

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He serves his community on and off the job

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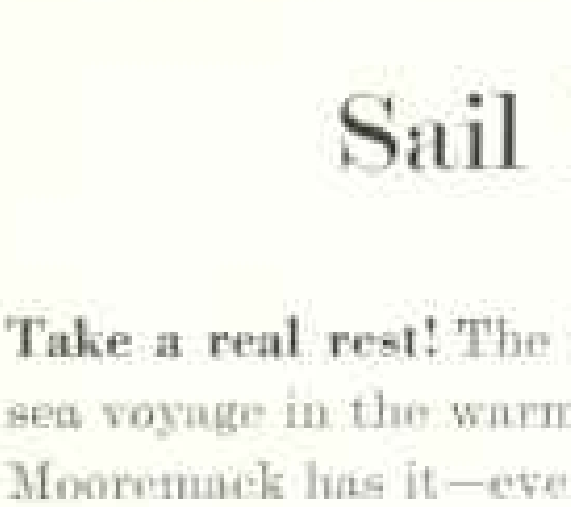

Harbor Policeman
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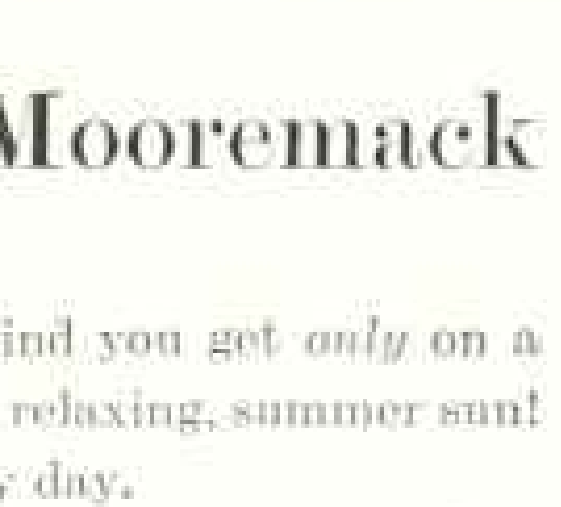

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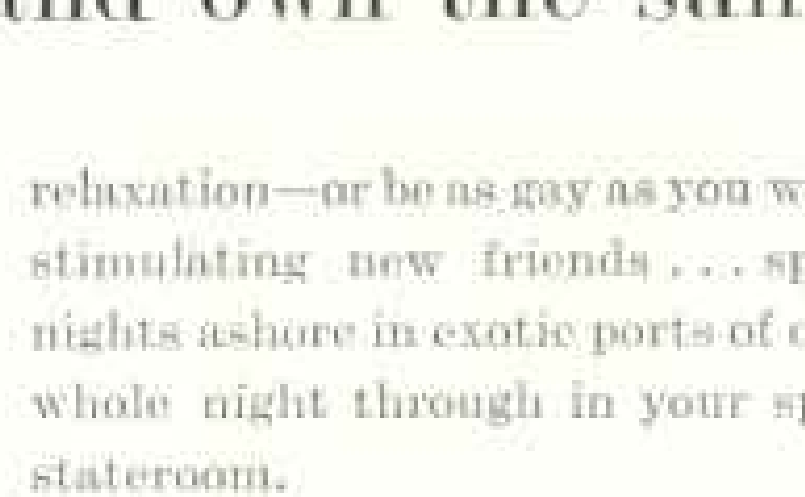

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