

VOL. 125, NO. 4

APRIL, 1964

NATIONAL GEOGRAPHIC

THE CATS IN OUR LIVES 508

ADOLPH SUEHSDORF
WALTER CHANDHA

**FROM SUN-CLAD SEA
TO SHINING MOUNTAINS** 542

RALPH GRAY, JAMES P. BLAIR

**NEW PORTRAIT
OF NORTH AMERICA** 590

**OVER AND UNDER
CHESAPEAKE BAY** 593

DAVID S. BOYER

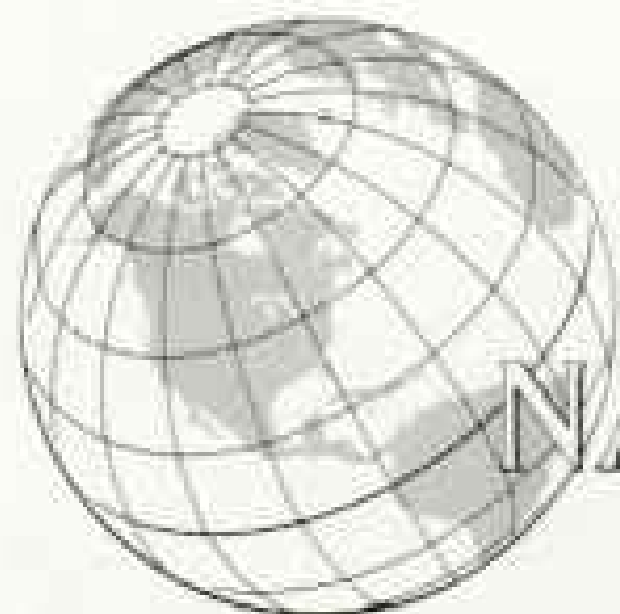
**AT HOME
IN THE SEA** 465

CAPT. JACQUES-YVES COUSTEAU

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April, 1964



NATIONAL GEOGRAPHIC

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At Home in the Sea

Pioneering a new underwater world for man, French oceanauts live for a month in a submerged colony on a Red Sea reef

By CAPT. JACQUES-YVES COUSTEAU

I AM FINISHING an enjoyable meal with my wife Simone and a tableful of good companions in a snug lodge we have built in a remote and primitive part of the world.

No one has lived in such a place before. In a corner of our bright, pentagonal *salon* there is a large electronic console that looks like a spaceship control center. Four rooms radiate from ours in a design suggesting the name of our lodge—Starfish House.

One arm contains the kitchen and laboratory, from which the chef is passing us fruit, cheese, and coffee. I light one of my reeking Tuscan cigars and look out the windows at a black, virgin wilderness where moving phantasms barely suggest themselves, and where lights that are not lights softly gleam.

"*Commandant, regardez,*" says the

man at the console. He turns off the inside lights, then flicks on powerful lamps outside. In a magical transformation, our windows turn into treasure chests lined in zenith blue—the blue of the undersea world. Jewel trays drift slowly past in a half-knot current. There are tiny crustaceans, larval jellyfish, swimming worms, and many-faceted hatchetfish that have migrated from the abyss to dazzle our eyes. Beyond is a somber, shifting tapestry of big pelagic fish, the far-riding predators. They strike singly into the little ones, snap them up, and speed back to the shadows.

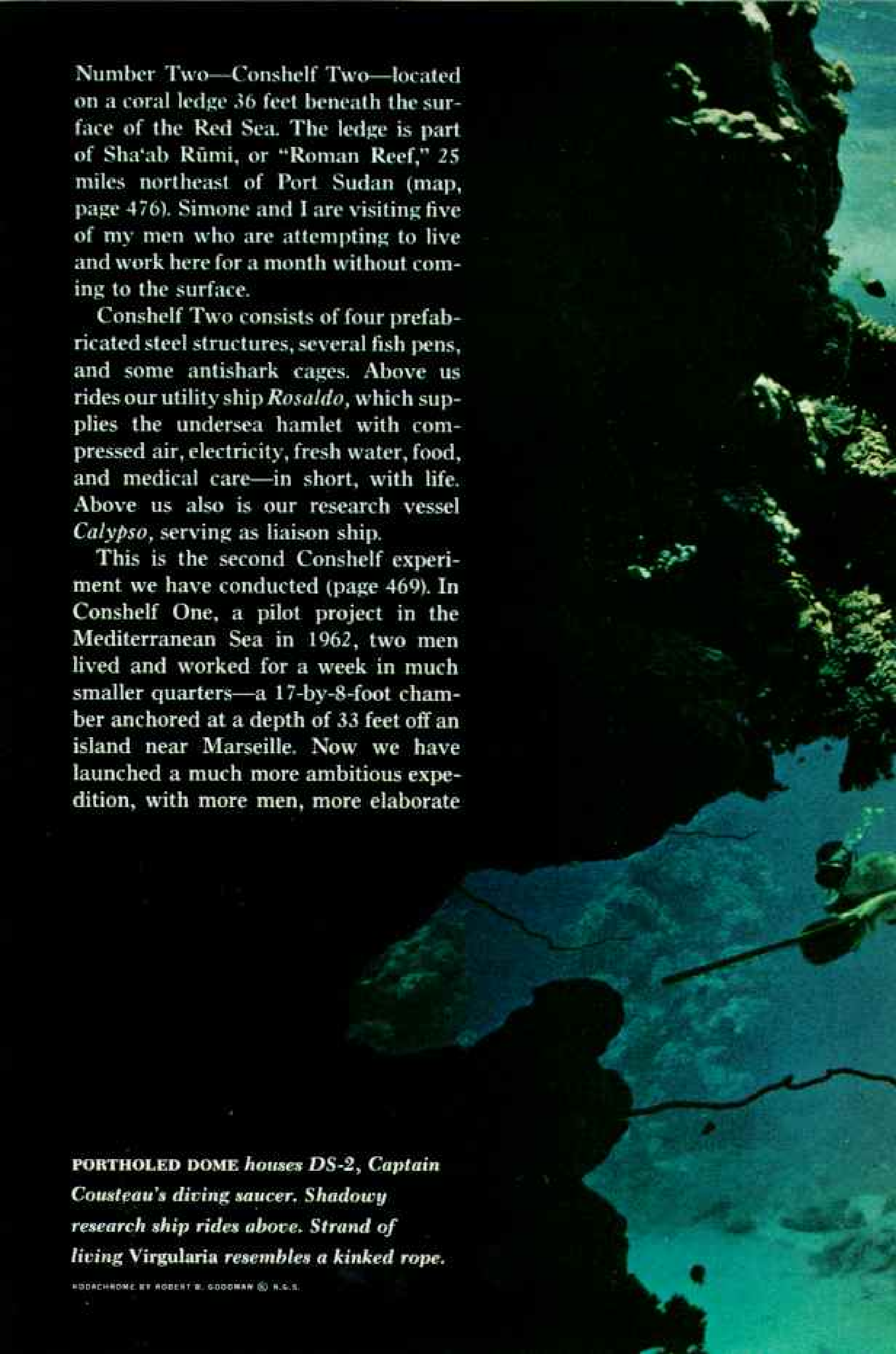
A thick school of sardinellas prances into view. We watch, spellbound, as they execute in unison a dance as precise as that of the Rockettes, then vanish as if the stage had fallen in.

We are in Continental Shelf Station

Number Two—Conshelf Two—located on a coral ledge 36 feet beneath the surface of the Red Sea. The ledge is part of Sha'ab Rūmi, or "Roman Reef," 25 miles northeast of Port Sudan (map, page 476). Simone and I are visiting five of my men who are attempting to live and work here for a month without coming to the surface.

Conshelf Two consists of four prefabricated steel structures, several fish pens, and some antishark cages. Above us rides our utility ship *Rosaldo*, which supplies the undersea hamlet with compressed air, electricity, fresh water, food, and medical care—in short, with life. Above us also is our research vessel *Calypso*, serving as liaison ship.

This is the second Conshelf experiment we have conducted (page 469). In Conshelf One, a pilot project in the Mediterranean Sea in 1962, two men lived and worked for a week in much smaller quarters—a 17-by-8-foot chamber anchored at a depth of 33 feet off an island near Marseille. Now we have launched a much more ambitious expedition, with more men, more elaborate



PORTHOLED DOME houses DS-2, Captain Cousteau's diving saucer. Shadowy research ship rides above. Strand of living *Virgularia* resembles a kinked rope.



equipment, and at a far more remote site.

The control panel in the corner is actually the command center of the entire Conshelf Two expedition. Its operator has a three-camera-closed television circuit, intercom, ultrasonic underwater wireless, and telephone. He issues instructions not only to the station but to the ships overhead. Forty-five men, above and below, follow these directions.

The controller also communicates with a strange building near Starfish House, an onion-shaped dome on stilts. It is the hangar of our two-man hydro-jet submarine, the diving saucer *DS-2*, which voyages a thousand feet down from its submerged shelter—the first submarine vessel to operate from a base on the ocean floor (page 502).*

The underside of *DS-2*'s hangar is open to the water so that the saucer pops up into the air inside, to be hoisted into the dry by an electric winch, discharge her crew, and receive maintenance and battery recharges. Like Starfish House, the hangar is filled by a hose from *Rosalda* with air compressed to 30 pounds per square inch, slightly more than double atmospheric pressure, to equal that of the surrounding water.

Simone and I get up from the table and have a look at the console. The gas-analysis indicators show that our air is pure. So is the atmosphere of helium and air in our Deep Cabin, a rocket-shaped underwater chamber 90 feet down on the reef below, where two men will presently attempt to live and work for a week without surfacing (pages 500-501). We check meters showing direction and velocity of the current outside. The temperature in Starfish House reads 27° centigrade (80.6° F.), and the humidity is 85 percent.

Undersea Scientists Go for a "Stroll"

The 38-year-old director of the undersea station, Prof. Raymond Vaissière, chief of the biological division of the Oceanographic Museum at Monaco, asks us, "Care to join our evening promenade?"

The men go to one of the branching wings of Starfish House to don their gear.

When the professor is dressed for his "stroll"—part of the scientific program that requires our oceanauts to spend several hours a day in the open water outside the station—he pauses at the console and starts a clock next to his name on the personnel roster. Each name has a clock that records the time a man spends outside in the water.

The next man to clock out is a sprightly 30-year-old, Claude Wesly, chief diver of Conshelf Two. He is called "*l'ancien*," the veteran, because he was one of the two occupants of Conshelf One.

André Folco, 33, starts his clock. He is a slender, handsome industrial designer with a calm, restrained personality, which is helpful in unprecedented living conditions like these. The fourth man in the night-diving party is Pierre Vannoni, 31, a former customs inspector with literary tastes.

Simone, only a temporary visitor like myself, comes out of a bedroom in her foam-rubber diving tunic, designed as a gift for her by a fashionable Paris couturier. She shoulders her lady-sized Aqua-Lung.

"Coming?" she asks.

"Later," I reply. "I am going to join Falco in the hangar." Albert Falco, not to be confused with André Folco, is the saucer's pilot.

Handouts Win Chef a Devoted Friend

There is no door in the foyer from which the diving party is to depart. Wesly steps over to a circular blue section of the deck—and descends into it. It is open water, the sea itself, held down by internal air pressure. One by one the divers disappear through the open sea hatch.

The fifth man in the permanent underwater party stays inside with me and clears the table. He is our bearded chef, Pierre "Pierrot" Guilbert, 43. Pierrot is veritably the morale officer of this village beneath the sea. His cuisine bolsters the others, and he inspires himself with a grand collection of photos of his wife, two children, parents, relatives, and friends tacked over his bunk.

Pierrot taps on the window with his signet ring. A large triggerfish appears in the window, eyes him (page 485), and disappears. Pierrot moves to the sea hatch and holds some food scraps above the water. The triggerfish sticks its head up and grabs the offering.

Pierrot made friends with the fish when he first arrived. The trigger lives 100 feet away in a recess of the reef. It quickly recognized Pierrot as the dispenser of free lunch and associated only with him. Let another man rap on the window, the fish will come, but, recognizing an impostor, will at once go back home. When Pierrot is out swimming

*Captain Cousteau described his first undersea saucer explorations in "Diving Saucer Takes to the Deep," NATIONAL GEOGRAPHIC, April, 1960.

EXPLORING THE CONTINENTAL SHELF: CAPTAIN COUSTEAU'S LONG-RANGE RESEARCH PROGRAM

Conshelf One, September, 1962. A 17-by-8-foot steel cylinder, 33 feet deep in the Mediterranean, housed two men for a week off Marseille, France. Divers descended to 85 feet.



Conshelf Two, June, 1963. Starfish House, 38 feet below the Red Sea, sheltered five men for a month. Deep Cabin at 90 feet held two men for a week; divers worked at 165 feet.



Conshelf Three, August, 1964. Plans call for a 20-foot-wide sphere at 165 feet off Villefranche, France, in which five men will attempt to live for two weeks. From it, divers hope to work regularly at 280 feet.



Conshelf Four, May, 1965. Five men expect to stay at 330 feet for two weeks off Villefranche. Divers will try to penetrate to 525 feet.



Conshelf Five, August, 1965, or August, 1966. Down at the drop-off line of the continental shelf, five divers propose to stay two weeks. Oceanauts will attempt dives to 900 feet. Site of the program remains to be selected. Captain Cousteau's ultimate goal is to send divers to 1,300 feet from an underwater home 660 feet below the surface.

Since 1952, the National Geographic Society, through grants from the Committee for Research and Exploration, has been a supporter of Captain Cousteau's undersea studies.

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Fish men trailing bubbles move lead pigs lowered from the surface. The weights will hold an air-buoyed chamber against the sea floor.



with three or four other men dressed in identical head-to-foot suits, their features completely hidden by masks, helmets, and mouthpieces, the triggerfish will unerringly come to the cook.

I go to the console and call, on the intercom: "Starfish to Saucer Hangar. Over."

Falco answers, "Davso and I are checking the batteries on the diving saucer." Armand Davso, the saucer's chief mechanic, has dived from *Calypso* to join Falco.

I reply, "I'm coming over." I shoulder an Aqua-Lung and go down the ladder into water that feels like warm silk. Starfish House stands seven feet above the coral sand on five stilts. Steel bars that surround the ladder protect us against sneak shark attack when entering or departing (pages 481 and 487).

I swim toward the lighted ports in the yellow onion dome. Down the reef I see the flashlights of the professor and the night prowlers.

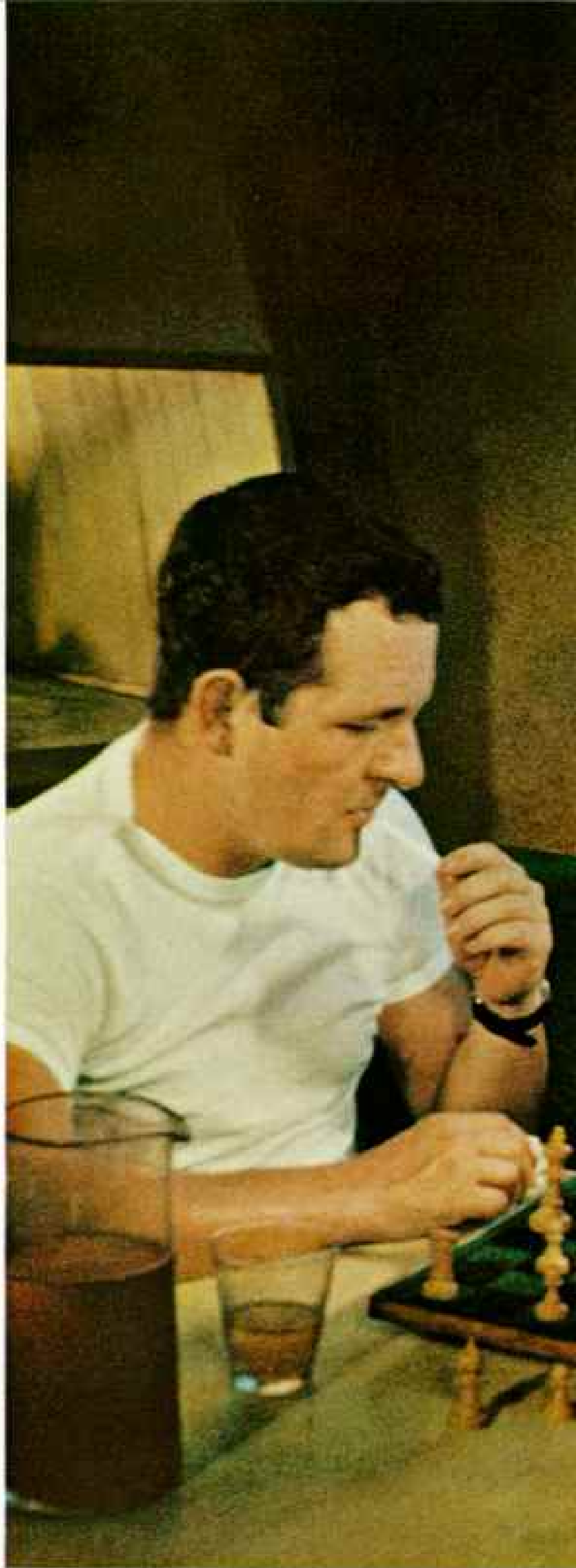
Man Who Works Magic in the Depths

I swim under the tripod legs of the diving saucer hangar and play my flashlight up into the big hatch. My distorted reflection ripples in a mirrorlike effect on the tissue of air and water above (page 503). It looks exactly like an inverted swimming pool into which I am diving upside down in slow motion. My mask breaks through to the air. The saucer is above me, and Falco and Davso are standing on the walkway, sweating over the battery boxes.

Sturdy, quiet Albert Falco, 35, besides being the pilot of the diving saucer, is diving chief of *Calypso* Oceanographic Expeditions—and an underwater magician. Time after time in this hazardous business of establishing an undersea village and making it work, it is a decisive act by Falco that saves the day. Without seeking power, he has become the indispensable man of Conshelf Two.

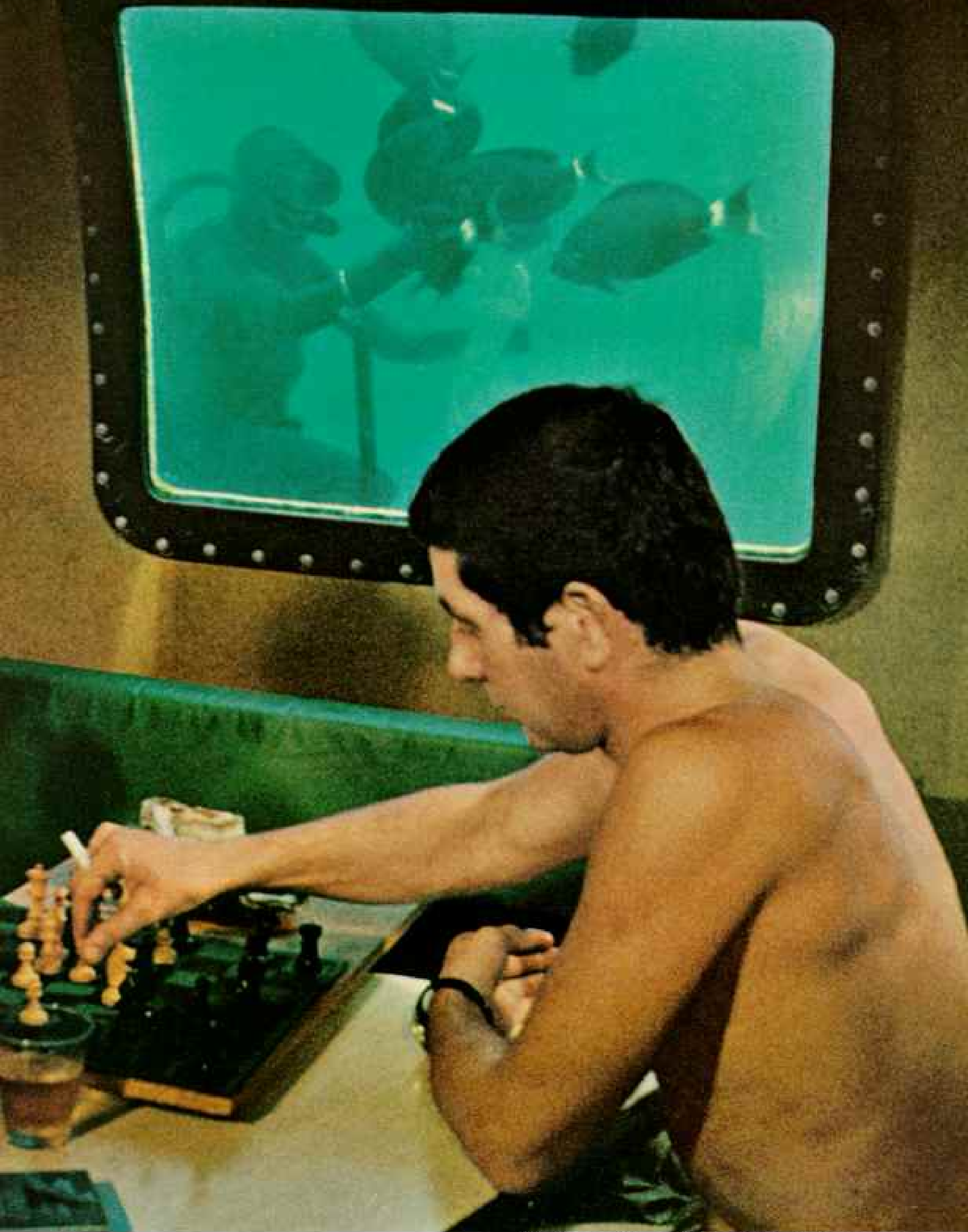
Falco's 20 years as a free diver and his week below with Wesly in Conshelf One are ancestral lore to people in Starfish House; his more than a hundred depth cruises in *DS-2* make him the most experienced scientific submariner in the world. Yet Falco is wholly unambitious. He is content with plain, hard living, and is never so happy as when he is roaming around the bottom studying things with no particular object in mind.

My own job in Conshelf Two is as over-all supervisor of the expedition, with Commandant Jean Alinat as my alternate. Our ship operations are conducted by Capt. Christian Perrien, marine superintendent of our five-vessel research flotilla. And my old comrade



Oceanauts Play Undersea Chess; Outside, a Diver Feeds Hungry Surgeonfish

In a Red Sea village 36 feet down, five men spent a month without once resurfacing. They sought to test whether divers can reap the fish, oil, and min-



APPROXIMATE BY ROBERT B. GOODEMAN © NATIONAL GEOGRAPHIC SOCIETY

eral riches of the continental shelf while actually living on the bottom. The oceanauts worked several hours a day at greater depths, returning to their sunken house to eat and sleep. Forty men aloft cared for their needs.

Chess players are Prof. Raymond Vaissière,

chief biologist of Monaco's Oceanographic Museum, and oceanaut Pierre Vannoni. They endure an atmospheric pressure twice that above the sea, temperature of 80° F., and humidity of 85 percent. Even so, they enjoy more comfort than their comrades on the hot, muggy surface.

Frédéric Dumas is topside with me as expert adviser. Prof. Jacques Chouteau heads the medical staff of the effort.

What is the purpose of the Continental Shelf Station? To begin with, I have long felt that undersea exploration is not an end in itself. It must lead to scientific research, to prospecting for wealth, and to greater utilization of the oceans. Finally, it must lead to human occupation of the sea floor—not only for the brief moments man has known before, but for days, weeks, even months at a time. Life is short: I wanted to hasten these

processes of exploration, of prospecting and occupation, push them together, and establish a working, manned undersea station in the richest and most accessible region of the ocean—the continental shelf.

Coastal Shelves Equal Area of Africa

The continental shelf is the submerged portion of the land mass before it assumes oceanic characteristics in the continental slope and the abyss. Most nations consider the offshore contour line where the depth is 600 feet to be the boundary of the continental shelf.



and many nations have proclaimed their submerged littoral as sovereign territory. The total area of the world's continental shelves is equal to that of all Africa.

There are many economic reasons for colonizing the continental shelf. The shoal waters of the world are rapidly acquiring offshore wells of oil, natural gas, and liquid sulphur. Troves of fine gem diamonds are being dredged from the South African continental shelf. Manganese nodules in almost pure state litter some ocean bottoms. Under-sea fish farms, analogous to stock ranches on

land, are now challenging man's imagination.

Theories for sea-bottom stations have existed for half a century. Prof. John Scott Haldane and the British Admiralty Deep-water Diving Committee established in 1907 that man can live in twice the density of the atmosphere for a long period and be decompressed rapidly without danger. Recently, Capt. George F. Bond, a United States Navy surgeon, drew up detailed plans.

In fact, pressure has no direct effect on human tissue short of a hundred atmospheres, such as occurs at depths of more than 3,000 feet in the sea. The only known handicap in extreme pressure would be respiratory fatigue. In 1962 we demonstrated in Conshelf One that lung fatigue was hardly a factor for two men living for a week in two atmospheres of pressure.*

Conshelf Two was not only planned to deploy more men for a longer stay in two atmospheres of pressure, but to leap forward by placing two men for a whole week in a Deep Cabin at a depth of 90 feet. To alleviate the strain on their lungs by air compressed to nearly four atmospheres, we planned to furnish them with a mixture of air and the second lightest gas, helium.

It is theoretically possible to push the working station down to 660 feet by using a mixture of the lightest gas, hydrogen, with a smaller amount of oxygen. Our long-range Conshelf plan is to do exactly that (page 469).

*For accounts of another dramatic undersea experiment, see "Our Man-in-Sea Project," by Edwin A. Link, and "The Long, Deep Dive," by Lord Kilbracken, both in the May, 1965, NATIONAL GEOGRAPHIC.

RESEARCHED BY ROBERT R. THOMAS © NATIONAL GEOGRAPHIC SOCIETY



Builders Work Late Into the Dusk to Link Ship and Undersea Village

A reef too shallow to swim over and too jagged to walk on separates the supply ship *Rosaldo* and the bottom-dwelling oceanauts.

Completed bridge (left) carries supplies, air hoses, and wiring across the reef from *Rosaldo* before they drop into the deep. Canopy at the end of the span shields Aqua-Lung air tanks from searing daytime sun. Bubbles rise from a submerged building.

Assembling a sharkproof cage, Armand Davso uses a hacksaw to trim a metal rib.

These manned stations exist only to permit men to work in the open water much longer and deeper than they can in surface-to-surface dives. Indeed, the shelf station does away with tedious and time-wasting decompression. If they live underwater, divers no longer need to decompress; they simply finish their work and return directly to the undersea billet. Only when they leave the undersea world altogether must they decompress.

We chose to plant Conshelf Two in the inhospitable Red Sea because it was far away, hot, and hard to supply. If we could build and maintain a sea-bottom station there, we could do it almost anywhere in the world.

To select the site, Albert Falco made launch cruises out of Port Sudan, diving for nearly

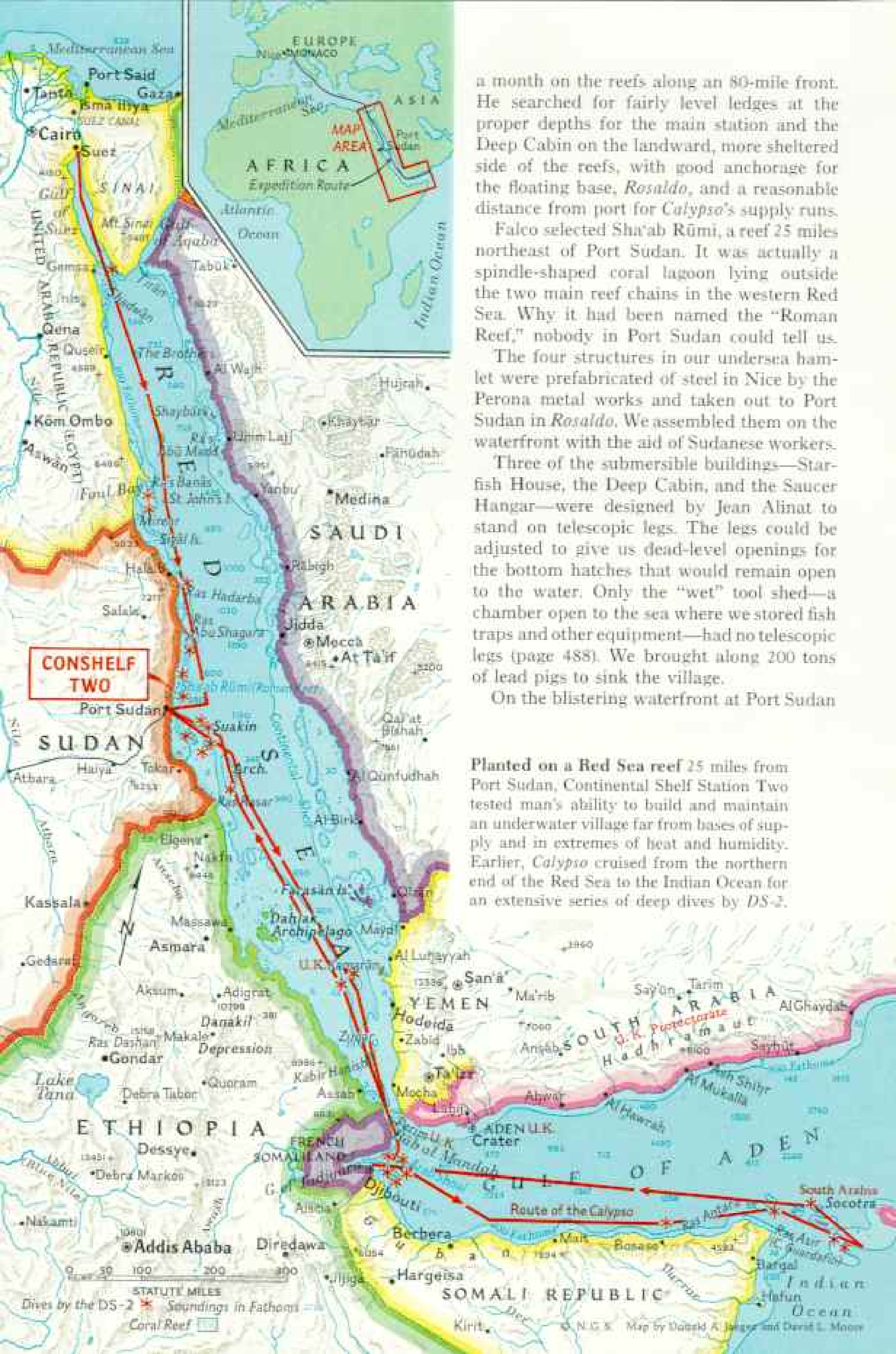
Wings and feet spread for landing, Starfish House is lowered to its bed. Protective shields cover the windows as the structure sinks. Frédéric Dumas records the historic moment on motion-picture film.

After-dinner chat in Starfish House rounds out a day's work. Mme Simone Cousteau, at the window, dropped down for the final week; her husband (center) joined her for their 26th wedding anniversary. He shows the loss of 20 pounds burned away in blazing weather on the Red Sea's surface. Ocean-aunts who dwelt in the cooler depths for a month did not lose a pound.

474







a month on the reefs along an 80-mile front. He searched for fairly level ledges at the proper depths for the main station and the Deep Cabin on the landward, more sheltered side of the reefs, with good anchorage for the floating base, *Rosaldo*, and a reasonable distance from port for *Calypso's* supply runs.

Falco selected Sha'ab Rūmi, a reef 25 miles northeast of Port Sudan. It was actually a spindle-shaped coral lagoon lying outside the two main reef chains in the western Red Sea. Why it had been named the "Roman Reef," nobody in Port Sudan could tell us.

The four structures in our undersea hamlet were prefabricated of steel in Nice by the Perona metal works and taken out to Port Sudan in *Rosaldo*. We assembled them on the waterfront with the aid of Sudanese workers.

Three of the submersible buildings—Starfish House, the Deep Cabin, and the Saucer Hangar—were designed by Jean Alinat to stand on telescopic legs. The legs could be adjusted to give us dead-level openings for the bottom hatches that would remain open to the water. Only the "wet" tool shed—a chamber open to the sea where we stored fish traps and other equipment—had no telescopic legs (page 488). We brought along 200 tons of lead pigs to sink the village.

On the blistering waterfront at Port Sudan

Planted on a Red Sea reef 25 miles from Port Sudan, Continental Shelf Station Two tested man's ability to build and maintain an underwater village far from bases of supply and in extremes of heat and humidity. Earlier, *Calypso* cruised from the northern end of the Red Sea to the Indian Ocean for an extensive series of deep dives by *DS-2*.

CONSHSELF TWO

STATUTE MILES
 0 50 100 200 300
 Dives by the DS-2 * Soundings in Fathoms
 Coral Reef

we struggled to float the buildings and ballast them for the 25-mile tow to Sha'ab Rūmi.

Building an undersea village may sound romantic, but the job itself was anything but glamorous. To begin with, we had to clear off humps of compacted sand and coral knobs to level the site for Starfish House and the Saucer Hangar (page 483). It was like breaking ground for a housing development ashore. We improvised a sort of plow, drawn by a rope which passed through a block made fast to the reef and ran up to a winch on *Calypso's* afterdeck. It took two days to level the lot.

Mooring Sea Blimps in a Gale

Placing the houses in the hamlet with a half-knot current running was somewhat like trying to tie down so many blimps in a gale. Our big steel bubbles were defiantly buoyant. They had to be sunk on an even keel to avoid flooding inside installations. This meant juggling tons of lead ballast.

In addition, one of our critical calculations for Starfish House was wrong. It needed 100 tons of lead, but the available ballast space under the floor would take only 80 tons. We had to build a 10-foot-wide rack on Starfish to hold the 20 extra tons of lead. We groaned and sweated through a day of suspense while sinking the main house, until finally it rested triumphantly on its telescopic stilts.

Then we lowered the hangar for *DS-2*. There was a crunching and a boil of bubbles

as one of the legs gave way. The dome tilted over, and all three legs collapsed. It took four days of unremitting labor to unload ballast, take off legs, repair them, and restore the hangar to even keel.

During the whole expedition we all lost weight. My share was almost 20 pounds. Occasionally a man would faint at his job, for there was no air conditioning on either *Calypso* or *Rosaldo*; we were dedicating our only air conditioner to Starfish House.

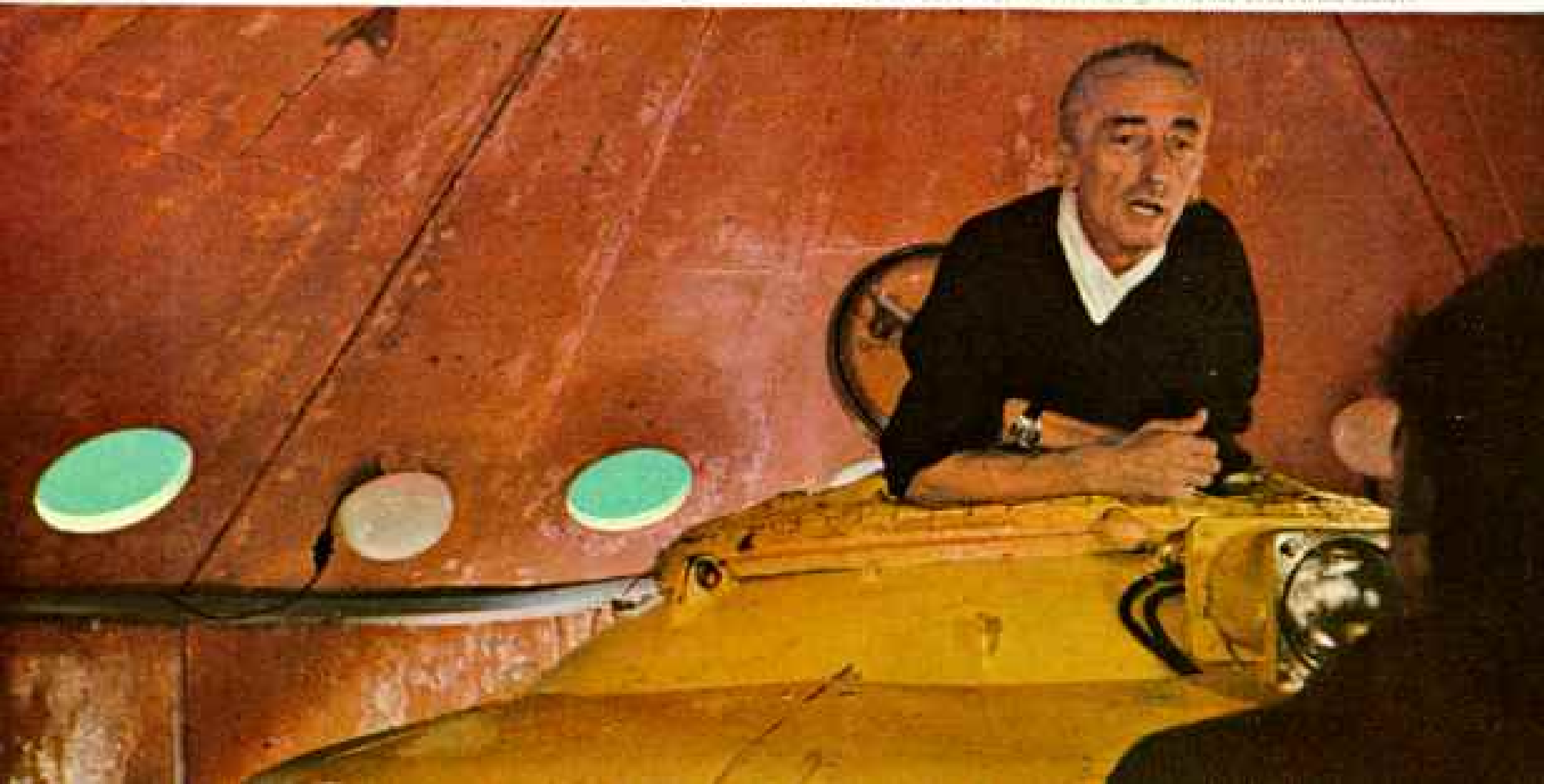
Accidents seemed almost part of the daily routine. Many were so nearly fatal, I wonder what dispensation we had. For example, take the accidents to the Deep Cabin. At its proper depth—90 feet—the only feasible perch on the reef was about a yard square, not large enough for its tripod legs. We had to anchor it and reinforce it with a mooring cable to a section of the reef above it to ensure the cabin against sinking. When this difficult lash-up was finished, the mooring pulled out and the cabin sank. We fished it up from 140 feet, with marvelous work by Bosun Maurice Léandri on *Calypso's* hydraulic crane. The cabin sank several more times. Let me tell about just one of the sinkings.

Whenever the cabin took off, it ripped out electrical, television, phone, and instrument cables. It would have taken weeks to hoist the rocket out of the water each time and repair it.

After one such misfortune our electricians,

Sweated against the chill of the lower depths, Captain Cousteau pops out of the diving saucer *DS-2* after a dive to 1,000 feet. First submarine ever to make its base on the sea floor, *DS-2* has "surfaced" here within the underwater hangar (page 467). Doubled air pressure keeps sea water from surging up through the shed's open floor.

ILLUSTRATION BY BRUCE TERRY, THE AQUARIUM SOCIETY © NATIONAL GEOGRAPHIC SOCIETY



Jacques Roux and Pierre Servelo, volunteered to do the job underwater. Servelo was diving for the second time in his life. The uppermost of the cabin's two compartments was still dry, and they could work there. A highly experienced diver, Raymond Coll, went down with them to do some outside repairs.

Roux and Servelo crawled up to the "nose room" and reconnected the phone to Starfish House. Just then Deep Cabin began to rock. It rumbled. With a snarl of bubbles, it began sliding down the steep slope of the reef, with two men trapped in the nose and Coll outside, entangled in a storage rack.

Servelo yelled over the wire to Starfish House: "What is happening?"

The controller relayed the distress call to *Calypso*. Commandant Alinat said, "I'm coming down." Then the phone line ripped out.

During the sinking, Roux scuttled down to the bottom hatch, thinking that Servelo was following. He dived clear, watching with horror as the cabin thudded on down the reef with one of his messmates inside and the other carried along, struggling, on the outside. The reef face fell off for 1,000 feet. Luckily, the Deep Cabin struck a ledge 140 feet down and came to a stop, leaning against the reef.

Men Escape From Near Death

Coll was pinned outside. Inside, Servelo felt the chamber settle and composed himself. Water had flooded up through the lower room, but the upper room was only a quarter filled. He had a pocket of air, he still had his Aqua-Lung, and he reposed a world of confidence in the last words he had heard on the phone, Alinat's "I'm coming down."

Servelo heard banging and scuffling outside; Coll's Aqua-Lung was clamped to the reef by the steel cabin. He was cutting away his diving harness.

Coll could not work one of his flippers loose, so he pulled his foot out of it. He took a last lungful of air, abandoned his Aqua-

Lung, and started a free ascent of 140 feet. Alinat and Falco came stroking down toward the sunken cabin and passed a nonchalant character with no breathing gear and one fin who was rising slowly with distended cheeks, blowing a bead of bubbles from his pursed lips. Coll was gradually lowering the pressure in his lungs as he passed through progressively lower water pressure. To have retained more pressure inside than that outside would have fatally ruptured his lungs.

Coll arrived on the surface unhurt but tired. Alinat and Falco went on to the cabin and conducted young Servelo up to safety.

Divers Hold Off Army of Sharks

In previous expeditions to the Red Sea we had gained considerable respect for its sharks, and this time came prepared to coexist with them. Coexistence began even before we arrived at the Roman Reef. In the Gulf of Aden we stopped to dive on Arab Shoal, an interesting rock reef near the Gulf of Tadjoura off French Somaliland.

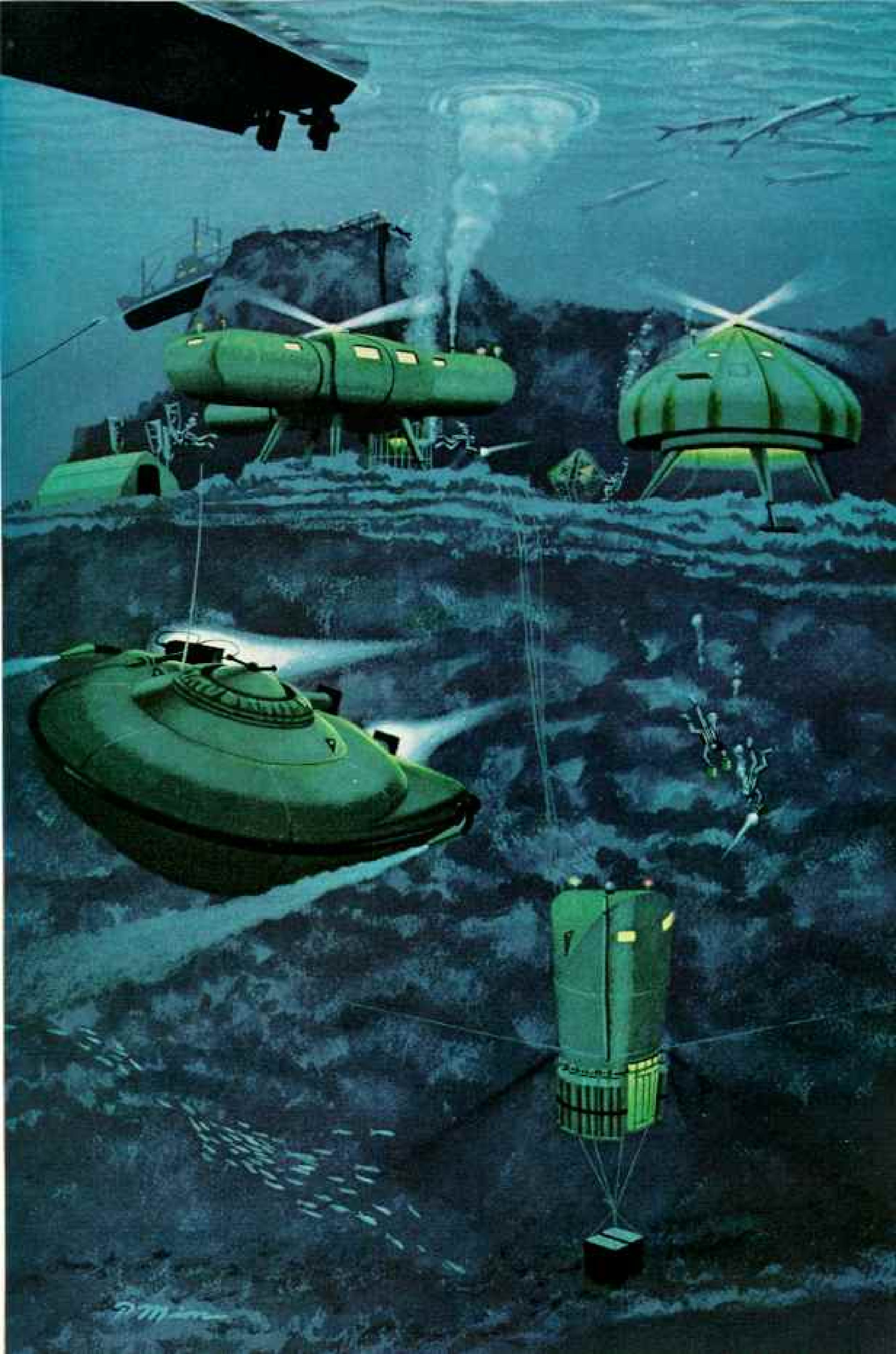
We launched the two-man diving saucer to reconnoiter, and the little submarine was picked up and escorted closely by about 30 large and bold sharks. Pierre Goupil, our cinematographer, and his three teammates dived at night to get some footage, with the antishark cage along just in case.

At a depth of 100 feet the floodlamps held by Raymond Coll and Christian Bonnici picked up the glittering eyes of a dozen big sharks. As Goupil and his assistant Gilbert Duhalde prepared to film them, the pack circled our team, moving in and growing in numbers until there were maybe 70 sharks.

Now Goupil was confronted with a fateful decision: The antishark cage would hold only three men, and the fourth man might well be taken by the sharks. Goupil rang the alarm to have the cage raised, then grabbed his assistant, who was the least experienced diver, and shoved him inside. Then he, Coll, and

Twin Lights Piercing Gloom, Diving Saucer Sails Into the Undersea Village

In a scene no camera could encompass, the fabulous structures of Conshelf Two glow eerily in the nighttime sea. Exhausted air boils up from Starfish House, where a five-man crew makes its home. Across the way, lights glow from the top and open bottom of the diving saucer's hangar-on-stilts. At far left, the flooded tool shed houses underwater gear. Divers drop down the reef to Deep Cabin, moored by a box of lead weights at 90 feet, where two men spent a week working regularly to depths of 165 feet. Another man constructs a fish pen between the two main buildings. Overhead hangs the research ship *Calypso*. Umbilical cords carry compressed air, power, and communication lines from *Rosaldo*, moored beyond the upper reef, across the metal bridge, down to Starfish House, and thence to Deep Cabin. Making the operation a truly undersea one, orders originated in Starfish House, not on the surface.



Bonnici got on top of the cage and sat back-to-back, facing all angles of attack.

The sharks broke their circle and flew at the men head on, confident as wolves of their superior numbers. The divers struck back with cameras, lights, and shark billies as we winched them up. The cage broke water. The men were unhurt. The frustrated killers thrashed on the surface in a frenzy.

Goupil wanted to film the diving saucer in the middle of the maddened pack. So we rigged two powerful floodlights on the front of the anti-shark cage, and he and Daniel Tomasi, the still photographer, went down in it, while Falco and I took the diving saucer down through the sharks.

Falco and I hovered near the cage at 80 feet. We were astonished to see Goupil and Tomasi suddenly abandon their cameras and dance crazily, slapping their ankles and leaping. Around them, picked out in the lights, innumerable white dots were swirling, like gnats around a lawn lamp in summer.

The cage was quickly hoisted out of our sight, apparently in answer to the alarm bell from Goupil. Falco and I later emerged from the submarine to find *Calypso's* work deck



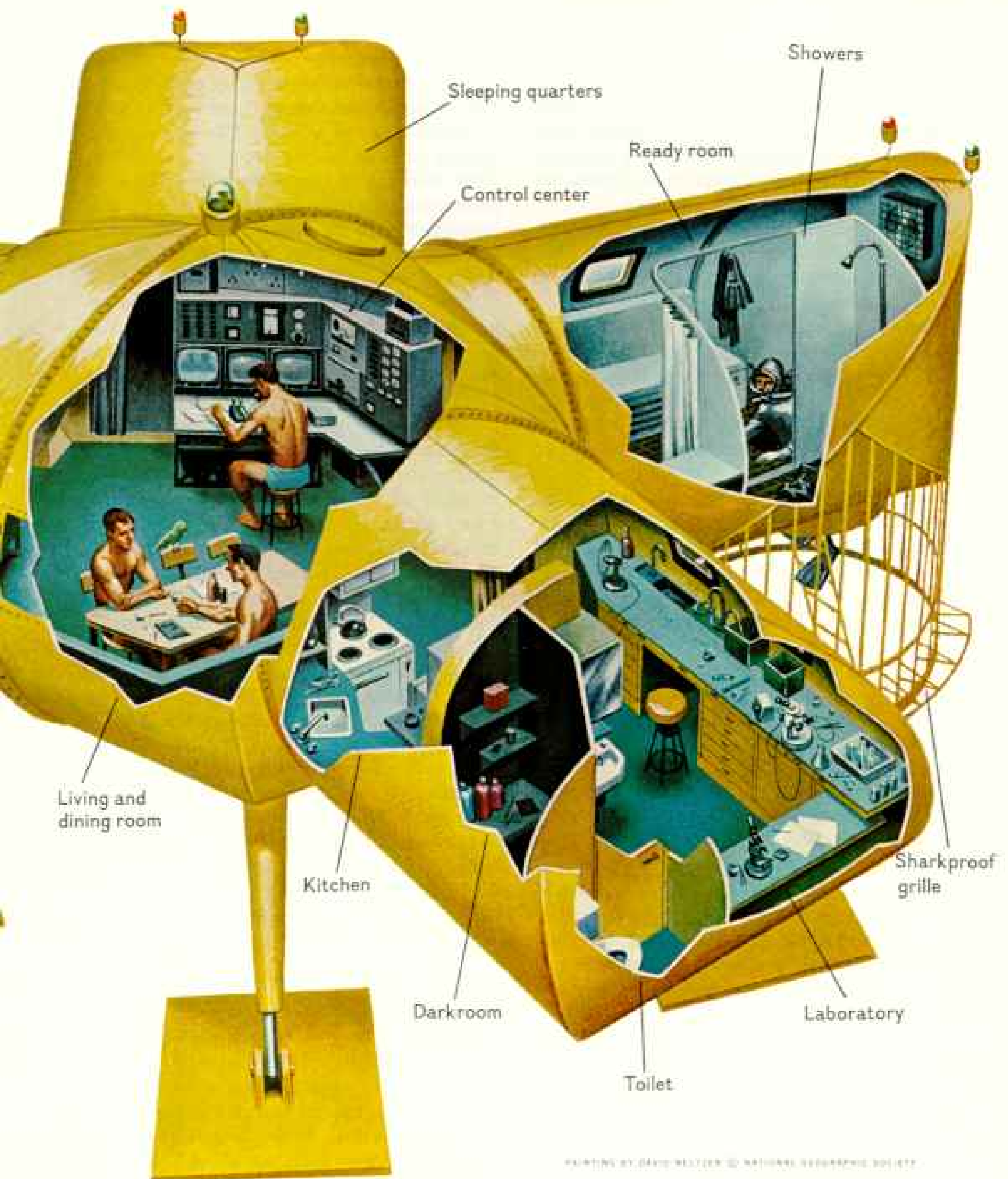
HEADGROWS BY ROBERT E. GOODMAN © N.A.S.



Conshelf Headquarters Floats High on Port Sudan's Placid Waters

After unshipping Starfish House, Captain Cousteau's team stowed ballast under her floor and towed her—low in the water—to Sha'ab Rūmi, 25 miles away. To sink her, they attached 20 more tons of lead weights to the outer hull. Bright yellow at the surface will appear bluish green under water (pages 474-5).

Cranes and vessels dot the harbor of Sudan's busiest port, founded in 1905 as the terminus for a railroad to the Nile.



PAINTING BY DAVID WELTZER © NATIONAL GEOGRAPHIC SOCIETY

Underwater Villa on Adjustable Legs: Cutaway View Reveals Starfish House

This lodge, 34 feet at its widest axis, kept five men healthy and working for a month. Divers here relax in their combination living room-dining room in company with a gas-detecting parrot. Man at the instrument panel controls operations both under the surface and above it. Three TV screens mirror events in the Deep Cabin, on the sea bed, and aboard *Rosalda*.

Gauges indicate temperature, humidity, air pressure, and purity of the atmosphere; clocks time every dive of the oceanauts.

One arm of Starfish contains kitchen, biological laboratory, darkroom, and toilet. Sharkproof grille at right admits divers to their ready room and shower. Two remaining arms (one cut away) hold four bunks each.

slippery with blood and the cameramen laid up with bandaged ankles. To my knowledge this was the first instance of bloodshed from attacks by "sea mosquitoes," agile planktonic crustaceans, probably isopods, as vicious for their size as the fearsome piranhas.

Goupil and Tomasi had been entirely protected by their diving suits—except for their ankles. On the way up, they had swatted away at the little monsters as the sharks followed. Léandri, on the crane, stopped the cage ten feet from the surface for the obligatory five-minute decompression stop. During the halt, said Goupil, "I was suffering such tortures from the mosquitoes that I felt like opening the door and going out in the middle of the sharks."

Although we set up our antishark cages at Sha'ab Rūmi, we saw few sharks there. Throughout our stay, we had to swim well out of sight of the station to see one. Apparently the sharks were equally impressed by us. And that is the way I hope it remains.

Silver Suits Mark Undersea Exiles

After weeks of aggravations, setbacks, and galling labor in steaming weather, Continental Shelf Station Number Two was finally ready for human occupancy.

The five oceanauts dressed for departure. I talked with them on the diving deck. They were dressed in flexible diving suits of gleaming silver, actually aluminized nylon-neoprene. The romantic armor had practical origins. Reflecting fabric could be seen farther at night, and it was vital that any of these five be instantly distinguished from the dozen or so black-suited servant divers and technicians who would be working with them.

The silver livery of the oceanaut was a sort of convict suit—the wearers were sentenced to one month in a watery dungeon and could come to the surface only at peril of their lives. During their prolonged stay in two atmospheres, including lengthy dives down to pressures of three and a half atmospheres, the silver men would become heavily saturated with nitrogen and could not rise into lighter pressures without decompressing, lest the gas bubble into their blood streams and kill or cripple them with embolisms.

The rest of us, wearing black diving dress, must always watch the silver oceanauts and never let one of them accidentally drift above the sunken village, possibly to his death.

At the end of a month, we planned to ad-

minister to the oceanauts a mixture of gases containing the minimum amount of nitrogen permissible, so as to lower the nitrogen saturation of their bodies and to allow them to swim nonstop to the surface. In case of an emergency, we were equipped to take a man immediately to the surface in a pressurized can and transfer him under pressure to a decompression chamber on *Rosaldo*.

The five men standing in front of me, sweating in their silver suits in the tormenting Red Sea sun, were not exceptional physical specimens. For Conshelf One I had picked two crack divers in top physical condition, but for this longer and more grueling trial in debilitating heat and humidity, I chose five unexceptional men. They averaged more than 35 years of age. Two were not very experienced divers. All were married, with a total of six children. One was pudgy and had minor arteriosclerosis. The only thing out of the ordinary about the oceanauts was loyalty to one another as Calypsonians and pride in being selected for Conshelf Two.

The second day that our contingent was living in Starfish House, I went down for dinner. Davso was still rigging the air conditioner, but even without it, the undersea house was noticeably more comfortable than *Calypso*. After coffee Professor Vaissière introduced me to the magical evening's entertainment they had discovered on the first night—house lights out, external floodlamps on. I suspect that looking out into the search-lighted sea will be something of which men in future undersea settlements will never tire.

DS-2 Takes to the Deep

Starfish House was a stationary viewing gallery. The beauty of the diving saucer, among other things, is its mobility.

We loved to take the saucer out at night because of the exotic creatures that come out then, and because of our long-held interest in the mysterious deep scattering layers that rise and fall in the depths of the sea. Here is the log of one of my Red Sea dives with Falco before we arrived at Sha'ab Rūmi:

"It is 2:00 a.m. Henri Plé, officer of the middle watch, awakens me and, despite the sultry clime, I pull on a blue nylon coverall. It will be cooler below.

"On the afterdeck, the diving saucer is lying in her cradle. Falco and I step on bathroom scales and the divemaster chalks the weights on the blackboard. Davso reads the



Men clear coral from the building site. Nearly weightless in a medium 800 times as heavy as air, they find it difficult to level off a reef platform.

Divers heap lead pigs on Starfish House's flat feet to weight the buoyant tank. Marker buoys, tugging upward, show irregularities of the bottom.

ESTABLISHED BY ROBERT S. GOODMAN © NATIONAL GEOGRAPHIC SOCIETY





Synthetic sunlight of ultraviolet lamp tans André Folco. Each man living in Starfish House sunned 10 minutes a day.

Breathing a mixture enriched with oxygen, Folco and Vannoni lower the nitrogen saturation of their blood so they may surface without lengthy decompression.

weights and adds a little water ballast to *DS-2*'s inner tank to attain neutral buoyancy.

"We climb in. While Falco dogs fast the top hatch, I start the oxygen recirculation system and check over the control panel. On the phone Falco answers the pre-dive catechism of the divemaster. Everything is O.K.

Sharks Keep the Saucer Company

"Maurice Léandri, at the controls of the hydraulic crane, picks us neatly off *Calypso*'s deck and, with a velvet swish, the saucer is in the sea. I switch on the headlights. A couple of sharks are hanging around. Christian Bonnici, keeping an eye on them, ducks under to wipe off our Plexiglas ports. At a thumbs-up signal from Falco, the diver gets on top of the submarine, pulls out the phone jack, and casts off the lifting tackle. Bonnici lends his weight to pressing us under, and our voyage begins.

"One hundred and sixty feet down, the echo sounder sketches the bottom of the first

reef—a gray slope of rock fragments. We land briefly. Falco adjusts our buoyancy and we go slaloming down the coral bank.

"We come to the very sharply defined drop-off line of the second reef. We leap into the void beyond and circle back to sink along the animate wall, our lights picking up the delicate pastel colors of coral and alcyonarians.

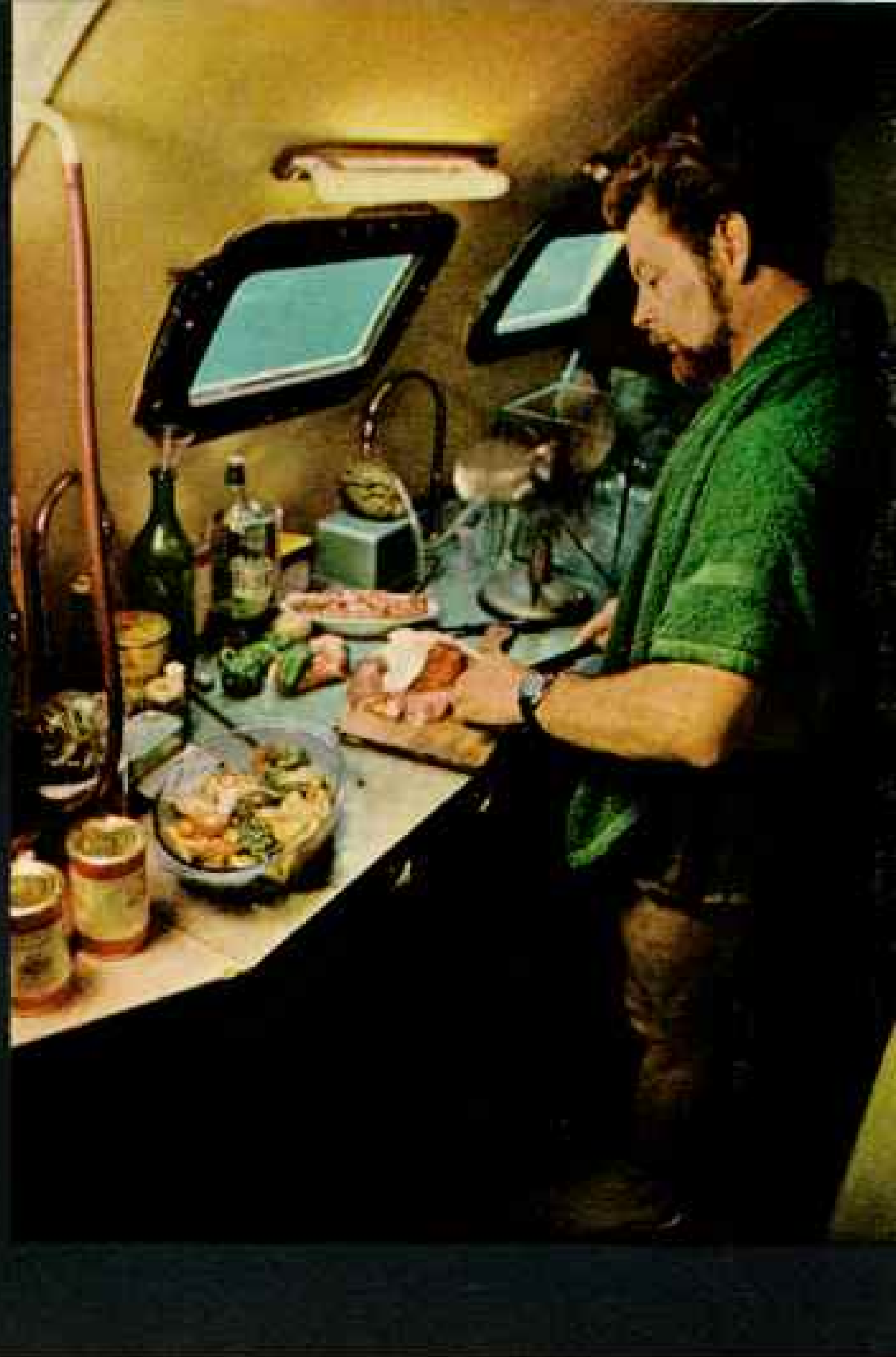
"Two hundred feet down we encounter the first deep scattering layer—DSL—a huge accumulation of micro-organisms that has risen at night from its daytime position 600 or more feet deep. From above and below small squids and many gill rakers come to graze in this plankton pasture. One of the things that makes night diving so profitable is these glimpses of deep creatures feasting in the DSL.

"We reach a depth of 325 feet and encounter there a phenomenon of the Red Sea reefs that has never been detected before, even by robot cameras or echo sounders. It is a well-

Life in the deep

WITH FISH EVERYWHERE, the oceanauts preferred red meat. What fish the crew ate they caught well away from the colony, so as to keep those at hand unwary of man. Bearded chef Pierre Guilbert shares space with biologist Vaissière.

Triggerfish awaits the dinner bell. When M. Guilbert tapped the kitchen window, his pet swam to the entrance hatch, poked up its head, and accepted scraps from his fingers. It ignored the other oceanauts.



defined horizontal ledge from six to 30 feet wide, running continuously along the vertical reefs. We have seen this ribbony shelf at every single place the saucer dived in the Red Sea.

"*Calypso's* echo sounders had not given the slightest hint of this hard, level 'Andean highway' ranging the reefs of the Red Sea, always found about 325 feet down. The winding *corniche* seems constructed of hard, dead coral. The only explanation we can think of for the ledge is that it marks a sea level during one of the glacial epochs, a level eventually overcome by water. [Our geologists are busy now trying to solve that riddle.]

"Now *DS-2* sinks along the vertical wall of the third reef. We are conscious of the overhanging ledge above us. Four hundred feet down, *DS-2* stops on her own.

"It's the thermocline," says Falco. We have touched the thin border layer between hot and cold water, and we are floating on top of the denser cold fluid.

"We can dive again, of course, by admitting a few pounds of water to our trimming tank, but we take time to let nature make the adjustment by cooling us off. The thermometer falls from 95° F. to 79° F. Falco pulls on a sweater. Again we are on our way down.

Squids Whirl Like Sea Dervishes

"We reach the floor 900 feet down, and Falco cruises on a sloping sandy bed strewn with great boulders, perhaps fragments of the fossil shelf far above. The water is very clear. In our headlights, we can see objects 100 feet away. We watch spiny lobsters with grotesquely long antennae excavating nests in the sand with their tails. Our lights turn small squids into whirling dervishes. The squids pivot on their heads in the sand, twirling their mantles and tentacles like carrousel.

"At the base of the reef, the sea floor is hidden under a tangled and struggling bed of living crabs, each averaging the size of a

human fist. There must be hundreds of millions of them. Above, in the lands bordering the Indian Ocean, are hundreds of millions of half-starved people. Falco and I muse that while men are trying to reach the moon, it also might be well to find out how to fish these crabs.

"It is now dawn, time to go up. Falco drops a ballast weight, and we soar aloft. Soon we are in green water, then dazzling sunshine. Divers put on the lifting tackle and Léandri hoists us aboard. The voyage is over."

Divers Tend Undersea Stock Pens

Perhaps the main achievement of Conshelf Two was to operate a submarine boat entirely from a submerged base for the first time. At Sha'ab Rūmi, *DS-2* was safe and efficient, stealing in and out of her sunken onion dome. No wind or wave menaced her, as often happened when *Calypso* launched or lifted her. Based on the bottom, she was never immobilized by bad weather.

Conshelf Two was a realistic approach to an industrial station under the sea, and the daily routine of the oceanauts was one of work. Housekeeping was shared among the quintet. They took turns standing watches at the control console and performed daily outside assignments for Professor Vaissière.

Every day a team turned out to scrub fast-growing tropical seaweed and algae from the dome of the Saucer Hangar and the "tentacles" of Starfish House. The field work con-

sisted of capturing live specimens for the biologist and putting them in the fish pens, steel frames fitted with plastic panels (page 493).

The divers captured live specimens by winding gill nets around a coral head. When fish had emerged and become enmeshed, the collectors gently disengaged the captives and placed them in plastic bags full of sea water. The men carried the fish in these invisible cages to the stock pens (page 488).

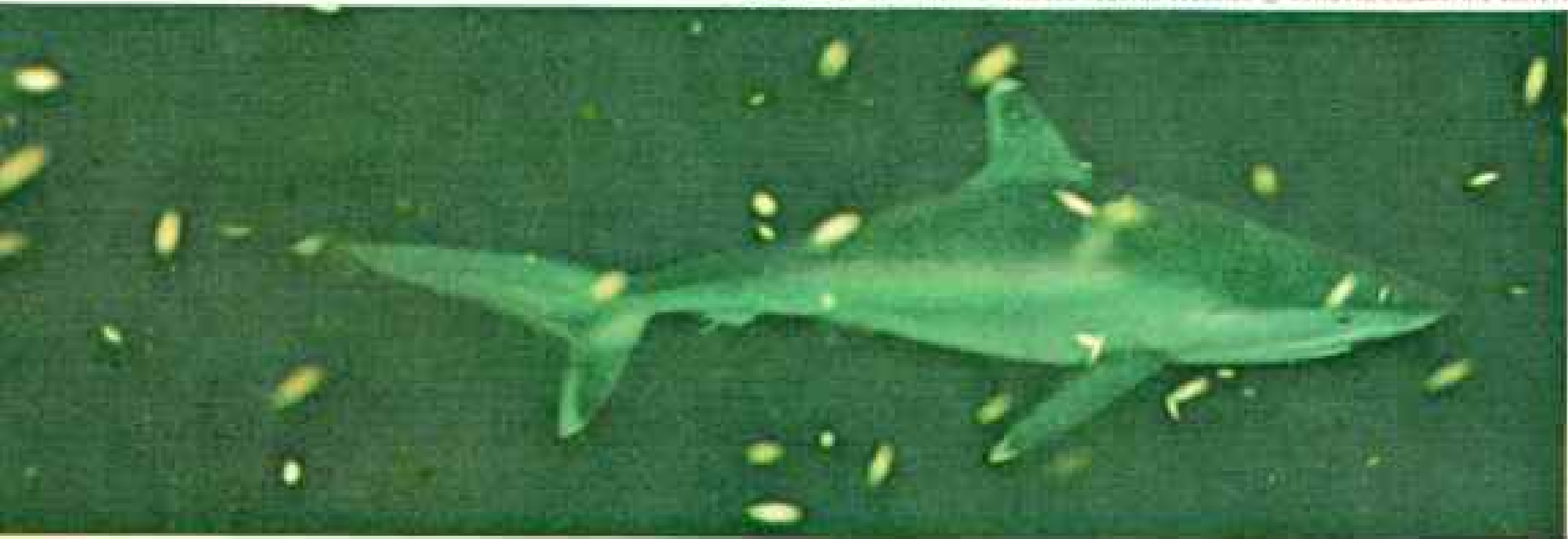
One time a powerful red snapper struck at a fish that Falco was carrying in a plastic bag. The sharp teeth slashed the bag and left the snapper with a mouthful of ripped plastic. The intended victim, thus dramatically liberated, jumped safely into a hole in the reef.

Professor Vaissière had none of the usual frustrations of the marine biologist—the difficulties of obtaining live specimens. He simply flippered out to the fish pens, picked the ones he wanted for the laboratory, and chose others to be air-expressed in oxygen-charged plastic bags to the Aquarium at Monaco.

Chef Pierrot did not use captives from the fish pens. In order to retain an innocent environment for Vaissière's biological researches, we enforced a nonaggression policy around the station. Seaman Antonio Lopez fished for the pot on distant reefs. I found out early in *Calypso* expeditions that easy access to fish does not increase one's appetite for them. We had a substantial red-meat dinner twice a day on *Calypso* and in the submerged house.

If you are planning a manned underwater

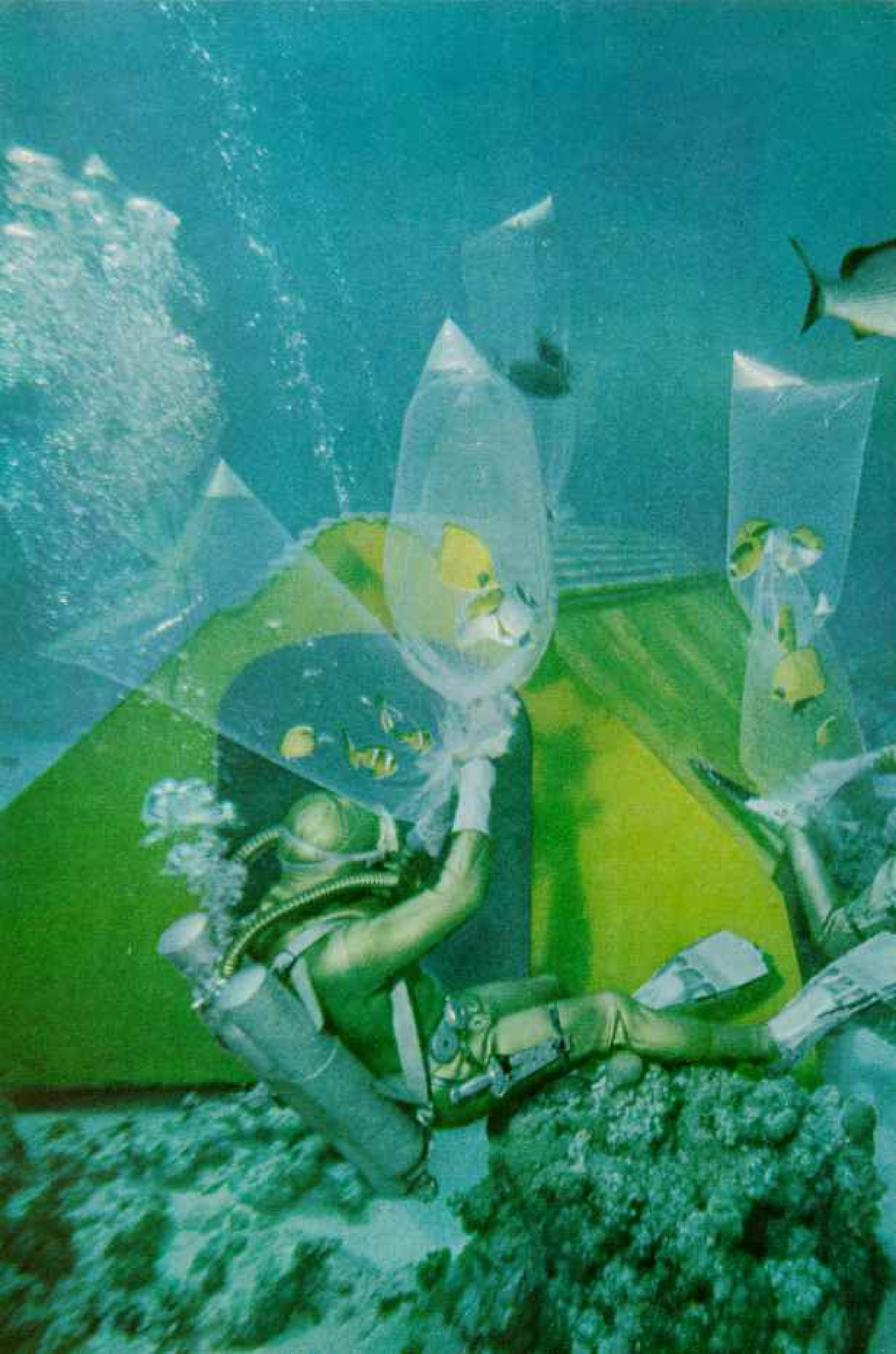
COORDINATED BY JARVIS TORRALLES; RESEARCH ASSISTANT © NATIONAL GEOGRAPHIC SOCIETY



Six-foot shark cruises amid a pack of "sea mosquitoes." On one dive, three men beat off the wolflike rush of about 70 frenzied sharks with billies, lamps, and cameras. The sea mosquitoes, probably isopods, were harder to discourage. Bites on unprotected ankles cost two men nearly a pint of blood each.

Silvery oceanauts leave Starfish House through a barred cage that protects them from sneak attacks by sharks. Easily visible aluminized suits identify them as bottom dwellers; their companions never allowed them to rise above the underwater village lest dissolved nitrogen bubble in their blood.







station, don't forget to lay in a bunch of pressure cookers. They are the ideal containers for fetching and carrying between the surface and the bottom. They were invented to keep pressure in, but they also keep it out. We carried medical instruments, a broken television tube, mail, biscuits, and even a live parrot in them.

Just as miners once took canaries into the pit and submariners took mice into the boat to give early warning of high concentrations of carbon gases, for the same reason we took along the parrots, Claude (after Claude Wesley) and Armand (for Davso). We took two just in case we lost one.

Standby Parrot Never Goes Below

Claude was selected as the first parrot under the sea, although Professor Vaissière disliked the idea. He was sure Claude was going to disturb his repose by squawking out sailors' blasphemies.

Wesly put his namesake in a pressure cooker and carried him down. Claude bore the dive well and settled calmly into his new quarters (page 495). He was not caged—Starfish House was escape-proof for a bird. The professor slept the sleep of the contented savant, and Claude came up at the end of the experiment in good health. The standby parrot, Armand, was never called to duty.

Our youthful doctor, Jacques Bourde, swam down and checked the men every day. Although his average patient was nearing middle age, Dr. Bourde found little to treat.

Once Vannoni complained of the incessant physicals. "I feel fine. What good are all these checkups?" Bourde explained that they went into the clinical record that would be published for the use of other sea-floor establishments.

The peculiar experience of living inside the sea, cradled in man-made shells, cosseted by machines and cables, and nursed by many comrades on the surface, quickly became natural to the oceanauts. Falco and Wesly had found this to be true in the earlier ex-

Filmy Plastic Bags Hold Live Fish Captured for Study at Monaco

Hungry predators, striking at prey within the transparent sacks, soon learned to rip open the plastic to reach their victims. Rudderfish swirl at the right. Professor Vaissière (left), with a catch of butterfly fish, and Claude Wesley swim near the tool shed. A bubble of compressed air buoys each bag.

periment, Conshelf One. Man is a very adaptable species, especially when a new experience contains so much that is novel, beautiful, and exciting.

In recent years our underwater groups have been diving more and more at night because of the strikingly different face that darkness puts upon marine nature. The creatures of the day are withdrawn and asleep, and the night animals are out.

"Walking Shrub" Startles Hardened Divers

At Sha'ab Rūmi in the rich Red Sea, night showed us a secret world within the silent world. We used the ingenious stiletto light that our undersea research and development center at Marseille had built for Albert Falco. Its narrow, intense beam has the power of mesmerizing fish in midwater, so that the divers can gather unharmed specimens with their bare hands.

The parrot fish did not come out after dark. These daytime strollers lodged safely for the night, asleep in the sheltering arms of poisonous fire coral, to whose sting they seem immune. When we came by, they rolled their lidless eyes about but did not stir. They were supremely confident of their formidable fortress.

At night there came into the open a creature that struck momentary fear even in our veteran *plongeurs*. Picture an animal shaped like a small bush with five main branches, a great tangle of sub-branches and thousands of twigs. You find it standing on top of a coral head. It begins to writhe, twisting its slimy branches in cobra-like motions. Play your light on it, and the weird creature shrinks and makes fast to the coral. Then, before your eyes, it walks away, contracts, squeezes into a crevice, and vanishes. This nightmare of the enchanted forest, which we saw only at night, is the basket star, or Gorgon's head, a member of the starfish family.*

On previous Red Sea explorations we had been intrigued by rare observations of a large type of parrot fish that we nicknamed "the bumpfish," because it has a big buffer on its forehead as hard as the brow of a bison. The fish weighed from 60 to 80 pounds and traveled in herds, chewing up coral hunks the size of a fist to get at tiny animals living in the coral maze.

The bumpfish would swim over a coral block, dive swiftly, and butt it heavily with the hard bumper, dislodging the *plat du jour*.

Occasionally it would defecate large clouds of white sand, the end product of its menu.

During our first dives at the Roman Reef, we spotted a school of about forty mature bumpfish that appeared to be in residence, although they whipped off when we tried to take their pictures. Then, thanks to the privilege of actually living under the sea, we discovered where the bumpfish stayed at night. Investigating grottoes in the reef, we came upon them sleeping singly or in pairs.

Holding the hypnotic flashlight in their eyes, we were able to examine them closely. They were a bright, flashing blue-green and orange in hue, but their teeth were covered with seaweed. We saw them emerge from caves in the morning and rub themselves vigorously against the sand to clean off parasites before moving off to graze. That accounted for their pristine bodies, but there was no natural toothbrush to demoss their teeth.

When we were in the caves with the bumpfish at night, we could feel their heads and

Protected against sharks by a cage vestibule, Claude Wesly, Albert Falco, and Gilbert Duhalde leave Starfish House. They go out to observe the reactions of fish to colors. Plankton clouds the lights.

Red coral shoots tongues of unquenched flame from the steel gears of an old wreck. A sea bass noses into clumps of coral. Ultraviolet rays spearing the reef at midnight triggered luminescence that altered and intensified the hues of day.

look into their mouths, but one touch on the tail sent them flying. One night Falco entered a bumpfish lair behind a big coral boulder and accidentally brushed the tail of an 80-pound specimen. The fish leaped past him and crashed head-on into the boulder. The coral, which must have weighed a ton and a half, overturned and rolled down the slope. The fish went on, apparently unhurt. Falco is convinced that if a diver had been in the way of the mad escape he would have been killed instantly.

Our divers have seen plenty of sea urchins in their years below, but they never dreamed

*For close-ups of the basket star, see "Photographing the Night Creatures of Alligator Reef," by Robert E. Schroeder, NATIONAL GEOGRAPHIC, January, 1964.



BACKGROUND: DRAWING BY ROBERT W. ADOWAN AND FORACTIONS BY DANIEL THOMAS, SCS. REUNING ASSOCIATES (C) W.D.T.



of the species they found one night near Conshelf Two—a large urchin with the usual mess of radial spines, but with the startling addition of a radarlike scanner on top. This appendage turned back and forth in what seemed to be a full circle, for all the world like the radar atop *Calypso's* mainmast.

Quite a few large triggerfish lived around the undersea hamlet. We saw the females lay grapelike clusters of pink eggs in hollows dug in the sand, then stand on their heads and blow streams of water on the eggs to oxygenate them. The male circled around protectively, prepared to strike at any intruder, be he shark or man.

We saw sharks turn tail and flee before an angry triggerfish, although the latter's teeth can deal no more than a peck to a shark or a painful nip to a man. Bernard Marcellin, Goupil, and myself were bitten to the blood by heroic males we blundered upon.

One of the most amazing creatures the divers found in Sha'ab Rūmi they dubbed the "bulldozer crab." It resembled a two-inch-long miniature lobster and spent its time shoving sand and coral around to construct homes and repair damages by intruders or currents.

Journal of a Modern Jules Verne

While Professor Vaissière kept the formal log of Conshelf Two, Vannoni, the meticulous ex-customs inspector, kept a rough, informal log—"What It Is Like to Live and Work Inside the Sea."

When he first popped his head up through the watery carpet in Starfish House, Vannoni had a "wonderful feeling of comfort and well-being" despite the "dreadful" heat and humidity. Indeed the accommodations were the best he had ever lived in—a cozy sitting room, delectable meals, a luxurious bed, and boon companions.

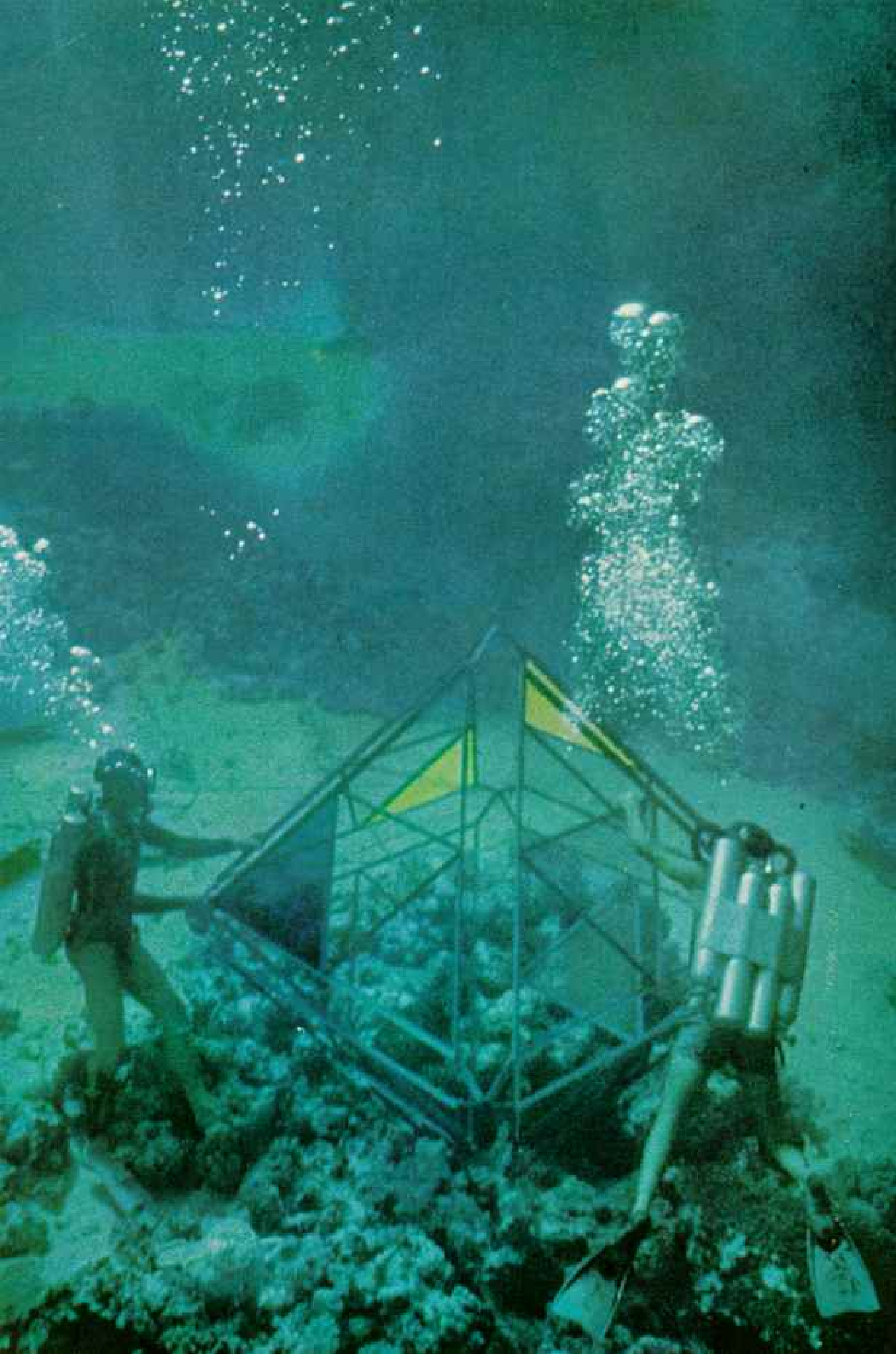
Of the work outside—the shifting of tons of lead ballast from the ballast rack to the large footplates of Starfish—Vannoni wrote: "In the water it is child's play to carry lead bars which would weigh a hundredweight on the surface. It is not long before we finish the

Divers Erect a Plastic-paneled Fish Pen in a Bubble-filled Wonderland

Captured specimens lived in the stockade till the biologist needed them. Many flew to Monaco's Aquarium in plastic bags of oxygenated sea water. Since they never left their element for an instant, few died.

REPRODUCED BY DANIEL TORRES, LEE BESSINE KASHNER © W.A.S.







job and return to the house fresh and well. But we do just a few light jobs, for we are still adapting to our new surroundings."

By the end of the first week of total submersion, Vannoni and his messmates had settled into "the usual daily chores"—such as setting up colored panels on the reef to see if fixed fauna and fish were attracted to certain hues; building Professor Vaissière's underwater aquariums; and scrubbing down the outside of the buildings. Vannoni noted that "the professor is becoming more dangerous day by day"—at chess. He wrote:

"June 21—We've been down for a week. I feel pretty well, but we've all had an earache in just one ear. Odd that it should be just one ear. I suspect the air ventilators which blow on our faces during the night. The doc [Bourde] is skeptical. But otherwise we're in pretty good form."

One morning, Vannoni wrote, he and Pierrot the cook were alone in Starfish House when "a triggerfish comes to look through the window into our living room. Guilbert torments him by holding a chicken leg against the glass. The fish bites at the window. We have a good laugh at the zoological textbook that claims the only way to study triggerfish is to kill them with depth charges or poison."

Submarine Pests Shun Bathless Diver

Vannoni looked forward to the night strolls in the coral mazes—"aesthetic orgies," he called them. The oceanauts went out in the dark, shrimping with hand nets. "Sorry we don't have an extra pair of eyes in the back of our heads." Once a barracuda swooped into the torchlights and seized a jack, which struggled desperately to free itself. "It disappears a moment later," wrote the diarist, "gulped down by the toss of the head and something like a yawn."

Always and everywhere in our liquid plantation we were surrounded by tiny beings—plankton—and were able to study them in situ, greatly enlarged with a movie camera devised by our research and development center in Marseille. One man would sweep a fine silk net through a fog of plankton and transfer living specimens to a clear plastic container the size of a matchbox. The container fits precisely into a theatrically lighted receptacle before the lens of the submarine cinecamera. The cameramen would then film in color the normal movements of wonderful life forms that dwell by the megatrillions in the world oceans.

Underwater people at Sha'ab Rūmi were



ILLUSTRATION BY ALBERT D. COONER © N.E.C.

Parrot and parrot fish refuse to fraternize through a window. Claude Wesley holds his namesake, whose duty it was to faint if the air grew noxious. Men trusted the bird more than all their warning gauges. Claude returned to the surface unharmed.

Blizzard of Small Fry Whirls Through a Coral Cavern

On the reef (opposite), fish stared and then swam away or drew near as the fancy took them. Innumerable kinds of coral scratched the divers' skin and enchanted their eyes. Crustaceans sat, crawled, swam, or bit. Microscopic plankton drifted like dust—a pasture for larger creatures. These fish flash past vinelike *Virgularia*, living animal colonies.

Undersea aquarium keeps specimens alive for Professor Vaissière's leisurely research.

ILLUSTRATION BY DANIEL TORRES. LIFE STUDIOS, BRUSSELS



In Deep Cabin's living quarters, André Portelatine telephones Starfish House and Raymond Kientzy takes notes. TV camera constantly surveys their activities. Within their sheet-metal capsule, the men lived for a week, breathing compressed air mixed with helium. Lacking air conditioning, they "perspired like fountains." Flipped "strolls" in the sea cooled them.

tormented by stings from almost invisible siphonophores—stringy colonies of gelatinous animals that suffused the water. These tiny pests are armed with a remarkable weapon. Coiled inside a single cell called a nematocyst is a hollow poison tube. When the nematocyst makes contact with an alien body, the tube uncoils and drives deep into the victim, discharging venom. Smaller prey are paralyzed or killed. Divers itch cruelly and often become infected.

The siphonophores concentrated on areas where our diving dress didn't protect us, especially on our ears. After a while, we noticed that one of the black-suited divers was never bothered. It developed that he, excusably enough in a place where every drop of fresh water was precious, did not wash too often. The natural wax in his ears protected him from stings. Some of his friends at once joined the water-conservation movement.

Wounds Heal Almost Overnight

The new life under the sea that is beginning to summon man will have a new hygiene. A fascinating avenue of medical research is opening in continental shelf stations. On shipboard, for example, in the burning miasma of Sha'ab Rûmi, ordinary cuts took as much as three weeks to heal. Below, in Starfish House, the same wounds disappeared in two days. Was this due to an excess of oxygen under doubled pressure, a difference in bacterial life, or what?

Vannoni noted in his journal: "Day by day we notice that our visitors are losing weight

Deep Cabin, Doors Lashed Open, Drops to Its Mooring 90 Feet Down

As the cabin descended, increasing pressure forced water high into the interior. To repel the tide inside, the divers emptied five bottles of the expensive helium carried on the outside. The cabin broke loose repeatedly before it was firmly anchored; once it carried two trapped divers to a ledge 140 feet below the surface (page 478).





and getting rings under their eyes. The effort demanded from everyone above is enormous. We follow all this from our sunken castle as powerless onlookers, rosy and plump, idle and pampered."

Arabs in dhows passing the dreaded Roman Reef at night must have counted their black coral prayer beads at the sight of the Conshelf expedition. A small diesel ship rode in an impregnable lagoon, throwing off the racket of generators and compressors. A white ship lay outside the lagoon, its crew working like galley slaves. Camera crews, toting apocalyptic floodlamps, lighted up the sea above and below, giving the whole scene a supernatural air.

Nobody worked harder than our electricians Bernard Marcellin, Jacques Roux, Pierre Servelo, and Louis Bidegant, who is called "P'tit Louis." They became so dazed with fatigue they made fun of it.

One morning Simone, the only woman among 45 men, wearing her most feminine sunsuit, encountered Bidegant in a narrow alleyway and *bonjour*-ed him cheerfully. The electrician squeezed past her with no reply.

"*Alors, P'tit Louis,*" said Simone in a hurt tone. He turned, deadpan. "Oh, pardon, Madame, I didn't recognize you."

Barracuda Becomes a Mascot

The black-suited servants shuttling back and forth between the ship and shelf became accustomed to a loiterer—a six-foot barracuda that hung under the midships rail ten feet down to receive chef Jacques Morgan's garbage. Falco named the scavenger "Jules" and said, "He's old and bitter, almost unable to make a living."

A visitor arrived from France and eagerly donned an Aqua-Lung. As he started down the ladder, Simone said, "Look out for Jules." The visitor put his faceplate under. Jules was yawning. The guest suddenly lost interest in diving.

Simone thereupon got her lung and conducted the visitor safely through Jules's territory.

Rosaldo's captain, Louis Sinagra, was rowing lazily one day over the outer rim of the lagoon when he noticed a pale ringlike form protruding from the shallow coral table under the boat. He reached in and felt the neck of an ancient amphora, or earthenware jar.

We excavated the jar from its coral bed and found it surrounded by shards of other amphorae. It closely resembled third-century

B.C. Rhodian cargo jars we had found in the ancient wreck at Grand Congloué.* The presence of these broken jars hinted at the wreck of a Hellenic ship on Sha'ab Rūmi. Was the reef itself misnamed for this wreck of two millenniums ago? If so, it is the only Hellenic shipwreck so far found in the Red Sea, and how it got there no one knows.

Depth Trial Begins 90 Feet Down

Ninety feet under stood our rocketlike Deep Cabin for two men (pages 500-501). It had two vertical rooms, the lower containing diving gear, tools, and the open sea hatch; the upper containing two bunks, kitchenette, intercom, phone, and a TV camera connected with the monitor in Starfish House.

The two men in the Deep Cabin were to breathe a recirculating mixture of air and helium—next-to-lightest gas in the atomic table. Many years ago U.S. experiments proved that helium would permit divers to go deeper than with ordinary compressed air. We intended to use a helium environment as a jumping-off base for deeper working dives with compressed-air Aqua-Lungs.

Our computations promised that the two men in the rocket could drop out of their bottom hatch and perform useful labor down to 165 feet, and that they could safely bring off short dives to 330 feet without too great a risk of nitrogen narcosis, or "rapture of the deep." We calculated conservatively that two men could spend a solid week in and out of the Deep Cabin.

I must here stress that we were not trying to break diving records, but simply testing, methodically and cautiously, the theory that a helium booster station could convey divers to deeper encampments on the continental shelf. The main point was to see if the deep men could work with clear brains in this stratum, and not be overcome by rapture of the deep.

The previous sinkings of the Deep Cabin did not daunt the two men who were to stay there a week. Raymond Kientzy, 33, is a splendid diver who has been ten years with our team. He is a robust, equable, reliable man. His companion was André Portelatine, 46, the volatile and highly accomplished director of the famous free-diving school at Nice, the *Aventure Sous-Marine*. Their first

*See "Fish Men Discover a 2,200-year-old Greek Ship," by Jacques-Yves Cousteau, NATIONAL GEOGRAPHIC, January, 1954.



Pressure Cookers Carry the Mail Between Deep Cabin and Surface

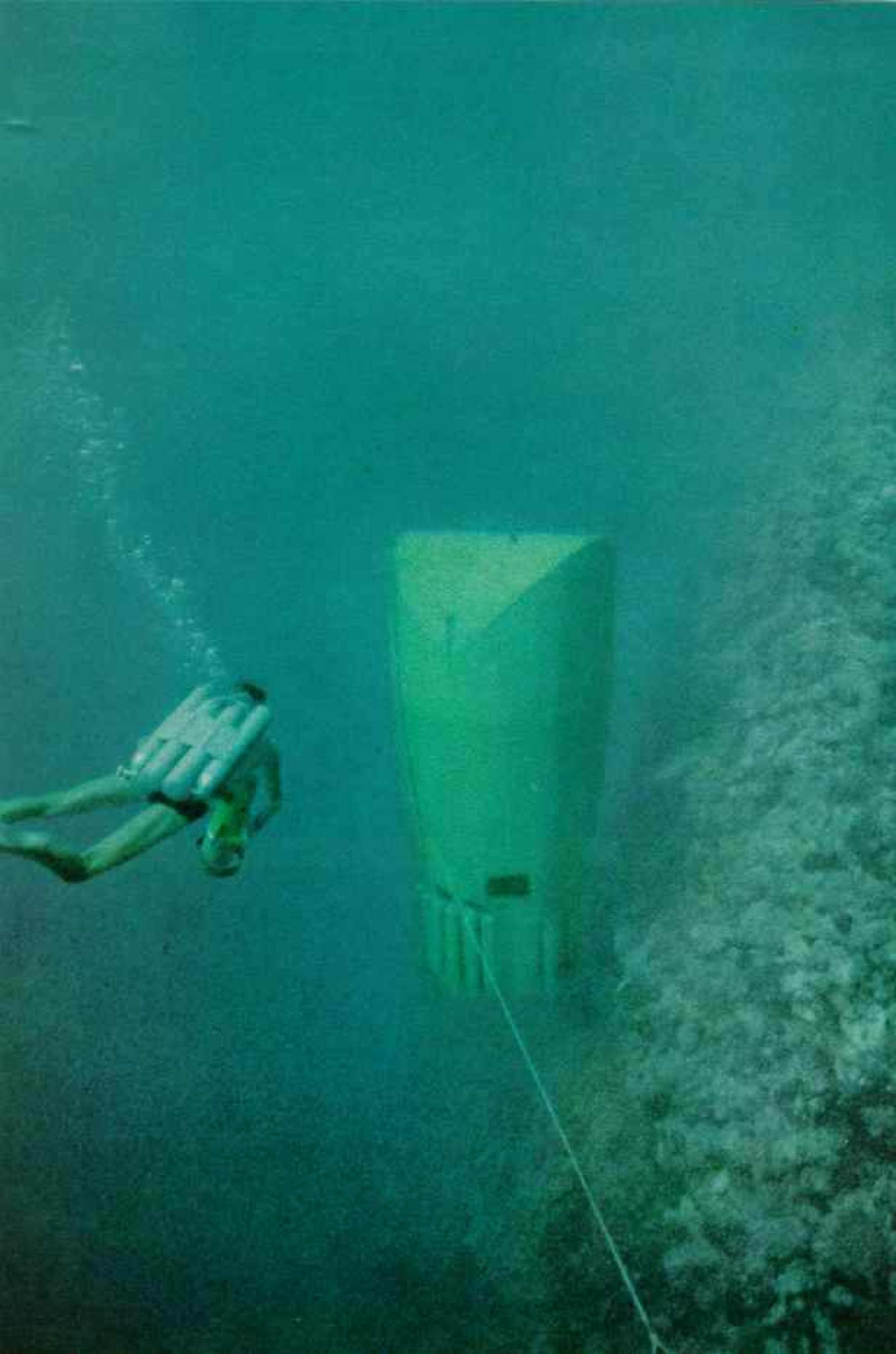
Nearly all supplies went down in sealed pots that kept pressure out rather than in. Hot food, letters, and even the parrot Claude made the trip under watertight cover. Here Christian Bonnici (left) and Raymond Coll return with empty dinner pails. They wear the dark suits of the surface team and carry shark billies. Deep Cabin fades into the blue.

After a day or two in the cabin, Kientey and Portelatine showed little interest in food and, despite the heat, seldom became thirsty.

Standing in Starfish's open hatch, half in, half out of water, Antonio Lopez demonstrates how air pressure keeps the water out. He arrives to cut the oceanauts' hair.

EXTERIOR © NATIONAL GEOGRAPHIC SOCIETY





hour in the Deep Cabin was a harbinger of the torments they were to meet.

The worst was the humidity. We had not provided air conditioning for the cabin, because we thought that the 90-foot depth would be in colder water below the thermocline. Also we had planned the expedition for March, when the Red Sea is nearly as cold as it ever gets. Now, it was July—hot July—and our thermocline data was wrong. The torture cabin was standing in water temperature of 86° F. with 100 percent humidity inside.

Deep Cabin Gear "Does Not March"

Kientzy was the diarist of the Deep Cabin. His first day's entry in "The Sauna," or Finnish bath, is datelined 5 July and notes, "*Le téléphone ne marche pas.*" Other things that did not march included the refrigerator and the emergency oxygen system, because of repeated flooding and reassembly.

The deep men dined lightly the first evening and turned in at 7:30. They tossed sleeplessly all night. Kientzy got up once and found water risen in the lower story—there was a leak somewhere.

On the second day Portelatine could eat no breakfast. Kientzy managed coffee and jelly bread before they went out in the sea. Portelatine had severe ear pains and had to return to the cabin, while his cellmate swam around. They lunched on tomato salad, turkey

Guy Lines Moor the Deep Cabin Against a Jagged Coral Escarpment

Tied in place, the big "rocket" broke its lines four times and plunged down the cliff. Each time narrow ledges stopped the cabin on its slide, the deepest at 140 feet. Finally it was anchored at 90 feet.

Cutaway shows the cabin during its week-long occupancy by two oceanauts. In their all-purpose room, less than seven feet across, Kientzy and Portelatine sit under a TV camera, which allows monitors in Starfish House to spot trouble instantly. Instrument panel shows carbon-dioxide and oxygen content of the air. Two bunks allow the men to rest in $3\frac{1}{2}$ atmospheres of pressure. By the wash basin, a trap door leads to the shower room, where Aqua-Lungs and diving suits hang. Open hatch drops directly into the flooded basement. Because inside and outside pressures neutralize each other, the cabin needs only thin metal walls.

ROBUSTHOOPS BY DANIEL FORMEL, LEE FEEDING ASSEMBLY,
AND PAINTING BY DAVID WELTZER © N.S.L.

(which Kientzy called "desert ostrich"), spinach, cheese, fruit, and wine. "*L'appétit marche bien,*" Kientzy noted.

That night Portelatine slept a little and Kientzy was out for eight hours. They perspired incredibly. I visited them and was appalled at the Finnish-bath environment. I promised to send down some cakes of ice.

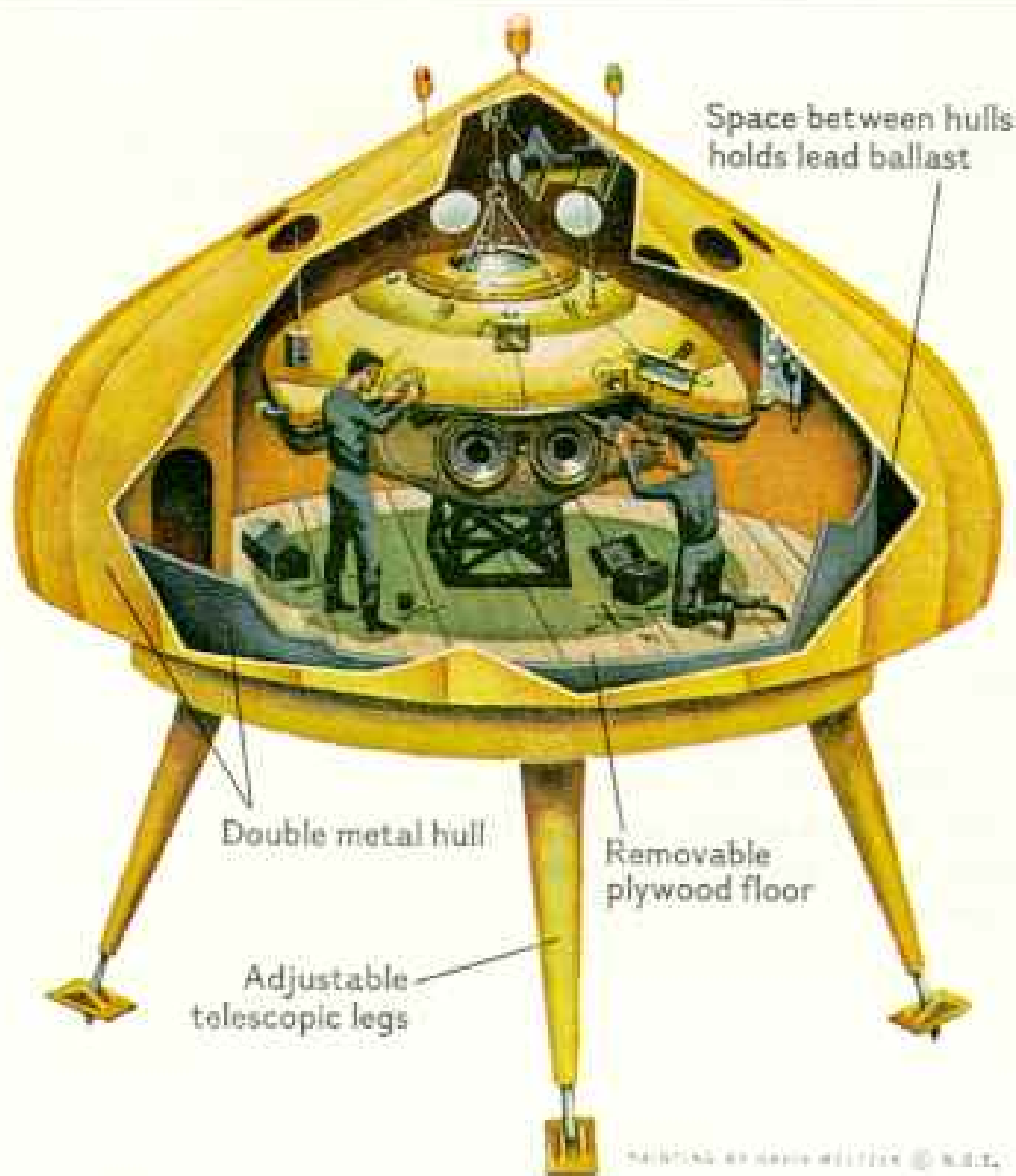
Dr. Bourde, who was making daily visits to the pair, reported generally good reactions. Their health was not in danger, although the Deep Cabin was a supreme trial of well-being.

The third night was the worst thus far. Kientzy said they "perspired like fountains." Several times he went out for strolls to cool off. He saw a pair of sharks that had been hanging around the rocket. He played his flashlight on them.

"Their eyes were brilliant in the night, like cats' eyes," Kientzy noted.

The next day the deep men went down to 175 feet, to a dim forest of black coral that grew at the foot of their cliff perch. There





Like an oyster in its shell, the diving saucer hangs from the garage roof for servicing. Pedestal keeps her from swaying. Folding floor covers the open water through which she enters and emerges. Trials in the Red Sea amply proved the feasibility of hidden undersea pens for submarines.

Dropped through the hangar floor, *DS-2* pivots for a run. Sensitive maneuvering takes the sub through coral grottoes.

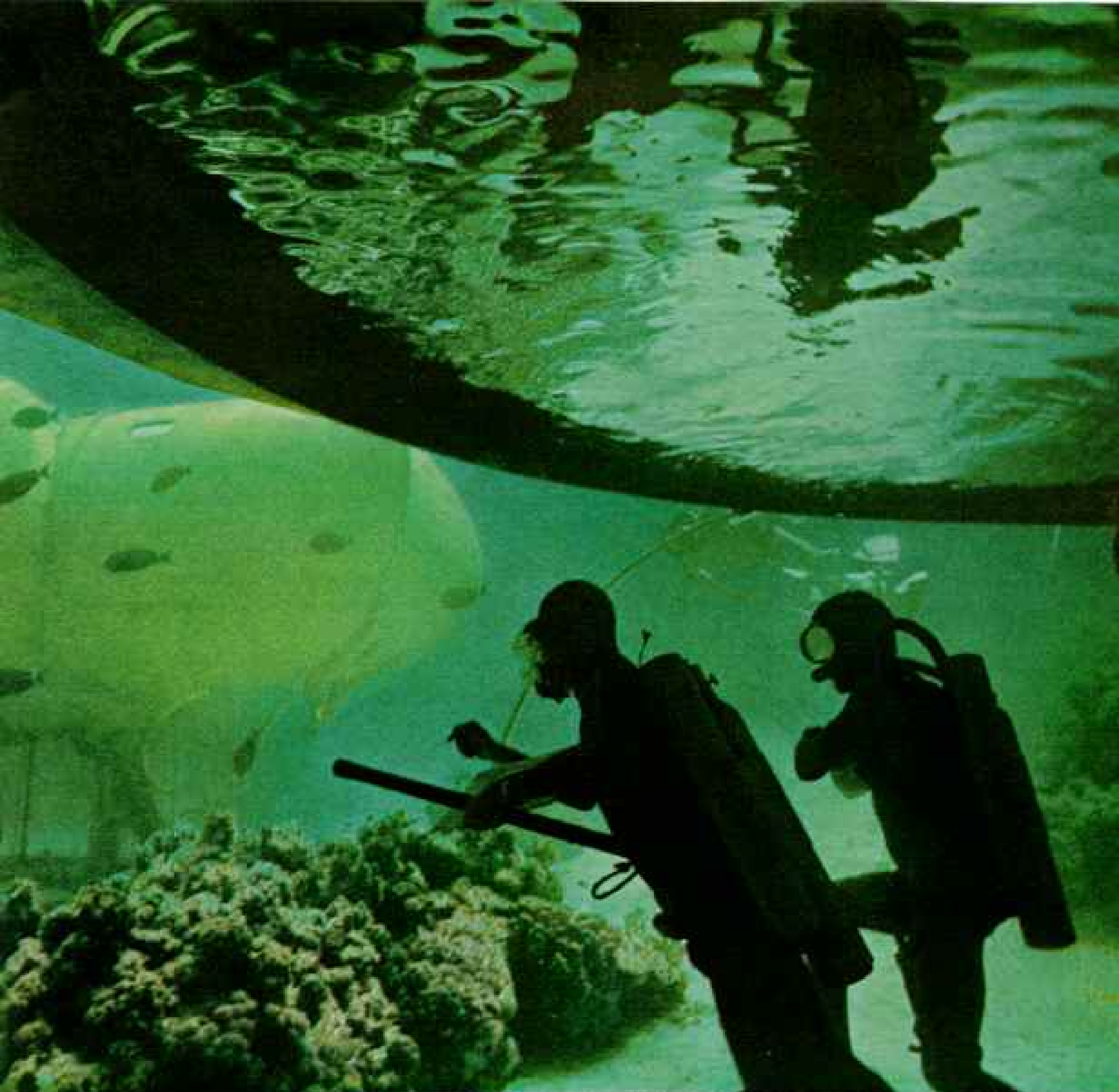


Divers drop out of *DS-2*'s hangar

they peered at another drop-off extending down, how far they could not tell. Despite his constant ear pain, Portelatine was as determined as Kientzy to attain the depth they had planned together, 330 feet.

They were seldom hungry or thirsty and forced themselves to eat and drink. Portelatine suddenly hated the taste of coffee. Kientzy forswore his beloved pipe because they were living in a recirculating breathing system that could not eliminate smoke.

A big laugh came whenever the controller in Starfish House spoke on the intercom with men in the Deep



PHOTOGRAPHS BY DANIEL TORRES, LEE FORDINE, AND OLIVER © NATIONAL GEOGRAPHIC SOCIETY

for a sortie in the blood-warm sea. Their images writhe overhead where water meets air.

Cabin. Helium has a hilarious effect on the human voice. The gas is so light that it cannot fully resonate the vocal cords, and the most manly male produces a high-pitched twitter.

I tape-recorded reports from Sha'ab Rûmi for French radio during the expedition and airmailed them home. Later I heard what happened in Paris when one of the "helium" tapes went on the air. The sound engineers heard a normal voice answered by soprano chirps. They stopped the machine, and the announcer apologized for the "technical difficulty." The sound men reasoned that the tape operator had accidentally speeded up when recording, so they slowed the tape. This time my voice went into a horrible, cavernous

drawl, and the reply from Deep Cabin was like nothing ever heard on land or sea.

The fourth night in the Deep Cabin was another bad one for the almost sleepless Portelatine, and in the morning they found the water once more rising in the rocket. Kientzy wrestled a bottle of helium off the outside rack and released the gas in the chamber, pushing the water back down with the added pressure. The mysterious leak persistently threatened to flood them in their sleep, although there would still be enough air compressed into a pocket in the nose cone to give them time to arrange escape.

Kientzy's terse narrative for the fifth day mentions a temperature of 89° F., humidity unknown (the hygrometer did not march).

"The water continues to rise in our house," he noted. "André slept a little and I did, too. *Tout va bien* [All goes well]."

Electrician Pierre Servelo, who had once been trapped in the rocket, came up with a theory about the leaks. "Is it possible that helium is seeping into the television cable and escaping through it to the surface?" he asked.

I had a strong inner seal put on the stuffing box. Servelo had the answer: The TV cable had been merrily conducting the superbuoyant helium to freedom in the world above.

During the week of the Deep Cabin trials, the men in Starfish House were completing their month underwater. Aboard *Calypso* Simone announced to me in tones that implied argument-will-get-you-nowhere, "I am going down to see them."

I said, "I'll have Davso go with you."

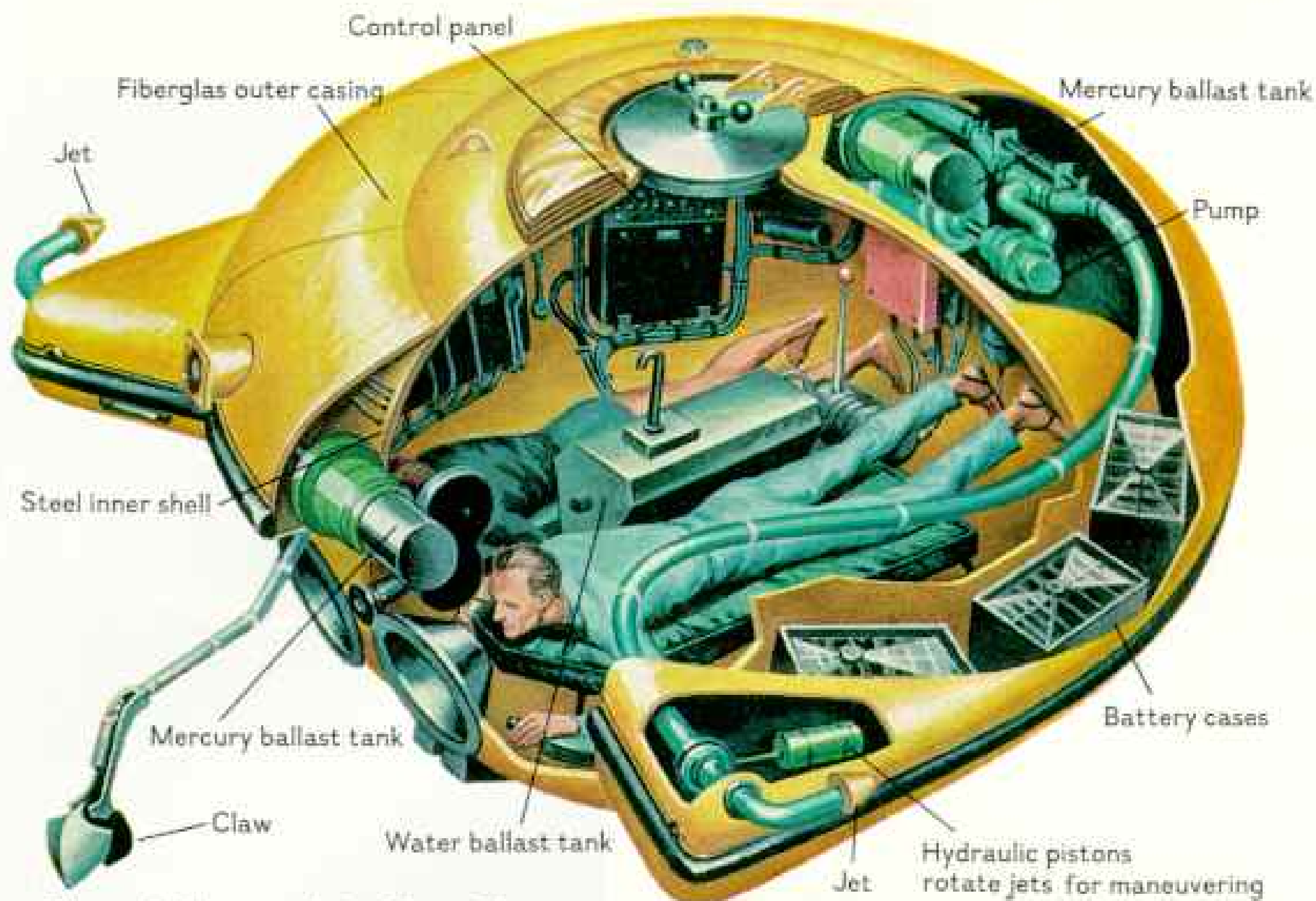
Before the mechanic could charge his bot-

ties, she was down the ladder. The lady who came for supper at Starfish House enjoyed the evening illuminations. Quietly two of the inhabitants evacuated a bedroom and doubled up with others so she could stay overnight. It turned into quite a visit. Simone might not be up yet, except that the fifth day was the close of the project.

Simone's subaqueous sojourn included our 26th wedding anniversary. I was invited down for the occasion. The champagne was terribly flat—doubled pressure tended to keep the bubbles imprisoned in the wine.

On the fifth day, the men in the Deep Cabin swam down through changing visibility and contradictory currents to the black coral copse and reconnoitered the region they would visit on the climactic 330-foot dive. Below, said Kientzy, "the water was crystalline and unmoving. I was near to vertigo."





Pilot and Observer, Lying Prone, Peer Out of the Diving Saucer's Ports

For motive power, pumps deliver sea water to jets. Pilot steers by turning the jets or by stopping the flow to one of them. Tank between the men holds water ballast for attaining zero weight in the sea. Mercury ballast pumped fore or aft cants the craft down or up. Batteries and pump lie in the water-filled section between the steel inner hull and the outer casing. Mechanical claw shears specimens off the bottom and drops them into a basket under *DS-2's* hull.

ILLUSTRATION BY DAVID BELTZER © NATIONAL GEOGRAPHIC SOCIETY

A thousand feet down, a squat lobster waves defensive claws at a four-inch crab.

ILLUSTRATION COLOR BY LEO ROSSIGNOL ASSOCIATES



They returned to the Deep Cabin, confident they could make 330 feet.

It was a good day. Portelatine's ears felt better. A moray snatched a plastic bag of lunch leftovers out of Kientzy's hand and swallowed it, plastic and all. For the first time both men were able to enjoy a siesta.

"The surface world interests us only because of our friends up there," wrote Kientzy. "The rest, the world, France, we do not think of. What day is it? I think it is the fifth day we have been here. It is of no importance."

After the nap, the pair went down again and reached a sandy slope at a depth of 250 feet—only 80 feet short of their goal. Hundreds of little eels stood on their tails in the sand, their bodies arched into question marks. When the men got within six feet of them, they vanished into the floor.

The sixth day was the one planned for the Aqua-Lung dive to 330 feet, a depth much too hazardous for compressed-air dives from the surface. However, dwellers in undersea stations could, we reckoned, attain the depth with clear heads and perform useful work there. Our calculations proved right.

Kientzy and Portelatine drilled down through the lambent depths to 300 feet. There, looming below, stretched the ribbony coral shelf, the "Andean highway" that we had discovered with the diving saucer. The deep men looked over the edge of the shelf; below 325 feet the cliff fell straight down.

Owl-eyed ports staring, the diving saucer meets a silver-garbed oceanaut, who extends his shark billy in salute. On a pressure test in the Mediterranean in 1957, the unmanned hull of Captain Cousteau's first saucer broke a cable and sank in 3,300 feet of water. Echo soundings show she still hangs there, uncrushed, 50 feet above the bottom, tugging at her ballast cable.

At this depth the divers were breathing 11 times the volume of air that they would on the surface, and even their four-tank Aqua-Lungs were quickly becoming exhausted. They shot up to Deep Cabin. They had not experienced rapture of the deep—nitrogen narcosis—despite the extreme depth. In the log Kientzy entered 330 feet as their greatest depth. Not until a week later did he confess to me that they had actually gone to 363 feet.

In the forenoon of their seventh day, Kientzy and Portelatine went out for their last swim, while black-suited divers rigged special gas masks over their bunks in the Deep Cabin to prepare them for a safe ascent to Starfish House. The pair put on the masks and breathed a mixture of 50 percent oxygen and 50 percent nitrogen for three and a half hours. This reduced the helium saturation in their bodies to a safe level. When Kientzy stuck his grinning face through the wet carpet in Starfish House, Wesley stuck a lighted pipe in his mouth.

Diarist Vannoni in Starfish House wrote: "Our stay draws to a close. Honestly, we don't think of our return to the surface as a relief. To continue our experiment further beyond the limits planned would not be difficult, but would prove nothing beyond what has been shown already."

In order to give the deep men room for an overnight stay to pass off gases, Vannoni and André Folco surfaced after 29 days below. The other three stayed until the 31st day, then breathed a mixture of 80 percent oxygen and 20 percent nitrogen—inverse proportions of these gases in the atmosphere—for 15 minutes. They took 15 minutes off, then a half hour back on, a half hour off and an hour on, and they were ready to go.

The last silver helmet passed through the blue floor, and they swam up to the roseate blaze in which other people live.

The manned undersea research station is a revelation to oceanography. Ocean scientists of the past like Prof. Henri Milne-Edwards of the Sorbonne, the first biologist to dive—in a clumsy and dangerous bucket helmet in 1844—would turn sea-green with



envy over our Professor Vaissière's privilege of spending a lordly month in the fishes' habitat with his own collecting staff, underwater cameras, stock pens, and field laboratory.

The Red Sea demonstration was especially interesting to the petroleum industry because of its offshore operations. Indeed, the main sponsor of Conshelf Two was Bureau de Recherches de Pétrole, the French national petroleum office. We believe that placing

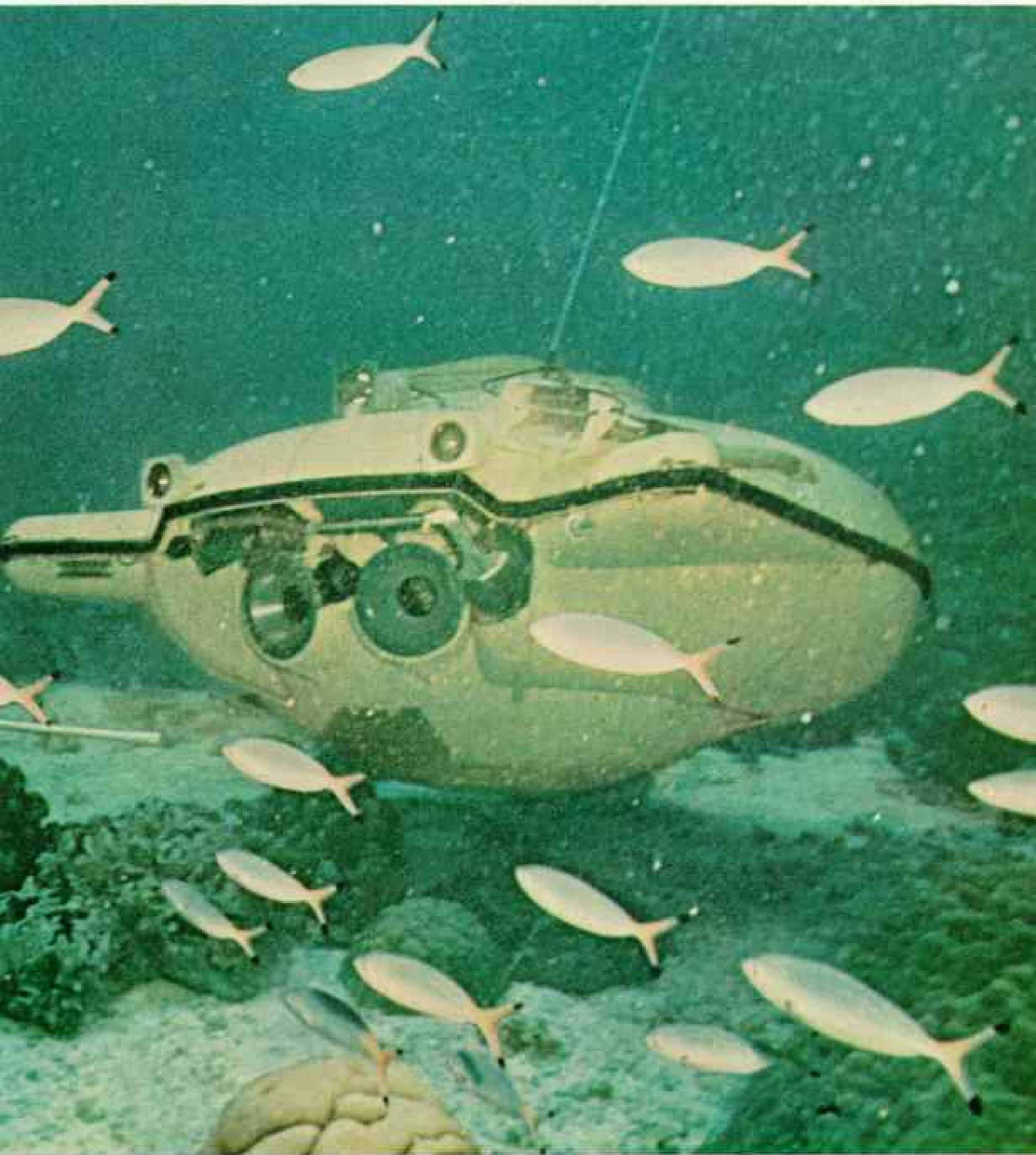


ILLUSTRATION BY DANIEL FORD. LEE NEZUMI. REEFLIFE © NATIONAL GEOGRAPHIC SOCIETY

marine oil wells and their personnel on the sea floor will be cheaper and safer than maintaining offshore drilling platforms. Professor Vaissière is confident that his oceanographic colleagues all around the world will sooner or later demand ocean-bottom laboratories.

Military applications of manned undersea stations include antisubmarine warning installations, coastal defenses, and submerged bunkering stations for submarines.

Conshelf One and Conshelf Two have convinced our underwater team that industrial and scientific sea-bed stations will become a routine thing in our lifetime.

A hundred practical applications will undoubtedly be found for submerged stations. Yet for us the greatest reward for the toil at the Roman Reef was none of these, but the ever-enchanting realization that we were living inside the sea.

THE END

EMPRESS OF THE HEARTH-SIDE, affectionate aristocrat – the family cat. This household has two, a Calico mother and her kitten, whose enlarged pupils show that it has just come from a darkened room. A knowing writer and a noted photographer here explore the winning ways of

The Cats in Our



Lives

By ADOLPH SUEHSDORF

Photographs by WALTER CHANDOHA



THE LADY WORE A SUNSUIT, wedgies, and a bemused expression. On impulse she had interrupted her stroll along Asbury Park's boardwalk, paid a dollar, and entered Convention Hall to see a big-league cat show. As it happened, she was seeing one of the biggest and best—a double show run by the Garden State and the Sand & Surf cat clubs of New Jersey.

Now, uncertain but curious, she watched Champion Ronnvikens Tutankhamon, a striking Abyssinian, pacing his wire cage with metronomic intensity.

"What kind of a cat is *that*?" she asked in a tone that said Tut wasn't a cat at all.

"Aby, ma'am," said the breeder-exhibitor standing nearby. "An Abyssinian."

"Well, what do you know about that," said the lady, polite but not persuaded. She moved on.

At a discreet distance, I followed the lady past the exhibition cages, and now watched her waver between astonishment and disbelief at the sight of Burmese, Manx, Lilac Point Siamese, and other exotic breeds, until, in time, she reached a purebred Black Domestic Shorthair.

"I know what *that* is," she said happily to another bystander. "That's just alley cat!"

The breeder, who had not achieved an admirably formed, glossy-coated, pure-black show cat without some effort and expense, protested mildly that "alley" was hardly the word. But the lady wouldn't be put off. Amid 256 odd and alien creatures masquerading as felines, she'd finally found a real cat.

This little incident tells a lot about the state of the cat

ENTERTAINMENT WEEKLY AND EQUUS MAGAZINE © R. A. J.



Determined mother, wise in the ways of kittens, brings a runaway back to the fold (left). This Domestic Shorthair carries her young by the scruff of the neck, a method that reduces the lively offspring to a quiet ball of fur. She makes a superior mother. Although solicitous and tender with her blind newborns, she wastes no time in letting them know who is boss and teaches them in their first weeks all they must know for adulthood.

Fitting her basket like a hand in a mitten, a relaxed mother serves dinner to her kits. Usually the Domestic Shorthair gives birth in a dark and secret place of her own choosing.





HE EGYPTIAN CAT AND PERSIAN BY WALTER CHANDLER © NATIONAL GEOGRAPHIC SOCIETY

512



world today. First, there is a vast upsurge of interest in cats. Ten years ago our lady very likely would have continued down the boardwalk in search of salt-water taffy without giving a cat show a second thought. Even today she is not an aficionado—but give her time.

Secondly, people are discovering that the common, ordinary, everyday pussycat has some spectacular and aristocratic relatives. There is a fascinating variety of breeds and an extraordinary and increasing range of shapes, colors, and temperaments.

Feline Population Skyrockets

Acting together, these two factors have produced a new boom in cat popularity and population. "The fancy" (made up of exhibitors, devotees, and professional breeders) detected the first stirrings about 1953 or 1954, but the full impact has been felt in the past four years. The result has been feverish activity in the cat markets of America.

Consider these statistics: The Cat Fanciers' Association, the largest of six national organizations of cat clubs, breeders, cattery owners, and individual exhibitors in the United States, reports that it is registering pedigreed cats at the rate of 10,000 a year. During all the years from 1900 to 1957, the C.F.A. had registered only 100,000 cats. From 1957 to the present it has added 60,000 more.

In New York City, pedigreed Siamese cats are reportedly outselling poodles, currently the most popular dog, three to one. This means 750 Siamese cats per month.

The upswing is not confined to the well-bred cat. A 1961 national cat census, conducted by the Pet Food Institute, found an estimated total of nearly 22 million family-owned cats. About one American family in every four was in possession of, or possessed by, one or more cats. These figures don't count farm cats and strays, several million strong.

Though such statistics must be taken with



"Curiosity killed the cat," an old saying, merely exaggerates the natural curiosity demonstrated by the pair at the window. Some are more curious than others, as T. S. Eliot indicated when he wrote: "Cats are much like you and me and other people whom we find possessed of various types of mind."

Like a Pied Piper, Hank Chandoha, the photographer's son, uses the promise of a feast to lure his troupe on a New Jersey farm. Though the cat lives peaceably enough with other cats, she reserves true friendship for man—but only on her own terms, as Swinburne recognized in addressing his cat: "Stately, kindly, lordly friend, condescend here to sit by me."

Streaking through autumn leaves, a kitten shows a burst of speed. But running is not its specialty. The cat hunts by stalking her prey, then attacking with a lightning pounce.

513



a grain of catnip, it is undeniable that the cat is in an ascendant phase. In our ever more densely populated suburban areas, apartment living is the choice—or fate—of millions of our citizens. And those who want a pet to live with are finding cats to be ideal apartment dwellers. The cat is neat, clean, odorless, easily housebroken, an amusing companion, inexpensive to maintain, and small enough to fit nicely in a four-room flat. Moreover, many apartments have restrictions against dogs.

Status Cats Unaware of Status

Fancy cats, too, are becoming status symbols. Chic and rather clever it is to have a cat—the rarer the breed the better. Anyone, however, who has purchased a Burmese, an Abyssinian, or a Siamese, thinking he has simply acquired another figurine for the breakfront to impress his friends, will soon descend to earth. Cats may be self-sufficient, but they have never heard of fashion, and they expect to be one of the family.

My own cat, a 15-year-old Domestic Shorthair that rejoices in the name of Kitty, is a case in point. Whenever ice cream is served at our house, Kitty gets a dab of vanilla. Not all cat dietitians would approve, but there it is.

One evening, Kitty trailed me to the kitchen, discussing the virtues of ice cream while I served the portions. I placed her dish in her accustomed eating place and took the family's into the study, where we were watching the

11 o'clock news. Kitty snooted her ice cream and joined us in the study, complaining.

My wife, who is quick at this sort of thing, said, "It's simple. She wants to eat with us."

And so she did. The scorned ice cream in the kitchen became delicious ice cream in the study, where we could all eat together.

This gets close to the heart of the matter. Whatever the ebb or flow of man's capricious feelings about cats, cats are pretty consistent. All felines share certain inherent qualities of being cat.

Generally, they have an independent turn of mind. This does not mean being aloof and unfriendly; actually, they are quite dependent on the people close to them for play, conversation, and affection. Breeders and vets claim that cats separated from their families for more than a month may go into a psychological and physical decline. Not always and not all cats, but it happens in enough cases to indicate that the "independent" cat is capable of strong feelings and attachments.

Independence does indeed assert itself in matters of obedience. Obedient the cat is not. Within limits, a cat may be trained to do her owner's bidding. For instance, there is a Siamese that knows and responds to commands of "Sit," "Heel," "Stay," and "Come." Pretty good for a cat. But the owner confesses that the cat will obey only when it pleases her. Another cat will roll over on the floor on command. The command, however, is not "Roll



All-purpose tongue serves kitty as a spoon when drinking milk. He takes four or five laps before swallowing. Minute hook-shaped papillae cover the tongue's upper surface, giving the cat a rasp for licking meat or cleaning fur. "His tongue is sponge, and brush, and towel, and curry-comb," wrote the French philosopher Hippolyte Taine. "Poor little washrag."

Cleanup time after lunch finds tongues still hard at work. Exceptionally fastidious, the cat spends much of her time bathing. Her body is so flexible that the tongue can reach almost everywhere except head, neck, and spine; some awkward areas are tended by a dampened paw. Paul Gallico, in *The Abandoned*, relates how Jennie, a cat, teaches Peter, a boy-turned-cat, how to behave in proper feline fashion. Drilling him in war games between cats, Jennie advises her pupil, "When in doubt—wash."





over," but "Chicken!"—which is what she gets on successful completion of her trick. A response to authority—or simply to appetite?

The final word on this subject, I think, was by a youngster (quoted in the *New York Times*) who said of his cat: "Its name is Jingles. We more often call it Pussy. And anyhow, it doesn't come if we call it Jingles."

The things a cat *does* do all seem to be in the furtherance of her own comfort and well-being. And the idea of doing them must be her own. No cat I've ever had, or heard of, performed a task for human benefit. My Kitty, however, figured out a simple bar latch on an attic door to enable her to enter or depart at her convenience. And I have heard of an even more accomplished cat who announces her presence by leaping up, hooking one paw through the front door handle, and using the other to bang the door knocker!

Is this intelligence? Well, some cats are smarter than others, to be sure, although as a group they seem to fit somewhere in the middle ground of the world of mammals. Intelligence usually means testing the ability to learn, and this inevitably raises the question, "Learn what?" Cat loyalists insist that any fool Tom or Tabby could thread a maze or

punch a button to flash a light, but seeing no good reason to do so, doesn't.

I think cats, like people, prefer to live harmoniously and will learn and execute whatever they must to keep life on an even keel. This is not all a one-way street, of course. A wise lady who has run a cattery for many years said to me recently, "Remember, the kind of household you have will go far toward determining the kind of cat you have." Cats occasionally are wrongheaded and persistent about having their own way, but at heart they are well mannered, dislike tumult, and accommodate easily to an orderly regime.

Cats That Tell Right From Wrong

Some cats can even distinguish between good and bad in their own behavior. A veterinarian told me that if she suspects that either of her Siamese has been up to mischief, she simply says, "Hey, you!" in a loud, accusing voice. The good cat pays no attention. The cat who's been clawing at the furniture or nipping at the roast scoots for safety under a bed. It never fails.

On occasion, cats will even keep each other in line. Mars is a sober, responsible cat. Neptune is flighty. One day Neppie became excited and unnerved while having her claws clipped and lashed out, scratching her mistress. The lady cried out, the cat leaped off her lap and ran into another room. Whereupon Mars went after Neptune to talk some sense into her. He scolded and threatened until Neptune abandoned her retreat, returned to the lap, and let the clipping continue!

So much for the feline personality. Now for

The Author: Adolph Suedsdorf, editor of the Ridge Press in New York City, works "on the other side of his desk" as a writer on such diverse topics as psychoanalysis, the stock market, and cats. **The Photographer:** Walter Chandoha, of Annandale, New Jersey, one of America's most respected animal photographers, is renowned for his cat portraits. The two men first collaborated in producing *The Complete Book of Cats* in 1956.



WALTER CHAMBERS

Caught in ambush by a mirrored adversary, a Blue Domestic kitten goes to war. Facing up to a fearsome opponent (far left), he flies into the fray, claws bared. He pounces, all paws off the floor, and notes that the enemy is doing the same thing. Paws boxing and ears tucked back, the warrior moves in for the kill (below). Now where did that tiger go?

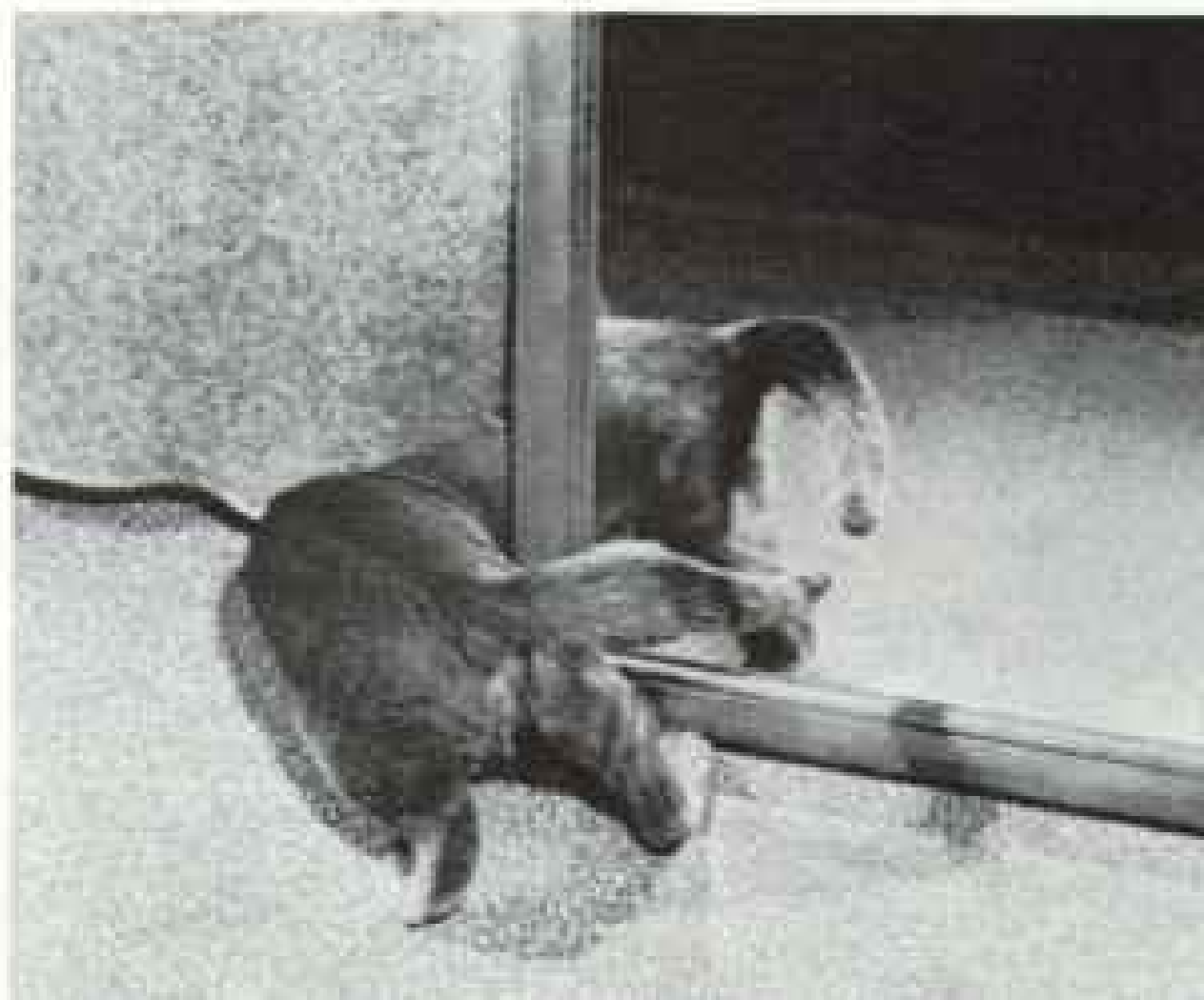
Mastery of such acrobatics, developed in the games of kittenhood, makes the cat a superb hunter.

a few categorical cat facts. It is *not* true that one year in the life of a cat is the equivalent of seven human years. A 10-year-old cat and a 70-year-old person might be said to have traveled a similar distance down life's road, but at no other milestone does the ratio have much relevance. Eight-month-old cats bear young far more frequently than five-year-old people, and truly ancient cats—more than twenty years—are certainly more common than senior citizens of 140.

The legendary "nine lives" of cats perhaps was a fancy that paid tribute to the mistreatment these remarkable animals can absorb and still survive. Nevertheless, the life expectancy of cats *is* increasing. Twelve years is still quoted as the average, but my hunch is that this figure trails the facts. Certainly 15 years is not unusual any more, and animal hospitals will tell you they are encountering many more 19- and 20-year-olds among their patients these days. (The oldest cat I've ever heard of, incidentally, was 27.)

Growing Old on Pizza and Olives

Some cats, it seems safe to say, are living longer because they are eating better. Research in this area, however, has been conducted entirely without aid from cats, who will eat anything. The list of things cats are not supposed to like, but do, is endless. In the case of one cat I know it includes pizza, peanut butter, mushroom soup, cookies, olives, and Münster cheese. Since this feline gourmet is now approaching 112—on the one-to-seven cat-to-human scale—it is hard to argue her dietary deficiencies.



Nonetheless, a really sensible diet would strike all of these prefabricated choices in favor of raw innards, such as beef kidney, or chicken or beef heart; raw chicken necks or backs; cooked and boned fish; an egg yolk every other day, and all the water the animal cares to drink. Plus, to be sure, a mineral-vitamin supplement in powder or liquid form.

Milk has many essential food elements, but it is not as good for a cat as any of the items noted above.

Starving a cat does *not* make her a better mouser. Mousing is as natural to cats as making money is to people. The cat does not need stimulation or encouragement; even well fed, she operates as a keen and successful hunter. This is why keen and successful money men are known as "fat cats."

Fat cats of the feline variety are overfed

Back arched, fur fluffed, a wary kitten presents a formidable aspect to would-be friends. Sidling movement adds to the illusion of size, as tensed muscle fibers in the skin raise each hair.

cats. Scrawny ones are underfed. Feed your pet enough to keep her lithe, agile, firmly muscled, bright-eyed, and lively. Weight, as such, is not much of a guide. A Siamese in fine fettle may weigh no more than five pounds, a Burmese or a Domestic Shorthair nine to twelve pounds.

Hunting Instinct Calls for Sprint Speed

A cat can see in dim light better than you can. Her hearing is probably also more acute. And she can run faster and more elusively than you can for perhaps a hundred feet. As far as I can discover, *Felis catus* has no staying power. She couldn't possibly stay on the track of a rabbit or a squirrel. A spurt, a small turn of speed to get her up the nearest tree or fence post is the best she can do.

Cats will stalk and kill birds. The impulse is inherent. If this offends you, get a different pet, for cats will never understand why they shouldn't stalk and kill birds.

It is very easy to stare down a cat. Their gaze is not unwavering. While it lasts, it is a fairly cool appraisal, but it shouldn't make you feel guilty. As far as we can tell, by the way, cats are color blind.

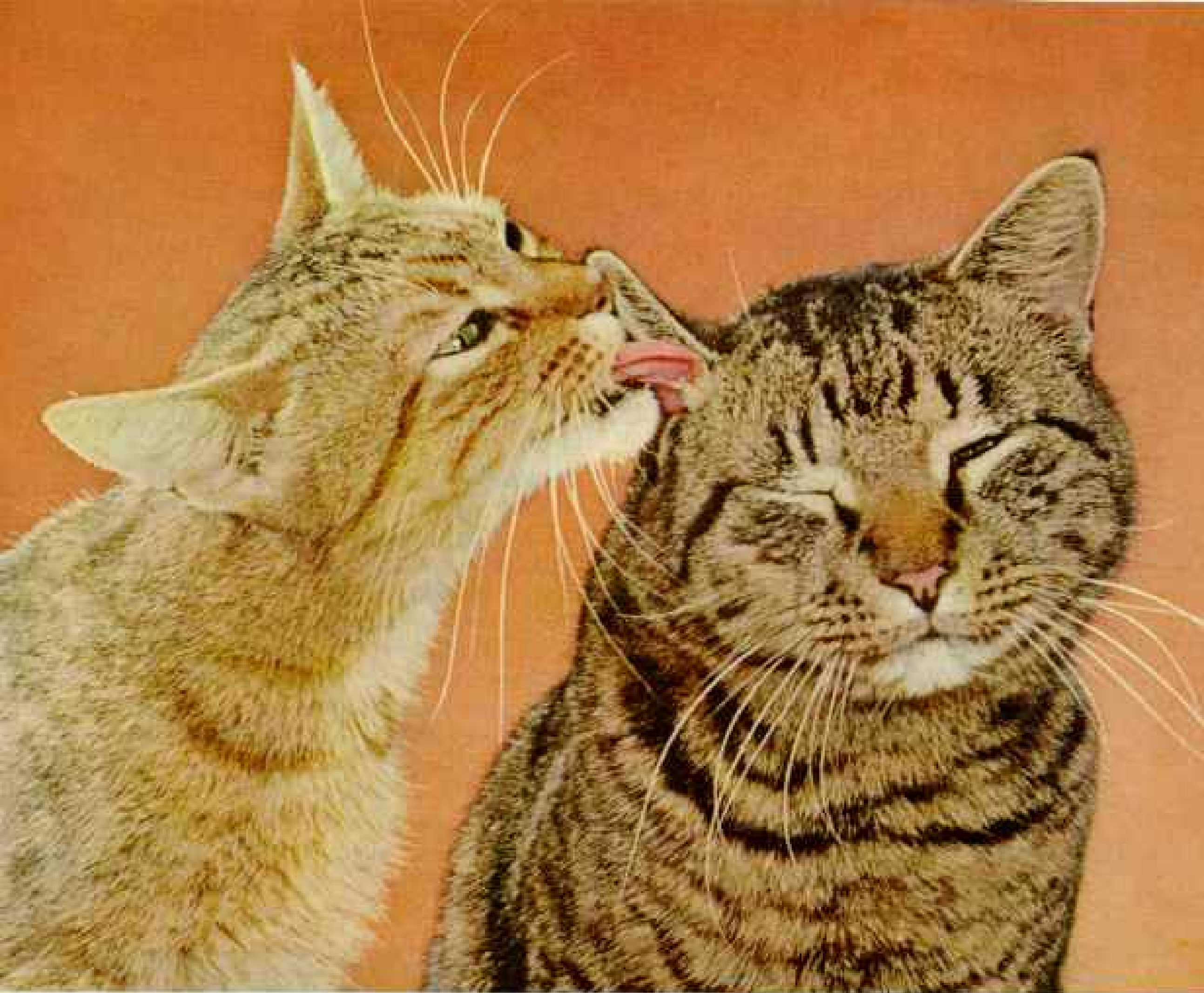
Cats do not engage in witchcraft in areas where people do not believe in witches.

Talking in specifics now about today's favorite cats, it should be understood that, with few exceptions, none of the breeds are really new. The first Siamese, for instance, seems to have been imported to the United States in the 1890's; one was exhibited at a cat show as early as 1902.

The Boston Cat Club had a show in 1907 at which Abyssinians, Manx, and Russian Blues were on display. (Boston also had the jolly notion, in the thirties, of a joint cat-and-mouse show. Fifty mice were entered, and one was awarded a blue ribbon as "Best Mouse.")

The Persians have been with us a long time, too, perhaps since 1880, certainly since 1895 when the best cat at the first





PHOTOGRAPHS BY WALTER LANGRISH © NATIONAL GEOGRAPHIC SOCIETY

Lick of love provokes a look of bliss. Although usually bestowed in affection, the lick bespeaks the manners required of a cat joining another in a preferred spot, such as a warm ledge.

Sitting in solitude, a tom calls to mind Kipling's lines, "I am the Cat who walks by himself, and all places are alike to me." Appreciating the cat's independent nature, Adlai Stevenson, when Governor of Illinois, vetoed a cat-control measure, writing: "It is in the nature of cats to do a certain amount of unescorted roaming. . . . Cats perform useful service. . . in combating rodents—work they necessarily perform alone and without regard for property lines. We are all interested in protecting certain varieties of birds. . . [but] the problem of cat versus bird is as old as time. If we attempt to resolve it by legislation, who knows but what we may be called upon to take sides as well in the age-old problems of dog versus cat, bird versus bird, or even bird versus worm."



Madison Square Garden show was a Brown Tabby neuter. To be sure, in the Longhair class new coat colors have been introduced. But only a few breeds, such as the Burmese, a development of the past thirty years, and the Himalayan, recognized by the C.F.A. in 1957, are legitimately new.

This is not to say that we simply are seeing a re-emergence of the same old cats. Cats, by all quality standards, are better than ever. Today's specimens are the beneficiaries of better diet, better breeding, and better veterinary medicine. They are sounder and healthier, and more of them approximate ever more closely the ideal show standards.

"Alley Cats" Dominate Feline Census

The Domestic Shorthair, the familiar and well-loved family cat, makes up the overwhelming majority of our feline citizenry. These are the salt-of-the-earth cats that live their lives among us, engaged in their immemorial task of ridding the earth of vermin and of producing kittens to carry on the job. These are the cats with endlessly varied coat colors and patterns, few of which are show standards and all of which are the haphazard result of marrying strictly for love.

This common breed of cat (but who would call his own pet ordinary?) traces its lineage, as far as we know, back to the sacred cat of Egypt. The resemblance to the ancient strain was lost, however, after cats spread to Europe about 700-600 B.C., perhaps in the ships of Phoenician traders, and mated with the European wildcat (*Felis silvestris*). The new breed flourished, and domesticated cats began to settle at man's hearthside.

The remains of cats have been unearthed at the sites of Roman villas in England, and there is documentary evidence of cats in Scotland and the Netherlands by the fifth century A.D., in Saxony and Wales by the ninth. (Cats of course moved eastward as well, and were known in China and Japan in ancient times, but information is fragmentary on this migration and on possible native cats of the Orient.)

These, then, the durable hangers-on of man in migration to fill up his world, became the cats of history, the cats of song and story. The legendary cat that made a fortune for Dick Whittington before he became Lord Mayor of London in the late 1300's, the cat who went to London to look at the Queen, Puss in Boots, the cats being carried in forty-



KODACHROME BY WALTER CHAMBERS © N.S.S. BLACK-AND-WHITE BY DAVID JOHNSON

Like brooding hens, cats on a cold morning sit with fur fluffed and feet and tails well tucked in. Half-closed eyes do not mean they are dozing. As Chateaubriand noted wryly: "The cat . . . pretends to sleep that he may see the more clearly."

With mad delight, Simba attacks his weekly treat, a whiting fresh from the market. Dancing on hind legs, the Seal Point Siamese works up an appetite for his favorite dish.



Alone against the world, a New York cat makes a living killing rats and raiding garbage cans. Booth Tarkington's words in *Petrod and Sam* fit the picture: "He contracted no friendships and had no confidants. He seldom slept in the same place twice. . . . The slow, rhythmic, perfectly controlled mechanism of his tail, as he impressively walked abroad, was incomparably sinister. . . . His soul was in that walk . . . a bravo of fortune, living on his wits and his valour, asking no favours and granting no quarter."

Pet on a leash proves that some cats will accept the dog's chain if introduced properly. But who shall lead? The cat, of course.



nine sacks by seven wives coming from St. Ives—all were Domestic Shorthairs.

Their destinies varied with the humors of the age. At times they were worshiped by cultists, at others they were cruelly destroyed by the superstitious and the fearful. Eventually, friends outnumbered enemies. Farmers and millers have always valued the cat's help in protecting grain from mice, and sailors have always welcomed cats aboard ship to rid forecandle and hold of rats.

The intellectual elite have also made obeisance to cats. The roster of distinguished cat fanciers includes Cardinals Wolsey and Richelieu, Petrarch, Montaigne, Newton, Dr. Johnson, Keats, Poe, Dickens, Walpole, Teddy Roosevelt, and Mark Twain.

Alexander the Great, Louis XIV, and Napoleon are high on the list of cat haters, or aelurophobes. They never could stand anyone who didn't come when called.

Cats, like people, found freedom from

persecution in America. It is believed that they first came over in the *Mayflower*, although it may have been earlier—with the Spaniards in the 16th century. In any event, once here they thrived.

Lowbrow Feline Makes Good

Today the Domestic Shorthair is the prevailing North American cat (pages 526-7). The classification is a bit high-flown for a cat with no pretensions; on the other hand, she does not deserve to be called "alley cat," which is not a breed, but a condition resulting from being left in an alley by some human being. Among the cat fancy, this Shorthair is a show class, and there are many purebred Domestic of championship caliber.

In temperament and behavior, the breed is familiar to us all. This is the essential cat, changed not a whit through the years. The English author, Edward Topsell, writing in 1607, limned her as well as anyone:



40 EXTERNAL LADDER AND SODACRONE BY WALTER SHANNON © NATIONAL GEOGRAPHIC SOCIETY

"It is needless to spend any time about her loving nature to man, how she flattereth by rubbing her skin against one's Legs, how she whurleth her voice, having as many tunes as turnes . . . how she beggeth, playeth, leapeth, looketh, catcheth, tosseth with her foot, riseth up to strings held over her head."

The Domestic Shorthair far more often than not is unpedigreed. The blue bloods of catdom are the purebreds, and of these the lithe, beautiful, and fascinating Siamese is far and away the most popular household pet (page 532). More than any other breed, the Siamese also is threatening the Persian's almost monotonous domination of United States cat shows.

It couldn't happen to a nicer cat, for the Siamese is a vivid personality, probably the most intelligent of all cat breeds, and strongly disinclined to play second fiddle to anyone.

The god who invented the Siamese, says an Oriental tale, gave her the "grace of the

panther, intelligence of the elephant, affection of the lovebird, beauty of the fawn, blue of the sapphire, softness of down, swiftness of light." All true, and your Siamese couldn't agree more, but while you are reading this aloud in a passionate voice to your friends, the cat will be climbing the curtains.

There is no satisfactory explanation for this. It simply is a fact that Siamese like heights and frequently can be found walking along traverse rods, clinging to valances, or on the top shelf of an eight-foot bookcase.

The Siamese isn't the pet for just anyone. But if you are sufficiently strong-minded to withstand an active and strong-minded cat, the Siamese can be a joy forever. Rascally, perhaps, but bright, inventive, audacious, and affectionate.

One breeder told me she would like to sleep later on Sunday mornings, but her Siamese won't let her. "That cat is persistent," she said, her admiration tinged with regret. "First

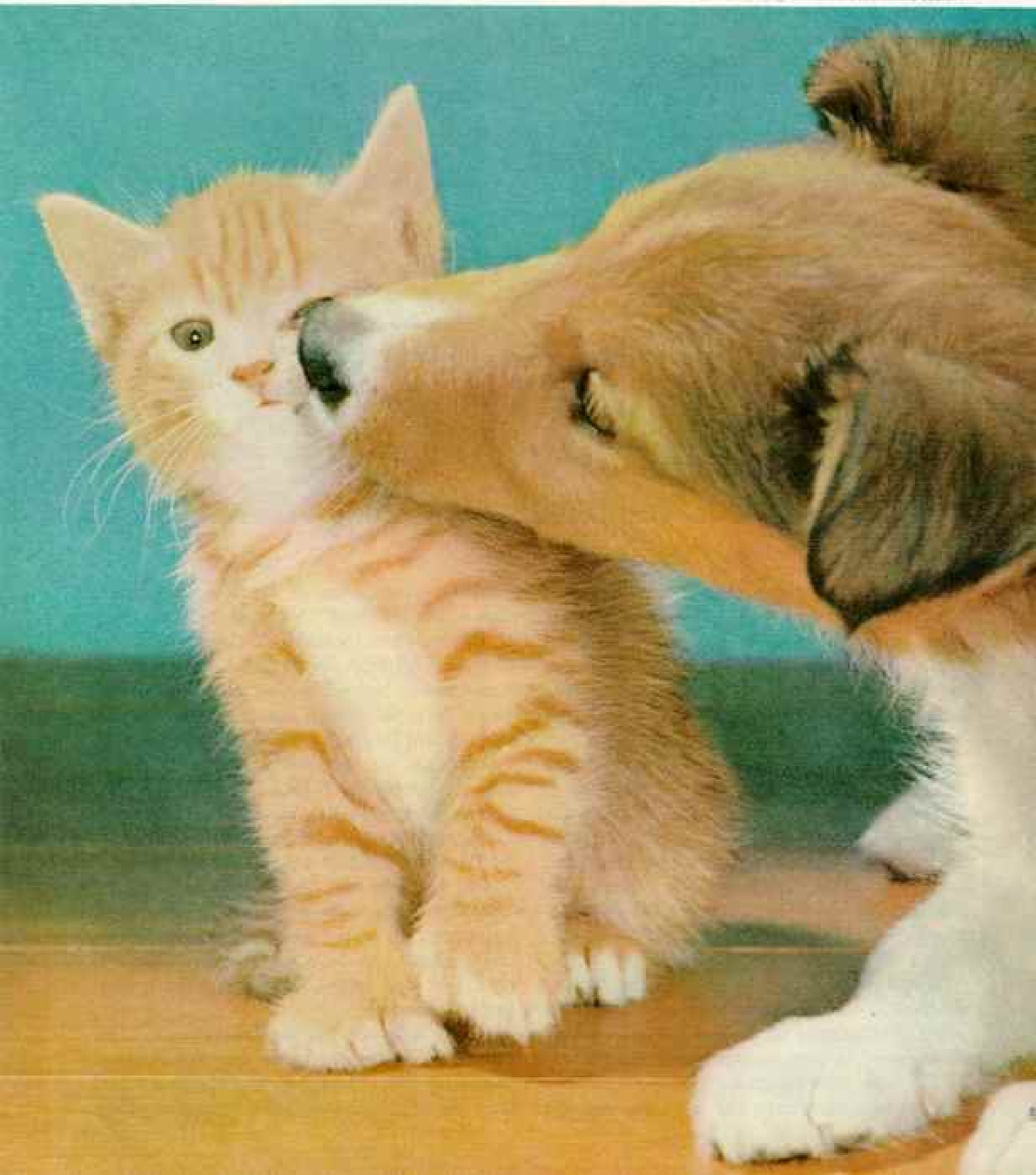
she pats my face with her paw. If that doesn't work, she starts knocking perfume bottles off the dressing table, and if that fails she jumps to the foot of the bed and pulls off the covers with her claws."

Singing Cat Keeps Time With Tail

Once you are up and have had your coffee, a Siamese can be all kinds of fun. Item: One Siamese of my acquaintance is an accomplished singer. It all began several years ago

with "The Siamese Cat Song" from Walt Disney's film, *The Lady and the Tramp*. While playing and singing "We are Siamese, if you please" to the cat, his veterinarian owner was inspired to wave a hand in front of the cat's face, and each time was rewarded with a meow. The cat quickly learned the points at which a meow would enhance the beauty of the song and now comes in on cue without prompting of any sort. Extending his repertoire to include several other songs, this whisk-

ENTOMOLOGY © ANIMAL BEHAVIOR SOCIETY



ered vocalist even switches his tail in time to the music.

Another Siamese I know loves telephones. She rallies around whenever the phone rings and complains bitterly until it is surrendered to her. Then, for as long as the caller's patience lasts, the cat will say "r-r-r-oww" every time a remark is made to her.

Only steadfast Siamese lovers can put up with this much vocalizing. The raspy Asian twang of the breed's voice grates on many

people's nerves. A few breeders, I understand, are trying to modulate the voice by selective breeding—it's possible—although the wiser course would seem to be to get a cat with more pear-shaped tones.

Siamese Stem From Royal Gift

We evidently have Owen Gould, an old-time British consul general at Bangkok, to thank for the Siamese cat. Gould seems to have been given a mated pair at a farewell

P. A. REUTER PHOTOS LTD. (OPPER) AND WALTER CHARONHA



Owl and pussycat, devoted English friends, have not gone to sea "in a beautiful pea-green boat" or "danced by the light of the moon," as Edward Lear's poem recounted of another such unlikely pair. But Ossie the brown owl and Snowy the cat do hunt mice together in their Lancashire garden. Here they appear smugly proud of their feat.

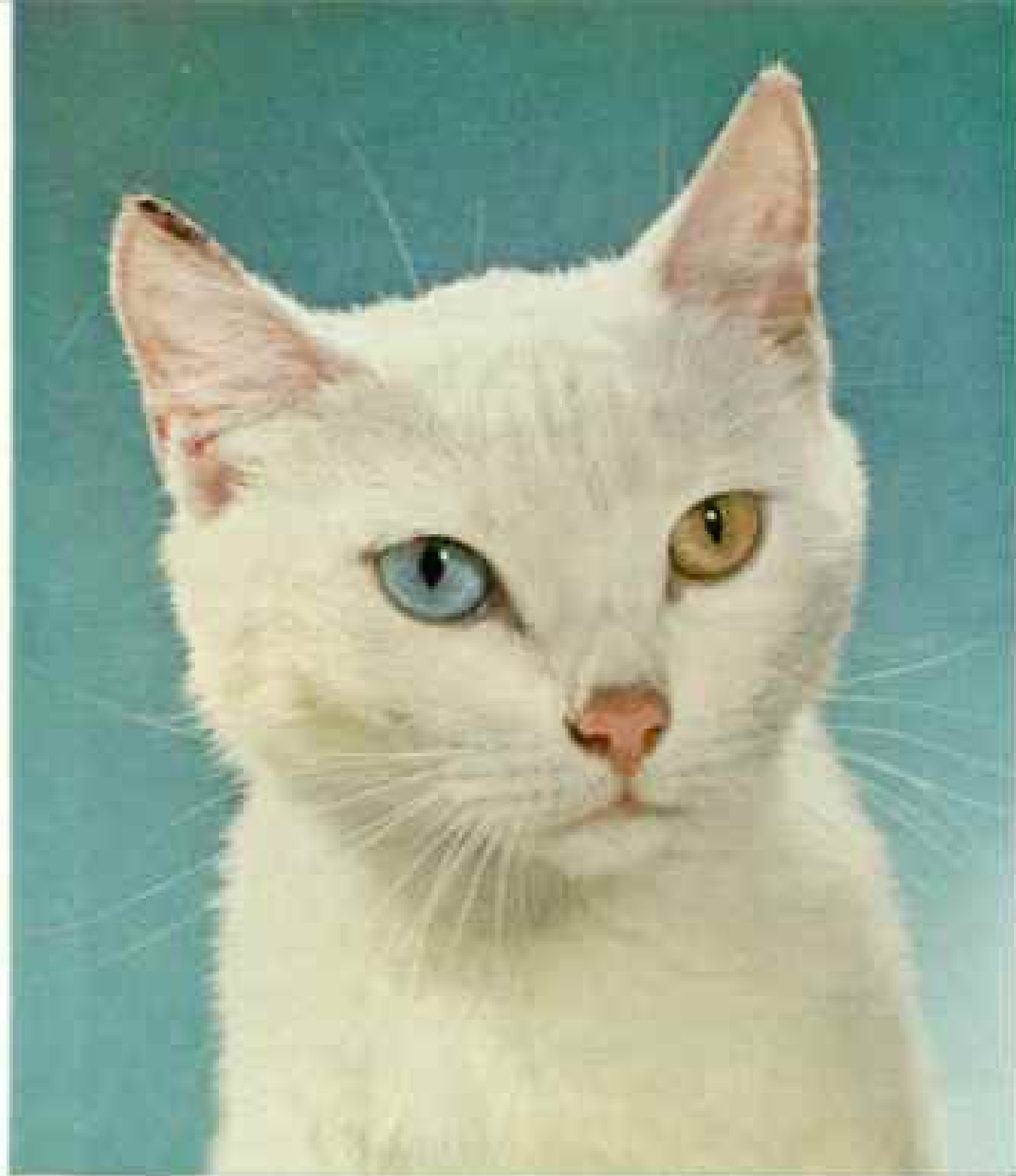
Taking liberties, a Collie puppy nuzzles a kitten. When permitted to grow up together, cats and dogs often forget their legendary enmity. Oliver Herford in *The Kitten's Garden of Verses* explained it thus:

*To Someone very Good and Just,
Who has proved worthy of her trust,
A cat will sometimes condescend—
The Dog is Everybody's Friend.*

BY PERMISSION OF CHARLES BISHOP'S SONS

Cat and white rat abide in peace.





EXTRAORDINARY © NATIONAL GEOGRAPHIC SOCIETY

Beginning with the familiar household cat, NATIONAL GEOGRAPHIC here presents outstanding examples of the principal breeds recognized in the United States, together with their show standards and characteristics.

Domestic Shorthair

"IN THE CAT WORLD, as elsewhere," writes the author, "the common people far outnumber the aristocrats. It is a safe guess that 99 out of any 100 cats encountered will be plain, ordinary citizens belonging in the boundless company of Domestic Shorthairs. . . . It is a recognized breed, and prime cats have emerged to win top prizes."

Taken to New England by the Pilgrims, the Domestic Shorthair earned its keep by protecting grain from rodents. A free roamer and free breeder, it developed coats of many colors and patterns, such as the Calico on page 508. Show standards of the Cat Fanciers' Association recognize 20. Unrecognized particolors and hybrids compete in the Household Pet Class; they are judged "solely on beauty and condition."

By selective breeding, the Shorthairs shown at upper left and opposite have become two specialties that have their own standards.

Odd-eyed White must have one blue eye and one copper or deep orange eye. Her coat should be short, thick, even in texture, and pure white.

Tortoiseshell standard calls for a coat of black, orange, and cream. Nose should be half black, half orange; the eyes, copper. Males are extremely rare and usually sterile.

Maine coon cat—a variant Domestic and not a recognized breed—exhibits long hair and long neck. Early Americans erroneously considered her a cross between cat and raccoon; experts now believe that she descended from wild tabbies with long-hair genes.





LITHOPHORE. © NATIONAL GEOGRAPHIC SOCIETY

audience with the King of Siam in 1884. The cats were not commonplace; breeding them had been a kingly prerogative for centuries, and the cats were known as Royal and Sacred Siamese. Legends had them highly placed as temple guardians and the companions of Buddhist priests.

In any event, Mr. Gould shipped his cats to England, where they were an immediate hit. Although not the first Siamese England had

ever seen (one was entered at a show in 1872), Mr. Gould's pair seems to have been a dynastic starting point.

Early imports to the United States were breathtakingly expensive, in some cases running to \$1,000 apiece. A rarity for a good many years, the breed finally became established in the mid-thirties and has been gaining adherents and dropping in price ever since.

Unless you expect to plunge into the cat

business, have your pets neutered. This holds for any and all breeds, but especially for Siamese. When the ladies are in season, which is often, the males become unmanageable and the females will howl the house down.

Burmese a Tractable Companion

Let it be clear that there is no such thing as a "best" breed of cat. It depends on your point of view. Nonetheless, comparisons can be made without prejudice to either party.

In these terms, it is fair to say that the Burmese is less active, less talky, softer voiced, not so kookie as the Siamese, and doubtless easier to live with. There will be less noticeable difference among any given six Burmese than among half a dozen Siamese.

Not that the Burm is an old sobersides. She likes to play, even to roughhouse, for she is a muscular and well-built cat. Her idea of fun will not be the vaudeville parlor tricks of the Siamese, but an impish pounce from ambush, or a grab around or under a door at a finger wiggling enticingly on the other side. She also has a somewhat greater need than most breeds for petting and affection.

Persian Pedigreed, pure-blooded, exotic breeds are catdom's elite. Valued by exhibitors, or "the fancy," no cat looks fancier than the Persian. Long glossy hair in 20 recognized colors, each color with a specified eye hue, gives the Persian a look of haughty languor. The standard for Persians calls for a chunky build, low on legs, deep in chest, massive across shoulders and rump.

Here Voo Doo, the Black Persian grand champion owned by cat judge Richard Gebhardt (page 536), exhibits the qualities demanded for the head: "Round and massive, with great breadth of skull." Ears: "small, round tipped." Nose: "short, snub, and broad." Eyes: "large, round . . . and brilliant." Voo Doo's expression here belies his gentle disposition. Unlike most males, the seven-year-old cat is devoted to his kittens and takes an active hand in helping their mothers raise them. In 1959 Voo Doo won *Cat Magazine's* honor as Cat of the Year.

Each standard lists undesirable characteristics. "In the case of the Persian," writes the author, "they are nothing less than a compendium of insults and sound like a whiskery prospector in a Western movie cussing his mule." Longhairs, says the standard, should not be "rangy, flat-sided, narrow-chested, spindle-legged, long-tailed cats."

Persians compete in the following classes: White, Black, Red, Blue, Cream, Brown Tabby, Blue Tabby, Red Tabby, Silver Tabby, Tortoiseshell, Calico, Blue Cream, Black Smoke, Blue Smoke, Shaded Silver, Chinchilla, Shell Cameo, Smoke Cameo, Shaded Cameo, and Tabby Cameo.

ILLUSTRATION © NATIONAL GEOGRAPHIC SOCIETY







STACHPONCE © NATIONAL GEOGRAPHIC SOCIETY

Chinchilla Persians achieve an aristocratic look with pure-white coats so subtly tipped in black as to seem silver. Black rims accent blue-green eyes, lips, and nose, whose center is brick red. Tail should be “carried without a curve,” says the standard. “But,” counters the author, “the man doesn’t live who can tell a cat how her tail should behave.”

Cream Persian grand champion stares at the world with eyes of brilliant copper.

Blue Cream Persian and her Cream kit arrive for a show in a carrying case. ▶

Altogether the Burmese is a charming and delightful cat, and one in which we can take pride, for as she stands today she is entirely an American development (pages 534-5). The story, like so much cat history, has some holes in it, but the popular version goes that the original Burm—a female named Wong Mau—arrived in the United States around 1930 in the arms of a sailor, who gave her to a cat fancier, Dr. Joseph Thompson, and promptly dropped out of sight.

Wong Mau was not a handsome specimen,

but she was clearly unusual, and for want of a mate of her own species was bred to a top-flight Siamese. With the passage of years, there gradually evolved the lovely sable-brown, golden-eyed cat finding such favor among today’s cat fanciers.

Burmese are intelligent cats, often acquiring an understanding of a few action verbs (“sit,” “come”) and a scattering of interesting nouns (“meat,” “fish,” “chicken”). They like to be taken for walks and will follow at heel, with or without a leash.



EXTRAORDINARY BY WALTER CHAROHA © NATIONAL GEOGRAPHIC SOCIETY

There is a trace of the ancestral Siamese in the timbre of the Burm's voice, although it is more dulcet and more sparingly used.

Abyssinian Shows Coiled-spring Wildness

Making steady progress in popularity among shorthair breeds is the regal Abyssinian (page 537). Even those who love her best admit the Aby is a nervous cat. Not jittery, not neurotic, not a chain smoker, but tense, hair-trigger, and volatile. They are pacers in their cages; their reflexes are lightning

fast, and they enjoy rough-and-tumble play.

If you can take all this suppressed excitement, you also will find them very affectionate—insistently so. At the same time, they take some knowing. They don't cotton to just anybody, and you may have to wait for the cat to choose you as a friend.

The feral quality—a strong strain of wildness—is close to the surface in the Aby. The breed is thought to derive from the Abyssinian wildcat, believed to be the paterfamilias of the ancient cats of Egypt. The Aby, going



Siamese Lithe and sinuous body in two-tone color, wedge-shaped head, and bright blue eyes distinguish the Siamese. The C.F.A. standard recognizes four colors—Seal (black-brown), Blue, Chocolate, and Lilac—for the points, as mask, ears, legs, feet, and tail are called. Red points are also recognized by other associations. Kittens are born almost white and add the mask and other coloring with age.

her own way, somehow survived virtually intact and is a modern incarnation of the forebear. Mummified remains of Egyptian cats look very much like the Aby, although larger.

Abyssinians take an uncatlike pleasure in water. They will play with a dripping faucet, dip paws into a bath or pool, and try to catch a reflection on a shimmering surface.

Elegance Comes in Assorted Colors

Before discussing Longhairs, which today are practically synonymous with Persians, there is one thing to get straight at the outset: Angora cats are not to be found in these parts anymore.

There used to be, and may still be, indigenous cats in the Angora (today's Ankara) district of Turkey, where the breed originated. For many years Angoras co-existed with the

Persian and often were confused with it. They are separate and distinct breeds, however, and the names cannot be used interchangeably. The Angora was a long-bodied cat with a small head and a flowing coat of fine, crinkly hair, like that of the Angora goat. The Persian has a "cobbler" (stockier) build, a larger head, and a woolly texture to the fur. Evidently these were preferable qualities, for sometime after 1900 the Angora went into a decline, while the Persian marched on to glory as the most spectacularly successful show breed of all time.

Since Persians are almost the only long-haired entries at shows (the Himalayan is not yet much in evidence), the breed enjoys a preponderance that is more apparent than real. The majority presence of Persians at shows partly results from the fact that pre-



These Seal Points, exhibiting the most popular color, show eyes conforming to the standard: "Almond shaped and slanting . . . in true Oriental fashion." Undesirable elements include crossed eyes and kinked tails, both weaknesses of the breed.

liminary judging is done on the basis of coat-color classifications. Breeders have made sure that interest in Longhairs does not lag by developing, over the years, 20 recognized coat colors. In all other matters of quality and appearance, the 20 must meet the same standards. (A maverick type is the Peke-faced Persian, which has been endowed with the pushed-in nose and wrinkled muzzle of the Pekingese dog.)

"A Luscious Bunch of Stuff"

Considering that there is only one Burmese class, one Abyssinian, one Russian Blue, and a mere four Siamese, the Persians make quite a mob at most shows. In all fairness, the Persian colorations are magnificent, and if it takes 20 classifications to see them all, so

(Continued on page 536)

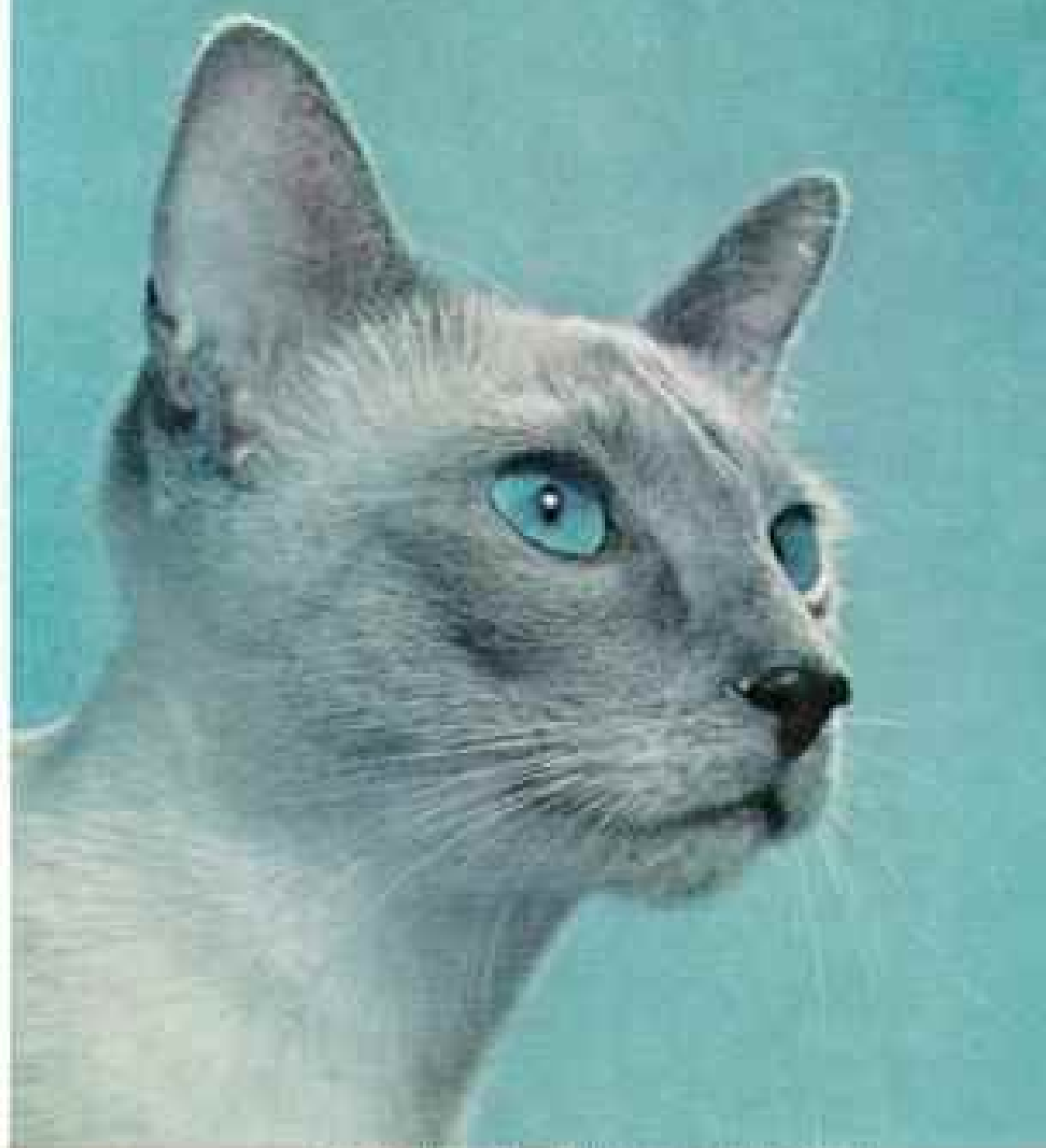


ILLUSTRATION © NATIONAL GEOGRAPHIC SOCIETY

Blue Point Siamese, grand champion Jerebelle, wears a coat of bluish white with points of the same shade of "definite blue, giving strong contrast of divided color," as the standard provides. "Nose . . . slate colored. Eyes clear and as deep blue as possible within the breed." How blue is blue? asks the author, and answers the question: "In coat coloring, the shade is slate or gray blue, but eyes are as blue as your little golden-haired sister's."

Lilac Point Siamese, champion Tai Shan, requires, for perfection, a body color of "glacial white." Points, says the standard, should be "frosty gray with pinkish tone. Foot pads . . . mauve."





ILLUSTRATION © NATIONAL GEOGRAPHIC SOCIETY

Himalayan Champion Goforth Tiara (right) and Blue Point Siamese differ in length of hair and color of masks. Seal Point Himalayan, a cross between Persian and Siamese, must show "conformation the same as for long-hairs," says the standard. But it must also reveal "color and points the same as for Siamese, with the same color classes." Goforth Tiara shows the characteristics that make her a ribbon winner: massive head with dusky mask, fluffy body above dark boots.

Burmese Mother and kittens reveal the Burmese to be compact and muscular. The three appear to be smiling gravely, an illusion created by up-turned mouths set in full faces. Their eyes glow with deep gold. Green eyes are a fault and blue eyes "outrageous enough to disqualify the cat," Mr. Suebsdorf affirms. The unique and wonderful color of the Burmese is a "rich, warm sable brown." Coat is short, lies close, has a glossy sheen and satiny texture. Fastest growing in popularity among the Shorthairs, the Burm commands a handsome price.

Russian Blue

“TEXTURE and appearance of the coat are the truest criteria of the Russian Blue,” says the standard in consideration of the fact that this cat’s fur is unlike that of any other breed and, in fact, closely resembles sealskin. Like seal, the Blue’s coat is short, thick, and very fine. It feels silky and has a distinct sheen. The color is “bright blue”—the standard’s term for gray or slate blue.

Here Grigio, a Blue once owned by the photographer, exhibits the required broad face with nose longer than that of the Persian but shorter than the Siamese. Vivid green eyes are set wide apart and appear round, rather than almond shaped. Young cats have yellow eyes, which change with time. “The neck is fairly long but looks short because of the thick fur,” as the standard demands. Ears are “large, wide at the base, pointed at the tips.”

A highly intelligent cat, Grigio enjoyed jumping from one high stool to another in a graceful, arcing leap. Sometimes Mr. Chandoha held a hoop between the two stools, and the cat sailed through it. The performance made it appear that the owner had trained his Blue. “But that wasn’t true,” says Mr. Chandoha. “I just added the props for Grigio’s own act.”

One day Grigio walked off the farm and disappeared from Chandoha’s life.



STYLING: JAMES H. HARRIS © NATIONAL GEOGRAPHIC SOCIETY



be it. They are, as one judge put it to me, "a luscious bunch of stuff" (pages 528-531).

The Persian nonetheless labors under disadvantages. The regal haughtiness of the cat, her luxuriance and languor, have convinced many people that the breed is cold, standoffish, and just plain no fun.

Don't you believe it. Persians aren't great lap sitters and cuddlers, but the reason is a simple one. Permanently burdened with a coat warm enough to wear to a pro football game in December, the poor old things just can't take the body heat of an adoring owner.

Aside from this, they are as pleased to give or receive affection as any other cat.

Secondly, it has long since been decided that the Persian is a "lady's cat." This is downright slander. It cannot be denied that ladies like them, that they look like powder puffs, and that people are always making them sit on blue silk cushions.

Yet given half a chance, Persians are playful, bright, and active. A onetime neighbor of mine, a fine Cream Persian kitten named Joe, was as sporty a cat as I ever saw when he escaped from his mistress and could prowl the back acre, chasing butterflies, leaping on grasshoppers, and generally living it up.

Tailless Mystery Cats

Writers of an earlier day were fond of describing the Manx as "lacking a caudal appendage," a phrase in the orotund style of the times which didn't shade the truth. Manx *are* tailless, no doubt about it (pages 538-9). How they got to be so, however, is not known.

They seem to have come from the Isle of Man. One story has it that they swam ashore from sinking Spanish ships when the Armada was beaten, by England and by storm, in 1588. Yet no record of tailless cats survives in Spain, and the Manxmen have nothing very enlightening to say about the problem, either.

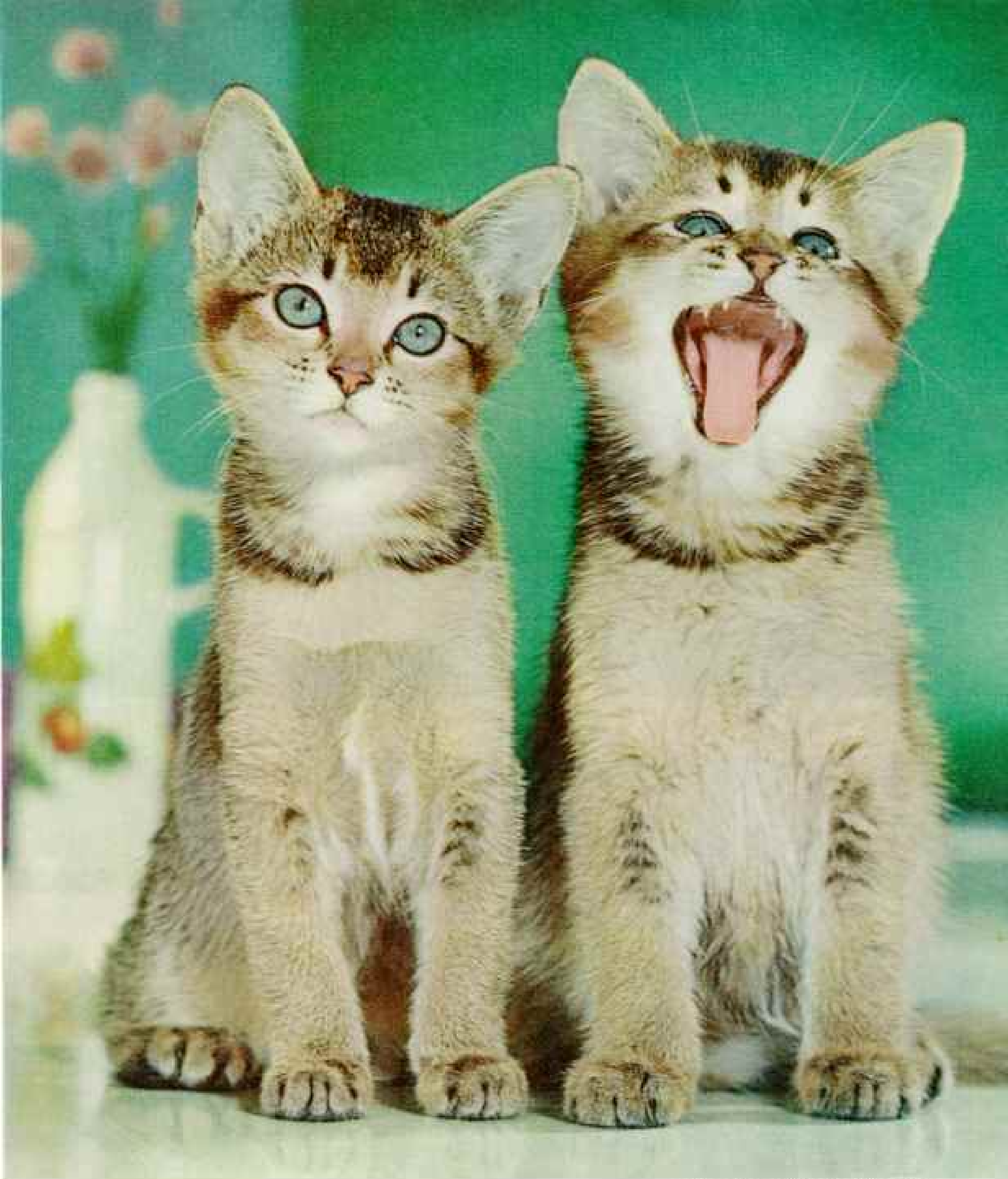
This leaves us with a curious cat which has many charms, but is fully appreciated mostly by connoisseurs. More than any other breed, Manx are an acquired taste.

Breeders ruefully admit that many people balk at a cat without a tail. They think they're getting a factory second, or damaged goods. This is too bad, for the Manx conformation is an interesting one, and the cat otherwise looks exactly like a cat.



ESTABLISHED BY NATIONAL GEOGRAPHIC SOCIETY

On the stretch for judging, a Lilac Point Siamese bares its teeth to Richard Gebhardt, the cat expert who served as consultant for this article. Judging cats, says Mr. Gebhardt, requires the "refined discrimination of a taster, piano tuner, or airplane spotter." The cat judge must "demonstrate full familiarity with extremely picky standards that cover every observable feature." Standards do not evaluate personality; charm and sterling character count for nothing if embodied in a faulty specimen; monumental stupidity carries no penalty as long as it is encased in a flawless head. From the judge's view, the best cat is a docile cat, because in any two-day, 250-entry show, a judge may lift more than a ton of felines. London held the first major cat show in the Crystal Palace in 1871.



DETACHING © NATURAL GEOGRAPHIC SOCIETY

Abyssinian A breed fast growing in popularity, the Abyssinian has been known for less than a century; England saw its first pair following a British campaign in Ethiopia in 1868. These kittens exhibit coats that resemble those of wild rabbits. From a distance, the fur looks brown but actually is ticked; that is, each hair is banded in black, brown, and white. Coat should be "soft, silky, fine in texture, but dense and resilient to the touch." Unlike the Persian, whose coat may pale when exposed to sunlight, and the Siamese, whose coat may darken, the Aby's fur flourishes in the sun. Kittens' small neat feet make them appear to be standing on tiptoe, as the standard demands. Both wear a necklace of color high on the chest, a marking that is now being bred out of the blood line. If a necklace exists, it must show a break at the throat. Some ambitious exhibitors, reports the author, "have been known to pluck hairs, to powder, dye, stain, or bleach out a necklace to meet the standard." Bars on the legs of these cats would also be considered a fault by judges.

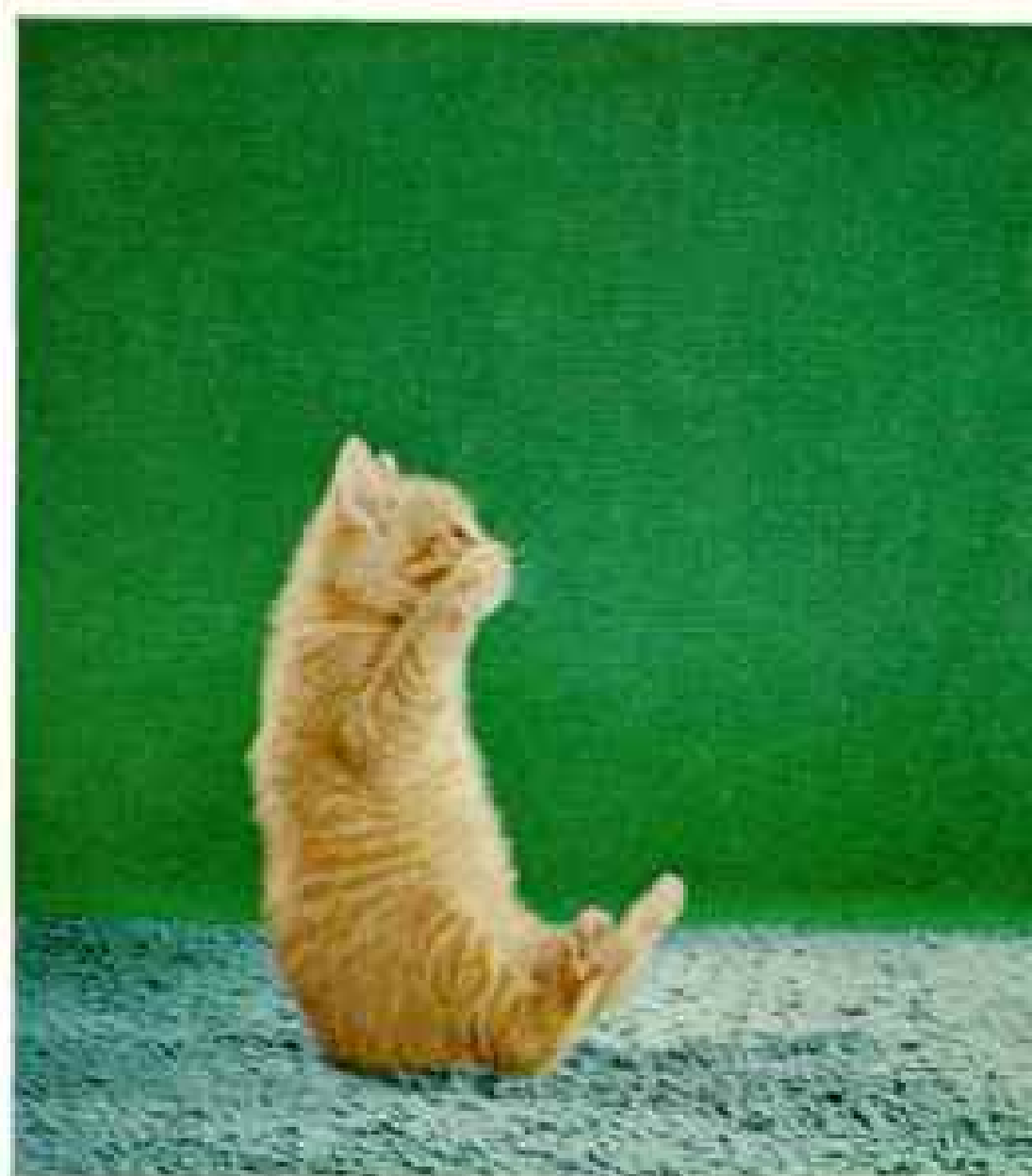
Lost in wonder, a Manx kitten awaits his chance to investigate the crackle of a mystery dangled by his mistress. High-flying leap puts Stumpy close to a strip of newspaper, but claws fail to



KIDNAPERS AND EXTREMES (LARGE) © R. G. L.



bring the plaything to earth (opposite). On the trip down, Stumpy neglects to twist into a proper landing position (below) and lands foursquare on his tailless bottom. This sequence brings up the question: Do cats use tails as stabilizers when falling? If so, the tailless Manx must find other aids for alighting on its feet. Contrary to the popular notion, even cats with tails sometimes fail to land safely on all fours.



EXCERPTS BY WALTER CHANDORA © N.Y.C.

In temperament, their virtues rival the Boy Scouts'. I have heard them praised for everything but helping old ladies across the street. They seem also to be pixilated in a nice way. When the spirit moves them, they will suddenly flip, twist, or gyrate in one spot, then sit down, looking a bit startled, as only a cat can who has ruffled her own dignity.

Tailless Rumpies, incidentally, can produce Stumpies with a vestigial tail, or, frequently and more embarrassingly, tailed cats just like yours and mine.

Secret Signal Triggers Loco

An interesting purebred with a personality much like the Abyssinian's is the Russian Blue (page 535). To the uninitiated, however, its solid slate blue-gray color is virtually indistinguishable from the hue of the old gray

cat at the corner grocery store, so its popularity is less than it deserves to be.

The Russian Blue can be an engaging cat. Walter Chandora, whose fine pictures accompany this article, had one named Loco whose pleasure it was, each evening on the stroke of 11, to stop whatever he was doing and make two circuits of the apartment at top speed. Always at 11, always two laps, and always the maximum linear distance along the outside walls of the apartment. The Chandoras could only surmise that some kind of whistle inaudible to human ears was set off each night somewhere in the neighboring industrial district. To Loco it was the signal for action.

Claiming attention from cat lovers today are a few rare and unusual breeds (or cross-breeds) which may be short-lived evolution-

Manx Lack of a tail distinguishes the Manx. As the standard makes clear, "Taillessness must be absolute. . . . There should be a decided hollow at the end of the backbone where, in the ordinary cat, a tail would begin." The rump should be as round as a ball and supported by hind legs that are longer than front ones. Long rear legs give the Manx a rabbit hop when it is running and make it a prodigious leaper. Grand champion Pola was the first White Manx to win that title. All colors are recognized for the breed, but they must be worn in a double coat—a thick, close-lying undercoat and an outer guard of longer hairs.

ary dead ends, or may, if all goes well, become favorite cats of the future.

The Himalayan already has been mentioned; this critter has the body type and long-haired coat of the Persian, the head and coloration of the Siamese (page 534).

The Havana Brown shows the slender structure of the Siamese and the coloration of the Burmese, but with eyes green rather than golden.

The Burman, as distinct from the Burmese, probably comes from the Far East, although little is known of its origin. It is a fawn-hued cat with a silky coat, the dark, contrasting points of the Siamese, a bushy tail, blue eyes, white feet, and a long and massive body.

The Korat (pronounced koh-RAHT) is a rarity from Thailand, a cat evidently indigenous on the Korat Plateau north of Bangkok. Puzzle: Where has it been all these years? Also built like the Siamese, the Korat is a solid slate gray in color with a silvery cast to the legs. The fur is satiny and lustrous; the eyes amber green.

Perhaps most intriguing of all the new-fangled breeds is the Rex, a cat with fur in marcel waves along the sides. On the stomach it curls like Persian lamb. The Rex has curly eyebrows, a small voice, and a mild and pleasing purr.

A spontaneous mutation, the Rex is a one-in-a-million oddity found among Domestic Shorthair kittens. One was discovered in England, another in East Berlin. Both strains now are being bred in the United States. There are very few of them so far, however, and experts feel it will be years before they are well established.

A Cat for Every Temperament

From the above, it is obvious that there are cats for all tastes and settings and seasons—cats of surpassing beauty, cats of elegance and charm, cats of every shade and nuance of temperament, cats accommodating and accomplished. For those who have no cat and want one, or for those who have a cat and want another—or two others, or three, or four—the way is clear.

Only one mystery remains. For all of man's long association with the cat, he has not learned much about her purr. This may offend the several experts who gave me precise descriptions of its mechanism, but they varied so widely I am forced to the conclusion that the secret still eludes us. She whurleth her voice, but how I knoweth not.

THE END

Rex Marcel waves rippling across body and tail give this cat its unusual appearance. Although the Cat Fanciers' Association has yet to recognize Rex, other cat groups have proclaimed it a breed and set up standards. The wavy coat should be the "texture of velvet pile."



and the head should exhibit a "Roman profile." Ears should be "large and naked, set high on the head."

With Rex, our story on cats and their breeds concludes, having presented a feline for every personality and household. But if you cannot find a cat, "a cat might find you," as Margaret Cooper Gay has written in her essay, *Nine Ways to Get a Cat*. "I can't tell you how to be found by a cat because that's a secret cats keep to themselves. I do know that the cats which choose their own people are the smartest cats of all. When a cat finds you, you may be sure it is a feline of discrimination, judgment, and taste."



From Sun-clad

I SHOULD never have brought *America's Wonderlands* home for my children. From the first time they opened the National Geographic book, they began needling me to take them West to see the great national parks.

But maybe that was just what I had in mind. I needle easily at any hint of travel, and my family knows it. Besides, discovering America has been a family hobby as long as we've been a family.

"We couldn't visit all the parks

EDWACHRONES © NATIONAL GEOGRAPHIC SOCIETY

SUN LIFTS ITS LAMP as a Yaqui Indian harvests shrimp from the Gulf of California, where Roadrunner's northward journey began.

WEIGHTED NET FLIES; the steersman poles the canoe across shimmering shallows.

Following North America's "national parks highway," a Maryland family rolls from cactus-studded desert to Canada's majestic glaciers

Sea to Shining Mountains

By **RALPH GRAY** Chief, National Geographic School Service

Illustrations by National Geographic photographer JAMES P. BLAIR

on one trip," I told them. "But there's a road out West—I call it International 89—that runs from Mexico's west coast to the Canadian Rockies. It connects six United States national parks, three parks in Canada, and so many other scenic wonders that it's also called the world's most beautiful highway."

The trip didn't take much selling. The only question was how to make it. We had followed the routes of explorers in canoes, on horseback, in jeeps, sedans, and station wagons,

but none of them seemed right for this journey.

We settled on a 26-foot Dodge motorized home, which we christened *Roadrunner*. Jean, my wife, liked it because it was fully equipped for eating and sleeping. I liked it because it was all one unit, giving the kids scrambling room while traveling, yet not sealing me, the driver, off in a cab.

Our inland voyage of discovery would begin on Mexico's Gulf of California, an arm of the "sun-clad sea," as the Western poet Joaquin Miller





STROCHUMER © NATIONAL GEOGRAPHIC SOCIETY



described the Pacific. And so, after picking up *Roadrunner* and giving it—and ourselves—a cross-continent shakedown, we drove onto a beach near Guaymas, Sonora, set the hand brake, and our conveyance at once became our camp.

Our college-age daughter Mary Ellen took steaks out of the refrigerator and began broiling them, while Will, 16, and Donna, 7, romped outside with Ginger, our dog. After dinner the children climbed into ready-made bunks in the rear, while Jean and I opened the sofa into a double bed.

Safari Starts at a Sailfish Derby

Down the beach next morning strolled Tommy Jamison, transplanted American who runs a fleet of sport-fishing boats.

"You're here just in time for the sailfish derby," he said. "If you hurry you can see the harbor parade."

I pressed the "Drive" button, and our home on wheels took us to the Plaza Centenario, where in the early-morning sun we watched the long-antennaed craft file majestically out of Guaymas harbor (left).

Señor Enrique Murillo, intrigued by *Roadrunner*, introduced himself. "It was to me the honor of being father of the fishing tournament," he said. "This is the fifteenth international contest. While we wait for the boats to return, permit me the showing of my city."

Everyone—city leaders, shoeshine boys, Indian fishermen—made us welcome in Mexico. Their gentleness and patience relaxed our Anglo-Saxon pace and gave us a lesson that lasted the entire trip.

That night we dined leisurely under orange trees and the stars on the terrace of the Hotel Playa de Cortés. A string quartet brought to our table the liquid, Latin sounds of "*Cielito Lindo*" and "In a Little Spanish Town."

In the morning I rounded up wife, children, and dog for a major population shift

Boats parade out of Guaymas harbor to begin an annual fishing derby. Here the author started his 3,000-mile safari along U. S. 89 and connecting highways across both borders. Often called the national parks highway, "International 89" links six parks in the United States and three in Canada. The Gray family's south-to-north trip intersected their previous east-to-west route across North America along U. S. 40 ("From Sea to Shining Sea," June, 1961, *GEOGRAPHIC*).

to the north. In their own car, which they dubbed *Roadrunner-up*, NATIONAL GEOGRAPHIC photographers James P. Blair and Gerald L. Wiley followed us across Sonora's lonely saguaro and mesquite flats.

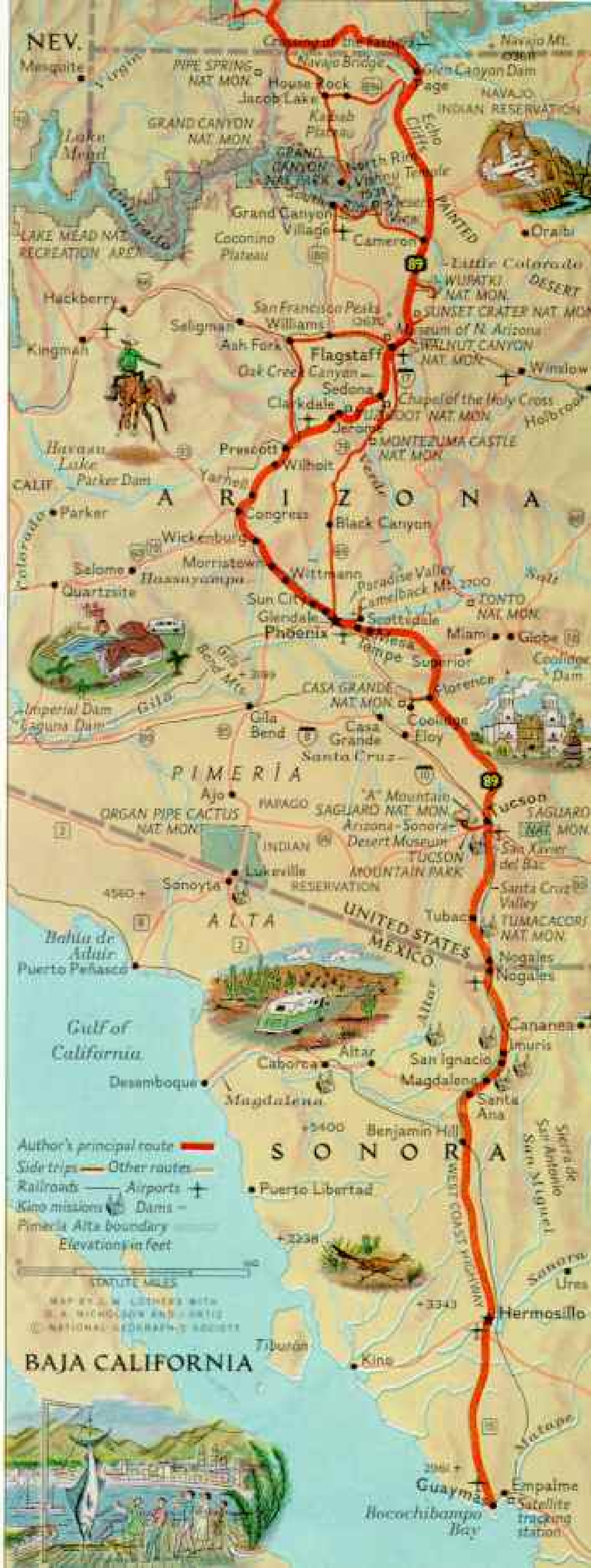
We were heading straight for the Arizona border. Through our picture-window windshield we saw the horizon dance in heat waves, while we visualized our snowy, mist-shrouded objective 3,000 miles away: Mount Robson, the Canadian Rockies' highest peak. (See the Atlas Map, North America, distributed to members with this issue.)

Sonora's mountains have yielded fortunes in tungsten, lead, and copper in recent decades, as well as untold millions in silver and gold since the time of the Spanish conquistadors. The only gold we saw, however, lay in wide fields of wheat stubble—the grain newly harvested from irrigated land that once was desert.

If the Mexican state needed further distinction, Sonorans could point to a satellite tracking station near Guaymas—and, farther south, a region that grows most of the world's Mexican jumping beans. Our children were intrigued to learn that the jittery little "bean" is really the seed of the desert-growing *yerba de flecha*, or "arrow plant." The larva of a small moth moving inside and bumping the shell causes the bean to jump.

Sonora's capital, Hermosillo, lies surrounded by irrigated fields producing figs, pomegranates, oranges, and dates. Hermosillo is named for a hero of Mexico's War of Independence. It is a delightful blend of modern city and early Spanish town. We drove past the clean-lined cubes of contemporary office buildings and

Route of Roadrunner. a Dodge Motor Home, led north from the Gulf of California across the Sonora desert. At Magdalena the Grays picked up the trail of Father Eusebio Francisco Kino, 17th-century missionary who explored this region. In Arizona they visited booming Phoenix, witnessed the All-Indian Pow Wow at Flagstaff, and toured the Grand Canyon by airplane (page 555).





SWINGING HIGH over Canada's Lake Louise (left), making friends with a ring-tailed cat (opposite) at the Arizona-Sonora Desert Museum, or skirting the craggy Grand Tetons (below), the author and his family found that memorable adventure lay only a step from their motor home. Roadrunner gave the Grays an ever-changing view of the vast and magnificent West.





At home on the move, the Grays enjoy the scenery as the author concentrates on driving. His wife Jean, daughter Donna, and Ginger the dog lounge on a couch. Mary Ellen and Will sit up front with their father.

Life aboard *Roadrunner*

NO VACANCY" signs held no terrors for the family. *Roadrunner* offered all the comforts of home—hot and cold running water in kitchen and bathroom; stove, furnace, and refrigerator fueled by propane; and 110-volt electrical system. If one day's schedule called for a long run, "expedition chef" Mary Ellen stirred around her well-appointed kitchen and cooked dinner as the miles slipped away. At bedtime the children piled into rear bunks while their parents converted the living-room couch into a double bed.

Buoyant as a boat, the author sits out a swim on Great Salt Lake, Utah. High saline content of the water keeps him safely afloat.

RODCHAGNER © NATIONAL GEOGRAPHIC SOCIETY





Border guard checks passes of Mexicans entering the United States at Nogales. A high wire fence divides the city between Arizona and Sonora.

Living mission, San Francisco Xavier del Bac, nine miles south of downtown Tucson, lacks a right cupola. One legend, among many, tells that it was left unfinished as a memorial to the 18th-century Spanish architect, who fell to his death from the tower.

strolled the colonial plaza on walks of colorful tile. We went exploring off the main thoroughfares, until *Roadrunner* got jammed in a narrow shop-lined lane and had to back out.

The road north from Hermosillo climbed gradually to the old Spanish province of Pimeria Alta—upper land of the Pima Indians—a parched land of waterless watercourses in what is now northern Sonora and southern Arizona. At Magdalena we picked up the trail of Padre Eusebio Francisco Kino, Jesuit missionary to the Indians of this region between 1687 and 1711. Thus we returned to our native land on the trail of an Italian who traveled under the flag of Spain.

Long before there was a United States, the saintly Kino planted Christianity here; he also introduced new crops and cattle ranching. He journeyed tirelessly through his vast parish, exploring much of the Southwest.

A century before California's famous missions were built, Father Kino had founded a string of them along



the route we followed—Santa Maria Magdalena, San Ignacio, Imuris, San José de Tumacacori, San Francisco Xavier del Bac.

From Nogales, Mexico's busiest port of entry into Arizona, we entered the United States—along with what seemed a mass migration. Customs officials told us that about 8,000,000 people—shoppers, workers, and tourists—cross here each year. Afterward, we drove along the high chain-link fence that marks the boundary and divides Nogales into two cities. The Sonora side counts 37,600 inhabitants; the Arizona city has 7,500.

Following U.S. 89, we came to Mission San José de Tumacacori, once a Christian outpost on New Spain's far-northern frontier, and now preserved as a United States national monument. Superintendent Michael J. Becker proudly showed us through.

"These ruins date from much later than Father Kino," he said, "although Kino passed this way in 1691."

San Xavier Mission Still in Use

Over the ears of his horse, Father Kino, Arizona's "first citizen," saw the beautiful Santa Cruz Valley on many trips to San Xavier del Bac, his northernmost mission. Before dawn on a Sunday morning, we approached the luminous white-plastered church over a dusty road.

San Xavier mission still serves more than 650 Papago Indians on their reservation south of Tucson. We watched as a squat Indian woman, black shawl over her head, crossed the plaza from an adobe hut and entered the ornate church.

I climbed a black hummock of rocks topped with a cross, just east of the mission, and watched the sun fill the valley. The mission towers, one shorter than the other, glowed like votive candles. A friar rang the bell. By ones and twos and families the Indians crossed the compound. Doves called in the distance. Seven o'clock mass began.

Franciscans built the present church in 1785-97, carrying on God's work begun here by the Jesuit Kino in 1692. On that occasion he gathered the Indians around him "and on the map of the world showed them the lands, the rivers and the seas over which we fathers had come from afar to bring the saving knowledge of our Holy Faith. I told them also how in ancient times the Spaniards were not Christians, how Santiago came to teach them the Faith... They listened with pleasure... [and] told me they wished to be Christians, and gave me some infants to baptize."

Spanish-founded Tucson counts a population of 233,000. Like Phoenix it grows so fast that these two were the only major cities in the United States whose populations quadrupled between the 1950 and the 1960 census. Northerners seeking year-round sun keep migrating to southern Arizona, and although Tucson clings to its Castilian heritage in street names and certain buildings, it fights a losing battle; eventually it may become an Indianapolis with cactus.

Unusual Museum Reveals Desert Wildlife

The mountains that enfold Tucson soon lured *Roadrunner* on. Past "A" Mountain, named for the University of Arizona's initial on its conical side, we knifed through the rocky defiles of Tucson Mountain Park to the Arizona-Sonora Desert Museum.

Along the museum's cactus-lined trails, we spent several hours amid habitat groupings, dioramas, and animal cages. I could scarcely believe that the stark land we had driven through could harbor so much life: everything from mountain lion, deer, and bear down to centipedes, scorpions, and tarantulas.

"Most of our visitors are surprised," said Dr. Lewis Wayne Walker, associate museum director. "People can look farther and see less in this wide-open country than any place in the world," he said. "Here we try to focus on one thing at a time and reveal the desert's amazing life." *

This unique show place drives children frantic with all there is to see. "No matter where he's at, he wants to be somewhere else," said a perspiring parent, following his son from jaguar cage to prairie dog village, to a nature trail, to bird enclosures, to a glass-walled tunnel where you look in on pack rats and rattlesnakes.

Next morning we drove on to Casa Grande National Monument. Casa Grande is a four-story apartment house of packed earth, built 600 years ago by Salado Indians. The settlement itself was founded by the earlier Hohokam, forerunners of today's Papago and Pima.

Supervisory Ranger Joseph P. Valcarce led us under the pagodalike steel roof that now protects the tower from the elements. He pointed out two small apertures in opposite walls of the ruin.

"We call them the Calendar Holes," he said. "Twice a year the morning sun shines through both holes. That was the signal for the Indians to begin planting or harvesting."

*Dr. Walker described "Arizona's Window on Wildlife" in the February, 1958, NATIONAL GEOGRAPHIC.

Archeologists have traced 250 miles of ancient canals in this area. The Hohokam farmed by irrigation, as do those who live in the Gila watershed today. U. S. 89 northbound crosses the dry bed of the Salt River, a tributary of the Gila, just before entering Phoenix. A series of dams in the mountains upstream impounds the waters and sends them down to the "Valley of the Sun."

Phoenix Pushes Back the Desert

Arizona's capital has more room to spread out than Tucson and is taking advantage of every sandy acre. In the older residential areas people build little six-inch-high dikes around their lawns, uncap a waterpipe every two weeks and flood the lot. The house sits there like an island until the water soaks in.

550

Result: greener lawns than in rainy cities.

In the "exurbs"—places beyond Camelback Mountain and Scottsdale—houses are put where a well can drive deep to water. In front there is usually a garden of saguaro and other cactus, palo verde, yucca, and the like. Many homes are L-shaped, their arms cradling a swimming pool and a few square yards of grass, all walled in from the desert.*

The desert doesn't seem so grim when viewed from such a patio—as was our privilege when we visited a home in Paradise Valley. A water-polo game for our children, a moonlight barbecue, a watermelon feast—all seemed a far cry from the Old West.

*The extraordinary growth of Phoenix is described in "Arizona: Booming Youngster of the West," by Robert de Roos, NATIONAL GEOGRAPHIC, March, 1963.



"We're not just a desert any more," engineer Carlton H. Paul told me. "Arizona is among the leaders in electronics production. We're first in percentage of air-conditioned homes. And have you heard about our *de*-heated swimming pools? The water gets so hot in summer we have to circulate it through a spray that cools it by evaporation."

Leaving greater Phoenix, we soon crossed the last irrigation canal and re-entered honest desert. "No Horses on Sidewalk," says a sign that greeted us in Wickenburg—an old stagecoach stop where drivers and "shotguns," as the armed riders were called, used to josh each other about having sipped the peculiar waters of the Hassayampa River. A drink was supposed to render the imbibor incapable of truth telling.

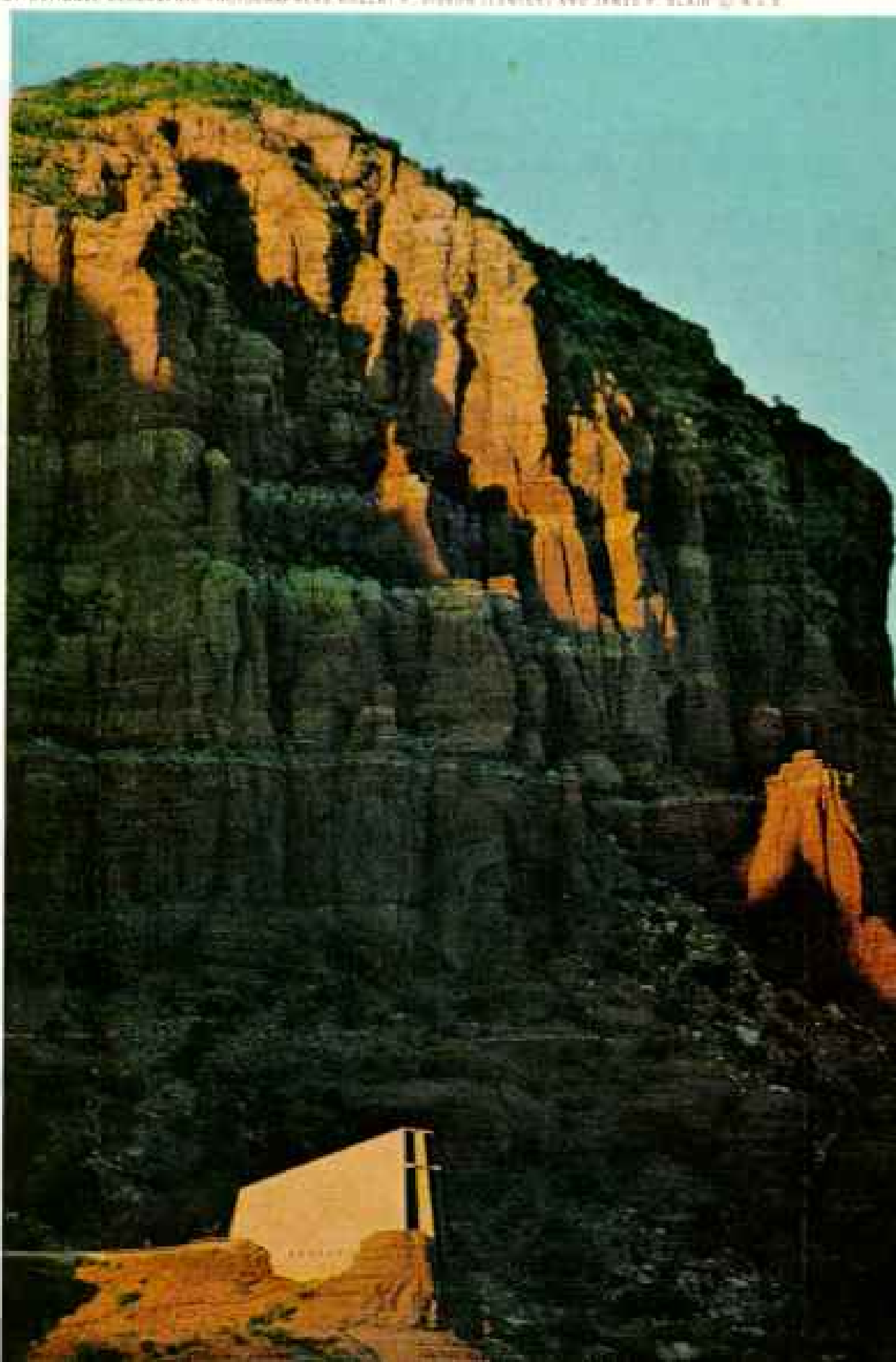
Wavy Streets of Melrose Paradise Break the Arizona Desert's Solitude

Desert living booms with modern conveniences—picture windows, sliding glass doors, air conditioning, and irrigated lawns amid wasteland. Melrose Paradise, a suburban Phoenix development, curves streets to slow traffic and protect children. Residents commute to jobs throughout the sprawling city.

Diners and pool beneath Camelback Mountain, Phoenix, would make an old-time desert prospector feel he had stumbled onto a mirage. Natural gas-jet blazes at the luxurious Mountain Shadows Hotel.

Spotlighted by the setting sun, Chapel of the Holy Cross nestles beneath towering red-rock cliffs near Sedona, Arizona.

PHOTOGRAPHS BY NATIONAL GEOGRAPHIC PHOTOGRAPHERS ROBERT H. FISHER (LEFT) AND JAMES F. BLAIR (RIGHT) © N.G.S.



At Wilhoit, we stopped for gas before climbing the long slope into Prescott.

"A little rain would feel good," I said to the man who ran the filling station.

"Yep," he replied. "We've got two chances for rain around here—slim and none."

We roared off and climbed, climbed, climbed into the cooler world of north Arizona (Prescott is 4,200 feet higher than Phoenix). Saguaros gave way to ponderosa pines. We were entering the fabulous canyonland of the almost mythical West that will live as long as there is an American to tell tall tales about it.

This West was tamed long ago, and everyone knows it. The Indians live on reservations, the wild buffalo herds huddle against extinction in sanctuaries, and cowboys more often ride a new Plymouth than Old Paint. The valleys have been planted, the rivers dammed, the mountains climbed.

And yet I have never met a tourist who was

disappointed. Something immortal endures of the dramas of Father Kino, Lewis and Clark, John C. Frémont, and Brigham Young: the setting, the terrain, the geography.

The scene-changers have been unable to cope with the Continental Divide. The mountains remain, as do the canyons, the deserts, the lakes, and the glaciers.

Kaleidoscope of Arizona Scenes

Such a phantasmagoria of wonders lay between us and Grand Canyon that this part of our trip always comes back to me in little scenes as brilliant as Arizona's cobalt sky:

Prescott... rodeo stars registering for Frontier Days, peeling off \$100 for four 8-second rides, gambling they'd win it back and more during the July 4 wingding (page 356). "It all depends on your luck in drawing a wild, spirited horse or bull. You win prizes on how you and the animal look as a team."

Hopi pirouette and stamp for clicking cameras on the South Rim of the Grand Canyon of the Colorado.

Maid in Indian feather bonnet wears paint and a smile at Flagstaff's All-Indian Pow Wow. Each July tribes from all parts of the Southwest gather for a parade, fair, and carnival. Arizona has more Indians than any other U.S. state—81,924 at the last count.



Jerome . . . "newest ghost city in America," whose last mine closed in 1953. Tuzigoot and Montezuma Castle National Monuments . . . true ghost towns abandoned by the Pueblo Indians 500 to 600 years ago.

Flagstaff . . . hearing the Navajo's unsmiling "Yah-tay" (hello) for the first time; watching two Navajo matrons, dressed in red and green velveteen and silver jewelry, screwing up their courage to ride on the merry-go-round. Flagstaff's All-Indian Pow Wow . . . thousands of Navajo, Apache, Zuni, Hopi, Pima, Sioux, and Paiute camped in tents, wagons, and pick-up trucks for the three-day rodeo.

Sunset Crater National Monument . . . Dr. Harold S. Colton, grand old man of the Museum of Northern Arizona, tells us he became the prime mover in preserving this volcanic cinder cone rising 1,000 feet above its plain when he learned a movie crew planned to blow out its side for a big scene.

The Museum of Northern Arizona . . . Dr. Edward B. Danson, the present director, munching black, paper-thin piki bread with us as we watch Hopi artisans weaving baskets and rugs, hammering silver, and firing pottery. Among its many educational activities, the museum helps keep Indian arts alive by presenting an annual exhibit in its Spanish-style headquarters at Flagstaff.

And then, Grand Canyon. With mounting excitement we coaxed *Roadrunner* up the long slope from Cameron to the South Rim, and suddenly we were gazing down into the most stupendous sight in Arizona (next page).

We climbed Desert View Watchtower and marveled. It seemed we could see at least half of Arizona and up to the shinbones of Utah—all the way from San Francisco Peaks to Navajo Mountain. The late-afternoon sun was putting its torch to the Painted Desert and the Hopi mesas to the east.





Like a white moth, a twin-engine Piper bears author and family on a flight into Grand Canyon, Zion, Bryce, and Yellowstone (map) lie ahead of the Grays.







BLAIR/SHAWBY © NATIONAL GEOGRAPHIC SOCIETY

Brahma bull chases a rider he has thrown at Frontier Days Rodeo, Prescott, Arizona.

Bull elk chases his lady love at Gardner's Hole in Yellowstone National Park, Wyoming. NATIONAL GEOGRAPHIC photographer Blair entered the area during the fall mating season, when the male wapiti form harems and bugle challenges to rival bulls. "This female," he recalls, "ran toward the bushes where I stood. When we were almost eyeball to eyeball, she saw me and veered off. The male almost ran me down and shook his head in surprise. But nothing could deter him from the chase of the cow."

556



But we couldn't tarry long. We were in a national park. First rule: Nail down a cabin or campsite early, before they are all taken.

Outside the national parks we camped overnight in such diverse places as national forest campgrounds, state parks, private land (with permission), parking lots, and trailer courts. In the parks we always took a campsite, the 26-foot length of *Roadrunner* just filling the parking spur.

At Grand Canyon we performed another national-park rite: attending the evening campfire lecture in the amphitheater. We heard a park naturalist tell the story of how Grand Canyon came to be. Learning about the titanic force that slowly thrust the earth upward against the relentless, scouring flow of the Colorado River helps you understand the phenomenon.

Sightseeing Plane Offers Upward View

Though the river averages only 300 feet across, rain, snow, and rockslide have eaten back the canyon rims as much as 18 miles. At the bottom, the narrow notch of the Inner Gorge alone would swallow the Empire State Building. Yet the North Rim soars more than a mile higher than *that*. This one dimension, bottom to top, duplicates the range of climate from southern Sonora to Canada—a microcosm of our entire 3,000-mile trip!

The next morning we began overlook-hopping—the favorite sport along Grand Canyon's South Rim. For the best lighting, you take the drive west from Grand Canyon Village in the morning and the drive east in the afternoon. At each point you get out and admire God's handiwork.

For a different vista, Henry Hudgin of Grand Canyon Airlines piloted us over and into the canyon. I wondered about our low-wing airplane.

"We use them," he explained, "because during most of the flight you are looking *up* at the canyon walls."

We entered the canyon over Grandview Point and found the air calmer than above the rim. Circling by Desert View and Vishnu Temple, we sailed down-canyon past Bright Angel Trail and Phantom Ranch. Below the Tonto Rim, flying west, we invaded the inner canyon and sped within 100 feet of the churning chocolate waters of the Colorado.

"There's no way of seeing this part of the park except by plane," Henry said, "unless you're a bighorn sheep or wild jackass."

He pointed down, and we saw a herd of the burros descended from a few turned loose by prospectors years ago.

We soared along the North Rim, which lies 215 miles by road from Grand Canyon Village, but only 11 miles straight across the gorge. The highway moves north to Navajo Bridge, crosses the Colorado 467 feet above the water, then turns south.

Next day we followed this route through the 20,884 square miles of the Navajo Indian Reservation, the Nation's largest. We stopped beside the Little Colorado and were engulfed by Navajo children, who touched with wonderment every object in *Roadrunner*.

Along U. S. 89, the once-wandering Navajo have settled down in more or less permanent hogans, from whose doors they sit and watch new nomads roaring by.*

"Rolling hogan—nice," one long-hair brave said, sweeping his eyes over *Roadrunner*.

The land is desert here as far as you can see. A woman took her first look at a vast expanse dotted with sagebrush. "It won't be bad-looking country when all those little trees grow up," she said.

Even without trees, it's one of my favorite drives. You crawl along in elemental splendor at the foot of Echo Cliffs in the late afternoon. The sun stabs into the gleaming vertical rocks. Miles across the Colorado, hidden in its deep canyon, rise the enshadowed Vermilion Cliffs, black and brooding.

Road Climbs "Mountain Lying Down"

The desert ends as you climb 4,400 feet from Navajo Bridge up through House Rock Valley onto the Kaibab Plateau—"mountain lying down," the Indians called it. A stepladder geography parades past your windows: barren sand, mesquite and sagebrush, juniper and piñon, and ponderosa. The wind soughs through the tops of the great trees, and clouds scud overhead as you turn south from Jacob Lake to the North Rim.

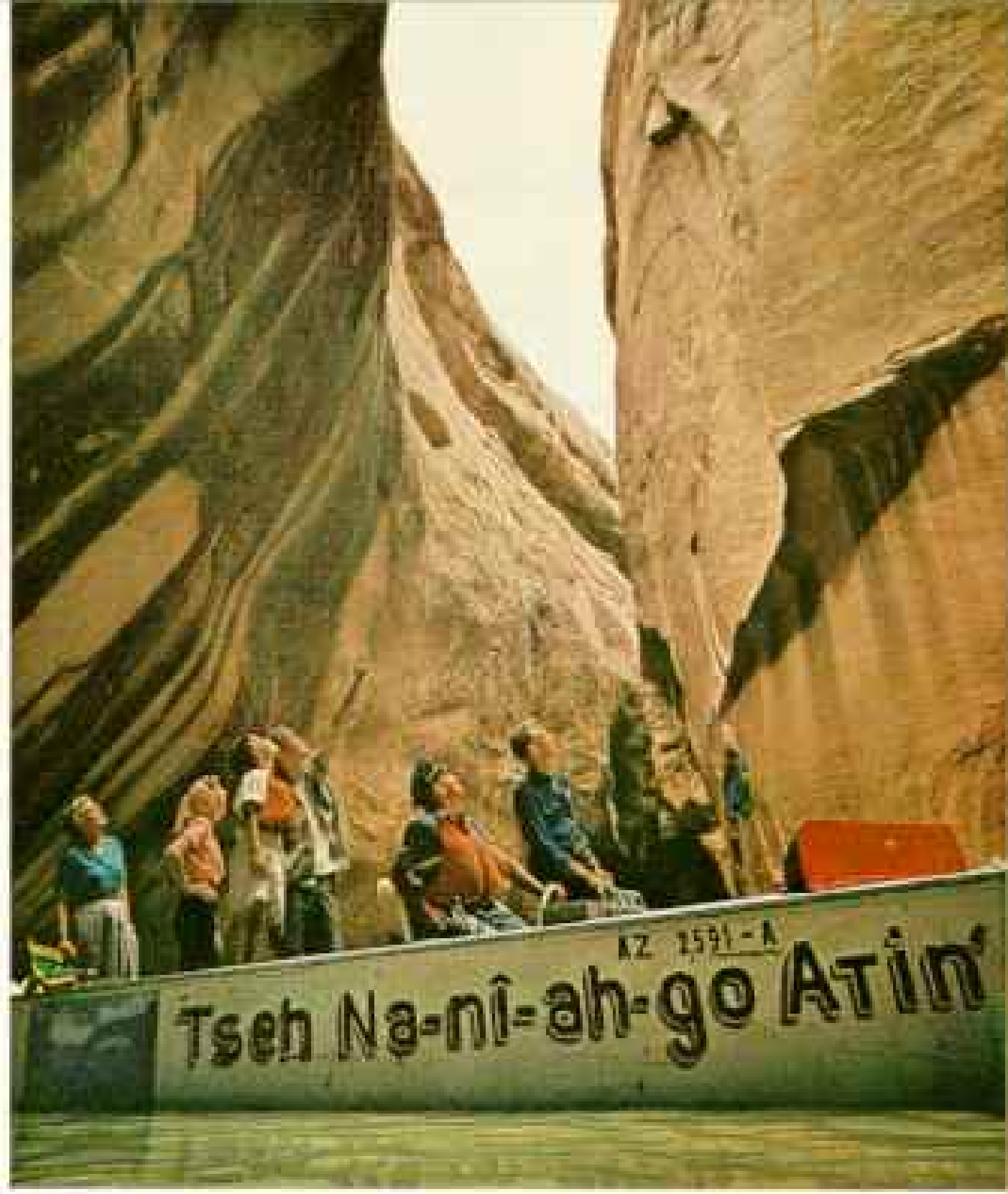
For us it now was dusk. We shivered in the chill of an 8,000-foot elevation. The children kept watch for graceful Kaibab deer grazing among the aspens as we meandered through a long mountain meadow.

Next morning we took the ranger-guided walk to Bright Angel Point, which juts into the canyon the way Cape Cod cleaves the

(Continued on page 562)

*See "Better Days for the Navajos," by Jack Brecht, NATIONAL GEOGRAPHIC, December, 1958.

Beetling walls of Dungeon Canyon, now drowned by Lake Powell, loom above sightseers. Boat's name means "Trail to the Rock That Goes Over," as Navajo call Rainbow Bridge, 10 miles away.



AZ 1531-A
Tseh Na-ni-ah-go Atin'



Arc of 710-foot-high Glen Canyon Dam blocks the Colorado as the river snakes across the Arizona desert. Beside it, travelers on U.S. 89 cross the world's highest steel-arch bridge. Only 16 feet lower than Hoover Dam, Glen Canyon bulks a third larger. Reservoir water has risen 300 feet since it

began backing up in March, 1963 (next two pages). Green lawns of Page, built as a construction town but now a permanent city, gleam where nothing stood 10 years ago. Fairways of Page's irrigated golf course form a maze in the foreground. Trailer camp beyond town is being abandoned.

559

PHOTOGRAPHS BY WALTER BENTON (TOP) AND JAMES H. HARRIS (BOTTOM), NATIONAL GEOGRAPHIC SOCIETY © 1963





**Glen Canyon's Man-made Lake Begins
to Lap Across a Weird and Broken Land**

Lake Powell will drown 254 square miles in enough water to cover Pennsylvania a foot deep. When filled, it will stretch 186 miles upriver, the second largest artificial lake in the United States, after Lake Mead, downstream on the Arizona-



PHOTOGRAPH BY WALTER WESTERS LOWRANCE, NATIONAL GEOGRAPHIC STAFF © N.G.S.

Nevada border. Cities, factories, and farms will draw on Glen Canyon's hydroelectric power and impounded waters. Already the flood hides the Crossing of the Fathers (right of center), where two Spanish padres forded the Colorado in 1776

after days of fruitless search for a place to descend precipitous canyon walls. Finally they hewed steps for their horses in the slick rock. Gunsight Butte (right center) will be left an island as Lake Powell rises almost to the shadow line in this picture.



Atlantic. Below us, crimson temples rose on purple islands, and eroded, pink-banded shorelines connected monstrous promontories flaunting the green dapple of living things.

Explorer Calls Grand Canyon "Profitless"

One of the first Americans to see Grand Canyon, Lt. Joseph C. Ives in 1858, regarded the region as "altogether valueless." He prophesied that his party would be the last "to visit this profitless locality," for once having entered the canyon, he said, "there is nothing to do but leave."

We didn't agree, and Jean best expressed

our reason: "After you've seen Grand Canyon, what do you do for an encore?"

"How about Glen Canyon?" I answered.

Backtracking to Echo Cliffs, we took the new 89 to Page, a new city perched on the plateau above the immense Glen Canyon Dam then being built across the Colorado (page 358). We crossed the great bridge, 700 feet above the river, that had to be constructed before the dam could rise.

We turned off to Wahweap, where my old friend Art Greene has his new diggings—all set up to take people boat riding when Lake Powell, the reservoir behind the dam, fills.



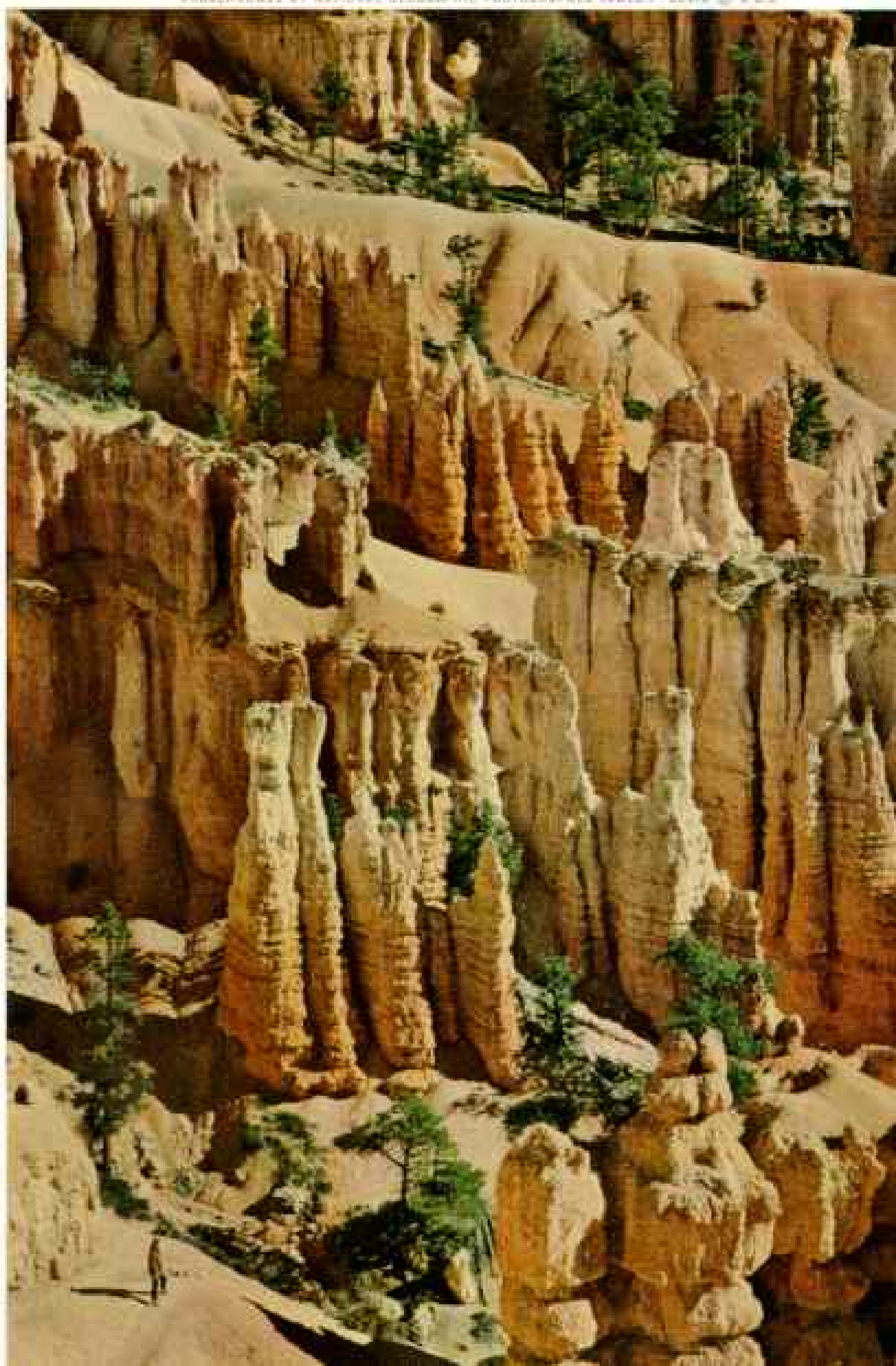
Road and River Wander Through Zion Canyon

Tumbling to the Colorado River with a burden of silt, Utah's North Fork of the Virgin River has carved its way grain by grain through the plateau for 13 million years. Today the top of the Great White Throne (left) lies a dizzy half mile above the canyon floor. White dunes that blew in on desert winds 160 million years ago now form the sandstone of the Throne. This lofty view is from Observation Point.



Saucy roadrunner at Arizona-Sonora Desert Museum kept photographer Jim Blair running for two hours to capture its picture. *Geococcyx californianus* belongs to the cuckoo family.

PHOTOGRAPHERED BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR © 1983



Grotesque chessmen parade down the edge of Paunsaugunt Plateau in Bryce Canyon National Park, Utah. Erosion slowly crumbles away soft rock save where caps of harder stone offer protection. In the millions of years since the plateau arose, the rim has been eaten away in fantastic varicolored shapes. Visitors wander wide-eyed, scarcely able to believe that wind, water, ice, and gravity could work such miracles.

Wahweap sits on a high benchland overlooking a dun wilderness of mammoth sandstone monuments carved by nature.

"It's hard to believe," Art said, "but the water will back right up here below us. We'll send our boats from here to Rainbow Bridge, up the San Juan, and all the way to Hite, Utah."

"As an old desert rat, didn't you object to waters filling up your canyons?" I asked as a group of us prepared for a day on the river.

"Yes, I fought it, but finally I decided 'if you can't lick 'em, jine 'em.' I remember when this country was so lonely that the jackrabbits spoke to the rattlesnakes when they met. Now a whole new breed of people can come out and be adventurers in safety."

On the swift brown Colorado we succumbed to the beauty of the canyon as our boats glided past cliffs 800 feet high.

"Nothing more beautiful in the world," said Art, pointing out a water-stained cliff face. "Take a good look. All this will be drowned."

Later we explored Dungeon Canyon, walking in ankle-deep water through a slit in the rock so narrow we could sometimes touch both sides. This side canyon, like many of its neighbors, is doomed to drown behind Glen Canyon Dam. On the other hand, many natural beauties now barely accessible to the average vacationer—magnificent Rainbow Bridge, for example—will be a comfortable speedboat ride away.*

A windstorm blew up, whipping sand and spume in our faces at the same time. When we returned topside and reached Wahweap, we found the storm had been a real roarer.

*See "Three Roads to Rainbow," by Ralph Gray, NATIONAL GEOGRAPHIC, April, 1957.



An open air vent in *Roadrunner* had let in a reddish-brown dust that covered everything, like instant coffee a quarter of an inch deep. We never got it all out of the upholstery or from nooks and crannies.

"Wherever *Roadrunner* goes, there's some corner of it that is forever Wahweap," said Jean as we beat our way through southern Utah to Zion National Park.

Canyon of the City of God

Zion was a name the Mormon pioneers, who settled all of what is now Utah, gave their desert realm. The term "heavenly city of God" seems especially appropriate for awesome Zion Canyon, lined by great stone temples not built with hands.

We wound our way through the Zion-Mt. Carmel Tunnel and over switchbacks down

Copper-sheathed dome of Utah's Capitol in Salt Lake City looms above State Street, downtown artery for Alternate U.S. 89. Founded in 1847 by Mormons under Brigham Young, the city has burgeoned from a sunbaked pioneer camp in Salt Lake Valley to a metropolis of 417,000. This telephoto view looks south from Ensign Peak.

Like icebergs in a frozen sea, peaks of the Silver Island Mountains rise from lifeless flats in Utah's Great Salt Desert. California-bound pioneers in covered wagons struggled six days to cross the 80-mile-wide waste. In 1963 race driver Craig Breedlove set a world's speed record for jet-powered cars by averaging 407.45 miles an hour on nearby Bonneville Salt Flats Speedway.

565

ENTRANCE BELOW BY NATIONAL GEOGRAPHIC PHOTOGRAPHER BILL LONGER AND TELEPHOTO BY JARRETT BLAY © N.G.S.





RECONSTRUCTED BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JERRY T. BLUM © N.G.S.

Mormon Temple in Salt Lake City glows against a darkening sky; the angel Moroni surmounts a 210-foot spire. Begun in 1853, the granite edifice took 40 years to complete. Only members of the Church of Jesus Christ of Latter-day Saints may enter.

Massive organ pipes obey the commands of tiny keys in Salt Lake City's Mormon Tabernacle. Organist Frank W. Asper controls more than 10,000 pipes; Richard P. Condie directs the 375-voice choir. Unlike the Temple, the Tabernacle admits visitors.



to the canyon floor, then followed the route along the North Fork of the Virgin River.

"Here in Zion the attitude is up," said Ranger Lloyd S. Sandberg, whom we met in the Temple of Sinawava at the road's end. "Unlike Grand Canyon and Bryce, where you look down, Zion puts you in a worshipful stance. Here we're at 4,411 feet above sea level, but we look up another 2,200 feet to see the white spires of Observation Point."

Lloyd is a splendid example of the national parks' seasonal ranger system. A teacher from a local town, he guides groups through The Narrows during the summer.

"I'm a Mormon," he said, "and I've lived near here all my life. My great-grandfather was one of the first settlers in the valley south of the park. This tree I'm leaning against is a Frémont cottonwood. It was John Frémont's exploration that convinced Brigham Young and other Mormon leaders in Illinois that Utah was their promised land."

With 30 or 40 others we followed Lloyd into a narrow, sunless recess almost completely filled by the crashing river. The walls rose 2,000 feet straight up on either side. We began to feel cool and damp.

Lloyd pointed out a great wall of bare rock, oozing and dripping water. "Here, and at Weeping Rock, you can see that Navajo sandstone holds moisture like a sponge."

Soon we reached the end of the trail, but we waded on up the swift, cold stream—the only way to proceed in The Narrows—until we got a good view of Mystery Mountain, its top bleached with sunlight.

Castles Carved From Rock

Bright sun, tempered by 8,000-foot elevations, was our constant companion at nearby Bryce Canyon National Park. Joy, not awe, is the dominant emotion in this Alice-in-Wonderland preserve—actually not a canyon at all, but an escarpment. We parked and ran to the guard rail and gazed at the pink-and-yellow fairyland.

Children were hallooming amid the castles and turrets and fantastic forms on the self-guiding trails below us. Bryce is a favorite of the young—a true playground. It's the sort of park Walt Disney might create, given the time and enough sand.

"Once all this beauty was nothing but a thick layer of silt," said Park Geologist Clele



Fletcher as he started us on the Navajo Loop Trail (page 563). "Later pressures turned it into Wasatch limestone, a pinkish stone easily eroded by wind and rain. Its hardness varies, hence the variety of forms."

At Grand Canyon's Inner Gorge, we had seen some of earth's oldest rock: pre-Cambrian deposits dating back nearly two billion years. The formations at Bryce are chiseled in stone laid down scarcely 55 million years ago, only yesterday on the geological calendar.

Clele pointed along the Pink Cliffs and said: "People have worn out dictionaries trying to describe this scene, but I think the Paiute Indians did it best. They said '*unka-timpe-wa-wince-pockich*,' meaning 'red rocks standing like men in a bowl-shaped canyon.'"

From Bryce Canyon National Park we drove to "little Bryce"—Cedar Breaks National Monument—and parked in the prettiest campground of the trip. At 10,280 feet we forgot the heat of weeks in deserts and canyons; we looked across an alpine meadow dotted with white columbine, Indian paintbrush, and goldenweed. Above our heads the Engelmann spruce sighed a continuous gentle complaint against the wind.

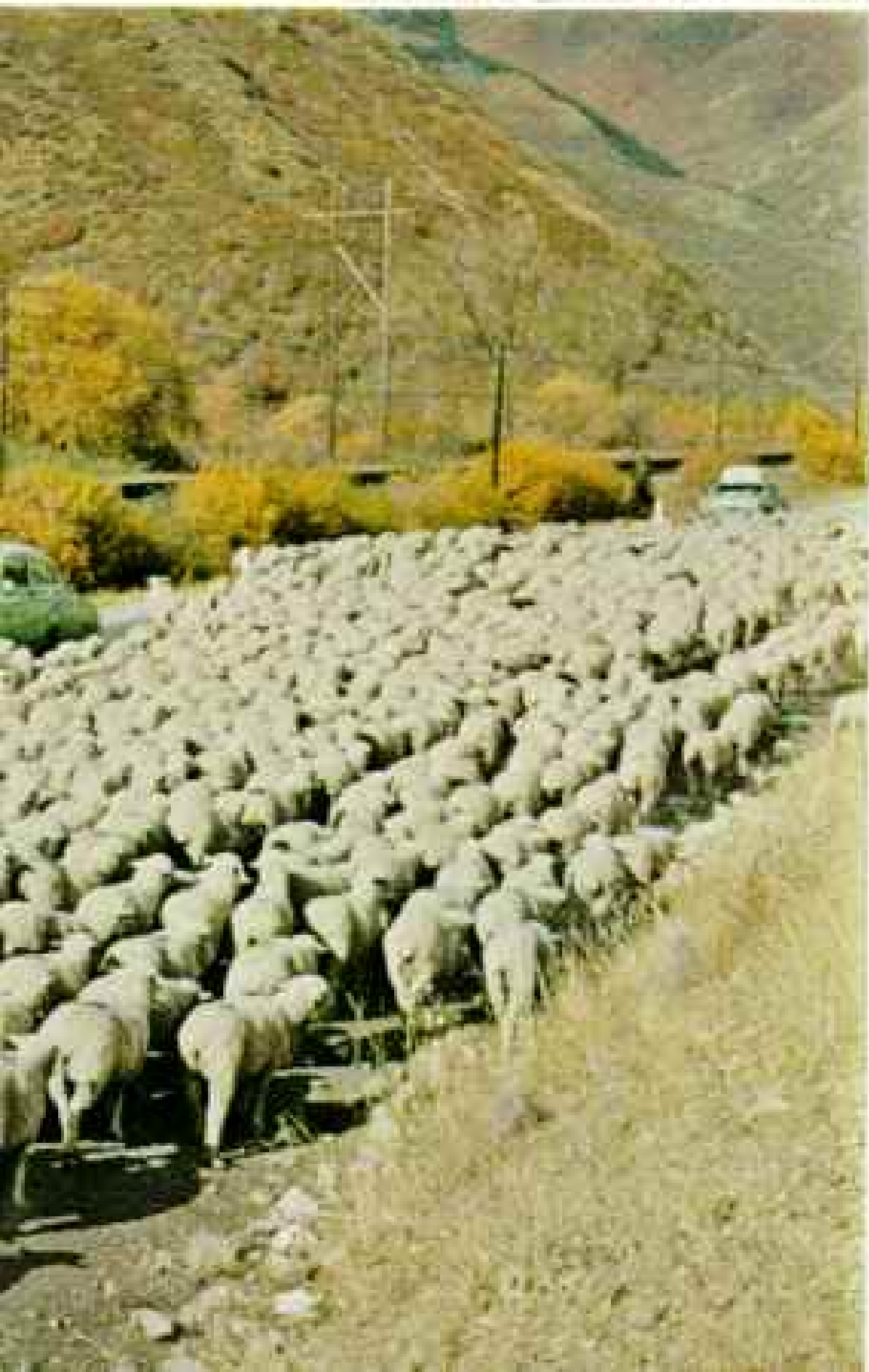


White pelican casts a mirror image in Bear River Migratory Bird Refuge, haven for millions of fowl.

Donna Gray touches history beside a Mormon boy in bronze. Salt Lake City's Hand Cart Monument honors pioneers who walked from the Missouri River to Utah in 1856 and 1857, pushing their belongings.

sheep thrive where cattle would go hungry.

ILLUSTRATION BY NATIONAL GEOGRAPHIC SOCIETY







BY BETACRYSTAL (ROOVE) AND FOLACHERRY © P. L. A.

Molten copper from a refining furnace surges into molds at a reduction plant of the Anaconda Company, Great Falls, Montana. In a continuous operation, the rotating casting wheel returns empty molds to ladles after the bars are dumped.

Where a mountain once towered, Kennecott Copper Corporation's Bingham Canyon Mine stair-steps down half a mile in Utah's Oquirrh Range. Each working day trucks and electric trains haul from the West's largest open-cut mine 300,000 tons of rock and ore that yield about 600 tons of copper. Dikes atop waste dumps impound water. Percolating through the dump, the water collects copper for recovery at a precipitation plant.

Next dawn the meadow was bathed in dew. Little Donna loved it and went out for an early-morning romp. She came back with a glorious bouquet of wild flowers.

"Donna," I said, "I've told you never to pick flowers in a national park."

"I thought this was a national monument."

"It's the same thing. These flowers belong to everybody."

"We're part of everybody, aren't we? I just picked our part."

At times only one argument can conquer a seven-year-old's logic. "Don't do it again," I said. She didn't.

From the canyon country, U. S. 89 wends north through connecting valleys to the rich Valley of Utah, where the history and works of man almost equal those of nature. Salt Lake City, Ogden, and Provo, Utah's three largest cities, rise from terraces beneath the beetling Wasatch Range and overlook two lakes whose identical blueness gives no hint that one (Utah) is fresh and the other (Great Salt) is saltier than the ocean.

Western Crossroads: Salt Lake City

At Salt Lake City's Temple Square, we slipped into the Tabernacle to hear the famous choir rehearse, while Jim Blair and Jerry Wiley busied themselves photographing its pipe organ and 375 choristers. Mormons labored 40 years to build the nearby Temple, their "Holy of Holies" (page 566).

As a non-Mormon coming into Mormonism's chief city every few years, I am amazed over and over at the greatness of its founder, Brigham Young. Like Moses, he brought his people to this promised land across a thousand miles of plains and mountains, decided that "this is the place," and even determined such details as the peculiar turtlelike shape of the Tabernacle. According to one yarn, he designed its ceiling after "the best sounding board in the world—the roof of my mouth."

On July 24, 1847, Brigham Young joined other pioneers in a temporary camp on a fork of City Creek. They had thrown a dam across the stream for irrigation and plowed the first land for planting.

Four days later Young assembled the Saints and said, "Shall we . . . upon this spot . . . build a city? We propose . . . that the streets be 88 feet wide, sidewalks 20 feet, the lots to contain 1 1/4 acres, eight lots in a block, the houses . . . 20 feet back from the street. . . ."

Salt Lake City's geometric spaciousness still reflects this grandiose plan. Today the metropolis counts 417,000 inhabitants.



PHOTOGRAPHS BY RALPH GRAY (LEFT) AND LARLE F. BLAIR © B&B



Summertime ranger and noted outdoorstman-writer, Albert Van S. Pulling lent canoes for the Grays' trip to Shoshone Lake in Yellowstone Park.

Impossible wave seems to menace four blurred paddlers on Shoshone Lake. The author shot the scene on wet film after a slip dunked his camera.

In damp camp on the cold lake shore, the Grays rush to eat before the sun drops. That night they hung all food out of reach of bears. "But," says the author, "not one showed up. On the road next morning, we ran a gantlet of highway-hiking bears."

Many a 49'er passing through must have enjoyed a giddy moment bathing in Great Salt Lake. Never ones to slight a tourist ritual, we did the same—discovering again the almost unbelievable fact that you cannot sink in this super salty water (page 547).

In the flats northeast of the lake we found flocks of waterfowl and wading birds enjoying the myriad ponds of Bear River Migratory Bird Refuge (page 569). The water, fresh from the nearby hills, was clear and sweet.

"Birds of the Rocky Mountain flyway congregate here at all seasons," said Roger D. Johnson, assistant refuge manager, as he guided us around. "Like you folks, they range from Mexico to Canada."

We roared through the waterways in an air-propelled boat. Birds disturbed by our passage circled and settled down where they had been feeding or preening—black-crowned night herons, white pelicans, western grebes, Forster's terns, gadwalls, pintails, black-necked stilts, coots, glossy ibises, sandpipers, avocets, and many others.

Bird-watchers of another sort were busy in nearby Ogden's freight yards where specialists were seeing that a Minuteman missile was properly loaded for its trip to Malmstrom Air Force Base in Montana. Encased in an enormous vehicle called a Transporter-erector, the "bird" had moved from its Ogden factory by highway and would ride piggyback on rails to Great Falls, Montana, where it would crawl again by road to its silo buried under a wheat field.

Later in our trip U. S. 89 would take us across the 18,000 square miles of farmland pitted by the silos of Malmstrom's missile installations (pages 576-7).

Utah and Oregon Share Bear Lake

Cutting through the Wasatch Range, which had walled us on the east so long, U. S. 89 followed the rollicking Logan River to a pass nearly 7,000 feet above sea level. Thus suddenly we were in the high country. We looked down in late afternoon on Bear Lake, shaped like a robin's egg and just as blue.



RESEARCHER BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR © N.G.P.

The Utah-Idaho line cuts it in half. "It's too beautiful for one state to claim it all," said Mary Ellen.

The highway teased us with just a corner of Idaho. Then we were in Wyoming, curving north through fertile valleys to the canyon of the Snake River, and finally to Jackson Hole—the fur-trappers' rendezvous of 130 years ago that has become a tourists' meeting place today. Jackson remembers its cowboy past, combining hitching posts and parking lots, coin-operated laundries and wooden sidewalks, the Pink Garter Theatre and the Jackson Hole String Quartet (page 579).

Jackson funnels traffic from the south into the highland playgrounds of Grand Teton and Yellowstone. As we drove north, the great range of the Tetons reared snow-streaked peaks 7,000 feet and more above us.

"I've never seen mountains like these," said Will at an overlook. "They go straight up."

We drove directly to the Jenny Lake campground, where the ranger, harried by overcrowding, took one look at *Roadrunner* and

said, "If you can turn that thing around, you'd better take it to the climbers' camp."

This advice put us right where we wanted to be—among the climbers who congregate at the foot of Teewinot and Grand Teton. There we found 25 or so campers—muscular young men, and girls to whom nylon now meant 120-foot coils of climbing rope. They were living in tents, cooking over campfires, and marking time with short climbs until that glorious day when all conditions would be "go" and they'd tackle "the Grand."

Hootenanny Starts With Teton Tea

We had meant to do nothing but observe and report, but Bill Briggs urged active participation. "You can see how simple and safe rock climbing is."

Bill, unofficial boss of the climbers' camp, is a mountaineering teacher and guide in the summertime and a ski instructor in winter. He continued his campaign to get me at the end of a rope by inviting us to the regular Tuesday night "Teton Tea."



GHOST IN MISTY VAPORS, Will Gray trails his family through steaming vents and hot springs of Norris Geyser Basin at Yellowstone National Park.

STONY MINERALS coat grass and moss (magnified 7½ times) beside a scalding pool.

KODACHROMES © NATIONAL GEOGRAPHIC SOCIETY





We picked our way to where a huge bonfire was ringed by people sipping from aluminum cups. Bill thrust a potion in my hand; it was warm and tasted tea-ish, but its real strength came from other ingredients.

"We're just making up some more Teton tea," said Bill. I watched while a washtub of boiling water, teabags, red and white wine, and pine-cone windfalls from the trees all came together in a formula I will not divulge, lest lesser men come to grief thereby.

The cheering cup was passed around, and suddenly guitars and autoharps twanged in a high-country hootenanny. I listened to folk songs and ballads until someone in the dark across the circle gave voice to:

"One of these days, I'm gonna climb
that mountain . . .

Walk up on them clouds . . ."

I said, "Okay, Bill. You got me. I'll go up on your rockpile with you tomorrow."

Several of us enrolled for the one-day course of Glenn Exum's mountaineering school. Pete Lev, our chief guide, and Bill took us and the other students across Jenny Lake and up a rocky trail beside Hidden Falls.

When we had climbed so high that the lake looked like a blue teardrop, Pete and Bill gave us a lecture. After a few preliminaries, they had us dropping backward over a cliff in a maneuver called a free rappel (page 579).

Did I mention that we were on ropes? My son Will and I both did well; he was too young to be afraid and I was too old to admit it.

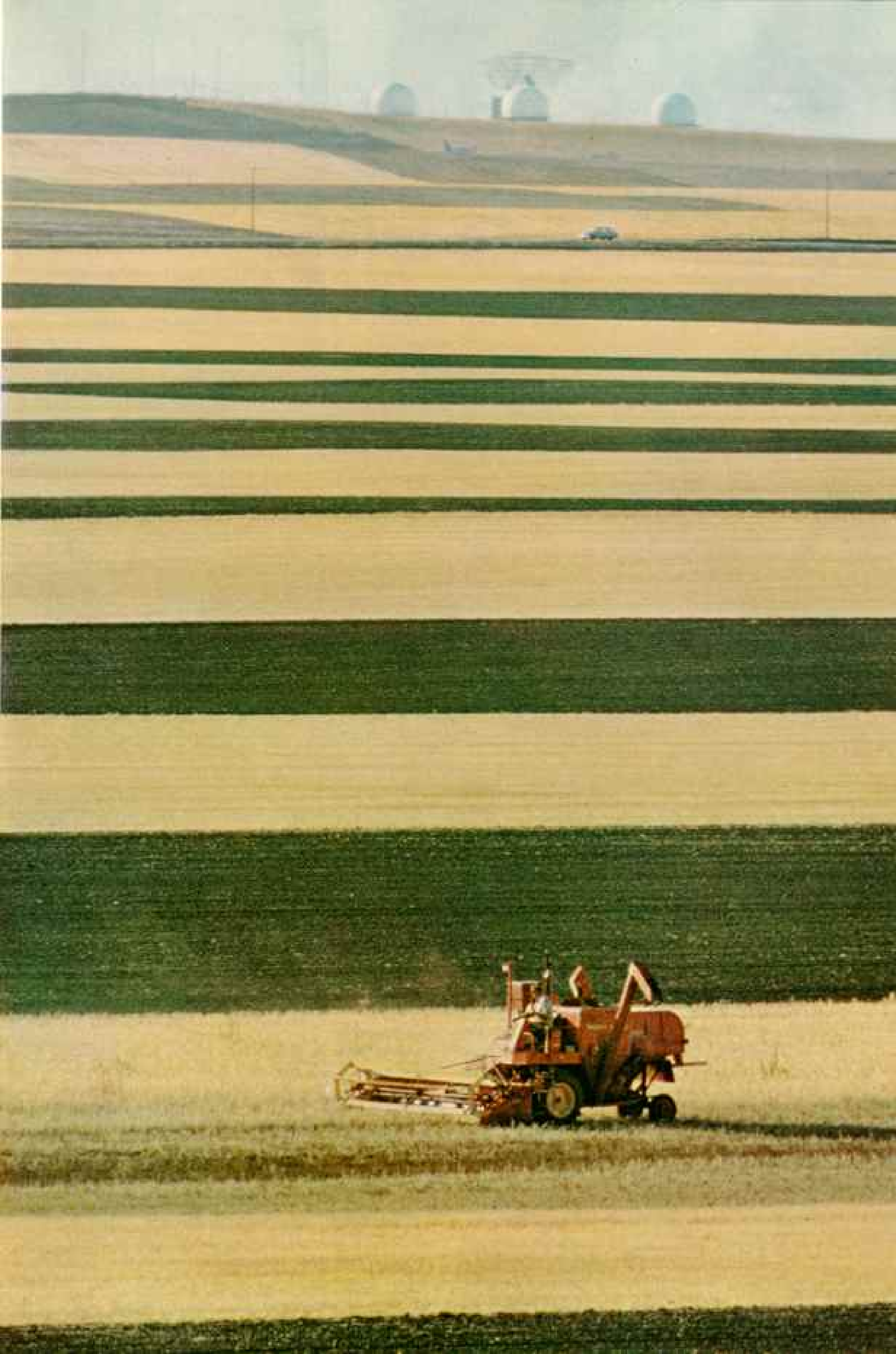
Yellowstone, the granddaddy of all national parks, is still just that. No American can say

Transporter-erector cloaks a Minuteman intercontinental missile during emplacement at Malmstrom Air Force Base, Montana. Airmen of the 341st Strategic Missile Wing stand guard as hydraulic arms raise the weapon above an underground silo. An enclosed winch will lower it into its steel-and-concrete nest. Across Montana wheat fields 150 nuclear-tipped Minutemen stand poised as deterrents to war. Only the President may order them sent roaring skyward.

Five-ton door looms above Mary Ellen Gray as she enters an access hatch for a peek inside an unfinished Minuteman silo.

Radar domes beside Route 89 stand sentry to give warning of any enemy craft approaching Malmstrom. Paths of ripe wheat alternate with strips left fallow.





he has "done" the West until he has seen the marvels that inspired the world's first national park: the geyser basins, hot springs, waterfalls, and lakes; the great canyon, the alpine meadows abounding with wildlife.

With thousands of others we toured them all. With hundreds we gathered to watch Old Faithful perform. ("What time does the old-fashioned go off?" I heard a lady ask her companion as they rushed to the scene.)

Actually, Old Faithful now erupts just as regularly as before an earthquake in 1959

minged us of suburban shopping plazas at home. We wanted to get off the beaten track. At Lewis Lake, seasonal ranger Galen S. Tidrick told me about the Shoshone wilderness.

"It includes the entire southwest corner of the park," he said. "You get there by foot, horseback, or motorless boat. I have to go up to Shoshone Lake tomorrow on a survey trip. Want to come along?"

While we made arrangements outside his trailer office-home, I complimented him on the size of the mosquitoes that were silently



Lunging madly, a wild horse evades an Indian's lariat during a roundup on the Blackfeet

knocked many of Yellowstone's geysers off schedule.* About every 65 minutes it shoots a plume of steam 130 feet or more into the air.

Yellowstone is so big that you call long distance from point to point. Driving the Grand Loop may take longer than you think because of the bear jams. Bruin comes panhandling along the highway, and the first motorist stops to photograph him. Soon all traffic both ways is stopped.

We took part in elk jams and moose jams, too, and claim credit for a Yellowstone first: a wild-flower jam, caused when we stopped to gambol on a meadow ablaze with color near Mount Washburn's 10,000-foot heights.

Yellowstone's crowded tourist centers re-

making a sieve of me. "Yes, they're the only wildlife in the park you're allowed to feed," Galen said.

Next day we filled two boats with people and gear, sped across Lewis Lake, and entered Lewis channel. A sign said "No Motors Beyond This Point." Galen and Kenneth Lindfors, a year-round ranger, began rowing upstream between narrowing banks lined with lodgepole pine. The current quickened; soon nearly all of us were wading and pushing.

The entire outflow of Shoshone Lake, a source of the mighty Snake River, pushed against our legs, sometimes sweeping our

*See "The Night the Mountains Moved," by Samuel W. Matthews, NATIONAL GEOGRAPHIC, March, 1960.

feet off the bottom. It was mulish work. My upper half was bathed in sweat and my lower half was refrigerated. I stepped into a hole, dousing my wallet and camera.

I looked around. It was amazing that, among the thousands supposedly enjoying themselves in Yellowstone that day, we had all this fun to ourselves.

A chill wind stirred the surface of Shoshone into a whitecap froth.



Four-horse stage and 200-horsepower *Roadrunner* meet at Jackson, Wyoming. Vacationists seeking the Old West ride the coach and stroll past stores on wooden sidewalks.



Swinging from a rock overhang in Grand Teton National Park, Wyoming, the author executes a free rappel at the Exum School of Mountaineering. Riding a nylon harness, he controls his descent by tightening or slackening the ropes' pressure. Jenny Lake and Jackson Hole, rendezvous of beaver trappers more than a century ago, stretch in the distance.

PHOTOGRAPHS © NATURAL GEOGRAPHIC SOCIETY

Reservation near Browning, Montana.

We transferred to canoes and fought our way up-lake. The bedrolls and bundled clothing made admirable sponges for the water splashing in.

We managed to set up camp and eat our supper fast enough to keep the pipelines to the mosquitoes filled (page 573). What food was left I cached against bears, and we all crawled into damp bedding.

The wind freshened during the night, and rain was in the offing when we rose. We were happy to see these signs, because the main purpose of being in a wilderness area is to join with nature in all its



moods. We finished breakfast and struck camp in a hurry so that we would be out on the lake in the open canoes to enjoy the offerings of nature to the fullest.

We planned it perfectly. Halfway back to the outlet, the rain started. It wasn't a down-pour, but the near-freezing cold eased our disappointment. We finally reached shore and returned our canoes to their owner, the white-bearded, pink-cheeked man who rules over Shoshone Lake for the Park Service—Albert Van S. Pulling (page 572).

This respected woodsman and author of books on canoeing, under the name Pierre

Pulling, had built a fire under a tarpaulin. He was giving us a choice of pleasures: Either stand out in the invigorating rain or hunch under the smoke-filled canvas and let the tears of joy come to our eyes. After enjoying as much of this as we could stand, we exultantly walked the four miles back to the highway on a trail deep enough in water to keep our feet from getting overheated.

You may run across people who return from wilderness outings with no joy on their faces, but we found the last part of our venture to be the best part.

U. S. 89 uses the valleys of the Gardner and



High in Canada's Columbia Icefield, a Snowmobile's passengers peer into a crevasse of Athabasca Glacier. Melt from the three-way divide flows to the Pacific, Arctic, and Atlantic.

Yellowstone Rivers as a route out of the big park. We followed the ever-broadening torrents down to Livingston, Montana, then continued north through the land of the big sky to the Little Belt Mountains. We camped in the Lewis and Clark National Forest and crossed the trail of those pathfinders the next day as we entered Great Falls.*

Lewis and Clark spent a month portaging around the Missouri River falls that gave the city its name. Dams now have tamed the turbulent water, and the commercial center that has sprung up here since 1883 serves a rich farming and mining region. Great Falls'

dominant landmark, visible for miles across the plains, is the 506-foot brick smokestack that rises above the Anaconda Company's reduction plant (page 571).

The flavor of an earlier, wilder West remains, however, in the paintings of Charles Russell, the cowboy artist. Great Falls remembers him by preserving his log-cabin studio and displaying many of his rip-roaring paintings in a modern gallery next door.

Big Montana's biggest city was the start

*The Gray family's adventures in "Following the Trail of Lewis and Clark," appeared in NATIONAL GEOGRAPHIC, June, 1953.



MEMORABLE BY NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. SLAY © U.S.G.

Triple-crowned Mount Merritt holds its 9,944-foot summit in clouds over Glacier National Park, Montana. Sixteen hundred square miles of precipitous peaks, knife-edged ridges, and forested valleys form the United States' share of the Waterton-Glacier International Peace Park, which straddles the Canadian border.

of a new trail for our daughter Mary Ellen. A rear-view mirror has more than one use, and I had noticed that Jerry Wiley was beginning to take closeups of Mary Ellen without his motion-picture camera.

The bright lights of Great Falls put us all in a holiday mood. It was a wedding anniversary for Jean and me. I stood the crowd to dinner and a nostalgic movie. Somewhere between boy-loses-girl and boy-gets-girl, Jerry and Mary Ellen fell in love. Now they are married.

After crossing northern Montana's striped wheat fields, only the high grass of the Blackfeet Indian Reservation separated us from the snowy peaks of Glacier National Park.

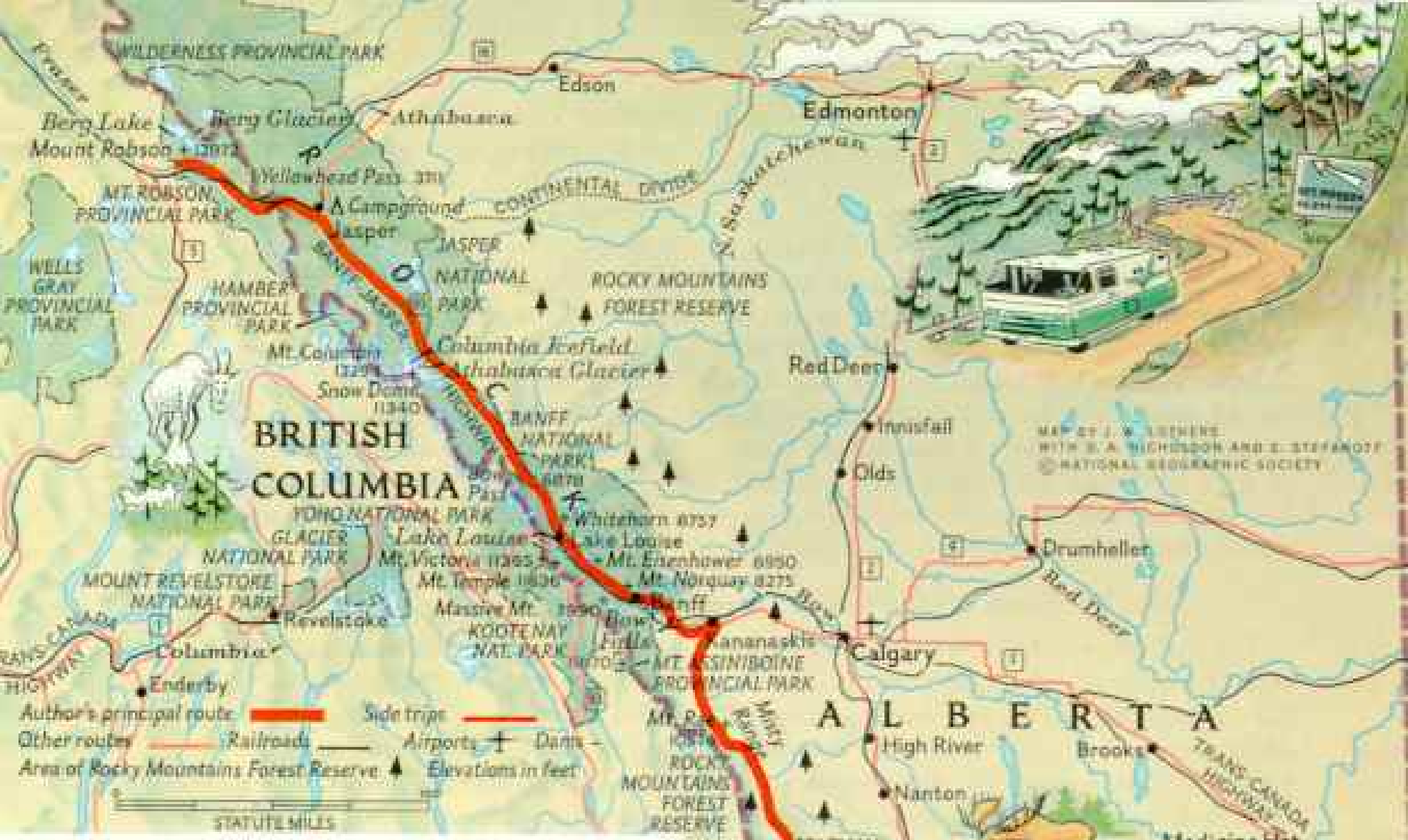
This final United States playground on our national parks highway preserves the untouched-wilderness look best of all. Lush forests, parted by long lakes, push upward to where the sharp, bare mountains rear madly as if trying to shake off their encumbering glaciers and snowfields.

Side Hill Gouger Travels in Circles

This is a park of trails; more than 1,000 miles of paths wind through forests, on cliff-sides, and beside alpine torrents. Only one road crosses Glacier—the magnificent Going-to-the-Sun Highway, 50 miles long. We eased *Roadrunner* up above timberline, with Donna counting the glaciers.

Wilderness pathway beckons visitors in Glacier National Park. On a ride from Many Glacier Hotel, they turn their backs on snow-streaked Mount Gould and the saw-toothed Garden Wall and file past Allen Mountain (left). Leaving Glacier, the Grays ventured north as far as Mount Robson, British Columbia (map), before turning homeward.





Jim Blair had been talking with James Whitt, Glacier's foremost "dude-wrangler" and humorist. Now he passed along to Donna some amazing wildlife lore.

"Keep a lookout for the Glacier Whooper," Jim said. "No one knows much about him because he has a broom on his tail to sweep away his tracks. Then there's the Side Hill Gouger. He has legs longer on one side than on the other and can only travel around the mountain one way. Once a right-legged mother gave birth to a left-legged baby, and they had to walk clear around the mountain in opposite directions before she could feed him."

Time Not Taken From a Life

The true glories of Glacier were more than enough for the rest of us. Beyond Logan Pass, the Continental Divide, we parked where an alpine stream roared beside the road and followed it on foot almost straight up to its snowfield birthplace. The milky snowmelt meandered in rivulets across a spongy, flowery

meadow below us, gathered its dispersed might, and plunged down to that other world we had come from.

John Muir, the famous naturalist, wrote that the time spent in Glacier "will not be taken from the sum of your life. Instead of shortening, it will indefinitely lengthen it and make you truly immortal."

Immortal or not, after we camped beside Lake McDonald and rode horseback from Many Glacier to Ptarmigan Falls it was time to leave Glacier National Park.

The fabulous Canadian Rockies—the shining mountains—lay ahead of us, groaning under their weight of glaciers and icefields. In Canada we had several choices of roads to continue our "International 89." We chose the route that clung most closely to the ridge of the Rockies, stringing together the greatest number of national park pearls.

So we crossed into Alberta at Chief Mountain customs station, going from one national park to another, or, more accurately, staying

ILLUSTRATIONS BY GLENN HOWES (LEFT) AND JAMES P. BLAIR © NATIONAL GEOGRAPHIC SOCIETY



Hunters with cameras take aim at a mountain goat unconcernedly crossing Banff-Jasper Highway in Alberta.

Mule deer in velvet accepts a handout on the Banff road.

Browsing moose in Grand Teton National Park leaves a wake in a grass-choked pond.





within one great preserve—the Waterton-Glacier International Peace Park.

Chief Warden Frank Camp told me that the United States furnished close to one-fifth of Waterton Lakes National Park's visitors. From there, north along the Coleman-Kananaskis Road, we drove through towering pines of the Rocky Mountains Forest Reserve to the town of Banff, at the southeast end of Banff National Park, Alberta.

At the nearby falls of the Bow River, I parked *Roadrunner* and sat in the driver's seat watching the creamy water return to its natural turquoise color. Suddenly a voice at my window asked where the golf course was. I said I didn't know, I'd just arrived myself. The man drifted off, muttering to his wife, "Even the bus driver doesn't know!"

North America's Three-way Divide

The wayward bus driver found the highway signs pointing upward as he drove to Lake Louise in the deep corridor of the Bow River. Arrows identify the peaks high above the road: Norquay, Massive, Eisenhower, Temple. We climbed one of them—Whitehorn—the easy way, by sedan lift (page 546).

A 20-minute ride in enclosed cars brought us to the most sublime panorama of the entire trip. Looking southward from our 6,761-foot eyrie, we scanned 75 miles of the serrated, snow-crowned Continental Divide. Directly in front of us, 11,365-foot Mount Victoria flaunted its huge glacier. At its foot, Lake Louise lay daintily cupped in a forest setting.

At Bow Pass the chills of the Arctic assailed us. We were higher above sea level than we had been on Whitehorn. Rain fell intermittently out of sullen skies. Water was everywhere—frozen, falling, lying colorfully in lakes, or rushing madly toward the most convenient ocean.

So far all water we had seen (except in the Great Salt Lake Basin) flowed either to the Pacific or into one of the Atlantic's great arms—the Gulf of Mexico or Hudson Bay. But as we entered Jasper National Park, we looked up and saw Snow Dome, the triple divide of North America. Its shining crown of ice, part of the 130 square miles of the Columbia Icefield, sends melt not only to the Atlantic and Pacific but to the Arctic Ocean as well.

As we camped at the edge of Athabasca Glacier, grateful for *Roadrunner's* propane heater, we were in the Arctic watershed—and the air felt like it!

Next morning early we drove up the steep road along the moraine beside this great tooth



Roadrunner Stirs Dust Under Mount Rae, Northernmost Sentinel of the Misty Range

Lodgepole pines march beside the gravel Coleman-Kananaskis Road in Canada's Rocky Mountains Forest Reserve. Bulldozed through coulees, foothills, and mountain passes, the highway attracts thousands of sightseers annually. Streams in the reserve teem with trout and whitefish. Moose, bear, elk, and mountain sheep and goat draw hunters in season. Mount Rae, bare of snow when the Grays drove past in August, is robed in white throughout the winter.

Doorstep campfire warms the home-bound family at a roadside park in Montana. Reminiscing about *Roadrunner* life, the travelers recalled the hungry Yellowstone bear that sniffed the refrigerator vent of their roving home, and the Bryce Canyon Park gasoline station attendant who remarked, "First time I've had to step into a living room to check the oil."



ROADTRIPPER BY JAMES P. BLAIR © NATIONAL GEOGRAPHIC SOCIETY







of ice that snaggles down from the Columbia Icefield.

"It's too bad you missed our summer," said Chester Kongsrude, manager of Snowmobile Tours. "Yesterday and the day before were nice and sunny."

We stepped onto the surface of Athabasca Glacier—a wrinkled ice cube 600 to 1,000 feet deep, half a mile wide, and four miles long. Next came a ride aboard a beetle-like Snowmobile which sped us along an ice highway. Our driver stopped to allow brief hikes across the frigid waste and once paused with the front wheel suspended over a crevasse 150 feet deep (page 580).

"We take 1,000 to 1,200 people a day onto the glacier," said Kongsrude, "and nobody has ever asked for his money back."

Clouds Cap Moby Dick of Mountains

The town of Jasper is as pretty as Banff, and it has a bit of a northwoods look to boot. This is the end of the trail for many big scenery hunters, but one monstrous specimen still awaited us—Mount Robson. We took an earth road barely wider than *Roadrunner* that pushes northwest beside the Canadian National Railway and enters British Columbia at Yellowhead Pass.

Clouds followed us. Rain fell. We kept alert for our first glimpse of Robson. Finally, after 53 miles, the Moby Dick of mountains burst into view—rising in lone grandeur, a small white continent in itself (left). Clouds clung to the upper third of the pyramidal peak, allowing us only brief glimpses of Mount Robson's 12,972-foot summit.

Here at last was the end of the trail. *Roadrunner* had taken us from the warm shores of the western sea, across parched desert and fertile plain, through rocky canyon and green forest, to the fringes of the Arctic. No comfortable home on wheels could be expected to push farther north on the narrowing rough roads. This was achievement enough.

I patted the beast's snub nose, climbed in, and pushed the "D" button. North America's most redoubtable piece of rolling stock headed home.

THE END

Iceberg and Glass-fiber Boat Support Riders on Mile-high Berg Lake

Inching into the British Columbia lake from the far shore, the toe of Berg Glacier drops tons-heavy chunks of ice whose splash would swamp a rowboat. Cloud-plumed Mount Robson, crown of the Canadian Rockies, rises 12,972 feet. Only expert climbers challenge its ice-sheathed slopes.

BOOKENRUBBY HARRY BOWEN © 1983

New Portrait of North America

From Viking beachhead to space center, cartographers remap a continent

A THOUSAND YEARS AGO the keel of a Viking longship grated on a cold and nameless coast. Bold, bearded men stepped ashore and built a rude settlement, little dreaming the magnitude of their discovery.

In the 19th century the restless Rio Grande changed channels, bestowing several hundred acres of Mexico upon the State of Texas.

A few months ago these remote and unrelated events changed from history to headlines—and National Geographic Society cartographers turned to the task of changing the latest plate in the Society's Atlas Series, *North America*, distributed to members with this issue of their magazine.*

Explorer Discovers Norse Ruins

Until last fall, few but its 50-odd residents had ever heard of L'Anse au Meadow, on the northern tip of the Island of Newfoundland. Then the Norwegian explorer Helge Ingstad announced an electrifying find near that tiny fishing village: A ruined community of turf-walled houses built by Norsemen—perhaps Leif Ericson himself—about A.D. 1000, five centuries before Columbus embarked on his voyage of rediscovery.

Icelandic sagas, long dismissed as fanciful, sang of the passage of "Leif the Lucky" westward to a strange new shore. But Mr. Ingstad's expedition, supported in part by your

Society, provided the first conclusive proof of pre-Columbian settlement by white men on North American soil.

National Geographic map makers promptly pinpointed L'Anse au Meadow, a few miles southwest of Cape Bauld. The new Atlas sheet shows this to be a natural landfall for daring sailors making the treacherous voyage without charts or navigational instruments.

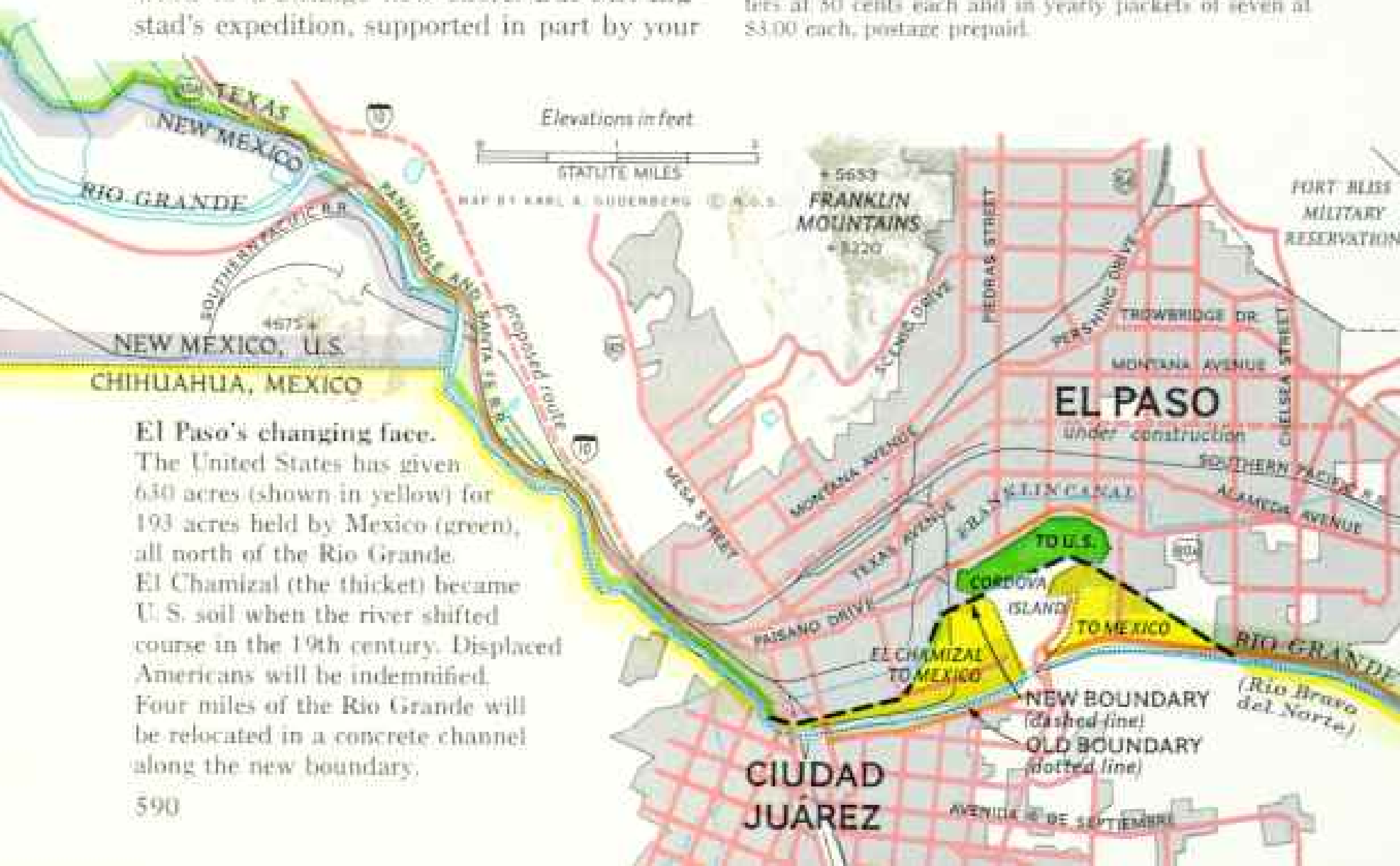
Rectifying the whim of the Rio Grande on the new North America map was a different matter. An exchange of treaty ratifications on January 14, 1964, restored to Mexico a large part of El Paso's Chamizal (thicket) zone, settling a century-old dispute.

The cartographers computed. On the scale of the new map, the boundary would move .002 of an inch—less than the width of a human hair. Even with today's exacting engraving and printing standards, the eye could not detect the change (below).

Day-to-day attention to such detail assures Society members the most accurate and up-to-date map of North America now available.

Outward soar the red-dashed rocket pathways of the Pacific and Atlantic Missile Ranges. The launch point of the latter now bears

*Extra copies of *North America*—and all other Atlas Series Maps published as supplements to *NATIONAL GEOGRAPHIC*—may be obtained from Society headquarters at 50 cents each and in yearly packets of seven at \$3.00 each, postage prepaid.



El Paso's changing face.

The United States has given 630 acres (shown in yellow) for 193 acres held by Mexico (green), all north of the Rio Grande. El Chamizal (the thicket) became U. S. soil when the river shifted course in the 19th century. Displaced Americans will be indemnified. Four miles of the Rio Grande will be relocated in a concrete channel along the new boundary.

two names, among the oldest and newest on the continent.

Cape Canaveral, sighted by Ponce de Leon in 1513 when he claimed Florida for Spain, was named by later Spanish explorers for the canelike reeds that grew there 400 years ago. Last fall President Lyndon B. Johnson changed the name of the rocket-studded sandspit to Cape Kennedy. The townsite on the Cape, however, retains the historic Spanish name, following its residents' wishes.

Natural Trenches Form Huge Reservoirs

North America, the third largest continent after Asia and Africa, abounds in natural superlatives, as the new 11-color Atlas Map clearly shows. From Arctic edge to Yucatán flatlands, for example, rolls the world's largest plain. A splash of blue in the center delineates this planet's largest fresh-water lake—Superior. In Arizona lies its greatest gorge—the Grand Canyon of the Colorado, which could comfortably hold 100 Great Salt Lakes.

In another spectacular Western chasm (pages 558-9), water is already backing up behind Glen Canyon Dam, near the Utah-Arizona border—part of the massive Colorado River Storage Project. When full, man-made Lake Powell will hold a two-year flow of the Colorado in rock-walled depths that could easily submerge the Washington Monument. In addition to creating a great new wilderness playground, the project will send hydroelectric power surging into five neighboring states.

A tangled mesh of major highways spreads across the map's midsection, including the route taken by NATIONAL GEOGRAPHIC's Ralph Gray between Guaymas, Mexico, and Mount Robson in British Columbia (his account begins on page 542). Bolder red lines trace continuing conquests of the road builders; the Alaska, Trans-Canada, and Pan American Highways. Even now surveyors are forging the final overland link between

North and South America through dense jungle from Panama into Colombia.

The scale of the 19-by-25-inch Atlas chart, including portions of the U.S.S.R., Norway, and Brazil, permits an inset detailing the Aleutian Islands and the Bering Sea. Here, too, one can read man's mark upon the continent.

North America was first peopled by nomads who crossed from Asia perhaps 30,000 years ago. Through shallow Bering Strait, daring U. S. submarines of the

nuclear age have pioneered a possible under-sea trade route beneath Arctic ice.

A century ago historian Francis Parkman wrote of North America: "A boundless vision grows upon us; an untamed continent; vast wastes of forest verdure; mountains silent in primeval sleep; river, lake, and glimmering pool; wilderness oceans mingling with the sky." Today's map makers must put the "boundless vision" into bounds.

How to transpose this segment of the globe to flat paper with least distortion and scale error? The time-honored Mercator projection depicts the world as a flattened cylinder, with

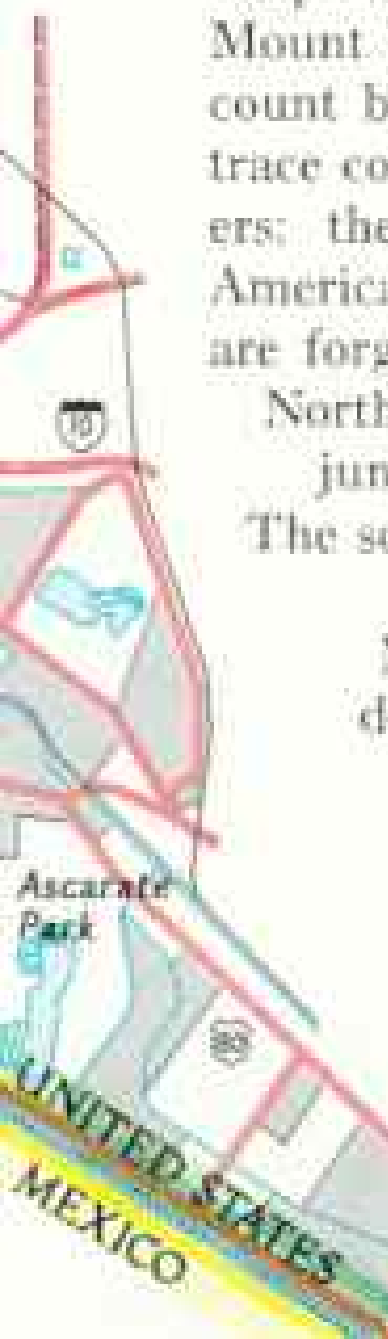


PHOTOGRAPH BY ANDY BRISTOL © N.G.S.


Unearthing a Viking home, explorer Helge Ingstad finds in Newfoundland first conclusive proof that Norsemen reached and settled the New World a thousand years ago.

polar areas stretched out as wide as the Equator. Though invaluable to navigators, a Mercator map of this region shows Greenland twice the size of South America; actually it is only slightly larger than Mexico.

National Geographic cartographers solved no fewer than 690 problems in spherical trigonometry to draw this Atlas Plate on the Chamberlin Trimetric Projection, devised in 1946 by the Society's Cartographic Engineer Wellman Chamberlin. The result: On North America, Greenland's true area is exaggerated by less than 3½ percent. THE END







Over and Under Chesapeake Bay

By DAVID S. BOYER
National Geographic Staff

Photographs by the author

THROUGH THE FOG came the wail of a ferryboat. Out where the Atlantic pulses into Chesapeake Bay, the *S. S. Pocahontas* was mournfully sounding her foghorn—and her own swan song.

One day this spring, she and six other ocean-going ferries will tie up at their Virginia slips for the last time. The cars and trucks they now haul to sea will roll on their own wheels 17.6 miles over, under, and through this windswept arm of the Atlantic. The 200-million-dollar Chesapeake Bay Bridge-Tunnel will be open—triumphant result of a three-and-a-half-year struggle with sea and storm.

Longest bridge-tunnel in the world, it closes the last water gap on a coastal highway from Canada to Key West, Florida. The builders say it will double traffic across the mouth of the Nation's largest bay—to four million people in the first year.

To conquer this long and lonely stretch where open ocean meets the bay, the engineers designed and built monstrous machines: Big D, a huge pile-driver with extensible legs, like some enormous water bird; the Two-headed

HIGH ABOVE A TWO-LANE HIGHWAY, the 1,045-foot-long aircraft carrier U.S.S. Forrestal sails out of Chesapeake Bay. U. S. Route 13 here dives into a tunnel from a man-made island to preserve the watergate for ships. Built with revolutionary new techniques, trestle, tube, and island form parts of an engineering miracle, the Chesapeake Bay Bridge-Tunnel, which will dramatically aid east coast travelers by linking the city of Norfolk and Cape Charles, Virginia, across 17.6 miles of water.

Monster and the Slab-setter, which crawl across the concrete piles, putting down roadway as they go.

Motorists will drive beneath two of the east coast's busiest channels, with the keels of ocean-going ships passing but a few yards above their heads. To allow free passage to the great Norfolk Navy Base, to busy Baltimore, and to other ports of Chesapeake Bay, the bridge at two points gives way to tunnels, laid ingeniously in prefabricated sections.

For more than 12 of its 17.6 miles, the bridge-tunnel is a seagoing centipede. On hundreds of concrete trestle legs, it walks away from the mainland Virginia shore at the edge of Virginia Beach (below).

Then it becomes a sea serpent. It dives beneath the water into a mile-long tunnel laid in a trench along the ocean floor. Reappearing, it curves along more trestle, then ducks for a second mile under the sea.

Sighting land from a third trestle, it arches itself into a high steel bridge. Then it curls $1\frac{1}{2}$ miles across Fisherman Island, slides over a low bridge and moves up an embankment onto the shore of Delmarva Peninsula.

It links two very different worlds. At one

end lie Norfolk, Virginia Beach, Portsmouth, Hampton, and Newport News—cities busily crowding together as the result of a population explosion in Tidewater Virginia. At the other end of the bridge, a pastoral, early-American calm pervades the Delaware-Maryland-Virginia peninsula.

Neither side will ever be the same again.

Half-hour Ride Will Cost \$4

Tourists to Miami and truck drivers with their loads of Florida oranges for New York won't have the Federal Government to thank, or even the Virginia Highway Commission, for a 30-minute drive across Chesapeake Bay instead of a 90-minute ferry ride.

They can thank—and pay (\$4 for a passenger car and driver, \$13 for a four-axle trailer truck)—a group of far-seeing businessmen and politicians from both sides of the crossing.

"There isn't a cent of tax money—Federal, state, city, or county—in our project," said Lucius J. Kellam, Chairman of the Chesapeake Bay Bridge and Tunnel Commission. "I can think of few other major highway projects for which that can be claimed."

On a Sunday afternoon Mr. Kellam and I

A ribbon unfurled from shore to shore, the 17.6-mile roadbed threads three long trestles, two tunnels, two bridges, and a causeway. Privately built for an estimated \$200,000,000 raised from bond sales, the thoroughfare opens to traffic this month. What will the motorist see, riding his car as he might a boat? Gulls wheeling above whitecaps that stretch to the horizon,



were gazing out a window across Delmarva farmland granted to his ancestor Richard Kellam by King Charles I in 1636. The family home is on the Virginia tip of the peninsula that Virginians call "the Eastern Shore." To be shuah, most of them call it "the Eastern Shoah."

"We've spent most of our lives trying to tell our friends around the country where the Eastern Shore is," Mrs. Kellam joined in. "Now people know. That's where the new bridge goes!"

"We first operated the ferries as an autonomous commission authorized by the government of Virginia," Mr. Kellam explained. "Then we petitioned to have it become a bridge commission. We acquired power of eminent domain and authority to borrow 200 million dollars by selling bonds."

That amount will build the bridge-tunnel, staff it, operate it, and pay \$30,000 daily interest on the bonds. When cash begins clinking in, the commission can pay the interest and start retiring its investment.

"We started out," Mr. Kellam continued, "planning to build high-level bridges where our two tunnels are today, over the channels

in the bay. But the Navy said it didn't want a bombed bridge bottling up the Atlantic Fleet in Hampton Roads. And the city fathers of Baltimore said they didn't want any height and width restrictions on ships heading for their port.

"So we wound up building tunnels instead. But we built a special bridge near the Eastern Shore for the fishermen. They weren't about to chase schools of menhaden up to a trestle and then lose them for having to detour 11 miles out to our tunnel and back."

The second bridge on the project, tying Fisherman Island to the Delmarva Peninsula, accommodates yachtsmen and others rounding the tip of Cape Charles.

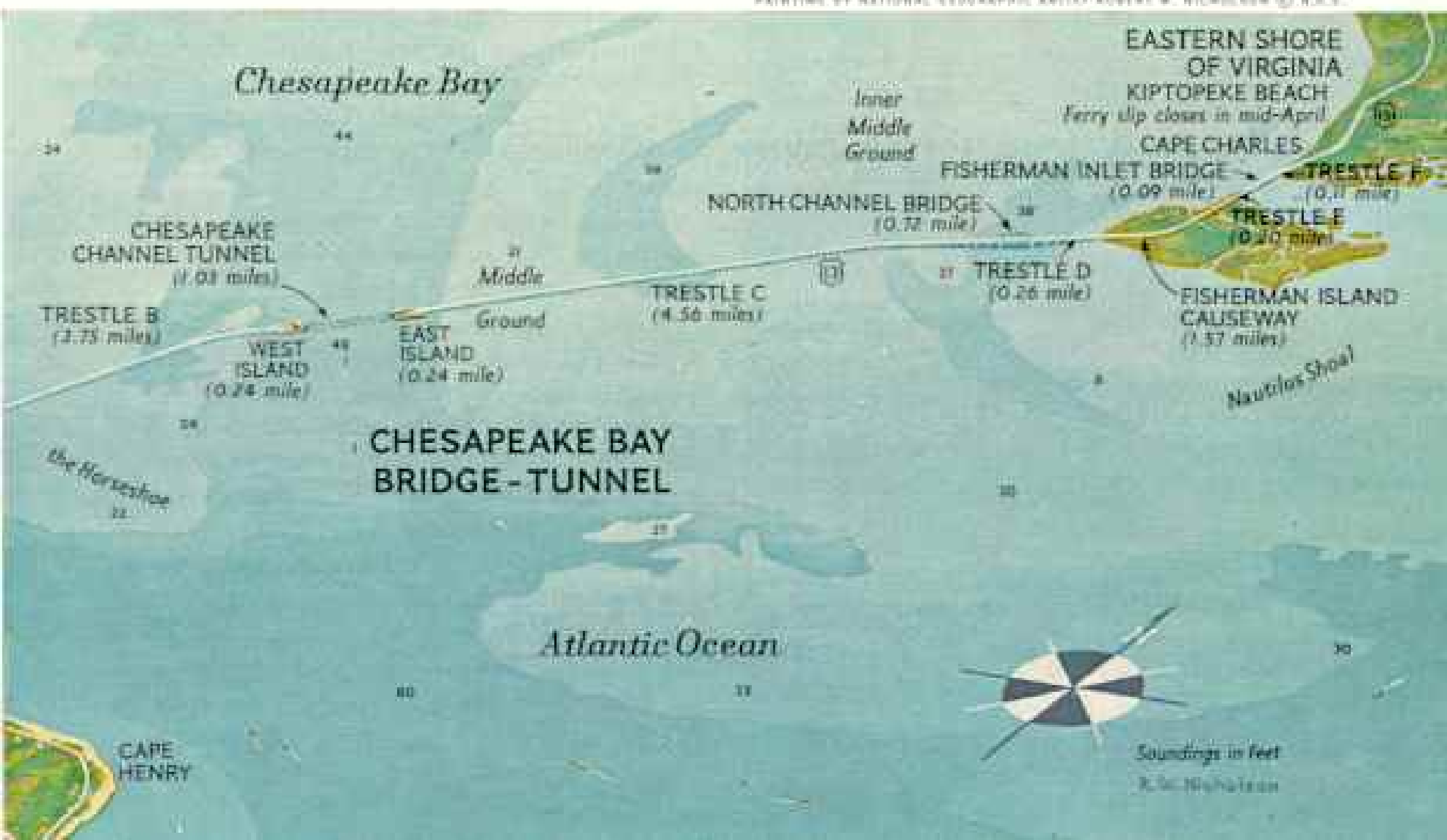
Preview of Crossing by Car

I visited the bridge-tunnel half a dozen times during the past year, coming to know its engineers and construction workers, who sometimes loved it and sometimes hated it. You can feel pretty close to a thing when you give three and a half years of your life to it. Many of the men were on the job when the mammoth project began, in September, 1960.

Finally a day came, this winter, when I

Ships from the Atlantic Fleet, based at Norfolk, proudly parading above Thimble Shoal Channel Tunnel. Close by, men of the fleet's Amphibious Force practicing naval games. Baltimore-bound freighters from all corners of the globe slipping through the gap between West and East Islands. And fishing fleets chasing schools of menhaden beneath North Channel Bridge.

PAINTING BY NATIONAL GEOGRAPHIC ARTIST ROBERT W. NICHOLSON © N.G.S.





Gull on the wing symbolizes the bridge-tunnel, which closes the last water gap on a coastal highway between Canada and Key West, Florida. Using it, north-south travelers may bypass traffic-clogged Baltimore, Washington, and Richmond. History buffs will find it a convenient passage to Jamestown, Yorktown, and Williamsburg. The new route links farmlands of the Delmarva Peninsula with factories in Norfolk and Hampton.



could drive across most of the almost finished bridge. The fog that morning was thick and cold. My Oldsmobile sailed straight out onto Trestle A into a gray, soupy mixture of ocean and sky.

Through the open wing-window came the sad sound of a ferry. I drove through the heavy air, recalling what an engineer had predicted. "You know," he said, "they'll barrel across this bridge at 40 or better and never give it a thought as an engineering marvel of the world."

It isn't that trestles and tunnels and bridges like these haven't been built before. They have. But never combined into such a prodigious, complicated feat as this. And never attempted in the teeth of the open ocean. Old-time watermen of Chesapeake Bay had warned that the ferocious winds and waves would never allow man to bridge them.

Tunnels Anchored to Man-made Islands

Two remarkable pairs of islands were keystones to the success of the undertaking.

Entrances and exits of the two tunnels are on these four man-made isles. The highway leaves the trestles and plunges down, through the islands, almost 100 feet to the bottom of the bay (page 592).

North and South Islands anchor Thimble Shoal Channel Tunnel, which dips beneath the sandy bottom of Thimble Shoal Channel. This busy shipping lane serves the ports of Hampton Roads, including the world's largest naval base, at Norfolk.

The second pair of islands lies four miles to the northeast and belongs to Chesapeake Channel Tunnel, a few feet shorter than Thimble Shoal but still more than a mile long. Above Chesapeake Tunnel, ships pass to Washington, D.C., Baltimore, and the upper bay.

Workmen ignored a confusion of official names for these two bits of dry land and called them East and West Islands.

I could see, up ahead in the thinning fog, where Trestle A was about to deposit me on South Island.

Like its mates, South Island is a pyramid of sand with a flattened top. Its surface, nearly a quarter of a mile long, rises 30 feet above the water, the same height as the trestles. A strait jacket of stone retains the sand, piled up on the floor of the sea by hydraulic dredges. First gravel, then rock, finally riprap—boulders big as automobiles—were carefully lowered by floating cranes to encase the sandpile as it grew (page 605).

All this only holds the sand in, not the water out. Engineers building tunnel approaches in the islands were constantly plagued by what they lightly called "de-watering" problems.

I drove into Thimble Shoal Tunnel. Down here a year before, I had watched a construction man weld a leak while standing in a torrent of salt water. There was a misfit in a joint of the strong double-walled steel tubes that formed the watertight skin of the tunnel. He welded till he could no longer stand the low-voltage electric current shaking his wet body. Then he passed his welding torch to a mate and crawled out of the spurted water. He let me pass him a dry cigarette and light it for him.

"The tourists," he said, inhaling massively, "will go through here bumper to bumper and never wonder what it took to lay this tube. We had to sink 19 of these tunnel sections here in Thimble Shoal Channel. Some 12,000 tons of steel and concrete in each one. And join 'em up under water."

Each of those tunnel sections was 100 yards long, a huge double-walled cylinder sealed at both ends. Each had been built by the American Bridge Division of U. S. Steel at Orange, Texas, and towed by tugboat 2,000 miles to a fitting-out wet dock at Norfolk (page 608).

There chutes poured concrete through roof hatches in the tunnel section, and workmen laid a roadbed. Then the space between the section's two steel shells was partially filled with concrete, leaving the whole monster wallowing like an iceberg, nine-tenths submerged.

Tugs took it to the tunnel



UNIQUE BIG D HOPS ACROSS THE SEA, pounding concrete piles into the bay's sandy floor. Hollow pile above, 4½ feet in diameter, shelters a worker. Diagram shows the \$1,500,000 rig standing on the bottom as it drives piles in sets of three. Tubes go as deep as 100 feet, where sediment and friction hold them fast. Lifting its legs, the massive hammer then floats to a new position.

KODACHROME BY DAVID S. BOEER
AND DRAWING BY RICH HALL © N. S. S.



site, and a few more tons of concrete were poured into the walls, enough to sink it into the tunnel trench. The trench had been meticulously cut to a tolerance of an inch, in the ocean floor, from a grading barge. As the section sank, deep-sea divers guided two giant pins into holes on a section already laid, mating the pair (pages 608-9).

"They had to sink 'em at slack tide," my welder friend reminded me. "These tidal currents are like rivers. And you know, they laid 'em within two inches of where it said on the blueprints."

"Now we're cutting out the end plates,

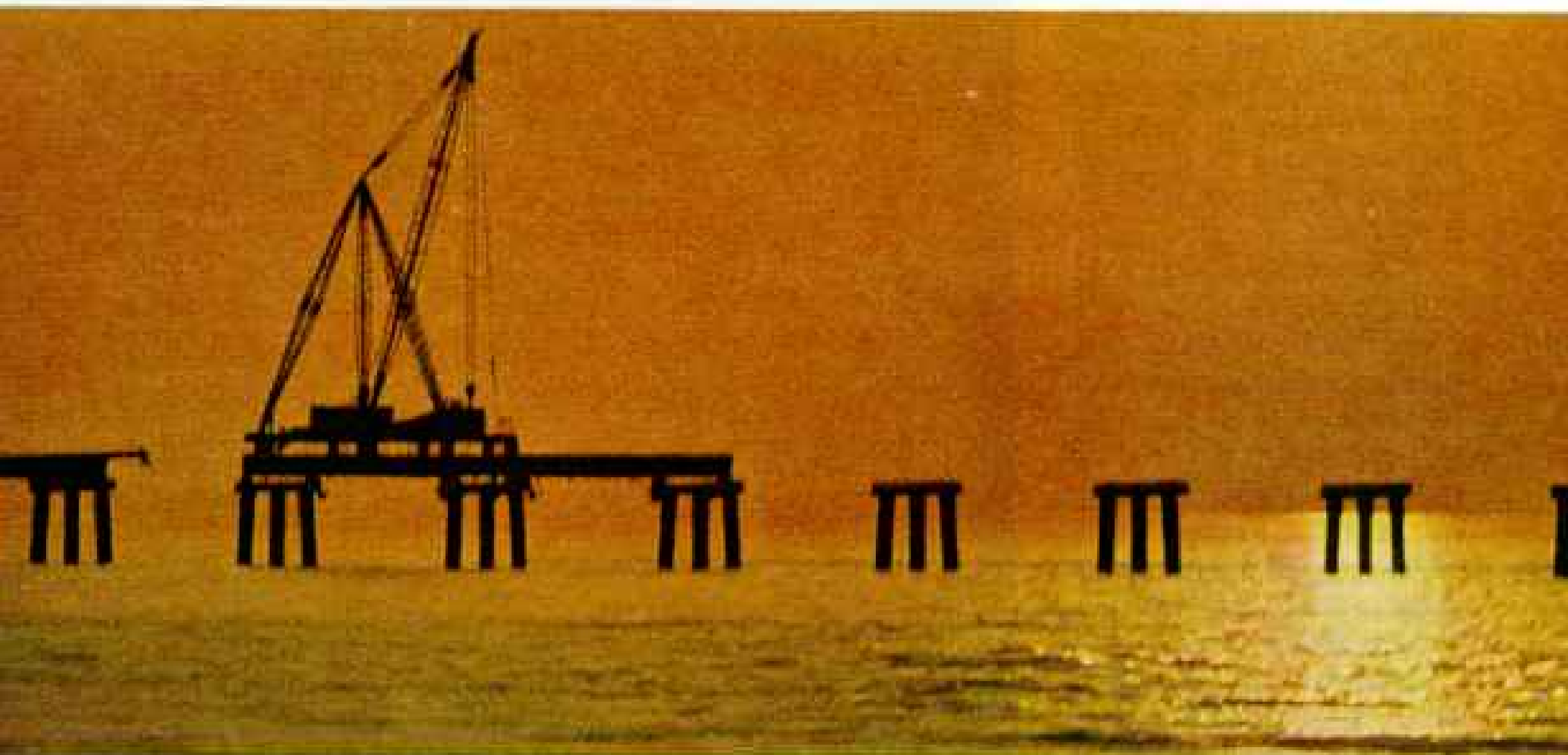
opening the joined sections into a tunnel [page 610]. After we weld them together and fix any leaks like this one, the concrete crew will fill the space and make the whole wall solid."

A high-quality underwater concrete is used to seal the joints. As the concrete is pumped in, the salt water is pushed out.

The welder had had his break and his smoke, and now he headed back to work. "Don't forget to mention," he said, "that six guys died to build all this."

The deaths were due to the kind of construction accidents that are expected: a fall-

Pins in the cushion of a sun-gilded sea, capped piles await the Slab-setter (left). Each pile has



ing crane boom, a defective electrical tool, a boiler explosion. I have heard it called a miracle that none of the deaths was the direct result of weather. Because the weather was unbelievably fierce.

As I drove on through Thimble Shoal Tunnel, I thought of some of the things I had seen out there on the bridge on cold and cutting winter days.

Once I saw a nor'easter come slashing in off the ocean. When that happened, a dozen cumbersome pieces of floating construction equipment had to be tugged into harbor through a wicked sea. Hundreds of men had

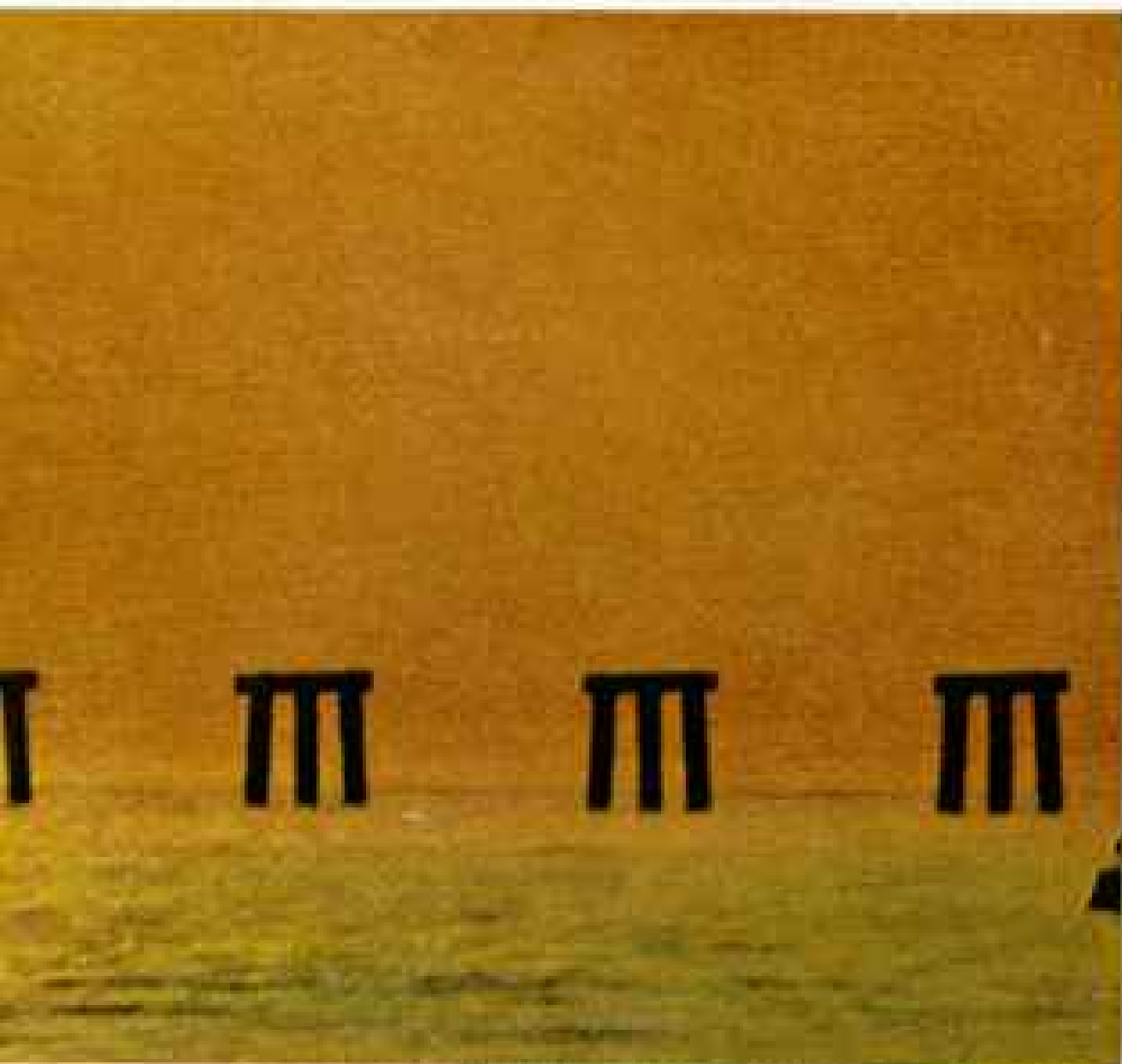
to be picked up, from trestles and bridges and islands, all across the angry bay. No matter that it was dangerous for the boatmen, and for the workmen themselves, who dropped to the rearing boat decks from rope ladders twisting in the wind.

Bad weather and wind, even swells that came in days afterward from hurricanes far out at sea, scuttled one working day in three during the hard years it took to do the job.

A nor'easter coupled with abnormally high tides struck one memorable March day in 1962. It washed away much of the sand in

(Continued on page 604)

been aligned within an amazing 3-inch tolerance.



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



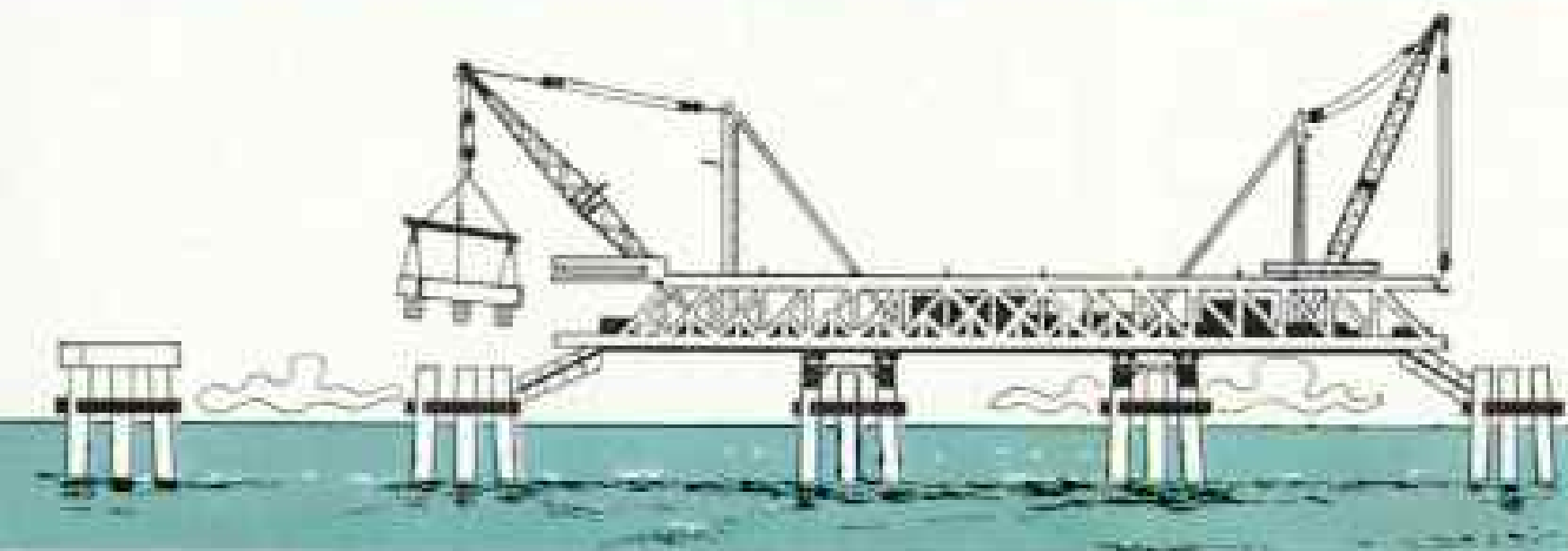
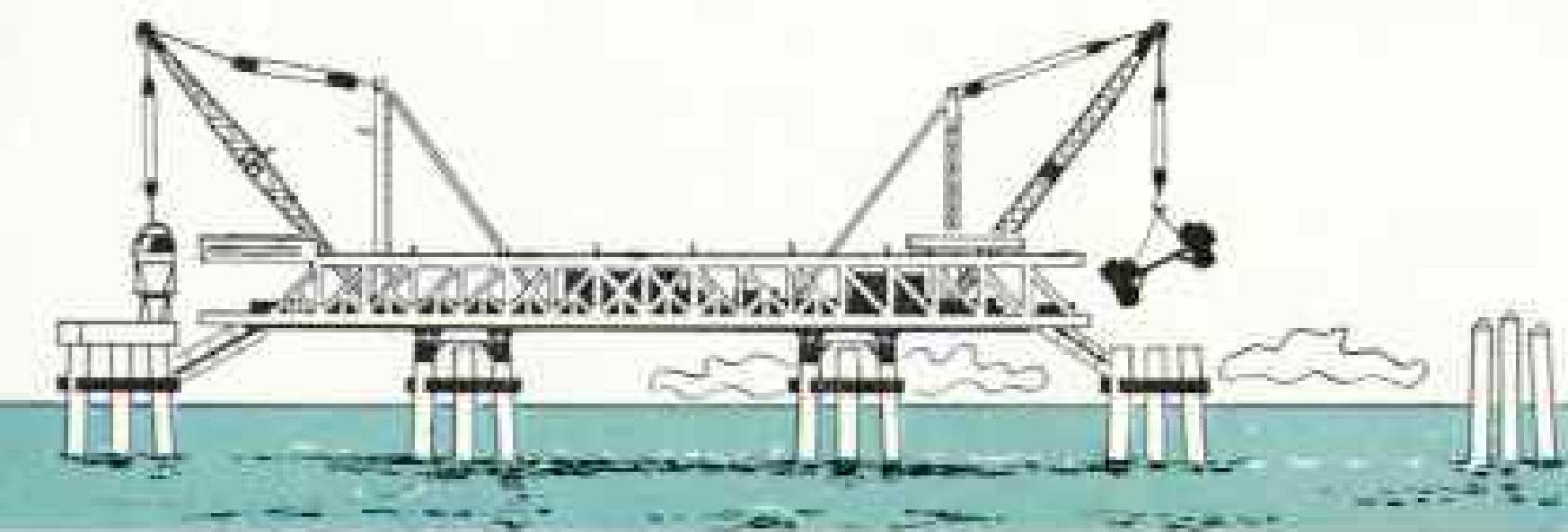
Worker cat-walks across upended piles awaiting transport in the yard of Bayshore Concrete Products Corporation. Prestressed steel wires strengthen each tube. Builders cemented together 16-foot piles for the deep mid-bay positions. The longest stretched 172 feet, height of a 16-story building. Average pile cost \$2,500.

Pouring concrete; laborers fill forms for a tunnel approach wall on West Island.





FOUNDED BY DAVID S. BOKER AND OWNERS BY RICK HALL © S.S.S.

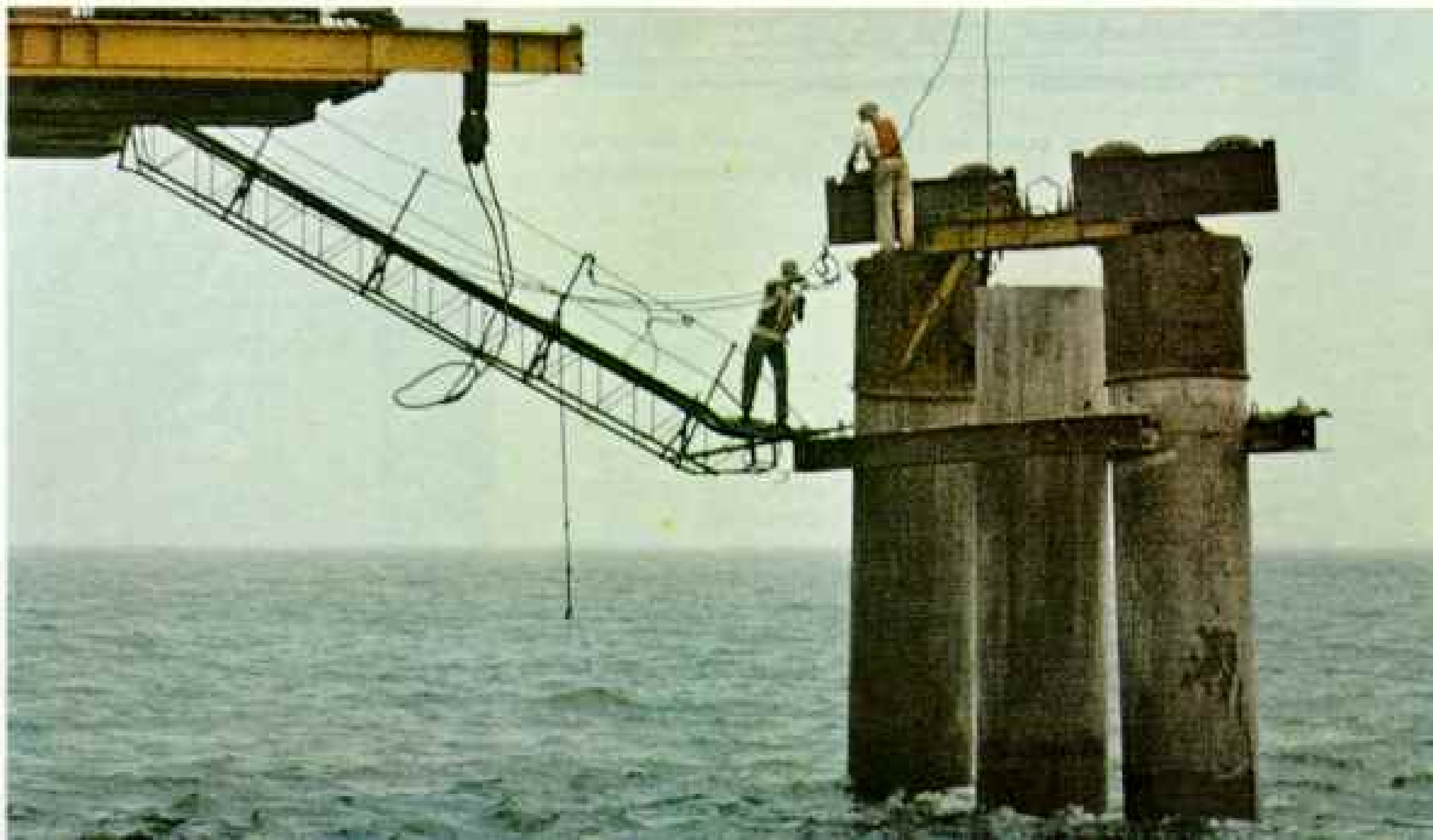


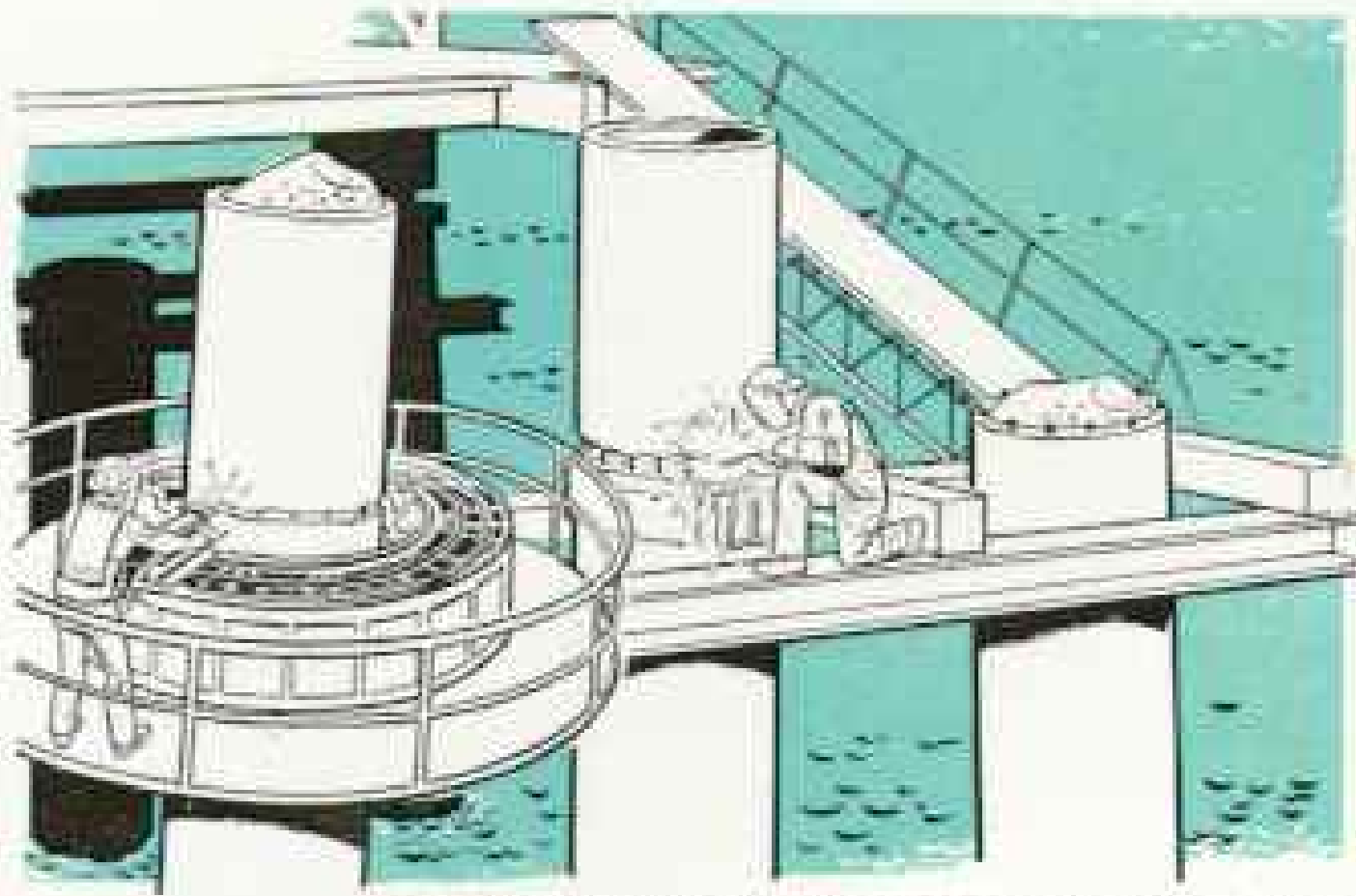
Two-headed Monster, as engineers call it, skates on piles that will support the roadbed. Machine's right end levels the piles by cutting them off or building them up. Left end caps three sand-loaded tubes.

Top diagram shows crane at left dangling a bucket of concrete to wed cap to piles. Boom at right lowers wheels on which the Two-headed Monster, powered by a diesel-electric generator, will roll forward.

Lower diagram pictures the machine setting a new cap in the next position.

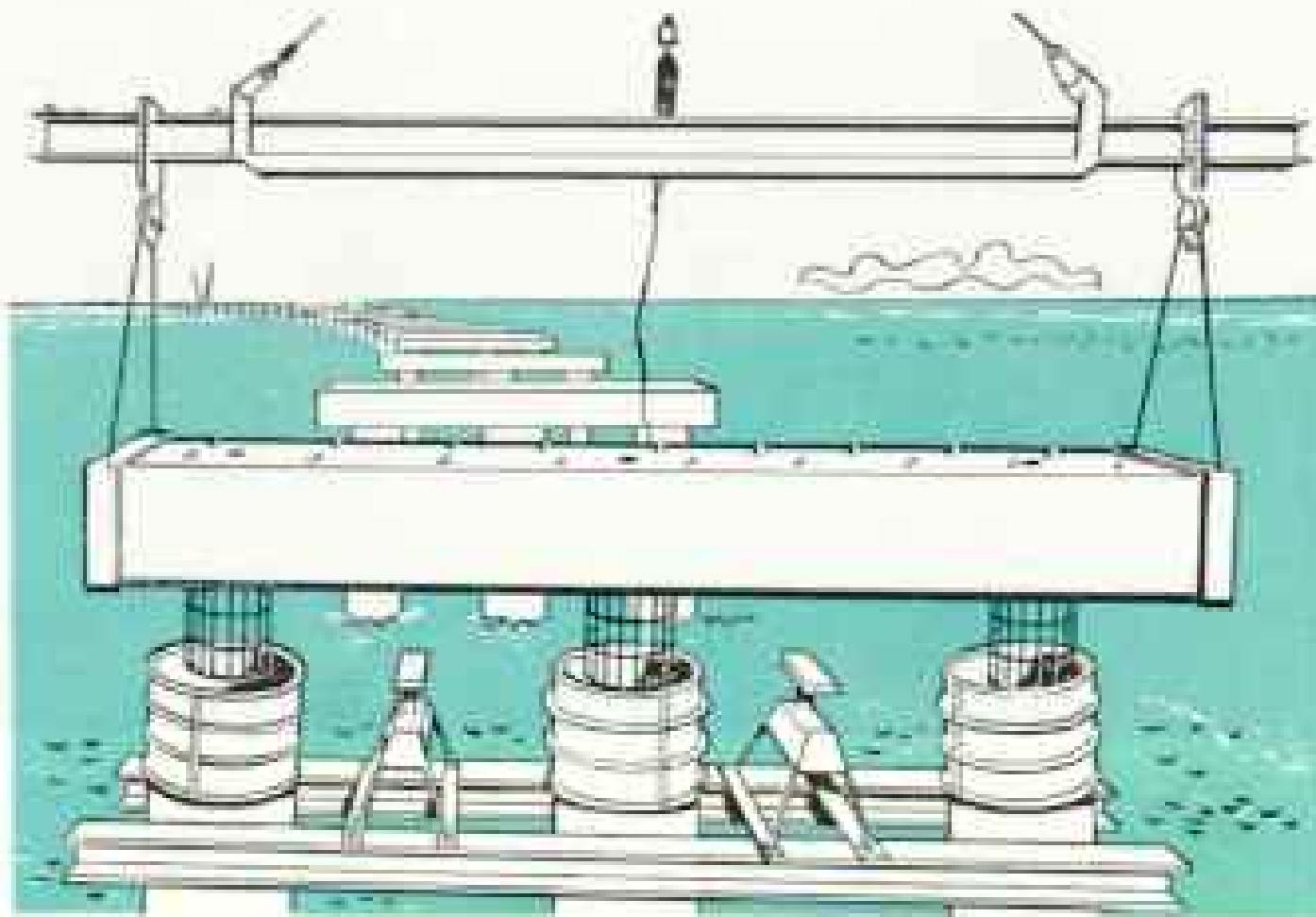
Wheel assembly locks on uncapped piles. Men ready it for the Monster's advance.





DESIGNED BY RICH HALL AND SUPERVISED BY DAVID L. COYER © N.A.S.

Helmeted workers level the piles. Man at left, guiding a jackhammer on a circular track, chips through a five-inch wall of concrete. Acetylene torch of worker in center cuts wires that are bunched together as in a cable and threaded through 16 holes in the tube's lining.



Twenty-ton cap, ready for installation, hovers above the trimmed piles. Plugs of latticed steel to reinforce concrete will fit precisely into pile tops.

Bucket and funnel, suspended from a boom on the Two-headed Monster and guided by an operator's rope, swing toward the fitted cap. Soon they will pour concrete through the hole atop the center pile and fill the cavity.

Here the trestle rounds a curve beside the survey tower (center right) that engineers installed to provide a landmark on the faceless water. In each set of three piles, the center one stands straight while outside ones add stability by leaning inward. Viewed from the water, they appear perfectly aligned, like the pillars of a cathedral. Builders, wearing life jackets and hard hats, commute to work by boat.





one half-finished island and sank the giant pile-driving complex known as Big D which contractors had spent a million and a half dollars to create (page 597). And it crimped the timetable of the whole project by months.

Up ahead now, I could see the rectangular target of daylight at the exit of the tunnel. I broached on North Island, the one decimated by the March storm, and started along the concrete legs of Trestle B.

I remembered photographing the Big D as it drove cylindrical concrete piles down into the ocean floor to make this ramp—2,640 piles in the entire 12.2 miles of trestle. The floor of the bay is unconsolidated sedi-

ment. Bedrock is 2,500 feet below. So some piles had to go 100 feet through the muck to be properly held by firm bearing strata and by friction resistance along their sides.

The longest of the piles measured 172 feet. They were made by cementing together 16-foot precast sections containing prestressed steel wires for strength.

The Big D planted its retractable feet on the hard sand of the ocean bottom when it drove piles. It had to be solid and secure to place the piles within three inches of where surveyors pinpointed them.

It could crank itself up on its own stilts, up out of the water if necessary, to ride out a

Man-made Island Rises Within a Wall of Automobile-size Granite Boulders

Floating derrick drops riprap into place on the island's outer rim; smaller stones at right will form an inner band to hold sand pumped from the bottom of the bay. The stones, quarried in Virginia and North Carolina, made the voyage north by barge. Engineers constructed four such islands to provide entrances and exits for two tunnels. South Island may eventually have a restaurant and piers for sports fishermen.

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Accuracy to the very inch keeps surveyor teams busy with folding rule, slide rule, and pencil.



storm. Still, the first Big D crumpled and sank in the March nor'easter. Helicopters dropped rope rigs to rescue two men clinging to the last steelwork above a sea so wild that boat rescue was impossible. A second Big D was built to take the first one's place.

Behind the Big D came a bizarre machine technically known as a traveling bridge, but dubbed the "Two-headed Monster."

The Two-headed Monster had cranes at both ends. It traveled across the piles, placing wheels atop each trio, then moving forward on its own steel track, five or six giant steps a day (pages 600-601).

At the advancing end, the Monster and its

crew lopped off the odd-level tops of piles. As the aft end came abreast of the leveled piles, it capped each group of three with a chunk of prestressed and reinforced concrete, big as a truck and weighing 40 tons. These caps would be the foundation for the giant slabs that would form the roadway.

The Two-headed Monster had a shadow, the Slab-setter.

The Slab-setter moved by stepping along the Monster's pile caps (pages 606-7). Operating high above the rough waters, its lofty crane hoisted precast concrete roadway slabs nearly twice as long as railroad boxcars. When four slabs were laid side by side from cap





Slab-setter Leapfrogs
Across the Water on
Its Own Portable Road



to cap, to a tolerance of a quarter of an inch, you had 75 more feet of oversea trestle.

This done, the Slab-setter rolled 75 feet forward, on wheels, along its own 150-foot base framework. It then picked up the half of its framework just vacated, swung it spectacularly out over the ocean, and lowered it onto the next set of caps (above).

It was an assembly-line job. Piles. Caps. Slabs. Then concreting the components to-

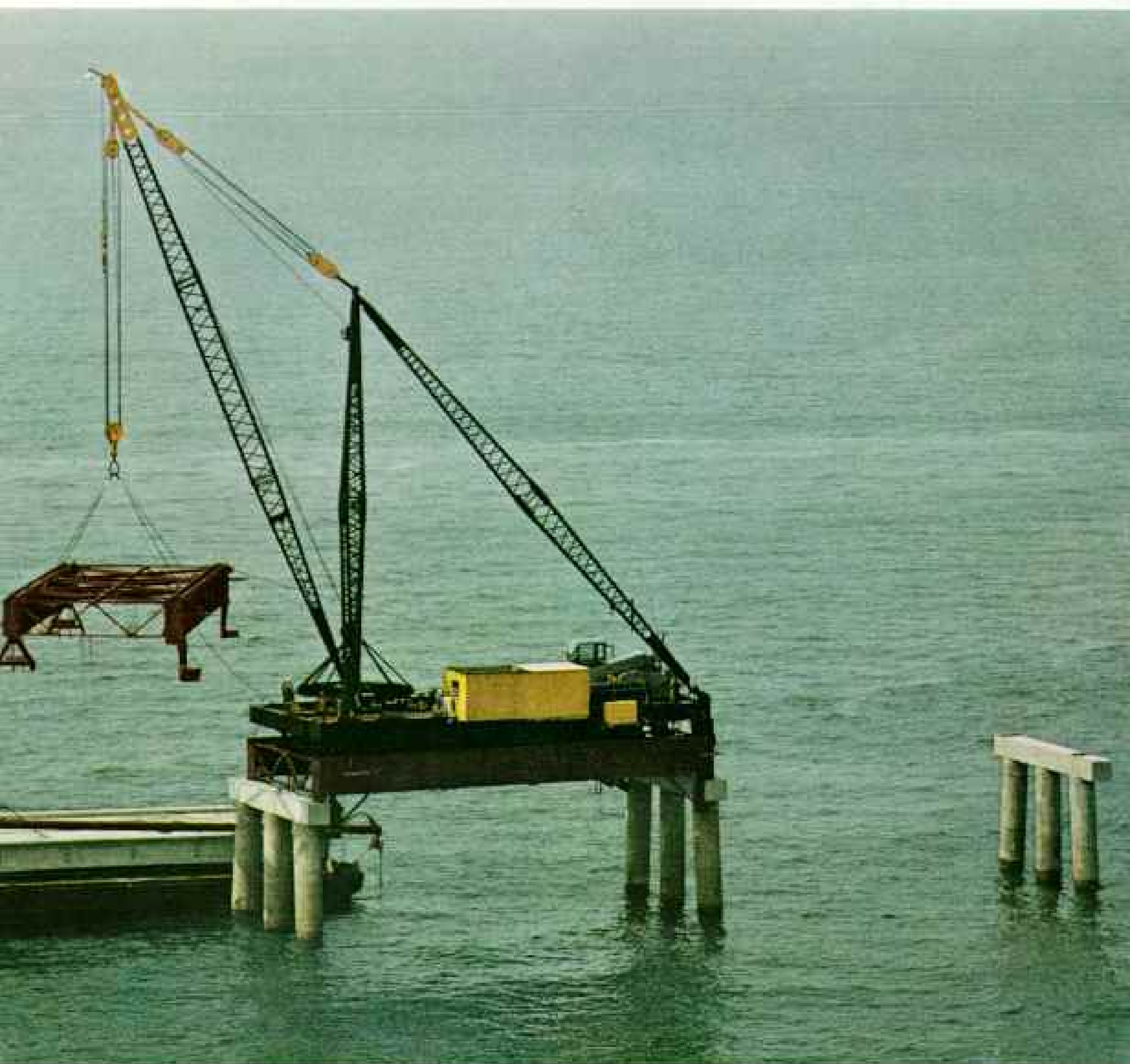
gether under stress and tension, bonding them into a monolithic defiance of the worst that battering sea and pounding traffic could do. Finally, guard-railings, mercury-vapor lighting towers, telephone lines, signal lights, asphalt, and speed-limit signs.

West Island was as far as I could drive. I walked through Chesapeake Channel Tunnel to East Island and Trestle C. En route, I watched tilesetters happily slapping white

A bridge in two sections, the Slab-setter lays four 75-foot-long prefabricated spans of concrete side by side on two sets of capped piles. At upper left, the machine lifts a slab from a barge to fill one section of the road. Picture at middle left shows the crane rolling forward on its own tracks. At

lower left and below, the crane picks up its tail bridge and swings it to the front, opening a gap for more slabs. Slab-setter averted work stoppages by operating high above rough seas.

Ferryboat *Northampton*, one of a fleet of seven destined for reassignment, churns across the bay.



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

ceramic squares into place on the tunnel's ceiling (page 611). When they finished this second tunnel, they would have plastered down five and a half million of them.

Next day I switched to a helicopter to see the full assembly-line view of the engineering prodigy: A trestle marching out to sea. The Big D, the Monster, the Slab-setter, one behind the other, like a train laying its own track. Two gaping breaks between the islands,

where the tunnels lay. Warships and freighters streaming through. Under them, I knew, welders and tilers were still at work in the cold, damp tunnels.

Below the 'copter, boats scurried back and forth beside the trestles—water bugs around reeds in a pool. Crew boats, survivors' boats, engineers' boats, supervisors' boats.

"We put 60,000 miles a year on these crew-boats," one skipper had told me. "That's a lot



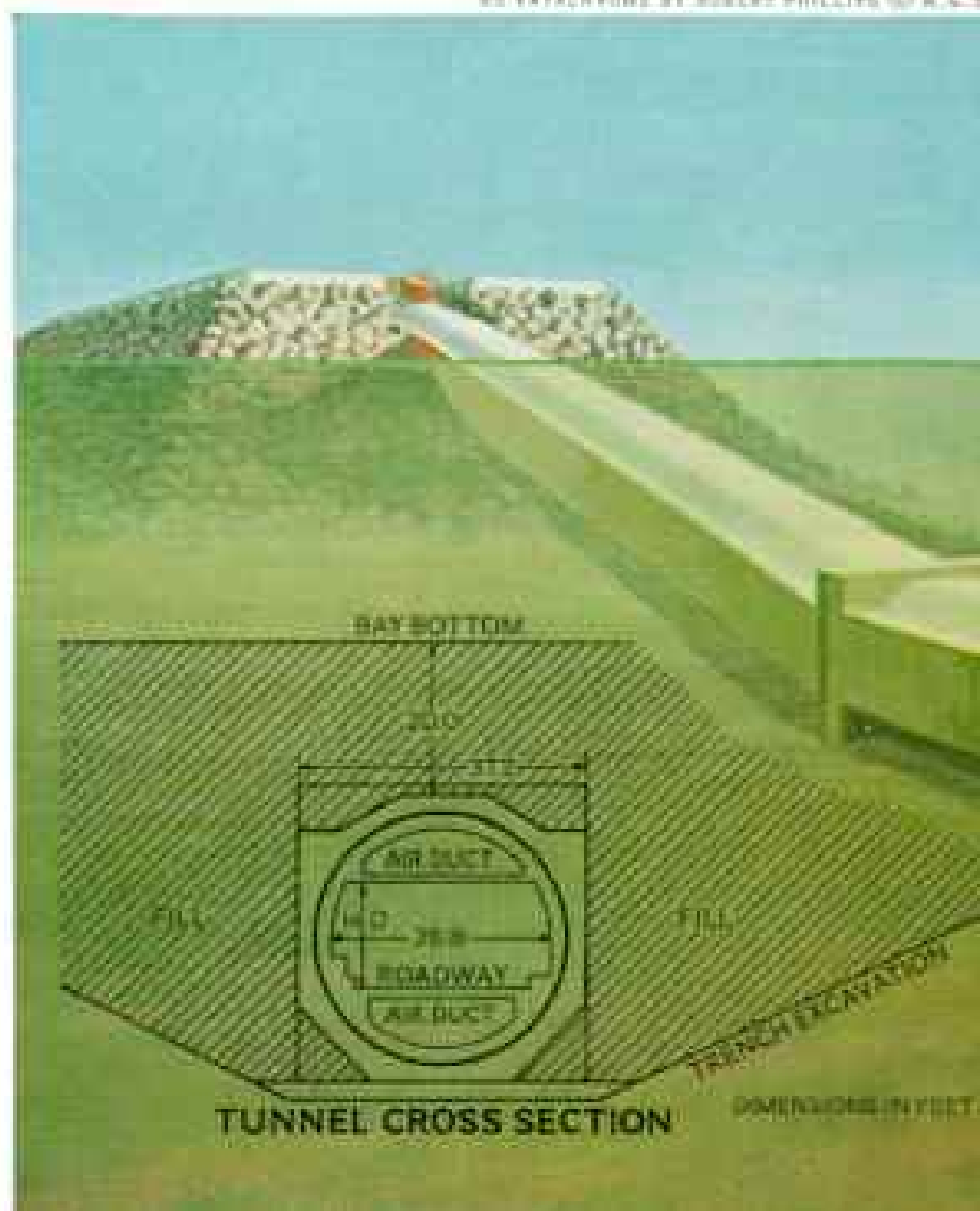
BY EXTRA PHOTO BY ROBERT PHILLIPS © H.G. 1

Twin Barges Hold a 287-foot Tunnel Section as Tugs Pull and Push the Assembly to Sea

Steel tube encased in a steel shell, the tunnel section—as long as a football field and as heavy as a Navy cruiser—rode the waves from its foundry in Texas, a 2,000-mile voyage. In Norfolk, Virginia, the tube was fitted with a roadbed and its casing filled with concrete.

Here a sighting tower rides the section's forward end for the convenience of surveyors who use it to determine the precise location for sinking. Lines from floating cranes maneuver the assembly into the drop position. A sea-going concrete mixer stands by at right to add enough bulk to sink the section and fill its joints.

Down into murky depths sinks the tunnel section, its bed already dug by a scraping barge. Now all the skills of an anxious team come into play. Lines from cranes pull taut or go slack as a diver, trailing air bubbles, directs the awesome beaching by telephone. To avoid confusion, the painting omits the maze of lines. Diagram shows a cross section of the tunnel with its casing filled with concrete and the trench covered with gravel.



TUNNEL CROSS SECTION

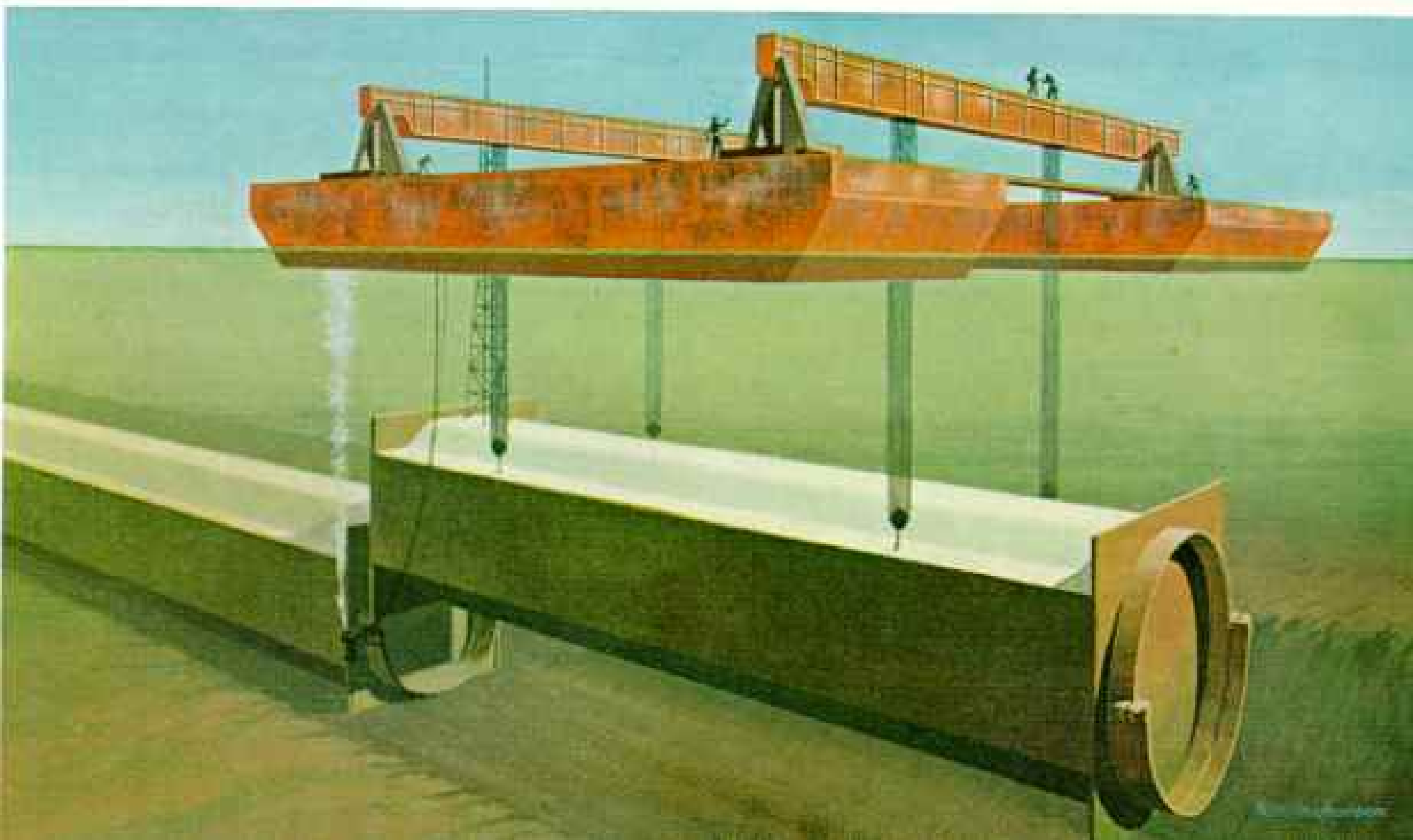
DIMENSIONS IN FEET



PAINTING BY ROBERT W. WHEELER

Under a diver's guiding hand, the linking pin on the upper rim of a newly dropped section of tunnel glides toward its hole on the lower rim of a bedded section. In inky darkness, the diver performs his dangerous job by touch. Later the joint will be protected by steel plates and sealed by concrete.

609





HE EXHAUSTIVE LABOUR AND APPROPRIED BY DAVID J. POTER, NATIONAL GEOGRAPHIC STAFF © R. S. S.

Sparks fly as welders cut away a steel bulkhead separating two sections of tunnel.

of miles, even if they'd been cars. For boats, it's terrific punishment. When something goes wrong, and it usually does, they patch us up and get us going again."

The helicopter passed over Chesapeake Tunnel to Trestle C, then on to the high span across North Channel, an arch of steel laid by the American Bridge Division of U. S. Steel Corporation to accommodate the menhaden fishermen. As I took in the whole complex in minutes, I remembered the way an engineer had characterized it. "It isn't only a question of building a bridge *over* the water," he said. "We're building this bridge *on* the water, *in* the water, and *through* the water."

In another sense, the bridge-tunnel was built on and over the air. Invisible spider

webs of radio lines connected all those machines and boats and trestles and islands.

I had ridden the boats and knew how the radio calls went: "*Diana* to the Slab-setter. Give me a guess on when you'll want the next bargeload of slabs. You'll have to work all night again tonight. I've got those two cases of Cokes for you aboard."

"Monster to TRK. We need a boat. Hinton got dropped in the water with the concrete bucket. It knocked him out. Callahan jumped in after him. We've got 'em fished out. But Hinton should get to a doctor."

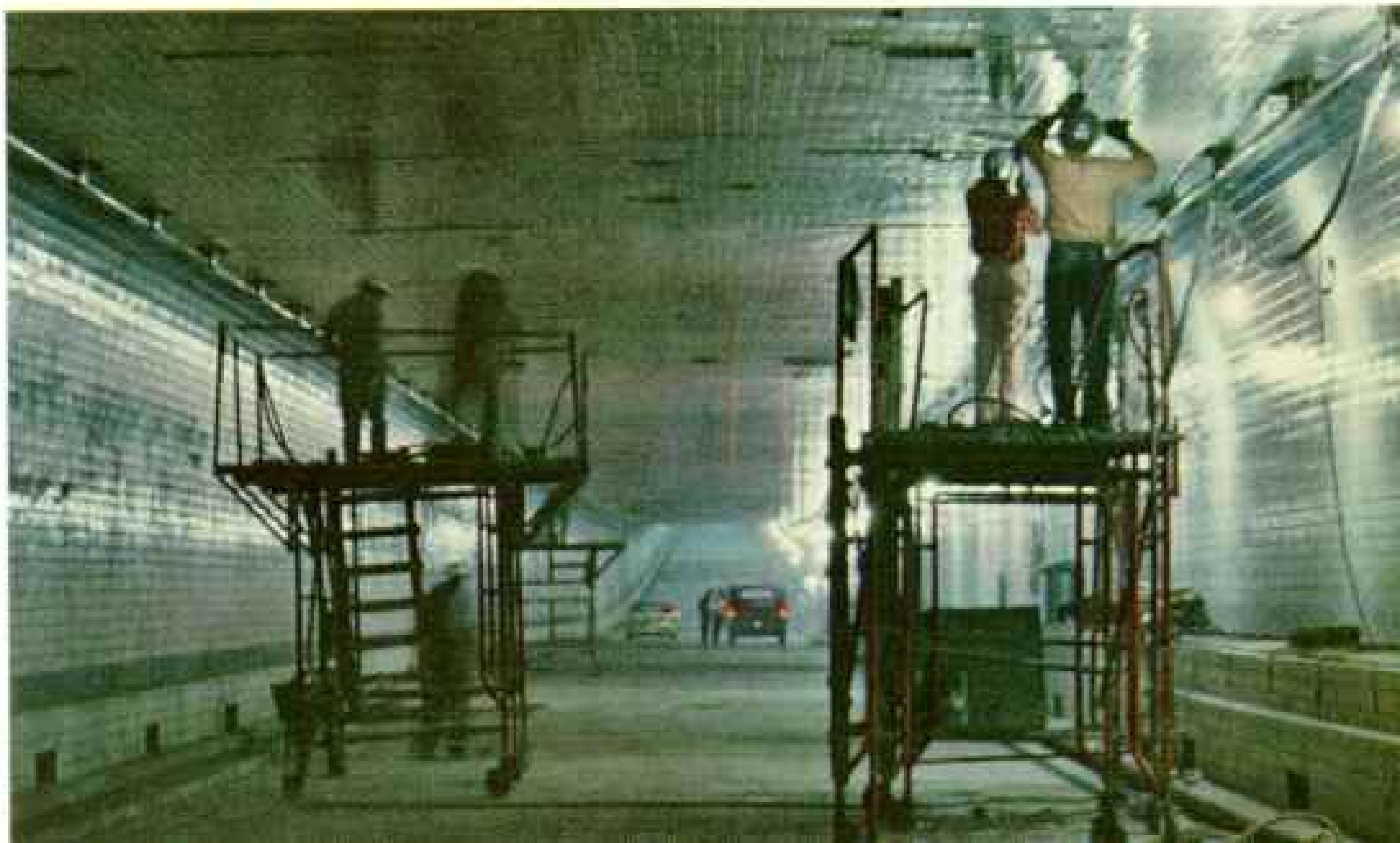
"*S & P-Two* to Trestle B. We'll come in under you in 20 minutes to pick up concrete samples. Have 'em ready."

And not one radio system going, but four.



Reverse twist on the tilesetter's art: Men working on a platform beneath the tunnel's arched ceiling (left) lay rows of tiles face down on a dry form. Concrete is then poured over the bottoms of the tiles to make a false ceiling (below) for air ducts. Height of the two-lane tunnel: 14 feet.

611



S & P-One, *S & P-Two*, and *S & P-Three* were all boats of Sverdrup and Parcel, a consulting engineering firm of St. Louis, Missouri, that designed and supervised the project. Shuttlng their engineers to every corner of the vast operation, they did en route planning and problem solving by radio.

Diana, *Sea King*, *Ann H.*, and a host of others were boats of TRK, Tidewater-Raymond-Kiewit. These three firms—Tidewater Construction Corporation of Norfolk, Virginia; Raymond International Inc. of New York City; and Peter Kiewit Sons' Company of Omaha, Nebraska—formed a joint venture and a joint radio system for building the trestle, the high-level bridge piers, the tunnel approach ramps and ventilation buildings on the man-made islands, the causeway across Fisherman Island, and for finishing the tunnel interiors.

Merritt-Chapman & Scott Corporation of New York City was the fourth partner in the venture. Responsible for building the islands and laying the tunnels, Merritt-Chapman had a separate frequency. A fourth radio hookup crackled between the crews of E. C. Ernst, a contractor installing intricate electric systems for the bridge-tunnel's operation.

Bridge Becomes a Magnet for Fish

Already the new bridge complex has proved a boon to sport fishermen.

Capt. Don Jordan of Sverdrup and Parcel's *S & P-Two* told me, "For thousands of us in this area, the bridge is more important for the fishing bonanza it created than it is to get to the Eastern Shore.

"We used to dump old automobile bodies into the bay to make artificial reefs. They grow barnacles and worms and all sorts of underwater life that attract fish, you know. We also used to fish around the ships sunk by German subs during the war.

"But now the bridge is just one great big beautiful reef. The bottom fish feed around the rocks of the islands and around the piles. Even around the wreck of the Big D. And the sport fish—the cobia, the black drum, the channel bass, and the bluefish—are right behind them. Come on out with me Saturday and I'll show you what I mean."

I did. And we could hardly find room to wet a line. Scores of fishing boats hovered around islands and trestles.

When I first met the new span, I had been

amused by plans to have fishing piers on the islands for tourists. It had sounded a little like a publicity stunt. Now I was learning.

Nor will all the amenities of the ferryboats be lost. Some tourists and truck drivers, I knew, and some highway-pounding traveling salesmen used to welcome that 90-minute ferry ride. It meant a leisurely meal in the dining room, the sight of sea gulls swirling by on currents of ocean air, the clean smell of salt wind, without noise or traffic or neon signs.

They may still be able to enjoy all that in the middle of Chesapeake Bay. A restaurant is contemplated for South Island. And besides eating and fishing, they'll be able to watch the Navy's fighting ships steam by at picture-taking range.

Grandstand Seat for Combat Rehearsals

If you like naval exercises, South Island will be a grandstand seat for one of the Navy's most spectacular shows. By chance, the new bridge parallels the Atlantic Fleet Amphibious Force training grounds.

It won't require much luck to find yourself watching Navy frogmen parachuting into the sea for underwater demolition of beach obstacles, Marine infantrymen egg-beating toward the beach in helicopters, and Army trainees swarming down troopship ladders into assault boats for D-Day-type landings.

On the day of my latest look at the bridge, I talked again with Lucius Kellam, chairman of the bridge-tunnel commission.

"Before we started," he told me, "there was a battle about whether the bridge should connect Delmarva to Norfolk and Virginia Beach, or to Hampton. Everybody from Hampton and Newport News, and up Historyland Highway to Yorktown and Jamestown and Williamsburg, naturally wanted the bridge in Hampton.

"The traffic engineers settled the issue. They predicted more drivers would pay the fare to the Norfolk shore.

"In ten years, though, I think we'll make everybody happy. By then the economic boom this bridge will bring to Tidewater and Delmarva should warrant a 'Y' to Hampton. Another 45 million dollars, another high bridge, and another ten miles of trestle."

And that, I reflected, should guarantee its title as the longest bridge-tunnel in the world for a very long time to come.

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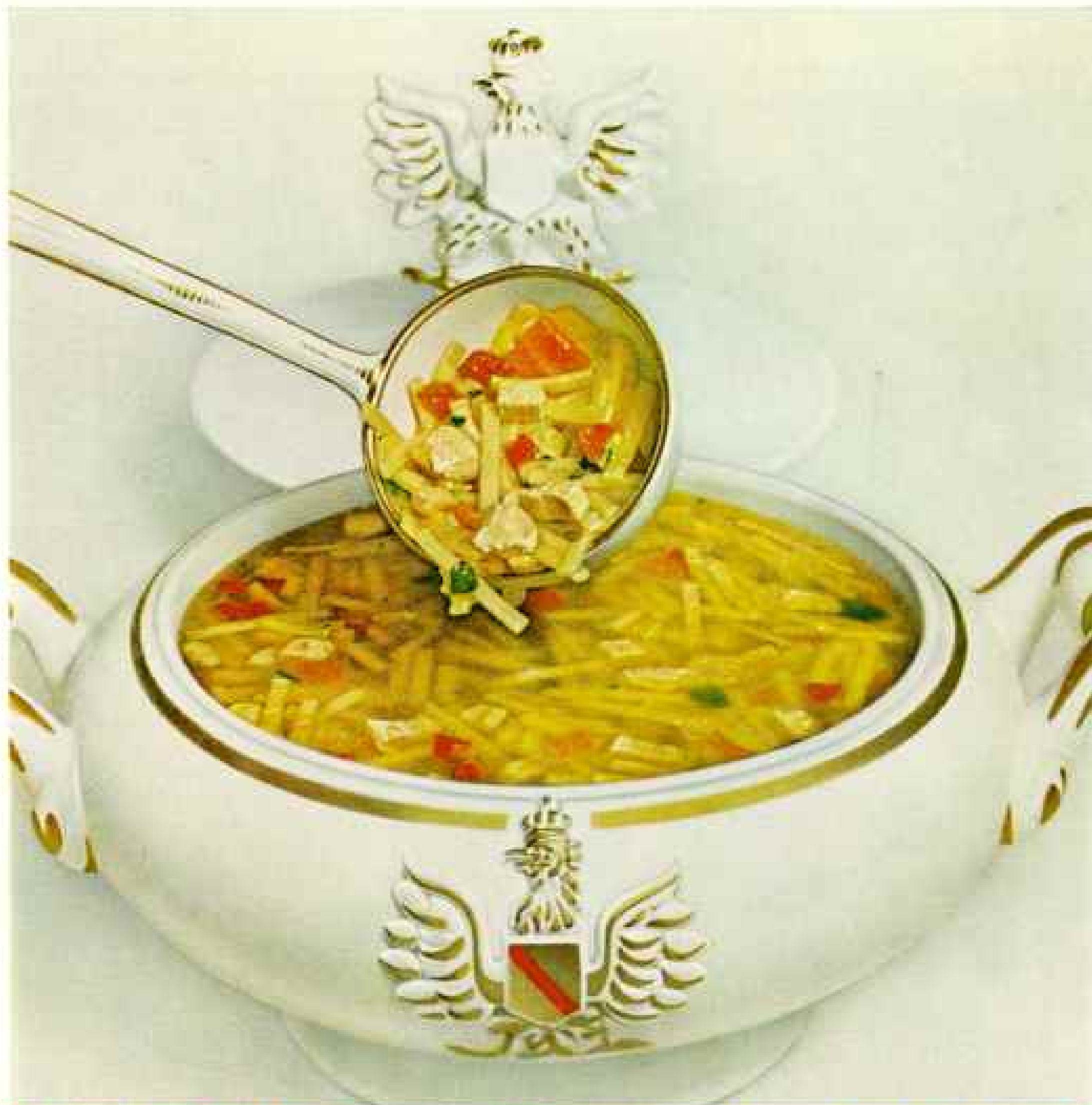
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◀ **COVER:** Armed with a shark billy, a cameraman skirts a coral ledge in Cousteau's undersea village (page 466).



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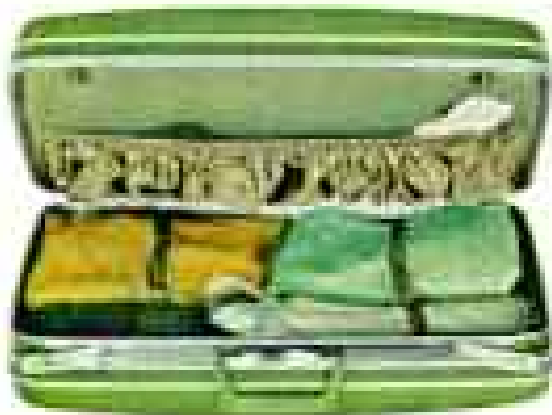
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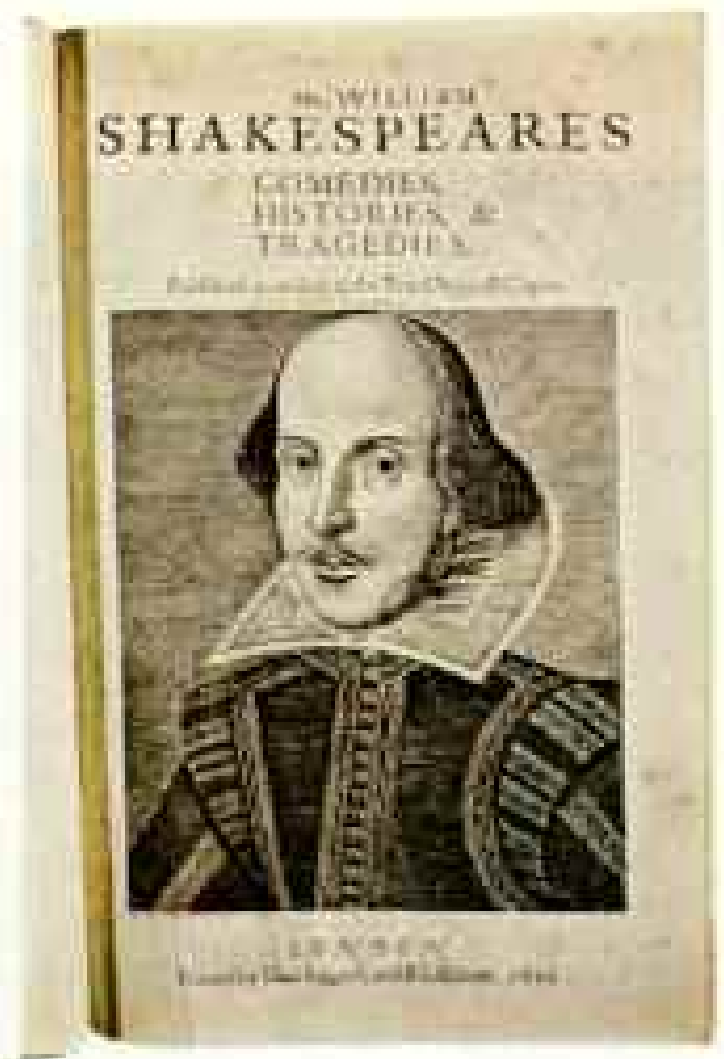
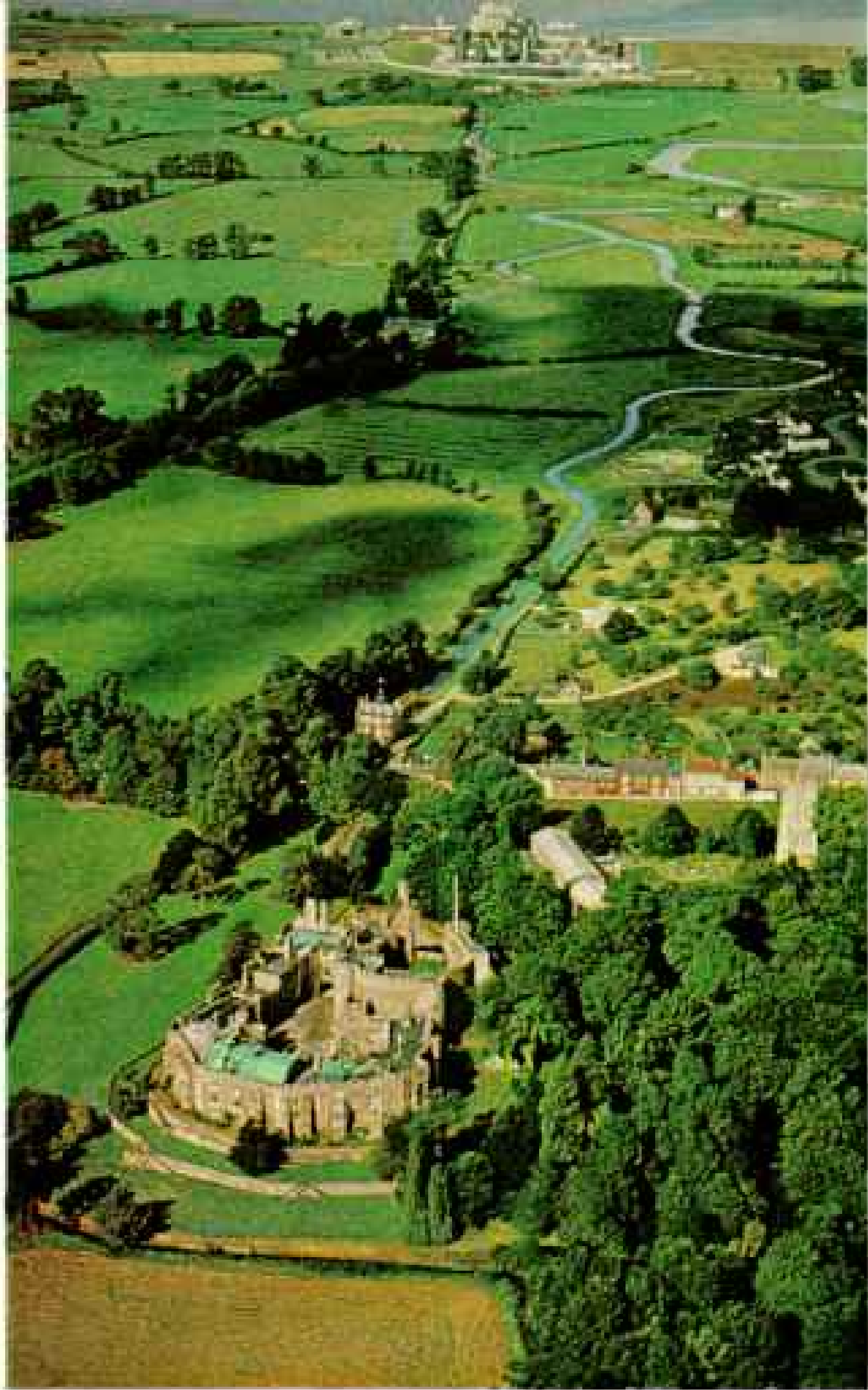
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Bard's portrait adorns the First Folio (1623).

Berkeley Castle still stands "by yon tuft of trees," as Shakespeare wrote in *Richard II*.

Land of Shakespeare four centuries later: a poetic legacy

"HE WAS NOT OF AN AGE, but for all time!" Thus Ben Jonson wrote in a poem for the First Folio, earliest collected edition of William Shakespeare's plays. This year the world celebrates the 400th anniversary of the playwright's birth—April 23, 1564—and in next month's *GEOGRAPHIC* Dr. Louis B. Wright, Director of the Folger Shakespeare Library in Washington, takes Society members on a tour of Shakespeare country. Many landmarks described in the plays endure; others live only in the magic of poetry. Lines from the Bard himself help to re-create his Elizabethan world. Your friends can also enjoy such timely yet timeless articles if you recommend them for Society membership on the form below.

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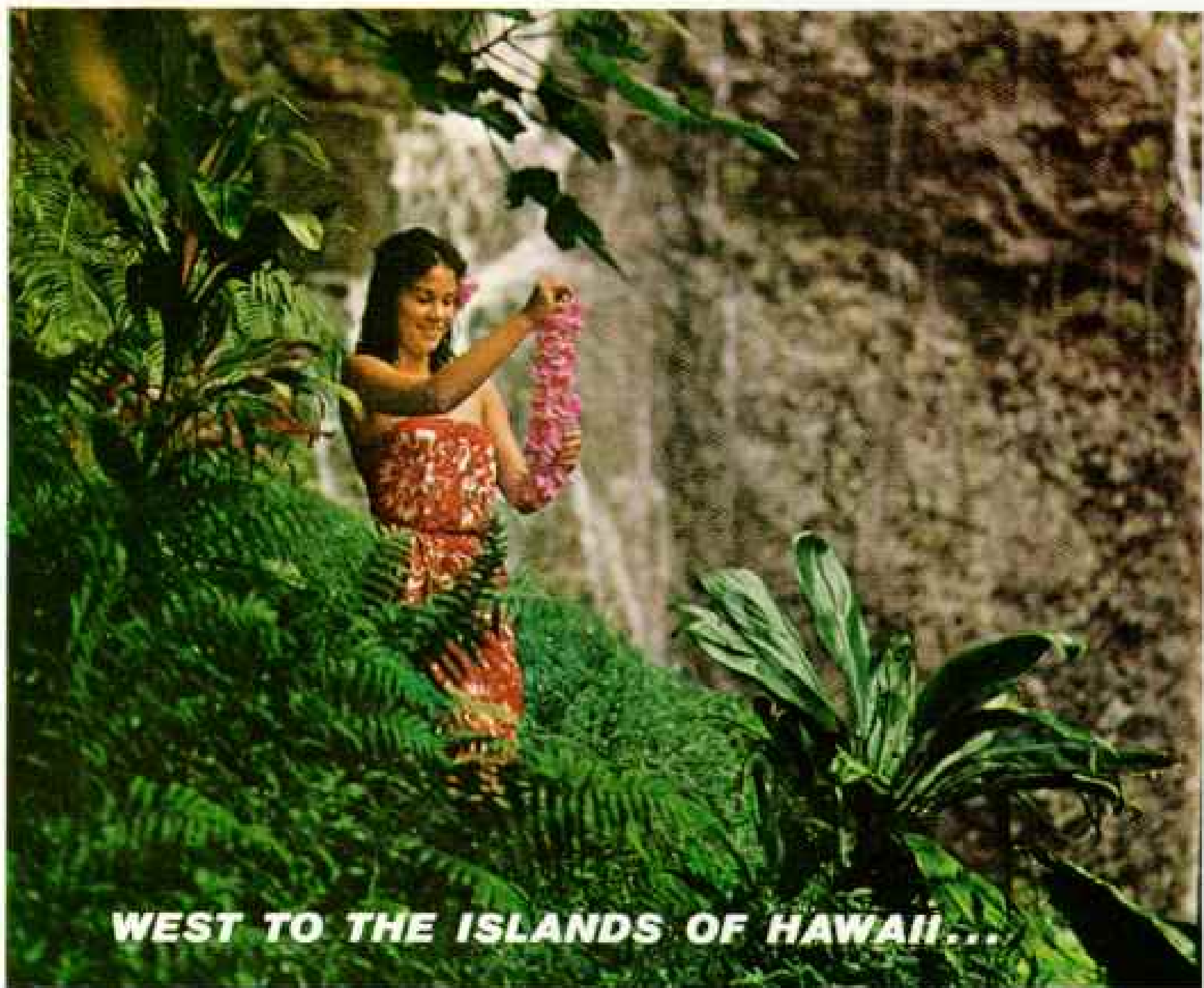
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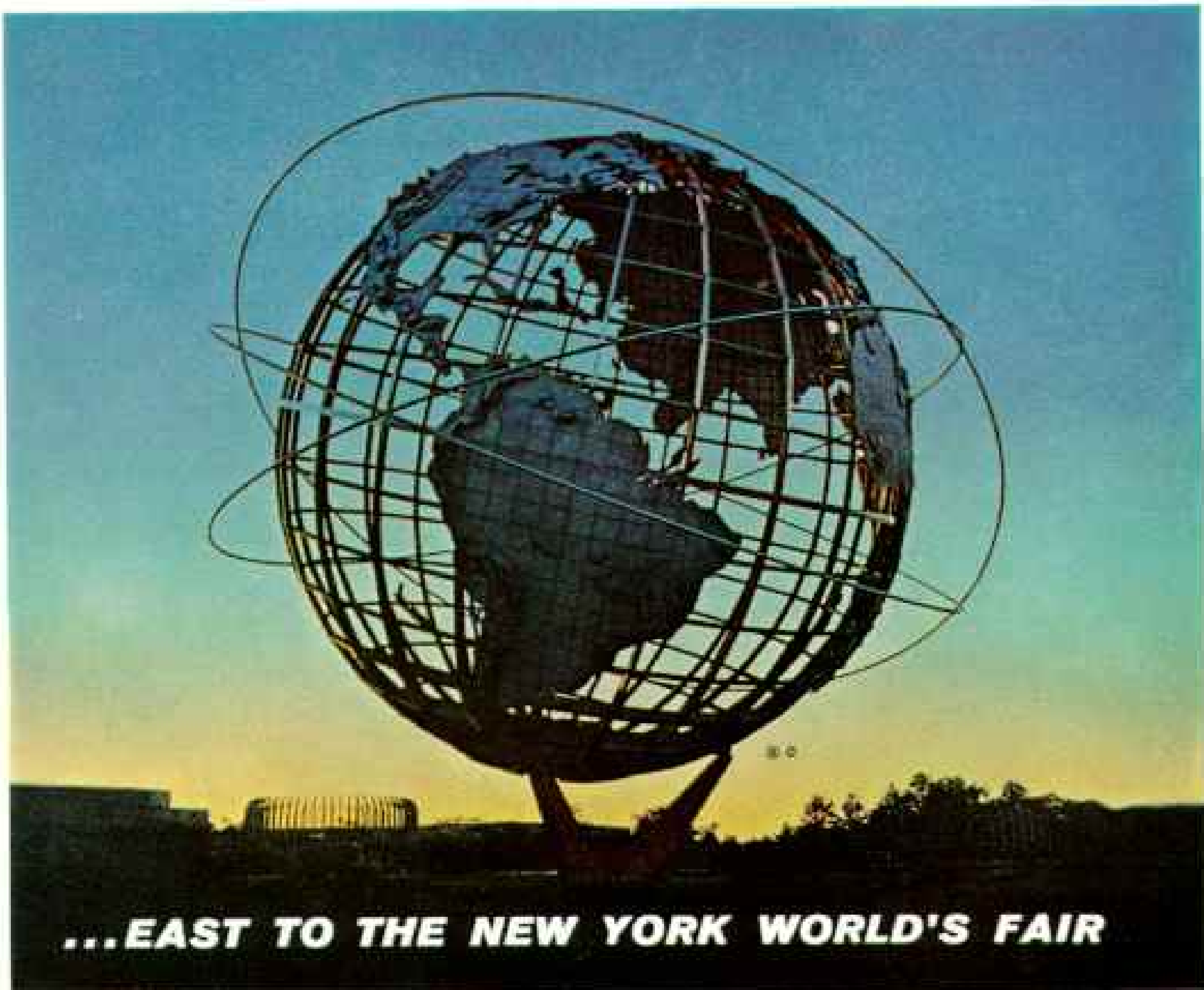
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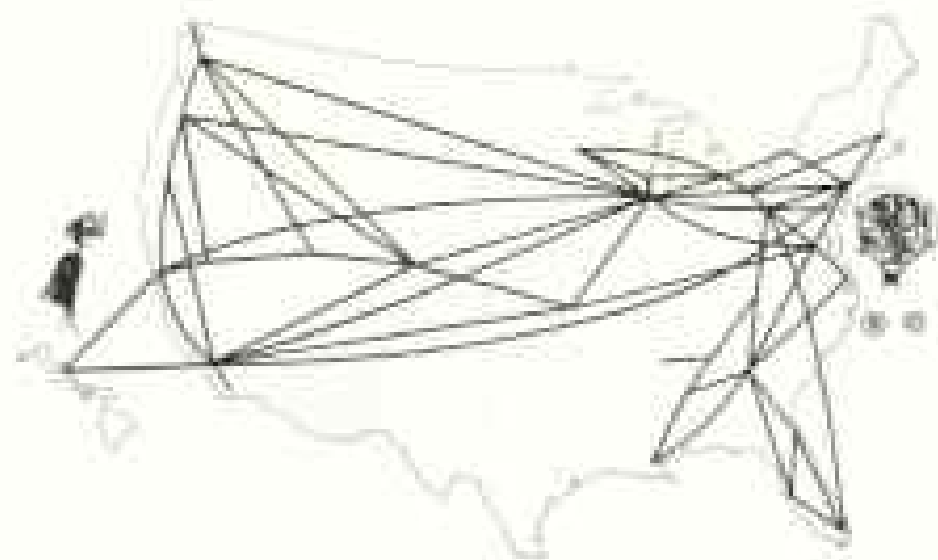
To make your trip to the Fair more fun, United offers a World's Fair Kit. In this \$1* kit you'll receive Doubleday's 230-page "Complete Guide to N.Y. City" (a \$1.95 value) with 16 pages on the Fair alone, United's Fair Checklist (to help you plan your time at the Fair), a folder with a variety of vacation plans, and complete N.Y. flight schedules.

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...EAST TO THE NEW YORK WORLD'S FAIR

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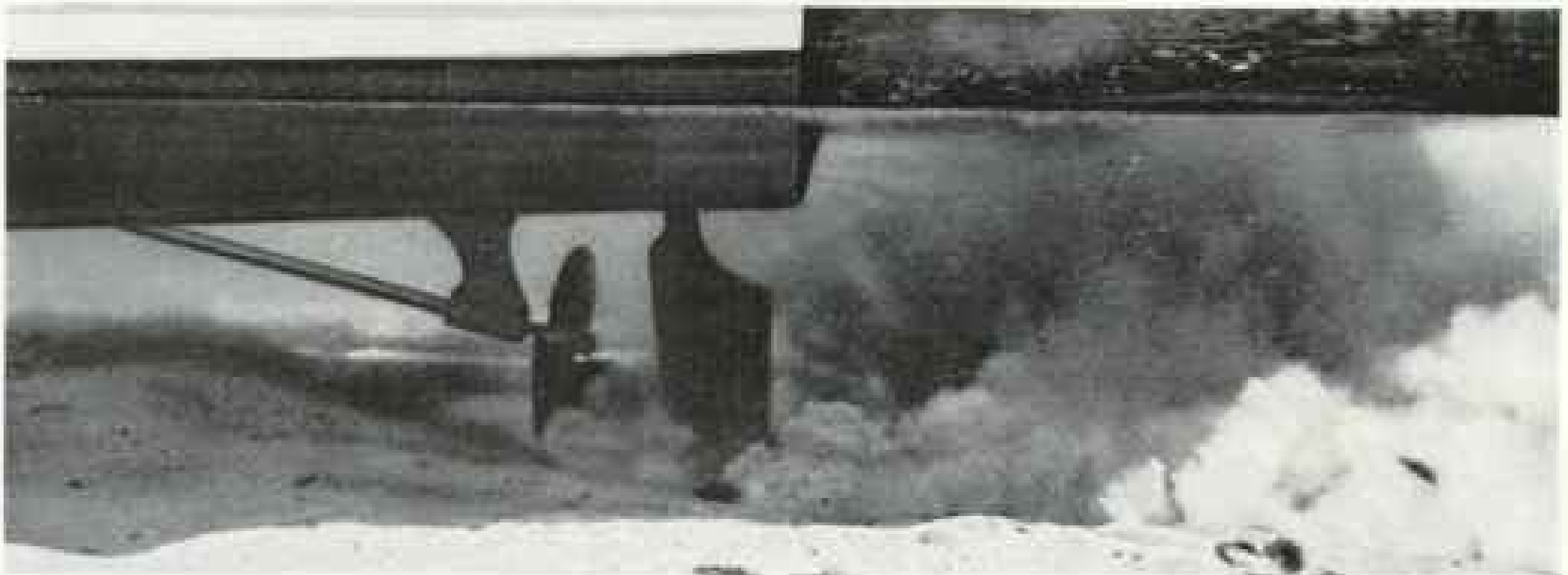
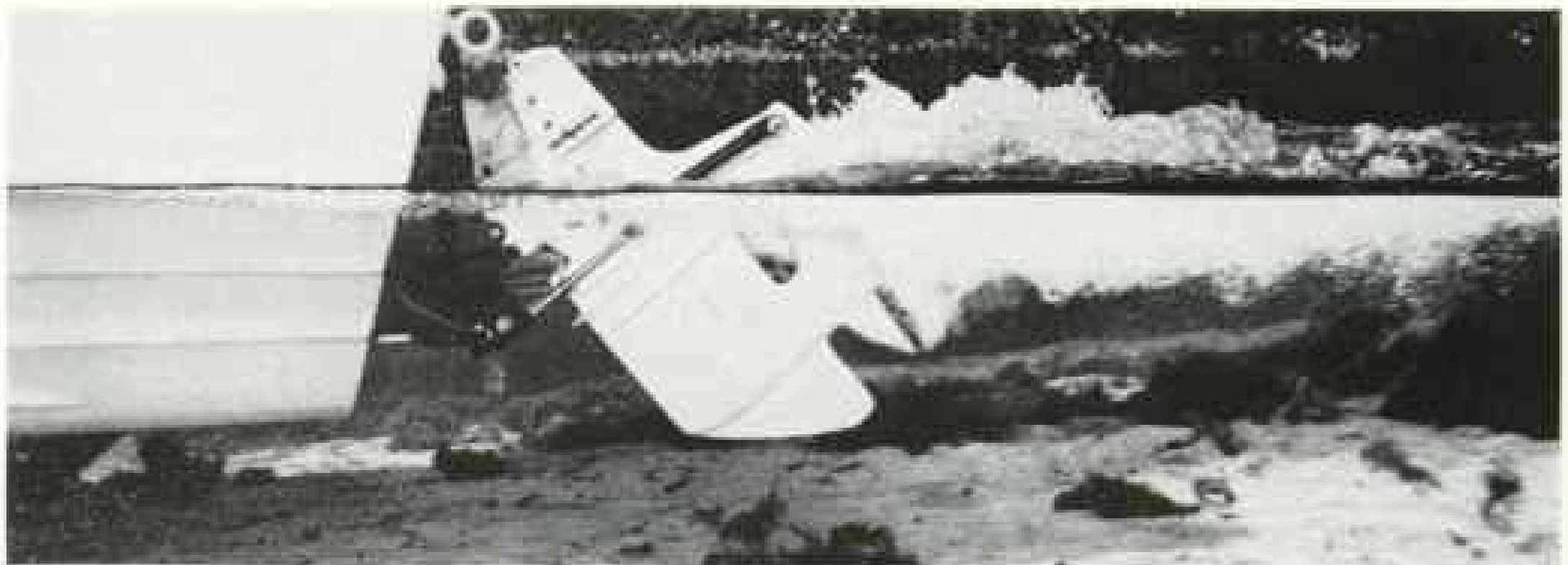


ILLUSTRATION COURTESY OF FLORENCE'S FLYER STORES

Shallow water takes the strut out of ordinary inboards

MerCruisers have no fixed struts, rudders or shafts on the bottom of the boat. Power tilt lifts the stern drive to the proper angle for shallow-water running.

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Boats powered by MerCruiser Stern Drive Power Packages give you the prestige of an inboard, the power range and fuel economy of 4-cycle engines... combined with the maneuverability, portability, propulsion efficiency and impact protection of an outboard.

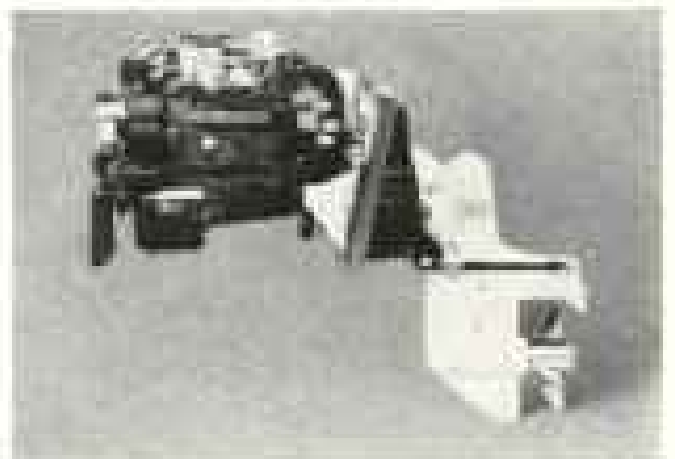
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See your MerCruiser dealer. Ask him to show you the boats you can own... equipped with MerCruiser Stern Drive Power.

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120 hp, 4-cylinder in-line engine and MerCruiser I Stern Drive. Dashboard-controlled power tilt. Hydraulic shock absorbers. Shearproof propeller drive with live-rubber safety clutch. Jet-Prop exhaust. Dual water pumps. Weedless water intake. Optional power shift and power steering.



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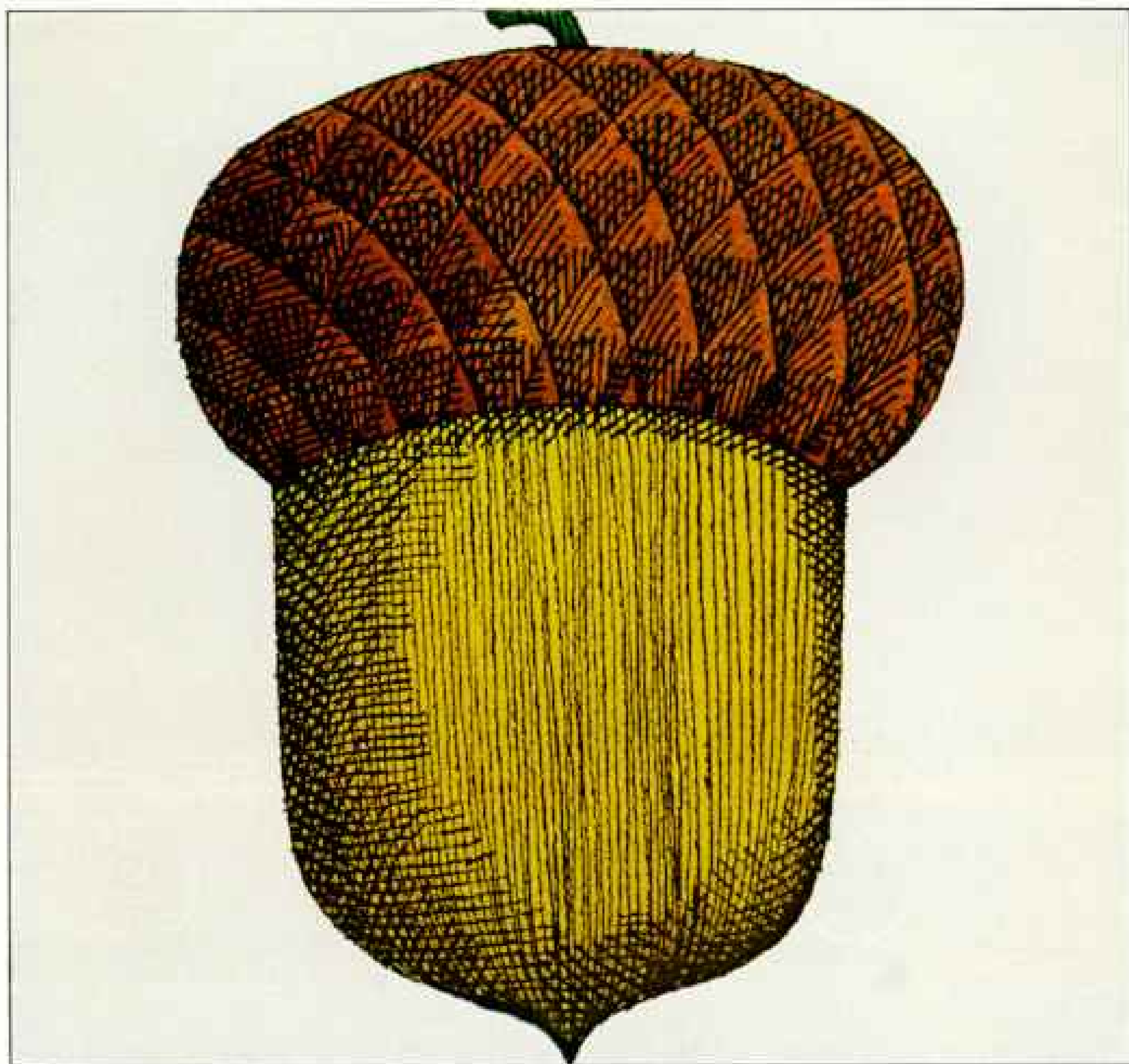
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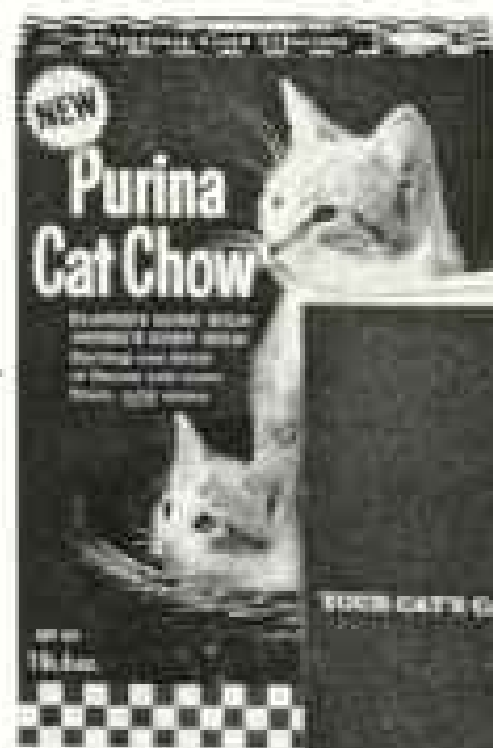
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This truck cab is only 54 inches long—with the engine tucked underneath! As a result, trucks and semi-trailer rigs can be shorter in length, lighter in weight and more maneuverable in traffic.

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Day at the Pacific: warm sands, cool sea breezes, the sound of the surf



An all-flower lawn



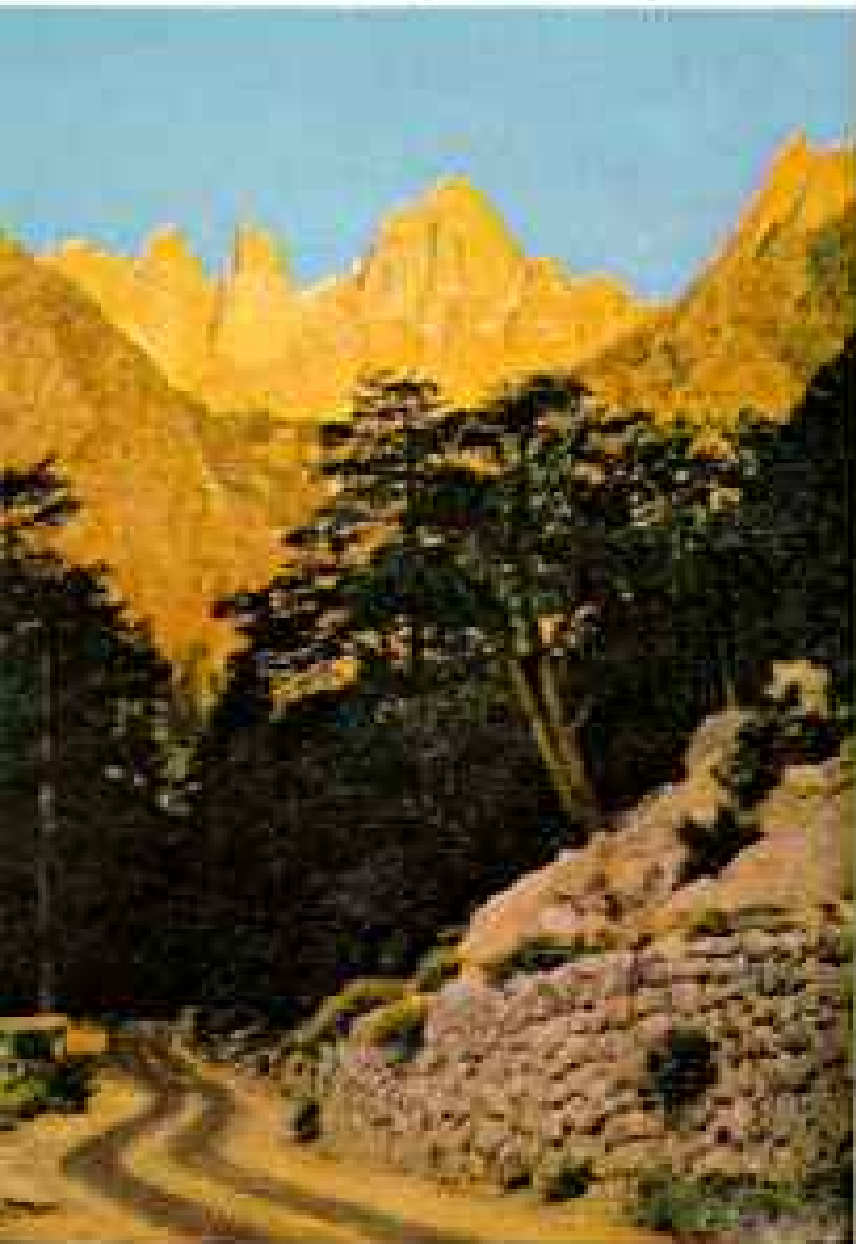
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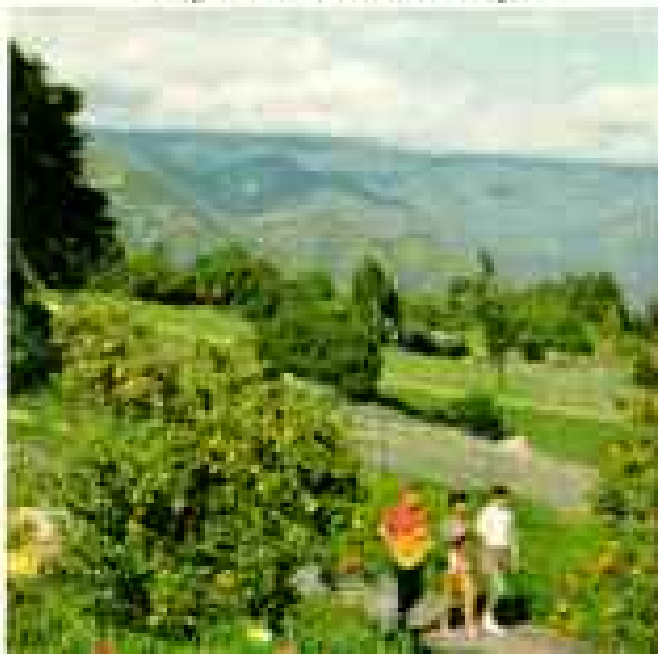
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Chevrolet Impala Super Sport Coupe with bucket seats

MAKES ROADS FEEL SMOOTH AS THE MAPS THEY'RE PRINTED ON

If you think this is going to be a lot of smooth talk about how luxuriously Chevrolet rides, you're right. And we've got the facts and figures to back it up.

Those new roads on the map with the double red lines seem pretty nice even in cars that don't have Jet-smooth ride.

But so do the old bumpy and hilly dotted-line ones in a Chevrolet.

So what's Jet-smooth ride? Not just a fancy name for Chevrolet's suspension system, if that's what you think.

It's Chevrolet's length and weight—17½ feet bumper to bumper and from 3,375 to 4,045 lbs., depending on model and engine. That makes bumps less noticeable all by itself.

It's over 700 sound quieters throughout the chassis and that big roomy Body by Fisher. Not

to mention sound-absorbing wall-to-wall deep-twist carpeting in every single Chevrolet.

It's Chevrolet's seven engines, precision-balanced for smoother running, ranging from the standard 140-hp Six to an extra-cost 425-hp V8.

And, of course, it's Chevrolet's famous Full Coil suspension—a big coil spring at each wheel. To show you how fussy we are, we tailor the springs' flexibility to the weight of the various models.

In short, Jet-smooth ride is really just about everything that makes Chevrolet a luxury car.

About the only thing that doesn't is the Chevrolet price.

... Chevrolet Division of General Motors, Detroit, Mich.

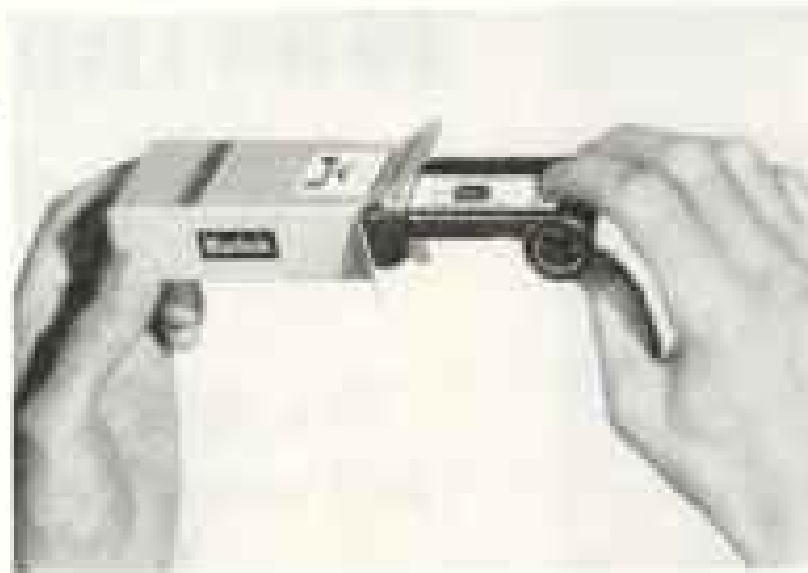
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Price subject to change without notice.

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The Special K breakfast is for you. Only 240 calories. Good in protein. 99% fat-free. Tastes fine, day after day.

Have you ever started on a weight control program and dropped it long before your goal was reached?

According to recent studies, most diets fail because they are too dull to live with.

The reason the Special K Breakfast has been so successful with so many people is that it is a normal kind of meal. It looks appetizing and tastes good.

And it is based on the concept that eating sensibly at breakfast can help you eat

sensibly at lunch and dinner.

While the Breakfast totals only 240 calories, it provides good nourishment: Complete high-quality protein. A balance of vitamins and minerals. And quick energy, too.

Mainstay of the Special K Breakfast is a unique, modern cereal—Kellogg's Special K. It is low in fat, high in protein, yet invitingly crisp and light. Its exceptional flavor is enjoyable month after month.

Doesn't Special K belong on your breakfast table?

Kellogg's

"The best to you each morning"
SPECIAL K

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THE SPECIAL K BREAKFAST

4 ounces of orange or tomato juice
—or half a medium-size grapefruit

1 ounce (1½ cups) Special K
with 1 teaspoon sugar

4 ounces skim milk

Black coffee or tea

(Only 240 calories)
(Only 0.62 grams of fat)

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One serving of Special K (1½ cups with ½ cup skim milk) supplies 14% of the recommended daily protein allowance for an adult man and approximately these percentages of his minimum daily requirements as established by the Food and Drug Administration

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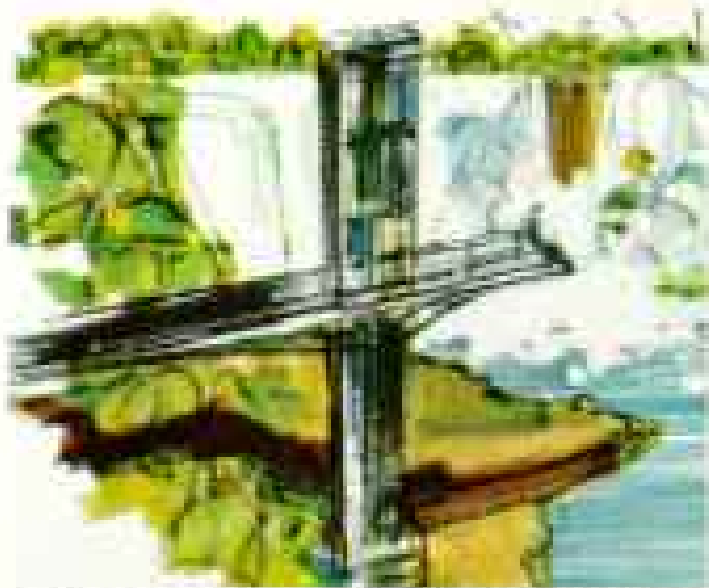
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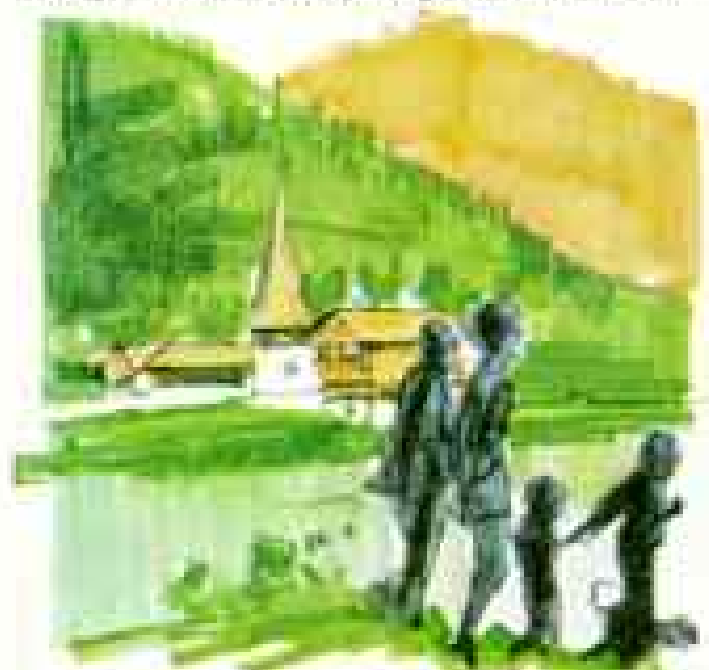
These delightful stops in New York State can double the fun of your World's Fair trip



This year and next, New York State welcomes you to the World's Fair. While you're here, see the sights of our state. Like spectacular Niagara Falls. All are easy to reach over the state's magnificent highways.



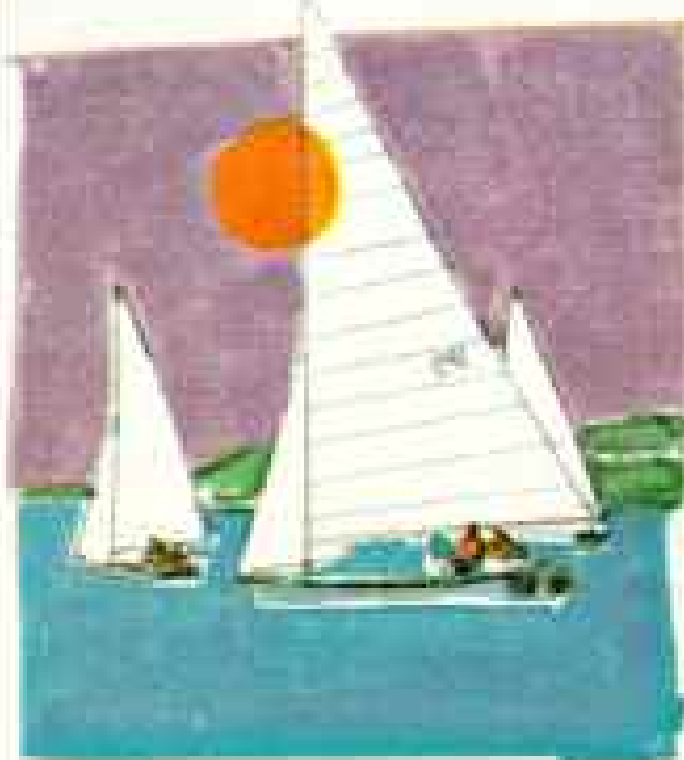
In summer, the whole state blazes with color. Each June, 35,000 bushes bloom at the Newark Rose Festival. At Rochester, there's a May Lilac Festival. Further south, you'll find over 17 miles of brilliant color in Genesee Gorge, "The Grand Canyon of the East."



The Adirondacks offer something for the whole family. Forts, animal farms, unusual attractions found nowhere else in the country. For a spectacular view, take the Tupper Lake, McCauley or Whiteface Mountain chair lift. On a clear day, you can see 100 miles.



If you want a real fishing challenge, go after fighting muskellunge in the Thousand Islands of the St. Lawrence. Or try for the wily black bass. If you have an extra day, take the 50-mile "ramble" through the islands.



The six magnificent Finger Lakes offer some of the best sailing in the area. Named by old Indian tribes, the lakes are now the center of the wine industry in New York. Don't forget to try some of the excellent local champagne at a nearby inn.



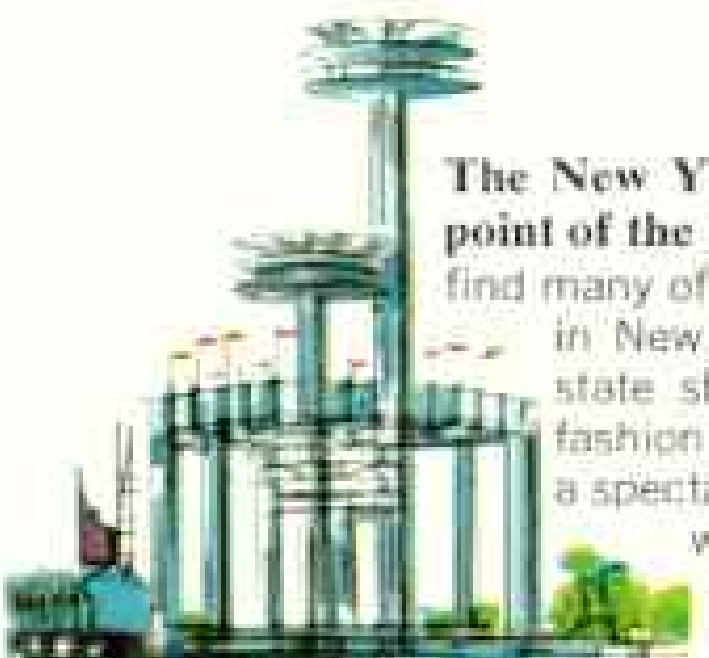
Now 101 years old, Saratoga remains the queen of race tracks. Watch the finest thoroughbreds racing there in August. Then take a walk through history on the site of the old battlefield.



In Sullivan County's world-famous hotels, you can sunbathe by the pool all afternoon, be entertained by some of the biggest names in show business in the evening. Close by is West Point, the United States Military Academy. And the only harness-trotting museum in the world is at Goshen.



New York City is the most colorful, exciting city in the world. You'll find its shops, restaurants, theaters everything you expected. See them by sight-seeing bus from midtown. □ This year, there's lots of information on New York and the Fair in our free "New York State Vacationlands" guide. And, of course, plenty of facts on what to see, where to stay around the state. Get your copy now from the New York State Department of Commerce, Room NG-4, P.O. Box 1350, Albany 7, N. Y.



The New York State Pavilion is the high point of the Fair. Beneath its canopy, you'll find many of the fascinating products made in New York. And a huge map of the state showing places of interest. See fashion shows and hear concerts. See a spectacular movie in the Theaterama with 360° screen. Then soar 220 feet to special platforms for a magnificent view of the Fair.

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the Gulf Stream warms the sands of



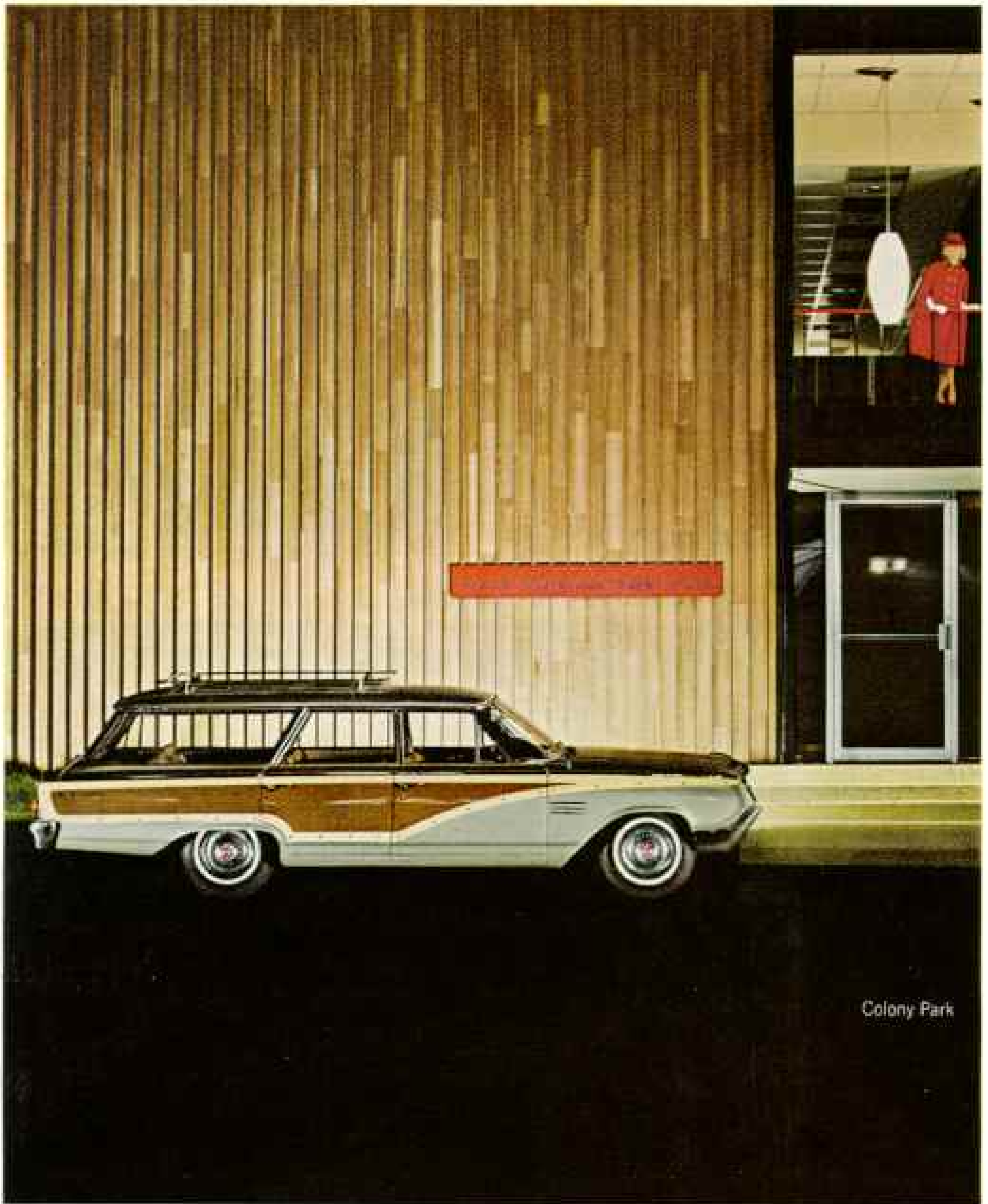
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Colony Park

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How much do you plan to spend? Pick a Lufthansa Tour priced from \$477 to \$2969.

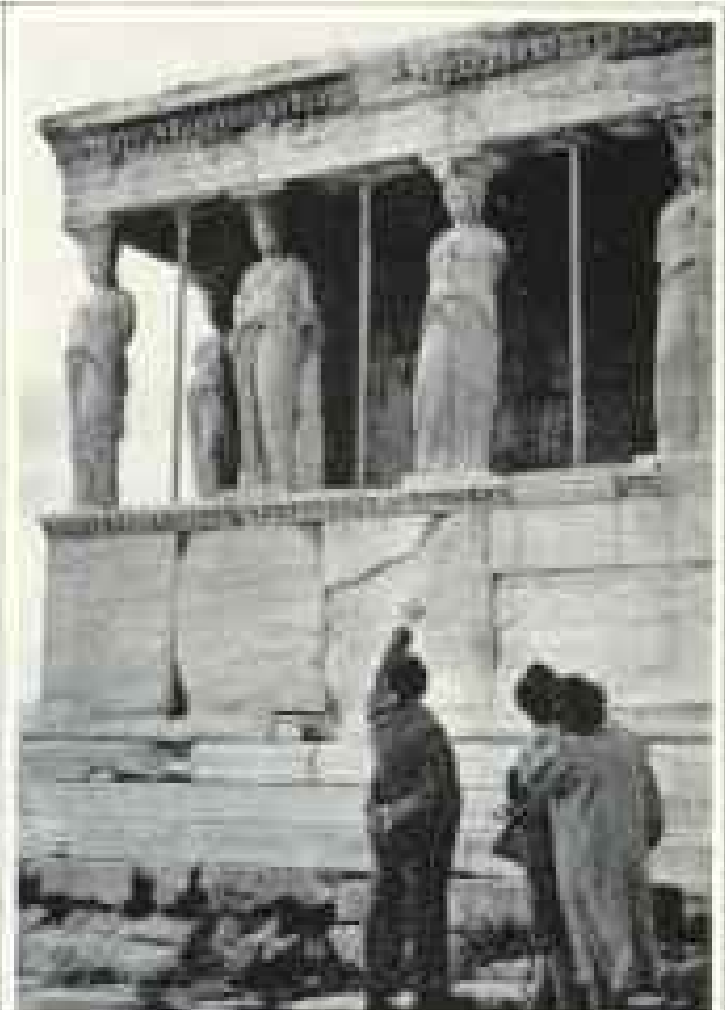
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Revolution

The world-famous army 'Jeep' vehicle started it all. Then came the evolutionary changes. Sensible changes. Like more ground clearance. Stronger suspension. Weather proof tops. Fun changes. Like pink and white striped upholstery. Fringed surrey tops. Lively colors. A sports roadster. A station wagon — rugged, durable, designed for work and play.

Then came the 'Jeep' Wagoneer. A revolution! The Wagoneer is so revolutionary, it's hard to recognize your old 'Jeep' friend. It's a station wagon. *And* a looker! You'll be stunned. Slide into that luxurious interior. Beautiful. Comfortable. Visibility unlimited!

Turn the ignition key. You've got an overhead cam engine purring for you. The only one in any American

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And the 'Jeep' heart and spirit are still there. Pull one simple lever and you're in 'Jeep' 4-wheel "Drivepower."† Then there's hardly a hill that can keep you down . . . hardly a mud hole that can bog you down. In fact, there's scarcely any driving situation that can get you down. You're free to go anywhere with the traction to pull you through.

Drop in on your 'Jeep' dealer. He's so enthusiastic about the 'Jeep' Wagoneer he'll be *glad* to give you a test drive. Actually, he gets a kick out of it himself!

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*Optional items at slight extra cost.

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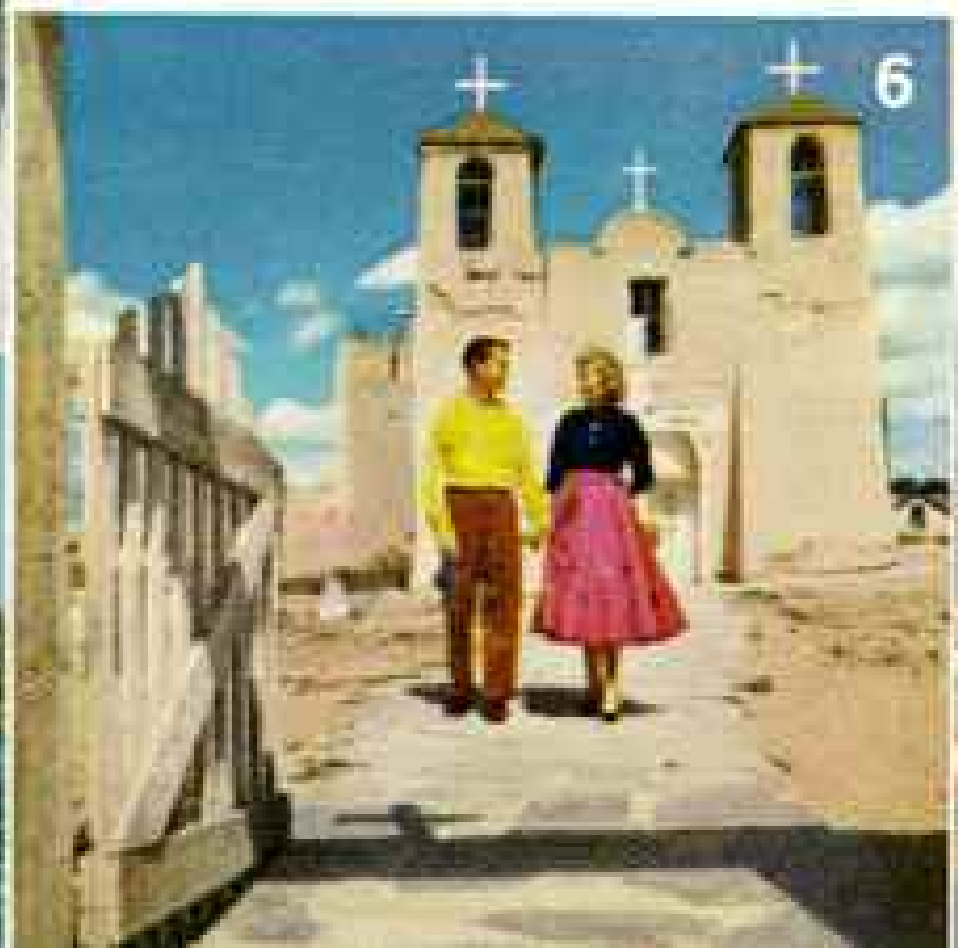
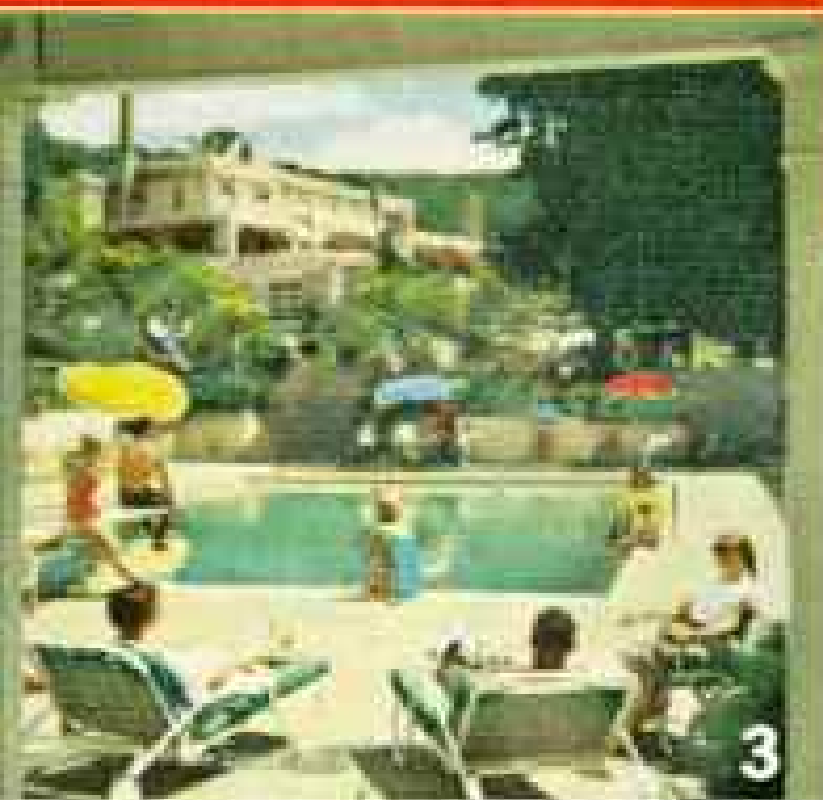
6 A PEEP INTO HISTORY?

Missions, historic ruins, trails of the pioneers, give a dramatic insight into New Mexico's colorful past.

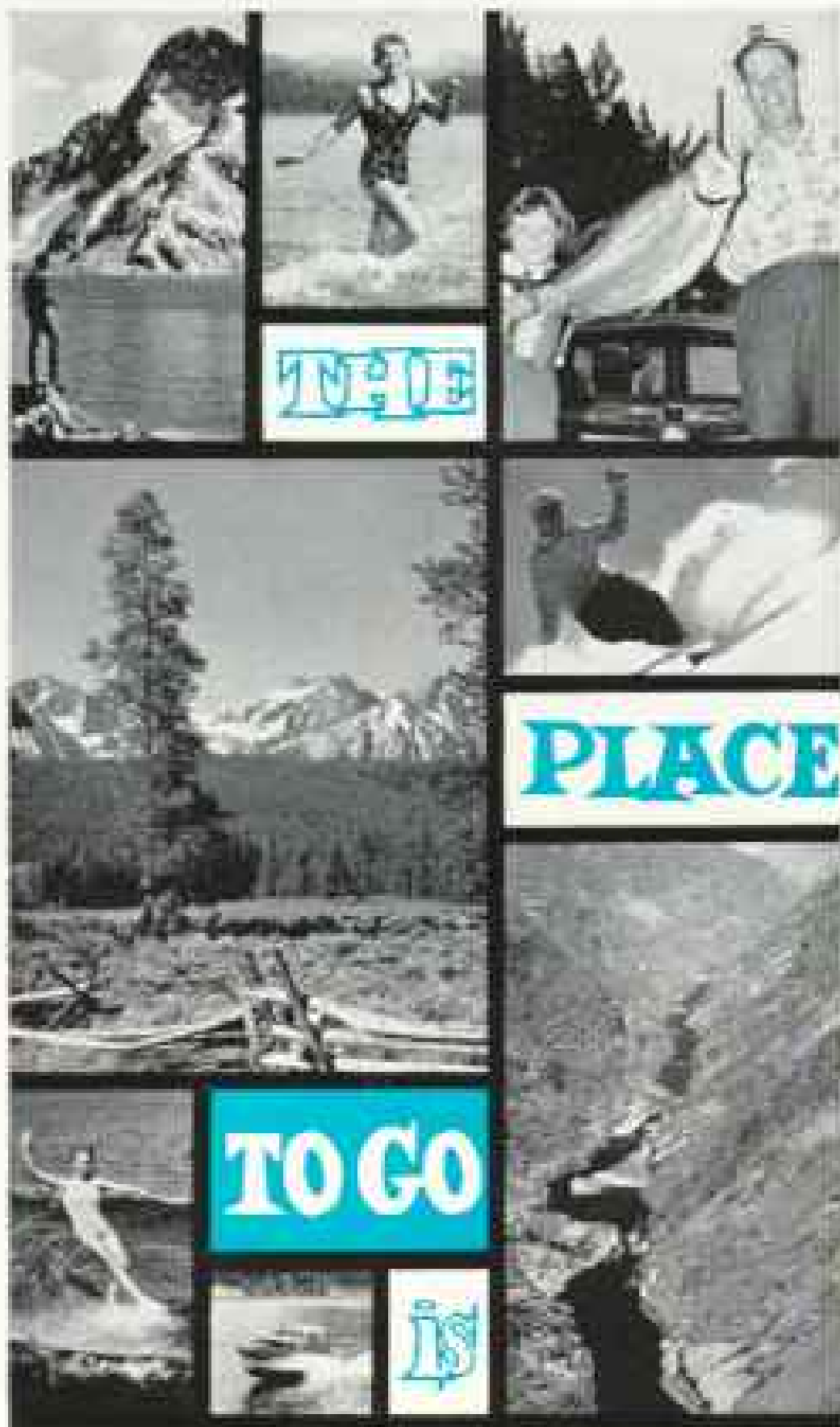
7 PAGEANTRY?

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Toss and turn at night?	<input type="checkbox"/>	<input type="checkbox"/>
Start when you hear a sudden noise?	<input type="checkbox"/>	<input type="checkbox"/>
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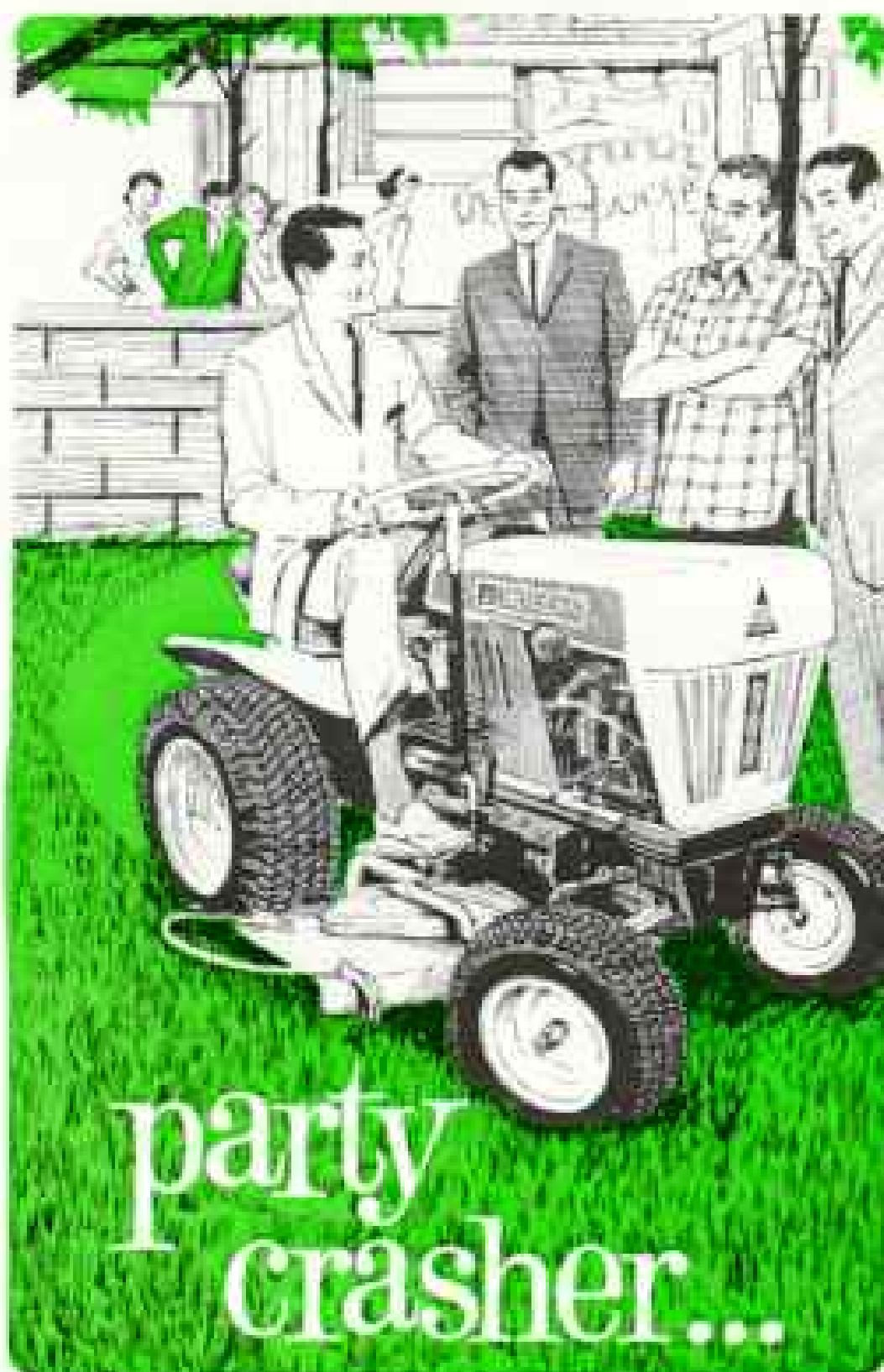


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'64 WIDE-TRACK PONTIAC



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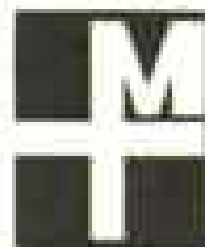
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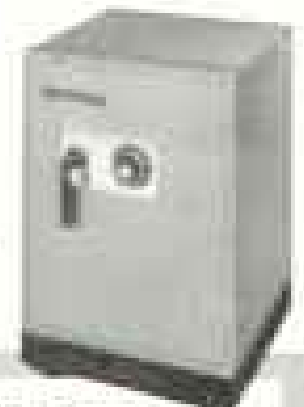


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Mr. Bob Blackburn

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"Our total automobile expenses are about \$400 per year less."

"Thanks to Rambler, my six kids are on their way to college! For our total automobile expenses (gas, oil and upkeep) are actually \$400 per year less than they used to be and we're converting the savings to our college fund.

"Being a sportscaster in the Northwest with its unpredictable winter weather, I count on my car to maintain my tight, fast schedule. Rambler has never let me down.

"I've sold many friends on switching to Rambler by just letting them drive one.

"To tell the truth, the cars I have now are performing so well and with so little expense, you're going to have a heckuva time selling me a new one for awhile!"

But wait till you see the beautiful '64 Ramblers—all more dependable and economical than ever. See your Rambler dealer now!



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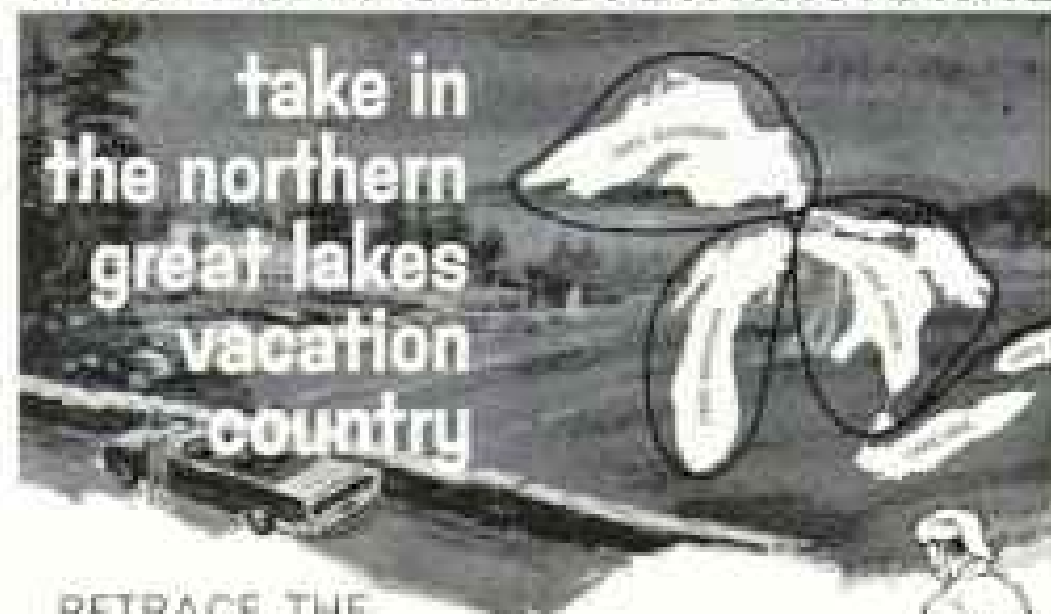
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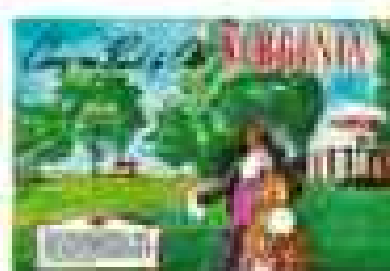


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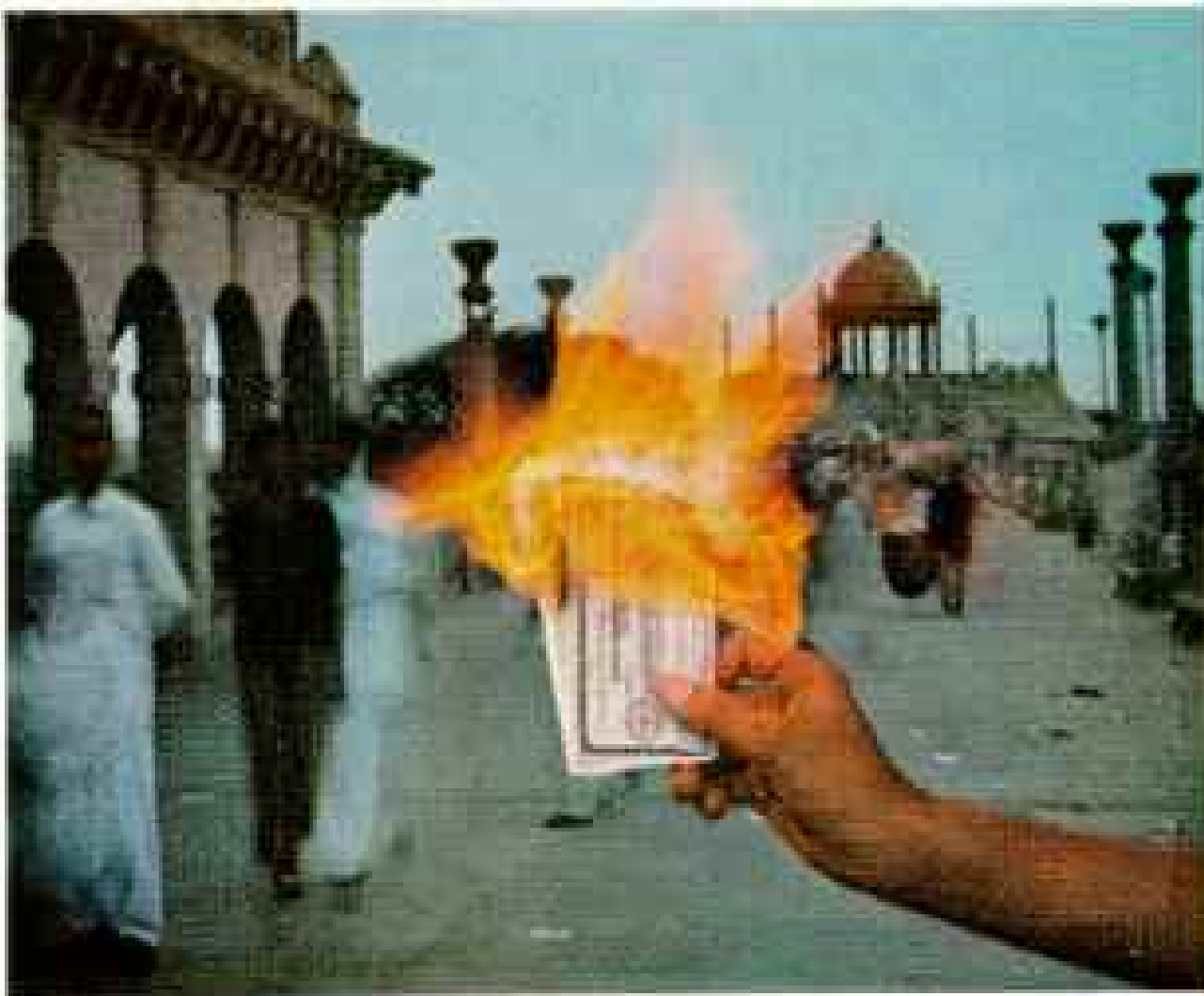
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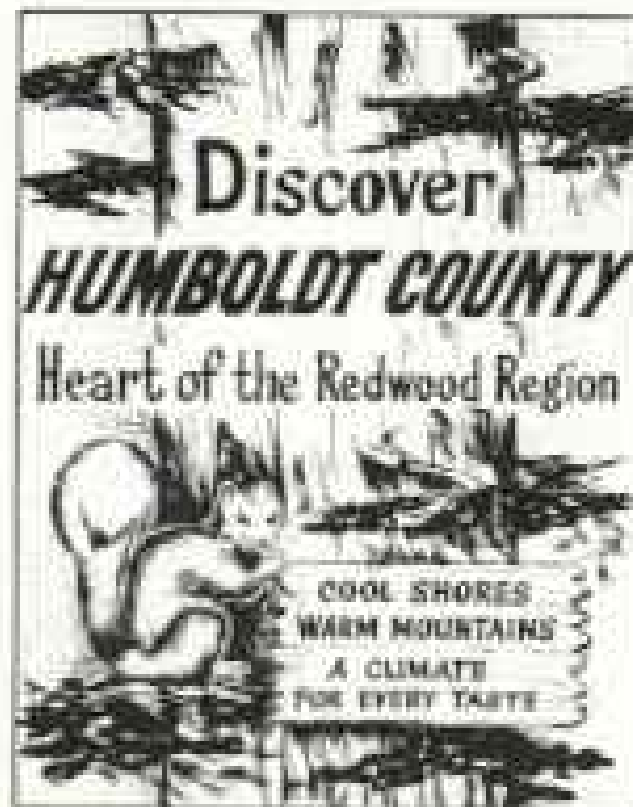
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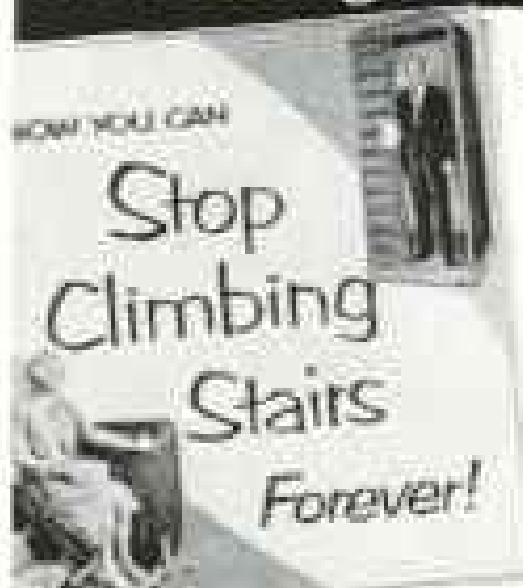
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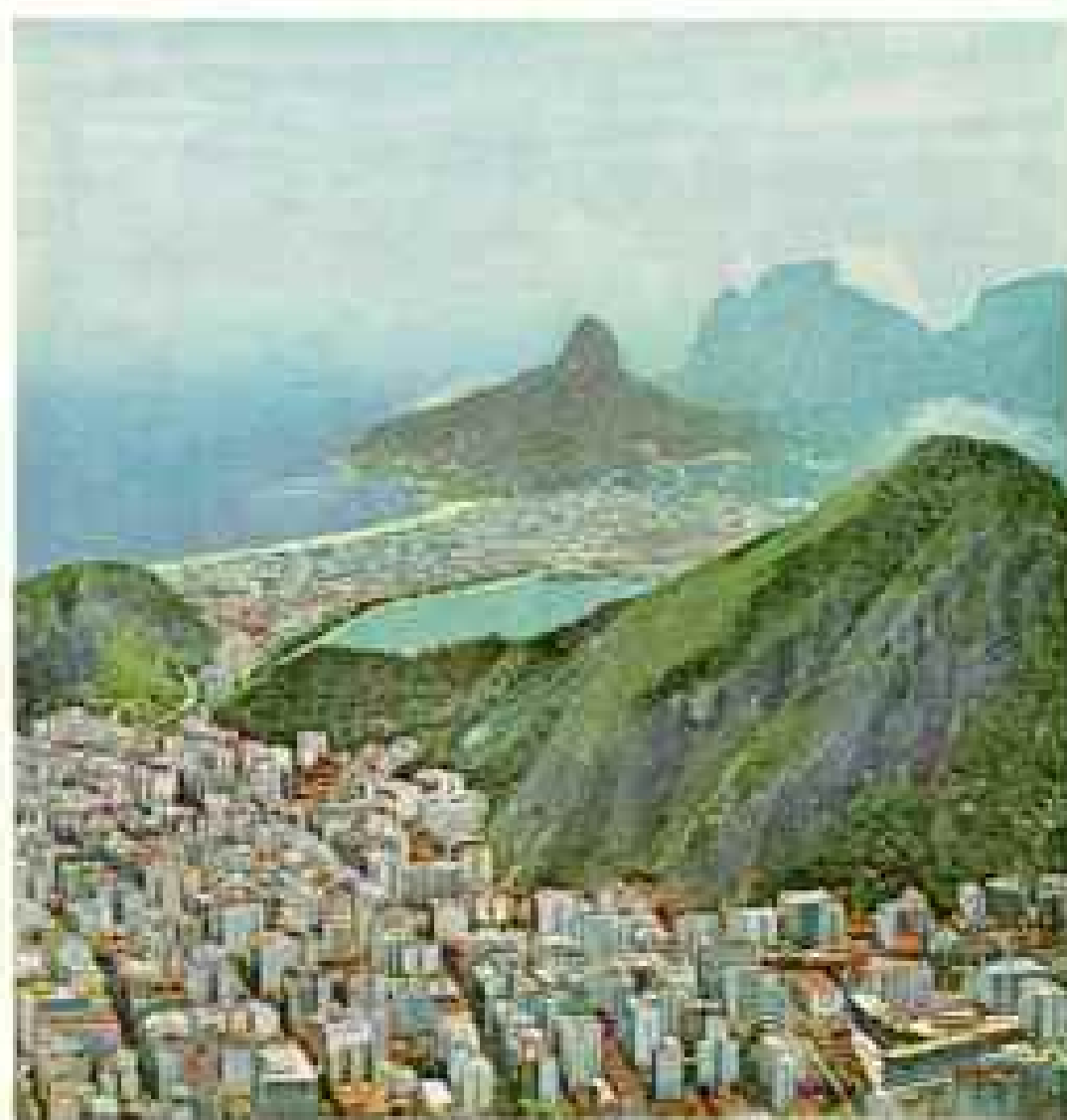
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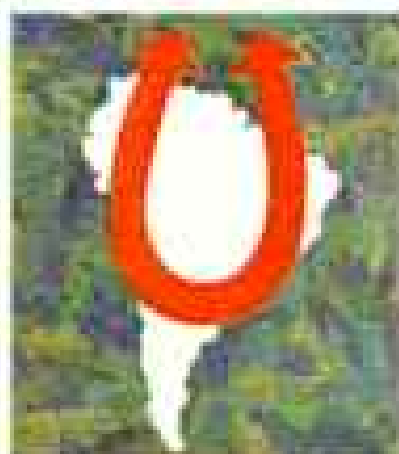


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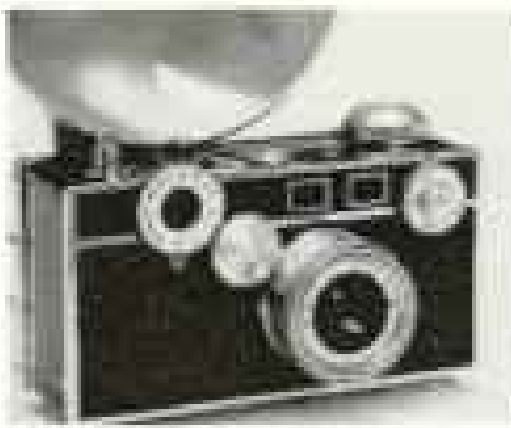
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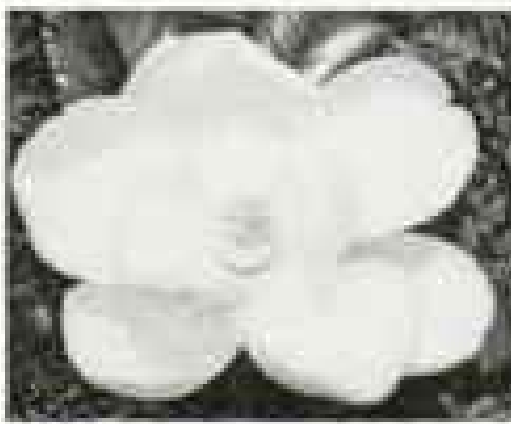
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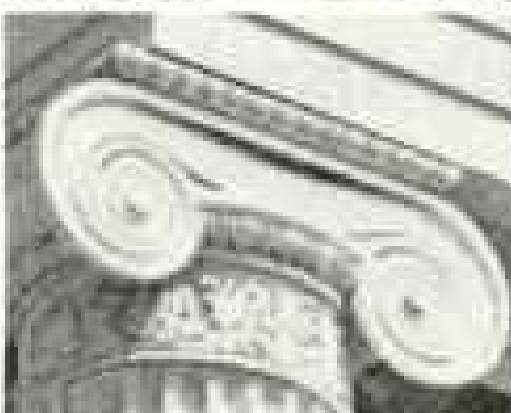




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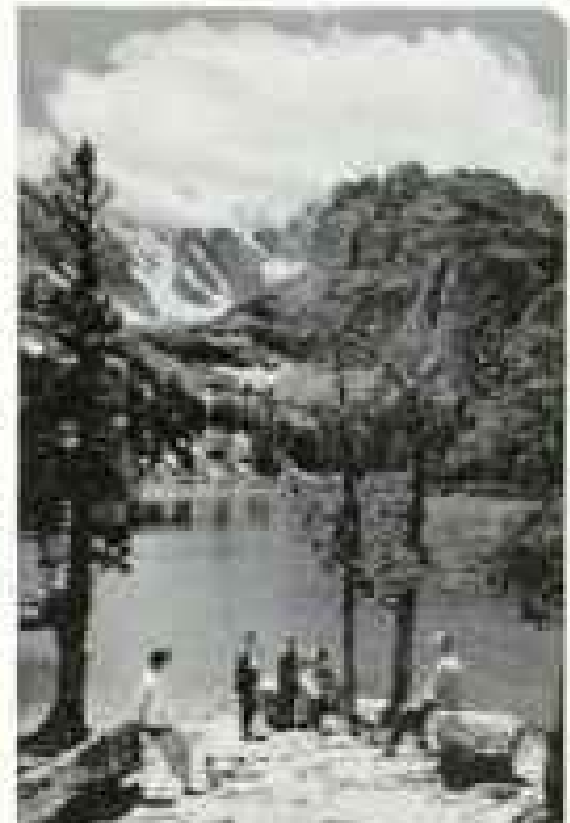
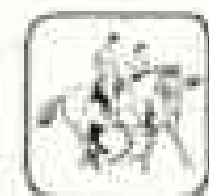
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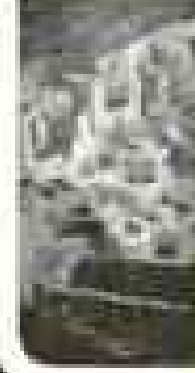


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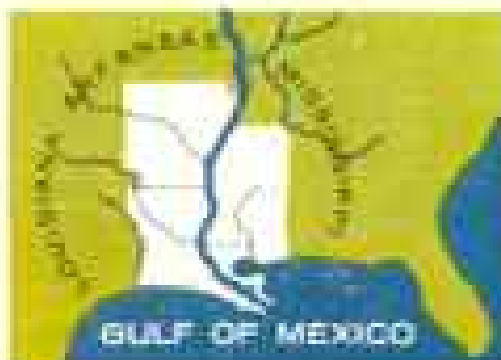
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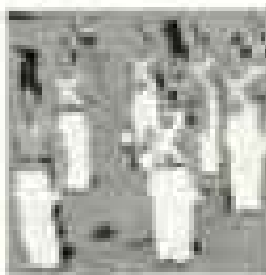
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