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Ten-Color Map, Lands of the Eastern Mediterranean

First Crossings of the Ends of the Earth

With 5 maps and 127 illustrations, 87 in color

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FIRST CROSSINGS OF THE ENDS OF THE EARTH

Two of the greatest achievements in the annals of exploration marked the year 1958. They came within six months of each other, at opposite Poles of our planet. First a British Commonwealth expedition led by Dr. (now Sir) Vivian Fuchs succeeded in crossing the great white 2,000-mile-wide continent of Antarctica. Then the United States Navy's atomic submarine *Nautilus*, captained by Comdr. William R. Anderson, blazed a sea route from Pacific to Atlantic under the ice of the Arctic Ocean. For the first time by land or sea the ends of the earth had been crossed by way of the North and South Poles, a feat heretofore accomplished only by air.

Color-illustrated accounts of both expeditions are presented in this issue of the National Geographic, which over the years has published the firsthand reports of great polar explorers from Peary, Amundsen, and Shackleton to Byrd and Siple. Commander Anderson and one of his brilliant young officers, Lt. William G. Lalor, Jr., write of the *Nautilus* voyage and the Arctic as a trade route of the future, while Sir Vivian describes the crossing of the earth's most formidable continent.—The Editor.

Submarine Through the North Pole

By LT. WILLIAM G. LALOR, JR., USN

With photographs by Chief Petty Officer John J. Krawczyk

FROM the slender antenna of *Nautilus*, in staccato *dit*'s and *dah*'s, a brief, triumphant message flashed across oceans and continents:

"*Nautilus* Ninety North."

Our radioman took his hand from the sending key. Beside him, waiting, stood the captain, Comdr. William R. Anderson. In less than a minute high-pitched signals of acknowledgment came winging back from United States Navy radio operators in Japan, Hawaii, and England.

"Send the other one now, Thomas."

Out into the Arctic air crackled a second message, again for relay to Adm. Arleigh A. Burke, Chief of Naval Operations:

"Ninety-six hours, Point Barrow to the Greenland Sea."

Two terse reports . . . a scant dozen words. Yet, in essence, they told a complete and dramatic story. *Nautilus* had safely concluded a voyage without precedent, one that, within hours, would be headlined around the world.

It was the morning of August 5, 1958. On the surface and basking in unaccustomed sunlight, we cruised south in calm waters between Greenland and Spitsbergen. To north and west we could see the stark outlines of our conquered adversary, the ice pack of the Arctic.

Our nuclear-powered submarine had sped 1,839 nautical miles beneath that treacherous

HERVEY GARRETT SMITH

mass, completing in four days the first submerged voyage across the Arctic Ocean. En route she had become the first ship in history to reach 90° north latitude—the North Pole (map, page 8).

A holiday mood prevailed throughout the ship. The jukebox blared its usual fare of everything from "Purple People Eater" to Hawaiian melodies. But, despite joking remarks and the noise of our record player, I suspected that many men, like myself, were offering silent prayers of thanksgiving for our swift and trouble-free journey.

Nautilus, while pioneering a new Northwest Passage, had carried 116 men in comfort that would have astounded the oak-tough individualists of past Arctic exploration. Yet the trip had not been without frustration and drama. Indeed, we had started our cruise feeling like conspirators in a mystery novel.

I began a personal log when we backed away from the pier at Pearl Harbor in the Hawaiian Islands. The first entry reads:

> July 22—8 p.m. In spite of the hour, about 200 people are on the dock to see us off. Among them is Rear Admiral Grenfell, Commander Submarine Force, Pacific Fleet, one of the few here who know we are bound north. The last few days have been very frustrating. An elusive fault in our all-important master gyrocompass has kept us at the dock since Sunday on a two-hour readiness. It's pretty hard to enjoy Hawaii this way, and we are anxious to be off.
>
> Reports from planes scouting ice above Bering Strait are encouraging. Looks like the ice is moving farther north each day.

Nautilus sped out the channel and turned to round Oahu Island. On deck seamen painted out the telltale white number, 571, on our sides. Our orders: Remain undetected and conceal your identity until the trip is completed and an announcement made.

As far as the world and our families knew, we were making a long underwater endurance cruise to Panama. My wife Sally had listed shopping items for me to pick up in Colón, and the captain and executive officer, Lt. Comdr. Frank M. Adams, had accepted dinner dates with friends in the Canal Zone.

The reason for veiling our true mission was simple. The Navy had taken on a unique, exacting job: we must show we could do it before we talked about it. Moreover, our crew knew from rueful experience that bad luck might turn us back.

Earlier Tries End in Defeat

From the deepwater Atlantic side, we had made three probes beneath the Arctic ice in August, 1957. On one of them we reached within 180 miles of the Pole, only to beat a reluctant retreat when an electric power failure shut down our master gyrocompass.

In June, 1958, we explored from the Pacific side, a far more difficult point of access. Layers of thick ice jam up in the narrow bottleneck between Siberia and Alaska. Running beneath that solid shroud is tricky, for water depths in the Chukchi Sea, lying between Bering Strait and the deep Arctic Ocean, average only 120 feet.

Nautilus, in June, had turned back after almost smashing into a deep floe—but more about that later.

Now we hopefully faced a new assault on the Arctic. The diving alarm sounded twice. With a rush of air escaping from ballast tanks, the ship tilted gently down. We were clear of Pearl Harbor and its shipping as we glided into the depths and checked for possible leaks in the thousands of valves and

A Sleek Gray Shark Beneath Arctic Ice, *Nautilus* Heads for the North Pole

Hardly a century after Jules Verne's Captain Nemo took the fictional submarine *Nautilus* under the Antarctic ice, history's first transpolar voyage became reality with the crossing of the Arctic by another *Nautilus*, the world's first atomic submarine.

In this cod's-eye view, a luminescent wake betrays the motion of the ship as shallow water in the Chukchi Sea forces her close to the surface. "The ice," says skipper Anderson, "looks like the inside of a fish bowl that hasn't been cleaned for three years." Sunlight filtering through open leads weaves a web of soft green.

Little disturbs the vessel's smooth contours save the lofty "sail" that houses antennas and periscopes, the bulges of sound equipment, and two stubby fins. Torpedo ports suggest windows; sonar panels on the bow probe ahead for inverted ice peaks that extend downward as much as 85 feet. Twelve-inch tomcods share the icy Arctic waters.

This painting of *Nautilus* under the ice pack's dark and jagged curtain was done for the National Geographic Magazine by the noted marine artist Hervey Garrett Smith, who painted the *Mayflower II* for the November, 1957, issue.

After 4 Days Under Ice, the Submarine Surfaces

Nautilus's heroic exploit is safely ended, and the dramatic news has just been flashed to the world; more than 1,800 nautical miles of ice lie behind. Lookouts see nothing ahead but the open Greenland Sea.

Smooth-running beneath the water, the submarine kicks up a heavy bow wave on the surface because of her stubby prow. Fins, or bow planes, so clearly seen on page 2, are folded back to protect them against the pounding waves.

Cruising at 400 feet at a speed exceeding 20 knots, *Nautilus* runs on automatic pilot while crewmen in the control room watch course, depth, and speed.

On orders from the attack center (opposite), the men swiftly change depth or course.

In the attack center Lt. Lalor, serving as conning officer, computes the ship's position. A periscope housing shines blue behind him; sonar screens and inertial navigator are close by. After the voyage, clock at right was given to Mrs. Dwight D. Eisenhower, who christened *Nautilus*.

fittings crammed into the 27-foot-diameter hull of *Nautilus*.

We were in our natural element. Down below, the water is always calm. Storms, seasickness, or fog never interfere. There was practically no vibration to disturb my pen, though we moved at more than 20 knots.

Temperature aboard *Nautilus* is 72°, winter and summer, Arctic Ocean or the Caribbean. She carries tons of air conditioning. The humidity remains always below 50 percent.

Now, as we cruised northward, automatic devices kept our blunt bow on course and our hull at exactly 300 feet. Teams began a careful final inspection of the ship for fire hazards—serious on any submarine, of course, but doubly so under ice, where finding a hole big enough in which to surface or raise our air-intake snorkel to clear smoke might be hard.

Aircraft Scout the Arctic Ice

We traveled deep most of the next day, July 23, before coming up near the surface to copy radio traffic. Low-frequency waves from powerful Navy shore stations penetrate water, but not down to 300 feet. We received another message about ice conditions.

Early in July Lt. Shepherd M. Jenks, our navigator, had flown to Alaska to set up ice-reconnaissance flights to Point Barrow and west along the pack boundary. Our naval aviator friends didn't know whom they were helping. Their latest relayed report said the ice still receded, although the Alaskan shore just west of Point Barrow was cluttered.

The next night our daily paper, whimsically named the *Panama-Arctic-Pearl-Arctic Shuttle Boat News*, featured Engineman 1/c Harry D. Hedin's eight-pound baby girl—number three. The radio had told Hedin of her birth.

In the crew's mess I watched *The Lieutenant Wore Skirts*. Friends at the movie exchange in Pearl had been kind to us—38 movies on board. Fifty men lounged in our spacious—by submarine standards—recreation center, with its hi-fi, tape recorder, library, and magazine racks (page 15).

> July 25—We are moving along at a very fast clip for the Aleutians, now only 400 miles away. Everything is working smoothly. Even our balky master compass performs perfectly, and the propulsion plant purrs like a fine watch.

I had turned over the job of navigator to Shep Jenks in January; since then I had been in charge of propulsion-plant machinery: turbines, condensers, pumps, piping, valves, steam system, and the mechanical components of the reactor plant. After three and a half years of operation, our nuclear power plant still seemed a marvel. It had propelled *Nautilus* more than 120,000 miles.

In the reactor compartment upper level, shielded from the lower level by a deck covered with lead and polyethylene, we cannot even hear the sealed pumps. They move primary water in a closed loop through the reactor and two heat exchangers. The primary water picks up the heat of controlled nuclear fission and transfers it to unpressurized secondary water, which boils into steam. Pipes carry the steam to two turbines driving nine-foot propellers and to four turbogenerators. These generators furnish electricity for lights, motors, cooking—everything, in fact.*

A four-hourly report comes to the conning officer and the engineer officer from our ship's doctor, Comdr. Richard F. Dobbins: "Oxygen 20.3 percent, carbon dioxide 1 percent, carbon monoxide 10-20 parts per million."

This tells us that our sealed atmosphere is healthful—almost as good as the air outside. Oxygen is kept at a uniform level by "bleeding" it into the ship from bottled stowage in tanks around the hull. Machines called burners and scrubbers hold carbon monoxide and carbon dioxide at very low levels.

To keep any possible radioactivity in the ship at a minimum, Dr. Dobbins has stored all radium-dialed wrist watches in a sealed can. Each day a voice solemnly intones over the speaker, "Now Doctor Dobbins, wind all watches in your care."

> July 26—We are approaching the Aleutian island chain. At 3 p.m. we crossed the Aleutian Trench, a 40-mile-wide 25,000-foot foredeep running east and west parallel to the Aleutians for almost 1,000 miles. We're able to check our latitude very closely by Fathometer.

The Fathometer, a sonar device, measures distance to the bottom by computing the time required for a sound signal, moving at 4,800 feet per second, to travel from ship to ocean floor and back. Since the trench had been accurately charted, its recognition on the Fathometer confirmed our position.

Nautilus also now carried half a dozen echo sounders topside. They would show distance

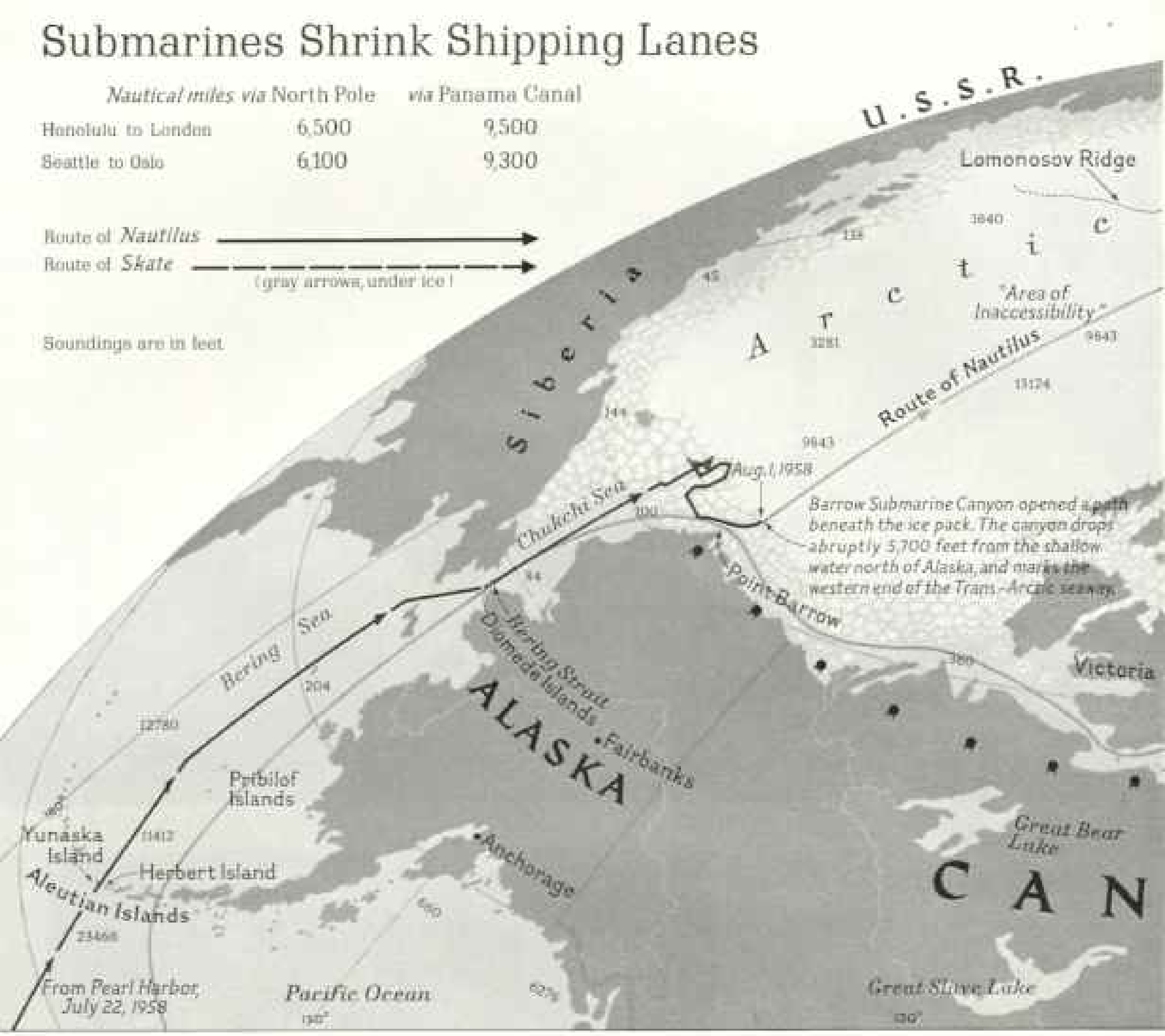
* See "You and the Obedient Atom," by Allan C. Fisher, Jr., NATIONAL GEOGRAPHIC MAGAZINE, September, 1958.

Captain Anderson Briefs His Officers on Ice Conditions Ahead

In the officers' wardroom, the 37-year-old skipper sketches a route in the Navy's Ice Atlas, a month-by-month chart showing the changing ice pattern.

Surrounding him, from left: Lt. John W. Harvey, reactor control officer; Lt. Comdr. Frank M. Adams, executive officer; Lt. Steven A. White, diving officer; Lt. Kenneth M. Carr, electrical officer; author Lalor; Capt. Jack L. Kinsey, a medical observer; Dr. Waldo K. Lyon, naval ice expert; and Lt. William S. Cole, Jr., electronics and supply officer.

Mail from the Pole is stamped with the *Nautilus* cachet. Some 1,500 friends, relatives, and distinguished persons received the coveted covers. The red-and-black cachet required two stamps. That at left, resembling the ice pack, outlines Oahu, where the voyage began.



Nautilus Recorded Water Depths and Ice Thicknesses Across the Forbidding Arctic.

to the ice above by sending signals straight up. In addition, a television camera would eye the ice and relay to our monitor screens pictures of ice formations scudding by like clouds. This battery of vital gear was the special charge of Dr. Waldo K. Lyon, distinguished Navy scientist, ice expert, and veteran of 13 Arctic expeditions.

By 9 p.m. on the 26th we were between Herbert and Yunaska Islands in a pass little used by other ships. The periscope confirmed our position; we slipped through into the Bering Sea and returned to high speed.

In the wardroom a group of officers prepared to give promotion examinations to some of the enlisted men. They would do well, as always. We have had 55 men advanced to officer status in 3½ years.

> July 27—Still in deep water just north of the Aleutians. The Pribilof Islands, with their huge seal fisheries, lie well to the east. Finally at 4 p.m. we are forced to slow down . . . came up from 300 feet to 150 feet. Soundings continuously now instead of every 15 minutes. We've crossed the 100-fathom mark and the deepwater honeymoon is over.

Our North Pole celebration committee, headed by Capt. Jack L. Kinsey, a medical observer from the Navy's Polaris submarine missile program, met behind closed doors. Meanwhile, many men spent their spare time working on two contests, one for design of a ship's flag to commemorate the crossing, and another for an appropriate name to give those who made the transpolar voyage. Some of the interest in these contests may not have been entirely due to the celebration; the prizes were three days of liberty in Europe.

At 11:30 p.m. on the 27th, the quartermaster awakened me and handed me a pair of red goggles. Time for my watch again. As conning officer, I had to wear the goggles until I had a cup of coffee and went back to the

Opening a Submerged Northwest Passage for the Atomic Cargo Fleets of the Future

darkened attack center. We keep the center lighted only by red lights between sunset and sunrise, so that our eyes are always adapted for night vision should we have to come up during darkness and use the periscope.

Down the ladder in control, the diving officer reported to me that depth and course held well, the compasses checked with each other, and the sounding showed 300 feet. I relieved the watch and made another careful check of positions plotted on the chart.

While doing so, I reflected on the navigational complications we would face when we were under the ice pack. Beneath that massive canopy we could not confirm our position by observational fixes or by radar. Success or failure would hinge upon how well we used five sensitive navigational aids.

Nautilus carried two magnetic compasses. Errors would creep into their readings, of course, for this type of compass is not wholly reliable so near the North Magnetic Pole. It tends to wander and finally, at the Magnetic Pole itself, to spin erratically.

We also had on board two fine gyrocompasses, one of them the master. You can point a gyrocompass at north and it will cling there, provided you compensate periodically for changes in the speed of the earth's rotation. This speed lessens as you journey north.

Our ace in the hole, however, was an amazing instrument called an inertial navigator, an aid we had lacked in 1957. Its stable platform points always at earth's center. Two instruments on the platform sense changes in acceleration, and hence changes in direction and speed, somewhat as a blindfolded person in a car can interpret movement by sensing how his body reacts against the seat as the car speeds up, brakes, or turns.

A computer records the machine's signals and disgorges information for us. In effect, this brainy navigator shows where it is by remembering where it has been.

A circled cross on sea ice marks earth's northern apex. *Nautilus*'s voyage came almost half a century after that historic day in April, 1909, when Comdr. Robert E. Peary and five companions became the first to stand atop the world. This photograph, the first to pinpoint the Pole from the air, was made in 1953 by Gilbert Grosvenor, then President of the National Geographic Society. He and Thomas W. McKnew, The Society's Secretary, retraced Peary's route by plane on an Air Force polar flight; they described their trip in the October, 1953, issue of the NATIONAL GEOGRAPHIC MAGAZINE.

Frosting on a cake baked for the celebration on reaching 90° N. reproduces *Nautilus*'s polar flag.

3:20 a.m. Sounding 130 feet.

I had slowed *Nautilus* to 10 knots. She measures 50 feet from keel to the top of her "sail," the streamlined tower housing periscopes and antennas. Therefore, at this shallow depth, we had only 80 feet of water for maneuvering.

Later, just before turning in, I commented to Doc Lyon how quiet the ship had become at 10 knots. He had noticed it, too. There was absolutely no vibration or sense of motion, no sound of water rushing by along the hull. I felt suspended, as one might in space.

July 29—By 1 a.m. we were well into Bering Strait. Visibility was very poor, but we got a quick radar position from the Diomedes and Fairway.

Our radar fix also had given us a good check on the inertial navigator. It was performing like a champion—testimony to the hard work of Tom Curtis and George Bristow. These two gifted engineers had been assigned to us by North American Aviation, Inc., builders of the inertial system. Its mechanism was designed to guide the Navaho missile on a three-hour 1,500-knot flight, but we had had it working now for weeks in a submarine.

At 6:25 a.m. on the 29th, everyone on board became Bluenoses again as we crossed latitude 66° 33′ N.—the Arctic Circle. We were making good progress. Our spirits rose when, later that day in the Chukchi Sea, we safely passed the point of our near disaster of the previous June.

With the exception of the captain himself, perhaps I had more reason than the others to recall vividly that harrowing ordeal. I had been the conning officer, responsible for the safe maneuvering of the ship. At that time the Chukchi ice stretched farther south, and *Nautilus* had ducked beneath the pack.

The Fathometer showed only 160 feet of water. Yet it seemed unlikely that the congealed mass overhead would reach down to us. Instruments tracing the ice contour revealed underwater ridges averaging only 10 feet deep.

But sonar soon picked up deep ice ahead. With much inner apprehension, I watched the ink recorder draw the profile of a jagged tongue 62 feet down, a depth we had never before experienced. It cleared our sail by eight feet. Quickly I slowed the ship and called Commander Anderson.

Without hesitation, he ordered me to turn around and ease down to 140 feet, only 20 feet off the bottom. *Nautilus* was still in her turn when sonar reported a massive ice ridge stretching more than two miles across our path. It could not be dodged. Instinctively, while staring hypnotically at the swooping pen of the recorder, we ducked our heads.

The ridge cleared us by a mere five feet; its depth: an incredible 85 feet. As Commander Anderson remarked to me later, "God's hand was on my shoulder when I said make your depth 140 feet instead of 130 feet." Ice has the consistency of a poor grade of concrete, and the ridge would have damaged our sail severely. There had been no sense in continuing, for 300 miles of shallow water lay ahead. We had set course for Hawaii.

But now, late in July, that incident was only a haunting memory. Again we dared the Arctic, and we sailed a lucky ship.

July 30—1 a.m. At periscope depth, 15 knots, visibility poor to fair.

When I took over the watch from Paul Early, he pointed out our first ice of the trip through the periscope. It was a lone floe, about 100 yards long, which we easily dodged. It looked like a beautiful sailing ship moving majestically by, reflecting a rainbow of colors.

An hour later I sighted a two-foot transparent chunk of ice ahead. In a few minutes, scores of these pesky blocks surrounded us, and the captain reluctantly decided to surface and get a better look at the situation.

Pack in sight to the west. One ice cube on deck recovered and preserved in the freezebox.

Nearly a month later, in New York, we presented that chunk as a souvenir to Rear Adm. (now Vice Adm.) Hyman G. Rickover, whose ingenuity and tireless drive had been so largely responsible for construction of *Nautilus*, world's first atomic submarine (page 19).

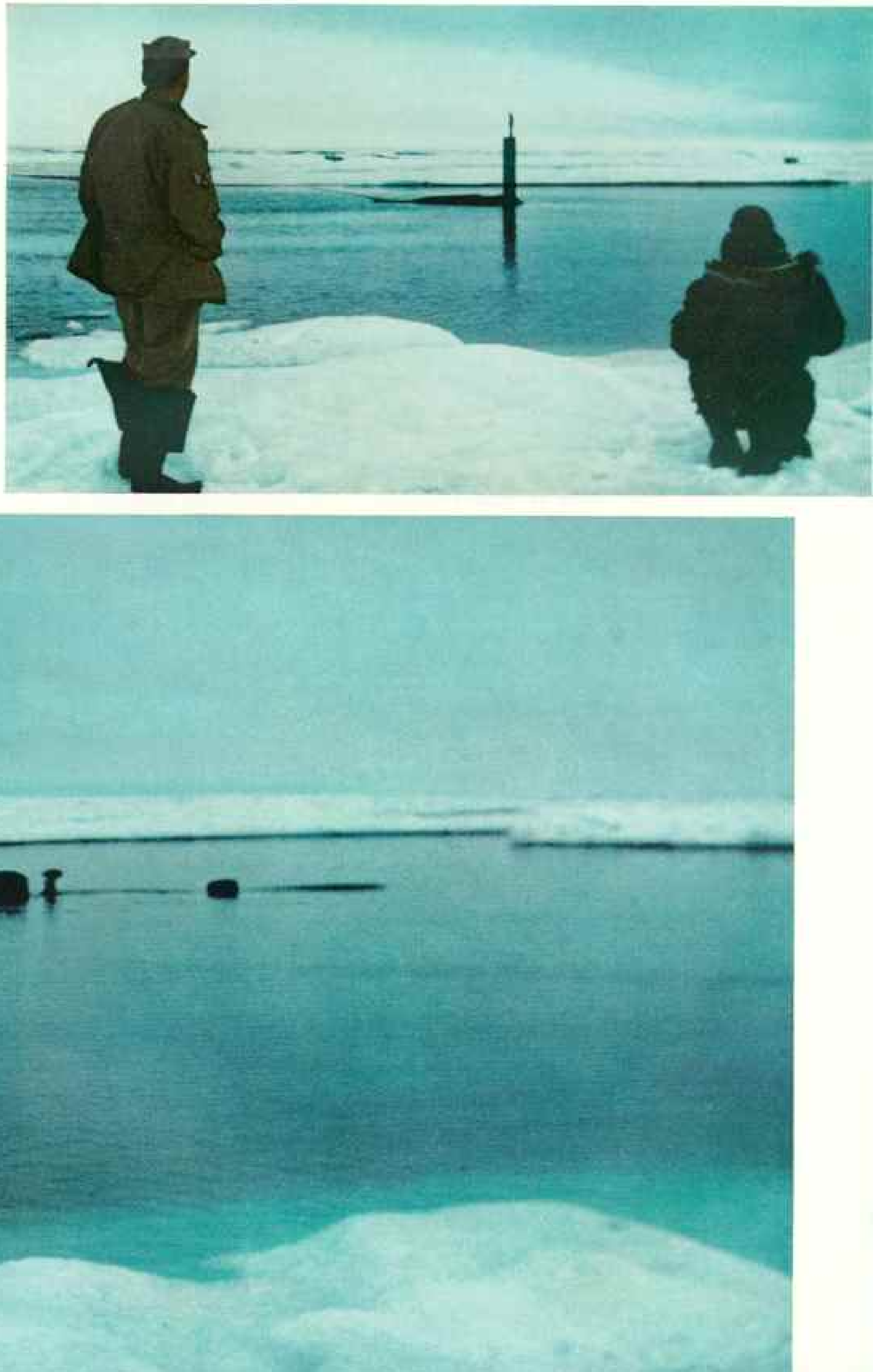
Cruising slowly south, we began a disheartening routine that held for the next 24 hours. Since ice loomed to the west and the sea that way was shallow, we turned east and then north again, hoping that the pack boundary would be closer to deep water along the new approach. Our object was to reach at least 300 feet of ice-free water before diving.

My log shows the way it went:

July 30—3 a.m. Clear of ice . . . 4 a.m. Turned north after running east 15 miles. Visibility changing from 10 miles to 300 yards. Complete overcast . . . 1:20 p.m. Pack edge at 72° 24′ N. Close but no cigar . . . 6 p.m. Five miles farther east. Pack

Going . . . . going . . . . A few days after *Nautilus* crossed the top of the world, the Navy's third nuclear submarine, *Skate*, followed to make under-ice studies. During 10 days beneath the pack, *Skate* reached the Pole twice and frequently surfaced in open leads. Here, in a blue Arctic gloom, she begins to submerge after visiting Station Alpha, a United States IGY post on sea ice 300 miles south of the Pole.

Gone . . . Only the periscope remains as *Skate*, with infinite caution, drops straight down. Submersion took 15 minutes. Seven-eighths of each floe lies threateningly below water. 13



edge at 72°15′ . . . 12 p.m. Fifteen miles more to the east. Pack in sight all along to the west. . . .

July 31—1 a.m. Turned on our radar and picked up ice ahead at about 30 miles. We may make it. Visibility and speed variable. Captain up almost continuously now. Going to catch cold on the bridge. It's between 35° and 45° but raw. Sea is flat calm. Many walruses in sight. . . .

2 a.m. 72°45′ N. 165° W. End of the line. Solid ice to west and north, also 15 miles to the east. Moved into pack but deepest water only 180 feet. We couldn't make it this way. At 4 a.m. the captain ordered course set for Point Barrow.

Now we would try to find a deepwater lead by moving in toward the Alaskan shore.

Quartermaster Richard Williamson came up on the bridge and took a long look at the dirty, heavily ridged ice.

"Do you mean to say that men ever ran dog sleds over that? Some of those ridges are 30 feet high," he said.

I, too, wondered how they did it. We owed a great deal to those men—Peary, Nansen, Sverdrup, and many others. Without the information they obtained so heroically, *Nautilus* would not be venturing into the Arctic.

At 4:37 a.m. on August 1, we cruised north of Point Barrow, invisible just over the horizon. The Fathometer, whose moving arm had been monotonously showing 160 to 180 feet of water, now suddenly indicated 420 feet. There was jubilation in the voice of Chief of the Watch John J. Krawczyk as he called the bridge on the intercom. We were there—in a tongue of the deep Barrow Submarine Canyon, which should lead us north to the even deeper Arctic Ocean. This tongue had been discovered previously by icebreakers.

The captain, in the attack center, spoke to Lt. Robert Kassel on the bridge. "When you are ready, clear the bridge and submerge."

The diving alarm honked twice; in a minute *Nautilus* slipped beneath the sea. The ship eased down to 200 feet, 300, then deeper, as we followed the ever-deepening bottom. Hereafter we would be measuring depth of water in hundreds of fathoms rather than feet.

The captain, exec, navigator, and others plot our position with extreme care. Compasses are watched constantly, checked one against the other. The inertial navigator, with sleepless Tom Curtis watching it like a worried mother, clicks cheerfully. Our major problem now: navigation.

Men on watch—those by the shiny stainless-steel reactor cylinder, those carefully checking temperatures near the humming turbines, and the men in the control center—do exactly what they do any time at sea. Their job is the same, surfaced, submerged, under ice, or in clear water: answer the bell. Telegraphs read "Ahead Full" now, and they won't change for four days.

Our undersea "ears," the echo sounders, give out a cacophony of sounds. From the control room I can hear one instrument bouncing signals off ice or open water above us. It chirps when an echo returns from open water but sounds a dull thud when the echo returns from ice. I can also hear a Fathometer sounding the bottom, and the bow-mounted sonar probing ahead for submerged mountain peaks or ice in our path.

By 4:30 p.m. we had reached 74° N. with things looking good. Went up slightly to blow sanitary tanks and eject garbage. When we eased back down the captain watched the ice again for a while. We went to 20 knots, one degree of latitude every three hours.

The ice seemed meaner to us than it did in 1957, much more rough and jagged. Dr. Lyon thought it was because his equipment was better, more sensitive than before.

Watching the ice trace coming from our sonic recorder, I felt glad for Sir Hubert Wilkins's sake that his old submarine, also named the *Nautilus*, did not get under the ice pack in 1931. A stern-plane failure balked the attempt. He was certainly ahead in his idea of using a sub under the Arctic ice, but the runners he was going to use to slide along under the floes would just not have worked. Too many ridges! Moreover, only an atomic sub, its propulsion plant independent of the atmosphere, could traverse the Pole safely.

August 2—At Lat. 76°22′, soundings went from about 2,000 fathoms to 500 fathoms very abruptly. We were crossing a 9,000-foot submerged mountain range, uncharted and unknown. This feature continued for 70 miles, when the soundings just as abruptly smoothed out again, about 2,000 fathoms. . . .

80° N.—600 miles from the Pole, and 1,200 miles from the ice edge in the Atlantic. Just past noon we shifted our master compass to a high latitude mode. Everything checks perfectly. . . .

Big news! Lt. Wes Harvey announced the

Men Off Duty Watch Movies Under Polar Ice

This mess room holds 32 men at a meal, 50 at a movie. It may be converted into an operating room.

Night and day are indistinguishable during long submerged runs. To relieve monotony, *Nautilus* shows films twice a day and maintains jukebox, tape recorder, library, soda vendor, and an icebox that may be raided at will.

Lockers along the wall store 90 days' provisions.

The National Geographic shows Quartermaster 1/c Ronald L. Kloch what he may see when *Nautilus* reaches England. He looks at Westminster Palace in the July, 1958, issue.

winners of the flag-design contest. Electronics Technician 1/c James P. Knotts, Chief John Krawczyk, the photographer for this article, and Electrician's Mate 2/c James A. Morley.

Chief Sonarman James R. Norris was declared winner of the second contest. His name for transpolar veterans: PANOPO (Pacific to Atlantic via the North Pole).

A paper blizzard engulfed the wardroom. Letters were being prepared, for signature at the Pole, to families, friends, and others most closely connected with *Nautilus* and this voyage. Yeoman 1/c Charles A. Payne groaned when he saw the work piling up.

These letters would go out later with our North Pole cachet and postmark. Engineman 1/c Ernest F. Holland carved the postmark from a sheet of rubber. A commercial firm in Hawaii made the cachet for us with the words "Pearl Harbor" in the center. We substituted "North Pole," and Oahu Island became the ice pack (page 7).

Passing through fairly light ice now—six-tenths coverage with many large water openings suitable for surfacing as we near the Pole of Inaccessibility.

This imaginary area is supposed to be the hardest to reach in the Arctic, almost the geographic center of the ice pack. It was located by taking all the points reached in the Far North by ship or sledge and then marking the center of the unexplored region. I found it hard to imagine the grinding floes and bitter cold overhead as I sat in my shirt sleeves, smoking my pipe and writing to my wife and my small sons Billy and Michael.

August 3—10 a.m. Latitude 87° N. Passing history's, and our, farthest point north by ship.

Soon the bottom rose up again as we crossed the Lomonosov Ridge. This 9,000-foot mountain range is named for the Russian scientist who first predicted its existence from geophysical studies of the earth's crust.

I had hoped we would reach the Pole on my watch, but it was not to be. Close, but still some 75 miles to go when I went off duty.

Dinner was delayed to allow party preparations to go on in the crew's mess. Leading cook Jack L. Baird put the finishing touches on his North Pole cake, with the replica of our

Skate Moors to the Ice Near the Huts of Station Alpha

Said the IGY station commander: "Watching *Skate*'s periscope come slowly up in our little lake was the eeriest experience of my life."

polar flag as icing (page 10). Ship's cameramen set up floodlights; another group prepared a tape recorder.

I sat with the captain in the wardroom as he signed letters and put the finishing touches on those to the President and to the ship's sponsor, Mrs. Eisenhower. Frank Adams came in.

"Two miles to go, captain." The jukebox was turned off, and the captain spoke briefly and movingly over the intercom:

"With continued good fortune, *Nautilus* will soon accomplish two goals long sought by those who sail the seas.

"First, the opening of a route for rapid voyages between the great Pacific and Atlantic Oceans.

"Second, the attainment of the North Pole by ship.

"Thus our remarkable ship has been blessed with her greatest opportunity—the discovery of the only truly practicable Northwest Passage. On this historic Sunday, August 3, 1958, let us offer our thanks to Him who has blessed us with this opportunity and who has guided us so truly. . . ."

We observed a moment of silent prayer. As *Nautilus* approached the Pole, the captain began a countdown: "8 . . . 6 . . . 4 . . . 2 . . . 1 . . . Mark! August 3, 1958. Time, 2315 (11:15 p.m.) Eastern Daylight Saving Time. For the United States and the United States Navy, the North Pole."

A dream had become reality. We had arrived. Sounding, 13,410 feet, a lot of water.

As we watched in awe, our gyrocompasses swung, finally to point back to where we had been. Tom Curtis was manipulating his slide rule beside the inertial navigator. I asked how close we had come to the exact Pole.

"We pierced it, Bill."

In the crew's mess, Electrician's Mate 1/c James R. Sordelet came forward, and the captain swore him in for another six years in the Navy, the first man to re-enlist at the Pole. Eleven others received the captain's congratulations for completing their qualification in nuclear submarines. Behind them was up to a year of making drawings, checking pipes, switches, valves—everything in our 320-foot-long ship.

"What are you doing dropping garbage

U. S. NAVY, OFFICIAL

Quonset-type huts of insulated canvas sheltered the 29 Air Force men and civilian scientists of Alpha. Drifting one to three miles a day on their half-square-mile ice floe, they studied weather, oceanography, and geophysics, until severe polar storms forced abandonment last November.

all over my front lawn? Merry Christmas!"

Engineman 2/c William J. McNally, Jr., as Santa Claus, appeared in a costume the quartermasters made from some red flag material and cotton. He had "a message for the children," and then it was time for our steak dinner and North Pole cake.

Now that the Pole lay behind us, however, we had another goal and job to do. We had to reach the Atlantic, completing our transit of the Arctic Ocean safely.

Actually, all of us knew that we were now playing a game of longitude roulette for very high stakes. At the North Pole all directions are south, and an error in navigation could head us for the U.S.S.R., Alaska, or Canada instead of for our planned exit into the Greenland Sea. Concentration on our instruments never flagged for a moment.

We steered for our old stamping grounds, a deepwater opening between Greenland and Spitsbergen. There an arm of the Gulf Stream curved north, and we hoped to reach open water little more than 600 miles from the Pole.

I was sleeping when it happened, but at almost the same spot as in 1957, we lost the power supply to the master compass. Experience pays off, though. We had installed an emergency supply, and it took over without skipping a beat.

Ice Overhead Watched by Television

By noon of August 4, when my watch began, we were feeling so good that we decided to divert ourselves with television—"Polar TV network, Channel 571," we dubbed our underwater ice observation hookup. It had been installed primarily for finding small ice in otherwise open pools. In 1957 one bent and one ruined periscope had taught us the danger of being in a hurry when surfacing in ice, and the limitations of our sonar.

U. S. NAVY, DEFENSE.

Fireboats cascade greetings as *Nautilus* traverses New York Harbor after her 6½-day Atlantic crossing. Crewmen on deck eye lower Manhattan, their first glimpse of the United States east coast in four months.

The television received enough light to outline clearly the edges of floes; we watched the screen avidly.

August 5—In the hours past midnight, almost everyone is up waiting for us to clear the ice. The inertial system and our navigator's best plotted position from compasses and distance indicator are only 15 miles apart. Sea-water temperature is up to 38°, indicating we are in the right slot and running into the Gulf Stream branch. Soundings decreasing gradually, up to 700 fathoms, indicating we are passing over Nansens Rise between Greenland and Spitsbergen. Even the ice says we are approaching the edge. Many 400-yard holes, and a lot of 1- and 2-foot new ice.

By 2:30 a.m. soundings read 1,000 fathoms. Our position: 80° 20′ N., 2° E. We still had about 60 miles to go.

At 3 a.m. the bottom dropped suddenly to 2,500 fathoms. There was nothing like that on the chart, and we were in a fairly well-known area. In fact, we had explored this area ourselves in 1957 and had observed nothing over 1,500 fathoms. To add to the confusion, we found ourselves under a giant floe that seemed never to end, more than 10 miles long, 12 feet thick on the average, and with many 50-foot ridges.

All our confidence suddenly evaporated. Were we really in the right ocean? Nothing to do but go on. But, about 4 a.m., we had the expected signs again—water temperature up, 1,000 fathoms, thin ice.

At 5:12 a.m., quite suddenly, we ran into

NATIONAL GEOGRAPHIC PHOTOGRAPHER W. J. HENNESSY

A heroes' welcome met Commander Anderson and his men during the confetti-strewn ride up Broadway. The captain acknowledges a noisy ovation. Rear Adm. (now Vice Adm.) Hyman G. Rickover, father of the nuclear submarine, shares the glory. Their host is Richard C. Patterson, Jr., New York City's Commissioner of Commerce and Public Events.

Back from the White House, a Happy Skipper Returns to His Ship

A helicopter picked up Anderson at sea, and a plane carried him from Iceland to Washington, D. C. President Eisenhower decorated him with the Legion of Merit. The ship received the Presidential Unit Citation, first ever given in peacetime. The captain rejoined *Nautilus* just before her triumphal arrival at Portland, England.

open water. All sonars and the television gave negative ice reports. We slowed and eased upward to check.

Nautilus stopped dead and got a perfect neutral trim. Commander Anderson ordered the diving officer, "Bring me up. Make it about 10 feet a minute."

5:39 a.m. Hooray! Open water all around, ice visible to the north and west, but two-foot waves say this is the Greenland Sea.

In a short while our messages went out. Washington, New London, and Pearl Harbor could relax. And so could we, as *Nautilus* submerged again and barreled south toward Iceland. I turned in.

1,500 Letters Mailed from Pole

The next two and a half days seemed one continuous, frenetic scramble as the crew prepared for the captain's departure. A helicopter was to pick him up off Iceland for a flying trip to Washington. We began to doubt that a helicopter would hold him and his luggage. He would carry some 1,500 letters from the Pole, reams of technical data, still and motion pictures, a chart and clock for Mrs. Eisenhower. The paper flew as we passed lonely, volcanic Jan Mayen Island.

But very early on the 8th we were ready. Two seabags, two suitcases, a briefcase, and chart had been stacked in the wardroom. *Nautilus* lurked submerged 10 miles off the coast of Iceland; meanwhile, the captain took a nap, his last sleep for quite a while.

Right on schedule the helicopter appeared, we surfaced, and crewmen boosted the skipper into the hovering 'copter. *Nautilus* submerged again and loafed along toward Europe.

In the next weeks and months we would receive overwhelming receptions in England, New York, and Groton; honors, luncheons, speeches, letters, telegrams—enough to amaze us all. The first and most meaningful message, though, came that early morning off Iceland in a plain white envelope handed down from the helicopter. It was addressed to the "Acting Commanding Officer." Inside we found a letter that said:

> "To the officers and men of the *Nautilus*. Congratulations on a magnificent achievement. Well done.
>
> Dwight D. Eisenhower."

Atomic cargo submarines may someday ply the ice-roofed depths of the polar ocean

The Arctic as a Sea Route of the Future

By COMDR. WILLIAM R. ANDERSON, USN

Captain, U. S. S. *Nautilus*

MAN'S last unknown sea, the ice-mantled Arctic Ocean, has yielded to the Atomic Age. Across the top of the world, blazed by thousands of instrument readings, lies a maritime highway of tomorrow—strategic, commercially promising, and, I am convinced, safe.

For centuries the Arctic Ocean has remained almost as unmapped as the far side of the moon. Even less than six months ago, the concept of a submerged shipping route through the Arctic might have been dismissed as science fiction.

Today it is a distinct possibility. In four nuclear submarine cruises—three by *Nautilus*, one by *Skate*—that ocean has been sounded out, ice and bottom, to such an extent that we can now say that a new transocean route has been opened between Pacific and Atlantic.

Submarines Chart the Arctic Depths

My shipmate, Bill Lalor, describes on the preceding pages the now-historic 1958 voyage of *Nautilus*. I was privileged to lead the crew of that superb atomic submarine in attaining her "first": a west-to-east crossing of the Arctic via the North Pole, August 1-4, 1958.

One week later the nuclear-powered *Skate* appended a highly significant chapter to our own tale of exploration. On August 11, captained by Comdr. James F. Calvert, she became the second vessel in history to reach the Pole, entering and departing the Arctic Ocean by the Atlantic side.

Skate surfaced several times in open leads in the ice pack, once within 40 miles of the Pole, and another time directly in front of the manned IGY Drifting Station Alpha on a huge ice floe (pages 12-13 and 16). While at the North Pole itself, she made a complete circle around it, and hence "around the world," in only 50 minutes of maneuvering.

The first two voyages of *Nautilus* beneath the Arctic ice, in August, 1957, and June, 1958, consisted of a series of tentative probes from the Atlantic and the Pacific. During these preliminary excursions much scientific data was collected and many lessons were learned about the new techniques of polar navigation and in-ice maneuvering and surfacing.

The third voyage of *Nautilus* was the history-making rapid shot directly across the Arctic via the North Pole. The only direct, fast Northwest Passage had been opened.

Both *Nautilus* and *Skate* sounded the Arctic depths along their courses and measured salinity, temperatures, and ice thicknesses, giving valuable clues to the movements of water in the Arctic Basin. *Nautilus* alone compiled more than 11,000 individual soundings.

We found that this is a very deep ocean, with deep approaches from the Atlantic side, shallower avenues in from the Pacific side. Though it was disconcerting at times to find variances of more than a mile between estimated and actual depths of the sea, the basic features of the Arctic Basin were confirmed.

It will take our chief scientist, Dr. Waldo K. Lyon, months to analyze the ice data recorded on our crossing—he brought back two trunkfuls of it—but I am sure that polar ice experts are due for some real surprises.

The record showed two things: One, that the under-ice profile is fantastically rugged, far more so than anyone ever thought; and two, that there is, stating it plainly, a lot more ice up there than anyone has suspected.

Ice No Bar to Atomic Subs

This ice may forever bar the routine transit of surface ships. But it will not deny the Arctic Ocean to submarines—provided they are nuclear powered.

Conventional subs, cruising submerged on battery power, possess limited endurance. They must surface frequently or raise air-intake tubes, in order to fire up their big diesel engines and recharge batteries.* No such necessity haunts the atomic sub. Her power plant does not require oxygen, and a built-in atmosphere sustains the crew comfortably on long underwater cruises.

* See "Our Navy's Long Submarine Arm," by Allan C. Fisher, Jr., NATIONAL GEOGRAPHIC MAGAZINE, November, 1952.

Commercial submarines, given that same capability, would shave great distances from many of today's sea lanes. For example, the surface route from Tokyo to London totals 11,200 nautical miles; by the polar passage the distance shrinks to 6,500. Similarly, a vessel bound from Seattle to Oslo logs 9,300 miles, but an Arctic sub would travel only 6,100 (map, page 8).

Not to be overlooked is the advantage a cargo submarine would enjoy in wartime. It would be far less vulnerable to attack than a surface vessel.

Cargo Subs on Drawing Board

Our Federal Maritime Administration is keenly aware of these possibilities. Recently it contracted with Electric Boat Division of General Dynamics Corporation, builder of *Nautilus* and *Skate*, for a study of possible nuclear-powered submarine tankers. Under consideration are proposals for ships of 20,000 to 40,000 tons carrying capacity—all much larger than *Nautilus* (diagram below).

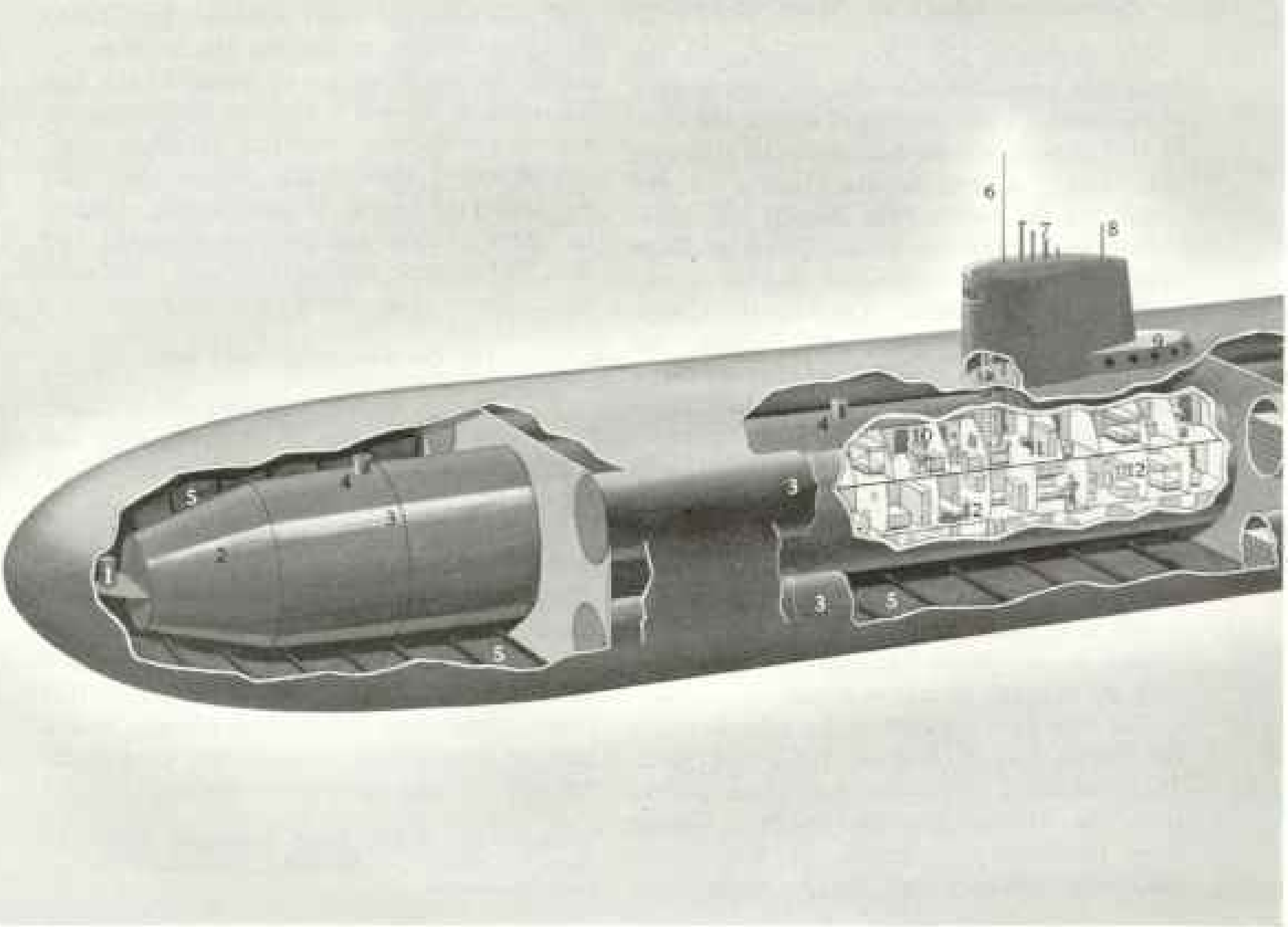
Hydrodynamic studies long have shown that a submarine is more efficient at high speed than a surface vessel. The Maritime Administration believes a 40-knot submarine tanker is a "possibility." To attain that speed, the sub would require far less power than would its surface counterpart.

Moreover, I do not know of any practical limit to the size of such submarines. The Japanese have announced that they are studying a 100,000-ton design.

No one can say with surety when commercial ships will ply the Arctic. That day will come, but, in the meantime, further exploration is needed. More trips must be made at all seasons to determine varying ice conditions, as well as the best possible routes.

It seems surprising, but the Arctic Ocean may be easier to negotiate in the dead of winter than in spring or summer. Lieutenant Lalor describes the difficulty we experienced last summer dodging ice in the shallow-water approaches off Alaska.

In the eastern approaches we found the polar pack ice pure white and reasonably predictable. In the western approaches, however, during the summer months it can be quite ugly—black, dirty, irregular, rugged.

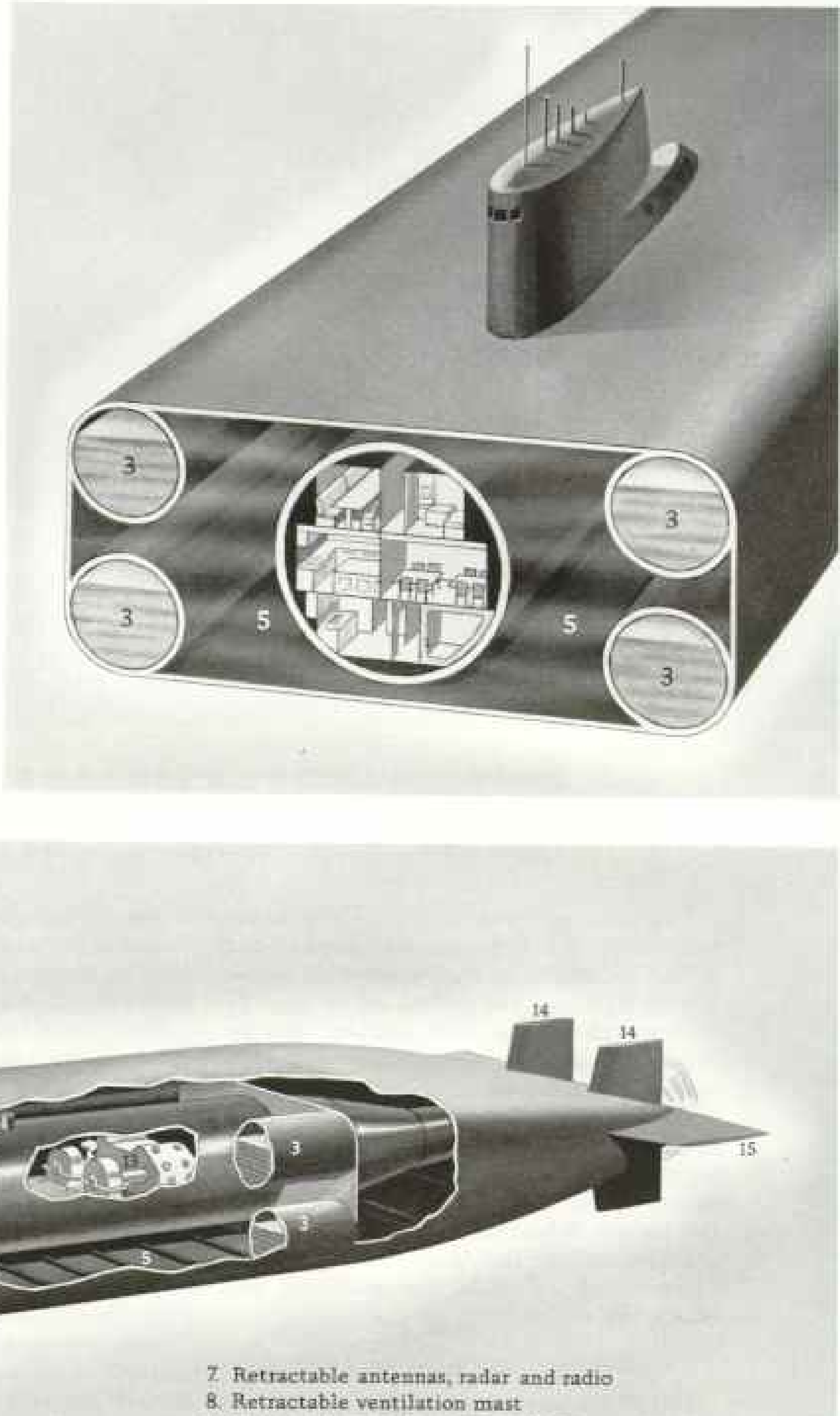


DRAWING BY HERBERT SANDELL SMITH

Future Atom Tanker Envelops Its Crew in a Pool of Oil

Plans being drawn for the U. S. Maritime Administration by Electric Boat Division of General Dynamics Corporation envisage a 565-foot submersible capable of carrying 20,000 tons of oil beneath the Arctic ice. It is a submarine within a submarine. Liquid cargo (or sea water on the return voyage) surrounds the pressurized inner hull, which contains living and working quarters and machinery.

Variable cargo tanks are filled with just enough liquid to give neutral buoyancy. Filling or blowing smaller sea-water tanks permits diving or surfacing.



1. Navigating sonar
2. Trim tank
3. Variable cargo tank
4. Access and escape trunks
5. Main cargo and ballast tanks
6. Periscope
7. Retractable antennas, radar and radio
8. Retractable ventilation mast
9. Cargo-pumping shore connections
10. Officers' quarters
11. Control room
12. Crew's quarters
13. Engine room
14. Rudder
15. Diving plane

U. S. NAVY, OFFICIAL

Seemingly wedged in the ice, *Skate* surfaces in an open lead behind a steep pressure ridge. Across the face of the ice pack, snow and ice pile up in endless stretches, reaching heights of 30 feet. *Skate* surfaced nine times to gather information about weather and ice; *Nautilus*, by comparison, remained submerged the full four days.

This is not sea ice at all, in the classic sense, but coastal ice from Siberia, Alaska, and northern Canada, ice that broke away in the late spring thaws and drifted out to sea. In shallow water it can cause trouble. But by winter it will have wasted away and been replaced by new, relatively thin sea ice.

Point Barrow, Alaska, northernmost town in the United States, may one day grow beyond recognition as an important base for Pole-bound submarines. Off the community lies the Barrow Submarine Canyon, a deepwater slot leading into the Arctic Basin from the Chukchi Sea. *Nautilus* ran that slot, and others will follow.

Eyes for Hazards of the Deep

One of the most touching letters I received after our pioneering trip came from a wounded British veteran. Totally blind, he commented: "I have some small idea of how your long trip in the unknown must have felt."

Yet, though traveling beneath eternal ice, we by no means lacked eyes. Fine navigational aids saw many things, and commercial submarines must be similarly equipped if they are to succeed.

Our nuclear power plant has always performed with steadfast efficiency. With such a plant as that on *Nautilus*, I am sure that my crew will volunteer to go anywhere.

Many times have I said that no better ship than *Nautilus* ever sailed, and certainly no captain ever put to sea with finer officers or crew.

The reception that the world gave news of *Nautilus's* feat proved overwhelming and humbling. Honors and messages from the great showered upon us. But the crew marveled most at the thousands of letters we received from private citizens of practically every country in the Free World.

Some persons commented upon the obvious military significance of the voyage. Most, however, regarded it in a gentler and more perceptive manner: as a triumph of human ingenuity and human spirit, one in which men and women of all nations could take great pride.

Perhaps, like myself, many thought of the voyage of *Nautilus* not as an end but as a beginning—a presage of the remarkable benefits due mankind from the peaceful uses of atomic power.

Commonwealth explorers conquer the last untraversed continent in a history-making trek from sea to sea across the South Pole

The Crossing of Antarctica

By SIR VIVIAN FUCHS

Leader of the British Commonwealth Trans-Antarctic Expedition *

With Photographs by George Lowe and Other Expedition Members

AS if determined to break our will at the outset, Antarctica threw some of her worst pitfalls in our way at the very start of our two-thousand-mile journey across the continent.

Before our clanking, roaring caravan of six tracked vehicles had traveled 30 miles, we found ourselves in a maze of crevasses that could not have been more diabolical if they had been traps deliberately set.

Some 300 miles south of our starting point—Shackleton Base on an arm of the Weddell Sea—lay our first objective, South Ice, the advance base we had established by air at 4,430 feet on the great polar ice sheet.

Spring Thaws Set Death Traps

Even though we had just spent more than a month in painfully pioneering an overland route, the sun meanwhile had seriously weakened the crevasse bridges, and often danger lurked where before we had passed in safety.

"It reminds me of driving a tank over a mine field," David Pratt had said during the reconnaissance, "except that in this case you are waiting for something to go *down!*"

We did not have long to wait. On the second day out, a snow bridge fell away beneath the Sno-Cat we called Rock 'n Roll, leaving David Stratton and myself suspended in mid-air over an impressive chasm (page 26).

Peering out of the right-hand side, I thought the situation looked distinctly uncomfortable; it was impossible to tell how firmly we were wedged against the sides, and in any case there was nothing to step out onto. Meanwhile David, my second in command, had found that on his side he could reach the rear pontoon, and I followed him out, crawling over the ladderlike track as it hung in space.

At first sight, recovery seemed almost an impossibility, but after careful prospecting along the length of the crevasse, we found a point where the two Weasel snow vehicles could be brought round in front. There they were attached by steel cable to Rock 'n Roll's front axle, preventing the vehicle's front end from falling vertically into the crevasse when the two other Sno-Cats, side by side, attempted to pull it out backwards. One of Rock 'n Roll's pontoons failed to clear the edge, and we had to use our Muskeg tractor to free it.

Success depended upon teamwork involving all five recovery vehicles and also upon the immense power of the other two Tucker Sno-Cats, using their emergency low gear known to us as "Grandma." Grandma showed what she could do against odds, because after the recovery we discovered that Rock 'n Roll had been left in forward gear the whole time!

Several times, as we pressed on, it seemed we were leaving the crevasses behind. But just as we began to feel happier, a new batch of monstrous black caverns would be found beneath innocent-seeming snow. Some of them would have accepted a double-decker bus.

In a Blizzard a Plan Is Born

But the story of our crossing of the continent really begins about eight years earlier, in a tent in an Antarctic blizzard. On a thousand-mile exploring trip by dog sled for the Falkland Islands Dependencies Survey, my South African friend Ray Adie and I had been confined to our sleeping bags for three days, except for brief trips outside to feed the dogs and keep them from being buried. Idly we talked of ways of making longer journeys.

* In recognition of this epic achievement and its contribution to knowledge of the Antarctic, the National Geographic Society has awarded Sir Vivian its Hubbard Medal, to be presented February 6 at Washington, D. C.

Dr. Fuchs, knighted upon completion of the journey, was born in England on February 11, 1908, and educated at Brighton College and Cambridge. A geologist, he has led expeditions to Africa and has explored in the Arctic and Antarctic. With Sir Edmund Hillary, he is author of the book *The Crossing of Antarctica* (Cassell & Co. Ltd., London), soon to be issued in the United States by Little, Brown & Co. Article and photographs are copyright, 1958, by the Trans-Antarctic Expedition.—The Editor.

If one could go as far as the Pole, I mused, why not continue to the far side of the continent? Such an expedition would require bases on both sides of Antarctica, aircraft for reconnaissance and support, and mechanical transport to carry the heavy loads necessary for a proper scientific program.

On my way home to England early in 1950, I cabled my idea to Mr., now Sir, James Wordie, Master of St. John's College, Cambridge, who had been Shackleton's Chief of Scientific Staff and who had taken me on an expedition to northeast Greenland in 1929. Later I discussed it with him in person.

At that time nothing could be done, but he did not forget, and in 1953 he asked if I was still interested. The matter was discussed with Sir Miles Clifford, then Governor of the Falkland Islands, and, as I was working for the Falkland Islands Dependencies, it was Sir Miles who asked me to produce plans for a journey across the Antarctic.

Proposal to Drive Across Antarctica

The first tentative outline—subsequently carried out in all its essentials—proposed that a party travel from the head of the Weddell Sea to McMurdo Sound in the Ross Sea (map, page 35). They would use tracked vehicles, with dogs and aircraft in support. At various stages vehicles would be abandoned, having served their purpose as traveling depots.

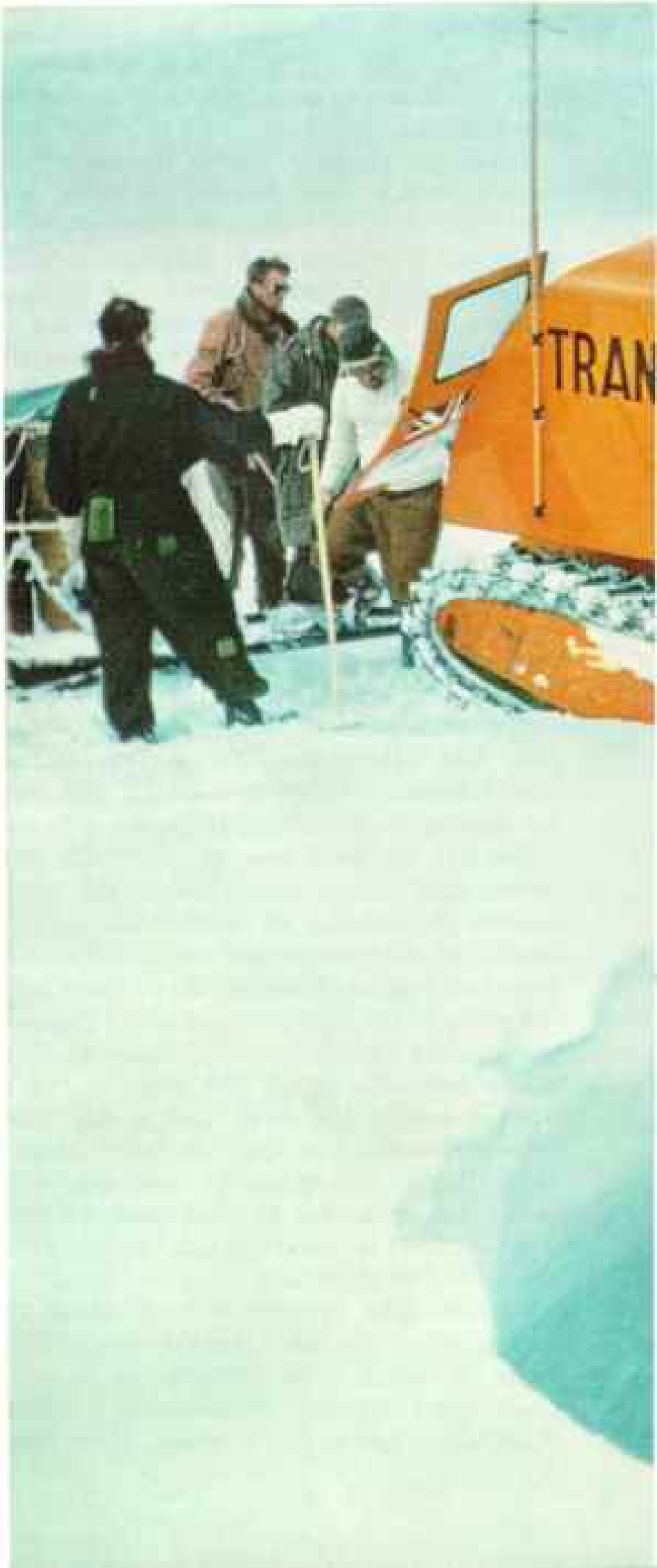
On the Ross Sea side a party was to reconnoiter a route up through the mountains to the polar plateau. They would lay food and fuel depots along the route, thereby reducing the load to be carried across the continent.

Such a journey would permit the exploration of an entirely unknown area between the Weddell Sea and the Pole and make possible the mapping of the western side of the mountains surveyed by Scott and Shackleton from the east. An inland station was to be established and manned during the winter for weather and glaciological purposes, and this would also be the main depot from which the crossing party would set off, fully supplied.

During the journey, seismic soundings and a gravity traverse would be made to discover the depth of the polar ice sheet and the form of the rock surface beneath.

The next step was to obtain support, and the response was generous and immediate. Financial aid came from Her Majesty's Government and from New Zealand, South Africa, and Australia. Later New Zealand was to do a great deal more by assuming responsibility for the Ross Sea Party and Scott Base and placing the noted climber of Mount Everest, Sir Edmund Hillary, in charge of that vital part of the project.* Contributions came

*See "Triumph on Everest," by Brig. Sir John Hunt and Sir Edmund Hillary, NATIONAL GEOGRAPHIC MAGAZINE, July, 1954.



Stranded Sno-Cat straddles a crevasse, one of many hazards that faced the Commonwealth Trans-Antarctic Expedition. Other vehicles towed the tractor to safety despite difficulties with the 8-foot pontoon dangling in the crevasse (page 25). The men unload cargo.

too from various trusts and societies, notably the Royal Geographical Society, and from industry, schools, and the general public.

To establish a base and land a wintering-over party, the expedition headed south in mid-November, 1955, aboard the chartered Canadian sealer *Theron*.

All Winter in Tents and a Crate

Unusually bad ice conditions delayed us, and it was January 30 before the ship was made fast at the foot of the ice shelf near Vahsel Bay and unloading began.

About one mile from the sea we built our base, called Shackleton in memory of Sir Ernest Shackleton, who had set out in 1914 with the same object of crossing the continent.

Because of the lateness of the season there was no time to erect the hut in which the eight members of the Advance Party were to spend the winter. Pack ice was threatening to close the *Theron*'s escape route, and all that could be done before the ship left was to re-erect the Sno-Cat packing case to serve as an emergency shelter until the main hut could be built.

As it turned out, blizzards prevented build-

ing the hut, and these eight men spent six months sleeping in tents with only the crate as living quarters. It measured 21 feet by 9 by 8. Despite these appalling conditions, the Advance Party under Ken Blaiklock performed their tasks. When spring came, they had the hut built and soon reconnoitered the first part of the route to the south.

Now these hardy veterans would be reinforced with more men, more vehicles, and new stores with which to face the second winter and prepare for the crossing of the continent. Our ship this time was the newly built Danish polar vessel *Magga Dan*.

South Ice, our inland scientific station and advance base 300 miles nearer the Pole, was promptly established by air. We made many flights inland, exploring and naming a number of physical features (page 31). The Touchdown Hills, for example, take their name from the time Flight Lt. Gordon Haslop in the de Havilland Otter was flying in bad light conditions and went down to find out the height of the lower clouds. Suddenly the Otter bounded upward as its skis at 110 knots hit some snow-covered hills so merged with the cloud as to be invisible. Fortunately he regained control.

Marooned! Ship Leaves, Not to Return

When a party is finally left by a ship in the Antarctic, there is a sudden brief feeling of intense loneliness. In our case, perhaps, that much misused word "marooned" could have been applied, for as in the days of the buccaneers we had been purposely set down on a desolate coast, and no ship would return to pick us up again. Our way out lay 2,000 miles across a continent.

We turned to the vehicles and dog sledges that had brought us down to the ship and hastened back to Shackleton. So much to do, so few to do it! Sixteen pairs of hands were not enough . . .

Late August, 1957, brought the returning sun, and we were eager to come to grips with what was to prove the worst part of our entire journey across the continent—reconnoitering a land route to South Ice, until then reached only by air. But atrocious weather made traveling impossible until October, in contrast to conditions across the continent where Hillary at Scott Base fortunately could start his spring journeying early in September.

It was October 8 when at last we were able to leave for South Ice—David Pratt, Geoffrey Pratt, Roy Homard, and myself, with three Weasels and one Sno-Cat. While we struggled through the crevasses of the Filchner Ice Shelf, our dog-team parties explored the Shackleton Range, to which they were taken by plane (page 42).

From beneath us often came startling sounds caused by movement of the ice below. In one crevasse the staccato metallic sound of breaking ice made us liken it to two men building a metal shed in the dark depths beneath. Another, about five feet from our tents, was even louder, sounding as though boilermakers were at work. We noticed that while at night there were a few sudden cracks, the hammering increased rapidly with the rising sun, to reach a crescendo at midday, then gradually to lessen and cease by the later afternoon.

Vehicles Roped Together Like Climbers

After some very narrow escapes, we began driving the vehicles roped together like climbers on a mountain. Often we also found it necessary to probe ahead on foot. In many particularly difficult stretches, each long and tiring day of prodding took us forward but half a mile. We used thin six-foot aluminum tubes to probe the layers of snow and ice, and assumed the area safe if resistance was still encountered at the full depth of the thrust.

Our ice chisels, mounted on solid wooden poles, were used differently. We plunged them downward, butt end first. If they struck a crevasse bridge, it would reverberate loudly, and these we came to call "boomers." Then, with the chisel end, we would cut a hole large enough to thrust one's head, and sometimes shoulders, through the lid to see the width and direction of the crevasse.

Hanging head down over a bottomless pit, with sloping blue-white sides disappearing into the depths, can be somewhat alarming—especially when you know that very soon you will be driving a three- or four-ton vehicle, together with heavy sledges, over the precarious snow bridge above the dark abyss.

Despite our best efforts and the help of our flyers, who flew reconnaissance and dropped supplies, only two of four vehicles completed the trail-blazing journey, and it took us 57 days and 400 trail miles to reach South Ice. We flew back to Shackleton in 2½ hours. Nine days later we started all over again!

In a radio message to Hillary I said:

WE COULD BE UP TO FORTNIGHT LATE ARRIVING SCOTT BASE BUT WILL ENDEAVOUR REDUCE THIS THOUGH POSSIBILITY REMAINS WE DO NOT ARRIVE TILL 9 MARCH . . . . DELIGHTED YOU HAVE VEHICLES ON PLATEAU AND GOING SO WELL. CONGRATULATIONS FROM ALL.

Snow cairn built by the trail-blazing dog-team party marks the route on the polar plateau. Such shining beacons were visible for miles. The Britons dubbed this one Snowhenge.

In a tent beyond the Pole, Sir Vivian Fuchs (left), expedition leader, confers with Sir Edmund Hillary, conqueror of Everest, whose Ross Sea Party laid depots the last 700 miles.

When we left for the Pole on November 24, 1957, the vehicles had all been nicknamed by their drivers. Behind Stratton and myself in Rock 'n Roll rumbled another Sno-Cat, Able, manned by David Pratt, engineer, and Kenneth Blaiklock, surveyor. Then followed our two Weasels: Rumble, with Dr. Allan Rogers, medical officer, and Hal Lister, glaciologist, while Wrack and Ruin was piloted by our New Zealand photographer George Lowe, a veteran of the conquest of Mount Everest.

Next came the Muskeg tractor named Hopalong, driven by our Australian geologist, Jon Stephenson, and bearing the emblem of a jumping kangaroo. Bringing up the rear was the Sno-Cat County of Kent, named by Kentish Sgt. Maj. D. E. L. (Roy) Homard of the Royal Electrical and Mechanical Engineers. With him rode Ralph Lenton, our radio operator.

Sno-Cats and Weasels were American vehicles; the Muskeg, Canadian.

Four days after Rock 'n Roll's narrow escape from that first big crevasse, we arrived at the 50-mile depot. By December 3 we were nearing the 11-mile-wide crevasse belt lying in front of the huge ice wall which marks the southern edge of the Filchner Ice Shelf.

Caution Comes a Moment Too Late

Presently we saw the checkered flag we had planted during the October reconnaissance to mark the first of these crevasses. I was just about to say to David Stratton, "I should

stop a little way before you get there," when we felt that horrible, prolonged sinking sensation. The Sno-Cat's hood rose up and up in front of us, then there was a jolt, a pause, and a final nerve-shattering lurch.

Carefully we crept out and scrambled to firm snow, to find the front pontoons clawing at the far edge of a chasm like the one that had almost proved our undoing earlier.

Recovery took less time than before, but we had cracked the steering platform of the rear pontoons, and repairs went on late into the night and the next day.

Less than a week later we were faced with our third major recovery when David Pratt's Able dropped almost out of sight in an immense crevasse. Here for the first time we used our crevasse-bridging units—14-foot lengths weighing 125 pounds and stressed to carry four tons. We had to fill the chasm below the stranded Sno-Cat by shoveling in snow until we had a surface capable of supporting the bridging team.

As we held our collective breath, the recovery vehicles began to strain, the Weasels whining, Grandmas growling, and then, like some monster rising from the deep, Able heaved and wallowed its way to the surface.

Three Narrow Escapes in a Day

By the time we had made about 200 miles, Squadron Leader John Lewis, commanding our Royal Air Force contingent, arrived in our Otter aircraft, bringing a spare Sno-Cat pontoon and other replacement parts. John was welcome, too, for his sense of humor. It was he who had remarked, when being fitted for his windproofs: "I'm 42-44-40. Call me Pear!"

We changed to night travel through the crevasse region. The lower temperatures, we reasoned, would give a crisper surface and perhaps add strength to the snow bridges.

In the crevasses at the foot of the Whichaway Nunataks, however, the warmer weather had wrought great changes. We were frequently astounded by our luck during the earlier journey. Continually the old tracks led across the now-sunken lids of great crevasses which could easily have swallowed all our vehicles, and we were obliged to probe for new routes and stronger bridges.

Twice in one day we nearly lost Ken. First a snow bridge gave way beneath his skis, and they fell 80 feet, to be lost forever. Fortunately the crevasse was narrow, and he saved himself by a truly remarkable display of acrobatics. New skis were taken to him, for it would have been foolhardy to walk in such an area. Later, as he knelt to examine a hole he had cut in a snow bridge, the whole bridge dropped away, leaving him balanced prayerfully on his skis over a four-foot-wide gap.

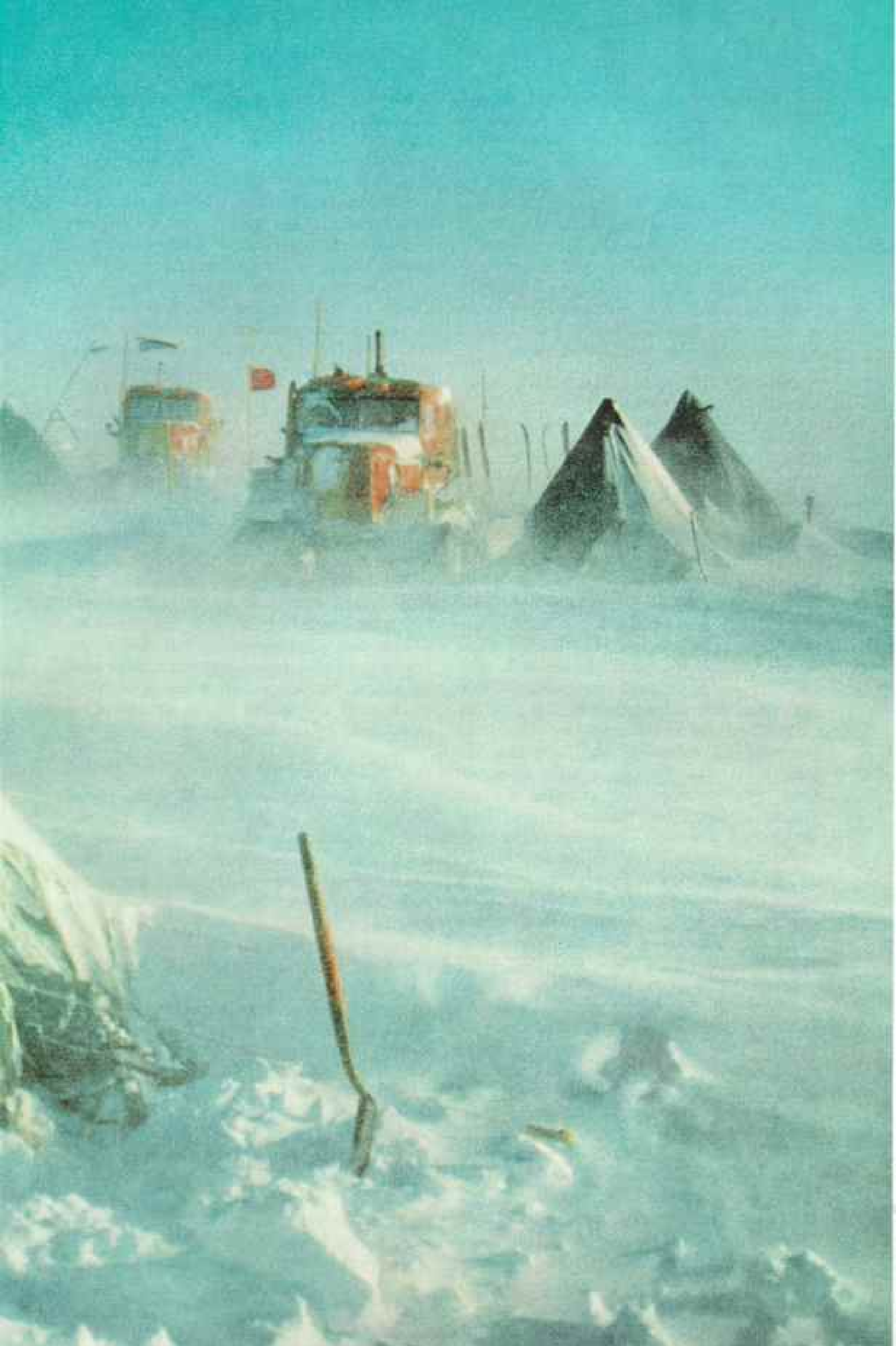
Finally, to cap our day, when the probing was over and we were walking to our tents beside the vehicles, the snow gave way beneath Jon Stephenson and left him hanging by one elbow over a deep, dark hole. Australian Jon emulated his national beast and

JON STEPHENSON

In the Theron Mountains the author found coal and sedimentary rocks that offered valuable clues to Antarctica's past. Fossil plants showed that 200 million years ago the continent supported tropic vegetation. RAF Squadron Leader John Lewis, pilot on this exploring flight, stands beside the Auster ski plane.

Subzero gales lash a camp bedded down in the ghostly light of the polar sun. Ventilators project from tent peaks like machine guns from turrets. Eternal winds scour snow from the surface, shrouding sledges, tractors, flags, and skis.

[illegible] BY DAVID PRATT



reached safer footing by a leap which would have done credit to any kangaroo.

After this treacherous stretch was passed, we had relatively clear sailing toward the Whichaway Nunataks, where we celebrated our progress with a visit to the great bleak rocks looming above us. After so much ice and snow, and with the prospect of nothing else until we arrived on the far side of the continent, it was a pleasure and a relief to feel the solid rock and to find a few fragmentary fossil remains of a bygone vegetation.

On December 21, at last, we arrived safely at South Ice, having traveled 349 miles in 29 days. Next day I radioed Hillary:

CONSIDER THIS WORST STAGE OF JOURNEY AND EXPECT RAPID TRAVEL FROM HERE ON .... WE LEAVE HERE WITH FOUR SNO-CATS THREE WEASELS ONE MUSKEG. WILL PROBABLY REACH YOU WITH FOUR CATS AND ONE WEASEL. TWO DOG TEAMS WILL TRAVEL AHEAD .... HAPPY CHRISTMAS TO YOU ALL.

Dog Teams Mark the Trail

Now our party was complete, for here we picked up Johannes La Grange, our South African meteorologist, and Geoffrey Pratt, geophysicist. Ken Blaiklock and Jon Stephenson, with two dog teams, were to drive ahead of us to mark trail. Off they went on December 23, carrying 20 days rations and wireless equipment with which to report their progress.

With the dog teams away, we turned our attention to unlashing and reloading the sledges. It was certainly a busy scene, for there were eight vehicles, counting the two already at South Ice, together with 12 large sledges and a number of smaller ones.

Everywhere stood piles of material—scores of fuel barrels, dozens of jerricans, stacks of boxes, ropes in profusion, and a hundred other items, all to be sorted, stowed, and lashed down before we could leave on the next leg of our journey to the Pole.

When we went to our sleeping bags on December 24, 320 gallons of petrol had been used to fill the tanks of all eight vehicles. The sledges bore another 109 barrels, totaling 5,200 gallons and weighing about 21 tons. We also carried half a ton of lubricants and a ton and a half of tools and spare parts.

The remaining nine tons of pay load included half a ton of explosive for the seismic work, one and a half tons of food, half a ton of kerosene, and scientific equipment, tents, camping gear, ropes, skis, ice axes, and all the other minor needs of a party that is to be entirely self-contained for three or four months.

Christmas was the day set for our departure, but overriding all else was our determination to hear the Queen's Christmas Day broadcast. Congregated in the hut in utter silence, we listened to that faraway voice speaking across the world. To us, who were perhaps the most isolated listeners of all, there seemed to be special encouragement, not only because we were proud that Her Majesty was the expedition's patron, but because we were engaged upon a Commonwealth enterprise.

Outside once more, we still found last-minute things to do, and as each vehicle and its sledges were completed, the drivers decorated them in Christmas spirit. Besides Union Jacks and flags of the Commonwealth, a White Ensign and the ensign of the RAF appeared. The gay scene was further enhanced by the fluttering of dozens of red-and-black trail pennants and red-and-white-checkered flags for marking crevasses. The long column rounded the now deserted hut and turned south toward the Pole 555 miles away.

Blaiklock and Stephenson had reported no trouble over the first 32 miles, although the surface consisted of patches of iron-hard sastrugi—ridges carved by the wind in the surface snow—with very soft snow lying between.

That first evening progress was slow as the vehicles and sledges bumped and banged over the ridges, but we pushed on for three hours to camp at the second of the six-foot snow cairns built by the dog party.

White-out Shrouds the Way Like Fog

White-out—that condition of diffused light when there are no shadows and no horizon, and the sky merges with the snow—made it impossible to move the next morning without danger of damage to the vehicles. We therefore took the opportunity of making a seismic sounding (page 44).

As soon as we could see the surface, we moved off over the terribly hard and extensive sastrugi. A series of undulations extended across our path, and we found that the worst sastrugi always occurred on the north-facing slopes. That night we stopped at the dog party's 35-mile cairn after making 25 miles.

So developed the picture of travel which was to be our lot throughout almost the entire journey—long hours of slowly grinding over hard sastrugi or through deep, soft snow, frequent minor troubles with one or another of the vehicles, taking meteorological and gravity observations every three hours, and periodically boring holes for seismic shots.

Camping, eating, vehicle maintenance, and

First Across Antarctica

THE BRITISH COMMONWEALTH TRANS-ANTARCTIC EXPEDITION
November, 1957 to March, 1958

0 100 200 300
STATUTE MILES

* Features named by expedition

Vahsel Bay (Duke Ernst Bay)

*Touchdown Hills

*Theron Mountains

Shackleton Base (U.K.)
Fuchs party left November 24, 1957

50-mile Depot

*Shackleton Range

Filchner Ice Shelf

South Ice (U.K.)

Expedition passed between mountain peaks sticking through ice and named them Whichaway Nunataks

Dufek Massif

Atlantic Ocean

Weddell Sea

*Emperor Bay

Shackleton Base

Palmer Peninsula

ANTARCTICA

South Pole

Scott Base

South Magnetic Pole

Pacific Ocean

Indian Ocean

Trans-Antarctic trek, described by Sir Ernest Shackleton as "the last great Polar journey that can be made," took the 12-man Fuchs party 2,158 snowy miles across a vast continent still wrapped in the Ice Age.

Between Shackleton Base and the Pole the expedition traversed a part of Antarctica on which man never before had set foot.

Figures along the route indicate altitudes in feet on the polar plateau, as determined by the explorers. Supply depots established by the Hillary support party are numbered by their distance in miles from Scott Base.

Soundings indicate that a 50-mile-wide basin, covered with 8,000 feet of ice, lies beneath Polar Station

Polar Plateau

South Pole

Amundsen-Scott Station (U.S.)
Fuchs party arrived January 19, 1958

Shackleton's deepest penetration on his attempt to reach the Pole in 1909

Route to Pole from Scott Base pioneered by Hillary party

Queen Maud Range

Amundsen, 1911-12

Beardmore Glacier

Queen Alexandra Range

Depot 700

Midway Depot

Depot 480

Shackleton, 1908-09

Scott, 1911-12

Ross Ice Shelf

Amundsen, first to reach South Pole, traveled this route, 1911-12

Scott died here returning from the Pole in 1912

Skelton Depot

Skelton Glacier

Plateau Depot

Mt. Feather

Mt. Newall

Little America V. (U.S.)

Bay of Whales

Scott Base (N.Z.)
Expedition arrived March 2, 1958

Ross Island

Mt. Erebus

Ross Sea

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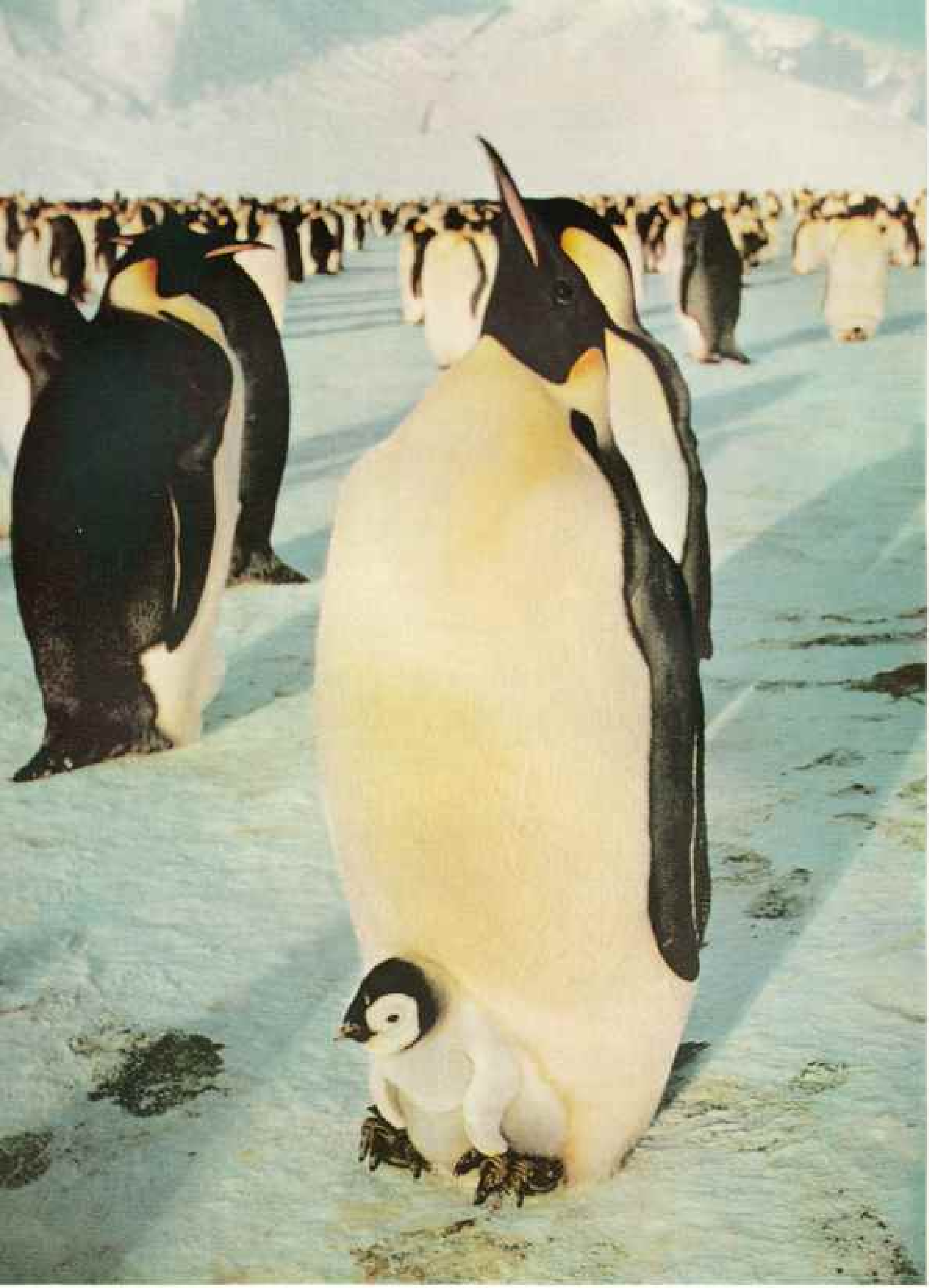


BROADCASTING BY ALLAN HOUSER

Emperor Penguin Chick Surveys an Icy World from Mother's Stomach Flap

This colony at Emperor Bay, one of the largest rookeries in Antarctica, numbers some 20,000 flightless residents. Males of the species brood the eggs until hatching time.

sleeping had all to be fitted into what hours remained. There was generally very little time for sleep, and at the end of the journey I am sure that we all considered the outstanding hardship to have been lack of rest.

On the fifth day of travel on the polar plateau, we reached the cairn marking 100 miles from South Ice. Our altitude was now 5,800 feet. The cairn stood in a hollow running east-west to join another deep, curious-looking depression which appeared to extend almost north-south. Geoffrey's gravimeter indicated a sudden shallowing of the ice, and we thought that the surface disturbances were probably due to this.

The last day of 1957 brought beautiful clear weather—but bad luck. George Lowe broke a sledge runner, and then Allan's Weasel, Rumble, broke a track and had to be abandoned, for no replacement was carried.

Fortunately we had left the Muskeg tractor at the last camp site only six miles back. It was the first of the vehicles to be dropped, according to plan, as consumption of fuel lightened our loads. Now it was possible to go back and pick it up to replace Rumble. Everyone had a soft spot for Hopalong because it had gone so far and so well with a heavy load and had given no trouble. But since we had no Muskeg spares, it would have to be the next to go.

"Another 30 miles today," I wrote in my journal on January 2, "but what a labour! All vehicles in first and second gear all the way over the most corrugated fields of continuous sastrugi. The strain on vehicles and sledges is prodigious. . . ."

Sled Tracks Tell a Story

It was impossible to go round the high, ice-hard ridges, for they formed a great field that extended out of sight in all directions. Each driver had to judge the course for his own particular type of vehicle, and often we found ourselves scattered a mile or two apart, working our way among ridges four and five feet high.

Twisting and turning, sometimes at right angles to the course, we tried to keep within reasonable distance of the dog-sledge tracks. Even these wandered considerably, and here and there the tracks in the snow revealed the upsetting of a sledge. Where two ski tracks ended abruptly against a ridge, we knew that someone had come to grief.

Some of us had the added irritation of towing a dog sledge behind the main load. This, being narrow, would yaw from side to side, often turning over and having to be righted by a fuming passenger. And yet we had good reason for taking these additional dog sledges. Should the vehicles break down, making it necessary for us to walk the remainder of the distance, we should have to have sledges that we could man-haul.

Mile after mile this trial of tempers and equipment continued. "Will it ever stop?" we wondered. By now we had expected to be well up on the polar plateau, experiencing relatively easy going instead of these endless sastrugi stretching at right angles to our path. The winds, it seemed, must blow perpetually from the east, scouring and grooving the surface year after year.

Hillary Advises Postponing the Attempt

Meanwhile, on the other side of the continent, Hillary on December 20 had finished his task of stocking depots for us and had set out with three tractors and four companions on a dash to the Pole (page 40). Just after midday on January 4 he drove through the last few miles of soft snow into the U. S. South Pole station, completing a trip of 1,250 miles.

Now from the Pole he sent a message suggesting that, as we were delayed, I should consider stopping at the Pole and flying my party out with the aid of the Americans, to complete the journey the following year.

As I, and all my party, had complete confidence in our ability to carry the journey through, there was virtually no decision to make. Although the frightful sastrugi had slowed our progress, we had come more than 200 miles from South Ice. We had previously operated our vehicles at −60° F., and I did not expect such winter temperatures by March, by which time I planned to be at Scott Base, approximately 1,600 miles distant.

I radioed Hillary that there was no question of abandoning the journey. The worst was behind us, and we all felt we could beat the Antarctic winter to McMurdo Sound. We were determined to complete the job.

Unfortunately, this exchange of messages became known to the press, which presented it to the public as a *cause célèbre*, although we were not to realize this until our arrival at the Pole. Certainly we did not regard it as such and were principally concerned with getting on quietly about our work.

At last, on January 5, the dog-team party reported passing out of the bad sastrugi, and

Quilted Eiderdown Suits Protect Surveyors Mapping the Royal Society Range

Members of Sir Edmund Hillary's party, exploring mountains west of McMurdo Sound, charted areas unknown to cartographers. This team atop 7,000-foot Mount Newall takes sightings with a theodolite. Hillary designed the cold-weather gear on the basis of his Everest experience.

Colors in snow crystals appear in a film made with polarized light for scientific study. The unaided eye sees nothing but white. This section came from 150 feet below the surface; dark line across middle indicates an old wind-crust layer.

Frozen blue-green algae lie imprisoned by ice in a pool near the Shackleton Range. Testing the leathery plant as a starvation ration, expedition members found it almost tasteless.

PHOTOGRAPHS BY GUY WARREN (ABOVE), JON STEPHENSON (OPPOSITE), AND GEORGE LOWE

presently we too began to make better progress, thankfully completing 32 miles that day after finally being able to drive two or three consecutive miles in top gear. On this day, as well, we regretfully abandoned the Muskeg tractor Hopalong, a hard-working friend whose memorial is an empty sledge and a pile of 14 empty fuel drums at 85° 15′ south latitude.

From January 6 onward, the dog teams ran with the vehicles, and that day we made 30 howling, yelping miles.

During the night of the 6th, John Lewis and his RAF party flew almost over our camp on their nonstop flight from South Ice to Scott Base in the expedition's Otter—the first trans-Antarctic flight ever even attempted in a small single-engine aircraft. The flight had been delayed by weather, and, unaware that this was the day, we were asleep when they tried to raise us by radio as they passed.

Ice About 6,500 Feet Thick

Our routine called for seismic shots every 30 miles, gravity tests every 15 miles, and the use of the ramsonde—an instrument to measure variations in the hardness of the snow due to the weather of other years—once or twice a day. The ramsonde had an annoying habit of getting stuck when driven deep, requiring the digging of a pit to extricate it.

A seismic shot on January 9 at a point 240 miles from the Pole showed the ice to be about 6,500 feet thick. As our altitude at this time was 7,850, bedrock must have been 1,350 feet above sea level—lower than in the vicinity of South Ice, so much nearer to the coast.

Mysteriously now the dog drivers, Blaiklock and Stephenson, developed a sudden illness. Both had severe stomach disorders, nausea, and temperatures of 101° F. We quickly pitched their tent and made them as comfortable as possible in their sleeping bags.

During the past days four others had suffered the same trouble in lesser degrees, and it seemed that some infection was running through the whole party. This was especially puzzling because infections are rare in the Antarctic, and practically unknown among men long isolated from the outside world. Later all the rest except Ralph Lenton and myself fell ill with the same complaint. All recovered. We never did learn the cause.

On January 15 we abandoned Hal Lister's Weasel, transferring his glaciological gear to Rock 'n Roll. We now had four Sno-Cats and one Weasel. We had taken to traveling by sun compass, for the magnetic compass was already showing some sluggishness.

On the morning of January 17 two American planes flew over. By radio we learned that they carried Ed Hillary, Rear Adm. George J. Dufek, commander of the United States Navy's Operation Deep Freeze, and John Lewis, his trans-Antarctic flight successfully completed. With them, to our considerable surprise, was a posse of reporters.

Suitably impressed by this advance reception committee, we made 30 miles that day, and then, on Sunday, January 19, we began our last run of slightly more than 32 miles to the South Pole. We had come approximately 900 miles from Shackleton Base since our departure almost two months before.

Traveling well over soft, smooth snow, we topped a snow ridge, and suddenly there it was—a small cluster of huts and radio masts: the United States Amundsen-Scott IGY Station at the South Pole.*

* See, in the National Geographic Magazine: "Man's First Winter at the South Pole," April, 1958, and "We Are Living at the South Pole," July, 1957, both by Paul A. Siple.

Tractors in tandem haul a foundered mate from the jaws of a bottomless crevasse near Depot 700.

Blazing the 1,250-mile trail from Scott Base to the South Pole, Hillary's five-man support team used British-made Ferguson farm tractors modified with canvas windbreakers around the cabs and endless tracks over the wheels. Locking the steering wheels, drivers maneuvered by braking one track.

Glancing back at our little convoy, I could not help thinking it a brave sight. The Weasel heaved and plunged like a small ship in a brisk sea, churning out great sprays of snow, while the Sno-Cats sailed majestically, like battleships, over the snowy waves.

Now, in addition to our initial complement of banners, we were flying the expedition's official ensign, plus the flag of the city of Bristol in honor of Allan Rogers' associations with that city's university. A brilliant green streamer prepared by Johannes La Grange, our South African, bore the image of a springbok and a protea. Above all this wildly snapping color streamed the billowing white plumes of our exhausts.

South Pole Sees Its First Panama Hat

As we approached, two Weasels met us, and there was our reception committee, headed by Ed Hillary, George Dufek, and some 30 others (page 42). For the occasion I wore my regular sledging kit of red snow boots, blue ski pants, and white turtle-neck sweater, but George Lowe outdid all of us when he emerged from his vehicle impeccably attired in antarctic gear topped off by a Panama hat. This curious object he had purchased in Madeira on the voyage south and had carefully preserved for this high moment.

"Hello, Bunny," Ed Hillary called as I jumped down from Rock 'n Roll.

"Glad to see you, Ed," I replied as we shook hands, and then we were surrounded by a milling swarm of photographers, reporters, and cheerfully grinning base personnel.

As we had not crossed the date line, our day was still the 19th, but we found the Americans were keeping New Zealand time, which made it January 20. Their actual time was Greenwich Mean Time plus 12 hours. We therefore arrived in our night and their midday. I decided we should change to their time at once, and as a result I think most of us missed one whole night's sleep.

That night Admiral Dufek had to return to McMurdo Sound, taking Ed Hillary and John Lewis with him. Ed was to meet us at Depot 700 and accompany us the rest of the way.

The Americans gave us a party on the evening of January 22, at which we were each presented a fine colored testimonial to the effect that we had been around the world on our feet, a deed made possible by walking the few yards round the flag marking the site of the Pole itself. In our turn, we presented to the station our expedition flag.

On January 24, 1958, precisely two months after leaving Shackleton, we set out on our way north to the other side of the world. We had by no means reached the halfway point. Shackleton was only a little over 900 miles behind us, and the distance to Scott Base was another 1,250 miles, but we knew that every advantage, with the possible exception of the weather, lay with us.

JIM BATES

Americans Welcome the Britons to the Pole; Sno-Cats, Weasel, and sledges halt for the official

We had fewer vehicles to maintain, and when we dropped the last of our Weasels, we should be able to increase speed. Admiral Dufek having kindly offered to fly our dogs out to McMurdo Sound, we should no longer be held to 30 miles a day—the distance beyond which dogs begin to lose efficiency. The seismic soundings would be spaced more widely, and for the last 290 miles, from Hillary's Plateau Depot at the top of the Skelton Glacier, there would be no need of them.

Lastly, and very important, Ed Hillary and his parties had pioneered a route and provided all the fuel and food we needed. During the last 700 miles we should be well within range of aircraft flying from Scott Base.

Our only real concerns were the persistence of strong winds and drift and long periods of white-out. If these delayed us, and McMurdo Sound froze early, forcing the New Zealand ship *Endeavour* to leave, we should be committed to another winter in the Antarctic.

This we had always known, even before leaving England, and an extra year's supply

JON SWENSON

Airborne husky peers from the plane. The animals seemed to enjoy air travel immensely. "On one flight a dog sat behind the pilot," Dr. Fuchs says, "breathing encouragingly down his neck."

U. S. NAVY, OFFICIAL

Flags Fluttering, Dogs Yelping, the Expedition Arrives at Amundsen-Scott Station

greeting. With 900 miles behind them and 1,250 miles to go, the convoy pauses for a rest.

of food and fuel had been ordered for both Shackleton and Scott Bases. None of us wanted to winter over again, certainly not those who had already spent two consecutive years in the Antarctic, but, as we knew from earlier occasions, that is one of the chances taken by anyone who visits the continent.

Pole Lies in an Invisible Valley

Our first seismic shot, 25 miles beyond the Pole and 130 feet higher, told us that the depth of ice was something less than 2,000 feet. We had found almost the same depth 25 miles short of the Pole on our way in. But soundings at the Pole itself had confirmed an ice depth of about 8,000 feet at an altitude of 9,200.

It seems, therefore, that the Pole is situated on a great ice-filled basin some 50 miles wide between mile-high rock massifs, the second of which we had now reached. These observations were borne out by gravity readings.

On January 28, about 142 miles north of the Pole, David Stratton found Geoffrey Pratt unconscious in the cab of his Sno-Cat. Allan Rogers immediately diagnosed carbon-monoxide poisoning and went dashing for an oxygen bottle from our welding gear.

Now for the first time we were faced with a truly desperate problem. We had barely five hours' supply of oxygen, and we knew that at our altitude of 10,000 feet Geoffrey would require far more, for the rarefied atmosphere was impeding his breathing and might damage his heart. We were at the extreme range of our Otter, now at Scott Base, and even if the plane made it out to us, it would probably be unable to take off again to evacuate Geoffrey by air. This left us with the problem of carrying a sick man in conditions hardly suited to convalescence, for we could not stop traveling.

There was only one thing for it. We had to seek help from George Dufek.

By eight o'clock that night two American Neptunes had taken off from McMurdo Sound. One of them carried Dr. Griffith Pugh, a physiologist undertaking a special project at

Seismic charge hurls a snowy spire above the polar plateau. Batteries of sensitive Geophones detect shock waves, revealing the depth at which solid ground lies beneath the icecap.

Between South Ice and the Pole, the expedition halted every 30 miles, laboriously boring a 36-foot hole in which to bury the charge. Vehicles within two miles had to stop engines to avoid interference with recording instruments. The Sno-Cat Haywire trails a sledge with a bicycle wheel to record mileage.

McMurdo for the British Medical Research Council. By a fantastic coincidence, he was a specialist in carbon-monoxide poisoning!

The Neptunes reached us about midnight, picking us up by their radar. Their visibility was barely half a mile, and the cloud ceiling was at about 800 feet, making a landing doubly risky. After a radio consultation it was agreed that the planes should not land but instead should drop us two oxygen bottles by parachute. Down came the bottles from the sky, and with plenty of oxygen to speed his recovery Geoffrey was soon fit and back on duty.

About the same time, we abandoned our last Weasel, Wrack and Ruin, which had broken down and was no longer required, 212 miles north of the Pole. Sno-Cat maintenance, too, was haunting us, although this was hardly surprising in view of the tremendous punishment these big cruisers had been absorbing.

On February 7, traveling in the van, I spotted Depot 700 three miles ahead. Thirty-five minutes later we drew up beside the tall mast with its waving flag, surrounded by barrels of fuel and boxes of rations. Now, indeed, there was a sense of accomplishment, for we had reached the end of the 700-mile-long supply line laid out to meet us from the other side of the continent. From the Pole we had traveled 521 miles in 15 days, giving an average of almost 35 miles per day. Over the whole distance of 1,427 miles from Shackleton, it was now up to 19 miles per day.

White-out Brings Surprise

Late in the evening of February 9 the Beaver aircraft from Scott Base, piloted by Squadron Leader John R. Claydon, RNZAF, landed beside our camp bringing Ed Hillary, who was to accompany us the rest of the way. Besides mail they brought us eggs and fruit—which promptly froze solid.

We reached Depot 480 on the 17th, and set off from there the next day in a complete white-out, which of course prevented the use of the sun compass. I was driving with eyes firmly fixed on the magnetic compass when David Stratton drew my attention ahead. There I saw three Sno-Cats coming toward me! I had turned completely round and was heading straight back along our track.

Because of our relative nearness to the South Magnetic Pole, the compass had become so sluggish as to be utterly unreliable.

After some experimenting, we were able to devise a method of flagging the trail by placing in line three flags carefully orientated by a prismatic compass which had been allowed to steady for a long time. Two men riding on the sledges of the leading vehicle planted one flag after another in line with the first three at intervals of about 200 yards, thus extending the original line indefinitely. The vehicles followed the flags, a man on the last sledge picking them up for use farther on.

To keep on course, the leading driver had to steer with one hand while looking backward out the open door. With the other hand he gripped the window frame lest the lurching

precipitate him out the door and under the rear tracks. Forward vision and accelerator control were provided by the passenger.

The strain on the driver's arms and neck was considerable, but by changing drivers every two hours we managed to move 42 miles in the second day of white-out and felt we had devised a means of traveling satisfactorily even under these conditions.

First Rocks in 1,450 Miles Appear

Soon now came a day when the first distant rocky mountains swam into sight over the snow horizon to the east—the first rock we had seen since leaving the Whichaway Nunataks 1,450 miles back. More and more snow-clad masses, with a few dark patches of rock, began to show themselves as our course brought us close to the edge of the plateau.

Mount Feather, wearing a small plume of cloud, formed a good marker for locating the Plateau Depot, and there we arrived the following day, February 23.

Ralph Lenton had radioed Scott Base the approximate time of our arrival, but it was a great surprise when, as we were pitching our tents, there was a roar of engines and the Otter and the Beaver flew low over the depot, to circle and land a few yards away.

Since the temperature was −30° F., the engines of both planes were kept running while we exchanged greetings and had a brief celebration in the Otter. Presently the planes took off again, carrying with them Blaiklock and Stephenson, who were to prepare for a small exploring venture the following season.

That night we laid out the seismic gear for the last time. As the task was completed, the sun disappeared beneath the southern horizon. The season was drawing to a close, and it would soon be time to leave the high plateau, where we were still above 8,000 feet.

With the clouds lit red by the hidden sun, and the snow mauve in semishadow, yet flecked by darker colors in every hollow, we walked to our tents, knowing that the next

day we should plunge over the edge and wind our way down through the unfamiliar scene of rocky mountains and towering cliffs.

As we started on the long descent of the Skelton Glacier, the sky clouded over, the guiding rocks were hidden from view by blowing snow, and we began again to flag our route—Ed's tall figure planting the markers one after the other in an invisible surface.

Soon the following wind began to fill the cab of the lead Sno-Cat with snow, and the cold became too great to endure the necessarily cramped and twisted driving position. When we stopped to camp after 15 miles, we found the wind speed to be 35 miles per hour and the temperature –38° F.

Soon, however, the wind dropped, the sky cleared, and for 52 miles we had the most brilliant weather as we descended what Hillary's parties called the Upper Staircase, Landing, and Lower Staircase.

Toward the end of the day the wind rose again, and before we could pitch camp, it was gusting to over 60 m.p.h. Using the vehicles as windbreaks, we had little difficulty in erecting the tents, but all night the poles were bending ominously and we listened to constant noisy flapping (page 32).

Traffic Accidents Even in Antarctica

As we went down the steeper inclines of the glacier, we found them so smooth and hard that the sledges slid from side to side, completely out of control. Those linked to a Sno-Cat by a solid bar came to no harm, but Roy Homard's sledges were on steel-wire tows. The front one smashed into the Sno-Cat's rear, and a wooden beam on top of the load pierced its rear door, nearly transfixing those inside. Roy had to use a heavy rope brake under the sledge runners to reach the bottom of the slope.

All the way down the glacier, Ed's firsthand knowledge saved us many hours of route finding and possible difficulty.

Finally, away in the distance, some dark specks began to show, and this we knew must be the Skelton Depot on the Ross Ice Shelf.

Now came the last day of maintenance. We were happy to think that it would be some time before we would have to fill a grease gun again in numbing cold or become covered in a mixture of oil and drift.

On March 1 we very nearly capped our journey by a serious antarctic traffic accident which, happily, had its ludicrous aspects. Just as we were setting out, we saw an American Otter flying toward us, and as a gesture of sheer zest we fired a "two-star-red" flare in greeting. The Americans took our signal to mean that we needed something, so they circled and came in to land. Looking back from Rock 'n Roll, I saw the plane touch down.

"We had better stop," I said to David.

Seconds later, as he did so, the following Sno-Cat, whose driver was also looking to the rear, climbed over the top of our rear sledge. Its forward pontoons crushed a box containing hundreds of detonators. Had they exploded, it would certainly have been the end of that Sno-Cat.

In all the excitement, we forgot about the plane, which had taxied across the snow and taken off again without stopping.

That day we traveled 75 miles—the longest run of the whole journey. This left us 22 miles to go to reach Scott Base—a comfortable distance to travel by 2 p.m., March 2, which several days previously I had estimated as our time of arrival.

The Long Journey Ends

Before starting, we decorated our Sno-Cats for the last time with all the available flags and then moved off toward Castle Rock. There we picked up a line of trail pennants leading through the pressure ridges. This route had been prepared with the assistance of American bulldozers from the McMurdo station, only two miles from Scott Base.

As we ran in toward Ross Island, we saw the huts of Scott Base against the dark rocks of Pram Point, and now Weasels, Ferguson tractors, and Bren-gun carriers began to stream out to meet us. Soon we joined up, and as the Sno-Cats thundered and weaved between the ridges, escorted by a wide variety of vehicles, scores of figures stood, cameras clicking, at every vantage point.

At precisely three minutes to two on March 2, 1958, our long journey was over. We had traveled 2,158 statute miles from Shackleton to Scott Base via the South Pole. We had thought the journey would take 100 days and our average speed would be 20 miles per day. We now found that we had completed the trip in 98 days (99 by the calendar, because we had crossed the date line at the Pole), and had averaged 22 miles per day.

We knew one man would be particularly happy at our arrival—Capt. Henry Kirkwood, RN (known to us all as "Harry Plywood"), commanding HMNZS *Endeavour* and waiting to take us to New Zealand before McMurdo Sound froze over. He told me later that,

according to his calculations, we were one day late!

In front of Scott Base the vehicles assembled on the sea ice, and confusion reigned as scores of photographers had their way with the somewhat astonished new arrivals. Then we all congregated around the flagstaff and listened to speeches of welcome from our own people and the Americans.

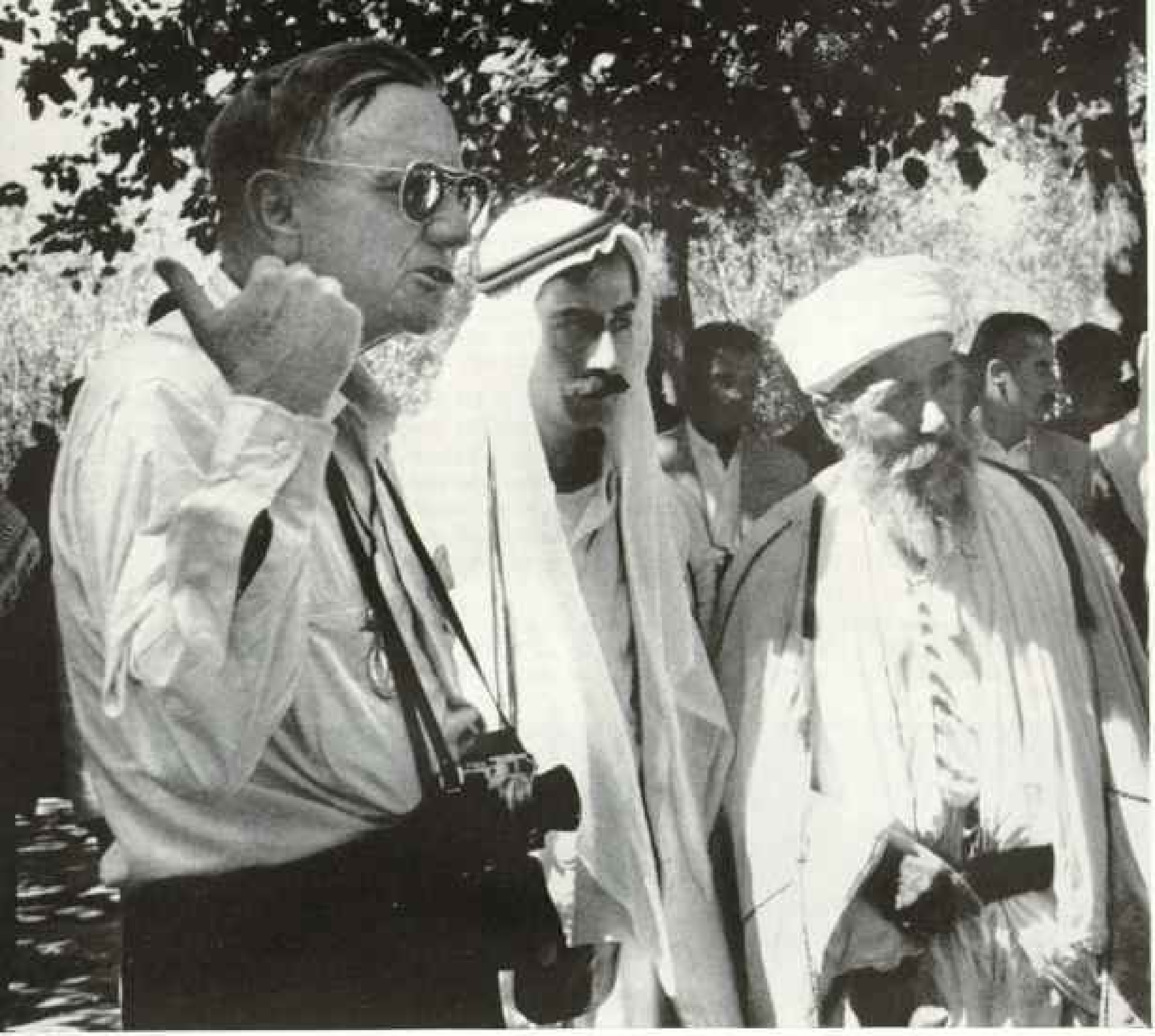
An improvised band from "over the hill" did their worst with our national airs, ending up with what we were told was "God Save the Queen." The band had been formed the night before by calling for all who thought they could play an instrument. "It doesn't matter if you can play," they were told, "but you gotta be able to play loud." And they certainly did.

The finest reward for all of us, for all the years of labor and all the long days on the journey, was a cable received at Scott Base from our patron, Her Majesty the Queen:

ON THE COMPLETION OF YOUR HARD AND ADVENTUROUS JOURNEY ACROSS ANTARCTICA, MY HUSBAND AND I SEND OUR WARMEST CONGRATULATIONS TO YOU AND TO ALL MEMBERS OF THE COMMONWEALTH TRANS-ANTARCTIC EXPEDITION. YOU HAVE MADE A NOTABLE CONTRIBUTION TO SCIENTIFIC KNOWLEDGE AND HAVE SUCCEEDED IN A GREAT ENTERPRISE. WELL DONE.

Not far from Scott Base, on a lonely hill, stands the simple cross erected in memory of Robert Falcon Scott and the members of his party who perished with him in March, 1912, just 46 years before our journey ended. I believe all of us wished deeply that he could have lived to receive such a message.

American bandsmen hail an epic victory beneath the British colors at Scott Base, the expedition's goal. Volunteers from neighboring McMurdo Sound included musicians and non-musicians. Britons could scarcely recognize their national anthem, "God Save the Queen."



STATION WAGON ODYSSEY:

Baghdad to İstanbul

A famous American traveler continuing a journey across the Moslem East finds new friends and changing nations

By WILLIAM O. DOUGLAS

With photographs by the author and Mercedes H. Douglas

OUR first day's drive from Baghdad toward the distant Golden Horn took us from the Fiery Furnace to a meeting with the Prince of the Devil Worshipers.

Baghdad was still asleep when we left it. Lampposts cast lonely shadows on empty streets. We met only an auto with sputtering yellow headlights and a creaking bullock cart as we headed toward Kirkūk and Mosul (Al Mawsil) in northern Iraq (map, page 52).

My wife Mercedes, an American friend of ours, Mary Watkins, and I were well past the

A Supreme Court Justice Touring the Simmering East Talks with Tribal Leaders

"People are a good mirror in which to see the soul and spirit of a nation," reports Justice William O. Douglas after his most recent journey through Southwest Asia.

Motoring many a dusty back road on their trip from Karachi to Istanbul, the Justice and his wife met shepherds and governors, nomads and shopkeepers of five nations. He described the lands and peoples east of Baghdad in the July, 1958, National Geographic.

Here the author and Prince Tahsin Said (right), leader of the Yazidis, a Kurdish religious sect sometimes called Devil Worshipers, talk with priests and elders at Ash Shaykh 'Adi, the faith's holiest shrine.

Yazidis claim followers in the U.S.S.R., Turkey, Iran, and Iraq. Adherents believe in a God who created the universe but pay deference to *Shaitan* (Satan) as a fallen angel who carries out God's will on earth. They honor him with feasting and dancing, regard the peacock as his emblem, but never speak the name Shaitan.

halfway mark of a journey across 4,000 miles of Southwest Asia, a journey which with all its side trips stretched to 7,000 miles. West Pakistan, Afghanistan, Iran, and much of Iraq had already rolled beneath the wheels of Mary's laden, long-suffering station wagon.*

By now we knew all too well our car's inclination to break springs, drop its muffler, or blow a tire at the most awkward spots. With a cruel plain of gray sand and camel's-thorn ahead, we wanted to embark on this next major leg in the cool of morning.

Flaming Gas Above the Plain

The sun was not long up before it was showing its authority. By 9 a.m. the thermometer was mounting toward 120° F. By 11 a.m. we had sighted the flaming jets of natural gas from the oil field of Kirkūk; they seemed a fitting climax to the burning, desolate country we were crossing.

Kirkūk is the center of a vast petroleum industry operated by IPC, the Iraq Petroleum Company. Revenue from IPC finances Iraq's great capital developments—particularly the irrigation, drainage, and flood-control projects that we saw the length and breadth of Mesopotamia.

We stopped at the U. S. Consulate to visit Mr. and Mrs. Lee Dinsmore and to talk of these developments and the changes oil is bringing to the face of Iraq.† Then we drove

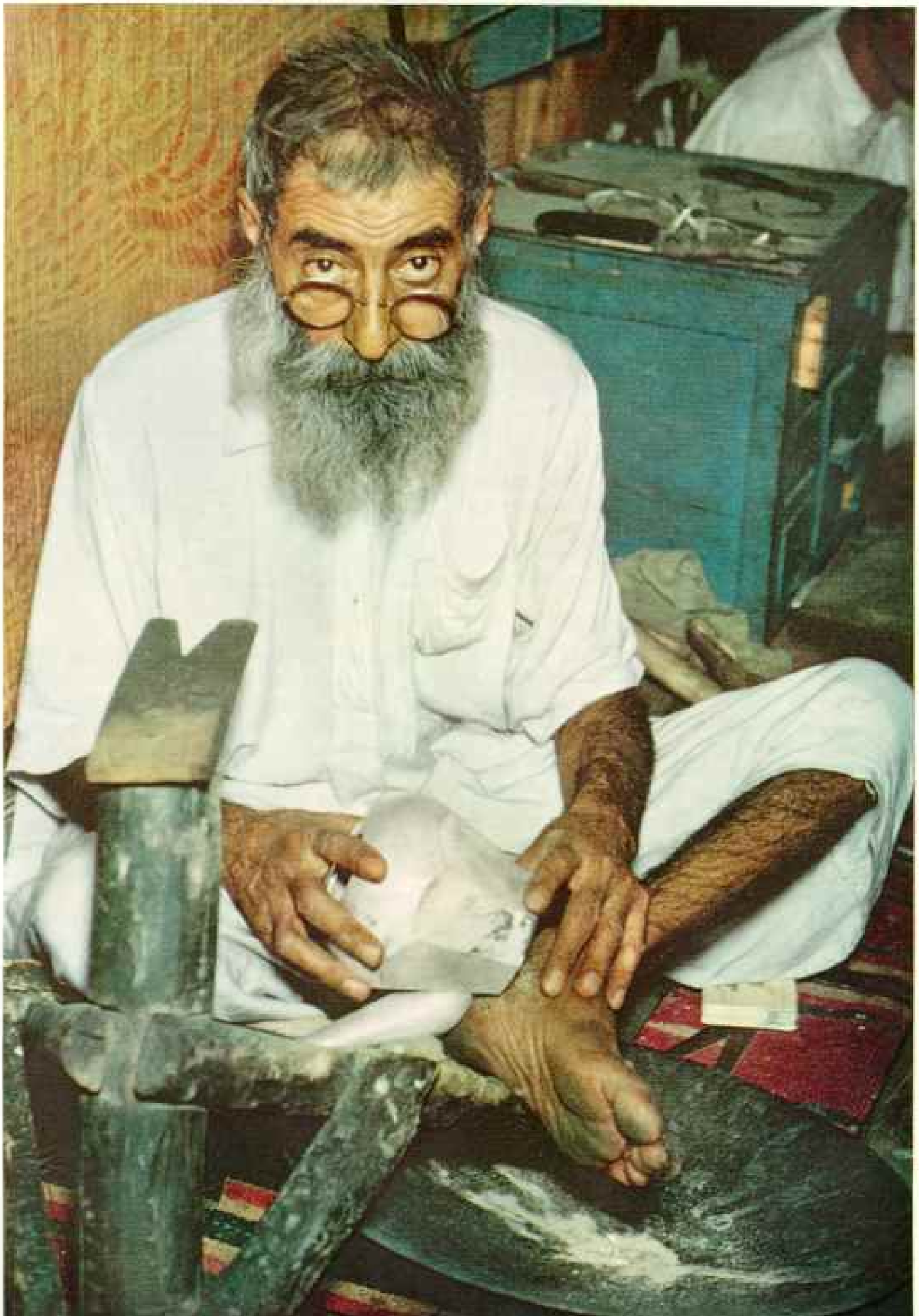
* See "West from the Khyber Pass," by William O. Douglas, NATIONAL GEOGRAPHIC MAGAZINE, July, 1958, and the author's new book, *West of the Indus*, published by Doubleday and Company.

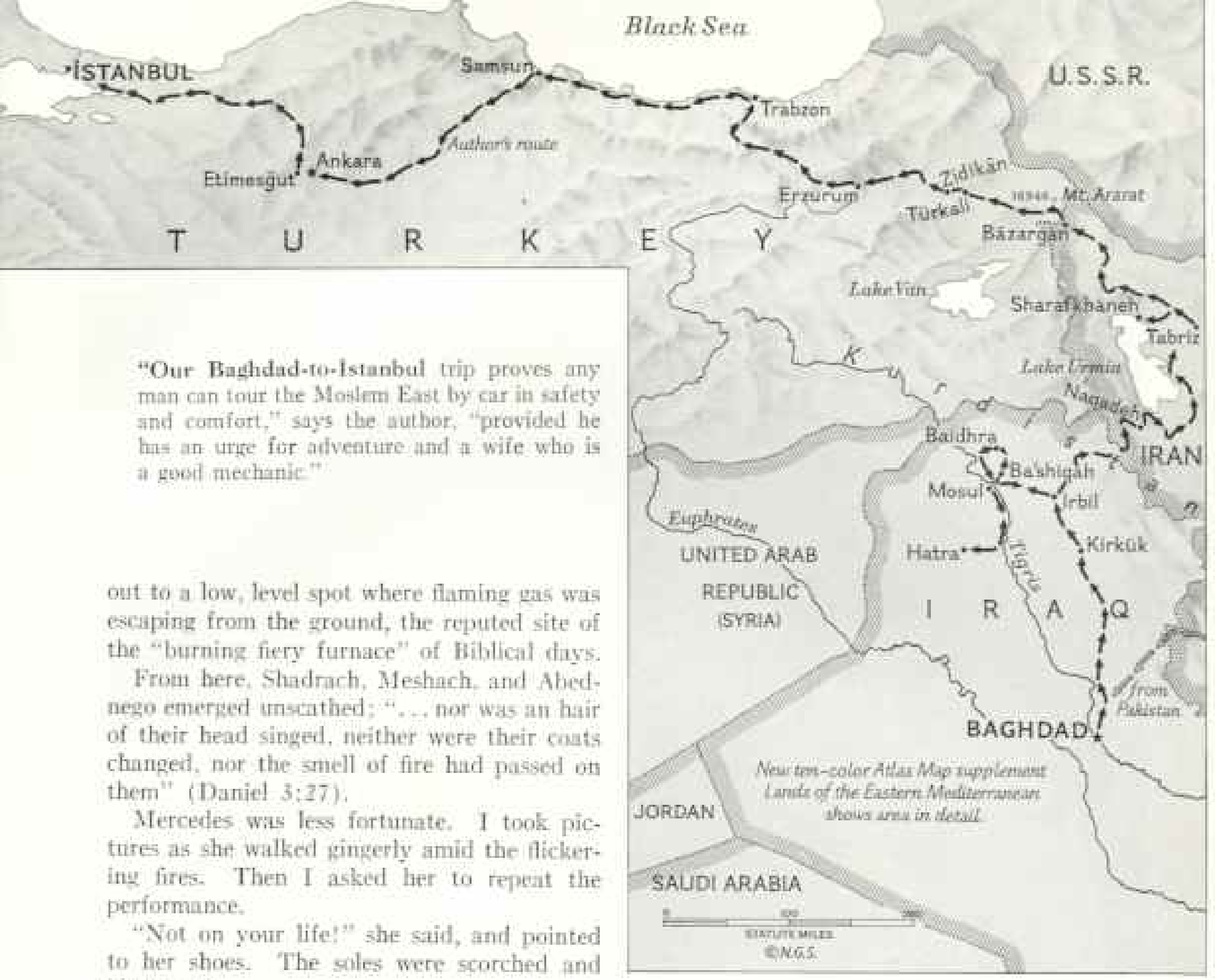
† See "Iraq—Where Oil and Water Mix," by Jean and Franc Shor, NATIONAL GEOGRAPHIC MAGAZINE, October, 1958.

John the Baptist, a Baghdad Silversmith, Claims Descent from the Saint

Artisans of River Street, a lane of silverworkers, are Mandaeans (Sabaeans), a minority neither Moslem nor Christian. Members often call themselves Baptists.

BOOKBINDERS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER J. BAYLOR ROBERTS (OPPOSITE) AND WILLIAM C. AND MERCEDES H. DOUGLAS © N. G. S.





"Our Baghdad-to-Istanbul trip proves any man can tour the Moslem East by car in safety and comfort," says the author, "provided he has an urge for adventure and a wife who is a good mechanic."

out to a low, level spot where flaming gas was escaping from the ground, the reputed site of the "burning fiery furnace" of Biblical days.

From here, Shadrach, Meshach, and Abednego emerged unscathed; "... nor was an hair of their head singed, neither were their coats changed, nor the smell of fire had passed on them" (Daniel 3:27).

Mercedes was less fortunate. I took pictures as she walked gingerly amid the flickering fires. Then I asked her to repeat the performance.

"Not on your life!" she said, and pointed to her shoes. The soles were scorched and blackened.

She was still feeling aggrieved late in the afternoon when, hot and weary, we pulled up to the railway station hotel in Mosul. No sooner had we reached our rooms than a bellboy announced that the Prince had arrived to pay his respects.

My mind went blank for a second. Then it dawned on me that this was Prince Tahsin Said of the Yazidis—the people known as the Devil Worshipers (page 49).

Dirty as I was, I went down to see Prince Said. He was a large man in his twenties, with coal-black hair and heavy beard. His brown eyes were deep-set and slightly bulging; his fingers were long and slender, almost delicate. He wore a dark Western coat over typical Iraqi clothes: loose white trousers, a long white shirt, and a white kaffiyeh with a black cord. When he rose from his chair, I noticed a holster and revolver at his waist.

Through an interpreter I declined his dinner invitation because of our late arrival. I arranged instead to meet him at seven the next morning to visit the shrines of this strange and little-understood sect.

The Yazidis, I was to be told the next day, believe in God and maintain that He is good, forgiving, and all-wise. God, however, does not need to be propitiated, for He can be counted on to do the right thing. The force to reckon with is the Devil.

While God will eventually rule the earth, the Devil, called by them Malak Ta'us, the "Peacock Angel," rules at present and for the foreseeable future. Therefore he must be constantly honored.

The Yazidis follow many teachings of the Koran, as well as having two holy books of their own. The most important, their *Kitab al-Djilwa*, or Book of Revelation, contains the teachings of Malak Ta'us. Its opening lines are, "I was, I am, and I shall be unto the end of time, ruling over all creatures and ordering the affairs and deeds of those who are under my sway."

In the morning, almost as soon as we were in the car, the Prince said through our interpreter, "I want to congratulate you on the Baghdad Pact."

Mercedes Douglas Films Hatra's Crumbling Ruins

At the ancient Assyrian village of Hatra in Iraq, conquering Parthians built a fortress city ringed by four miles of thick walls. Using mud blocks, limestone, and marble, they raised palaces, public buildings, and a vast Temple of the Sun.

Hatra repulsed the sieges of two Roman emperors; but the Persian King Shapur I sacked it in the third century after Christ, leaving the proud city a mass of rubble standing stark on the plain.

Wooden plow, fashioned from a tree branch and capped with iron, still serves an Iraqi farmer. Mat hut in background shelters a family south of Baghdad, where cereals, vegetables, fruit, and cotton grow on lands reclaimed by drainage.

"Thank you," I replied. "Do you think it is a good defense against Communism?"

"I do not know about Communism," he answered. "But the pact is good for the Yazidis. There are many Yazidis in Turkey. Since World War II, I have not been able to visit them. But since the Baghdad Pact, travel is easier. I can thank America for bringing the Yazidis of Turkey and Iraq back together."

I asked him how many Yazidis there were in Iraq. He said there were 280,000—a figure which Iraqis believe is much too high. In Turkey, he said, there are 15,000 Yazidis.

He seemed visibly disturbed by border barriers that kept him from his flock. "Turkish members are delinquent in dues," he said.

The contributions of the Devil Worshipers support, in part, 400 members of Said's royal family, I was told. The Prince can appropriate any farm, livestock, food supply—even women for his harem—from the Yazidis.

Not only does he levy taxes on his people, but he sits in judgment on them also. In Iraq each religious community has its own courts. Crimes such as murder come before the Iraqi courts, but a murder involving only Yazidis may be handled by the Prince directly, even to imposing the death sentence.

"How is the sentence executed?" I asked.

"The Prince hands down word that the man

A Subdivision Springs Up in Ancient Mesopotamia. Lawns and Trees Ring the New Houses

shall die," a Yazidi explained. "He turns the convicted person loose; and we hunt him down and kill him in private."

I learned too why the Prince always goes armed. His father and his grandfather, I was informed, were each murdered by a relative who wanted the lucrative job. Few of his predecessors died in bed.

In the Yazidi village of Baidhra, a small place on a barren slope dotted with mud huts, we visited a brother of the Prince for lunch. A dozen or more armed men, bodyguards of the Prince, lounged around the sparsely furnished square stone house.

We were offered refreshments before lunch and ordered soft drinks. To my wonder the Prince ordered whiskey, which he drank down like lemonade. I expressed my surprise that this religious order, in the heart of Islam and holding some tenets in common with it, should sanction alcoholic beverages.

"We drink what the Devil would want us to drink," a Yazidi whispered.

I never saw men eat as the Yazidi royalty did that noon. The Prince and his relatives went to work on the huge pile of food and uttered hardly a word until they finished. Over and over again they came back for helpings and chided us for our meager servings. The whole roasted sheep soon vanished as they tore away at it with their fingers.

After lunch there was no siesta, for we had a tortuous drive ahead to the foremost Yazidi shrine of Ash Shaykh ʿĀdī, northeast of Baidhra and nearer the Turkish border. Here we visited their holy of holies, a temple shaded by mulberry trees and bearing, cut into its marble doorway, a shiny black serpent with its head pointed skyward. The threshold stone was worn smooth from kissing.

The Prince took us into the temple's dark interior. An attendant lighted an olive-oil lamp, illuminating two pitch-dark naves that had vaulted ceilings. In a corner of one was a spring; the other opened into a rock-lined room, where a casket lay draped with cloth.

The Prince stood in silence, then knelt and prayed. The oil lamp flickered, casting weird shadows. It was a relief to get back to pure sunlight.

After it was all over, I had a melancholy feeling. No Yazidi I met had smiled. They seemed eternally sad and rather cowed. There was no simple, lighthearted moment in our long day together. An important element seemed missing from their religion. Love was not there.

I could remember only how the Prince gulped his whiskey, his limp handshake on departure, the slightly bulging eyes that seemed filled with fear and infinite sadness.

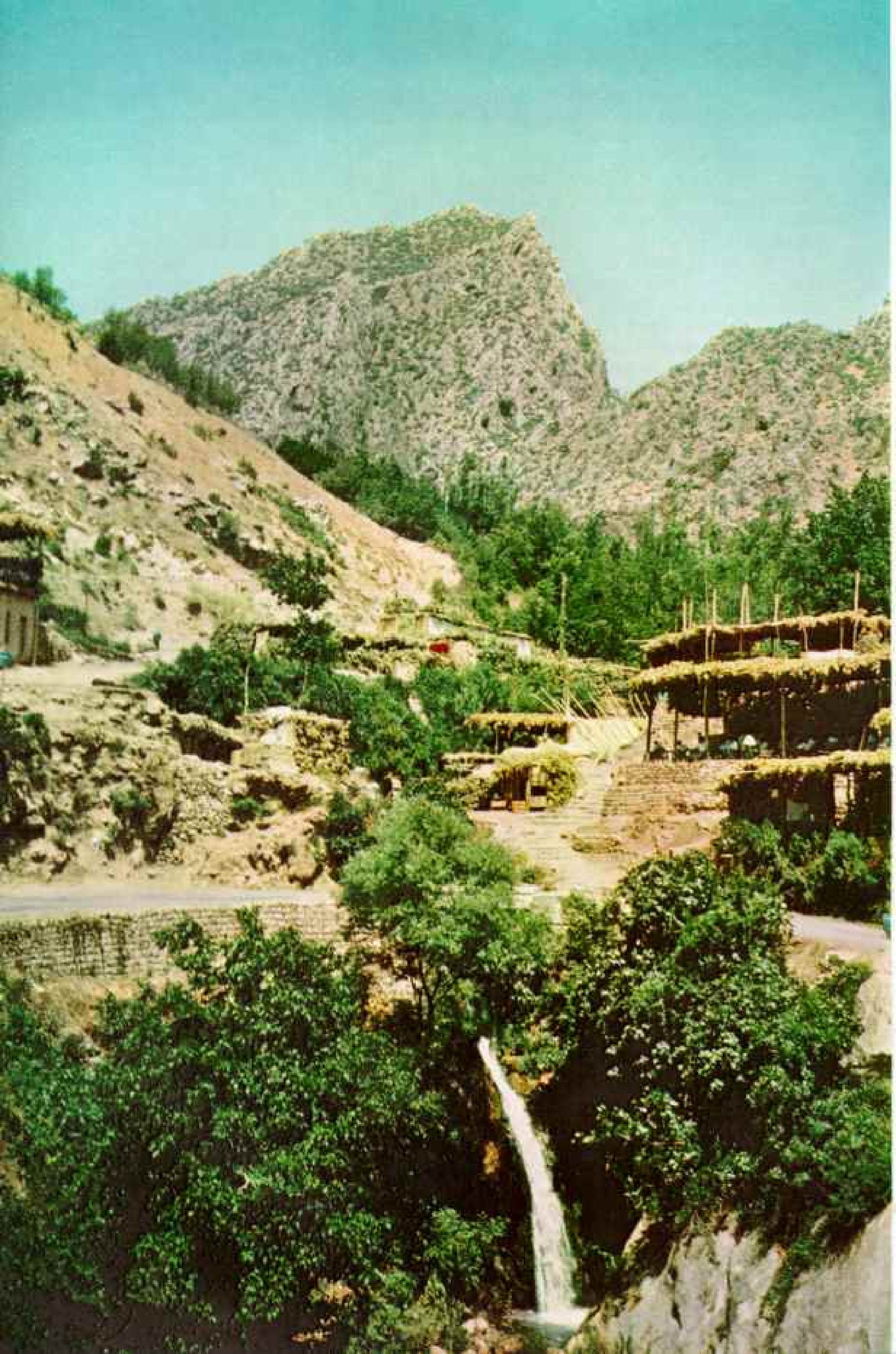
of Executives in the Kirkūk Oil Field

Mosul Gave Muslin Its Name

Mosul, the metropolis of northern Iraq, sits on the west bank of the Tigris River not far from the borders of the United Arab Republic (Syria) and Turkey. The name means "crossroads," and such it was for centuries before the Suez Canal sent east-west traffic by ship.

Marco Polo referred to Mosul as a busy

(*Continued on page 61*)



Girl in holiday garb, a heavy turban crowning her braids, attends a festival in Ba'shīqah, Iraq. Bright beads and gold chains encircle her neck.

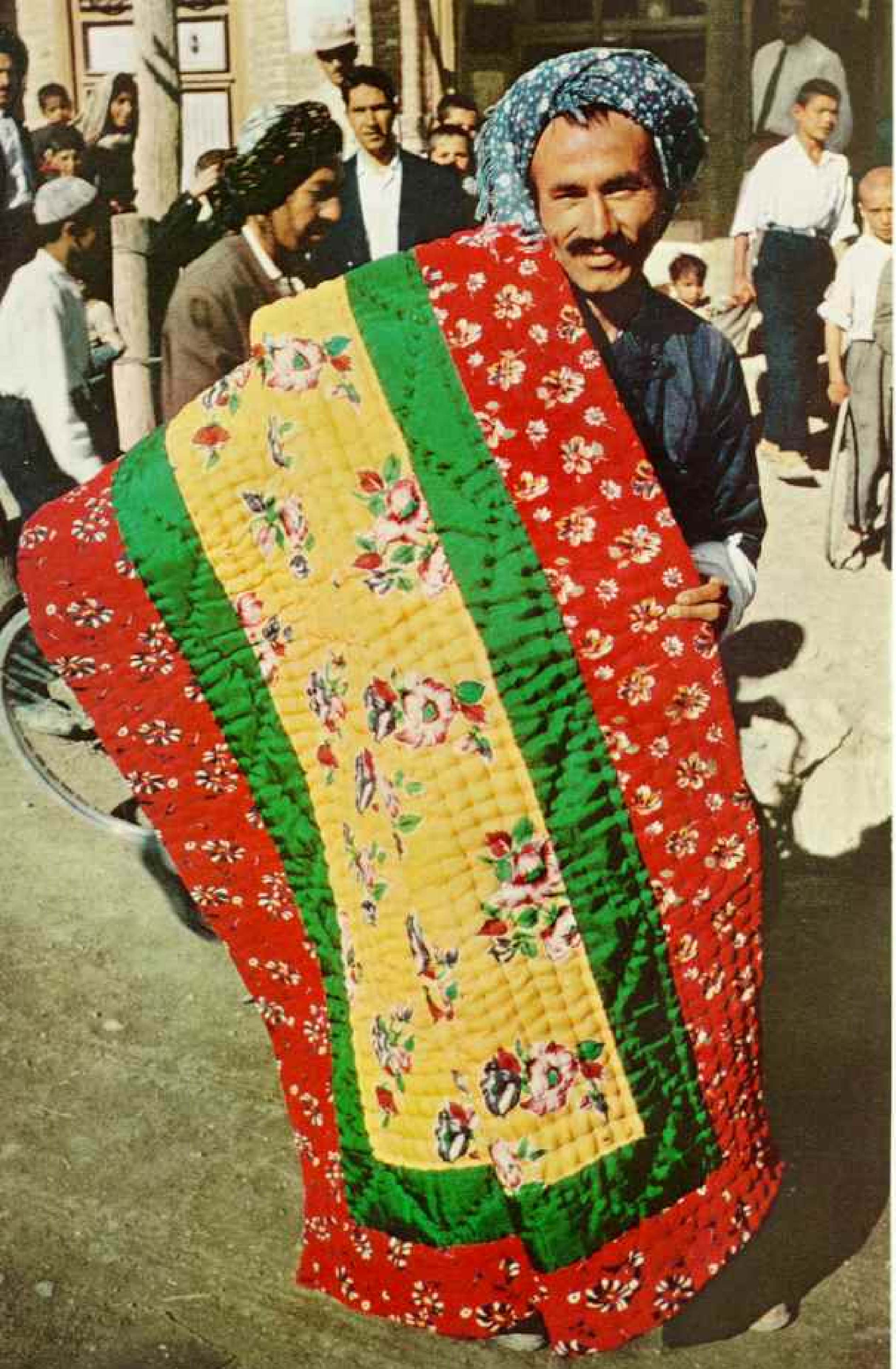
Open-air Teahouse Perches amid the Tumbled Hills of Iraq

Spectacular gorges split the ranges that divide Turkey, Iraq, and Iran. Writes Justice Douglas: "The colored cliffs and peaks took on fascinating shapes, sometimes almost human. The road crossed and recrossed the river on narrow bridges. We looked down on roaring white water and calm, deep-blue pools."

Irbil Sits atop the Ruins of Millenniums (next page)

Ancient Irbīl, inhabited since Assyrian times, crowns a mound that rises 200 feet on the rubble of previous towns. On the plains close by, Alexander the Great routed the armies of Darius III in 331 B.C. and overthrew the Persian Empire.

PANORAMA (LEFT) BY IRAQ PETROLEUM COMPANY; DUOCHROME AND BLACK-AND-WHITE (PAGE 56) BY NATIONAL GEOGRAPHIC PHOTOGRAPHER J. BAYLOR ROBERTS © N. G. S.



trading and manufacturing region whence came the word "muslin." Its modern history dates from 1516, when the Ottoman Turks incorporated it into their empire. They stayed until the British took over in 1918. We found many Christian minorities flourishing here—Armenians, Jacobites, Chaldeans, and Nestorians.

Hatra's Sun Defeated Attackers

Southwest of Mosul lie the ruins of the Parthian fortress city of Hatra, or Al Hadr. With thick walls, a moat, and high guard towers, Hatra withstood many sieges, the most notable in the year 116 by the Roman Emperor Trajan. The heat of the sun and the lack of water defeated Trajan, as they did many others.

We made the three-hour drive to Hatra on a blistering-hot day, half of it over a dirt road that was hardly more than a trail. The surrounding land was powder dry, and the wind raised countless dust devils on the plain.

Though the village of Hatra today has only a few dozen souls and a garrison of police, the remnants of numerous ancient Parthian temples and palaces still stand (page 53).

The seven vaulted halls of the huge Temple of the Sun are open to the east, their main arches and lintels ornamented with sculptured heads and carved masks. These were badly mutilated, and I asked the guide why.

"Tribesmen with guns like to shoot at the old statues," he replied. "The statues are symbols of evil."

"Why?" I inquired.

"There is only one God and that is Allah."

The Moslems, regarding any likeness of the human form as an affront to Allah, had defiled these sculptured heads as being the images of ancient, unknown gods. And perhaps they were.

We took another side trip out of Mosul, this one to Tall Kayf, a town of more than 10,000 people where the Chaldean church claims 10,000 members. It is a neat, tidy place, though almost barren of trees. This is wheat country, and when we were there the wheat was on the threshing floors being separated in the ancient way, ground out by oxen pulling heavy wooden sledges and tossed into the air by villagers for the wind to winnow.

A former mayor, Yussif Hakim, invited us to his home and produced a wine made of Tall Kayf grapes, bottled by him ten years before. It was sealed with enough wax to weigh a quarter of a pound. We drank to his health and the health of Tall Kayf.

The conversation took a wide range—from the gypsum pit near Tall Kayf to the wheat crop to politics and the business ventures of the town's native sons.

Tall Kayfis, we learned, have vast interests in Iraq. They own practically all the hotels in Baghdad, and many, if not most, of the theaters. They also are the waiters in most Iraqi hotels and clubs.

"Tall Kayf in Iraq is proud of Tall Kayf in America," Yussif said suddenly.

"Tall Kayf in America?" I asked.

"Yes, Tall Kayf, Detroit, Michigan," he said, explaining that about 250 Tall Kayf families have migrated to Detroit. Curiously, most of them own or work in grocery stores.

"Do they keep up contacts with the Iraqi Tall Kayf?" I asked.

"Certainly," he said. "Most of the Tall Kayf boys in Detroit come back here to get married."

"Not girls from Detroit?" I said.

"No, no. Tall Kayf boys, wherever they are, like the Tall Kayf girls best."

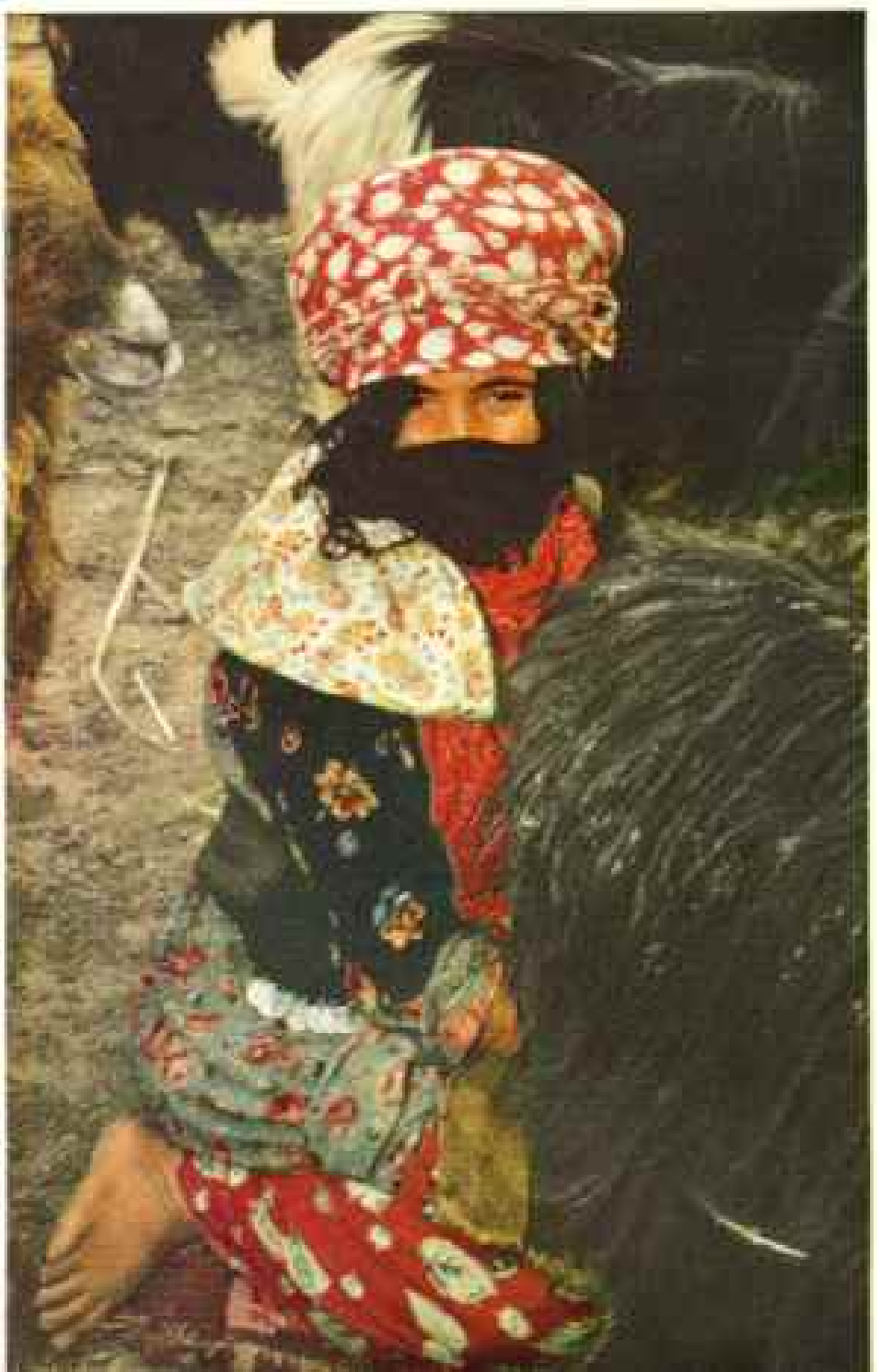
Irbil Rises on Its Own Ruins

We left Mosul at seven o'clock one morning, heading east across the Tigris through rolling wheat land toward Irbil (Arbela). In this neighborhood Alexander the Great, outnumbered at least five to one, defeated the Persian host of Darius III. The battle of Gaugamela in 331 B.C. marked the end of the Persian Empire.

We had seen Irbil from the air on a flight from Baghdad. Then the center of the town seemed to rest on a high, fortified mound (page 58). Now, by car, we saw not a fort but a 200-foot mound of debris from ancient times. When old mud houses fell, the ground was leveled and new houses were erected on the same site, which has grown higher by about three feet a century.

This mound, known as a tell, undoubtedly holds archeological treasures; I heard it discussed by antiquarians throughout Iraq. Mary, an enthusiastic amateur archeologist, wondered aloud how many layers of civiliza-

Quilt Merchant Displays His Merchandise in the Streets of Mahābād, Iran



Migrating North, a Kurdish Woman Tucks Her Children in Saddlebags

Tribal herdsmen inhabit the region known as Kurdistan, running from eastern Turkey across northern Iraq into the Zagros Mountains in Iran.

In recent years most Kurdish tribes have adopted the settled life, dwelling in adobe villages, but some still migrate seasonally with their sheep and goats.

With a young sleeper strapped to each side of the saddle, this Jalali Kurd heads toward the Iranian-Turkish-Soviet border. Mount Ararat looms in distance (page 66).

Kurdish girl milks a long-haired sheep at an overnight camp south of Lake Urmia. Her face mask protects against blowing dust.

Camels carry tents and household goods of Iranian Kurds on the move near Mahābād. These women rest against rugs lashed around belongings. Grandmother lowers her scarf to puff a cigarette.

tion lay buried here. But no shovel has touched the tell to this day.

Our destination that day was Ṣalaḥ ad Dīn, named for Saladin, the Kurdish military genius who took Jerusalem from the Crusaders. The village lies at about 3,500 feet on a mountainside and proved delightfully cool. It seemed strange after the heat of Baghdad, Kirkūk, and Mosul to sleep under blankets.

From Ṣalaḥ ad Dīn to Iraq's border resort of Ḥājj 'Umrān, the excellent black-surfaced road follows scenic river canyons most of the way. I went for a hike out of Ḥājj 'Umrān and in a willow grove met Fowzi Saib, the administrator for this district. Like most northern Iraqis, he is a Kurd.

Changing Life of the Kurds

Most Kurds these days are sedentary, although some still migrate with their flocks in spring and fall. The Iraqi Kurds are organized into tribes, with strong tribal loyalties. They agitated during and after World War I for a separate Kurdish state.

Kurds and Arabs hated each other for centuries. The Arab said: "There are three plagues in the world—locusts, rats, and Kurds." And the Kurd would reply: "Just as the camel is not much of an animal, so the Arab is not much of a man."

But times are changing. The Kurds are more and more civilized, more contented. I asked Fowzi Saib for the secret.

"There is no secret," he said. "Once we were foreigners in our own country. Now we are equals with the Arabs. We have schools. We are no longer treated like subject people."

Harold Josif, quiet, scholarly looking American Consul at Tabriz, Iran, had driven all the way to Ḥājj 'Umrān to meet us, for we were going back into Iran and across its northwest corner before entering Turkey. Lee Dinsmore came from Kirkūk to say goodbye.

There was no guard at the border pass between Iraq and Iran—no building, no gate or barrier until we dropped off the mountains on the eastern slopes and reached the Iranian village of Khāneh.

This is handsome country. From Khāneh, looking east, there is a great bowl many miles long and wide. The slopes are barren, treeless; dark-green streaks mark canyons where there is water. As far as we could see, the hills seemed covered with a brown nap, as soft as velveteen.

As I stood there, I thought of Alexander the Great, to whom Persia must indeed have been a powerful magnet. Here is a land to embrace. Here one can ride with the wind. It does something to the possessive instincts to see rich land rolling to the horizon.

This was my first view of this part of Kurdistan since 1950, and I felt at home. Then, as now, I had found the Kurds friendly people and admired their fierce sense of independence.

We stopped at Naqadeh, a small town not far from Lake Urmia, Iran's great salt lake. There we had lunch with the Khosrovis, members of the Qarapajah tribe of Kurds.

The Khosrovi house was a typical country home of a middle-class Persian. We sat on its whitewashed second-floor porch, cracking pistachio nuts and talking of sugar.

Sugar, next to bread and *chai* (tea), is the most important item in the Iranian diet. Four or six huge, coarse lumps may be put in a cup of tea; sometimes a countryman will put several lumps in his mouth and sip the tea through them.

Sugar—like tea, tobacco, salt, caviar, and matches—is also a government monopoly in Iran. Governments may totter if sugar is unavailable. During a serious shortage in 1953, 100,000 tons of sugar shipped from the United States saved the day; some think it may have prevented the emotionalists of Iran from sweeping the nation to the Communists.

Mahābād—City of Turned-up Toes

We spent the night in Mahābād, which did not seem to have changed since I saw it in 1950. Next morning we paused long enough to visit the covered bazaar, or suq. Here we saw the embroidered skullcaps and typically Kurdish turned-up slippers for which Mahābād is famous.

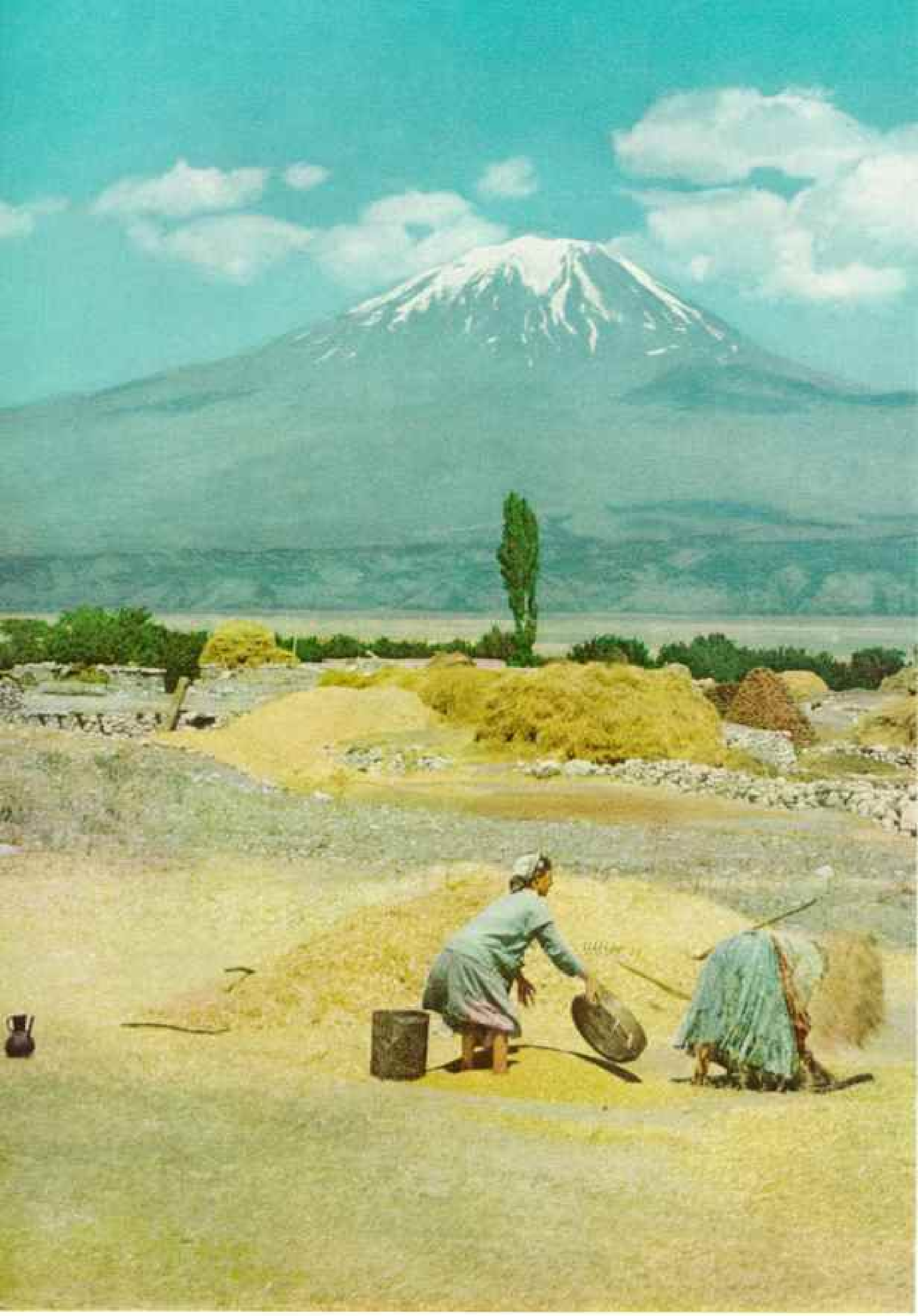
Beyond the covered section stood a compound perhaps half a block square, rimmed with shops and filled with farmers' stands. Quilt merchants walked up and down, displaying their bright merchandise like peacocks (page 60). Kurds jammed the bazaar. Each man had fierce brown eyes and gleaming white teeth; most had a mustache, but none a beard. Many wore daggers thrust into their waistbands. These were Kurds of the Mukri tribe, who once lived on the move with their flocks, but now have become largely farmers or sedentary business and professional men. Still, however, they remain individualists.

At Marāgheh, on our way north to Tabriz,

(Continued on page 73)

Health Seekers Cake Bodies with Lake Urmia's Thick, Malodorous Mud

Briny water allows no fish to live, but the mud supposedly relieves arthritis, rheumatism, and other ailments. Men bathe at this spot, women a mile or so away.



66 Turkish Women Winnow Grain Threshed by a Farmer and His Oxen at the Foot

KODACHROME BY W. ROBERT MOORE, NATIONAL GEOGRAPHIC STAFF © N. G. S.

of Snowy Mount Ararat, Traditional Landing Place of Noah's Ark

Kurdish Shepherds at Sundown Drive Home Their Flocks in a Cloud of Dust

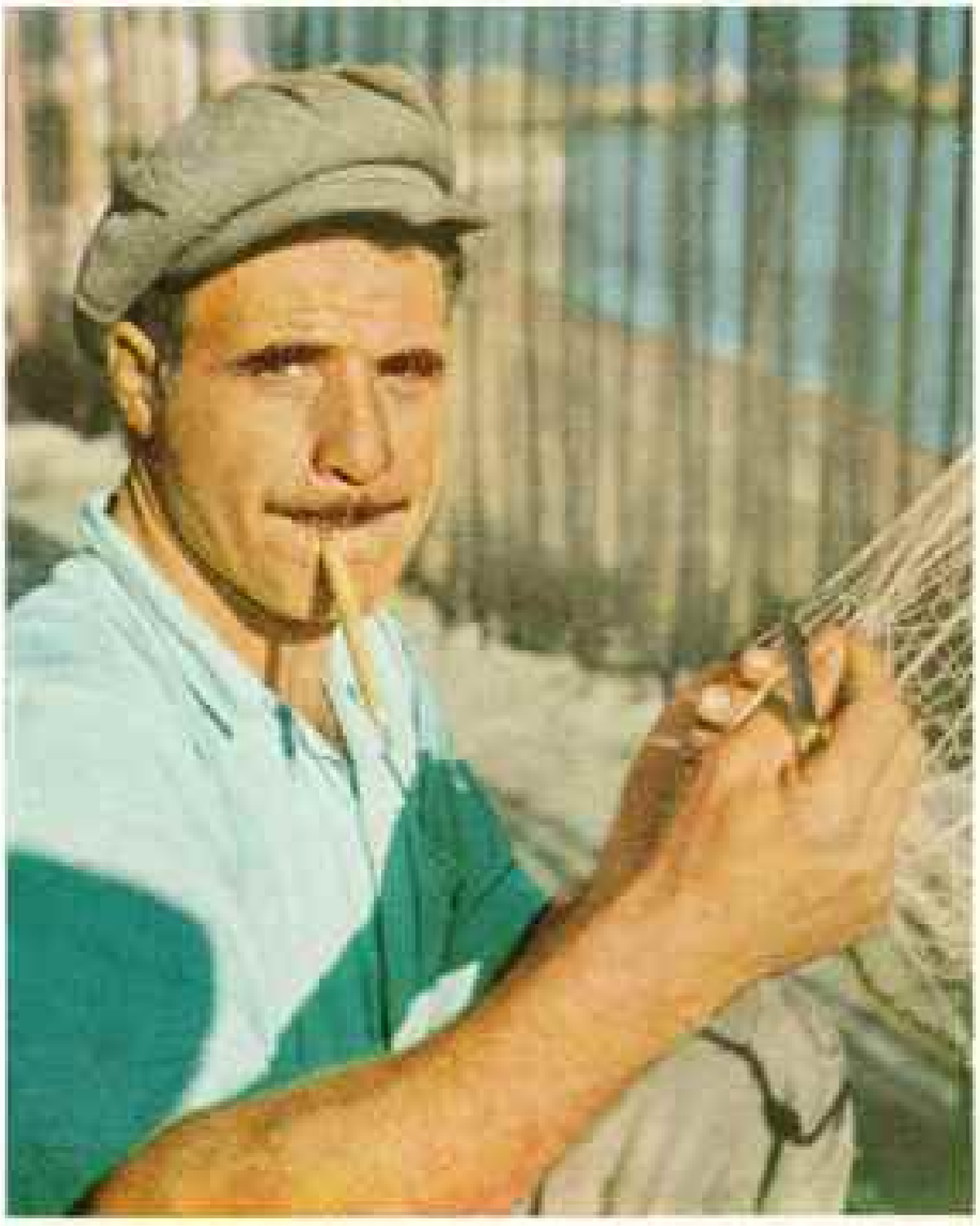
Türkali typifies scores of hill villages in eastern Turkey. Families build homes and barns in compact units, leaving fields for farming and grazing.

Sheep and goats, put to pasture at dawn, return at nightfall. Flat-roofed stone houses hug the slopes; crops are stored in man-made caves. Dried dung cakes, stacked in brown pyramids, heat living quarters in this region of short summers, long, snowy winters, and little wood.

Giresun on the Black Sea Has a Mediterranean Look

"The serpentine road leading into Giresun reminded us of the Pacific highway along the Washington and Oregon coasts," reports the author. Spurs of the North Anatolian Mountains, patterned with groves of bush-like hazelnuts, olive and orange trees, and green fields of corn, slope down to the water.

Giresun's stone houses with red-tile roofs climb a hillside overlooking the sea.



Black Sea boatmen unload bread and bags of hazelnut shells on a rocky beach east of Giresun. Shells are sold for fuel.

Fisherman of Trabzon holds a needle in his teeth as he mends a net.

PHOTOGRAPHED BY W. ROBERT MOORE,
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Turkish farmer, threshing wheat in the blistering August sun at Bogazkale, hoists his wooden water jar for a cooling drink.

The entire jug, including spout, handle, and hollowed body, was carved from a single section of log.

Tobacco ranks as one of Turkey's main export crops. Farms edging the Black Sea grow small-leaf tobacco renowned for its aroma.

These workers near Trabzon thread the emerald leaves onto long cords. Strung on racks, the tobacco cures in the late summer sun until it turns to tan or gold.

we noticed railroad construction. When I had visited the Shah of Iran, he had told me of his plans to extend the railroad to Tabriz and from there west to Turkey. Another project would carry the line eastward to West Pakistan.

In a few years, the Shah had said, one could board an air-conditioned train in Istanbul and step off at Karachi, avoiding all the heat, the dust—and the adventure—of our thousands of miles by road.

Tabriz lies 55 miles from the Soviet border in a lovely setting of orange- and red-colored hills. It is probably the largest commercial center in Iran after Teheran; its bazaar, the Ghaza, is known as one of the best in Asia.

The three of us hailed one of the colorful two-horse droshkies that crowd the cobblestone streets. In these the driver sits up front in a higher seat than the passengers. Old-fashioned lanterns hang on each side of the carriage. The seats are lined with leather, usually red and green; though the ride is bumpy, this is the way to sightsee.

The business streets of Tabriz are lined with small shops filled with the products of Tabriz factories—leather goods, cotton products, perfumes, silverware, wines, and rugs. Many of the shops carry American and European products. The Germans fill the camera shops with their film. Household appliance shops display U. S.-made refrigerators, toasters, and electric mixers.

Marco Polo wrote that the Moslems of Tabriz were "treacherous and unprincipled." The Tabrizi is different from a Teherani or Shirazi—more rough and ready, less polished. His life in a troublesome border region has made him more severe perhaps, more suspicious of foreigners. But he is a stout individual, one whose pledge of friendship is worth gold. There is a strong Turkish influence in his culture. Most of the merchants in the bazaars of Tabriz speak Turkish.

The Bab Faces a Firing Squad

One day in Tabriz as Mercedes, Mary, and I were window-shopping, a tall, heavy-set man about forty years of age came out of a shop and called me by name. How he knew me, I do not know. He was a Bahai. Inviting us in for soft drinks and huge pistachio nuts, he soon brought us up to date on the Bahais.

Tabriz was the scene of the execution of the Bab, founder of the Bahai religion. On July 9, 1850, he was suspended by a rope under his arms and shot by a firing squad. The shots rang out, but the Bab was not touched. The bullets merely cut the rope, and he fell to the ground unharmed.

The firing squad refused to shoot again, and it seemed in that instant that the miracle of the Bab might sweep Iran from its Moslem foundations. But a quick-witted officer summoned another firing squad that soon did kill the Bab, putting an end to any mysticism about his powers. A public school now stands where the Bab was executed.

Village Reforms Change Azerbaijan

Iran's Azerbaijan region, in which Tabriz is located, has been notorious for the exploitation of tenant farmers by landlords. Yet today Azerbaijan is way out front in land reform and village development work. No small credit is due to the then governor, Ibrahim Zand, whom I had first met in Isfahan in 1949. I called on him in Tabriz to pay my respects. Over a cup of tea he told me proudly that projects were under way in 4,000 of the 7,000 villages in Azerbaijan.

Under a new law, five percent of the landlord's share of each crop is set aside for village improvements. This has made landlords more village conscious; some have even volunteered new school buildings or water systems.

No great revolution is sweeping the Azerbaijan villages. But progress is being made, bit by bit, particularly in introduction of primary schools. For the first time a child born in a mud hut may not be doomed to illiteracy.

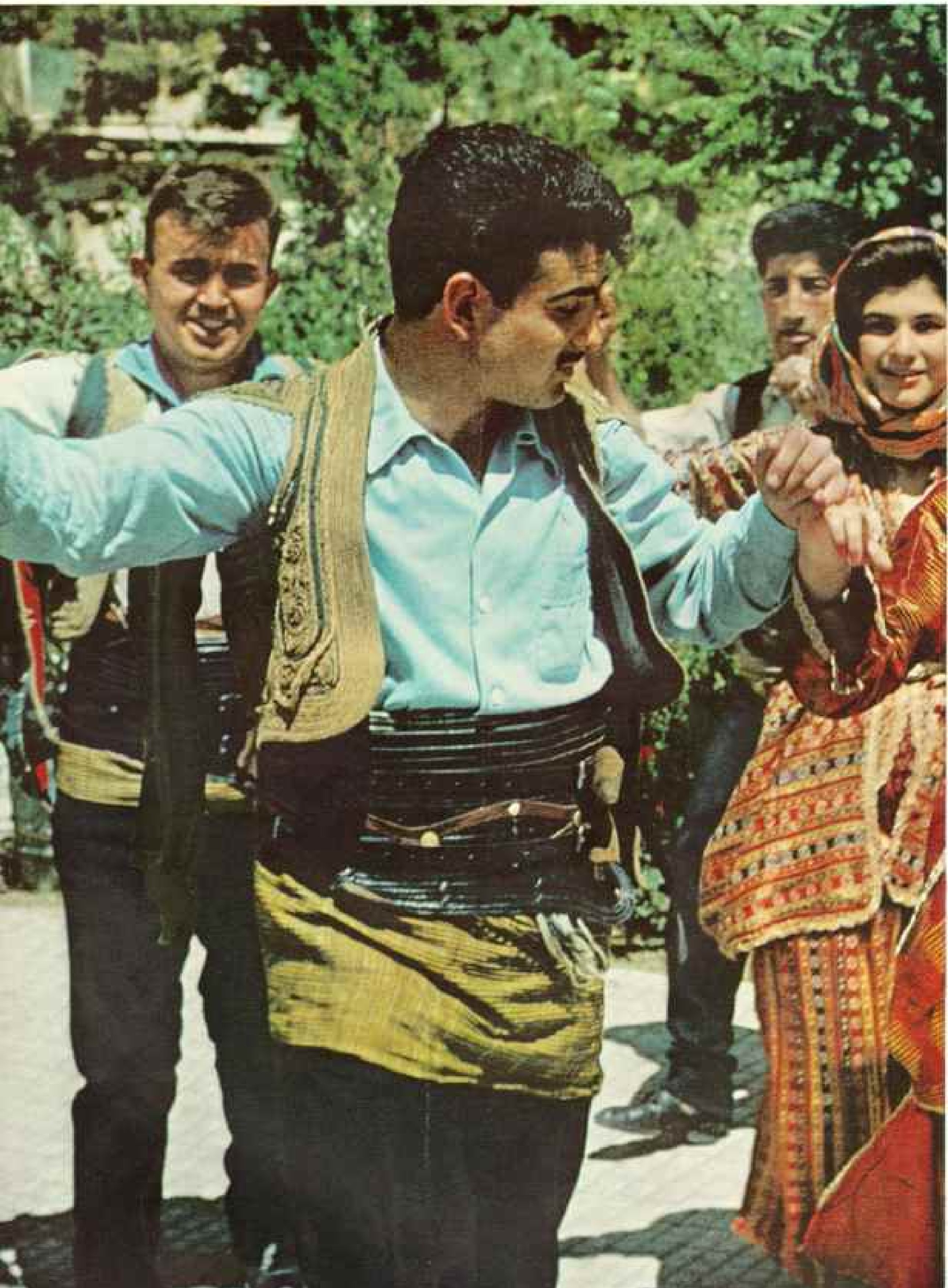
Before we left Tabriz for Turkey, Sgt. Anthony S. Bifora of the U. S. military mission looked over our car and diagnosed several broken spring leaves, worn-out spark plugs and distributor points, and broken casings in three tires. Obviously we had been headed for some resounding blowouts. We had the necessary repair work done and bought new American tires in the bazaar.

We left the main road to Mākū at a village called Ṣūfīān for a side trip to Lake Urmia. It took us more than two hours to make little more than fifty miles. We had to creep across innumerable ditches and creeks, usually angling the car so as not to scrape bottom.

At midmorning we reached the northeastern shore of Lake Urmia. Across the lake Zoroaster is supposed to have lived. In that vicinity are found mounds of ash that mark the fire shrines of the sect he founded.

Swinging in Pairs, Turkish Dancers Glide Through Measured Paces

Recent years have witnessed a revival of folk dancing throughout Turkey. These girls wear silk garments and headdresses; the men, embroi-



dered boleros, apronlike sashes, and outsize leather belts. They live in Çorum, which Justice Douglas recalls as "a rather bleak, barren place. Viewed from the air, it could pass for a west Texas cow town, except for the thin minarets spiring above its mosques."

But we had come to see the mud bathers. Lake Urmia is noted for its black mud, said to have medicinal qualities. People with arthritis, rheumatism, or just ordinary aches and pains roll and lie caked in this thick, malodorous mud for hours, then take to the water and bathe. We spent an hour taking pictures (page 65).

As we drove on through pleasant rolling country, a small shrine on a height was pointed out by the Iranian Army officer, Lt. Col. Mansour Ghadar, who was traveling with us.

"People who have hydrophobia or snake bite go there to be cured," he said.

"Are you teasing?" I asked.

"By thy precious life, I am not," he said.

"Why do you swear by my life rather than your own?" I asked.

"In Persia," he answered, "to swear by one's own life is to swear by something not as precious as the other man's life."

It was dark within an hour after we had quit the town of Khvoy. The wind came up. It fairly howled out of the north, sweeping ahead of it great clouds of dust that forced us to stop again and again.

About an hour short of Mākū the road makes an elbow to the northeast. Here we were only 16 miles from the Soviet border. Beyond the Aras River, through the storm, we saw blinking lights. They marked the town of Shakhtakhty, in the Azerbaijan S.S.R.

Migration to the Soviet Border

Morning came cool, bright, and glorious. We had scarcely started our 15-mile journey from Mākū to the Turkish border when we saw nomads on the move. Several families with a dozen or more heavily loaded camels were headed northeast across the valley. We parked and ran across fields of thistles to get their picture (page 62).

Another group appeared with camels, then another on horses and donkeys. Our questions revealed that this was a tribal migration of Jalali Kurds headed for a new camp along the Aras River, which marks the Russian border.

Hundreds of families kept pouring over a hill from the south. The rich Jalalis owned camels; the poorer ones, donkeys. Big gray dogs herded sheep by the thousands. Some of the women rode horses, with large woven bags on each side of the saddle to hold their small children.

Mary commented on the bearing of the women. "They seem to have a wonderful air of nobility about them," she said.

Soldiers Shout a Welcome to Turkey

Outside the main building at the Iranian-Turkish frontier, twelve Iranian gendarmes presented arms as we passed. The buildings form a courtyard, the border running down the middle. A young man in his twenties crossed the courtyard to greet us. Vedat Uras had been sent by the Turkish Government to be our interpreter.

"There is a guard of honor to meet you," Uras said.

I walked with him through an archway of the customs building to find a squad of nine Turkish soldiers. They came to attention.

Uras whispered, "You are supposed to say '*Merhaba*' to them."

"*Merhaba*," I shouted.

"*Sağol, sağol*," they shouted back. Then they marched away.

"What did we say?" I asked Uras.

"*Merhaba* is a salutation like the English hello; and *sağol* means long life."

It warmed our hearts to get this welcome. And in retrospect it seems that *merhaba* and *sağol* were symbolic of the hospitality we received all across Turkey.

The road ahead of us stretched over rolling hills as far as the eye could see. Snow-capped Mount Ararat rose straight ahead, almost close enough to touch (page 66). Beside it was Little Ararat, free of snow.

This is big country. From the border looking west there is no sign of habitation. It looks much like Wyoming and Colorado—country for horses and cattle, for unfenced pastures, for unlimited horizons.

The day we crossed this region, the air was freshly washed by a storm. The good dirt roads—for which modern Turkey has become famous—had been thoroughly wetted down. We met no dust, no washboard ruts crosswise of the road, no high centers to ride. We found

Ancient Hittite carvings adorn the walls of towering cliffs near Boğazkale. "When one steps into the jaws of these limestone cliffs, he seems completely shut off from the world," says the author. This bas-relief portrays a Hittite god in pointed headdress throwing a protective left arm around the neck of the smaller priest-king.

such roads all across Turkey, east to west. A nation once notorious for poor communications has now superb dirt highways everywhere.

U. S. Helps Build Turkish Roads

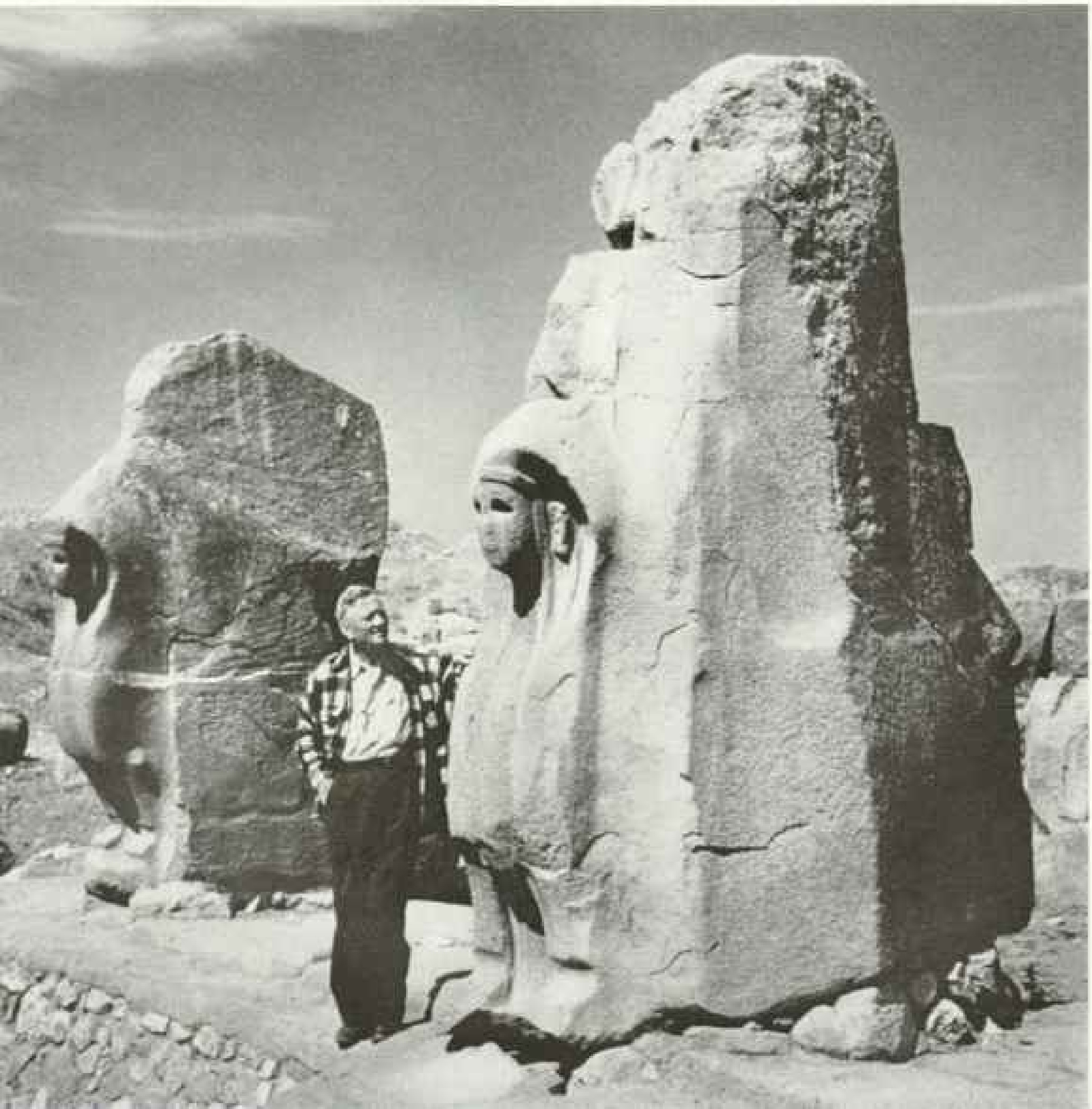
Money, men, and machines from the United States have helped Turkey stretch its highway network from 7,800 miles of all-weather roads in 1947 to more than 20,000 miles today.

An 11-year-old American aid program totaling some $42,000,000 has sent thousands of trucks, tractors, power shovels, graders, and other road-building machines to Turkey. American engineers and technicians have advised and trained Turkish counterparts in highway construction and equipment use.

In Karaköse (Ağrı), a provincial capital of perhaps 20,000 people, I stopped to pay my respects to Gov. Ali Akseven. He insisted we stay for lunch. Afterward he turned to Mercedes and asked if we would like coffee. This was the ultimate in hospitality, for Turkey, the nation known for its good coffee, has none these days. It has no foreign exchange with which to buy it. Only a few, like Governor Akseven, have a precious reserve left from earlier years.

Mercedes, knowing these things, quickly answered: "No, we prefer tea."

After lunch our host insisted on escorting us to the town of Zidikân (Eleşkirt) to see that we got gasoline there. We had not followed him far when we saw that he was in trouble. He had tried to pass an oxcart on a soft, steep embankment. His car leaned at a precarious angle; Uras and I pushed, but with each spin of the wheels it slipped farther down the bank.



The situation was dangerous. The Governor could not negotiate the steep pitch of the front seat to escape from the right-hand door. So he jumped from the left. As he jumped, the car started to hurtle after him. Miraculously, the door swung open just far enough to catch on the slope and hold the car up.

After a consultation we left the Governor and went on to inform a near-by gendarme station of his plight. Then we drove to Zidikän to await him. In half an hour his car bounced merrily down the street toward us.

"How did you get out?" I asked. "Did they send a truck?"

"A truck? Two oxen got me into the ditch; two other oxen got me out," he said jovially.

From Erzurum it is a long, hard day's drive to Trabzon, the Black Sea port. To save time, I bought our lunch in Erzurum's bazaar while Mercedes, Mary, and Uras went for gasoline. I bought a loaf of round, black Turkish bread, some tender unroasted peanuts, sweet white grapes, and juicy peaches. Then I selected a watermelon from a pile outside a shop. The young proprietor smelled it, then put it to his ear and squeezed it. He shook his head. He went through the pile himself, using his nose and ear. Finally he beamed and handed me a melon.

When we stopped for lunch, I cut the melon; it proved to be wonderfully sweet. A merchant who had a chance to do a foreigner in had done a fine favor instead. I was to find this trait in all the Turkish tradesmen we met.

Return to a Green World

It was dusk when we crossed Zigana Pass at 6,675 feet and felt the motor relax on the downgrade. Soon we were amid conifers, the first thick stands we had seen all summer.

A jeep was waiting for us at Trabzon's gendarme station. We followed it to our destination for that night—"Atatürk Köşkü"—the massive stone mansion which his nation gave to Mustafa Kemal, or Atatürk. It was big and spacious, ablaze with lights, with high ceilings, magnificent furniture, and modern plumbing. We fell into bed exhausted.

In the morning I stepped onto a balcony off our bedroom to look at the city and the Black Sea beyond. A slight mist seemed to heighten the green of vegetation between us and the water. In a few minutes I felt suddenly relaxed and sensed why.

The bright, burning skies of the East produce intensities of heat, of color, and of other sensations. The blue sky of Persia has an infinity that other skies do not know. The mountains of West Pakistan and Afghanistan are barren, brown, and seared. Desert wastelands produce a tension in man from which he ultimately needs to flee.

But here the thick vegetation, the green countryside, did something soothing to the eyes and through them to the nerve ends. This was my first sensation on seeing Trabzon by daylight.

Giresun: City of Hazelnuts

The coast road from Trabzon to Giresun is reminiscent of the Pacific highway along the Washington and Oregon coasts. The mountains come right down to the sea, heavy with vegetation on the seaward side (page 71).

On the cliffs behind Giresun I found delicate saxifrage and the brazen dandelion. The Giresun gardens have chrysanthemums, asters, hydrangeas, and snapdragons; there are figs and oranges, tangerines and olives. But Giresun is most famous for its hazelnuts.

We saw the bushlike trees everywhere around the city. Nuts were drying in every sunny spot available—in open fields, on lawns and sidewalks, even on the beaches.

Gov. Ali Cahit Betil is given to overweight, and his wife Ielal was teasing him about it at breakfast. He laughed and, patting his stomach, turned to me and said:

"There is a saying that the fattest men in Turkey come from Giresun."

"Why Giresun?" I asked.

"It's the hazelnuts," he replied.

All the way west to Ordu we saw hazelnuts drying by the roadside. Whenever we stopped to take a picture, some man or woman filled our pockets.

At one picture stop a tall, thin, red-haired farmer, Ali Karaarslan, wanted me to meet his seven sons. When he called, they came running. One must have been thirty; one was a babe in arms carried by a daughter. Each had his father's red hair.

Eroding Sphinxes Guard the Gateway to Hittite Ruins at Alaca Hüyük

An Indo-European people of unknown origin, the Hittites ruled most of Asia Minor from about 1800 to 1200 B.C. Author Douglas inspects monoliths carved with bulls' chests and human faces. They look out on the Anatolian plateau.

United States Jets Streak Above Ankara in Turkey's Victory Day Air Show

Ankara, selected as capital of the new Turkish Republic in 1923, has mushroomed from a dusty hilltop town into a modern city. Each year the

KODACHROME BY B. ROBERT MOORE, NATIONAL GEOGRAPHIC STAFF © N. G. S.

nation celebrates August 30 as the anniversary of a decisive victory over the Greeks in 1922. The holiday last summer saw infantry and tanks of the Turkish Army, largest in the Moslem world, parade past the distant citadel. Skyblazers, a U. S. Air Force team, demonstrate these Super Sabres.

Ali insisted we come into his house, a two-story stone affair. Household goods and farm supplies were stored downstairs; the family lived on the second floor. Bedrolls, spread out on the floor at night, were piled neatly in a corner.

Our host gave orders that sent his two daughters flying. They came back in a few moments with trays of ice-cold *ayran*, water mixed with yoghurt. There is electricity along the Black Sea, and this farmer had an electric icebox.

Karaarslan praised Atatürk, who abolished the old Ottoman tax on farm produce of 10 to 50 percent. Atatürk established instead a profit tax and excise taxes. Farmers, like all consumers, pay the excise taxes. An income tax graduated up to 50 percent has since replaced Atatürk's profit tax, but the unique thing is that farmers are exempt. Moreover, they pay only a nominal tax on their lands. Our host had only praise for the government.

The Turkish farmer is at long last awakening to the political power which universal suffrage grants him. He makes up four-fifths of the population, and his voice is more and more heard. He enjoys his income tax exemption, and it will be difficult for any party to take it from him.

A Farmer Fights a Deadly Enemy

Samsun, a city of some 70,000, is on its way to becoming a great Black Sea port. We saw the beginnings of a harbor system that will enable 20 ships to unload at one time.

Before leaving Samsun we drove to a nearby beach for a morning swim. The black volcanic sand scorched our feet, but a brisk

Doctor's Tender Ministrations Ease a Baby's Pain, a Mother's Concern

Turkey's Ministry of Health and Social Welfare, created in 1920, supervises a public health program throughout the nation. Residents of Etimesgut, a village in Anatolia, keep this clinic's staff busy.

wind whipped up a white surf, and the water was wonderfully refreshing.

A farmer led a small band of cattle down the beach and into the water, where he began to bathe their feet. They were suffering from the crippling hoof-and-mouth disease, which sheep brought into Turkey from Syria.

The old man told us he had tried every other remedy to no avail; he hoped the salt water would help. The government had told him the animals must be destroyed to prevent infecting others.

He shook his head. "How can I live without my cattle?" he asked us.

That night in Çorum a hard wind carrying rain rattled the shutters. It seemed I had been asleep only a few minutes when I heard a weird, ghostly sound. In this moment between sleep and consciousness it seemed more a part of a dream than reality. I awoke and raised the window blind.

The street was barely visible in the predawn darkness. I saw a long train of carts, pulled by oxen, lumbering into town. The wagons creaked and groaned at every turn of their solid wooden wheels.

The noise could be heard for a mile. It is a distinguishing feature of rural Turkey. At that hour it seemed also a challenge—an echo of Turkey's need to turn oxcarts into tractors, to build its industrial capacity.

Atatürk Shook a Nation Awake

Before Atatürk made it Turkey's capital, Ankara was a small, dusty country town. Today it is a bustling modern city of almost half a million, growing so fast that water has to be rationed. At the Ankara Palace Hotel where we stayed, the water was turned on for only four hours a day.

The new town has taken over a broad bowl and the slopes of the surrounding hills. It is, on the whole, well planned. The new government office buildings are light and airy. There is a fine university, training men for public service. All the governors we had met across Turkey were graduates of this school.

Ankara is filled with stories of Atatürk, who in the 1920's took the country by the neck and shook it, established a dictatorship to get his program going, but wisely planned for a democratic regime when the people had developed a capacity for self-government.

When we asked at the desk of our hotel where we could find a good restaurant, the old man in a faded blue jacket and round brass buttons would say:

"Would you like to eat where Atatürk used to eat?" Or he would say:

"Would you like to eat where Atatürk's old chef works?"

Even the choice of restaurants seemed to this old man to turn on the strength of an association with his hero.

It's a nice day's drive from Ankara to Istanbul, over a fine black-topped road. Open, rolling country gives way to a range of wooded hills fringing the Black Sea. Here

YAPI
ve
KREDİ
BANKASI

the valleys are planted to corn, peppers, tobacco, beans, and sugar beets. Wild sweet blackberries run riot.

We ate our last rural luncheon at Düzce, a rambling town about 18 miles from the Black Sea. By four o'clock we reached the Sea of Marmara and saw the distant spires of Istanbul. By five we were at the Bosporus in the Asian part of Istanbul, squeezing by inches onto a heavily loaded ferry to cross to the European side.

San Francisco on the Bosporus

As I drove onto narrow stone-paved streets and shifted into low gear for the steep hills of Istanbul, I was reminded of San Francisco. For a second it seemed I would have to learn to drive all over again. After two months of travel on lonesome highways, I was suddenly confronted with thick, threatening traffic and its earsplitting noise. A tension took hold; I found myself fighting a roaring tide of automobiles and trucks.

In between packing, preparing the battered station wagon for shipment home, shopping and other errands, we found time only for hasty sightseeing.

Istanbul has shops as modern as any in Europe; it also has a covered bazaar, not as extensive as Isfahan's and not quite as Eastern, but nonetheless interesting. The floor is dirt; the ceilings are high and vaulted; small windows high up are barred. Kurds work as porters. Here all sorts of articles are made, from wedding rings to samovars. The place is filled with cries of hawkers, the din of hammers on brass, and the odors of spices, candy, and leather.

The Archeological Museum impressed us with its variety of exhibits: Roman, Greek, Arabic, Turkish, and Persian. Mary pointed out the transition from Roman art to early Christian, to the strangely elongated Byzantine figures. "The styles seem almost to slide one into the other," she observed.

I lingered at the ornately carved sarcophagus of Alexander the Great. As a result of this and three earlier journeys, I had now covered almost every mile of Alexander's long track.

I liked the man because he, too, liked horses. But even more, I honored him for his tolerance and moderation; for the fact that he destroyed armies, not civilizations. He found good in the "barbarians" he conquered, as well as bad. He respected their religions, studied their cultures, was interested in their art, ethics, politics, and natural science.

One clear September day we cruised the Bosporus to see Istanbul from the water. Robert College, the American institution that has done pioneer educational work in that part of the world, sits high on a bluff to the north of the city.* Below it stands the castle known as Rumeli Hisar, built by Mohammed the Conqueror in 1452.

The Bosporus was heavy with traffic. We saw black, dirty ships, loaded with coal, looking for berths. Others unloaded corn and wheat into lighters. Dories shuttled back and forth with provisions.

Peoples of Warmth and Pride

As I stood watching the Asian shore line, I felt strangely saddened. I had been lost in the villages and on the back roads of Asia for close to two months. Now our journey was at its end.

The Asian wants a handclasp for friendship. He welcomes the stranger who comes as a neighbor, to drink his tea and share his worries, to feel the measure of his life by living it with him.

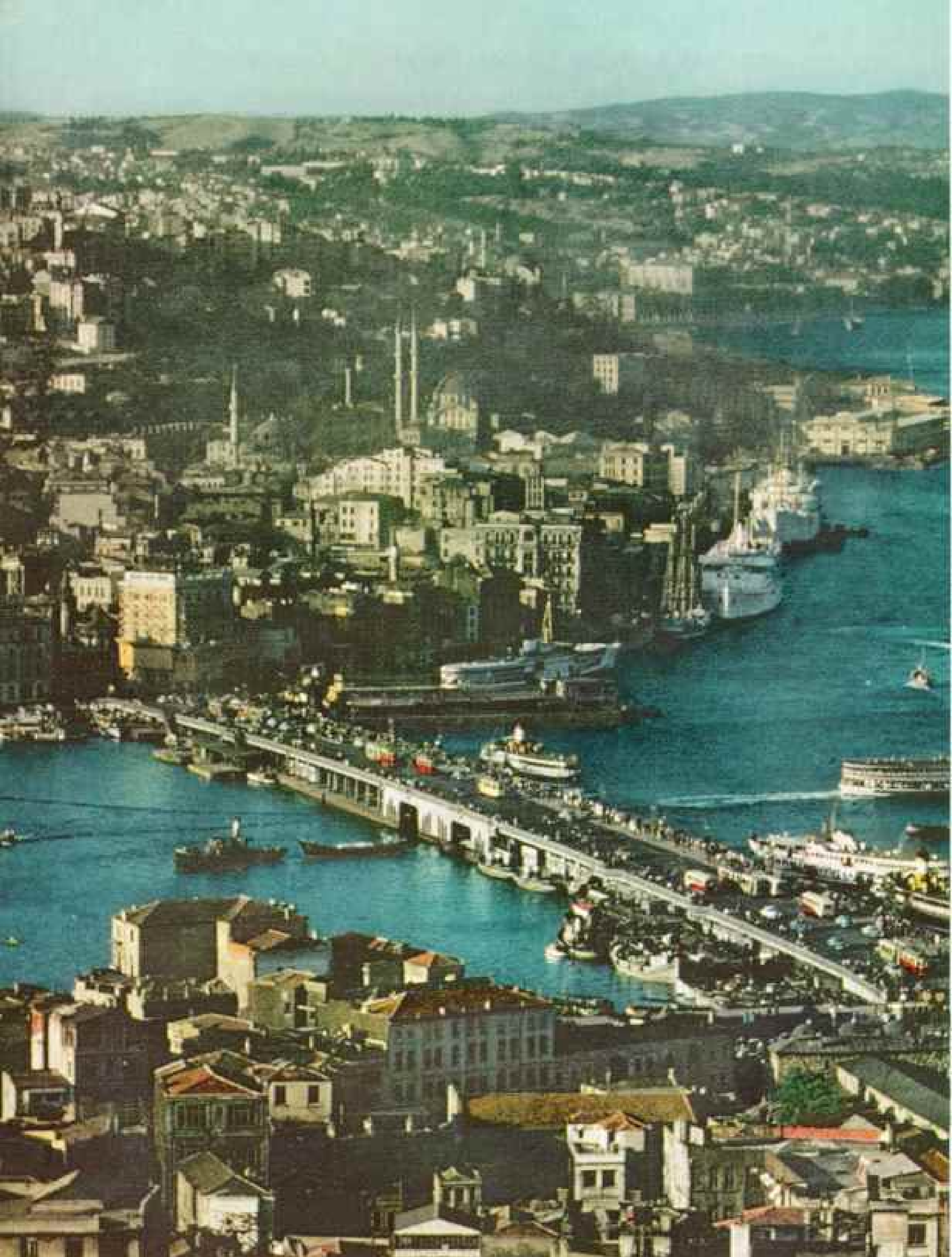
I knew the warmth of these peoples, their longing for equality, their great pride in race and culture. Asia, with its mysticism, subtlety, indirection, and of course poverty, was somehow a home in which I had left much of my heart.

* See "Robert College, Turkish Gateway to the Future," by Franc Shor, National Geographic Magazine, September, 1957.

Istanbul's Rush-hour Traffic Jams Galata Bridge Across the Golden Horn

Curving like the horn of a bull and glittering gold at sunset, the Golden Horn, a narrow offshoot of the Bosporus, divides the Galata mercantile section and the modern Beyoğlu section from the old city that served as seat of the Ottoman Empire. Morning and evening see parades of commuters boarding and leaving ferries that ply the Bosporus and the Sea of Marmara.

This view, taken by telephoto lens from a building at the Galata end, looks toward the old city (foreground in the photograph on the next page). Stairs at left lead down from bridge to ferry slips. Clocklike disks on light poles advertise a bank.



Teeming Crossroad of Europe and Asia, Istanbul Straddles the Bosporus

Istanbul, the Greeks' Byzantium and the Romans' Constantinople, presents a panorama of hills, domes, and minarets. Ocean-going liners and

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freighters tie up at quays in Galata (opposite, across the Golden Horn) or drop anchor in the Bosporus (right), the 17-mile-long strait linking the Black Sea and Sea of Marmara. Ferryboats dock beside Galata Bridge. The New Mosque, in foreground, lifts twin minarets above a shady park.

ATLAS MAP REFLECTS PROGRESS IN EASTERN

As current as tomorrow's headlines, yet showing places as old as time, the National Geographic's new Atlas Map No. 47, **Lands of the Eastern Mediterranean,** portrays the part of the world where the seeds of western civilization first sprouted and where three great religions—Christianity, Judaism, and Islam—were born.

Close your eyes and put a finger almost anywhere on this eighth Atlas sheet, mailed with the January issue to 2,400,000 National Geographic families, and you locate a place now or recently in the news:

Lebanon, host not long ago to thousands of United States troops; Cyprus, scene of frequent, tragic strife; Israel, ringed by Arab neighbors but planning to absorb half a million more overseas immigrants during the next decade.

In Jordan, which won its independence in the wake of World War II, British troops landed last year to buttress the tottering throne of young, Harrow-educated King Hussein.

Egypt and Syria now form the United Arab Republic under fiery Gamal Abdel Nasser, who preaches the doctrine of Arab nationalism.

The lands of the Persian Gulf find earth's richest liquid legacy beneath their shifting sands. Conspicuous on the map are the long pipelines that carry oil. One, from Kirkūk to Haifa, has been unused since 1948 because of Arab-Israeli difficulties.

Last-minute Changes Are Shown

Hundreds of revisions, some made as the lithographic plates were going on the presses, make this 10-color map thoroughly up to date in geography and nomenclature.

Lake Hula in northern Galilee disappeared as Israeli engineers reclaimed 15,000 acres of rich farmland from the malarial

EGON ORBAN, MAGNUM

MEDITERRANEAN LANDS

swamp that had covered it since long before the days of the patriarchs. National Geographic Society cartographers have shown instead the narrow drainage canal that takes its place.

Another feature, forgotten for 1,800 years, appears beside the Dead Sea, where archeologists have laid bare the ruins of Khirbat Qumrān. Here lived the monastic sect whose hidden library gave the world the Dead Sea Scrolls.* Three dots, showing an archeological site, mark this exciting discovery.

The United States Board on Geographic Names and its British counterpart have agreed on uniform spellings for place names in the Arab world, and many changes result. Bayt Laḥm—literally "house of meat"—is given as the native name for Bethlehem, with the familiar spelling beneath it. In Syria the local spelling Dimashq appears with the better-known Damascus; in Lebanon, Tyre and Sidon bear both their Biblical names and the modern designations Ṣūr and Ṣaydā.

Detailed insets magnify vital spots in this area where three continents meet. One shows in enlarged scale the all-important Suez Canal, whose seizure in 1956 precipitated an international crisis.

Another reveals the political boundaries that crisscross the Holy Land, divided today among Israel and her three Arab neighbors.

A third inset portrays Jerusalem, the modern City of Peace, sundered for a decade by a cease-fire line established between Israel and Jordan.

*See "The Men Who Hid the Dead Sea Scrolls," by A. Douglas Tushingham, NATIONAL GEOGRAPHIC MAGAZINE, December, 1958.

Israel and Jordan Meet at Mandelbaum Gate in a Divided Jerusalem

When Arabs and Israelis put down their arms in 1949, the city lay sundered. One side became the capital of the new Jewish state; the other, including the walled Old City, lies in the Hashemite Kingdom of Jordan. Mandelbaum Gate, actually an open place near the heart of Jerusalem, provides the only crossing place.

Here an Arab couple from Israel is being escorted across the border into No Man's Land for a meeting with their two sons, whom they have not seen for a decade. Gun ports face the frontier of Jordan, which is still technically at war with Israel.

Rails to Link Paris and Persian Gulf

Heartening changes are reflected by the lines and symbols on this timely map.

Iraq begins construction of a standard-gauge, 355-mile railway linking Baghdad and Basra; when it is completed, travelers will be able to go by direct train from Paris to the Persian Gulf.

New dams promise control of the disastrous floods that have swept the Tigris and Euphrates Valleys since Old Testament times.

Israel finishes her "overland Suez Canal"—a paved road through the desolate Negev from Eilat to Beersheba—and another line is added. A pipeline also threads the Negev, from the new Red Sea port of Eilat to the great refinery at Haifa on the Mediterranean.

Maps already issued in this growing and valuable series are: Southeastern United States, Southern South America, U. S. and Canadian National Parks, British Isles, Poland and Czechoslovakia, North Central United States, and Greece and the Aegean.

A packet of these first seven Atlas Maps, folded once to fit the Atlas Folio, may still be obtained by writing the National Geographic Society, Department 94, Washington 6, D. C. Price $3. Individual Atlas Maps, 50¢ each; the distinctive Folio, $4.85.

A National Geographic Society–Tulane University expedition unearths in Mexico the forgotten metropolis of a great people

DZIBILCHALTUN:

Lost City of the Maya

E. WYLLYS ANDREWS, Expedition Leader

ON a sun-beaten thorny plain in northern Yucatán, an expanse of overgrown, long-forgotten ruins is emerging as possibly the largest and longest inhabited city of ancient America.

In this fallen, vanished metropolis, our National Geographic Society–Tulane University team of archeologists, surveyors, divers, and artisans is now in a third season of work. Already this site has opened new perspectives into the dim story of the Maya, most civilized people of the pre-Columbian New World. Gradually we are uncovering the first continuous, era-by-era record of Maya life over its entire span, from its rise thousands of years ago down to the Spanish conquest in the 16th century.

If you could stand with me upon the terrace of the Temple of the Seven Dolls and look about you, what would you see? Only the flat, dusty scrub of Yucatán, stretching to the horizon in a monotonous mantle of faded green. You might discern the bone-white scar of a great triumphal avenue, a few blurred mounds of rubble. You would not see my city.

It is there, nonetheless: Dzibilchaltun ("Dzeeb-eel-chal-*toon*," which in Maya means "where there is writing on flat stones"), one of the earliest and surely the latest of the cities inhabited by the ancient Maya.

Mile on mile it extends in orderly, if now

Up from the depths of a Yucatán *cenote*, or natural well, comes an unbroken jar perhaps a thousand years old. Flashlight on wrist, the diver rises through murky ooze stirred up as he probed for Maya relics 80 feet below the surface.

KODACHROME BY LUIS MARDEN, NATIONAL GEOGRAPHIC STAFF © N.G.S.

concealed, array—20 square miles by our current estimate, more than one-quarter the size of the present-day District of Columbia, one-third that of the modern capital city of Mexico. So vast is its scale, so small the portion yet excavated, that even I, after long study, have trouble bringing it into focus. Yet I can sense the nobility of its proportions, the grandeur of its conception.

Dzibilchaltun, in its heyday, had a central area thick with pyramidal temples, palaces, and buildings of vaulted stone. Thatched houses on stone foundations crowded between the more massive and permanent structures. Outside this 10-square-mile "downtown" zone lay "suburbs" studded with fewer pyramids but equally dense in stone-vaulted temples and residential platforms.

Memories of the Gods Grew Dim

Long before the birth of Christ, men inhabited this site, and not even when the Spaniards came and conquered did they leave it. For thousands of years the rulers of Dzibilchaltun—secular or clerical—held court upon this plain.

Had Dzibilchaltun simply been abandoned, like many another Maya center, more of it might have remained intact. But its distinction of long, continuous occupation brought with it attendant penalties. In its temples men worshiped until their memories of the gods grew dim; then they used the holy places as houses.

In time the builders of seven haciendas and two towns ravaged the old city for stone; much of it went into the highway from Mérida to the port of Progreso (map, page 95). Even in 1958, despite strenuous efforts by the Mexican Government to protect the site, fleets of trucks every day raided the ruins for material to feed near-by gravel crushers.

I first visited this site in 1941 with the late Dr. George W. Brainerd of the Carnegie Institution of Washington. Near the hacienda of Dzibilchaltun we found a large group of hitherto unreported mounds. While Dr. Brainerd collected pottery, I explored, recorded bits and fragments of architecture, and studied the one temple that remained partially standing.

Even those few short weeks convinced us that we had stumbled upon the remnants of a truly extraordinary city. Not only was it of very large size, but it appeared to predate other well-known Maya centers in Yucatán, such as Uxmal and Chichén Itzá.*

To an archeologist this was of major import. Maya centers of power earlier than these cities were all supposed to lie in the lowland jungles to the south, in Guatemala, Honduras, and adjacent regions of Mexico. They were not known to exist in northern Yucatán.

Yet here was a city at the peak of its grandeur perhaps half a thousand years before the rise of Chichén Itzá, 75 miles away.

World War II cut short any further investigation. Not for 15 years, despite all my plans and pleas, was I to return. Then in 1956 the Middle American Research Institute of Tulane University signed a contract with the Mexican Government authorizing four seasons of work at the ruins.

In our first season we set about restoring the still-standing temple; it seemed in imminent danger of collapse. And day after day my young assistant, Willard Sloshberg of the Tulane graduate school, tramped through the brush with his Brunton transit to make a rough survey of the site.

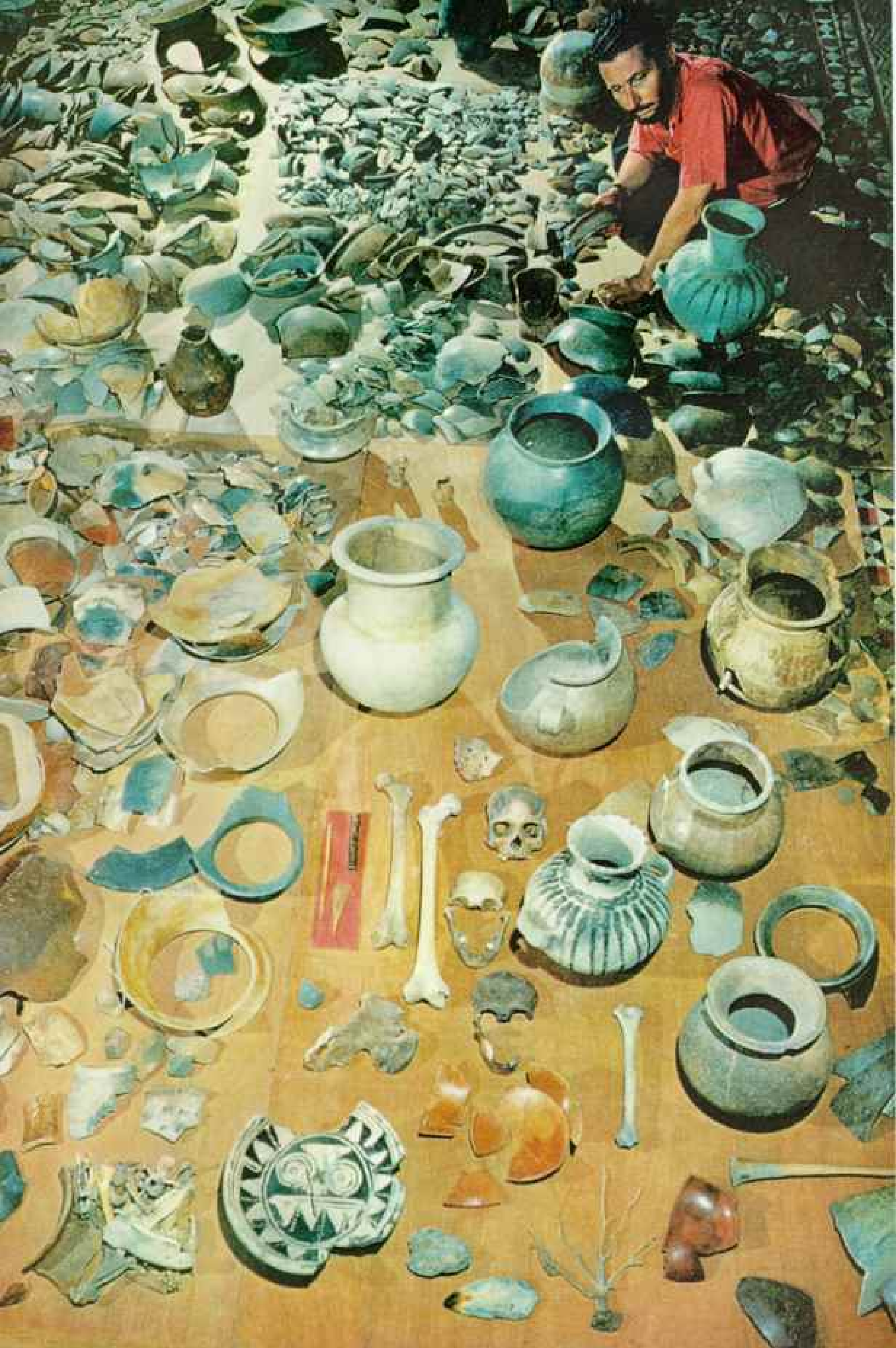
It extended beyond our most ambitious estimates. Sloshberg located more than 400 ruined edifices, yet had to leave large areas totally unexplored. Even now, after a second

* See, in the National Geographic Magazine: "'Pyramids' of the New World," by Neil Merton Judd, January, 1948; and "Yucatán, Home of the Gifted Maya," by Sylvanus Griswold Morley, November, 1936.

Drowned Treasures of the Ancient Maya Return to the Light of Day

National Geographic divers, in three months' work in Cenote Xlacah at Dzibilchaltun, raised some 6,000 artifacts. Among several puzzling finds was the shallow dish at lower left. No one knows its origin; the staring eyes and dripping fangs seem non-Maya. The larger human thigh bone (center) may have been a slain Spaniard's; the smaller, that of a Maya. Broken skulls await anthropological study to determine if they were male or female, young or old. The fine intact jar in center is that shown on the preceding page; most others had to be reconstructed. Pieces of a branching gorgonian (lower right) baffled archeologists. Occurring only in coral waters, the sea fan must have been carried inland and thrown into the cenote, possibly as a ritual offering.

Dr. E. Wyllys Andrews, leader of the National Geographic Society–Tulane University expedition, examines a part of the collection.



full year of work by a professional surveyor-turned-archeologist, George E. Stuart, our best guess is that it will take two years more to map Dzibilchaltun adequately.

We quickly discovered that our Standing Temple had a long and varied past. In the cement of its foundations and walls we found polychrome pottery imported from the region of Uaxactún in Guatemala. Thus for the first time we could accurately cross-date architecture in Yucatán with that of the southern area.

The temple itself, built on the base of an even earlier sanctuary, was utterly unlike those of other Maya sites in Yucatán. Whereas the walls and vaults of the latter were built of thick concrete faced with a thin veneer of carved or smoothed stones, here the walls were formed of roughly squared blocks, and the vaults of great slabs of rock laid one on top of another, each projecting a bit farther than the next, until the gap was small enough to be closed by a capstone (page 108).

Interesting as the Standing Temple proved to be, we found it puny beside the awesome rambling complex of buildings which we christened the Palace (opposite page, to the right of the causeway). Covering more than a dozen acres, this colossus was large enough by itself to swallow most of the principal buildings at such sites as Chichén Itzá.

To excavate the Palace as a whole was utterly beyond our means; it would take 10 to 15 years of intensive work by hundreds of laborers. But we couldn't help pecking at this buried giant.

We assigned a crew to dig a single big exploratory trench into what seemed a vast refuse heap behind one wing of the Palace. We were looking for something exceedingly rare in stony, hardpan Yucatán—a deep deposit of undisturbed artifacts capable of giving us a kind of ledger of the long centuries.

And that is just what we found.

In a series of cuts only 16 feet wide and 14 feet deep we recovered nearly 250,000 fragments of pottery—a "haul" that will require months and years to assess fully. A preli-

Great White Way of Dzibilchaltun, the *Sacbe* Connects Fallen Temples

Long before Columbus, Maya Indians in Middle America developed a civilization marked by spectacular achievements in astronomy, mathematics, architecture, and art. But by the time of the Spanish conquest their civilization had sadly declined, and the Maya had mysteriously abandoned most of their templed cities. Today much of the Maya country lies largely uninhabited, with only forest-clad ruins to whisper its story.

At Dzibilchaltun, author Andrews has begun excavation of perhaps the largest pre-Columbian city yet discovered in the New World—29 square miles of ruined pyramids and temples. Archeologists eagerly await his findings, for Dzibilchaltun is the only known Middle American city inhabited from pre-Maya times (perhaps as early as 2000 B.C.) until after the conquest.

One of Dzibilchaltun's most striking features is the limestone causeway that spans its center (opposite). This tremendous concourse is eight feet high in places, wide enough for four automobile lanes, and as long as Pennsylvania Avenue between the United States Capitol and the White House. Now a weathered ruin of quarried blocks, it still shows evidence of the smooth plaster that once covered its entire surface.

In imagination's eye one can picture the throngs that crowded the thoroughfare, moving in procession past the Standing Temple (lower left), Cenote Xlacah and the huge Palace (right center), to the Temple of the Seven Dolls (upper left). This view shows the buried Doll Temple before excavation.

NATIONAL GEOGRAPHIC PHOTOGRAPHER BAIRD LITTLEHALES

Maya Indians Carry Water to Excavators Restoring a Shrine of Their Ancestors

Seemingly tiring of their temple-crowned pyramids, the Maya often covered them with higher structures. Such a fate befell the Temple of the

PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHER KATHY LITTLEFIELD © N. G. S.

Seven Dolls, so named for seven small clay figurines found beneath the floor. Only a corner protruding from the ruins betrayed its presence. More than 3,000 tons of rubble have been stripped from the first temple; earth and shattered blocks still mantle the underlying pyramid.

nary check, however, revealed an amazing number of pieces similar to those we had found in the Standing Temple, items obviously imported from the Uaxactún region of Guatemala. Nothing could have been more useful to us in linking the early history of Yucatán with that of lands to the south.

We found burials here, too, with whole vessels left as funeral offerings. One old man had been equipped for the afterlife with many plates and jars of food. Beside him rested the skeletons of two adolescents—presumably his wives, for Maya girls were married very young. One of the girls had her incisor teeth filed down to fine points; we could only hope she had found this fillip to her beauty sufficient to justify the pain of the operation.

Divers Plumb Dzibilchaltun's Well

Not all the treasures of Dzibilchaltun lie on the ground, or even in it. One of the striking features of the tremendous site is the *cenote*, or great natural well, in the city's center (pages 112 and 121). Largest of more than a dozen at the site, it is four times as deeply filled with water as the famous Cenote of Sacrifice at Chichén Itzá. We approached its exploration with tense anticipation.

Obviously, the traditional tools of the archeologist would avail us little here; we must trade pick and shovel for mask and Aqua-Lung. That first year we enticed two vacationing students from the University of Florida—David Conkle and Whitney Robbinet—to try out their Aqua-Lung, and in a very few days we struck real pay dirt. An amazing wealth of artifacts came up—complete jars of early and little-known wares, pieces of worked flint, carved bone earplugs, and nearly 3,000 potsherds.

By the end of the first season's work it was apparent that we had an archeological bear by the tail. Dzibilchaltun held secrets of the utmost importance; to unravel them would take a large and skilled staff years.

Most scholars have believed for some time that the great Maya ruins were not really cities, but ceremonial centers where a scattered population could gather from rural homes to worship and trade.

Dzibilchaltun appeared to refute this concept by the very size and number of the remains. Too many permanent structures were scattered over too immense an area. The flimsier thatched dwellings of the people may well have numbered ten to fifteen thousand, indicating a large, permanent population.

This posed new problems. How could such an immense center of urban dwellers have lived off the rocky soil of the area? Because of their slash-and-burn system of agriculture, the Maya never were able to use more than a small fraction of their land for crops at one time. To exist, Dzibilchaltun must have controlled a vast surrounding area, levying tribute far from the center of power. But this empire concept runs counter to long-held views on the social structure of the Classic Maya.

A final puzzle: When the Spanish conquerors arrived, they found masses of local historical tradition. The Maya themselves, when they had learned how to write their own language in the Spaniards' alphabet, duly set down much of this history. Although rich in detail, these chronicles say not a word of any great ruined city in the area which might definitely be Dzibilchaltun.

That Dzibilchaltun survived the conquest is attested by the presence, in the center of the great ceremonial plaza, of one of the first churches the Spaniards built to their Christian God. The chronicles tell us, moreover, that the Spaniards built their Yucatán capital, which they named Mérida, on the site of a very great and ancient city, T'ho. Could Dzibilchaltun be T'ho?

Expedition Begins All-out Assault

With such intriguing questions as these before us, we appealed to the National Geographic Society for help. Its response was typically prompt and generous. Thanks to its support, and that of the National Science Foundation and the American Philosophical Society, we were assured of funds for a coordinated assault on Dzibilchaltun of at least several years' duration.

The National Geographic Society's assistance took more than monetary form. Bates Littlehales, staff photographer for the Magazine, was assigned to us for the season, doing our technical picturemaking as well as photo-

Workmen Clearing the Temple Doorway Stir the Dust of Centuries

No one knows why the Temple of the Seven Dolls escaped destruction. Through some desire for preservation, the Maya stuffed it with limestone and buried it, then built a larger temple directly above. Four-foot-thick walls sustained the heavy burden.

NATIONAL GEOGRAPHIC PHOTOGRAPHER WILLIAM W. CAMPBELL III

Modern Maya Restore the Doll Temple's Façade

How the Maya raised their enormous pyramids and stone temples is one of the many mysteries that beset investigators. They had no metal tools, no wheeled vehicles, no beasts of burden. Yet they quarried 50-ton blocks of stone and transported them through rough country or dense jungle.

Awkward and ungraceful compared to most Maya structures, the Temple of the Seven Dolls is distinguished as the only one ever discovered with true windows. Four-foot-thick walls were mortared with mud.

Bones of a child were buried in this urn. By custom, the Maya often cut a finger joint from the mother and placed it in such a burial, though none appeared here. Archeologists were surprised by Dzibilchaltun's wealth of crypts. Seven excavated rooms yielded nine burials.

graphs and paintings for this article (pages 102 and 105). Through him The Society's superb photographic laboratories were made available to our project.

When Bates was forced home by illness, his place was taken by William Campbell, who did valiant service in finishing the job. The Society also sent Luis Marden, ace diver-photographer, to lead our underwater team. Of its web-footed exploration of the great cenote, Marden himself writes with vivid authority in the following article (page 110).

One of the most impressive remains at Dzibilchaltun is the *sacbe*, a great white causeway that runs for a mile and a half through the heart of the city, fanning out into gigantic paved decks that once supported groups of imposing temples. Sixty feet wide and, in places, eight feet high, this monstrous ramp was built of stone blocks covered with gravel and capped in white cement (page 94).

How much stone went into it? A good 700 million pounds. When one stops to consider that these neolithic people had no metal tools and could quarry the local limestone only with sharpened fragments of harder stone, their feat seems all the more fantastic.

Along this causeway, like government buildings along Washington's Constitution Avenue, stood temples and vaulted buildings. Throughout its length the way was marked by carved stone monuments bearing sculptured figures and hieroglyphic inscriptions. At intervals, smaller causeways led off at right angles to other palaces and ecclesiastical structures.

What was the purpose of this vast avenue? The ancient peoples of Dzibilchaltun knew not the wheel; they possessed neither vehicles nor domesticated beasts to draw them. We are left to conclude that their roadway must

National Geographic Research Chief Studies the Temple's Plaster Carvings

Dr. Lyman J. Briggs, Chairman of The Society's Committee for Research and Exploration, touches the stucco gingerly, for it has virtually disintegrated under time and weather. Excavators photographed and sketched the designs, preserved them in plaster, and made possible the artist's re-creation of the temple's original façade (pages 102-3). The carvings by their technique indicate something of the age of the Doll Temple. They obviously represent a stage in Maya culture before development of stylized stone carving such as that used at the later ruin of Chichén Itzá.

The Maya then, as today, made plaster by burning limestone. And doubtless then, as now, they believed bad luck would follow if a woman approached the limekilns.

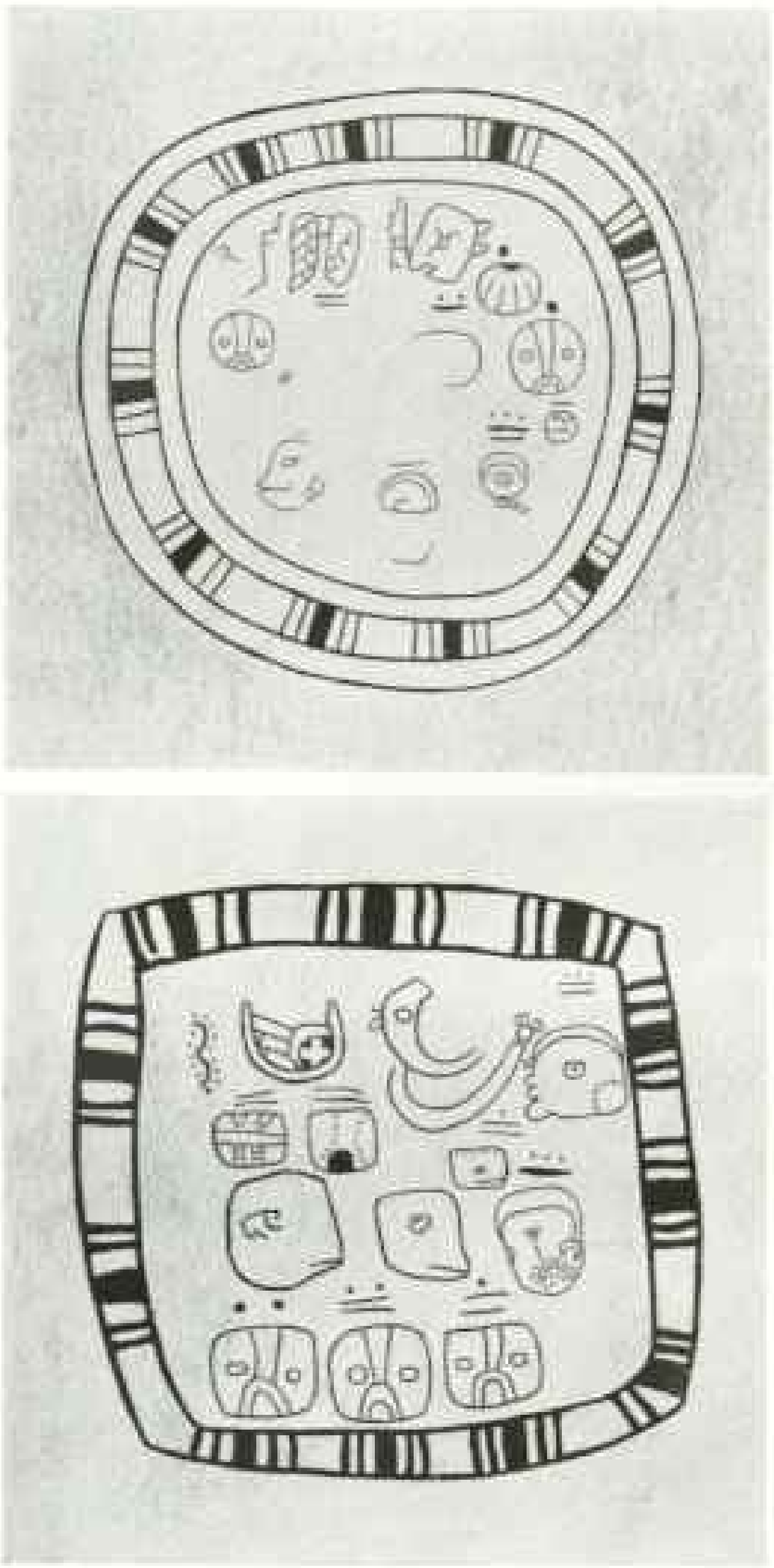
MELVILLE BELL GROSVENOR

Priests with Ceremonial Fans Preside Before the Temple of the Seven Dolls

A sacred mask above the door and at each corner accents the carved stucco façade, carefully reproduced by the artist on the basis of remnants uncovered by excavators. Atop each mask a stylized animal thrusts its head under a water

lily. Sea birds, fish, and crabs figure in the frieze. The tower, rare in Maya architecture, opens above the sanctuary. Dr. Andrews believes the temple may be the tomb of an important Maya.

In hundreds of similar temples atop man-made acropolises, the Maya offered sacrifices to deities such as Itzamna, lord of the heavens; Yum Kax, god of the harvest; and Kukulcan, the feathered serpent. Priests tore hearts from living victims while worshipers thronged the plazas below.



DRAWINGS BY GEORGE E. STUART

Calendar Symbols and Mythical Faces Fill Medallions in an Altar Room

To the Maya, the passage of time was life's most absorbing interest. They regarded the days as living gods and erected stelae to mark the end of significant time periods. From this consuming interest came a crowning intellectual achievement: a chronology as accurate as the Old World's Gregorian calendar devised centuries later.

Maya astronomer-priests developed the New World's first system of writing. Medallions at left, found on the altar decoration in the Doll Temple (painting, opposite), bear the most recent Maya glyphic inscriptions known. Believed to date from the 13th and 14th centuries, they are five to seven hundred years later than those of Classic times. Although the glyphs show substantial changes against those of earlier times, most are decipherable as calendric symbols. They probably denote auspicious days for planting, harvesting, and other activities. The author believes these texts may prove of great value in linking two eras of Maya history (page 109).

Scalpel and acid uncovered the complete medallion at left beneath a later and partially destroyed inscription (above). Dot-dash symbols among the faces are numerals. An expedition archeologist made these drawings in the temple before the medallion was painstakingly removed for preservation in a museum in Mérida.

have been primarily esthetic or ceremonial.

When I had first come to Dzibilchaltun, I had been fascinated by a large pyramid at the eastern end of the great causeway. Time, weather, and the depredations of man had virtually destroyed it, but the collapse of its superstructure had served to reveal traces of buried chambers from some earlier period.

Returning to the site for the second season, I began clearing away the dense jungle growth obscuring the fallen pyramid and plunged into actual excavation.

A Temple Emerges from Rubble

It soon became clear that we had stumbled upon a much greater find than I had suspected. Below us lay not merely some small forgotten chambers but an entire temple intentionally and carefully buried.

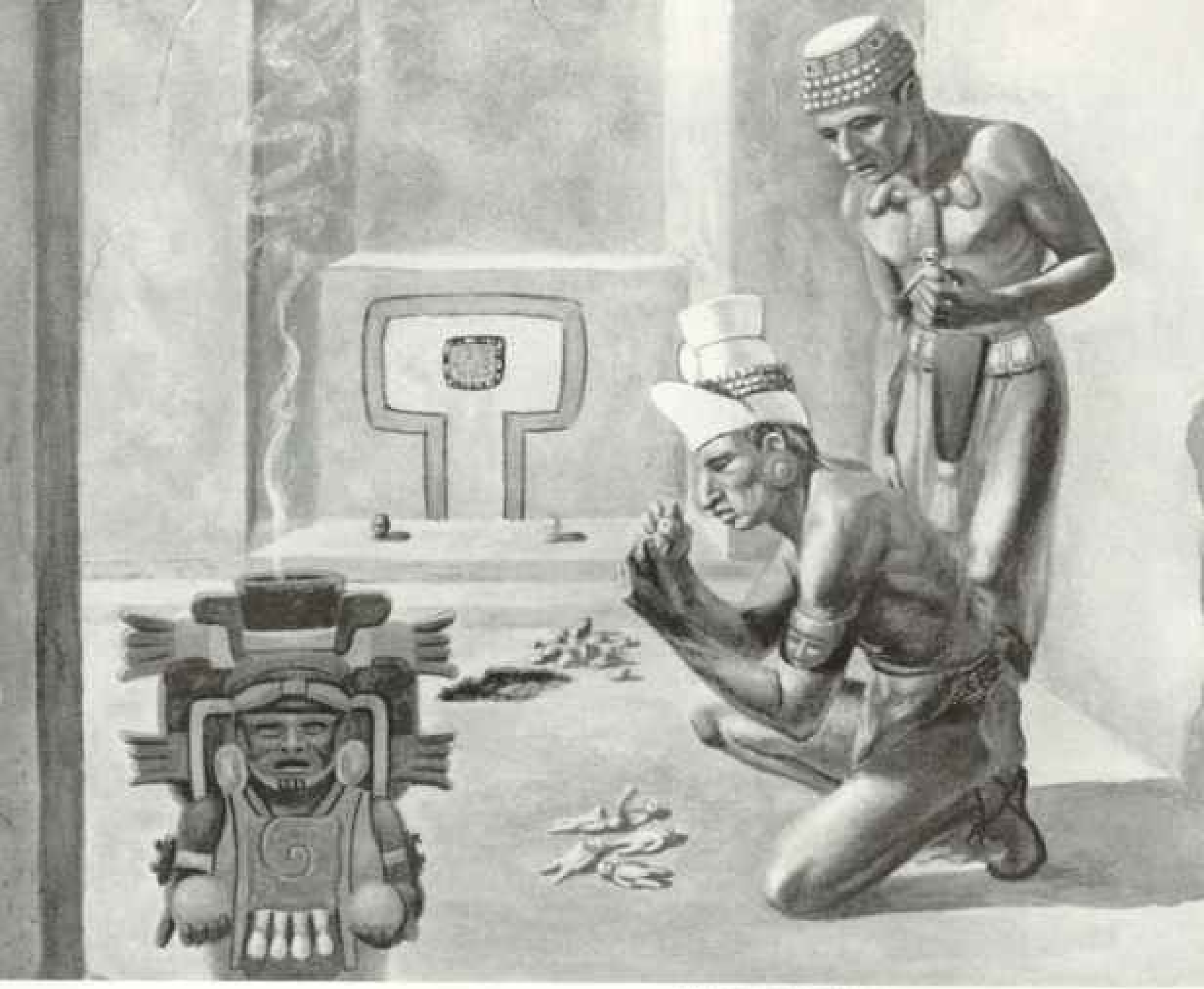
Four and a half months later we had peeled away more than 3,000 tons of stone and barely reached the temple floor. To excavate the almost perfectly preserved pyramid on which the temple rests will, we calculate, require removal of another 7,000 tons.

Meantime, however, we can describe the structure that has emerged thus far. It is, admittedly, a rather ungainly, uninhibited edifice, very different from the formal and classical buildings of later Maya days.

Certainly, the great slabs which form its walls, three to four feet thick, seemed crude to us at first. Scarcely worked, laid in mud, not mortar, they were more massive than strong. But we came gradually to know that their surfaces had been far from unadorned.

Indeed, the lower sections wore a thick coat of stucco which completely hid the rough masonry beneath. The upper façade and the two upper moldings boasted a frieze carved in such full relief as to be almost "in the round." The artist, obviously, had been given the freedom of his medium—stucco—and, in a fresh and naturalistic phase of culture, had let himself go with quite happy results. The sea bird, sting ray, and fish on the north façade, facing the sea, were delicately and imaginatively conceived (pages 101 and 102).

The temple's unconventional design did



PAINTING BY BATES LITTLEHALES, NATIONAL GEOGRAPHIC STAFF

Seven clay dolls, unlike anything previously found in Maya excavations, gave the temple its name. Artist Bates Littlehales re-creates the scene in which priests buried the images in a hole dug in the sanctuary floor. Burning copal resin from the *pom* tree fills the room with incense.

little to enhance my reputation among our crew of skilled native diggers. The best of these men came from the area near Chichén Itzá and were veterans of archeological excavations there. They were directed by the invaluable Eugenio May, who, when he is not digging, is Presidente Municipal of his little village of Pisté.

As chief of the labor force, Eugenio was well aware that one of my jobs is to interpret our finds as the dig progresses and to predict what will come up next. One day as we were excavating the lower part of the west façade, Eugenio rushed up and exclaimed:

"Don Beel! We have uncovered the top of what must be a window! It is much too low to be the top of a door."

I snorted. "Eugenio, after 25 years! You know as well as I that the *antiguos* never built windows. Let's have a look."

I had to admit that the opening *was* in an odd place. But I rallied quickly. "Keep digging," I ordered. "You'll find this to be a small side door flanking a larger central entrance that we haven't yet reached."

Rudely formed, each effigy shows some monstrous deformity. Experts suggest that the dolls may have been priestly devices for curing disease.

NATIONAL GEOGRAPHIC PHOTOGRAPHER WILLIAM W. CAMPBELL III

NATIONAL GEOGRAPHIC PHOTOGRAPHER BATEA LITTLEBALES

Two and a half feet farther down we came upon sills. We had uncovered true Maya windows (page 100) as we use the term today, unlike the small ventilation openings found in most Maya buildings.

Juan Chablé, our head mason, was as much upset by the temple's unorthodoxy as I. A diminutive Indian from the southern village of Oxkutzcab, Juan has worked for Mexican Government teams since the early digs at Uxmal. Born at least a thousand years too late, he would have been one of the ancients' greatest architects. As it is, he can now reconstruct Maya temples so well that, a season later, I cannot tell what is early Maya and what is late Chablé.

How old was this temple we had found? We took slices from a doorway beam of the tough local wood *subinche*, and sent them to two different laboratories in the United States to measure the amount of carbon-14 left in the samples. The first laboratory determined that the tree from which the timber was cut had ceased to live A.D. 458—plus or minus 200 years. The second put the date at A.D. 508, with the same margin of possible error.*

The temple, then, had been built roughly 1,450 years ago. And our studies indicated that it was in intermittent use for the amazing span of more than 1,000 years.

During many centuries the temple apparently served as the nucleus of about 15 structures at the eastern end of the great causeway. Then the Maya, perhaps ashamed of its old-fashioned lines, decided to bury it. At great effort they stuffed it carefully with big chunks of stone and used it as the foundation for a more up-to-date edifice, almost twice as large.

All we know about this later structure is that it, in its turn, was completely destroyed. Then, during the last gasp of Maya civilization—the so-called Mayapán Period—the Indians suddenly turned archeologists.

Tunneling down through the remains of the "modern" temple and entering, perhaps, some secret passage left open in the burial of the old one, they cleaned out the rubble obscuring the inner sanctuary and rededicated it as a subterranean shrine.

Sanctuary for Seven Dolls

They cut a hole almost in the exact center of the sanctuary floor and built a plaster tube leading down into the rubble below. At the bottom of this shaft they placed seven small clay dolls. None of us had ever seen anything like them. Of unpainted clay, crudely modeled, each exhibits some deformity—two are hunchbacks, one is a dwarf, a fourth has a swollen stomach, and so on (page 105).

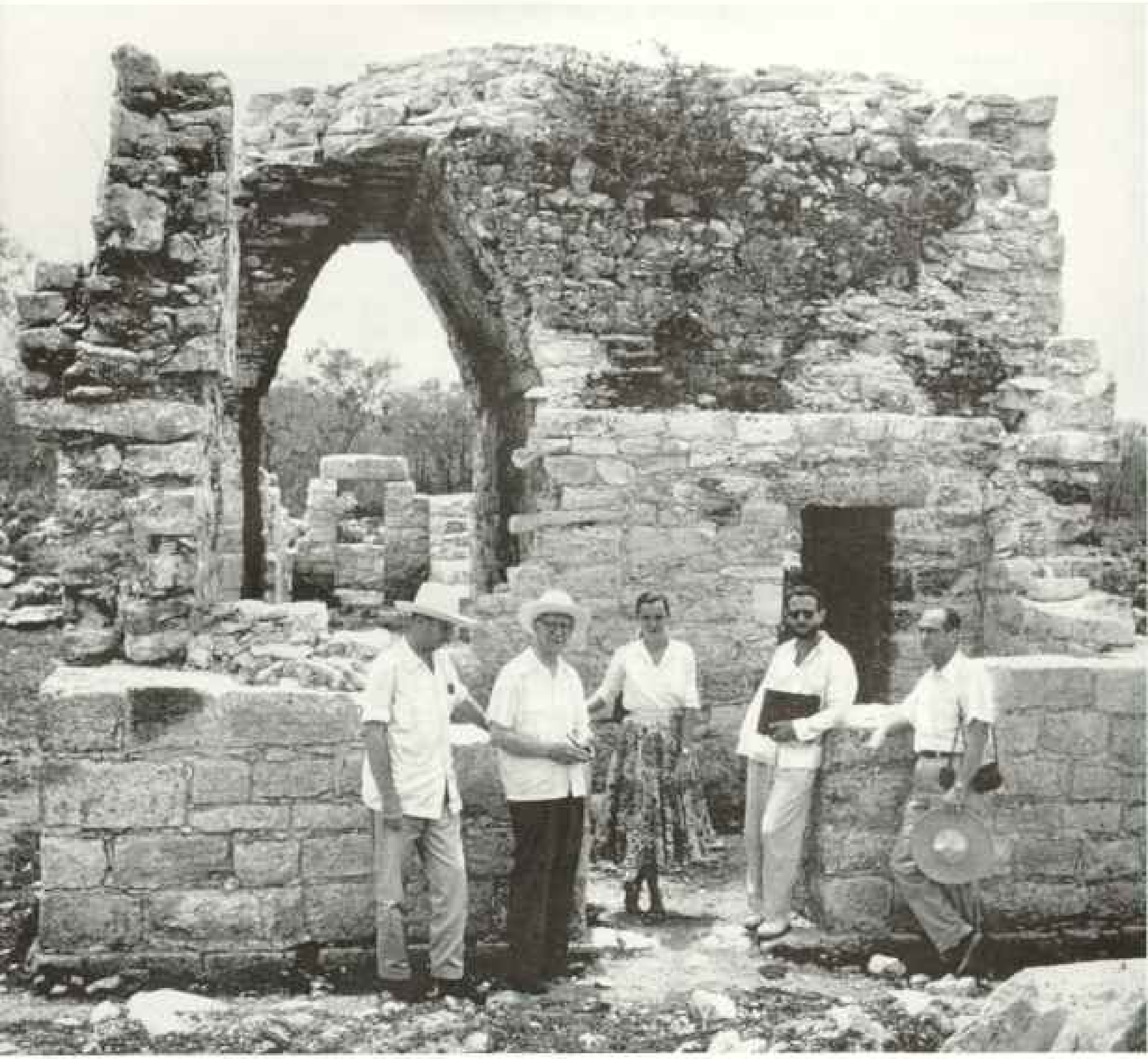
We can only guess at their significance. Perhaps these little idols embodied the Maya priests' formulas for curing disease. And perhaps the tubular shaft—the "psycho-duct," as we call it—was left open to enable these spirits of the tomb to communicate their mys-

* See "How Old Is It?" by Lyman J. Briggs and Kenneth F. Weaver, NATIONAL GEOGRAPHIC MAGAZINE, August, 1958.

DAVID S. BOYER, NATIONAL GEOGRAPHIC STAFF

A cracked lintel supports tons of rock above the Doll Temple's altar. Archeologists Andrews (left), Willard Sloshberg, and Robert Wauchope, Director of Tulane's Middle American Research Institute, inspect the altar room pictured in the painting on page 105. Beside them stretches the altar itself, its unrestored medallion a circular smudge on the dirty plaster. The splintered beam above their heads, unrotted through centuries, holds the key to the temple's age. Radiocarbon testing in two laboratories showed the wood to be 1,430 to 1,500 years old, dating the temple at about A.D. 500.

Iron-hard *subinche* wood of the lintel required a metal-cutting saw. Here a sample is taken from a beam end that Dr. Briggs took back to Washington, D. C., for testing.



Save for This Temple, All Dzibilchaltun Lay Buried or Ruined

Largest known of all Maya settlements, Dzibilchaltun is one of the most completely ruined. Even this remnant, after 13 centuries, stood on the verge of collapse.

In building, Indian masons never learned the secret of the keystoned arch. Instead they used corbeled vaults. This corridor shows how each course of stone was laid farther out across the gap until only a slit remained to be covered with a flat capstone.

Visiting the site, Melvin M. Payne, Vice President of the National Geographic Society, Dr. Briggs, Mrs. E. Wyllys Andrews, Dr. Andrews, and Dr. Leonard Muller, Professor of Modern Languages, University of Miami, Florida, pause for a photograph by Dr. Melville Bell Grosvenor, The Society's President and Editor.

terious powers to the human world above.

For the Indians' next step was to erect an altar just two steps up from the opening to the psycho-duct. Embedded in it was a T-shaped symbol bearing in its center a striking medallion. Near by stood tall, brilliantly colored incense burners, sculptured in clay in the stylized image of the brutal sanguinary gods of Maya decadence (page 105).

The medallion itself, covered with calendric and divinatory hieroglyphs, is the key object. Three times over the centuries the Maya remodeled the altar, and each time they blotted out the medallion with stucco and painted another with different texts (page 104).

The topmost painting was damaged beyond

recovery, but we could discern beneath it tantalizing glimpses of an earlier coat. Painstakingly we scraped away, photographing and sketching each stage of restoration in case whole segments should flake off and disappear. After bath upon bath of water and hydrochloric acid, we managed to salvage a partially damaged medallion in blue and orange, its crude hieroglyphics brushed on in black; only about half of them were legible.

Scalpels Reveal a Masterpiece

This discovery was thrilling enough. But it begged the question: should we sacrifice this bird in the hand for the still-earlier inscription which might lie below it?

Only in the final week of our dig did we muster the courage to try it. Wielding surgical scalpels and applying hydrochloric acid (which dissolved the plaster but had little effect on the pigments), George Stuart and I slowly pecked off the damaged medallion.

We were lucky: the paint of the new emerging medallion clung tightly to its own coat of plaster rather than to the overlay. Bit by bit we revealed an almost perfect inscription, a close replica of the other medallion, but square instead of round and with its glyphs precise and clear.

Should we go further still? A discreet probing around the edges dissuaded us; it seemed certain that the initial medallion beneath had been broken up when the altar had first been remodeled. We contented ourselves with the sufficiently hazardous job of removing the existing medallion for display in a Mérida museum.

Inscriptions May Link Two Eras

To any archeologist of Middle America, the significance of these two glyphic texts—the one we copied and destroyed, and the one we preserved—will be immediately clear.

These are the only hieroglyphic inscriptions ever found from the last 650 to 900 years of Maya history. Furthermore, they are specifically associated at Dzibilchaltun with artifacts and architecture that give us indisputable proof of their relative age, placing them perhaps as late as the 14th century.

Prehistory in Middle America has often been compared with a jigsaw puzzle, but this is unfair to the archeologist—because the pieces of a jigsaw fit together, and the bits and pieces we have previously used to reconstruct the past in this area do not.

The famous Classic Maya cities of the Guatemala jungles, with their development dated so accurately by the remarkable Maya calendar, were suddenly abandoned between A.D. 600 and 900. By the time of the Spaniards, the Maya were using an abbreviated calendar so vague that it is impossible to link the ancient calendar with our own.

Thus the Classic Period, though intensively studied and well understood in its own chronology, remains floating in the past, unconnected with modern history.

Maya culture continued in irregular spurts in Yucatán. The so-called Florescent Period developed at sites such as Chichén Itzá and Uxmal. Later there was a period of intensive trade with the Mexican highlands; this we call the Toltec Period, when Maya art showed a strong Mexican influence. Still later (but we do not know how much later) came the Mayapán Period, when, according to the chroniclers of conquest times, all Yucatán was ruled from the city of Mayapán.

Yardstick to the Distant Past

The earliest date in Maya history which we can place with any certainty in our own calendar is that of the destruction of Mayapán by civil war in 1441. None of the known Yucatán cities were occupied long enough to give us any firm yardstick of measurement or connection with the earlier calendar period.

Not so at Dzibilchaltun. The findings we have made there, the pottery, artifacts, and architecture, all show that this amazing city was founded between 2000 and 1000 B.C., if not earlier. Its culture developed on the spot and flowered through the Classic Period, when the city was perhaps the largest in the New World.

Then, instead of being abandoned, it kept on growing, thriving uninterruptedly through all the remaining crises of Maya history, on into Spanish colonial times.

Here is the site's great challenge for us. This is the yardstick we have never had before—a unique one more than 3,000 years long. And if we do our job well, we should be able to use it to bring some order into what has been thus far a most disjointed knowledge of history in this part of the world.

In short, the excavations we launched in the gaunt, gray ruins of Dzibilchaltun may yield treasures beyond even our most sanguine expectations, intangible yet more weighty in significance than the most imposing pyramid.

Divers plunge deep into a sinkhole to mine a treasure of Maya pottery, ornaments—and human bones

DZIBILCHALTUN:

Up from the Well of Time

By LUIS MARDEN

National Geographic Foreign Editorial Staff

With photographs by the author

WHEN I DIVED into the cenote of Dzibilchaltun, I took a plunge into history. Even as I sat on the edge of the big natural well, I felt that my rubber-flippered feet had already crossed the frontier of the ancient Maya world.

I slipped the mask over my face and clenched the Aqua-Lung's rubber mouthpiece between my teeth. My Indian helper patted me on the head; I took a breath of bottled air, slid into the water, and thrust downward toward the yawning black depths.

Cenote Xlacah (pronounced Shla-*cah*, Maya for "old town"), one of hundreds scattered over the face of the Yucatán Peninsula, is shaped like a sock, with a foot and toe that extend back under a rock ledge (page 112). The pre-Columbian Maya built their cities close to these sources of fresh water. I had come to the archeological site of Dzibilchaltun to dive and search for artifacts that might have been dropped or thrown into the deep sinkhole by the inhabitants of the old city.

I have often dived to the sea bottom, but this was the first time I had ever dived through it. I was plunging into a hole in an ancient ocean bed that slowly emerged from the tepid sea perhaps as long as a million years ago.

Rain falling on Yucatán percolates through the porous limestone, so that there are no streams or surface water of any importance on this hot, dry peninsula. Instead, fresh water stands in cenotes, or natural sinkholes, that reach the subterranean water table. Hundreds of these water holes, deep or shallow, clear or green with algae, pock the flat face of northern Yucatán.

Descent into the Pit of Darkness:

Through the passing centuries the slow rain of Maya pots and gourds, spears and lances, jade pendants and carved bone hair ornaments, even the bones of men and women, sifted softly down to their beds of rotting ooze. Here they were held, safe from the erosion of sun and wind, inviolate in the green twilight until man found a way to take his air with him into the aqueous world.

Cenote Xlacah is 100 feet across at its widest point and at least 140 feet deep. Twenty feet beneath the rock lip at the deep end, the bottom plunges steeply into blackness.

Schools of flat-bodied silvery characin fishes darted round my head as I stared into the darkness (page 127). Beneath me the green

Electric Torch Lights a Diver's Path into the Cenote's Black Night

carpet of tufted water weeds stopped abruptly at the limit of sunlight.

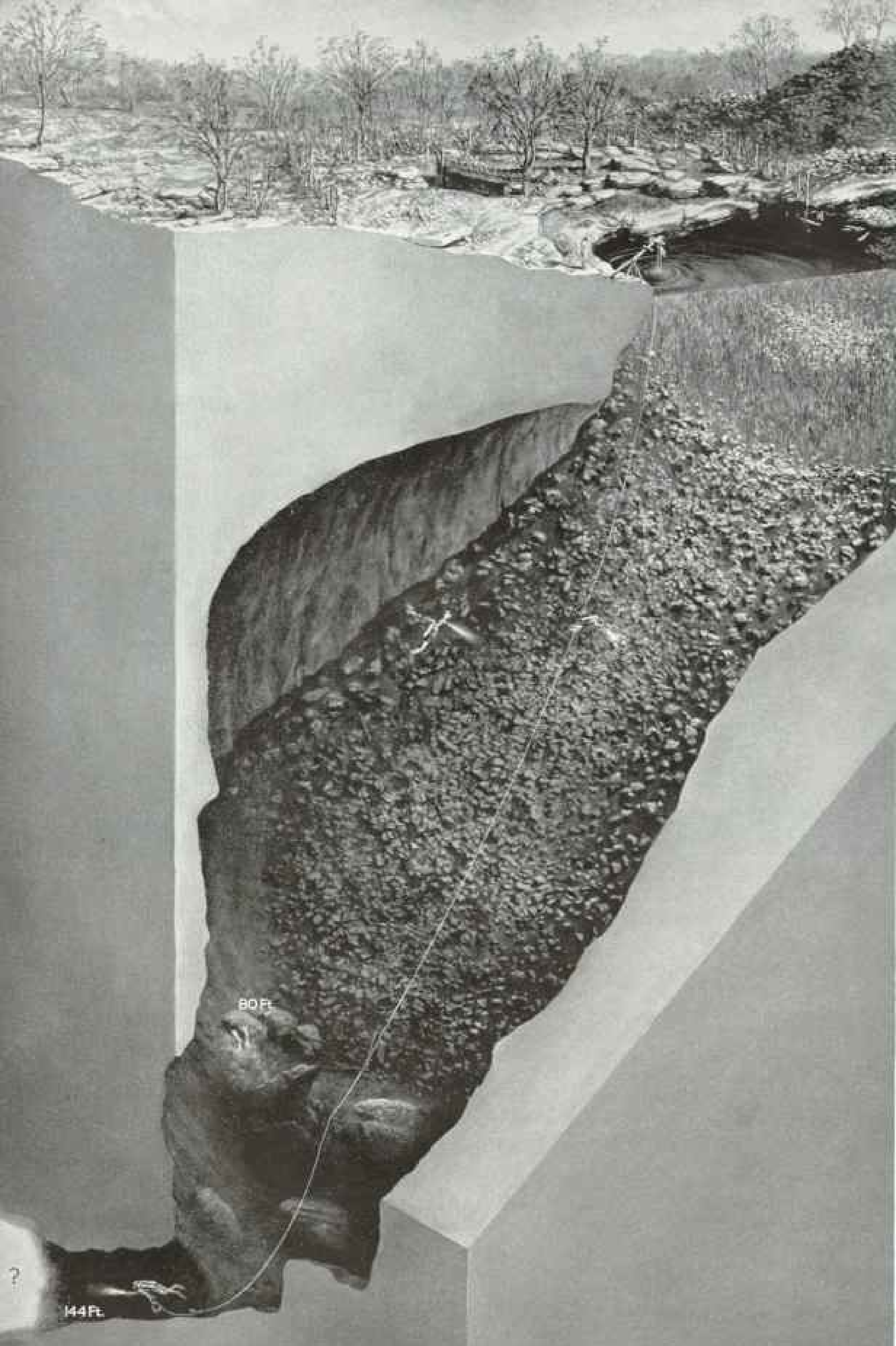
Under the overhang the darkness seemed almost total at first. I paused to clear my ears and to turn on the flashlight that hung from my wrist. As my eyes adjusted to the gloom, I could see the vast curve of the roof and back wall receding in a dim semicircle, like an amphitheater seen by moonlight. Under me the rubble-strewn slope dropped at an angle of 50 degrees.

I expelled the air from my chest and, with arms extended straight before me, sank silently down the slope. Below me the jumble of limestone fragments bedded in black ooze slid upward, seemingly reversing in slow motion their age-old fall into the depths. Here and there in the rubble lay squared and carved stones, evidence of human handiwork that had tumbled into the cenote centuries before.

Stone Lintel Found at 80 Feet

At 60 feet I paused to look upward. Against the lambent blue rectangle of the entrance Bates Littlehales, my diving companion, swam in black silhouette, like some space-suited alien suspended in a void.

Bates swam down to me, wagged his lamp reassuringly, and we continued to sink. At 80 feet the slope came to a flat landing of velvety mud, then plunged abruptly into blackness between two upthrust pylons of rock.


80 Ft.
144 Ft.
?

Divers with Their Lamps Shimmer Like Fireflies in Xlacah: a Cross Section

National Geographic men plunged into this natural well for a total of 52 hours under water. They followed a lifeline down to a half-buried anchor in the tunnel's mouth (lower). To continue, they attached a second line and, uncoiling it as they swam, reached a recorded depth of 144 feet. Beyond that point lay the black unknown.

Water lilies cover the pool's shallow end, and tufted water weeds grow down to the limit of life-sustaining sunlight. Rubble, presumably from the collapsed roof of the cenote, strews the slope down to the 80-foot level. A little below, a diver gropes in the ooze for unbroken Maya jars.

Overgrown with trees, a crumbling pyramid commands the shore. Cows and horses drink at a well where chattering pre-Columbian housewives once drew water.

PETER K. BURIAN

At the foot of the slope a big rectangular lintel of stone stood on end between a tree trunk and the drum of a column. Head downward, I carefully fingered it for possible hieroglyphs, but all four sides were smooth.

We edged over the drop-off between the leaning rock pinnacles. Our lamps threw cones of light on the back wall, which curved abruptly down to the toe of the cenote. At the foot of the rocky columns we came to another landing, and then the bottom dipped again, flattened, and slid into a low-arched black tunnel.

Divers Probe a Dark Cave

At the mouth of the tunnel the depth gauges read 120 feet. The exhaled air bubbled noisily from our regulators, and when I held my breath, I could hear the expanding silver mushrooms of air glucking and tinkling as they streamed to the rocky vault far above our heads.

I looked upward. Under the curve of rock the surface opening glowed faintly green, its dim arch of light slashed brutally by the diagonal masses of leaning rock, like monstrous jambs at the gate of some cold and silent hell.

Littlehales and I finned our way into the tunnel's mouth. We had to swim close to the floor of ooze to pass under the low arch, and the muck swirled in the wake of our fins. Suddenly the oily black stuff whirled up before my mask, and I turned to look for Littlehales just in time to see the green disk of his lamp wink out. I turned my own light full in my eyes and could see nothing. I was in utter blackness and could not tell up from down, or which way led back to the tunnel opening, to the surface, and to air.

For 10 seconds I felt black panic. Then reason returned. Inhaling deeply, I rose to the arched roof of the tunnel and clung there like a fly. As the roil gradually subsided, it left a foot of relatively clear water under the roof. The green firefly of Bates's light wavered toward me. We touched hands and started up. We had been down about 20 minutes.

When we emerged into the dazzling sunlight, I asked Littlehales if he knew why the mud had boiled up so suddenly.

"It was this," he said, holding up one arm. He wore an oversize armlet of terra cotta. It was the broken neck of a jar, our first artifact.

"I saw it lying half buried in the mud," said Bates, "and when I tugged at it, the ooze spurted up in a black cloud that obliterated everything."

Our first task was to take a lifeline down as far as we could and anchor it, so that we should always have a link with the surface.

We had engaged two experienced Mexican divers, Fernando Euan and Earl Becht, to work with us. The season before, Fernando had made several dives into the cenote. Earl could build anything, with or without tools. In a few days he had constructed, with the help of two Mayas, a diving platform just under water, where we could sit while putting on our Aqua-Lungs, as well as a kind of shear legs, or derrick, of slender logs, that leaned out over the cenote (page 122).

We made fast the line to the derrick head; then Littlehales and I put on our breathing apparatus and submerged. Each of us held one side of a 16-pound mushroom anchor, which dragged us down so fast that we had to keep swallowing and popping our ears.

We dropped the anchor just inside the black tunnel and watched it disappear in a cloud of ooze. On our way up we followed the white nylon line which stretched in a glistening catenary curve to the surface, a reassuring link with the upper world.

On the north rim of the cenote stands a great mound of rubble. As we dived day after day, we became convinced that much of the worked stone from the facing of this pyramid had at some time in the past slid down the slope into the deep waters of the well.

Beginning at 60 feet, carved and shaped stone flowed in a cascade to the foot of the slope: squares and rectangles of white limestone with sharp, uneroded edges, blocks faced with intricate geometric carving, columnar drums, and finally the great door lintel at the foot of the slide. An "Engulfed Cathedral" of pre-Hispanic Yucatán.

Explorers Work a Treasure Vein

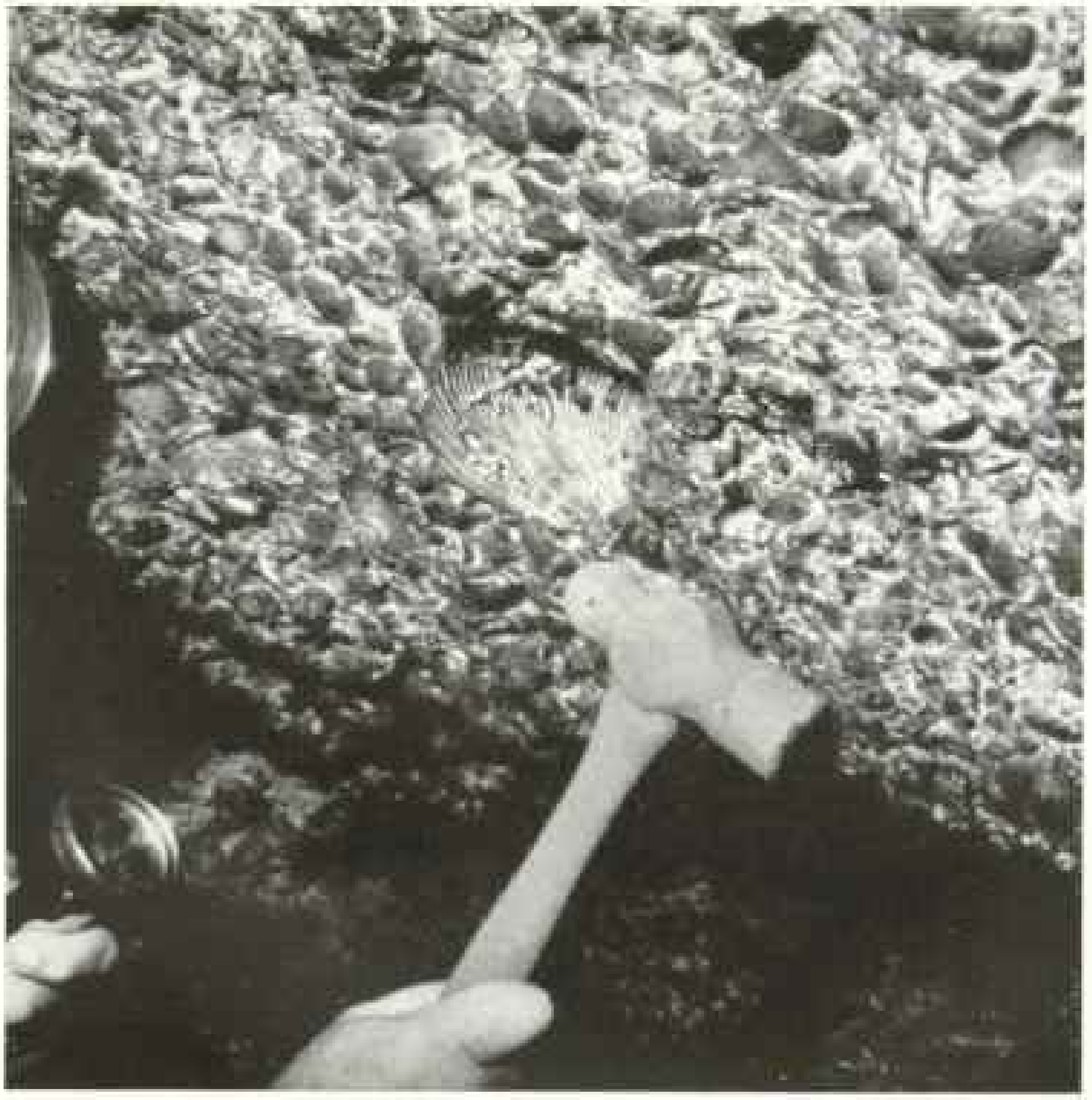
Manuel, the camp caretaker, heard diver Fernando Euan and me discussing the enigma of this cataract of carved stone. It did not puzzle him.

"That's the cacique's castle, *jefe*," he said. "Our people say that a king had his *castillo* standing where the cenote is now. One day his mother came to him asking for water, and he sent her away, saying he had none. God in His anger caused the ground to give way under him and his fine house, and they all sank together into the cenote. He had plenty of water then."

At 60 feet we struck our first rich lode. Pieces and whole necks of earthenware pots lay thick among the tumbled rubble. In one dive we could easily fill our wire baskets. Lying head upward on the slope, moving as little as possible to conserve our air and to avoid clouding the water, we could stay down forty to fifty minutes on a single tank of air. We sent pail after pail of potsherds to the surface (page 123). The ancient clay was soft and crumbly when it first came out of the water, but after a day's drying in the fierce Yucatán sun, the pieces became quite hard.

Sometimes we inad-

Fossil shells 100 feet down show that the cenote once lay beneath the sea. Scallops, clams, and cockles form the limestone matrix.



vertently moved a key stone; the rubble would tremble and shift, then start to tumble down the slope in slow motion. Usually we heard a warning click, or saw an uneasy stirring of the mass of rock, which barely gave us time to inhale a chestful of air and rise safely above the underwater landslide.

Such landslips threw up clouds of ooze. This excited the few venturesome finger-length fish that had followed us down from the sunlit shallows, and they would dart through the water, snapping at bits of organic matter. When the cloud had subsided, we would search the new working face minutely.

For days we mined pieces of pottery. Then one day I heard Bates hooting through his mouthpiece. He held a slender tapering object toward me. I took it, thinking it was an abnormally long thorn, but when I turned my lamp on it, I saw that is was a bone awl engraved with a vertical row of hieroglyphs (page 118). We shook hands and started up the slope.

Like nearly all nonnumerical Maya hieroglyphs, some of these carvings proved undecipherable. Actually, the awl may have been a hair skewer, thrust into the glossy black hair of some Maya girl who lost it while drawing water.

Skulls Hint Human Sacrifice

Dr. Andrews had always maintained that the objects found in the cenote had been accidentally dropped into the water by women who had come to draw water, or other persons.

But from the discovery of the awl onward, we began to find things that were not entirely utilitarian. We found a clay flute, a miniature molded head finished in the mysterious "Maya blue" pigment, obsidian flakes, bone noseplugs, and human bones.

A weightless diver hovers over a stone lintel, possibly a fragment from the ruined pyramid on the cenote's brink. Bare of any carvings, it lies on end 80 feet below the surface.

NATIONAL GEOGRAPHIC PHOTOGRAPHER WILLIAM W. SMITH III

Sunday at the cenote. Each weekend, when the divers suspended operations, carefree children from near-by villages turned the pool into an old-style swimming hole. Diving ladder at left awaits the return of the Aqua-Lung crew on Monday.

Interspersed with the bones of cows and small rodents we found human jawbones and crania. The skulls were so flattened that the top of the cranium was very little higher than the ridge over the eyes.

Bishop Diego de Landa, the misguided zealot of the 16th century who burned all the Maya manuscripts he could find, partially atoned for his cultural crime by writing his *Relation of the Things of Yucatán*. In it he says: "They had their heads and foreheads flattened, and this was also intentionally done by their mothers in their childhood." The infant heads were flattened by binding two boards tightly to the cranium.

Possibly the bones were of victims of drowning or even the *corpora delictorum* of pre-Columbian murders. But the increasing numbers of nonutilitarian objects, in addition to the bones, made Dr. Andrews think that Xlacah may have been the center of a cenote cult, like that which centered round the celebrated Cenote of Sacrifice at latter-day Chichén Itzá.

At the foot of the slope we found bigger bones. One enormous femur must have belonged to a giant of a man, perhaps a conquering Spaniard who either fell or was thrown into the sinkhole (page 93). Other thigh bones were smaller and more delicate, and one dainty pelvis was, I am convinced, that of a Maya maiden. My skeptical companions asked me how I could be sure, and I could only reply that I felt it in her bones.

Groping Blindly in Ooze

At the end of two weeks of extensive digging, our rich vein at 60 feet became exhausted, and we moved down to the landing at 80 feet. Here we worked standing on our heads, groping in ooze up to our armpits.

While we probed in complete darkness, Newton's third law of motion—"for every action there is an equal and opposite reaction"—was graphically borne home to us. If we made a violent effort to thrust our arms deep into the ooze, our bodies would move back an equal distance, so that to penetrate the stuff we had to kick our fins constantly.

Under a tree trunk we found a dozen buried

pots, some of them entire. It was frustrating to feel the rounded shape of a whole jar in the ooze, only to have a section come away in the hand despite the most careful digging.

At this depth the walls curved down to meet smooth side slopes of mud. We worked up these slopes, our right arms buried like plowshares. Ahead of our questing arms the quivering aspic of clinging muck heaved and erupted in geysers of cloudy smoke that shone brown and oily in the light of our lamps.

On this slope I found the handsomest whole jar of the season. Fortunately it lay mouth down, and so was easier to extricate in one piece. I left it for Fernando to dig out while I prepared to photograph him as he emerged with the magnificent specimen (page 90).

One day, while probing deep in the muck at 90 feet, I grasped something that felt like a branching twig. When I shook it free of its coating of mud, it shone too smooth and horn-like in the circle of light to be a tree branch. It looked familiar, and suddenly, to my astonishment, I recognized it. I held a piece of sea fan, a gorgonian such as I had swum among so many times on coral reefs. How did it come to be in the cenote, 90 feet down, under three feet of ooze?

Later I found more sea fan fragments, and these finds, more than any others, convince me that there must have been a cult of some kind connected with the cenote. Of no known use, the gorgonians must have been deliberately thrown into the cenote in some rite, perhaps a cult of the sea.

Repeated Diving Risks the Bends

While we dived to 60 feet or less, we had little cause to worry about the physiology of diving. We rarely had to decompress, because we stayed within the limits of the no-decompression tables, and so had no cause to fear the bends, that unpleasant ailment that hovers over the head of every diver who dives too deep and stays too long or comes up too fast. When we moved down to the 80-foot level and beyond, we had to keep close watch on our time below.

Complications confront a free diver when he makes several deep dives in one day. Then, even though he may adhere carefully to decompression times for each dive, the nitrogen which dissolves in his body under pressure slowly builds up to the threshold of danger. If he then comes up too fast, the gas dissolved in his tissues and blood turns to bubbles and causes pain, paralysis, or death.

One day Littlehales and I decided to see how far we could penetrate into the cavern at the bottom of the cenote. We dived to where the palely gleaming lifeline plunged into blackness between the rock pinnacles. I had rigged two lines tied to bronze snap swivels. We snapped them to the lifeline and swam down into the murk. The swivels slid to the end of the lifeline and clicked against the shank of the buried anchor.

Unwinding the lines as we went, we swam slowly into the black tunnel. In the cone of light from my lamp a single black catfish, its eyes gleaming dull ruby, trailed its whiskers in the mud. Above us the vault rose gently.

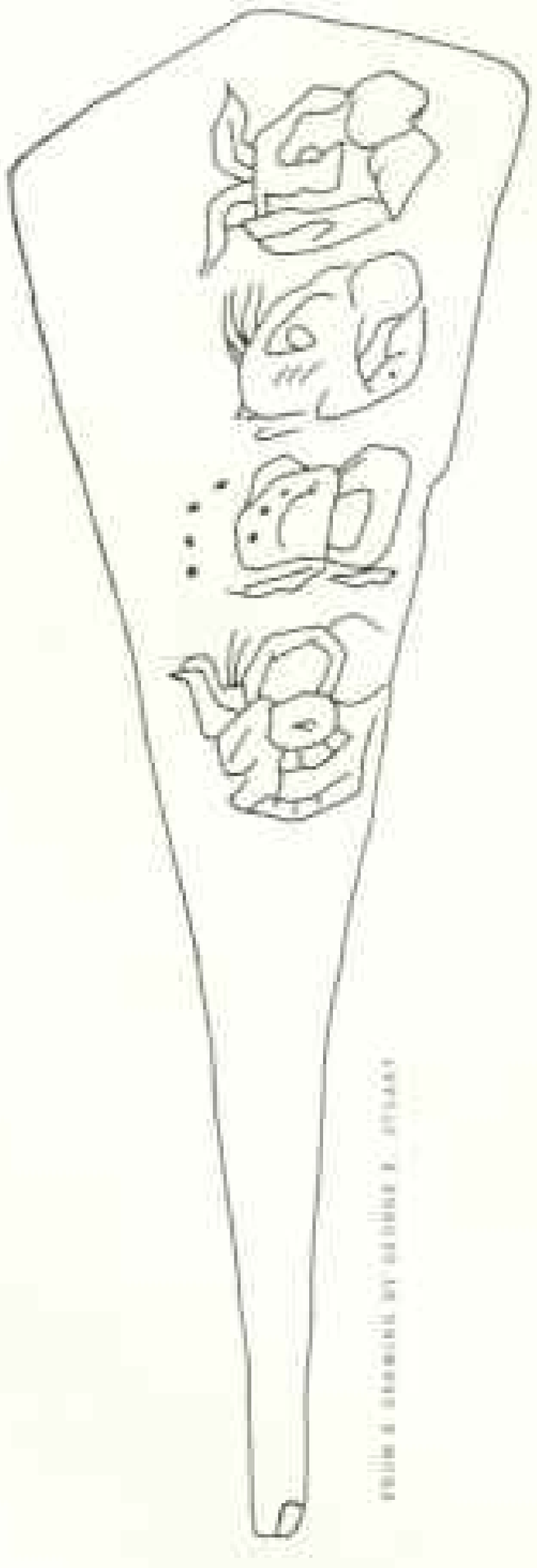
Eyebrows arched, the little mask (page 125) stares at its underwater discoverer. Divers rarely made open finds except when rock slides shifted layers of debris on the slope of the cenote. At the foot of the slope the men plunged arms deep into the black muck to feel out objects of interest.

Talking Pictures Carved on Bone Speak No More

Divers Littlehales and Euan discovered these bone awls or hair skewers carved with Maya hieroglyphs. They are among the most striking of thousands of artifacts recovered (page 93).

The meaning of the inscriptions is unknown, although most of the glyphs contain recognizable elements. Considerable progress has been made in interpreting numerical and calendric glyphs and others referring to color, direction, drought, and sickness. In still others, it seems certain that many elements represent sounds, as do letters in our own writing.

Archeologists have accumulated so much data that a cryptanalyst using modern techniques might unlock the puzzle. Col. William F. Friedman, the Nation's foremost cryptologist, and his wife Elizebeth, also an expert, have associated themselves with the Dzibilchaltun project to explore the possibilities.



Soon the cloud of ooze swirled around us. I looked at my depth gauge; it read 140 feet. Here, more than 50 feet into the tunnel, the floor ran nearly level. Our gauges were calibrated for sea water, which is denser than fresh water by 2½ percent, so that the actual depth was nearer 144 feet.

We remained at this deepest point only 15 minutes, then swam back to the outer amphitheater and rose at the then-prescribed rate of 25 feet per minute.

Ominous Twinge of Pain

We had dived twice before that same day, decompressing carefully both times on ascending. Within five minutes of emerging, I felt a slight pain in my right upper arm. Quickly I put on a fresh tank of air and went down to 60 feet, where I stayed for 10 minutes, then came up by decompression stages. Still I felt the pain, and so went down a second time to 80 feet for 20 minutes. When I rose, again by stages, the pain returned. By now I was blue with cold, having been under water so long that I was chilled through.

By coincidence an engineer friend, Melvin Art, who was building a new power plant in Mérida, had mentioned the night before that he could rig an emergency recompression chamber if ever we needed one.

During the 20-minute ride to town, the pain became almost unbearable. There was no doubt now; for the first time in 17 years of diving I had a case of decompression sickness—the bends.*

We telephoned Art from Dr. Andrews's house. "See you at the plant in 10 minutes," he said.

When we got there, workmen already were swarming over a square-sided oil storage tank the size of a small room. A pressure gauge and air hose had been connected, and men were cutting an airtight gasket of linoleum for the manhole atop the tank.

After briefing Mel on the use of the recompression tables in the U. S. Navy diving manual, Bates and I climbed up the ladder and lowered ourselves into the tank. Littlehales felt no symptoms but decided to take the treatment too. Mel handed down a flashlight and hammer, and then the men slammed down the cover and began to twist home the nuts. The clangor inside was earsplitting.

Air began to hiss into the tank. We lay

* See, in the National Geographic Magazine: "I Found the Bones of the *Bounty*," December, 1957; and "Camera Under the Sea," February, 1956, both by Luis Marden.

on our backs in pitch darkness. The hissing grew into a roar so deafening that we had to cover our ears. We began to sweat, because the compression of air raises the temperature sharply. The roar fell, then died into silence.

The tables called for a pressure of three atmospheres, the equivalent of 100 feet of water. We had popped our ears a couple of times, but I could feel that we were not under very great pressure, so I banged three times with the hammer, signaling "more air." The valves opened and air roared in. Almost immediately the roar died to a hiss. Still my ears told me we were not at 100 feet, but we lay quietly, knowing that Mel was doing his best.

After 20 minutes we signaled for more air but none came, so we hammered six times, the signal for "take us up." The air screamed out, and the temperature dropped until we shivered. The manhole cover clanged aside, and we climbed back to the fresh outer air. My arm still ached dully.

"What happened?" I asked Mel. "The tank wouldn't take any more pressure," he said. "We hadn't reached two atmospheres when the sides began to bulge."

If the tank had exploded, the men standing round it would have been seriously injured, if not killed, and I should probably have had a permanently paralyzed right arm from the explosive decompression.

Bolted into a Dark Drum

"I've got a cylindrical oil tank that should stand a lot more pressure," Mel said.

This tank was big enough for only one man. Bates still showed no signs of bends, so I entered it alone. So much time had now elapsed that we decided to try a recompression to five atmospheres, equivalent to a depth of 165 feet, and a total time in the chamber of 10 hours and 48 minutes. For the long wait I took with me flashlights with extra batteries, paperbound books, my diving watch, a copy of the treatment tables, and a hammer.

When the manhole cover was bolted fast, I was in Stygian darkness. The air hissed in, the temperature soared, and sweat streamed off my body in rivulets.

Standard recompression chambers are ventilated every few minutes. We had no such provision, and what I feared most was asphyxiation in my own exhaled carbon dioxide. I had asked Bates to "crack" the inlet valve periodically, to let in a little fresh air, and I lay quietly to avoid building up excess CO_2.

My time in that steel coffin was one of the least pleasant experiences of my life. I would not recommend it to anyone with claustrophobic tendencies. The books soon wilted to the consistency of limp lettuce, and I made no attempt to read. Now and again a hammer blow would startle me, and I replied with a single bang.

Faintly, as from a great distance, I could hear Bates say, "Well, at least he's still alive!"

When, after centuries of time, I heard the six-blow hammer signal "We're bringing you up," I felt as though I were emerging from a dungeon in which I had lain for years. I looked at my watch; to my surprise, I found I had been in the tank only 6 hours and 12 minutes (page 127).

Never had the air of Mérida, so hot and sticky at that time of the year, smelled sweeter

Carved stones from a temple's face lie on the cenote's slope. Dr. Charles Aquadro examines a slab bearing a swastikalike design.

or felt cooler. Blinking in the blaze of light, I saw long faces all around me.

"We couldn't get you down to 165 feet," said Littlehales. "The tank wouldn't stand more than 100 feet."

The treatment had temporarily alleviated, but not cured, the bends.

That night I slept under strong sedatives. When I awoke, Littlehales had not yet come downstairs. I found him stretched stiffly on his bed. He complained of a pain at the base of the spine and could not sit up. Now I was truly alarmed. If this was also the bends, Littlehales was in danger of complete paralysis.

There was no choice. Allen McLean, Jr., the United States Consul, telephoned Mexico City, and with the U. S. Ambassador's approval, the Naval Attaché sent out a radio call. Within the hour we received word that an aircraft would arrive that afternoon to evacuate us to Florida and a Navy recompression chamber.

Navy Airlifts Stricken Divers

The four-engined airplane was a welcome sight as it circled Mérida airport. The Navy had sent the big aircraft because it could pressurize its cabin fully. We flew at only nine thousand feet across the Gulf of Mexico, so that sea-level pressure could be maintained. High flying in an unpressurized cabin would have expanded the bubbles in our blood streams, causing permanent injury.

Less than three hours later we landed in Panama City, on the northwest coast of Florida. At the Mine Defense Laboratory, it seemed that the entire base, headed by the commandant, Capt. Richard Anderson, had turned out to meet us. We were hustled straight to the recompression chamber.

Because of the long delay between the onset of the bends and treatment, we spent 44 hours and 26 minutes all told in the gray tank. At the end of that time, thanks to the expert care of the Navy, we emerged completely cured.

I should like to express here the deep gratitude of Littlehales and myself for all that the United States Navy did for us. They took care of two unshaven and ailing civilians with unfailing good humor, and we shall always remember them with heartfelt thanks.

I planned to return to Yucatán to finish the job. A Navy specialist in diving medicine, Dr. Charles Aquadro, offered to go to Yucatán with me. I was delighted, because Lieutenant Aquadro is an experienced underwater swimmer, and he would bring the latest and as yet unpublished U. S. Navy tables for repetitive dives.

When I returned to Yucatán a few days later, I was warmly welcomed at the cenote. Some of the Indians seemed rather surprised to see me back, and I asked Fernando why.

"They fully expected to see you get in trouble," he said. "They say their patroness, St. Ursula, lives at the bottom of the cenote and resents anyone digging up the bones and household goods of their ancestors."

Fernando handed me a clipping from a Mexico City English-language daily newspaper that was headlined:

"Ancient 'Curse' on Mayan Wells Strikes National Geographic Divers."

The Indians of Chablekal settlement at Dzibilchaltun say that the image of their patron saint once stood in the ruined Spanish chapel on the east side of the cenote. When she was moved long ago to the church of Chablekal, her "little sister," or another manifestation of the saint herself—it was not clear which—remained behind in the cenote.

"It is dry down there where she is," they insisted. I had been to the bottom many times and had been wet all the way.

Whenever the feast day of St. Ursula is celebrated in Chablekal, music and fireworks can be heard issuing from the cenote, they told us.

(*Continued on page 129*)

Cenote Xlacah, an Ancient Sinkhole, Holds Secrets of a Ruined City

For at least 2,000 years dwellers in Dzibilchaltun dropped clay pots and ornaments into the pool. Beyond its carpet of lilies, the water preserved objects usually found disintegrated on dry land. Today the well remains a nucleus of life in a parched land; man and beast still come to drink (painting, page 112). Visitors from Mérida and Progreso hold picnics around the pool, and dusty laborers on the archeological project refresh themselves in the cool waters at the end of the day. The expedition erected a fence to keep pleasure seekers out but opened the gates after working hours.

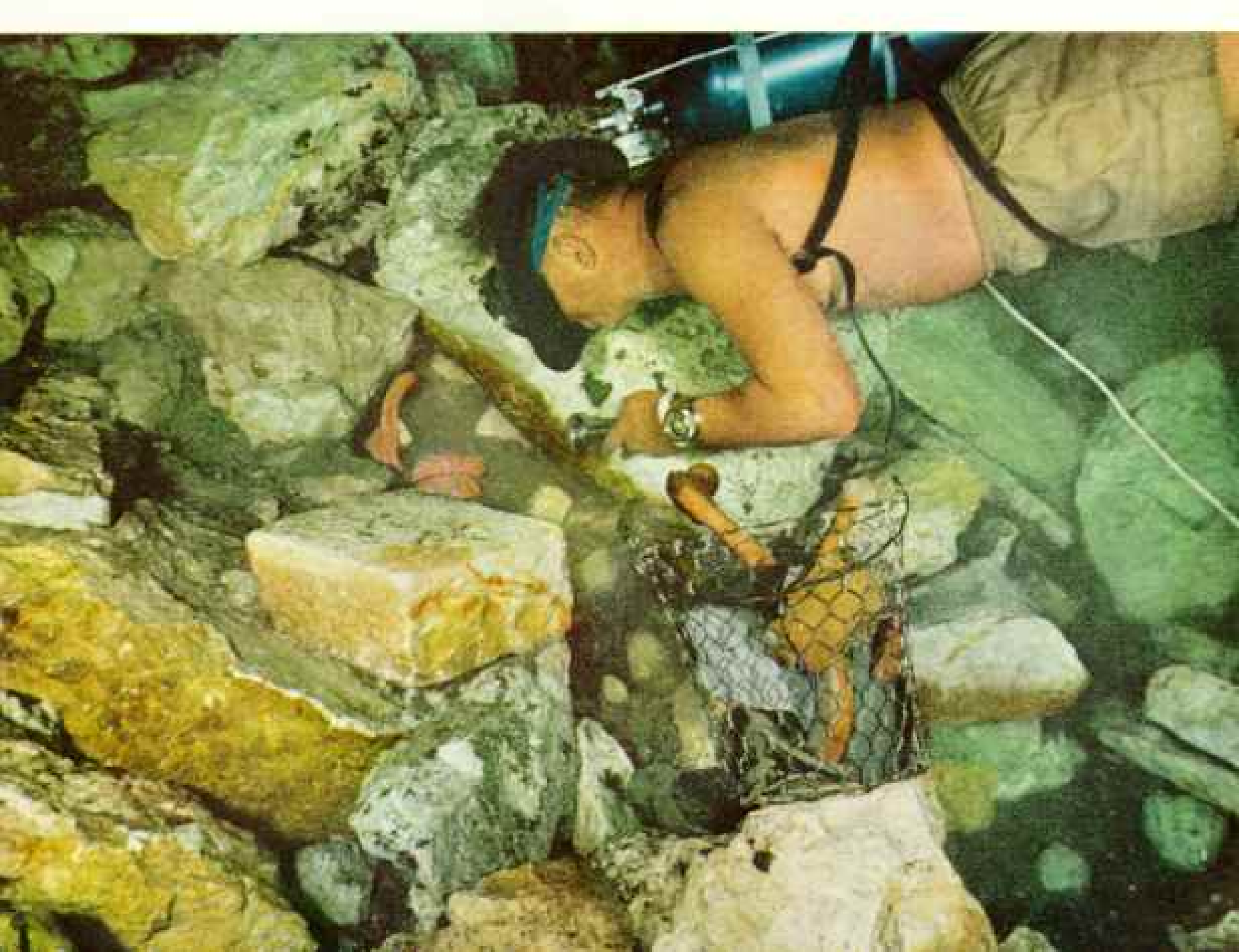
Here rising bubbles mark a diver's descent; two men at the right of the red pump tank prepare to descend. Yucatán's porous limestone has few rivers and lakes; water usually appears only in these natural wells.

Red-and-white Flag Says a Diver Is Down

Dr. Briggs (center) and Dr. and Mrs. Andrews watch for telltale bubbles to signal the diver's ascent. When men swam under the lip of the well, no bubbles rose because the overhang trapped their exhaled breath. At such times watchers on the bank grew uneasy.

A clay flute is examined by Dr. Andrews. The upper portion of the instrument broke off as diver Marden extricated it from clinging black mud and stone. Many other nonutilitarian finds led Dr. Andrews to the conclusion that the cenote may have been the center of a ceremonial cult.

Working by flashlight in 60 feet of water, diver Fernando Euan studies the broken collar of a water jar before removing stones which may fall and crush the terra cotta pieces. Squared stones probably tumbled from a temple on the cenote's brink. The wire pail holds a human femur and ceramic fragments.



Softened from Centuries of Immersion, Broken Pottery Dries in the Yucatán Sun

From a rich mine 60 feet under water, divers brought up potsherds, obsidian implements, and human bones. Most fragments broke in olden times, but sometimes a whole object snapped under a diver's questing fingers despite his most careful handling. Centuries of soaking under pressure left the clay soft and crumbly.

Dr. Andrews here examines pieces of a carved orangeware bowl, a fine expression of the Maya ceramic art.

Manuel May spreads his ancestors' work to dry. The thigh bone in his basket may be a symbol of human sacrifice. At Chichén Itzá, 75 miles away, the Maya threw victims into a cenote to intercede with the rain gods for good crops. It now seems possible that Dzibilchaltun held similar rites.

Surface excavators uncovered an astonishingly large quantity of potsherds. One dig revealed nearly a quarter of a million fragments. Highly diversified types of jars and dishes bespoke a well-developed trade with remote Maya cities in Middle America.

A smiling jaguar emerges into sunlight. Ethel Marden, the author's wife, found the clay figurine at 60 feet. Its hollow form suggests use as a whistle.

KODACHROMES BY WILLIAM W. CAMPBELL III AND LOIS MARDEN (OPPOSITE), NATIONAL GEOGRAPHIC STAFF © N. G. S.

Bulging cheeks and double-topknot hairdress give this miniature mask a distinctly non-Maya look. A rock-crystal plug also found in the cenote fits perfectly into the mask's open mouth.

Unreadable glyph elements were incised around this bone ring by a pre-Columbian craftsman.

A Cloud of Fishes Nibbles Bread from the Hand of Diver Euan

Usually these little characins hovered near the surface but soon learned to follow divers down to 60 feet. Bothersome as mosquitoes because they nipped at every fleshy protuberance, the fish proved welcome when they ate ticks off the divers' bodies.

Rising to the surface after an hour's dive, Marden suffers a leg cramp. Bates Littlehales massages the leg under water as Marden hangs on the lifeline. At Dr. Andrews's feet lies a fragment of a clay plate that puzzles archeologists because it is unlike any other pottery known from this region. Divers brought up a piece of this dish a year earlier.

Emergency recompression in an oil tank failed to cure Marden's bends, an ailment contracted by rising too quickly from great depths. In pitch blackness and wilting heat Marden lay bolted in the cylinder for six hours. Here he emerges. Engineer Melvin Art (rear) rigged the tank.

My wife had come to dive with us for a few days. One morning Ethel went down with Fernando and me. She halted at 60 feet while we sank to the slopes below to make photographs.

As I worked, I hummed "Adelita," Pancho Villa's old marching song. Fernando, who could hear me quite clearly, recognized the tune and looked up from digging to grin.

Later, when we had come up, my wife said: "You know, while I hung there waiting for you, I heard a high, thin singing. It was very faint but quite clear."

"Impossible!" I said. "You have been listening to too many old Indians' tales."

"I tell you I heard it," Ethel insisted, "and what's more, the melody sounded vaguely familiar. I can't explain it, but I know it was not imagination."

"You must have heard the singing of Santa Ursula," Fernando said with a straight face.

My wife will not know the answer to her mysterious singing until she reads these lines.

First Figurine from Well

We had gradually worked our way down the slope, and finally we moved into the black tunnel at the bottom. The floor is nearly level here, and anything that rolled down the slope must have been caught long before it reached this point. We found nothing. Returning to more productive levels, we opened up another vein at 60 feet.

On my wife's last day of diving, she made a unique find. Fernando and I were searching the slope when we heard an urgent hooting. Ten feet above us, Ethel waved her lamp violently. Gently, in order not to raise clouds of ooze, we pulled ourselves hand over hand along the stones. She held out her hand, and there in the beam from my lamp lay a little clay jaguar, not quite five inches tall, the first figurine from the cenote (page 124).

The days slipped swiftly by toward mid-June and the rains. Charlie Aquadro, Fernando, and I worked our new mine. The potsherds were smaller and fewer now, but of better quality. We found nearly all of a beautiful orangeware dish. Its glowing pieces felt as silken to the touch as jade.

For nearly two weeks we had a phenomenal run of luck; not a day passed that we did not turn up some odd or striking piece. Once Fernando held something out to me that shone white in the light. It was a spatulate bone hair skewer, with four hieroglyphs carved on its triangular face (page 118). That same day I found a small cylinder of rock crystal; Fernando next found the only bit of jade to come out of the cenote, a grass-green bead.

One of the most unusual finds was a small wooden mask (page 125). The puff-cheeked face, with its curious double-topknot hairdress and wide-open mouth, looked more African than Maya. In the laboratory we experimentally inserted the rock-crystal cylinder I had found into the mouth; it fitted perfectly, and may well have been fastened there when the mask was tossed into the cenote centuries ago.

My own best find came nearly on the last day of diving, when I saw a yellow circlet embedded in mud. It was a bone finger ring, incised with glyphs and a zigzag design, as fresh and sharply outlined as if carved yesterday (page 125).

On the last day Fernando and I retrieved the anchor and lifeline. As we neared the surface, we heard a sudden rattling. I looked up. A myriad of silver rods punctured the surface, dimpling and starring the water mirror. The rattling became a loud sizzling: the first heavy rain of the season was falling.

As we emerged, the pelting rain felt cold and wet. When a naked diver comes up into heavy rain, he feels much as a fully clothed man does when walking into a thundershower. If he can, the diver ducks down under the surface again to keep "dry."

Summer Rains Interrupt the Search

With the suddenness of the Tropics, the rain passed and the sun came out, washing everything in a pale champagne light. In the distance the sky lowered black, but near at hand the trees and rocks shone with the newness of a freshly made world. The bush, awakened by a week of tentative raindrops, burgeoned with spring green. Clouds of butterflies, pale chartreuse, sulphur yellow, and white, clustered on the rims of the rain pools.

I thought of the archeological treasures that surely lay still hidden beneath my feet. All over Yucatán, cenotes hold in their cool grasp secrets as yet unprobed by earthbound archeologists. One day, with St. Ursula's permission, I should like to dive once more deep into the centuries of ancient Yucatán.

Beyond a Sea of Sisal Spikes, the Doll Temple Gleams in Restored Splendor

The sea horse has a colt's head, an insect's shell-like body, and the pouch of a kangaroo, yet actually is a fish. Moreover, the male gives birth to the young.

Little Horses of the Sea

By PAUL A. ZAHL, Ph.D., Senior Editorial Staff (Natural Sciences), National Geographic Magazine
With photographs by the author

ONE winter morning the kindergarten teacher in a New York City school for boys gathered her brood for a conversation period. Peter spoke profoundly on the subject of scooters; Jim, about his collection of plastic soldiers; Tom, of the sailboat pond in Central Park.

When it was our son Paul's turn, he announced that he would talk about sea horses, on which he considered himself something of a specialist. He had recently watched me set up, in our apartment, salt-water aquariums stocked with pygmy sea horses, whose more normal habitat is the grassy inlets and shallow bays of warm seas.

Our success had been considerable: Our horses frolicked contentedly in their aquatic corrals, feeding with gusto on the brine shrimp we provided, and giving birth in due course as though in the privacy of their natural environment.

The teacher nodded approval as young Paul began:

"Yesterday I watched a sea horse give birth to many babies. I saw the babies come out of the father's stomach."

The teacher reddened slightly and interrupted to say:

"Paul, I think you mean a *mother* sea horse."

"No," insisted the youthful ichthyologist, "the father had the babies."

A patient smile played over the teacher's face as Paul, with quiet confidence, told how he and his sister Eda, age 9, had the night before watched a male sea horse delivering. One by one, the babies had come out of the "stomach," usually tailfirst. Quickly they had gained confidence and propelled themselves off in search of a blade of grass about which to twine their tails.

Whether Paul convinced the teacher, I do not know. Next day in the faculty lounge, however, her story caused some chuckling. As she confessed subsequently to my wife, she was inspired to check Paul's story in an encyclopedia.

There it was in black and white—the facts of a strange life cycle in which the female sea horse deposits her eggs directly into the male's brood pouch. Here they are fertilized and developed, to be live-born after a hatching period of about 10 days.

Stable in an Apartment

Converting our apartment into a sea horse stable was more than a whim. In earlier years we had kept a home menagerie of animal pets, including many fresh-water tropical fish.* Then, like many home aquarists, we discovered that certain marine species may be maintained almost as easily as their fresh-water cousins; it is now possible to get salts and concentrates which produce a solution closely resembling pure sea water.

For the beginning salt-water aquarist, the pygmy sea horse (*Hippocampus zosterae*, a member of the fish group) is ideal, not only because the species is hardy, but because it is one of the most delightful miniatures in the whole aquatic world.

Our first shipment of sea horses arrived one

* See "In the Wilds of a City Parlor," by Paul A. Zahl, NATIONAL GEOGRAPHIC MAGAZINE, Nov., 1954.

Pygmy Sea Horse Tethers Tail to a Giant Cousin's and Mimics His Repose

Spangled with silver and gleaming with galaxies of white dots, six-inch-long *Hippocampus hudsonius* arches his neck like a thoroughbred as he sways atop a sea whip in the author's aquarium. Smaller, less colorful *H. zosterae* clings to the tapered body; another pygmy perches at lower left. The two species live compatibly in Florida waters.

Skin Divers Hunt Sea Horses in Florida's Grassy Pastures

To observe and collect *Hippocampi* in their native habitat, the author and his family spent two months in Florida. Pygmy sea horses by the tens of thousands live in these grassy shallows near Key Largo.

Nine-year-old Eda Zahl and Robert P. L. Straughan, a marine collector, swim through the clear four-foot depths. Wearing face masks, snorkel tubes, and flippers, they scan beds of grasses for varicolored sea horses the size of paper clips. A net fastened to the anchored inner tube holds their finds.

Their quest was not without hazard. Voracious barracudas, tigers of the sea, have been known to attack swimmers in these subtropic waters. "We saw dozens, but fortunately none ever made a pass at us," the author reports.

Trawl pulled across the bottom captures sea horses, shrimp, puffers, sea slugs, and filefish. Swimmers ride the trawl's metal frame to keep the net from fouling.

Five pygmies in pensive pose range from dull brown to golden yellow (opposite, lower). The aquarium's green garden re-creates a Florida shallow.

icy February day. Eagerly, the children watched as I opened it.

In these days, "tropicals" are shipped in plastic bags containing water and, often, an overlay of pure oxygen. One of our bulging bags was tagged "Specimens," the other, "Condensed Sea Water."

In the shallow water of the first we saw several clusters of seaweed and a number of swimming fragments which, from above, bore little resemblance to sea horses. The other bag held a gallon of soupy sludge that smelled strongly of the sea. I poured it into a tub and added nine parts of tap water. Quickly the sludge became a solution of clear sparkling sea water. We distributed this among four two-gallon aquariums equipped with a simple aerating and subsand filtering system.

Another package contained white sand, dried sea fans, and other clumps of coral. These we arranged in the aquariums.

That evening, having given the chlorine in the tap water a chance to become partially dissipated, I transferred our sea horses to the aquariums. We had ordered two dozen, but a rapid tally revealed at least 36, many so small I could barely see them. Obviously one or more pregnant males had delivered in transit!

A final package held a small vial of what looked like sand but was actually the eggs of brine shrimp. We sprinkled a bit into a shallow dish of sea water. Within 24 hours these eggs hatched into nearly microscopic larvae, the best known food for captive pygmy sea horses.

South to Underwater Pastures

And so began our adventures with *Hippocampus*—a genus of creatures that intrigued us for months in our apartment and lured us, in early June, 1,000 miles south to the grassy shallows off Florida's famous Keys and Gulf coast. Authentic habitat observations, agreed the National Geographic Society, might add significantly to the general fund of marine knowledge.

In a motel on U. S. Highway 1 on Key Largo, we set up quarters. Soon our two-room apartment was abuzz with aerators and cluttered with collecting gear, snorkels, rubber flippers, and an assortment of aquarium tanks filled with sea water.

On my first collecting trip, my companion was Robert P. L. Straughan, a skin diver of consummate skill and one of the country's principal suppliers of live sea horses. Many a public aquarium as well as scores of home aquariists depend for their displays on Bob's collecting prowess.

It was Bob who had sent our specimens the previous winter. He had written of shallows in Florida Bay, south of the Everglades and fringed by the Keys, which in summer were veritable sea horse pastures.

One June morning Bob and I rented a skiff from a near-by fishing camp. We were soon a couple of miles offshore, where a line of dense mangrove tapered into the sea.

Shallows Just Salty Enough

The water was about four feet deep and fairly clear. The bottom was covered with a solid blanket of green, predominantly manatee and turtle grasses.

"Sometimes the salinity here changes after heavy rains," Bob was saying as he prepared the trawl. "Pygmy sea horses disappear from an area if the water gets either too salty or too fresh."

The trawl's metal frame made a rectangle about four feet wide and twenty inches high. A long bag of nylon netting was attached to it in such a way that it would bulge out behind as the frame was pulled through the water. Any creatures adhering to or swimming about on the grassy bottom would be scooped up by the trawl's mouth and caught in the pocket of netting.

Bob jumped overboard, equipped with a face mask, a simple snorkel tube, and flippers. He swam alongside the open mouth of the net in order to prevent its fouling on any large sponge masses or coral heads that might be hidden in the grass. Also, he wanted to observe what we were catching.

With the outboard barely chugging, we moved slowly in a large circle. After about 15 minutes of sweeping, Bob climbed aboard and we drew in the net.

"Pygmies are here all right," he said. "I could see them in the grass."

A minute later we had the net turned inside out, revealing grass, sponge fragments, mud, sand, bits of shell and coral.

My eyes focused on a wriggling object no larger than a small paper clip—a tiny sea horse. But this one was not gray or dull brown like those we had kept in New York; it was a beautiful golden yellow.

Quickly we spotted others in the debris—more yellow ones, a few bright green, some

As if Mowing Underwater Grass, Collectors Push Nets Along the Bay Floor

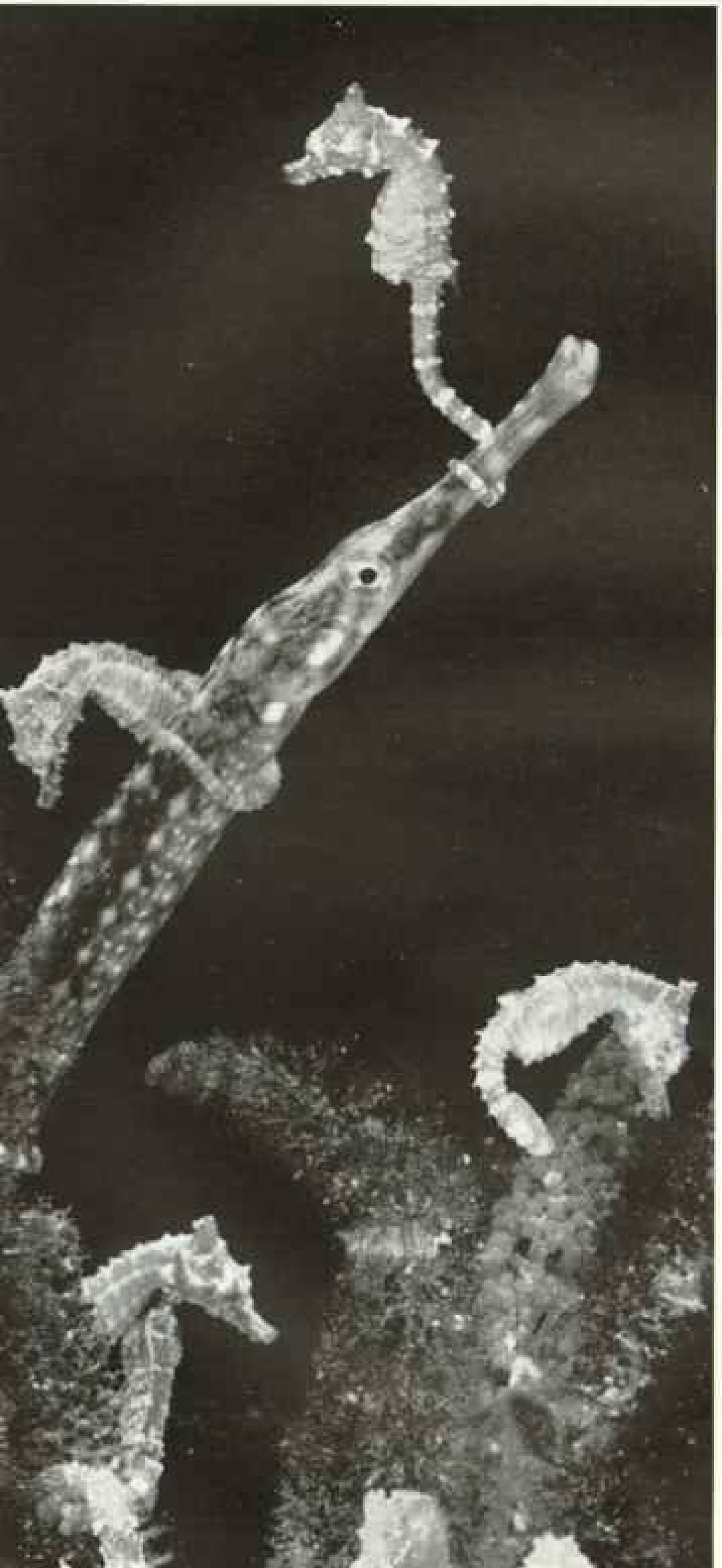
"This isn't work; it's fun," young Donna Deane (right) told the author, "but it pays my school expenses." Ace Spencer (left) manufactures the lightweight push net used to collect sea horses, shrimp, and sea stars.

Grasping the handle bars, a pusher rolls the framed net at an angle of 45° through thick sea grasses. Captured sea horses go into a can hung around the neck, shrimp into a side bag. Pygmy sea horses sometimes bring $60 a thousand. Often a pusher scoops up more than 2,000 a day. *Hippocampus* breeds so rapidly that these beds in Tampa Bay are quickly replenished.

A thorny trident of cirri, or skin branchings, springs from the head of an adolescent pygmy fresh from the sea. Captivity will dull its golden coloring. (Enlarged 12 times.)

Lassoed Pipefish Serves as a Mobile Roost

Eyes, snout, and mouth of *Syngnathus floridae* markedly resemble those of its sea horse relative. Like the latter, the male pipefish incubates its young in a brood pouch. The two species dwell together harmoniously in the wild or in captivity. Seiners often catch both in the same bag.



chocolate brown. From this haul alone we recovered 32 pygmies.

We tossed the net overboard and made another run; then another, and another. By midafternoon we had approximately 200 sea horses in storage pots. A portable aerating system supplied our specimens with oxygen.

In each net haul there were other sea creatures: cowfish, filefish, puffers, sea slugs, shrimps, shellfish, pipefish.

The pipefish were of special interest, for they are first cousins to the sea horse (left). If you were to take a sea horse and forcibly straighten it out, you would have, to all intents and purposes, a pipefish. On the other hand, bend a pipefish into the shape of a knight chessman, and, lo, a sea horse! What is more, like the sea horse, the male pipefish incubates its young.

By early evening I had the day's catch in my motel aquariums. Bob drove back to his home in Miami, leaving me for a few days to study and observe.

The Wonder of Male Motherhood

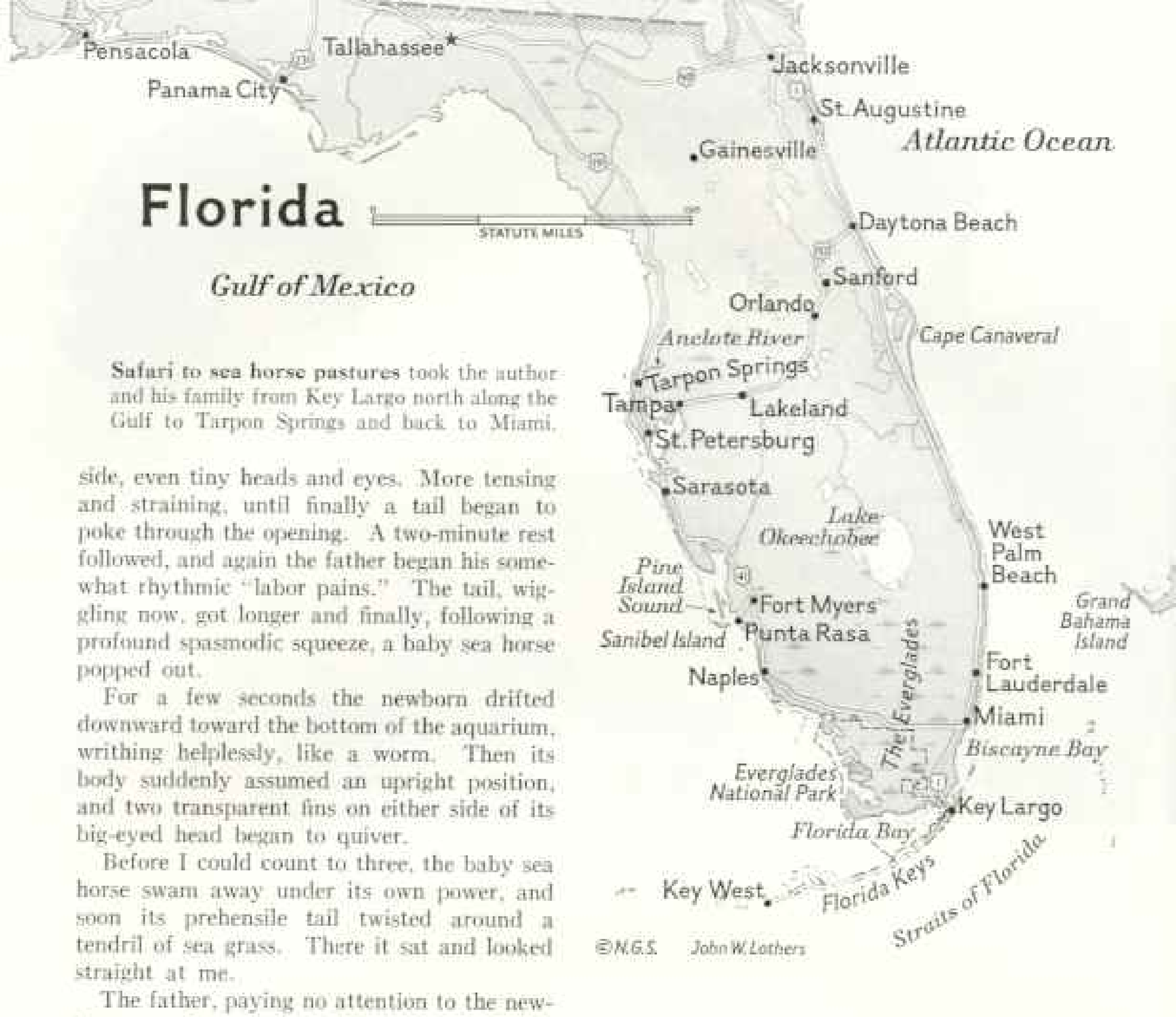
"Look at the hippocampuses!" yelled Paul as the children came in that evening, their bathing suits still dripping.

"And see the pregnant males," cried Eda, as though Paul needed any coaching on that delicate matter. "Will they give birth tonight, Daddy?"

"I'll let you know in the morning," was my answer, as I prepared for an all-night vigil.

Hours later, with the children and their mother sound asleep, I sat quietly before the front glass of the largest aquarium and watched. At about 11 o'clock one of the pygmy males began to twitch uneasily. His tail was firmly coiled around the branch of a sea fan, but his body was beginning to sway, and at about one-minute intervals he would thrust forward his bulging pouch and seem to tense his entire system.

The pouch aperture, previously shut tight, began to open. I could see little embryonic tails coiled in-



Safari to sea horse pastures took the author and his family from Key Largo north along the Gulf to Tarpon Springs and back to Miami.

side, even tiny heads and eyes. More tensing and straining, until finally a tail began to poke through the opening. A two-minute rest followed, and again the father began his somewhat rhythmic "labor pains." The tail, wiggling now, got longer and finally, following a profound spasmodic squeeze, a baby sea horse popped out.

For a few seconds the newborn drifted downward toward the bottom of the aquarium, writhing helplessly, like a worm. Then its body suddenly assumed an upright position, and two transparent fins on either side of its big-eyed head began to quiver.

Before I could count to three, the baby sea horse swam away under its own power, and soon its prehensile tail twisted around a tendril of sea grass. There it sat and looked straight at me.

The father, paying no attention to the newborn, continued in labor. Soon another baby emerged. In two and a half hours the father delivered twenty young (pages 146-9).

He had still more in his pouch, or so it appeared. But his pouch vent closed, and the father swam off to another branch and relaxed, eying me in wise contemplation the rest of the night.

Solemn Eyes Can Peer Two Ways

Pygmy sea horses give birth in usual course to 10 to 35 young at one delivery. The babies usually emerge singly, sometimes tailfirst, sometimes headfirst. Now and then two or three pop out at once.

There is no truth to the notion that baby sea horses may return to the pouch, as does the kangaroo. Once born, the young one is strictly on its own.

It is an odd-looking foal. The characteristic horselike snout is only half developed, giving the youngster a definitely pug-nosed appearance.

The sea horse's solemn, bulging eyes swivel independently of each other, like a chameleon's, the right one quite capable of gazing astern while the left scans the scene ahead. Sensitive to minute variations in light and form, they keep the fish well posted as to what's going on.

But even good vision can't make up for experience. A baby sea horse doesn't always distinguish between solid and nebulous objects: one of the drollest spectacles in marine life is to watch a youngster try to curl its tail around an air bubble.

That prehensile tail, which will grow to have the grip of a young child's finger, is only one more peculiarity of the sea horse leading one to doubt that it is a fish at all. Another is the fact that it doesn't have scales. Instead, it is clothed in a strange "skin skeleton" composed of some fifty bony rings, rather like the structure of an insect.

These rings, extending from neck to tail, support a series of plates. The ultimate effect is that of a medieval war horse clad in jointed armor, and the hope of the otherwise defense-

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Game but Cautious, Visitor Cecilia Ellison Meets a Horned Cowfish

Tiny spikes above the eyes identify the cowfish, a pasture mate of the sea horse in the shallow flats of a Florida bay. Horns are just beginning to pierce the brow of the dime-sized baby below.

Young trunkfish, little larger than a pea, wears a bony box about its body, leaving only eyes, jaws, fins, and tail free. Like a coat of mail, the hard case gives protection against predators.

less fish is that it will look equally unappetizing to wandering marauders.

Slow and helpless the sea horse may appear beside, say, a shark. But it is much more sophisticated, more evolved, than its streamlined associate. It represents, indeed, an ingenious, complex, and quite successful adaptation to its environment.

The mother produces the eggs, but after that, gestation is the male's responsibility. The couple performs a mating dance, the female deposits her eggs in the father's pouch, he fertilizes them as they enter, and from then on he's in charge of the hatchery.

His pouch enfolds and protects the young; spongelike, it expands, the capillary blood vessels swelling and multiplying. Around each egg a tiny film of tissue forms, providing it a room of its own.

The sea horse seems to have carved out quite a secure niche in the marine world. In its several species it is found throughout the world's warmer seas, and it ranges as far north as the chilly English Channel. The pygmy sea horse measures about an inch, but in Australian and Japanese waters fishermen often bring up sea horses a good foot long—real Percherons!

Big or small, they do not lack a statuesque dignity, their necks so proudly arched, their gait so obstinately upright. Too fascinated to be fatigued, I sat for hours that night studying their antics.

Horse of Many Colors

In subsequent weeks Bob and I netted thousands of pygmy sea horses. I wanted a wide selection, so that I could study color variation in the natural state.

The hues we observed—those distinct yellows, greens, browns, and even oranges—clearly represented a protective adaptation to the sea floor. If a sea horse lives amid bright green grass, its color is apt to be bright green; if among yellow, brown, or gray grass, or among colored coral or sponge, it takes on corresponding hues. Minute changes in the pigment cells, or chromatophores, of its skin help it produce these colors.

In addition to pigmentation, the sea horse often employs another trick of mimicry, displaying weird branchings from its head and body that look like arboreal growths (page 135). These help to hide it in its forests of sea grass. Again, its unfishlike verticality and the broken profile of its spiny body also serve to camouflage it most effectively.

A dwarf sea horse might seem to be among the sea's least aggressive inhabitants. Its tiny mouth at the end of the horselike muzzle lacks the fierce teeth possessed by many denizens of the deep. But to its prey it doubtless seems savage enough.

Clinging by its tail to some object on the ocean floor, the sea horse waits for copepods, shrimp larvae, or other plankton to drift by. Suddenly a tiny trap door at the tip of its snout snaps open. There is a lightning-fast intake of water, like air through the nozzle of a vacuum cleaner, and down a sea horse gullet sweeps the hapless copepod or larva. There's no delay for chewing; the victim is swallowed whole.

Drumbeat Signals Spawning Season

Sea horses do not exactly neigh, but they aren't inarticulate, either. They seem almost to smack their lips when they suck in their victims; and during the spawning season they emit an intense but somewhat monotonous underwater drumming sound.

Poor swimmers by any fish standard, sea horses are seldom found where tidal currents are strong; they would quickly be swept away from the safety of their grassy homes. In the aquarium the observer will note a rapidly vibrating fan halfway down the sea horse's back, two delicate fin flaps on either side of its head, and a tiny bit of fin tissue just below the abdominal bulge. These little buzzing outboards give the sea horse its motive power, although not an overgenerous amount; even though its dorsal fin flutters at the rate of 10 flaps per second, it may take a sea horse five minutes to scull across a three-foot-wide aquarium tank.

The sea horse's pectoral fins act as vertical stabilizers, helping it to maintain its equilibrium and its unique stance. Unlike most other fish, it has no caudal fin.

When the sea horse wants to rise, it unkinks itself, straightening out like a pencil. When it wants to descend, it tucks its neck in and rolls up its tail.

On some of our trips, my daughter, who by now had become quite an accomplished skin diver, came along and snorkeled with Bob near the trawl (page 132). She was enthralled by the sights seen through her face mask.

We came in one evening after a long day of collecting. My wife soon had the children fed and tucked in bed. From the darkness

Collectors Comb the Beaches of Sanibel, Treasure Isle of Rare Sea Shells

Crescent-shaped Sanibel Island, lying two miles off Florida's Gulf coast, ranks as one of the Western Hemisphere's finest shelling grounds. Spreading its 12-mile length from east to west, Sanibel catches millions of shellfish cast up by the waves. Most are still alive when washed ashore.

From its coarse white sands, shell collectors glean specimens of more than 300 varieties, including coquinas, whelks, conchs, lion's paws, angel wings, cockles, junonias, buttercups, Chinese alphabets, and Scotch bonnets. An exceptionally rare shell may sell for as much as $35. The island's annual shell fair in March attracts conchologists from all parts of the world.

According to legend, Spaniards searching for gold, rather than shells, christened the island Santa Isabella in honor of their queen; later the name was shortened to Sanibel.

Zahl family stages a private exhibition—the fruits of one afternoon of shelling on Sanibel's shores. Mrs. Zahl shows a guest a sea horse washed up by surf and dried in the sun.

Sanibel Shell Hunters Examine a Lion's Paw, a Prize Discovery

of their room we overheard Eda spellbinding her little brother with tales of the wondrous anemones she had seen, the colored sponges, the coral forests, the delicate sea slugs, and, of course, the sting rays and man-eating sharks.

"Sharks?" I heard little Paul gasp. "Did they attack you?"

"Well," she replied, hesitant but truthful, "we didn't really see any, but Mr. Straughan warned that they were around. I could well have been eaten."

Search for a Gaudy Giant

For weeks Bob had been aware of my fascination with the variety of protective hues assumed by sea horses. One day while visiting him in his aquarium supply shop in Miami, I brought up the subject again.

"That golden-yellow pygmy," I said, referring to an extraordinarily beautiful specimen we had taken on our first day out, "have you seen many similar to it?"

"They're not common," he replied. "Perhaps one in a thousand. Of course, sea horse colors don't usually last in a tank."

The public, alas, sees only specimens that have taken on neutral hues. Dried sea horses, widely sold as souvenirs, are sometimes artificially colored by dyes.

"Speaking of color, Paul, you should have seen a giant sea horse I had around here a few months ago. A *Hippocampus hudsonius* I caught in the trawl in Biscayne Bay—it was bright red."

Then I recalled that Dr. Charles M. Breder, Jr., ichthyologist at the American Museum of Natural History, had once mentioned to me that large red, orange, or yellow sea horses had been found in the Bahamas and in Sheepshead Bay, Long Island.

"I'd give my eyeteeth to see one," I said. "Do you think there's a chance of finding another?"

"Well," Bob replied, "giants are not nearly as abundant as pygmies and are found only in deeper waters. We might net for the next six months without any luck, or we might go out tomorrow and get an orange or a red one on the first trawl.

"Colored sea horses are found where the bottom has a lot of orange or red sponge growths. I know such a place out in Biscayne Bay. We could have a look there."

During the following weeks I virtually commuted between Key Largo and Miami. Here, day after day, about two miles offshore within clear sight of Miami's majestic skyline, Bob and I dragged in water seven to ten feet deep. We collected a few dozen giants, but none had color approaching that which Bob had described.

Hippocampus hudsonius ranges throughout the Caribbean and as far north as the New England coast. Attaining an overall length of from five to eight inches, *hudsonius* is very similar in structure to *zosterae*: tubiform snout, hard exterior armor, upright orientation, fins, prehensile tail, and pouched body of the male.

Its prenatal and natal processes differ somewhat from the pygmy species in that 200 to 700 young are produced at one delivery, spurting from the pouch not singly but in a veritable cloud of life. In the one case of *hudsonius* birth I witnessed, the entire aquarium seemed within seconds to fill with wriggling young, not much bigger than those of the pygmies.

Gulf Holds Rich Hunting Grounds

Discouraged by our lack of success, I pressed Bob for advice on a better hunting ground.

"You'd find lots of big ones over on the Gulf," he said. "The shrimpers bring them in."

Accordingly, in mid-July, having more or less completed our work at Key Largo, my family and I set out for the Gulf coast. At Naples we came to a temporary halt. I wanted to talk with an old friend of earlier flamingo-hunting days—Stephen F. Briggs, an avid nature photographer. My wife felt sure he could help us locate our bright-hued quarry. After all, she pointed out, Steve is chairman of the board of directors of the Johnson Outboard Motor Company, whose engines bear the trade name "Seahorse."

Soon we were having lunch at the Briggs home, and I was explaining my interest in colored sea horses—the kind that swim.

Steve said he never knew they came in color. He suggested, however, that if colored live sea horses were really of importance to me, we should put his secretary on the problem. "What that lady can't do over the telephone just can't be done."

An hour later the secretary turned in her report. "Yes, a few months ago Mr. Lester Norris had a large colored sea horse. He bought it in Miami, but it died.

A Curio Dealer in Tarpon Springs Mounts Sea Horses on Driftwood Blocks

John Georgiou displays the giant horses, along with sponges, rays, spiny lobster, sea turtles, barracudas, and other marine souvenirs collected in Gulf waters.

"I also called the local U. S. Fish and Wildlife office. They told me that a scientist from the National Geographic Society, who knows a lot about sea horses, is working here in southern Florida right now. They suggest that we consult him."

The secretary was all ready to place a call to The Society's Washington offices to see where that specialist might be located, when Briggs let out a roar of laughter.

"Well," he said to me between chuckles, "you've obviously come full circle and met up with yourself."

Shells Wash Island of Sanibel

From Naples we drove northward to Fort Myers, then crossed via the Punta Rasa ferry to shell-famed Sanibel Island. My good friend William D. (Tom) Wood was in charge of the Government wildlife refuge there. He would certainly be able to help.

That we were still in sea horse territory was emphasized within an hour of our arrival on Sanibel. We stopped for lunch and had just sat down at the counter when Jack, the jovial proprietor, handed each of the children a dried sea horse.

"A memento of Sanibel," he said with a smile. A little self-consciously, the children accepted. I didn't tell Jack that our car was loaded with carboys containing scores of the same species—alive!

"The waters here are full of sea horses," Tom Wood told me next day. He mentioned that currently his job was to fly a little pontooned four-seater along the coast in search of sea discoloration stemming from pollution by the dangerous *Gymnodinium breve*. Outbreaks of this microorganism, he told us, have left miles and miles of Florida's Gulf coast littered with millions of rotting fish.

"Why don't you come along on my next reconnaissance trip?" Tom asked. "We'll put down at Earl Johnson's fish house in Pine Island Sound. He makes his living collecting sea horses for the souvenir trade."

While waiting for Tom's next scheduled take-off, my family and I settled in a carefree house near the edge of Sanibel's blazing white beach. Suddenly sea shells gave strong competition to sea horses, for Sanibel is one of the most famous shelling centers in the world (pages 140-1).

My wife and children soon became enthusiastic conchologists, filling the house with beautiful calicos, angel wings, coquinas, turkey wings, cockles, buttercups, sun-rays, lion's paws, whelks.

"Some beach, isn't it?" shouted Tom above the motor's noise, the day of our first flight over Sanibel. The broad white ribbon below, with its accompaniment of gently rolling surf, was indeed something to behold. Tom banked and headed for the island's inner flank, then flew northward up the sound. In a few minutes we spotted three strange huts on pilings out in an empty expanse of water.

"These chaps live here year round," Tom commented as we landed. "They don't go ashore for months at a time."

Soon, with the plane tied up at one of the pilings, we were in Earl Johnson's watery one-room hermitage.

"Yep, lots of sea horses here. Mostly dwarfs." Rummaging on a shelf, Earl produced a box containing thousands of dried *zosterae* done up in neat cellophane packets of a hundred each. "Price too low right now . . . only $12 a thousand. Holding these till the price goes up.

"Giants? No, we don't get many here. The shrimpers up at Tarpon Springs get the big ones. Or try the 'pushers' in Tampa Bay."

Pushers? Tom looked at me and shrugged. The reference, however, intrigued me.

Sweeping the Shallows of Tampa Bay

A few days later, leaving my family happily ensconced on Sanibel, I drove north to the Tampa-St. Petersburg area. There I looked up Mr. Ace E. R. Spencer, who manufactures a special type of lightweight push net.

"Certainly," said Mr. Spencer, "Tampa Bay is full of sea horses. Soon as this rain lets up, we're going out on a collecting trip. Glad to have you come along, if you like."

The rain was pelting down with an almost tropical fury. But before long it abated, and we set out—Spencer, Mrs. Selma Deane, and her pretty young daughter, Donna.

"Donna easily makes school expenses from sea horses," Spencer said as the outboard propelled our skiff well offshore across the vast shallows of Tampa Bay. "She gets up to $60 a thousand, although the usual price is $25. On good days a single 'pusher' can take 1,500 or 2,000, or even more . . . figure it out."

A definition of the term "pusher" was soon supplied. We had cast anchor in water about three feet deep. Spencer, Mrs. Deane, and Donna hopped overboard, each with a net—

(Continued on page 153)

The Zahls Refresh Sea Horse Passengers at a Roadside Stop

Carboys of living specimens rode in the back seat with the youngsters during the family's tour of Florida. Twice a day the author refilled the jars with fresh sea water.

"Deep Water! Beware!" reads the sign in Greek near Tarpon Springs, home port of sponge fishermen of Greek origin.

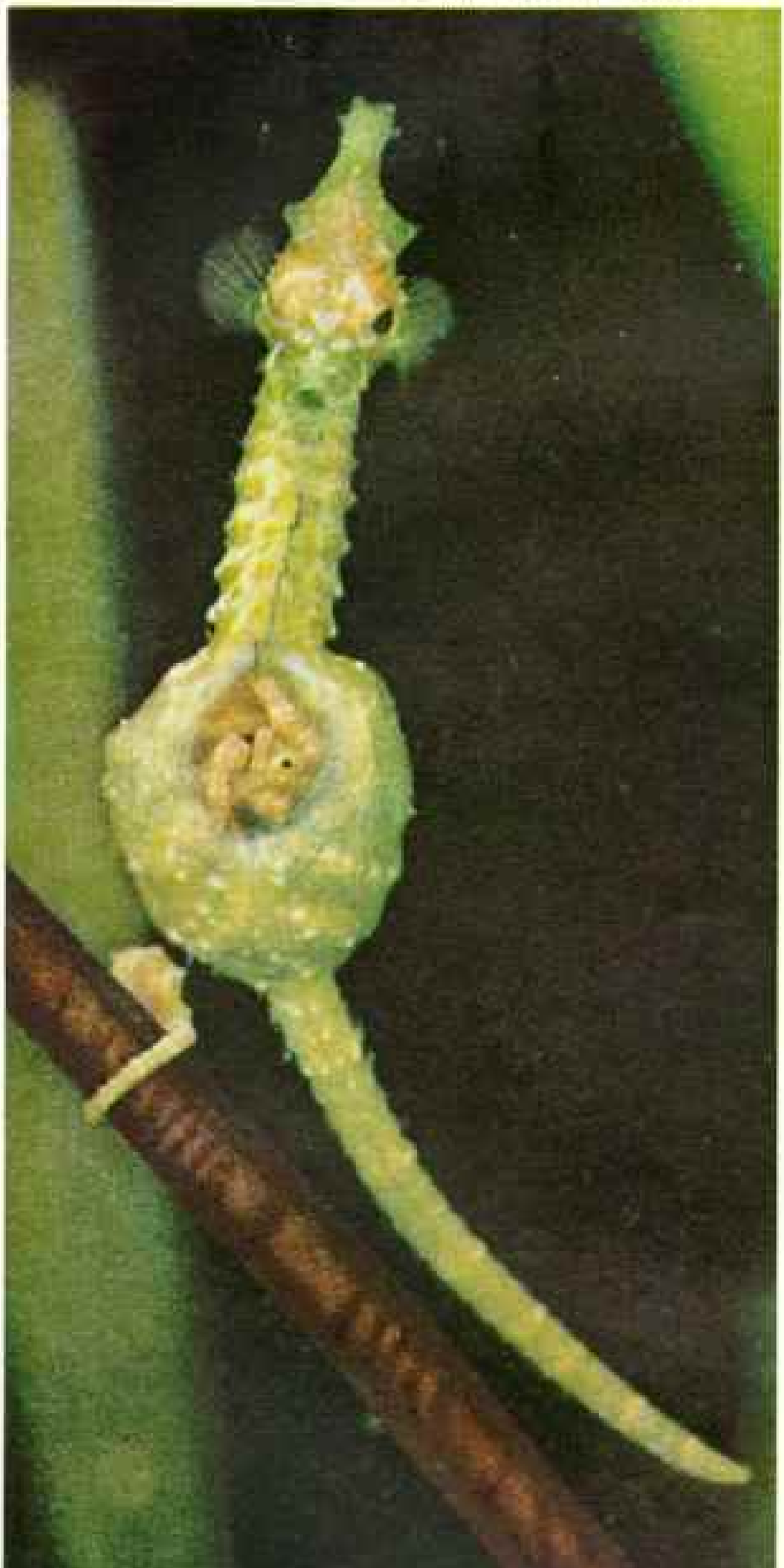
Giant sea horses cling to the author's fingers with a grip equal to a small child's. Brick red and ashen gray illustrate the wide color range of *H. hudsonius*.

Pregnant Male, His Tail Grasping a Stem, Gives Birth to a Herd of Sea Colts

The female sea horse plays but the briefest part in the foaling; she merely deposits the eggs in the male's pouch, then swims away, perhaps never to see her young.

Father meanwhile carries the embryos for an average of 10 days. Then, from his distended brood pouch, he ejects the young with a series of convulsive jerks (pages 148-9).

Saclike pouch shows clearly on the male at upper left. He shares his paternity ward with another father-to-be at the right and two noticeably slimmer pygmies below. Several babies perch with their elders.



Floating Free, a Male Delivers His Young, Who Clutch a Passer-by

Infants drift helplessly for a few seconds, then right themselves and swim away in a vertical position. They grow rapidly and mature in a few months.

The baby sea horse cannot return to the safety of its parent's pouch, as does the kangaroo. Having emerged, it must fight a lonely battle for survival.

Pouch aperture, fully opened, reveals a mass of young. One black eye peers forth. Another baby, ejected a moment earlier, clings to a branch.

Moment of Birth: Tail First, a Foal Pops Out of the Pouch

Shivering and shaking, the male seems to undergo actual labor pains; he ejects his minute progeny with convulsive spasms. Newborn may emerge tail first or head first (opposite). Pygmies give birth to several dozen, sometimes over a period of hours; the giant *hudsonius* may pour out as many as 700 in quick spurts.

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"And here I am," a newborn seems to say as its out-of-proportion eyes survey the aquarium. The sea horse's beady eyes pivot independently; one can gaze up while the other looks down.

Yellow-orange *hudsonius* makes his normal companion appear drab despite the latter's glistening carapace and Milky Way markings. Slitlike mouths at tips of their long snouts suck plankton.

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Take Home a Live Hippocampus, Suggests a Sidewalk Display

Life in Tarpon Springs centers around the docks of the sponge fleet on the palm-fringed bayous of the Anclote River. Neon lights advertise a Greek restaurant.

Robert Straughan uses a hydrometer to check the salinity of sea water in his plastic tank, an innovation among home aquariums. Mrs. Zahl and Eda watch the test; floating sea horses ignore it. Sea fans decorate the wall.

Sea horses, like chameleons, tend to adopt the color of their surroundings as camouflage against predators. Before capture these red specimens lived among brilliant sponges; the brown one dwelt amid drab grasses.

nylon mesh stretched over a two-by-four-foot aluminum frame fitted with what looked like bicycle handle bars. A wooden roller extended along the long lower edge of each frame.

The technique called for pushing this roller and frame across the grassy bottom at about a 45-degree angle. Every five minutes or so, the pushers would lift their nets and extract sea horses, tiny sea stars, small shrimp, and other creatures. They looked for all the world like suburbanites gone berserk and mowing their lawns during a flood (page 135).

In two or three hours we took more than 300 sea horses.

"Mostly dwarfs here, some green or yellow," said Mr. Spencer. "In clear weather, dozens of pushers are out. Nice hobby for retired people."

Touch of Greece in Tarpon Springs

I rejoined my family on Sanibel, and loading our car with a two-week haul of shells, we set out for Tarpon Springs, famed center of Florida's sponge industry.

Again we settled in a motel, this time near a quiet bayou connected with the Anclote River. We were enchanted with the predominantly Greek atmosphere of Tarpon Springs and the Old World courtesy of its fishing folk.

At the wharf we met young Johnny Georgiou. Johnny had worked on a sponge boat, which his father had skippered. But the industry in recent years has been nearly ruined by an infectious disease, and Johnny had become the owner of a small curio shop and the pilot of a deep-sea fishing craft. What drew us to Johnny's shop window were some large sea horses mounted artfully on blocks of driftwood (page 143).

"I mount them myself," Johnny told us with justifiable pride. "Bait shrimpers bring in big ones almost every night."

Half an hour later I was on a dock talking to Ralph Cooper, owner of one of the four shrimp boats tied up alongside.

"Sure, we see big horses. Sometimes we haul 20 a night; sometimes not a one." Every day at dusk Ralph and his crew of one teenage boy trawl for bait shrimp in the waters along the coast. "If we get any sea horses tonight, I'll keep them alive for you in the shrimp well. Too bad you weren't here yesterday; one of the shrimpers brought in a sea horse red as blood. It's over by our trailer in a bucket of formaldehyde."

I hurried to the trailer and found a sea horse a good seven inches long, still showing signs of its original scarlet.

"Should have seen it yesterday morning before I dropped it into the formaldehyde," said Mrs. Cooper, watching near by. "Don't get them that red very often."

I visited a number of shrimp camps along the coast, asking the shrimpers to save any unusual specimens. For a week, early each morning, I made the rounds. I secured a considerable number of *H. hudsonius*, but only a few showed signs of vivid color.

Finally, having uncovered only one mildly colored specimen, and feeling that we could afford to tarry no longer, I helped my patient wife and children to break camp at Tarpon Springs. We returned to Miami for a good-bye visit with Bob Straughan.

Brilliant Prize at Journey's End

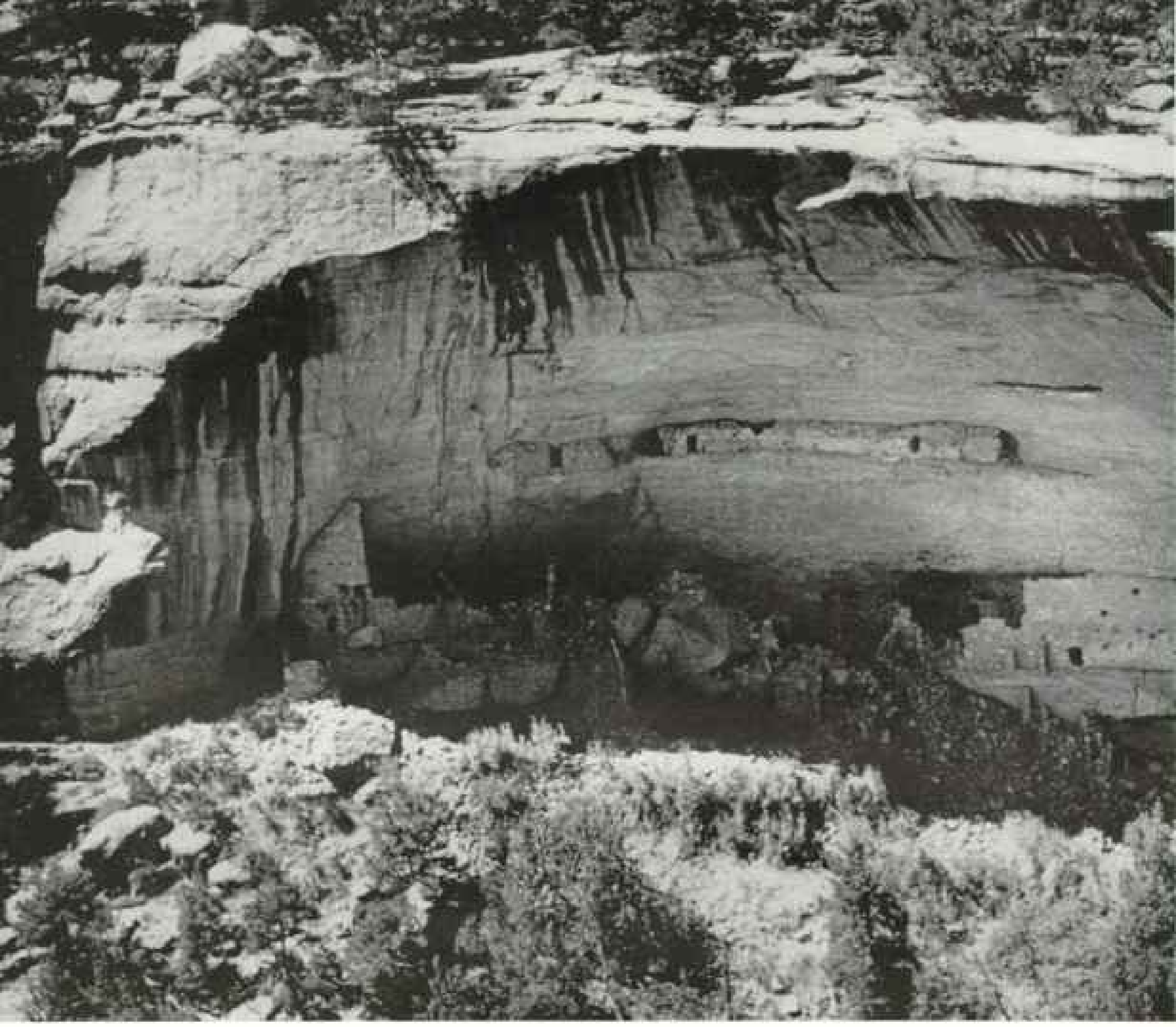
"Are you lucky!" Bob exploded happily as he met us. "Ever since you left I've been trawling the bottom of Biscayne Bay to get a colored *hudsonius*. And yesterday, believe it or not, I netted a beauty in the first trawl. It's bright orange, and it sure makes a good subject for color photography."

An hour later, in a Miami motel, the whole Zahl family gathered around my aquarium on the kitchen table to stare in wonder at the rare brilliant specimen Bob had presented to me.

"Isn't it beautiful!" breathed little Eda.

"Yes, it's a female—no pouch, see?" little Paul added.

"And now that you have your colored sea horse," sighed my wife, "I guess we can get back home. Two months of wrangling sea horses is enough!"



Your Society to Seek New Light on

DEEP IN Colorado's southwest corner, high among the cliffs of majestic Mesa Verde, Indian chant and laughter echoed for 1,300 years—then died in a series of drought-stricken seasons two centuries before Columbus. Mountain lion and mule deer fell heir to a lonely realm of fortresslike dwellings and strange ceremonial kivas.

Now, on Wetherill Mesa—a remote and hitherto undeveloped area of Mesa Verde National Park—the National Park Service and the National Geographic Society have launched a major archeological project which will shed new light on these shadowy prehistoric builders. Eventually it will open an imposing series of little-known, long-silent cliff dwellings to the American people.

"Mesa Verde has one of the largest concentrations of prehistoric ruins in the United States," says Conrad L. Wirth, Director of the National Park Service and a Trustee of The Society. "Of its hundreds of known archeological sites, only a few have been scientifically excavated and opened to public inspection.

"These fine remnants of a long-dead culture are now beginning to show the alarming wear of an increasing tide of visitors. There is very real danger that if nothing were done, the ruins themselves would be ruined by the sheer human attrition of the ever-increasing thousands filing through them year after year."

Last year Mesa Verde received some 200,000 visitors, and by 1966 the National Park

MELVILLE BELL GROSVENOR

The silence of centuries broods over Long House, at Wetherill Mesa, Colorado, where a joint expedition of the National Geographic Society and the National Park Service has launched a major research project. This 13th-century cliff village lies beneath a massive stone canopy; its fortresslike dwellings served as a refuge for Indians who farmed the mesa top until droughts forced them to leave. Ledge under the overhang, accessible only by poles or rope ladders, provided an impregnable defense outpost.

Climbing a ladder to Mug House, in Mesa Verde National Park, Dr. Melville Bell Grosvenor, President of the National Geographic Society, inspects one of the Wetherill Mesa ruins where scientists will seek new light on the mysterious cliff dwellers of 600 years ago. Behind him climbs Park Service archeologist James A. Lancaster.

the Cliff Dwellers

Service expects that the park will be called upon to accommodate half a million annually. As part of a long-range program still in the planning stage, it hopes to relieve this pressure on such famous ruins as Cliff Palace, Spruce Tree House, and Balcony House on Chapin Mesa by developing equally interesting cliff dwellings at near-by Wetherill Mesa and making either or both groups of ruins available to visitors.

For the scientific unearthing of these new sites and the preservation of the resulting treasure of archeological knowledge and artifacts, the National Park Service turned to the National Geographic Society. Dr. Melville Bell Grosvenor, The Society's President and Editor, personally visited the scene with Dr. Lyman J. Briggs, Chairman of the Committee for Research and Exploration, and Vice President Melvin M. Payne, who is Secretary of the Committee, and the project was unani-

mously approved by the Board of Trustees.

"The Society is proud to take a leading part in the important work at Wetherill Mesa," said Dr. Grosvenor, in announcing a research grant of $50,000 to launch the archeological program.

"Over the years the National Geographic Society has been privileged to play a part in the exploration and preservation of such national treasures as the Valley of Ten Thousand Smokes in Alaska, Carlsbad Caverns and Pueblo Bonito in New Mexico, and the giant sequoias of California. Recently it presented Russell Cave, Alabama—a record of 9,000 years of American prehistory—to the people of the United States as a national archeological monument. The Wetherill Mesa project will carry on that tradition."

"The Department of the Interior," said Secretary Fred A. Seaton, "is deeply appreciative of the cooperation of the National Geographic Society in developing the rich heritage represented by the National Park System. For years The Society has worked closely with the National Park Service. It has been instrumental in the acquisition and development of a number of important scenic and historic areas. We are hopeful that this collaborative effort will add to the archeological knowledge of the great western region of the United States."

Five- to Six-Year Task Ahead

Under the field supervision of Dr. Douglas Osborne, a veteran archeologist at 46, the expedition comprises a survey crew, two field excavation teams, and a laboratory staff. Its members contemplate a five- to six-year task of mapping, digging, and study. Members of the survey team already have begun mapping the surface of Wetherill Mesa, named for the ranching family whose members discovered most of Mesa Verde's largest ruins. As a gauge of the region's rich archeological promise, the surveyors had pinpointed 35 mesa-top perched homes sites in a single month before this winter closed in.

Besides numerous ruins atop Wetherill Mesa, three sizable cliff dwellings have been selected for excavation: Long House (second largest of Mesa Verde's cliff villages), Mug House (page 155), and Step House.

When the expedition's work is completed, a fascinating cross section of prehistoric life in the southwestern United States will lie exposed. It will span perhaps 800 years (circa A.D. 500-1300), and will trace the colorful Mesa Verde civilization from primitive pithouses of the so-called Basket Maker periods to the spectacular masonry towers of the era known as Pueblo III.

Cowboys Discovered Cliff Palace

Early Spanish explorers who named the 15-by-20-mile plateau Mesa Verde (green table) probably had no inkling of the wonders its canyons held. In December, 1888, two cowboys hunting stray cattle first fixed white man's eyes on the ghostly splendor of Cliff Palace, largest of the ancient villages that stand like giant swallows' nests in caves in canyon walls.

Discovery of Mesa Verde's ruins, silent for six centuries, began an era of tragic exploitation during which many splendid sites were badly damaged. Fortunately, half of the area was established as Mesa Verde National Park in 1906 and closed to indiscriminate digging.

Despite the havoc wrought by "pothunters" more than half a century ago, deep drifts of undisturbed rubble at the Wetherill Mesa sites indicate a wealth of material yet to be uncovered. The excavations may help explain the Indians' mysterious retreat from villages atop the mesa to easily defended cave dwellings in the final century of Mesa Verde's occupancy and their eventual disappearance from their mesa-top cornfields and high-perched homes.

Coming in February—Next month members of the National Geographic Society, through the richly illustrated pages of their Magazine, will explore the reaches of space, travel to Central Europe and the Caribbean, and see a skier's-eye view of the snow-mantled United States.

Allan C. Fisher, Jr., will describe Cape Canaveral, Florida, and the lunar probes being launched from there. Beverley Bowie writes of gay Vienna and Austria's eastern provinces. Kathleen Revis takes members to famous winter resorts from New England to California. Gwen Allmon, who lived 10 years in the Caribbean, tells of colorful Martinique.

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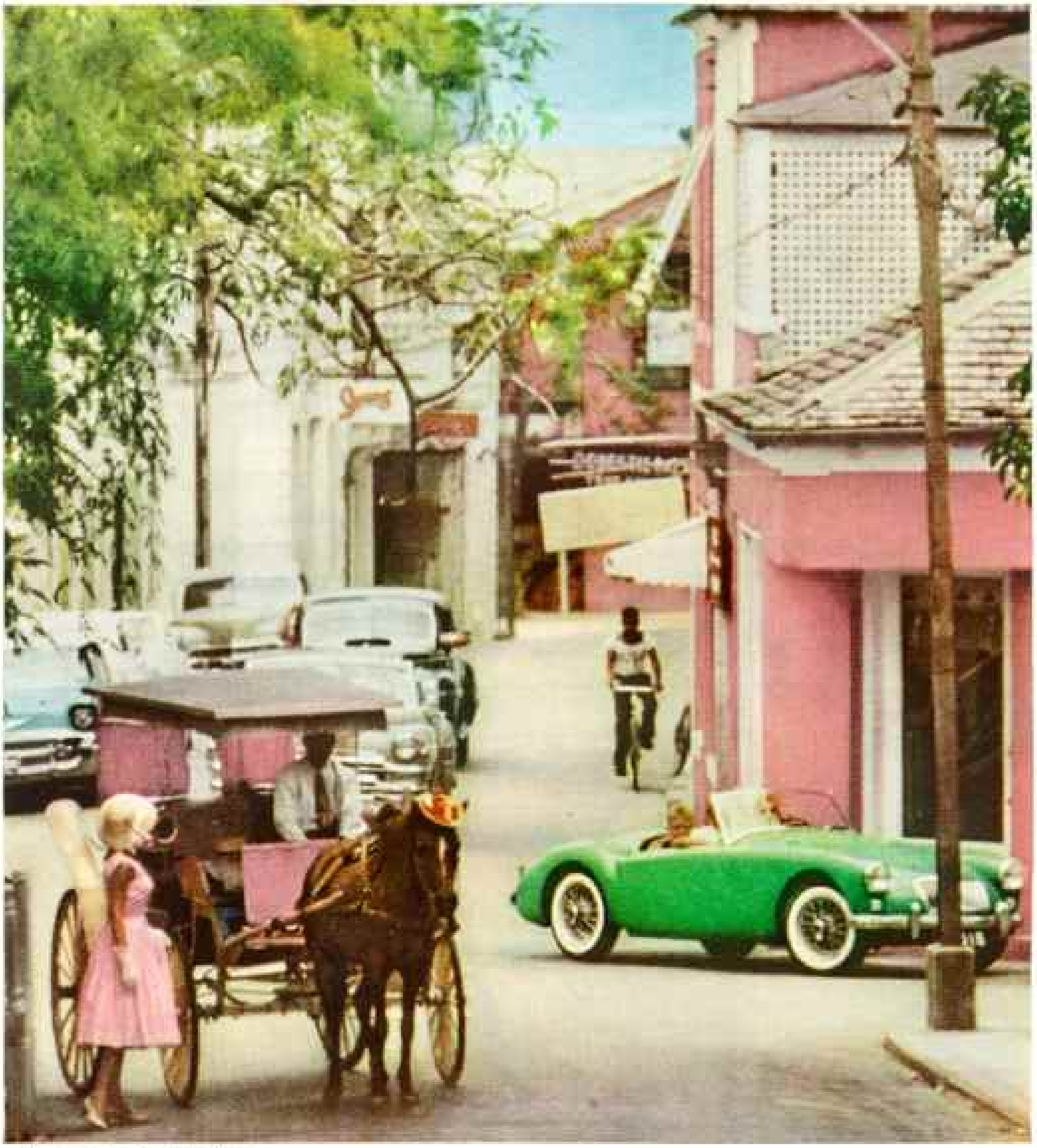

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SECRETARY THOMAS W. McKNEW TALKS ABOUT MEMBERSHIP

"How can I become a member of the National Geographic Society?"

This question is asked again and again in our mail, and I meet it constantly in my travels at home and abroad.

Our bylaws state: "Members shall be persons interested in the increase and diffusion of geographic knowledge." Most new members, of course, are elected through nomination by a member — just as when The Society was formed 71 years ago. But unfortunately, there are many, many persons who don't know a member and who think there is no avenue open to them. The latter just isn't so.

The Society's Membership Committee meets regularly for the specific purpose of making membership possible for all worthy persons who would like to participate in our work and receive the National Geographic Magazine.

In diffusing geographic knowledge, The Society is one of the biggest customers of the post office in the Nation's Capital. Incoming National Geographic mail pours out of sacks at a rate up to 90,000 pieces a day, the bulk of it addressed to the Secretary.

It's phenomenal how many of these letters come from nonmembers. People write to their Congressmen . . . and they write to the National Geographic Society. They question us on nearly every conceivable subject because geography is as wide as the whole world, its peoples in all their works, and the infinite variety of nature's kingdom. Today we go even farther, for it is not only "our" world we roam seeking knowledge. Man has now set his sights on the vastness of space and has added a new dimension to geography.

Do we answer all these inquiries? We certainly do! The Society exists by and for its members, but it has a further purpose, to inform mankind.

Naturally, the thousands who inquire about membership are taking the straightest road to the wealth of knowledge and enjoyment The Society presents through the National Geographic Magazine and its book program.

For the thousands more who haven't yet put their desire for membership in writing, this third page inside the front cover of the Magazine provides a direct line to the Membership Committee. We will welcome hearing from them!

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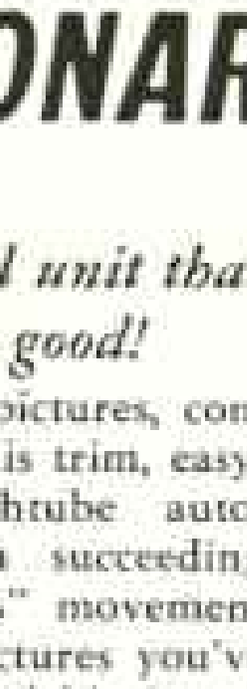

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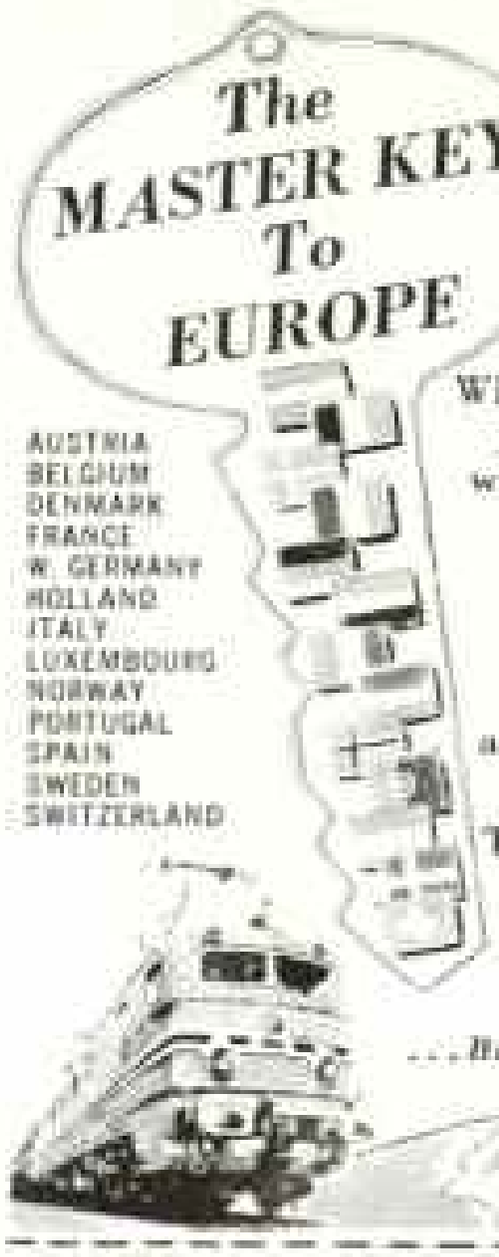

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Seaside Scenes: Watch a gay sailboat race. Search for starfish souvenirs. Smile at a pelican waddling by, wave to a barking seal family.

World's Biggest Camellia Show is starting at Descanso Gardens — 165 acres of fairyland color. See 48,000 camellias in 400 varieties — some growing over 20 feet tall!

Patio on Wilshire, one of many Los Angeles streets where you can shop 'neath the palms. Lunch while latest fashions parade by.

Putting Under Palms at one of our many courses. Other sports...winter as well as summer types...are yours to enjoy the year 'round.

Where else
in the world
so many exciting
attractions in one
vacation place?

Winter Orange Harvest in the great foothill groves east of central Los Angeles. Background: 10,264 foot San Bernardino peak.

Show Business Showcase — Theater on Hollywood Blvd. where stars make their mark in concrete. See foot, leg, even nose prints!

Hello, Aloe! These exotic succulents, native to South Africa, frame part of Southern California's 200 miles of bays and soft sand beaches.

Los Angeles Arboretum, a living museum, recreates jungle, African veldt, Australian bush! Many movie scenes have been shot here.

Most vacations offer you one, or possibly two attractions. Mountains, perhaps. Or ocean. Or city fun.

But Southern California gives you all these and *more*...most of them within a few minutes of central Los Angeles.

Whether you have two weeks or two months, plan to spend as much of your time here as you can. On arrival, visit All-Year Club Tourist Information Center, 628 W. 6th St., Los Angeles for free help in planning your vacation.

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There's a lot of pleasure in that happy impulse.

Take right now for instance. Isn't there someone you'd like to call? And someone who would like so much to hear from you? A friend? Brother or sister? Mother or Dad?

There's always news to share. And fun in the sharing at both ends of the line.

So don't let friendships lag when it's so easy to keep in touch. Day and night, in town or out of town, you are never far away by telephone.

Bell Telephone System

Help your family to a healthy, happy winter...

THERE IS, of course, no *sure* way to escape colds and other respiratory ailments during the raw and chilly months of winter. But there are certain safeguards that you can take *now* to help you go through this season in better health—and enjoy some of those invigorating days that winter always brings.

Keep in top physical condition. If you've neglected to have a health examination in the past year, now's the time to make an appointment with your doctor for a complete check-up. If you're especially susceptible to colds—and the complications that they often cause—he may be able to advise you about how to avoid them.

Eat a well-balanced diet. Food provides fuel for warmth and energy . . . and what you eat has an effect on whether you catch colds easily and whether you recover *quickly* from an illness. If your meals—including a good breakfast—are based on a wide variety of foods, you can be sure of getting all the nutrients you need.

Get lots of rest and sleep. Fatigue can lower your resistance to respiratory diseases. Rest, sleep and recreation can help you avoid that "run-down" feeling that so many people complain of during the winter season.

Do not get too close to people who have colds. When someone has a respiratory disease, it's easy to pick up germs from the sick person. Be careful to protect young children from people who sneeze and cough carelessly.

Avoid drafts and chilling . . . and always wear clothing suited to weather conditions.

If you protect your health in these ways, the chances are that your resistance to colds, virus infections and pneumonia will be increased. In the event you develop one of these ailments, your ability to fight the infection and recover quickly will be greater.

Remember that the danger of the common cold lies mainly in other infections that may follow it. So, if your cold is accompanied by fever, a persistent cough, or a pain in the chest, face or ear, call your doctor promptly.

To help you feel fine this winter and the year round, Metropolitan offers a booklet called "Help Yourself to Health." Clip and mail the coupon below for your free copy.

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Aunt Agatha satisfies a yen

Aunt Agatha's chopstick technique is scarcely Nipponese — sitting on the floor may have a devastating effect on her arthritis. But at least she is satisfying a yen to see Japan with her own eyes. Aunt Agatha is only one of millions who, through colorful advertising and publicity, has been transformed from a timid stay-at-home into a bold world traveler — another example of the power of the *printed page.*

VACATION

on the smoothest, sunniest sea-lanes in the world

Discover new places, new faces, new ships—Moore-McCormack's two new luxury liners, seagoing resorts to South America.

THINK OF a fine resort hotel. Distribute its pleasures aboard a fast new ship with broad decks for sunshine, moonlight, stargazing.

Add picture-window walls to frame blue tropic seas. Air condition the ship throughout.

This is the new S. S. BRASIL; S. S. ARGENTINA.

All staterooms are first class, spacious, decorated in attractive sun-and-sea colors. All are outside. You can adjust the air conditioning to your liking or open portholes to the fresh sea air.

Mooremack food is famous. Deliciously international, spiced with Latin-American specialties.

27 days of sunshine—that's average on a month's Mooremack cruise! Days of smooth sailing in waters sailors call the gentlest, sunniest sea-lanes in the world.

Before you know it, the sun and salt air unwind even the tautest nerves. You'll wake up rested, ready for a dip in one of the two outdoor pools, breakfast on deck, a brisk turn around the full circle of the Promenade Deck.

Later, a pre-release film, a night club evening of dancing—or quiet conversation with new friends, prominent business men, diplomats, stimulating and rewarding company. Many know the ports of call well and can help you choose the shore trips, shops, restaurants you'll enjoy the most.

What do you do ashore? Swim off a white beach in Barbados, spearfish in warm green waters, golf in all seven ports of call. Shop for semi-precious gems, superb nutria coats, elegant leather bags.

CARNAVAL IN RIO

February is summer and Carnaval time. The jungle beat of samba pulses through the city. Spectacular floats, hill folk in gay, gaudy dress, a never-ending parade throngs the streets.

Everyone joins the fun. Brasilians say: During Carnaval, solitude is a sin!

Choose the January 30th sailing of the S. S. BRASIL for a day and a half of gaiety in Rio.

Only 5 business days to Rio—executives please note! Glorious days of relaxation en route that brace you for busy days ahead.

Take the full 31-day cruise for the *best* vacation. Come back rested, feeling ten years younger.

See your Travel Agent soon. 31-day cruise fares from $1,110 Thrift Season, $1,350 Regular Season—less than many a landlocked resort. Liberal credit terms let you pay out of income.

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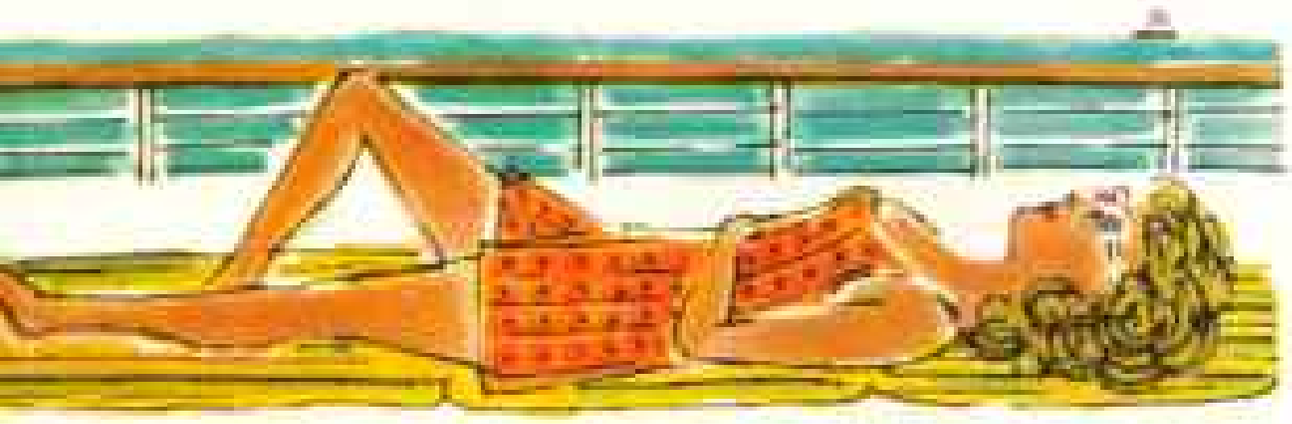
S. S. BRASIL Jan. 30, Mar. 6, Apr. 10, May 15.
S. S. ARGENTINA Feb. 20, Mar. 27, May 1.



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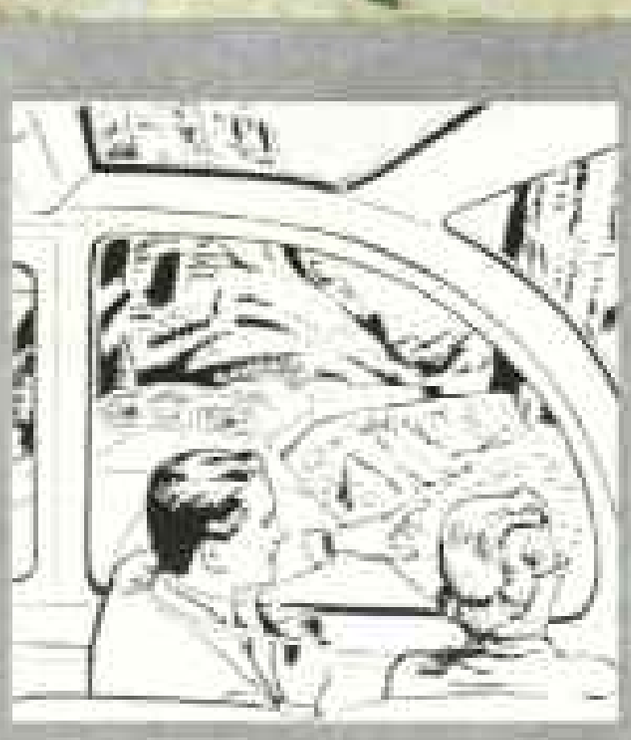

The California Zephyr in the Colorado Rockies

Through the Colorado Rockies and the High Sierra

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There are *many* good reasons why this Vista-Dome streamliner has become the most talked about train in the country: it travels through hundreds of miles of spectacular mountain scenery during daylight hours; it has *five* glass-enclosed Vista-Domes (120 *extra*, upstairs seats for both Chair Coach and Pullman passengers); there are delicious meals in the beautiful Dining Car, and delightful refreshments in the roomy comfort of the Buffet Lounge Car and unique, three-level Observation Lounge Car. The best way to see the best of the West is aboard the Vista-Dome California Zephyr, most popular of all transcontinental trains!

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Just spin that Wheel-Horse wheel and take the sharpest curve. Geared like an auto, Wheel-Horse shifts into three speeds forward, plus reverse. At 6 mph, you discover its big tractor 'look' is more than skin deep. Tremendous gear reduction produces pull-power to spare. Those tractor-type rear tires plus weight of its husky steel body assure top Wheel-Horse traction on hills and terraces.

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3. Pause here to take your bearings. A company may not make a profit, may not pay a dividend. Stock prices go down as well as up. Always get facts. Never depend on tips or rumors. And for investment, use only money left over after bills are paid and emergencies provided for.

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For offices of Members nearest you, look under New York Stock Exchange in the stock broker section of your classified telephone directory.

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Please send me, free, "DIVIDENDS OVER THE YEARS, a *basic guide for common stock investment.*"

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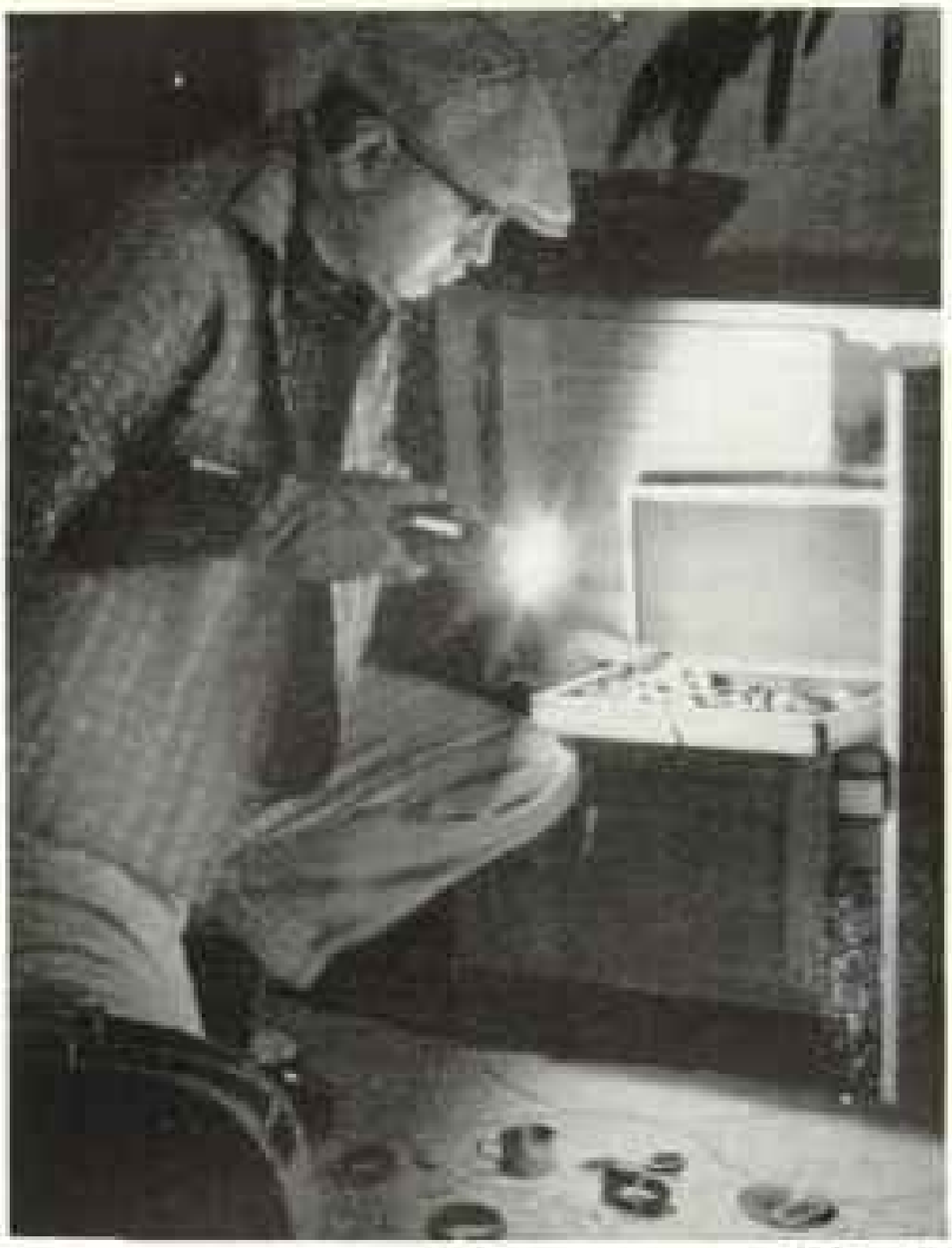

Ames, Iowa – We were robbed twice last year. In January we lost $2,170 in personal and household things and cash. In July a burglar stole property valued at $351. But we were covered by Hartford's 1-Policy Package.
(Company File #429257)

Clearwater, Fla. – Our dog bit a neighbor. It might have brought on a lawsuit but our Hartford 1-Policy Package took care of everything with a $250 cash settlement. It saved us considerable trouble and embarrassment, too.
(Company File #472569)

Jamestown, N.Y. – We had a fire in our house. It started in the kitchen and spread to the garage, ruining our freezer and my favorite tools. Our Hartford policy covered the damage – and provided us with extra living expense money while the house was being repaired. All told, Hartford's 1-Policy Package paid us $6,783.
(Company File #117820)

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. . . Hartford's 1-Policy Package protects you against all three. *Convenient*—only one premium... one agent. *Economical*—savings up to 20% of what you'd pay for the same coverage in separate policies. *Flexible*—this policy is tailored to your individual needs . . . you buy only as much protection as you need, pay for it through Hartford's Premium Payment Plan if you wish. *Efficient*—you can depend on Hartford's Claim Offices for quick, thorough service anywhere. See your Hartford Fire Group Agent. Look for his name in the yellow pages of your phone book. Or call your insurance broker.

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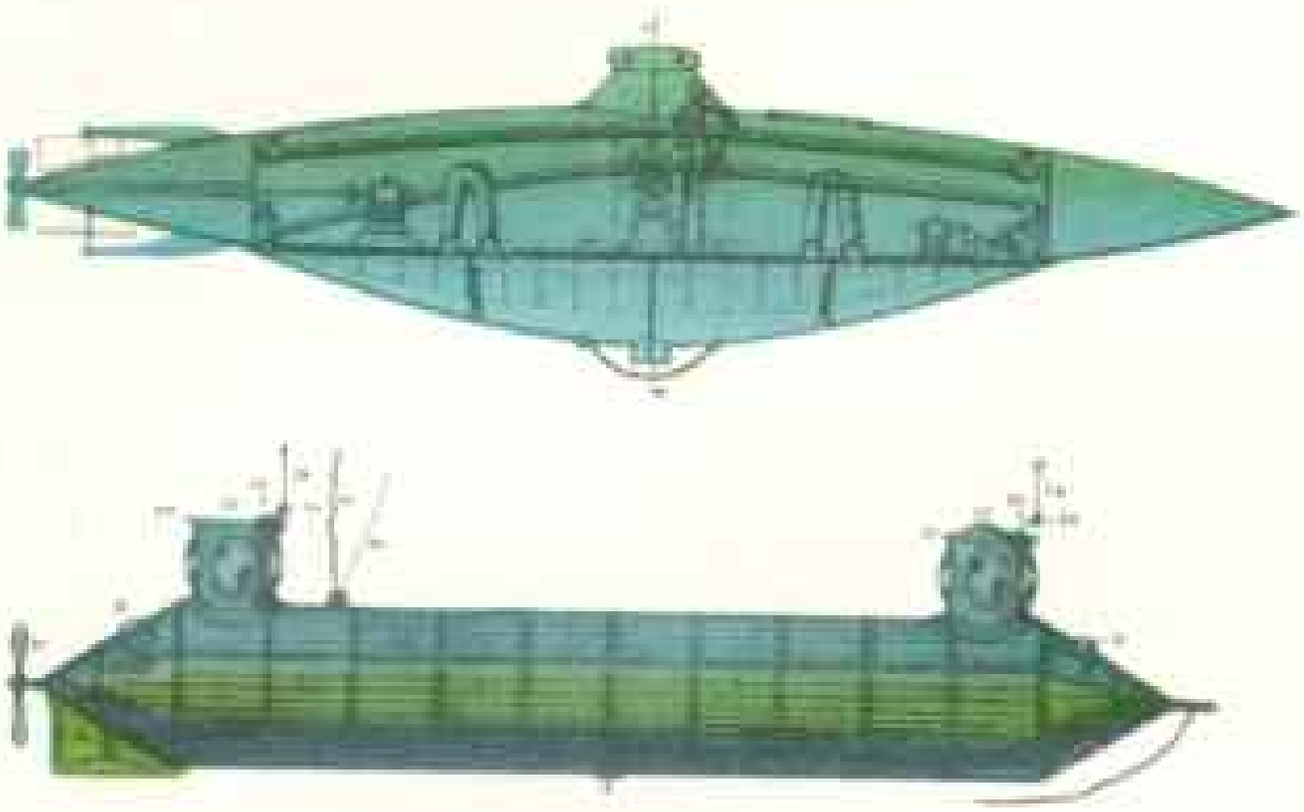

"The Crew Sang, Played Cards, Caught Clams"

In 1958 the first nuclear-powered submarine, *Nautilus*, designed and built by Electric Boat, crossed the North Pole beneath the polar ice-cap. In 1897 the *Holland*, the United States Navy's first submarine and ancestor of the *Nautilus*, was launched by the John P. Holland Torpedo Boat Company, predecessor of Electric Boat. Before the submarine won recognition as a naval weapon, there had been at least a hundred years of experimentation with submersibles. Bushnell's *Turtle* futilely attacked British warships during the Revolution. The Confederate submarine *Hunley* went down off Fort Sumter with her one victim, the frigate *Housatonic*. Simon Lake's wheeled *Argonaut of 1897* explored the bottom of Chesapeake Bay while the crew sang, played cards, caught clams.

From "Dynamic America," a history of 420 pages and 1500 illustrations to be published soon by Doubleday & Company and General Dynamics Corporation, 445 Park Avenue, New York 22, N. Y.

GENERAL DYNAMICS