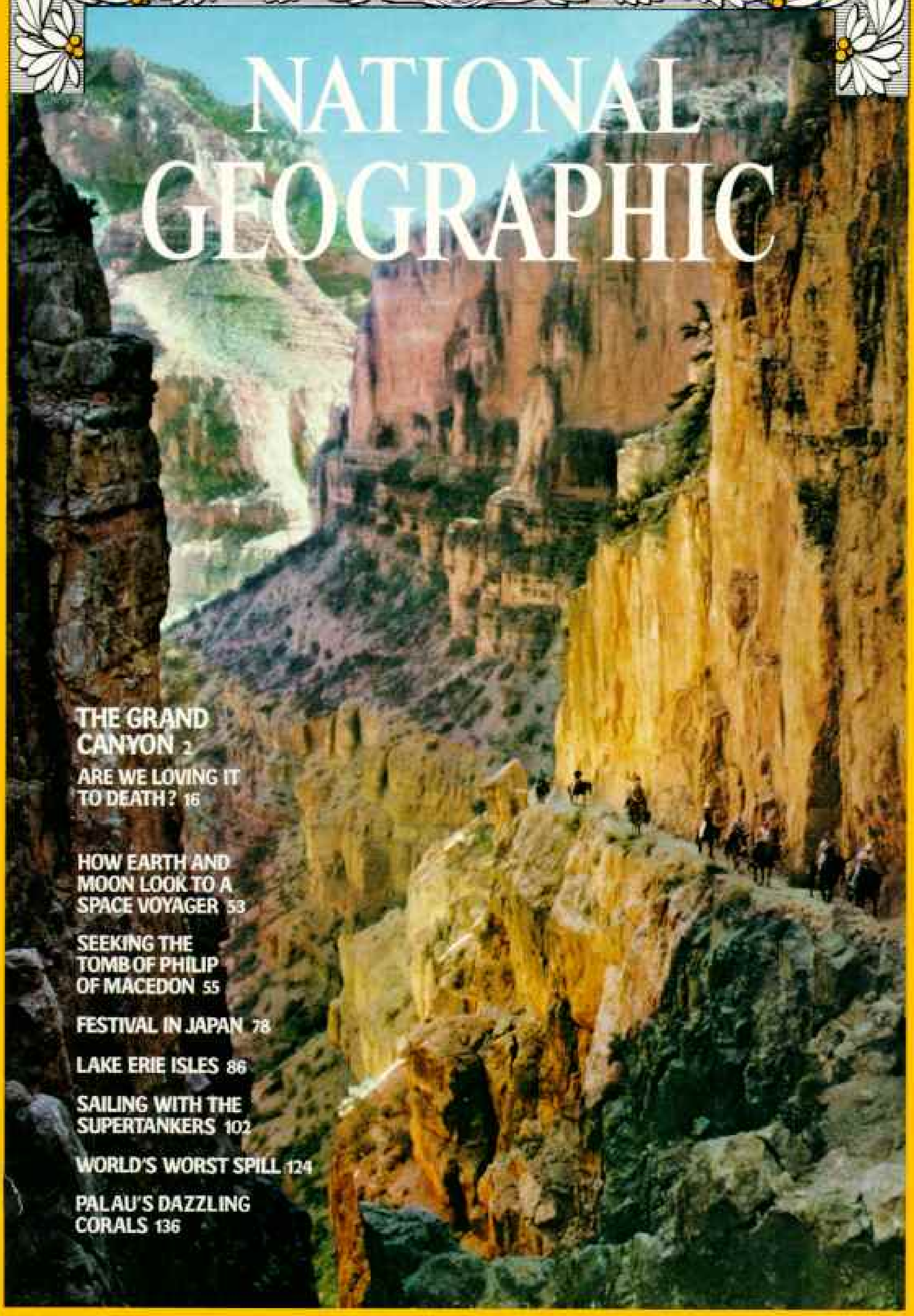
DOUBLE SUPPLEMENT: THE GRAND CANYON OF THE COLORADO

VOL. 154, NO. 1 JULY 1978

# NATIONAL GEOGRAPHIC

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I HAVE BEFORE ME, as I write, a copy of the first proof of Noel Grove's "Superships" article that appears in this issue. A part of it reads:

> "At this writing, no supership over 200,000 tons has yet broken up fully loaded. No one can predict the environmental impact of such an accident. No one seriously doubts that it will happen."

Happen it did, off France's Brittany coast on March 16 of this year. The 229,000-ton tanker *Amoco Cadiz* lost steering control; attempts to tow her to safety failed, and she broke up on the rocks—a colossal whale of a ship pumping her black lifeblood of 69 million gallons of oil into an angry sea that carried the pollution along more than a hundred miles of coast and fishing grounds. It was the largest spill and potentially one of the most terrible ecological disasters in history.

Noel and photographer Martin Rogers were on the first Concorde flight to Europe after the news came, the grim culmination of half a year's voyaging with superships in every part of their special world—from Alaska's Valdez Narrows to the Persian Gulf.

The tragedy poses a direct and serious challenge to all nations that supply and rely on oil. Unlike the *Argo Merchant*, a notorious anachronism that dumped seven and a half million gallons of heavy fuel oil off Nantucket in 1976, the *Amoco Cadiz* carried the best that modern technology could offer in the way of navigation aids and operating mechanisms. Still, she went aground, a victim of nature's fury and disabled steering, and left an impact that can only be compared to one of nature's own calamities.

The vast spill that smeared the once beautiful coast might have been in the shape of a black question mark. The repercussions were not only environmental but also political. As an anguished young Breton helping with the cleanup remarked: "We will leave a chamber pot for our children. They'll manufacture plastic birds with motors so that kids can see what a bird was like."

It has been widely speculated that the conservation movement lost some of its steam because of the demands of the energy problem. It takes only one *Amoco Cadiz* to remind us that the questions will not go away.

Gilbert M. Grosvenor


# NATIONAL GEOGRAPHIC

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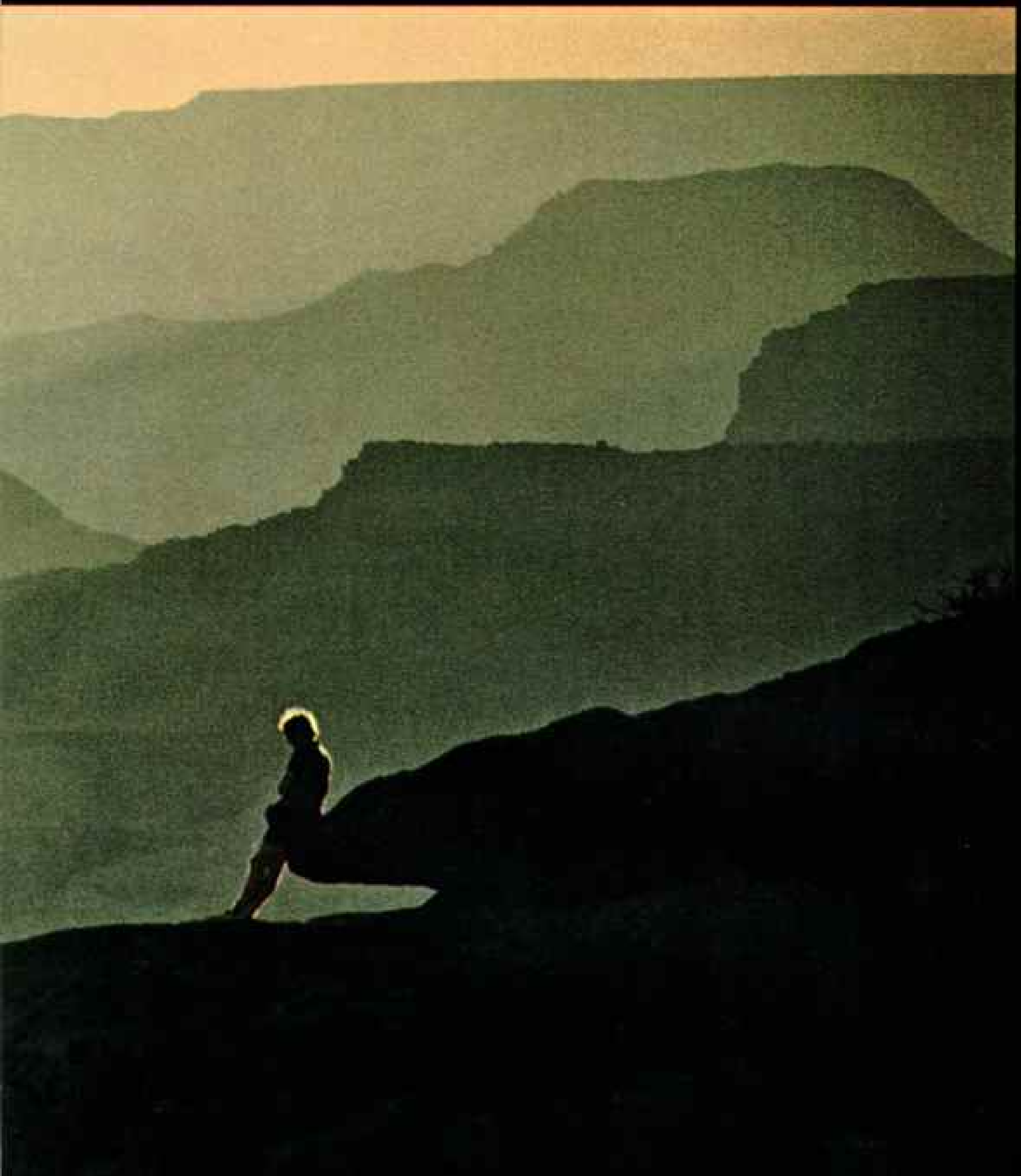
# GRAND CANYON

"Leave it as it is.
You cannot improve
on it. The ages
have been at work
on it, and man
can only mar it."

Theodore Roosevelt, 1903

A PORTFOLIO BY
W. E. GARRETT
ASSOCIATE EDITOR



"Then he rolled a river

into the gorge, a mad, raging stream that should engulf any that might attempt to enter thereby." Southern Paiute legend

"All these canyons unite to form

one grand canyon, the most sublime spectacle on the earth." Maj. John Wesley Powell, 1895

"I dismounted... a slight deviation in a step would have precipitated one into the frightful abyss."

Lt. Joseph Ives, 1861

"It is possible to make such a wilderness...

accessible without ruining it...." Wallace Stegner, 1955

GRAND CANYON

# Are we loving it to death?

ARTICLE AND PHOTOGRAPHS BY
W. E. GARRETT
ASSOCIATE EDITOR

**Preceding pages:**

On Toroweap Overlook *(pages 2-3)* 3,000 feet above the Colorado River, a visitor basks in North Rim solitude.

Flowing fast, flowing red with a burden of silt from side canyons in flood, the Colorado churns an inflatable raft through Granite Rapids *(pages 4-6)*.

Under a sift of snow, Mather Point on the South Rim *(pages 7-10)* faces across the barely visible Inner Gorge and into Bright Angel Canyon, which cleaves the North Rim along a fault.

Brinkmanship of the most literal sort accompanies a party ascending North Kaibab Trail by mule *(pages 11-13)*. Although destructive to trails, mule trips, begun in the 1880's, remain popular.

Creating its own rockscape by depositing calcium carbonate on everything it touches, the water of Havasu Creek *(pages 14-15)* models travertine into fantastic shapes in the fastness of the Havasupai Indian Reservation.

AT ONE TIME everyone at Toroweap had an airplane, but that was before Merribeth came along in 1965 to marry John. Now only half the people at Toroweap have an airplane. Its name is *Pogo*. It belongs to John Riffey, the only park ranger there since 1942.

Merribeth and John live in a stone cabin that blends modestly into a vast solitude, atop a scree slope about ankle high on a 1,500-foot canyon wall. John casually presides over 200,000 pristine acres on the north side of Arizona's Grand Canyon National Park. For Dr. Merribeth Riffey, an ornithologist, it's a well-stocked aviary.

The Riffeys have no neighbors. The few visitors usually come by way of St. George, Utah, turning right off Route 389 at the park sign and driving down their 60-mile unpaved driveway.

"Only got snowed in once," John laconically volunteered. "In 1948. Didn't want to go anywhere anyway. Weather was bad."

Six miles beyond their cabin Toroweap Valley ends—awesomely. Where it should be, athwart its path, lies the Grand Canyon.

And nothing else. No steel guardrails, no asphalt parking lots, no manicured paths with starched rangers leading nature walks.

Your eyes ricochet up, down, east, west, north, or south and see only a unique, sublime natural spectacle (pages 2-3).

Stand on the rim, if you dare, and you can look past your toes straight down half a mile.

Listen hard. You'll hear an insistent murmur drifting up from the tiny squiggle of a river down there. It originates as a deep-throated roar from mighty Lava Falls, considered the world's fastest navigable rapids.

At river level the Grand Canyon measures 277 miles (see the double-sided supplement map distributed with this issue), but up here the rim wrinkles into thousands of miles of unspoiled niches like Toroweap, where nature can be heard, seen, and smelled unmolested. Where you can take your soul for a long walk—slowly. Where the canyon experience can seep into your memory to stay warm and handy and comforting. More than ever we need our Toroweaps.

Fortunately Congress provided for them when it established the National Park Service in 1916 and ordered that the parks be managed "by such means as will leave them

unimpaired for the enjoyment of future generations."

Preserving them is the sole responsibility of the National Park Service. Increasingly there have been charges, some formalized in lawsuits, that it's not doing it very well in the Grand Canyon.

The most unusual and important accusation is now before the U. S. district court for Arizona. The national park—literally the place itself—is the plaintiff suing the National Park Service, charging that mismanagement of river trips results in irreparable damage to the environment and the public's ability to enjoy the park. Such suits can be brought when an organization, in this case the Sierra Club, files as joint plaintiff.

TO REPORT on the park and its problems, I hiked, boated, and flew hundreds of miles in the Grand Canyon. First I went to park headquarters to meet Superintendent Merle Stitt, whose name heads the long list of defendants in the suit. He greeted me with relaxed western hospitality—on guard but not defensive. I asked if his management of the park fulfills the 1916 congressional mandate. After the briefest hesitation he answered.

"No. I'd have to say no. As the visitors increase, so do the demands for protection. So we've had to set limits on camping, hiking, and river running. We may have to set limits on how many can enter the park."

A quota? The idea disturbed me. Perhaps because when I first saw the park in 1949, as a student hoboing through the Southwest, there were no crowds. Only 600,000 visitors shared the view from the rims that year. A negligible handful of us hiked the inner canyon. Only a dozen adventurers challenged the river rapids. Only a hundred people had run the river in recorded history.

This July as many as 200 people a day will line up to take the trip. More than a quarter of a million of us hiked into the canyon last year, while another quarter of a million toured overhead by plane and helicopter. A crush of nearly three million jammed the two-lane roads and crowded onto the same overlooks I used thirty years ago. And more are coming. The United States Travel Service says the canyon heads the list of natural attractions that Americans want to visit.

Merle noted that despite its apparent hardiness the canyon's desert ecology is fragile. Overuse and ignorance, as well as malice, can damage it severely.

He told me of one group of hikers who accidentally burned a lovely oasis in Deer Creek Valley. Another party damaged Rampart Cave's iron gate, and their torches started a smoldering fire in the cave's five-foot-thick floor of Pleistocene sloth dung. In the priceless deposit, 11,000 to 30,000 years old, were remains of extinct horses, cats, mountain goats, and birds.

Ranger Marvin Jensen, inner-canyon manager, admitted that the park wasn't adequately patrolled and had become shabby from overuse.

"Our trails are in poor shape," he told me. "They're a safety hazard to mule trips. I've only got nine full-time people, counting myself, to manage almost a million acres. That's just not enough people to do what needs to be done."

To add to his problems, as many as 12 hikers a day with more enthusiasm than endurance and good sense collapse and have to be "dragged out" of the canyon.

MARY LANGDON, who's in charge of backcountry reservations, warns hikers they're entering a tough world.

"Young guys who think they're in great shape try to run down the trail and back. They find the canyon's stronger than they are. I found one guy halfway up the North Kaibab Trail lying beside a campground faucet—never saw anyone so sick—he cramped for three hours. He told me he runs ten miles a day at home, but it took him two days to recover."

Some don't recover—usually because they ignore good advice. Mary pulled a file on one young hiker. When he was found near death on July 12, 1977, on Hermit Trail, his backpack contained a set of motorcycle tools and a book on desert survival. He had already tossed out along the trail three pairs of motorcycle boots, a camp stove, and extra clothes. He hadn't wanted to risk theft by leaving the gear with his bike. He died because he hadn't carried the recommended two gallons of water.

Mary's office issues permits for 360 backcountry campsites a day. For Easter week,

requests had to be submitted between October 1 and 5 to be eligible for a lottery. Only 20 percent of the requests could be filled.

Conservationist Rod Nash, speaking at a park symposium, stated the problem simply: "We're loving the Grand Canyon to death. We must protect it from its friends."

ONE EARLY FRIEND of the canyon, President Theodore Roosevelt, contributed to the destruction of its ecology by ignoring his own sage advice. After visiting the canyon in 1903, he delivered an eloquent and spontaneous tribute:

"In the Grand Canyon, Arizona has a natural wonder which, so far as I know, is in kind absolutely unparalleled throughout the rest of the world. . . . Leave it as it is. You cannot improve on it. The ages have been at work on it, and man can only mar it. What you can do is to keep it for your children, your children's children, and for all who come after you, as one of the great sights which every American . . . should see."

Three years later he declared the canyon a game preserve, and gave it national monument status in 1908. He returned in 1913 for a mountain lion hunt—a popular sport that eventually pushed the animal to the brink of extinction on the Kaibab Plateau.

With its major enemy decimated, and a ban on nonpredator hunting, the mule deer soared in numbers from an estimated 4,000 in 1906 to 100,000 in 1924. They munched through meadows and forests with the efficiency of a plague of locusts. By 1924 deer were starving by the thousands. The pre-park balance has never recovered.

Nor will it. It would be something like Humpty-Dumpty putting himself back together while all the king's men stomped on him. Because the children's children for

**To protect or deface:** Every visitor to the Grand Canyon must be a ranger of conscience. Park employee Trinkle Jones (**above, right**) gently removes a clay jar stashed in a cairn perhaps eight hundred years ago. Patched with a thumb-size corncob smeared with pine pitch, it probably served as a corn cache for Indians in the canyon. Some visitors scrawl their own thoughtless graffiti across Indian rock paintings (**right**).

DAVID C. OCHSNER (BELOW)

whom Roosevelt wanted to save the canyon are here. We're hiking and boating through the park with a Malthusian vigor that Roosevelt couldn't have anticipated. We wear heavily on the trails, the ecology, and each other's tempers.

Over the years people have come who feel they can "improve on" the Grand Canyon. In 1889 a railroad was planned to run the length of the canyon at river level.

A huge interfaith chapel was almost begun in the 1950's; it would have seated 350 people facing into the canyon from the South Rim. Hydraulic jacks would have lifted Protestant, Catholic, or Jewish accoutrements from the basement as needed.

In 1961 the Western Gold and Uranium company proposed building a hotel on their South Rim mining claim that would cascade 18 stories down the wall—offering a canyon view from each of its 600 rooms.

A Phoenix group, in 1974, wanted to build a tramway from rim to floor so that more people could enjoy the wilderness.

Arizona Congressman Bob Stump submitted a bill last year to revive the plan for a Hualapai Dam, which would flood fifty miles of the western Grand Canyon.

Despite Roosevelt's wish that there not be "a building of any kind . . . to mar the wonderful grandeur," a suburb of shops, motels, and tacky government housing and facilities sprouted just back from the South Rim to cater to the ever growing crowds.

Now neither these facilities, the Park Service, nor the park itself seems able to cope.

For decades the "parks are for the people" policy meant satisfying demands for recreation. This left superintendents to stick their fingers in cracks in the environmental dikes to prevent floods of damage—usually with hands tied by lack of funds and a public ignorance of ecology. Growing awareness of ecology and pressure from environmental groups are changing the priorities. Superintendent Stitt told me, "If I err in the balance between recreation and conservation, it will be on the side of conservation."

**Oldest evidence** of man in the canyon, deerlike figures made from willow shoots (**above**) have been dated as far back as 2100 B.C., a time when the megaliths of Stonehenge were being put in place. Today mule deer (**facing page**) thrive to the point of tameness in canyon country.

TO EASE river congestion, the park staff has suggested more people take winter trips. That's what I was doing when the Glen Canyon Dam stopped me.

A group of us had been on the river two weeks and were about to run Lava Falls Rapids when a computer turned off the water. Its microminiaturized brain—programmed to see the river only as a force to spin turbines—closed the faucets in Glen Canyon Dam, which control the Colorado River's flow into the canyon. The reservoir level and power demands were down, and conserving water seemed the right move.

For a hundred people floating down the river on Easter vacation, it wasn't.

Marvin Jensen later told me, "Some of them we helicoptered out, and some came as

far as Phantom Ranch and hiked out. That was after we got the Bureau of Reclamation to kick us some water to sluice them on down to there."

When California's summer heat has air conditioners gasping for electricity, the flow from the dam peaks at 30,000 cubic feet per second. In late March we were getting only about 900—not enough to get us over Lava's boulders intact.

Park Scientist Dr. Roy Johnson and I had planned to attend a boatmen's seminar starting in three days on the South Rim. We were stranded on the same side of the river and only fifty miles away, but to get there—if the water didn't rise—we would have to cross the river, climb 3,000 feet to Toroweap Valley, bum a ride to the highway, and drive 200 miles. From Navajo Bridge on the park's east side to Hoover Dam at Lake Mead, 300 highway miles to the west, the only way to cross the canyon is by footbridge at Phantom Ranch (map, pages 32-4).

Host of our small river party was Ron Smith, owner of Grand Canyon Expeditions. In hundreds of trips he had never seen the water so low. Since we had no contact with the outside world, Ron hiked out of the canyon to check on the water.

While Ron was gone, Roy held an impromptu seminar. The fickle dam that delayed our plans, Roy told us, was also altering the river's ecology for centuries to come.

"The clear, cold flow we get now won't sustain most of the pre-dam native fish. The Colorado River squawfish, a member of the minnow family that can weigh as much as one hundred pounds and reach six feet in length, will soon be extinct here—if it isn't already. They used to say the river was 'too thick to drink, too thin to plow.' Now it's a trout stream."

**Port-a-blaze** gives some comfort in a storm to boaters marooned by low water. To leave the river's shore unspoiled for others, wood or charcoal must be burned in metal boxes, and the ashes hauled out.

WITNESS the 12-pound rainbow John Craighead landed a few days earlier (facing page). Avid fishermen in our group removed the barbs from their hooks and pulled in and tossed back hundreds of trout. One trout tagged in Lake Mead reportedly was caught at Lees Ferry. Unknown in the previously wild and muddy river, trout thrive in clear water, eating the eggs and fingerlings of resident fish.

As Roy talked, he sifted beach sand—pulling out bits of charcoal and other human debris. A five-year study concludes that the annual swarms of 14,000 river runners are damaging the canyon—perhaps not irreparably but certainly enough to diminish its enjoyment for future visitors.

At flood stage the river used to flush detritus and plant life downstream and deposit new beaches. Now thick stands of tamarisk, an invader, congest the shorelines, and trash is collecting at an amazing rate on overused beaches. Also piling up on the beaches, an esthetic and health problem, is most of the twenty tons of fecal matter produced by river passengers every year.

"Some of the beaches here are as messy and cluttered as a kid's sandbox," Roy complained.

The river study confirms that boat motors

bother some visitors. Not only do they "mask the natural sounds," the study claims, but they also impede communications between boat operators and passengers—preventing safety warnings. Commercial motorboat operators counter that the motors do no damage and permit them to carry more people faster, cheaper, and more safely than oar-powered trips.

When the Colorado ran free, an average of 380,000 tons of silt passed the gauging station at Phantom Ranch every day. During a 1927 flood, 27,600,000 tons were recorded one day. Now there are about 40,000 a day, and no major floods. The rest is collecting in Lake Powell. The water no longer deposits sand but slowly hauls away beaches already there. Since the reduced flows can no longer clear debris brought down side canyons, rapids will get worse.

At Phantom Ranch, 90 miles upriver from Lava, I had talked with another Roy. Roy Starkey works for the ranch. He used to work for the U. S. Geological Survey.

"For 20 years I took water samples and checked flow and temperature every day," he said. "But I lost my job to a satellite."

An automatic "fish" now tests the river every morning. A solar-powered radio transmits the data directly to a weather satellite over Brazil, which relays it to a Virginia receiving station, which automatically telephones it to the Geological Survey computer at Reston, Virginia, for processing.

All of this happens each morning faster than Roy can turn off his alarm clock.

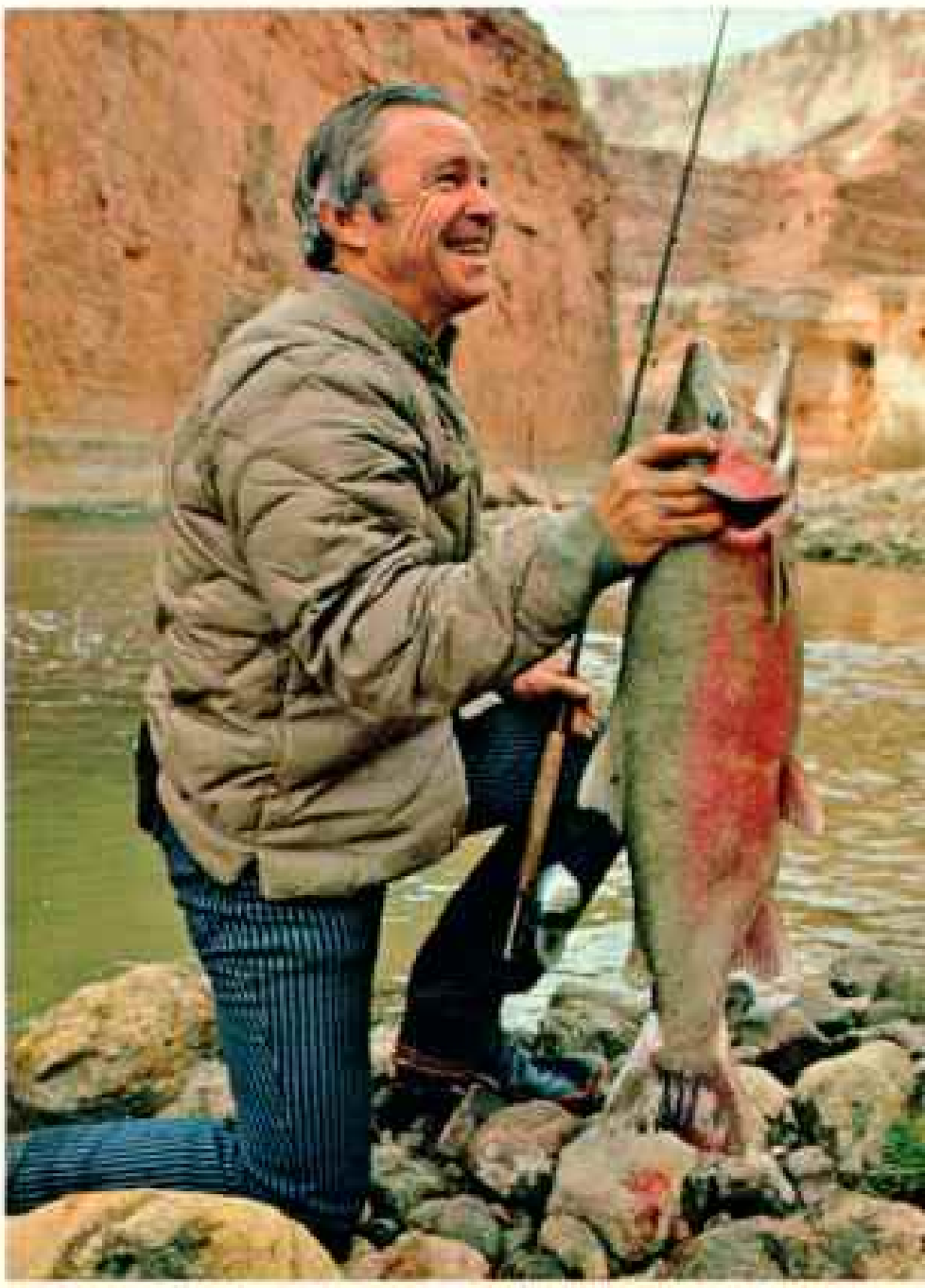
RON SMITH returned to our river camp to report that the water wouldn't come up for several days. Roy Johnson and I decided to pack out.

Fortunately for us, one of the few escape routes out of the canyon starts just above Lava. It follows a gully in a near-vertical 3,000-foot slope of loose black volcanic cinders. Under summer sun the surface temperature may reach 200°F. In March it was no problem, except that at times it was like going up a vertical treadmill. The trail seemed determined to slide to the river faster than we could go up. The slope continued on 600 feet above the Toroweap Valley floor to form a textbook-perfect volcanic cone called Vulcans Throne. A series of eruptions some 10,000 years ago formed the cone and nearby lava cascades (page 48).

Volcanism was no stranger to the canyon here: At several intervals beginning more than two million years ago, lava poured into the chasm, forming dams as high as 2,300 feet—high enough to create a lake reaching back beyond Lees Ferry, 179 miles upstream. The last lava dam, 80 miles long and perhaps 800 feet high, blocked the river about 250,000 years ago.

After each dam was created, the lake would eventually breach the top of the black barrier and the river would resume its grinding search for sea level, slowly wearing down and clearing the dam away.

Our trail finally led us to the Riffeys' back door, and they took us in like the waifs we were. John Riffey knew, but avoided, our



**Big-as-salmon rainbows** have invaded since Glen Canyon Dam upstream lowered river temperatures and trapped most of the silt. The cold water that the trout require could mean extinction for native species.

trail: "They say that slope sits at the maximum angle of repose, but sometimes it doesn't repose."

We told John we had to get to park headquarters. But isolation at his remote station for nearly four decades—he's two years beyond normal retirement—has encouraged a certain irreverence.

"Now why would you want to do that? You won't like it. They used to take us over there every year to try to civilize us, but they finally gave up on that."

John drove us back to the trail head that night to check on Ron. He had planned to join us but hadn't shown up, and a storm was lashing the area. Blasts of sand tattooed exposed skin. We reached Ron by radio, safe—so to speak—down on the river. That night, wind gusting at 80 miles an hour flattened two tents.

The next morning broke clear. I wondered what had happened to the storm.

John knew: "Went back for another load of sand."

Could John fly us to the seminar?

"I can't, but *Pogo* could. 'Cept he doesn't like it over there either—too crowded and he doesn't have a radio. He'll be glad to fly you around here though."

IT SEEMED like a good idea until we started to get in. *Pogo*, an old two-passenger Piper Super Cub, is 26 going on 50. I asked about a bulge on the front of the wing.

"Guess he's getting arthritis."

OK. But what about the box of mouse poison John had just pulled out of the wing?

"Oh, *Pogo*'s just made of light metal and cloth. Last time he went in for a checkup, they pulled three mouse nests out of his wing. Sometimes I hear them running around in there. 'Fraid they might chew up something important."

*Pogo*'s reliable, but a loose spark plug had once caused the engine to cut out briefly over the canyon. "It was OK," John said. "My hair was already gray."

John tied the window up against the wing with cotton clothesline so I could take pictures. *Pogo* twisted and dipped up and down the valley and the canyon like a teenager on a skateboard. We passed the pine forests of Mount Trumbull, which peaks at 8,029 feet, and were eyeball-to-rim with SB (for Son of a Bitch) Point at 5,600 feet. *Pogo* circled around Mollies Nipple at 5,551 feet before dropping to river level so I could photograph rangers on a burro study.

After landing, John replaced the poison.

JOHN WAS RIGHT about the South Rim. The congestion was a shock after Toroweap. My reservation at the El Tovar Hotel had been given to someone else. There was a two-hour wait for dinner. A television in the lobby entertained guests.

Before coming to the canyon, I had talked with Barry Goldwater, Senator from the Grand Canyon State. He had a plan to improve the South Rim.

"I'd like to see everything—the shops, hotels, restaurants—moved five miles back from the rim, even if it means tearing down that wonderful old El Tovar Hotel. That would be as far as you could drive. Electric or steam buses would take you from there."

He had winced at his suggestion to tear down the El Tovar and thought better of it. "I'd be willing to leave it but not as a hotel."

When the rambling log château was opened in 1905, it offered the latest in elegance, including electric lights. Recent modernization—which includes signs in Japanese—keeps it the Ritz of Grand Canyon accommodations.

The Park Service has no plans to move the El Tovar, but it does hope for an expanded public transit system that could replace some of the private cars on the South Rim. That's the only point on which its plan for the South Rim agrees with Goldwater's. The Park Service's more moderate ambitions include moving most parking lots and commercial operations back from the rim a bit and tearing down the worst eyesores as they become obsolete—all by the year 2000.

Everyone agrees something should be done, and many would support Goldwater's plan to hasten the obsolescence with a bulldozer, but he's not optimistic. "I don't think the Interior Department has the guts to face up to the resistance it would encounter."

The Senator can be forgiven if he feels possessive. He's been going to the canyon since he was 7—three years before Teddy Roosevelt's death. He first walked to the bottom of the canyon in 1919 when he was 10, the year the canyon was deeded national

park status. Thirty-eight years ago he became the 70th person to run the river.

He and Congressman Morris Udall sponsored bills that almost doubled the park to its present 1,218,375 acres in 1975.

Ironically, a decade earlier both had sought to back up the river in the added areas with the Marble Canyon and Hualapai Dams. A tenacious battle led by the Sierra Club stopped construction. Now both men are opposed to dams in the canyon. Goldwater admits that of all his Senate votes, the one he most regrets was the one for Glen Canyon Dam.

I RETREATED from the crowded hotel lobby to the overlook from which I had first seen the canyon. I've seen it often since. The magic never fades. But like a first love the first visit can never be repeated—and nothing can prepare you for it.

Forested slopes leading to the rims give no warning. As you walk the last few feet, the world suddenly slides away, leaving you hovering uncertainly over a forbidding abyss. It's as if nature has carved a monument to itself—a majestic phenomenon that hushes all but the most insensitive.

Gravity pulls at your soul. Your mind reaches for something familiar. Distance, depth, and time seem infinite. You sense more than see an opposite rim far away.

In gaudy rock layers the skeleton of the earth lies exposed. Without being told, you know that down there lie answers to questions about the birth of the earth.

Light and shadows flow among towering buttes in perpetual slow motion with no two moments alike—ever. When the weather's at its worst, the drama's at its best. Afternoon storms fester around sun-warmed buttes and rumble from valley to valley. Lightning stabs at the peaks—sometimes in crisp white thrusts, sometimes as flickers behind curtains of mist.

The spectacle frightens some people. I

**Put into perspective,** a visitor hikes into the narrowing cleft of Fern Glen Canyon. Accessible from the river, side canyons offer springs and microhabitats that husband bursts of greenery, from primroses to orchids.

*With a steady hand on Pogo's stick, North Rim ranger John Riffey eases his*

watched a Japanese lady tiptoe to within a few feet of a protective wall, lean forward, gasp, and back away. Mothers clutch children's hands. Men shorten their stride. For some people a quick look, a snapshot or two, and they want out.

Several of Roy Johnson's river researchers spoke at the seminar. During the past five years their study has taken on the status of a minor industry. Three dozen investigators from twenty institutions have fed data into computers. The goal—a management plan that would strike a delicate balance between maximum river recreation and minimum damage.

Now the recommendations are on record. Like a suitor not quite suggesting marriage—yet—the Park Service has issued a draft of the plan, with a notice that it has been neither approved nor disapproved.

But if the public says yes after a series of hearings, the recommendations will become policy within a year. Many may anyway if the Sierra Club suit now pending goes against the Park Service.

The plan recommends doubling the user days (one person on the river for one day), lengthening the summer season from three and a half months to six months, and establishing a six-month winter season. It would also raise the ratio of private trips from 8 percent of the total to 30 percent, and phase out all motors over a three-year period, resulting in longer, quieter trips.

Since each passenger would consume more user days, the overall result of the changes would be a 10 percent reduction in the number of commercial passengers.

*canvas-covered two-seater through the canyon near Toroweap Overlook.*

All human feces, 40 tons per year if the user days double, would have to be containerized and carried out of the park.

ONE DESTRUCTIVE park visitor we all meet along the riverbanks abides by no quotas. The bristly, clever, beloved, obnoxious little African burro—once a valued domestic pack animal—survived the prospectors who brought him a century ago. Now wild, or feral, he has prospered at the expense of the park—eating vegetation, trampling archeological sites, and carving an eroding network of trails. Some say he drives out native residents, most notably the rare desert bighorn sheep.

Since 1924 some 2,600 *Equus asinus* have been shot by the Park Service, and it once intended to keep on until "all" were gone. A 1976 report estimated "all" to be between two and three thousand. A year later another study indicated only 300. This confused the issue but didn't lessen the pressure.

Ever since Jesus rode a burro into Jerusalem, the animal has enjoyed a special status. A blizzard of emotional "save the burro" letters made burro-control ranger Jim Walters an instant villain.

Secretary of the Interior Cecil Andrus responded to the letters by delaying further action until accurate statistics and more proof of damage could be gathered.

The proof, an intensive study, will cost about $1,000 for each of the estimated 300 animals. The average will go down during the two-year project because the population will go up—to about 400—since man is the prolific burro's only predator in the park.

I joined a team of rangers assigned to determine the practicality of flying burros out by helicopter. After considerable effort, three burros were shot with an immobilizing drug. Two died. The other, slung in a cargo net, was whisked away at great expense (pages 30-31).

In another experiment, cowboys rounded up 12 burros from one of the more accessible areas. At auction in Phoenix the animals brought an average of $11 a head. It had cost $450 a head to round them up. The experiments convinced the Park Service that there's still only one practical solution—the burros must be destroyed.

"This isn't a park," lamented Walters. "It's a damn burro pasture."

The problem helped convince the staff it was running a billion-dollar business, with millions of customers, while uncertain of the quality or quantity of its assets—especially in the 600,000 acres acquired in 1975. Another 390,000 acres may be added.

AN UNUSUALLY FRANK introduction to a 2.8-million-dollar inventory and resource-management plan complains that resource-management funds have been nil in the past and are still inadequate. It admits that years of neglect of the park are apparent. It regrets that pressure groups know more about the park's resources than the staff itself and spotlights staff inadequacy by stating, "At best there are only four or five people on the staff that would recognize a Peregrine Falcon (one of our endangered species) if they saw one."

A ranger who would is Chief of Resource Management Dave Ochsner, godfather of the elaborate project.

"We have to remember this is one of the seven natural wonders of the world, and manage it accordingly. People come from all over the world to see it."

He invited me to join him and Park Anthropologist Dr. Robert Euler on a two-day inventory of Cremation Canyon with mule packer Stan Stockton as guide. . . .

A few days later I find myself high atop a stumbling mule on the precipitous Bright Angel Trail, contending with my latent acrophobia and a general distrust of mules.

The trail drops 3,000 feet down a fault line, crosses the Tonto Platform, and plunges through Granite Gorge to the river: a total vertical drop of one mile.

Stan means to be reassuring when he tells me no rider has been lost since guided mule trips started almost a hundred years ago.

"A few mules have gone over the side, but the riders have always dropped to the high side in time to avoid the long fall."

I'm reminded of lecturer Burton Holmes's experience on a trip down Hance Trail in 1898 with several men and one woman. On the "most awful" sections he dismounted and descended in "the posture assumed by children when they come bumping down the stairs . . . neither the mocking laughter of the men nor the more bitter words of sympathy from the brave Amazon could tempt me to forget that my supremest duty was to live to give a lecture on the cañon."

Captain Hance, his guide, referred to him as the "lecturer who came down part way like a crab."

"Couldn't happen now," Stan says. "A quarter of a mile down the trail at 'cinch-up' point everybody stops, supposedly so wranglers can tighten girths. Anyone who's had enough is quietly encouraged to quit right there. A few do. One time a guy decided he'd had it. He asked his wife—she wasn't quitting—if she needed anything. 'Yes,' she replied, 'a new husband.'"

We are well down the trail when Stan tells this story. He has assigned me to 15-year-old Pappy, said to be as safe as a rocking chair. And, I find, about as receptive to new ideas. For most of his life Pappy has walked these switchbacks nose to tail with the mule ahead. When I lag behind to take photographs, it breaks his pattern. He warns me he doesn't like it with a few snorts and a nervous four-footed fox-trot.

When the rest of our group disappears from sight far below, he rears up, gets the bit in his teeth, and bolts. Before I can remember which is the high side, we are lurching and rocketing around the switchbacks like a runaway train in a Buster Keaton movie. As soon as he reaches the tail of Bob Euler's mule, he clatters to a stop.

The other guys seem to be more than a little entertained and impressed by Pappy's performance. Bob, noting that Pappy had all four feet off the ground when we rounded the last turn, nicknames him Citation.

Stan congratulates me. He says I was right not to get off. How could I with my hand welded to the saddle horn? After that episode we get along fine—when I stop for pictures, Citation goes on without me.

On a summer day as many as 1,500 people hike down the Bright Angel Trail. Millions of hiking boots and mules' hooves have ground it into an eight-mile-long sandbox.

ON THE TRAIL I meet a gray-haired lady hobbling along on rented crutches. She had broken a leg stepping off a six-inch curb two days before.

Vera, 71, and Beecher Terrell, 70, left the rim at 6 a.m., walked to the river, and were returning the same day (right). "We move slowly, but we'll make it," Vera tells me. "We do it every year."

(This past winter Vera wrote me that she had fallen into a bandstand while doing a polka and had broken her back, but expected to be up and on the trail soon. No drag-outs, these two!)

We stop at Indian Garden, a campground built around a spring, 3,000 feet below the rim. To provide shade, canyon photographer Emery Kolb 70 years ago stuck cottonwood branches in the ground like fence posts. Now a 60-foot canopy of trees shades the inner canyon's busiest campground.

Its name, Bob Euler informs me, derived from its former use. In 1882 the Havasupai who lived along the South Rim were moved into a 518-acre reservation in Cataract (now Havasu) Canyon. A few stayed here and grew corn, squash, and beans until their eviction in 1911. According to children of the former residents, President Roosevelt personally asked them to leave because "he was going to make it a park for everyone." But at least two of the Indians remained until the 1940's.

Before he became park anthropologist in 1974, Bob had worked with the Havasupai on their land-claims settlement. They considered him a friend.

"When they heard I was joining the Park Service, they were hurt," Bob continues. "They wanted to know why I was going over to 'the enemy.' I don't think they've forgiven me yet." Since they still feel the land was taken from them unfairly, they probably won't. Before the white man arrived, they hunted along the South Rim in winter and used the inner canyon for summer gardening and as a source of water.

Their canyon is considered a verdant paradise by visitors (pages 14-15); the Havasupai saw it as a prison.* The park-expansion bill of 1975 awarded them 185,000 acres of land, 84,000 of it from the park. Various environmentalist groups objected strenuously.

When I visited the village, Wayne Sinyella, tribal chairman, told me, "The Sierra Club thought our land settlement was a Trojan horse that would spew out dams and pizza parlors in *(Continued on page 40)*

*See "Indian Shangri-la of the Grand Canyon," by Jay Johnston, NATIONAL GEOGRAPHIC, March 1970.

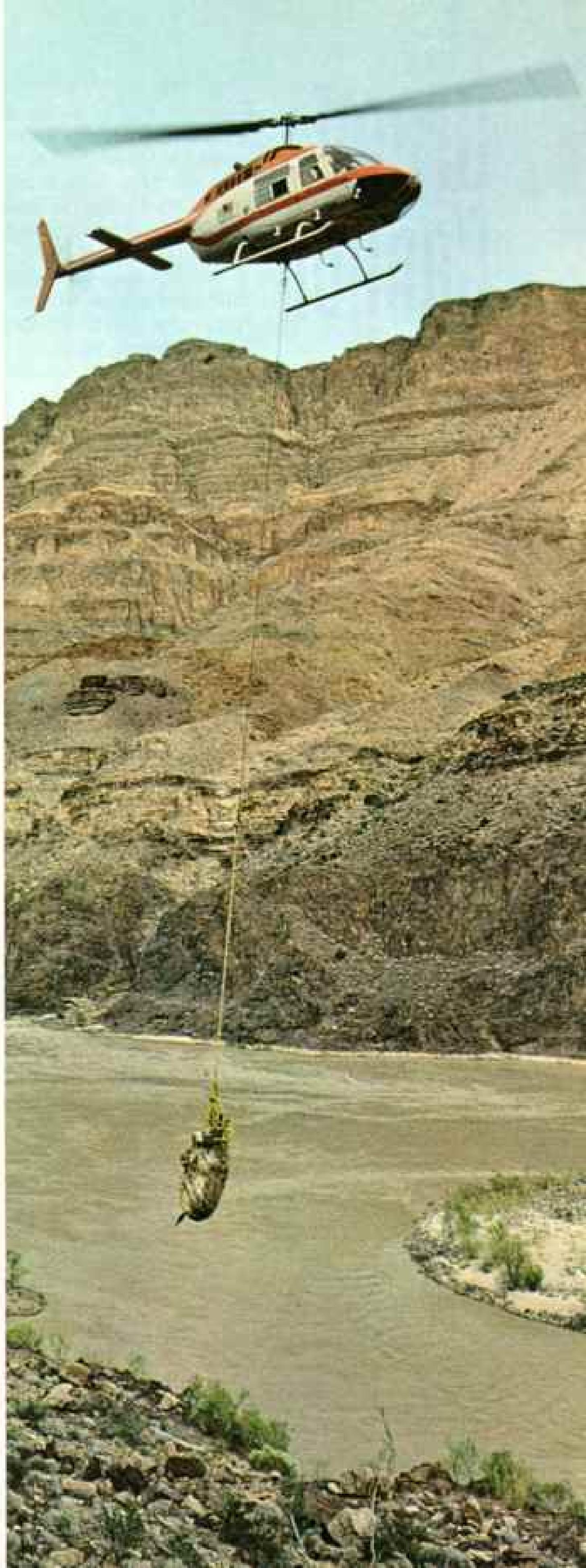
**"Be in good, healthy condition,"** advise Vera and Beecher Terrell, who yearly hike from rim to river and back out. They stay in shape by dancing five nights a week. And Vera has been a jogger for twenty-one years—since she was 50.

**Assaulting a dilemma,** park rangers led by Jim Walters (**left**) begin an experiment to remove from the canyon feral burros whose ancestors arrived with early prospectors. While undeniably appealing (**right**), the animals are also destructive, cutting networks of erosion-inducing trails (**below**), stripping vegetation, trampling archeological sites, and competing for food and territory with desert bighorn sheep and mule deer.

Routine shooting of the burros, begun in 1924, finally raised howls of protest, prompting rangers to try immobilizing darts instead of bullets. The plan: to see if burros can be removed under sedation. Cost in time, money, and manpower: very expensive, with park budget and manpower already stretched membrane thin. Outlook: not very promising.

**The breath of life** expires from a burro hit by an immobilizing dart, even as Stan Stockton (**below**) attempts mouth-to-muzzle resuscitation. Of three sedated in a long day's work, only one lived to get a $250-an-hour helicopter ride (**right**).



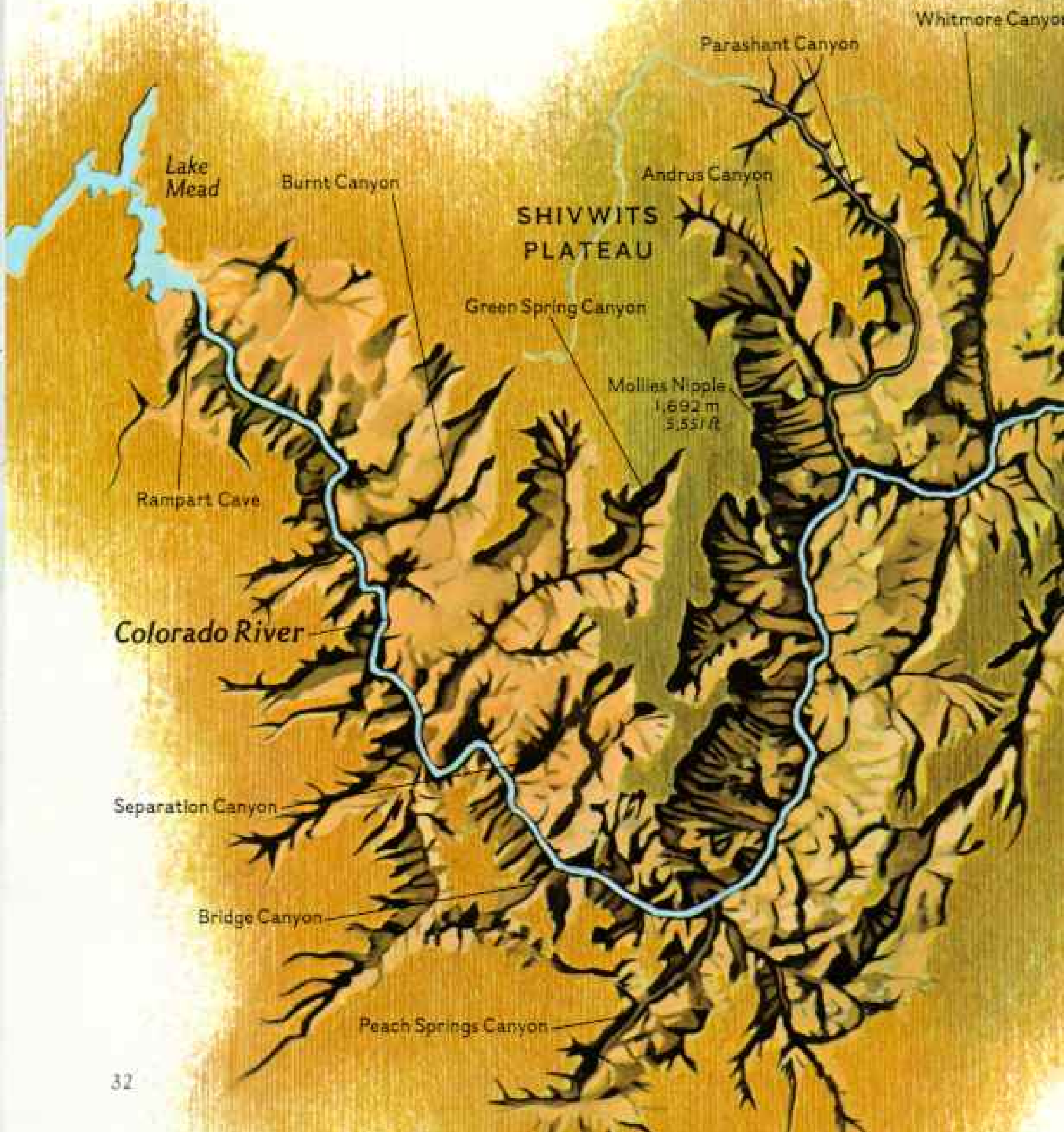


# Grand Canyon

INDIAN PEOPLES had lived here for millennia, but the first Europeans came looking for what the canyon would not provide. In 1540 a Spanish captain in search of gold found an impassable barrier. In 1776 a Spanish priest pursued the souls of Havasupai Indians, who responded with hospitality, but not conversion.

The first systematic exploration of the Colorado River, led in 1857 by Lt. Joseph Ives, steamed up the river from its mouth. After the boat wrecked south of present-day Lake Mead, the party continued overland. Ives fully appreciated the canyon's majesty but felt the area "shall be forever unvisited and undisturbed."

In 1869 Maj. John Wesley Powell began his epic expedition into the "Great Unknown." His reports not only revealed the river's carving descent through the rocky layers of geologic time, but also fired the public's imagination and appetite to see for themselves—which now motivates some three million visitors a year.

To St. George, Utah,
50 miles

Mount Trumbull
2,447 m
8,029 ft

Toroweap Valley

Ranger station

KANAB
PLATEAU

Kanab Canyon

"Garrett Site"

Deer Creek

Granite Narrows

Vulcans Throne

Toroweap Overlook

Fern Glen Canyon

SB Point

Powell Plateau

Shiva
Temple

Bright Angel
Canyon

Phantom
Ranch
776 m
2,546 ft

North Rim
headquarters
2,542 m
8,340 ft

Point
Imperial

North Kaibab
Trail

Redwall Cavern

Stantons Cave

KAIBAB
PLATEAU

Lake
Powell

Glen Canyon
Dam

Navajo Bridge

Lees
Ferry

Badger Creek Rapids

Soap Creek Rapids

North Canyon

Colorado River

KAIBITO
PLATEAU

Havasu Creek

Great Thumb
Mesa

Supai

Vulcans Anvil

Havasu Canyon

Lava Falls Rapids

Cape Royal
2,397 m
7,865 ft

Granite Rapids

Hermit Trail

Dana Butte

Indian Garden

Bright Angel Trail

Park headquarters

*Less than 12 miles separate park headquarters at Grand Canyon Village on the South Rim from North Rim headquarters across the canyon, but driving from one to the other involves a circuitous route of some 200 miles.*

COCONINO
PLATEAU

Desert View

Hance Trail

Hance Rapids

Cremation
Canyon

Grapevine
Rapids

Sockdolager
Rapids

Little Colorado

Mather
Point

Kaibab
Trail

To Flagstaff, Arizona,
55 miles

PAINTING BY LLOYD K. TOWNSEND
COMPILED BY HAROLD A. HANSON
NATIONAL GEOGRAPHIC ART DIVISION

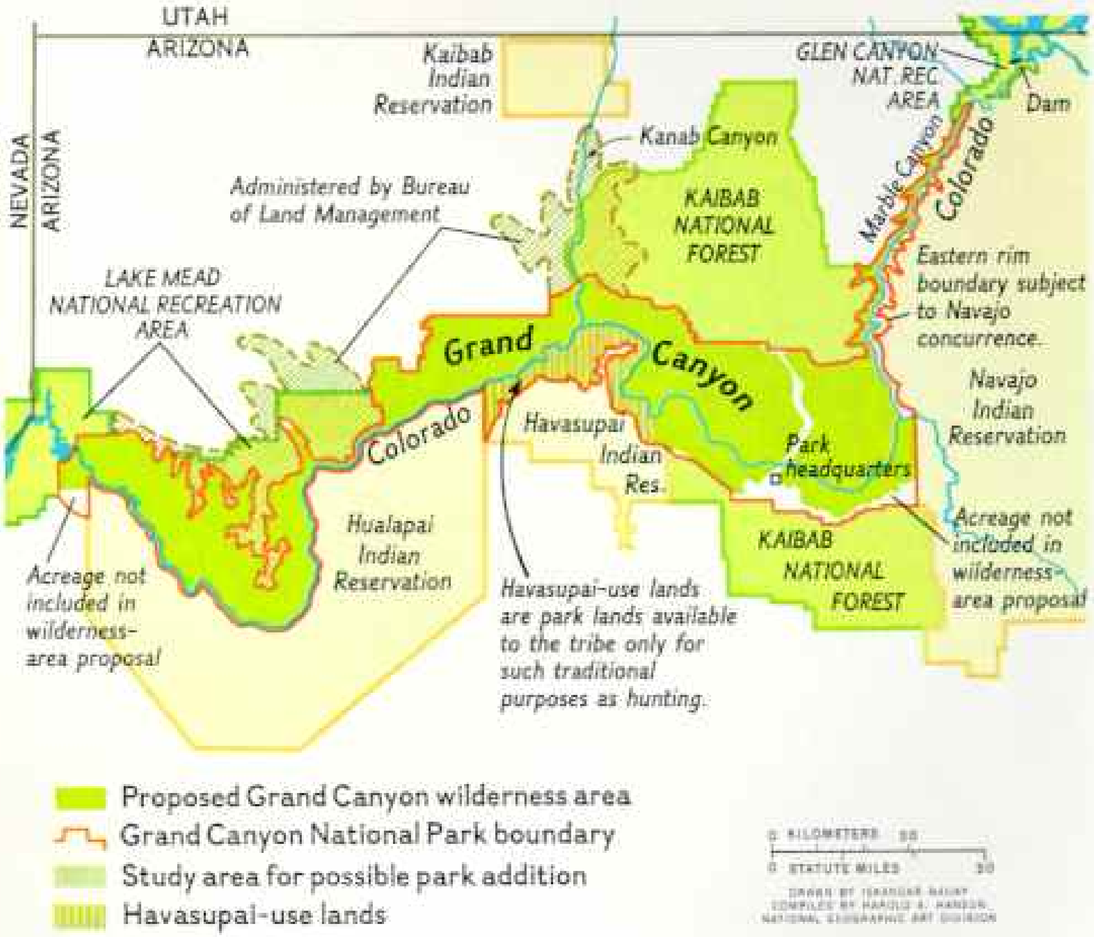
# "...unimpaired for the enjoyment of future generations."

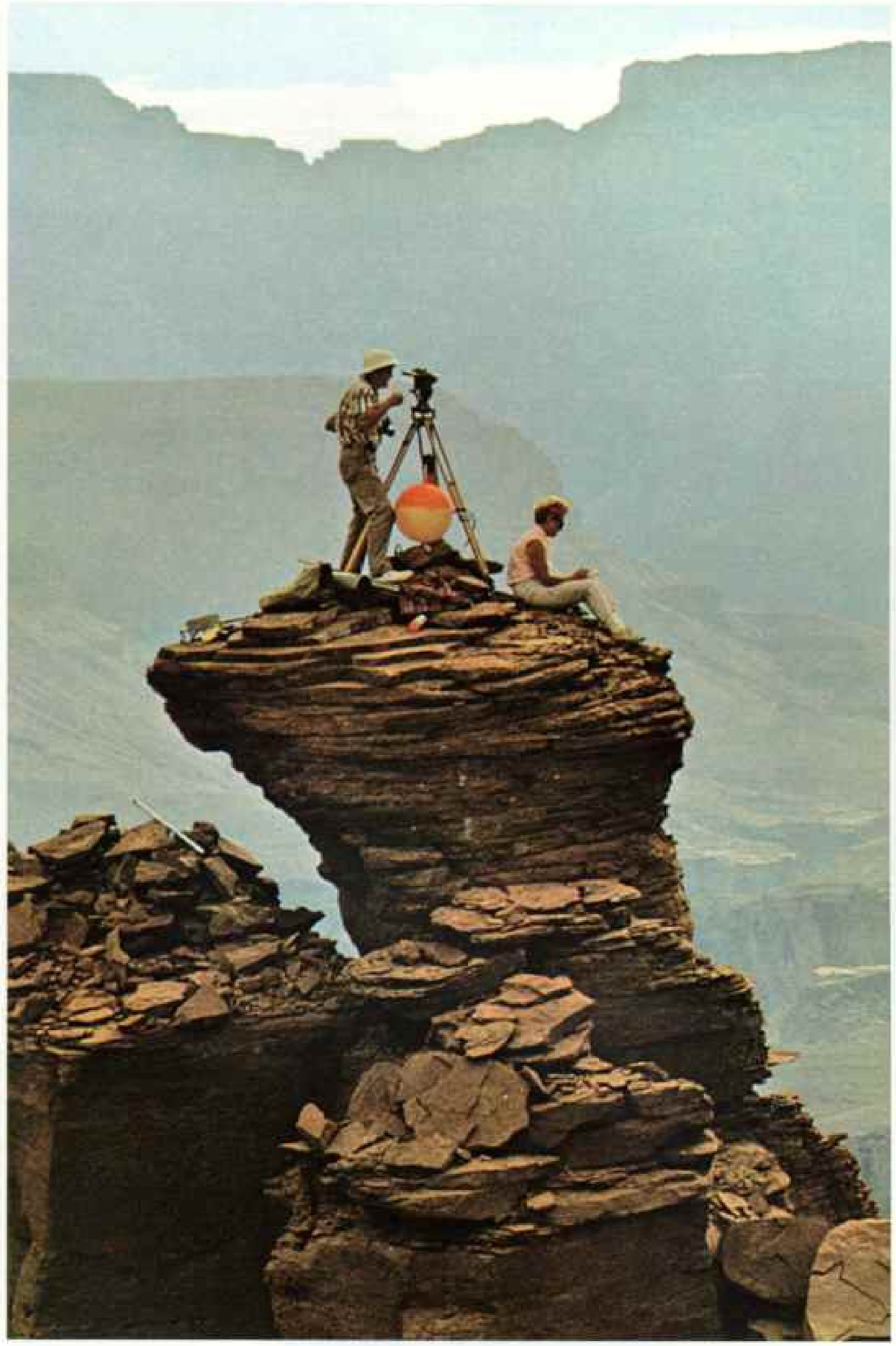
WHEN, in the less populated, less mobile year of 1916, the National Park Service was established to protect the nation's great natural and scenic resources, "unimpaired" may have seemed an easier mandate to follow than it now does.

In the consolidation of 1975, Marble Canyon and Grand Canyon National Monuments were abolished and, with other land, incorporated within Grand Canyon National Park, almost doubling its size. And an old injustice was mitigated as 185,000 acres were restored to the Havasupai Indians. Further additions to the park are under study, notably Kanab Canyon and surrounding watershed.

The fact of a larger, consolidated park does not guarantee prudent use or protection. One proposal that may help is the designation of most of the park as a wilderness area. Within its confines the landscape would remain or revert to its natural state, with few roads or structures, and no motorboats.

More difficult to resolve is the future of Grand Canyon Village on the South Rim, with its crowded visitor facilities. Recommendations have been made to reduce commercial clutter and dependence on automobiles so visitors can have a more pristine view of the canyon. But since private investments and public conveniences are at stake, debate has not produced agreement.



ALL BY CHARLES O'NEAR

# Mapping the canyon

DESPITE ITS STATUS as the natural attraction Americans most want to see, the heart of the Grand Canyon had never been mapped in sufficient detail for confident field use by scientists or hikers. In 1970 Dr. Bradford Washburn, an eminent cartographer and the director of Boston's Museum of Science, decided to remedy the situation. With the joint support of his museum and the National Geographic Society, Dr. Washburn began the task that was to take seven years, enlist experts from Arizona to Switzerland, and require nearly 700 helicopter landings on remote sites.

Although techniques such as aerial stereographic photography yield most of the detail on the map, precise measurements must be made on the scene. Atop Dana Butte (**left**) Dr. Washburn and his wife, Barbara, make one such measurement. For pinpoint precision, a laser beamed from a far shelf (**above**) is boomeranged from reflecting prisms in foreground, recording the distance within centimeters.

Rolling a wheel-mounted odometer, two assistants (**right**) measure trails several times. If the distance does not match within a few feet, the trail is walked again. The result of the work appears as a special supplement to this issue.

**Titanic stepping-stones**, cut, shaped, and smoothed from sandstone by rainfall and windblown sand (**above**), cobble the Esplanade, a broad, heavily eroded terrace of barren rock. The only living reminders of habitation here are small bands of horses. But on a hike the author came upon a chamber behind a fallen stone door (**right**). Numerous within the canyon, these elfin compartments were vermin-proof granaries fashioned by Indians called Anasazi—the Ancient Ones. Their grain, like the canyon dwellers themselves, has long since disappeared, and for perhaps 800 years the granary's open-door invitation went unused and unseen.

(Continued from page 29) the canyon." It can relax. "We plan tougher restrictions than the Park Service." Time will tell.

The two-day trip to Cremation Canyon added six prehistoric sites to the park's inventory and for me a new appreciation of a mule's agility. Nevertheless, on a subsequent trip with Dr. Euler I abandon Pappy for a helicopter.

Bob, his wife, Gloria, and I dismount from our Pegasus where no mule and few men have been. We camp 2,000 feet below Great Thumb Mesa's north wall on an isolated, waterless, hummocky sandstone terrace that extends for miles along both sides of the river; it's called the Esplanade. Created by marine sands and wind-formed dunes laid down a quarter of a billion years ago, the hardened sandstone has eroded unevenly into a Brobdingnagian garden of massive sculptures (preceding pages).

I discover curved around the stem of one toadstool-shaped masterpiece a miniature granary with its stone door lying open as if abandoned just yesterday. But here yesterdays are counted in centuries. In Europe the Crusaders were packing for their first trip to the Holy Land when an Anasazi Indian here was patting wet adobe into a vermin-proof storage cabinet for corn. The fingerprints left 900 years ago are still legible.

Bob says that the owner probably moved away about 1150 and posted no forwarding address. He may have left the door open because he didn't plan to return—but no one today is sure why.

"You're probably the first person to see this granary since he left," Bob comments. "We'll name it Garrett Site."

Officially it's Ariz. B:10:118, since Bob had already logged another 117 sites in this tenth quadrangle. But frankly, I like Bob's name better.

The christening party is attended only by Bob, Gloria, and me, but a sunset so gaudy it would embarrass a roll of Kodachrome puts


**Wilderness, everyone?** Rubber "baloney boats" powered by outboards are put in at Lees Ferry for trips into the canyon. To restore a sense of the primeval river, plans call for phasing out motors and for more even spacing of boat trips.

a pink blush over the world, helping to make it a memorable evening.

THE NEXT DAY we endure a steady buzz of sight-seeing flights. They destroy our sense of isolation but leave no permanent scars on the environment.

The routes of Dr. Euler's travels through the canyon lie over his map like a net, anchored by 2,000 red dots that mark his sites. Hiking with Bob is like touring a ghost town with a doting caretaker. The faintest clue can inspire a story so detailed it repopulates the barren canyon with people from the distant past:

A vague saucer-shaped rocky depression twenty feet across becomes a blazing pit. Anasazi women roast agave plants and collect a molasses-like confection. A hunter about 5 feet 3 inches tall with long black hair and wearing a cotton poncho-like shirt skins a bighorn sheep nearby.

A palm-size shard of reddish clay in Bob's hand grows in the mind's eye into a two-foot, globe-shaped jug filled with water from a spring a mile away. Nearby, a young girl shells ears of primitive corn slightly larger than a man's thumb.

Bob interrupts my thoughts to relate how archeologist Douglas Schwartz, twenty years ago, began studying two stick figures found in a canyon cave. Each was made from a single willow shoot split and twisted into a deerlike effigy (page 20).

"We've now found hundreds in the canyon," Bob says. "The oldest, with a 2100 B.C. carbon date, we excavated in Stantons Cave in 1963."

Since the effigies are always found by themselves, the mystery remains—who left them and why? Some are speared in the torso with a small stick, suggesting that hunting parties left them as good-luck talismans.

We leave the Esplanade as we found it. Our footprints will soon fade. I hope someone in a hundred years comes upon the granary, still unmarred, and enjoys the illusion of finding it for the first time.

The North Rim always seemed a bit mysterious—like a recluse who keeps to himself. Only 15 percent of the park visitors go there. The "strip"—that chunk of northern Arizona cut off from the rest of the state by the canyon—was one of the last regions in the United States to be developed. Polygamy survived there openly until the 1950's and may still exist covertly. The tourist year on the higher North Rim lasts only seven months because of deep snows. Its Canadian climate sustains a varied and colorful alpine flora and 11 animals not found on the South Rim. One of them, the Kaibab squirrel, is indigenous nowhere else.

It's so seldom seen today that it has been put on the list of threatened species. Last October one darted in front of me on a backcountry trail. It looked more like a small silver fox than a rodent loping through the woods. Bigger than an eastern gray squirrel, it had a reddish back and a black belly, tufted ears, and an elegant white plume of a tail (page 44).

The Kaibab squirrel depends for its existence on the ponderosa pine, nesting in it and feeding on its pollen, seeds, inner bark, and mushrooms that grow on its roots. A cousin, the Abert squirrel, lives on the South Rim and is just as dependent on the tree.

IT IS BELIEVED that during the Pleistocene Epoch they were the same animal, living in forests that extended completely across the canyon. Then the trees, unable to adjust to the increasingly warmer and drier climate, died out. As the trees receded up to the rims, the family was split and the Kaibab branch found itself trapped in a forest surrounded by deserts.

This fed a romantic notion that animal species unknown to man might have developed on buttes isolated in the canyon. In 1937 the American Museum of Natural History welcomed the chance to find out.

They mounted an expedition to explore the butte called Shiva Temple. The project captured the public's interest. Facilities were set up on the North Rim to flash the results to the world. One newspaper speculated that dinosaurs might be found.

When the party reached the summit, they found a few Indian artifacts but no new animal species. They also failed to find the Kodak film box that had been purposely placed there for their discovery by Emery Kolb. The photographer, apparently miffed that his offer to help had been refused, had beaten the expedition to the summit.

Pinnacles such as Shiva, which help give

the Grand Canyon its unique form, occur mostly on the north side of the river. They were not formed, as the Cracked Earth Society long maintained, when an uplift split the earth like a cake that rose too fast.

There's a logical explanation. Less moisture falls on the south side, and the plateau there slopes away from the rim. The Kaibab Plateau on the north slopes toward the river, dropping more water from a higher elevation and thus causing headward erosion to develop faster.

Streams, seeking paths of least resistance, often follow fault lines in the earth—as paper tends to tear along a crease. The steeper the slope of the stream drainage area, the deeper and longer the side canyon erodes, excavating vast amphitheaters and, where canyons meet, leaving behind the pinnacles.

Preston Swapp, a young packer on the 1937 Shiva expedition, still lives nearby and until recently grazed cattle on national forest land in Kanab Canyon. Last fall Swapp was forced to suspend his operation. He told me why. "The Forest Service came in and did a study. Said we were overgrazing."

"Were you?" I asked.

"No."

He maintained that the Forest Service study team had picked one of the driest periods since his father started grazing cattle here in 1906 to do its survey. Preston, a quiet, well-tanned cattleman of 64 years, said that cattle grazing was once an important industry here, but is now dying out. Upper Kanab Canyon is being studied as a possible addition to the park.

"They're trying to run us out," Preston complained. "They're taking away a man's rights. They don't know what this country will produce. If it isn't grazed, trash plants such as blackbrush will take over the land. Those cattle don't compete for food with

**A riffle of limestone** polished like marble (**above, left**) seems a mirror image of the rushing water that shaped it. A catcher's mitt of a rock (**left**) holds a stone that, when the water rises again, will resume grinding the pocket.

Deer Creek (**right**) has exposed a laminate of sandstone as it takes the easiest course to river level.

anything else down there in the canyon."

Dave Ochsner knows overgrazing can be a problem but sympathizes with Preston Swapp's problems. "These grazing operations are a way of life—they're a historical or cultural resource—a remnant of the Old West, if you want to call it that. Maybe it's a resource we should be protecting in our parks. If that way of life goes, something may fill the vacuum that won't be as good."

Preston's not optimistic. "If the land goes to the park, we'll be eliminated."

IN 1540 Don García López de Cárdenas and his small band of soldiers became the first Europeans to see the canyon. Finding no gold, they were soon on their way. For three centuries the canyon remained a mystery. Other adventurers found it an impassable obstacle, and went around.

Finally Maj. John Wesley Powell arrived in 1869, seeking neither gold nor a route west, but the canyon itself—a vast unexplored region of the United States.* His Civil War rank remained his title for life, but Powell came to explore the canyon as a college professor sponsored by the Illinois Natural History Society.

He conceived the expedition, raised the money, and brought the courage and brilliance to make it a success. He also gathered together a crew of nine frontiersmen who shared his enthusiasm for adventure. They were given little chance of surviving, and, like him, none was paid.

His classic adventure tale, *Canyons of the Colorado*, wasn't published for 26 years—and only then to fulfill an 1874 promise he had made to Congressman (later President) James Garfield in return for the Congressman's efforts to secure appropriations for Powell's Bureau of American Ethnology.

His captivating description of the canyon—enlivened by a harrowing litany of near disasters, hunger, and desertion—has made the book a basic reference work in any river-trip library. But it wasn't essential when I ran the river with Martin Litton—he seemed to have it memorized.

Like a latter-day Powell, Martin has become something of a legend among river runners. And like Powell, he also challenges the river in little wooden boats and has influenced the development of this area (pages 46-7). As an evangelist for the environment, the powerfully built outdoorsman was one of the leaders in the successful fight to stop construction of the Grand Canyon dams in 1966. He still approaches anyone he suspects of trying to damage our natural wonders like a Billy Sunday cornering a sinner in New York City's Hell's Kitchen.

All canyon river trips leave from Lees Ferry at the northeastern corner of the park. To reach it, we drove across miles of barren desert. Martin lamented its condition.

"When Kit Carson passed through here in the 1860's, the land was protected under a rich mat of native perennial grasses. Overgrazing by sheep has removed not only the grass and its soil-binding roots, but now, as you can see, the topsoil as well."

The Geological Survey designated Lees Ferry Mile 0 on the river for map purposes whether you go up- or downriver. If you go upriver to Mile 12, you encounter the Glen Canyon Dam; go downriver to Mile 240,

JOSEPH B. HALL

**Fussy eater,** dining on the inner bark and seeds of the ponderosa pine, the threatened Kaibab squirrel of the North Rim is a prisoner of geography and specialized adaptation. The changing climate cut off its range to the south, and its forest is surrounded by desert.

*See "Retracing John Wesley Powell's Historic Voyage Down the Grand Canyon," by Joseph Judge, NATIONAL GEOGRAPHIC, May 1969.

and you will enter the still waters of Lake Mead—after making the most dramatic white-water river trip in the world.

We found the boat landing paved with river rafts—giant, aluminum-colored sausages—in varying states of inflation (page 40). A passenger waiting for his ship to fill wandered among our little wooden dories as we packed our gear in the watertight compartments—smiling and shaking his head. "You gotta be crazy." He must not have known about Powell's boats—or then again, maybe he did!

WE DEPART LEES FERRY with as much dignity as we can muster. Sitting two abreast, four to a boat, under floppy hats, behind sunglasses and white sunscreen lotion, and wrapped in puffy orange life jackets, we look like seven boatloads of teddy bears being rowed to a masquerade party.

During this 18-day midsummer party we'll endure hours of blistering sun in open boats, be chilled by plunging through raging 50-degree rapids, eat sand on our pork chops, and be obliged to shake our sneakers every morning for scorpions. Rain falling onto our faces will awaken us on strange, dark, rocky shores.

But no one minds the little inconveniences. Like wearing tight shoes to your wedding—by the time you get there, you don't notice them.

The rim with its clutter of civilization slowly rises out of sight and mind. Each new bend in the river strains the imagination. The river becomes an escalator to the past, dropping us 2,200 feet through an ever deepening gash that exposes the earth's oldest geologic eras. From the side of our dory we'll run our hands down the ages of time—layer by layer.

In the quarter-billion-year-old Kaibab limestone, formed by the last Paleozoic sea to cover this area, we find a fossil crinoid, a disk shaped like a Navajo shell bead. Five miles downriver our fingernails scratch a line along the Coconino sandstone—laid down as windblown dunes 25 million years before that crinoid arrived. Thirty miles into our trip we stroke glistening water-polished limestone (page 42). Soon we're walled in by it, a 500-foot-thick graveyard of sea creatures that swam into the region 300 million years ago.

Martin calls a lunch break at Redwall Cavern at Mile 33—a huge chamber carved from this limestone layer called Redwall (following pages).

"The rock's not really red," Martin tells us. "It's gray. The iron oxide washing down from the shale stains it that color." He points to an unpainted gray scar left by a recent rockslide.

At Mile 61 the Little Colorado adds its bit to the big Colorado. It's a blue-white flow and has the appearance—and the effect, if one drinks it—of milk of magnesia.

On the sixth day we plummet down a stairstep of rapids—Hance, Sockdolager, Grapevine—until we're squeezed into Granite Gorge, a mile deep into the earth.

Streaked with pink granite, eerie fluted columns of black Vishnu schist formed about 1.7 billion years ago offer a macabre view of the Precambrian Era.

Our first rapids, Badger Creek, at Mile 8, had been easy. The story is that Jacob Hamblin, a 19th-century Mormon missionary, caught a badger here. The next rapids—more interesting—was Soap Creek. When Hamblin cooked his fat badger in the alkaline creek water, he got soap, not stew.

FOR TWO WEEKS our dories, all of them named for scenic wonders desecrated by man, are drawn through larger and larger rapids, each seemingly preparing us for worse to come. And always there's the old-hands' threat, "Just wait till Lava."

By Mile 178 the narrow canyon is widening again. A distant roar like a 747 jet liner revving for takeoff puts us on notice. Soon Vulcans Anvil—a tombstone-shaped slab of black basalt—looms in midriver as if to warn us away.

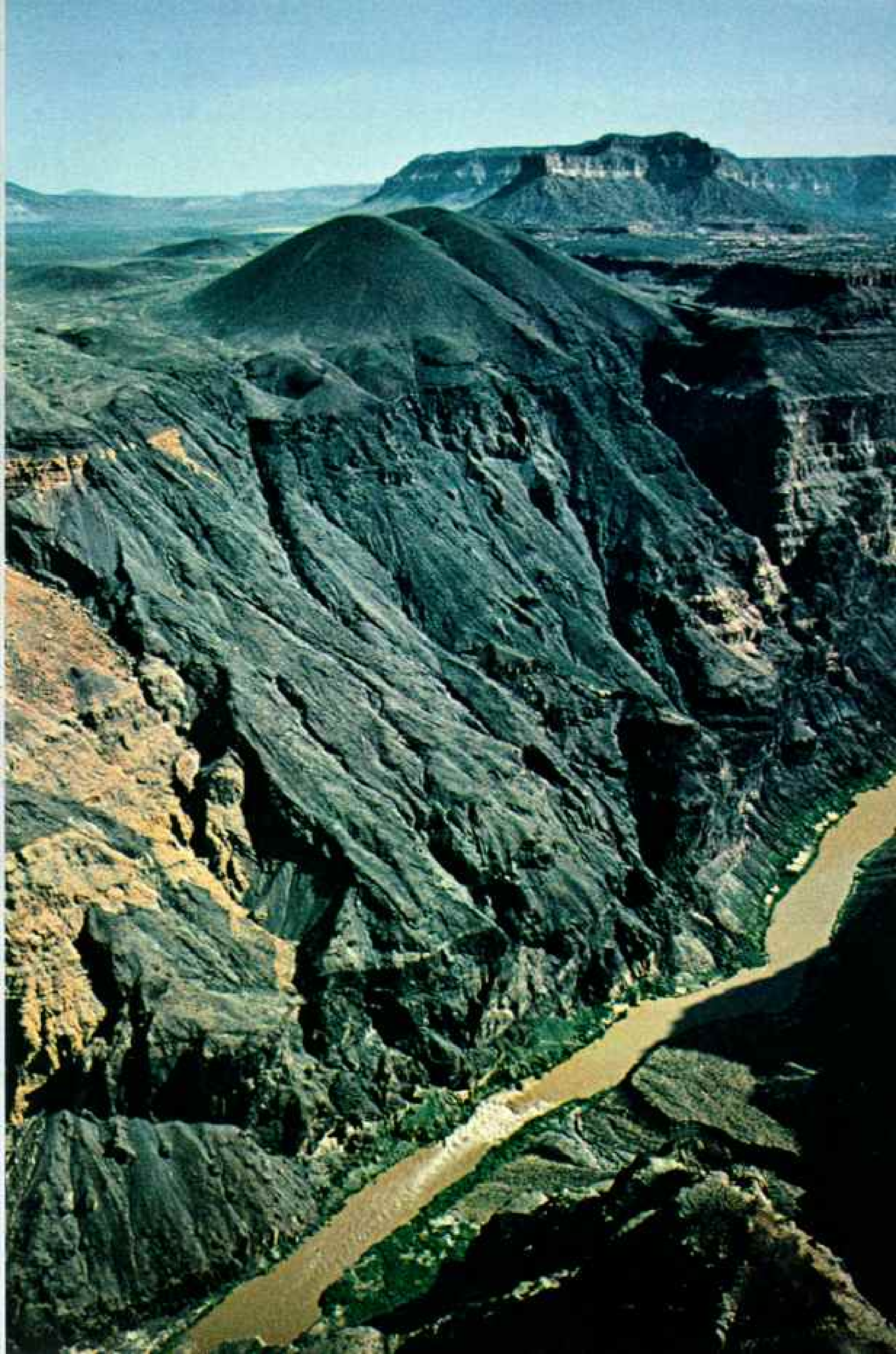
Just above Lava we climb the steep shore to stare down upon the awesome, terrifying spectacle. Like everything else in the canyon, Lava's better than its reputation.

Below us it sucks the river into a narrow, boulder-filled chasm, whipping it into a maelstrom of muddy froth leaping as if to escape its banks. Someone mentions that Lava has flipped more boats than any other rapids in the park (pages 48-9).

Boatman Regan *(Continued on page 51)*

**Intermission in the dramatic 2,200-foot descent** of the Colorado through the canyon is staged under the arch of Redwall Cavern (**above**), 33 miles downriver from Lees Ferry. Everywhere pocked by footprints, the beach here became such an overcrowded stopping place that authorities had to prohibit camping. As recently as 1948, fewer than a hundred people had run the river the length of the canyon. Today 14,000 travel some or all of it yearly.

Writer-conservationist Martin Litton (**right**) adapted the lines of the Grand Banks dory in designing motorless boats for the canyon's rapids. An advocate of nature undisturbed and leader of float trips, Litton faces the wilderness paradox: As more people come to understand and travel in it, they impinge on each other's solitary experience. "Even the people who care for conservation must ration their use of wilderness," he says. Long committed to the cause of a pristine river, some of the professional river runners have for years conducted end-of-season "carryouts" of trash.



**Last monstrous obstacle** in the canyon's most dangerous rapids, a giant wave lifts a dory (**below**) and holds it in suspension. Then, as oarsman O. C. Dale (**bottom**) breaks through the wave, the boat nearly submerges before squirting free. Lava Falls, world's fastest navigable rapids, has been run.

Even this rage of water looks insignificant when matched against the canyon's scale (**left**). The black cinder cone called Vulcans Throne was formed by volcanic activity about 10,000 years ago. "What a conflict of water and fire there must have been here!" wrote explorer John Wesley Powell.

LUCILLE H. GARRETT (TOP)

*(Continued from page 45)* Dale snaps a stern warning: "If there's anyone who came to see a boat flip, get away from here. We don't even want you around. If there's anyone here who says he's not afraid of this rapids, I don't want him in my boat."

Following the precedent set by Powell, who portaged Lava, a few of our group decide to walk around the rapids.

If fear is the only requirement, I am certainly qualified to ride. From above there was no scale; down here there's too much. As our dory slides down a smooth tongue into chaos, twenty-foot waves lash us. Boatman O. C. Dale yells an unnecessary, "Hang on!" Our boat thrashes like a wounded whale trying to shake a harpoon—plunging, broaching, shuddering.

The run lasts an interminable 30 seconds. That evening, Lava behind us, the teddy bears strip off the life jackets and a few inhibitions, and celebrate well into the night our smashing victory: Dories 7, Lava 0.

Sunrise comes late to the canyon floor but not without a glorious preamble. On the highest rims to the west the sun kindles a glowing tiara of light. A reflected pink blush flows down eastern walls. The raccoons have finished their nightly patrol of the camp. A family of coyotes snarl and bark as they scrap among themselves across the river. A golden eagle glides silently along a ridge, hoping to surprise a careless shrew.

IN WEEKS spent crisscrossing the park, I often felt the cold flash of adrenaline and fear as a foothold gave way along a steep pitch. One bone-chilling mugger of a rapids stripped me of camera, hat, sunglasses, and my right boot. I suffered blisters, bruises, and a cracked ankle. I've never enjoyed a place more.

I would heal. I hope I left no scars on the canyon that won't heal, because there are a lot of people coming to see it. They should always find it unimpaired. □

**In communion** with rock and light, wind and pool, a wader in the font of North Canyon Wash can take home for memory those private epiphanies the canyon endlessly supplies. Only one payment is required: Leave no trace.

# Voyager's Historic View of Earth and Moon

CRESCENTS in a dark void, the earth and its moon are photographed in tandem for the first time by NASA's Voyager 1 spacecraft. Clouds swirl above our planet, bottom, partially obscuring eastern Asia and the western Pacific. Because the moon reflects much less light than earth, engineers at the Jet Propulsion Laboratory in California enhanced the craft's imaging data to make the moon more visible.

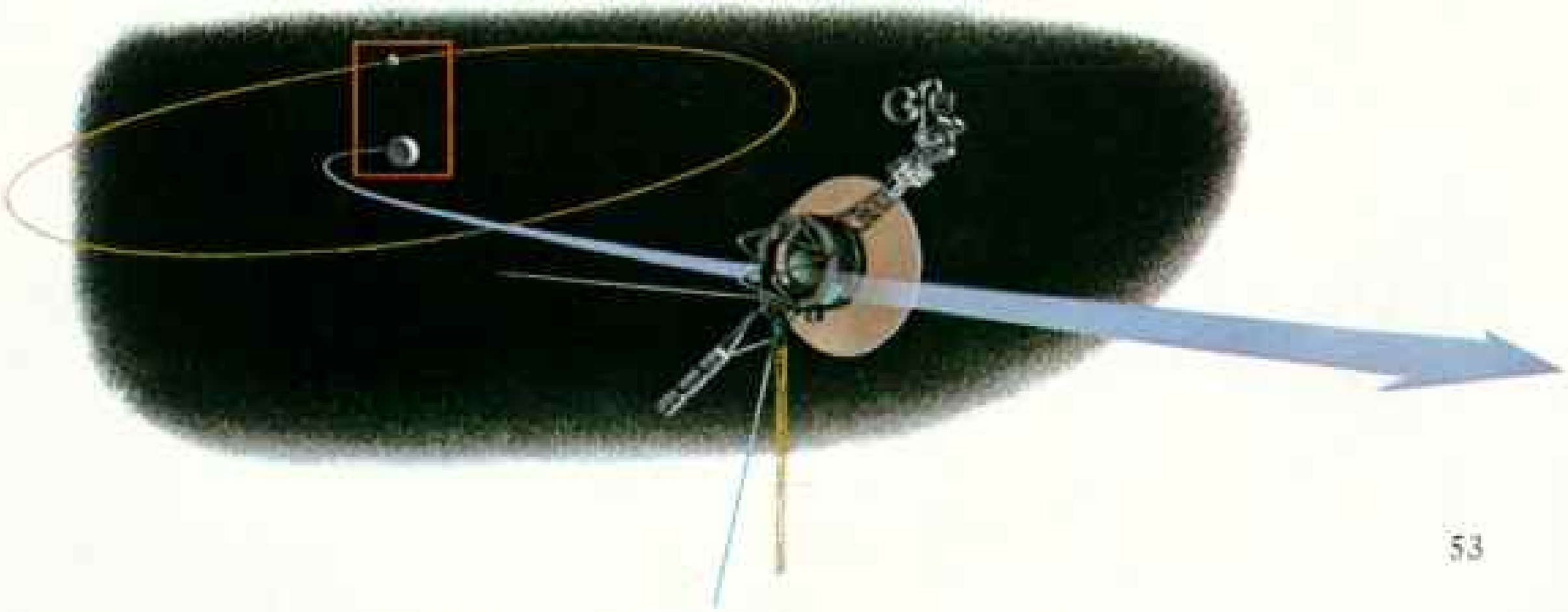
En route to Jupiter and Saturn, Voyager recorded data for this remarkable picture September 18, 1977 (diagram, below), when it was 11,660,000 kilometers (7,250,000 miles) from earth, directly above Mount Everest and well beyond the moon's orbit.

Trailed by a sister ship, the 815-kilogram (1,797-pound) Voyager 1 will fly by Jupiter in March 1979 to scrutinize that planet and several of its 13 moons. Jupiter's gravity—more than twice that of earth—will accelerate the two spacecraft in slingshot fashion, whipping them toward a rendezvous with Saturn. Voyager 2 may then proceed to Uranus, arriving in 1986.

Thus man explores worlds beyond his own. Two Pioneer spacecraft are being launched this year to probe the atmosphere of Venus. From high above the earth in 1983, a Space Shuttle orbiter will launch two vehicles to observe the polar regions of the sun; in addition, a telescope it sends into orbit will extend man's gaze about seven times farther into space, perhaps to the fringe of the visible universe.

Meanwhile, the two Voyagers cruise onward. When their missions are complete, they will exit our solar system and embark on interstellar space journeys that could last millions of years. If—somewhere, somehow—spacefarers of another civilization should encounter a Voyager, they will discover on board a phonograph record of terrestrial sounds and electronically encoded photographs—some provided by the National Geographic Society.

Imagine these beings, if you can, listening to sounds as dramatic as Beethoven's Fifth Symphony, as curious as crickets' chirps, as soft as a kiss, and puzzling over pictures as diverse as porpoises, Andean girls, and the Sydney Opera House in Australia. □



# REGAL TREASURES
## FROM A MACEDONIAN TOMB

By MANOLIS ANDRONICOS, Ph.D.
PROFESSOR OF ARCHEOLOGY, UNIVERSITY OF THESSALONIKI
Photographs by SPYROS TSAVDAROGLOU

ABOVE: SOLID-GOLD CASKET FROM "PHILIP'S TOMB" BEARS SUNBURST SYMBOL OF MACEDON. LEFT: WALL PAINTING FROM AN ADJACENT TOMB DEPICTS PLUTO ABDUCTING PERSEPHONE TO THE UNDERWORLD.

One of archeology's most intriguing discoveries, a 2,300-year-old tomb complex yields splendid relics from the epic age of Philip II of Macedon, father of Alexander the Great. Among the finds: extraordinary Greek wall paintings and a gold casket holding bones that may be those of Philip himself.

A LITTLE DIRT AND DUST trickled into it, a rectangular black hole. What did the darkness hide? Emptiness—or everything I dared hope for?

"Be calm, as calm as possible," I told myself. But I think my hands shook a little.

No question about my assistants, Miss Styliani Drougou and Mrs. Chryssoula Paliadelli; crowding in for a look, they were visibly excited, and with good reason. They had shared in all the difficult work of the excavation, and now we had uncovered a large Macedonian grave tied in to artifacts of the fourth century B.C. An unplundered tomb of that period would be a unique find.

We were about to climb down to see its interior. As it looked in the hour of burial? With all the offerings for the dead in place? Truly, an incredible moment was upon us.

The last shovelful of reddish earth had been peeled back from the roof of the barrel-vaulted structure that had been buried seven meters (23 feet) deep. Then, following the practice of ancient grave robbers—who we prayed had never found this site—we lifted out a keystone from the roof at the very back of the tomb.

I was first to peer in, by the light of a flashlight. Moving the beam about, I saw a square chamber; across the room, at the front, a marble door led into the antechamber beyond (painting, page 59).

Almost underneath me I glimpsed two groups of objects—bronze vessels and weapons in one corner, silver vessels near another. Scattered on the floor lay decomposed remnants of wood and other materials, among which shone leaves of gold. Directly beneath the opening I discerned the covering slab of a marble sarcophagus.

I had to have a closer look at these wondrous things. The ladder and everything else required to begin work were ready.

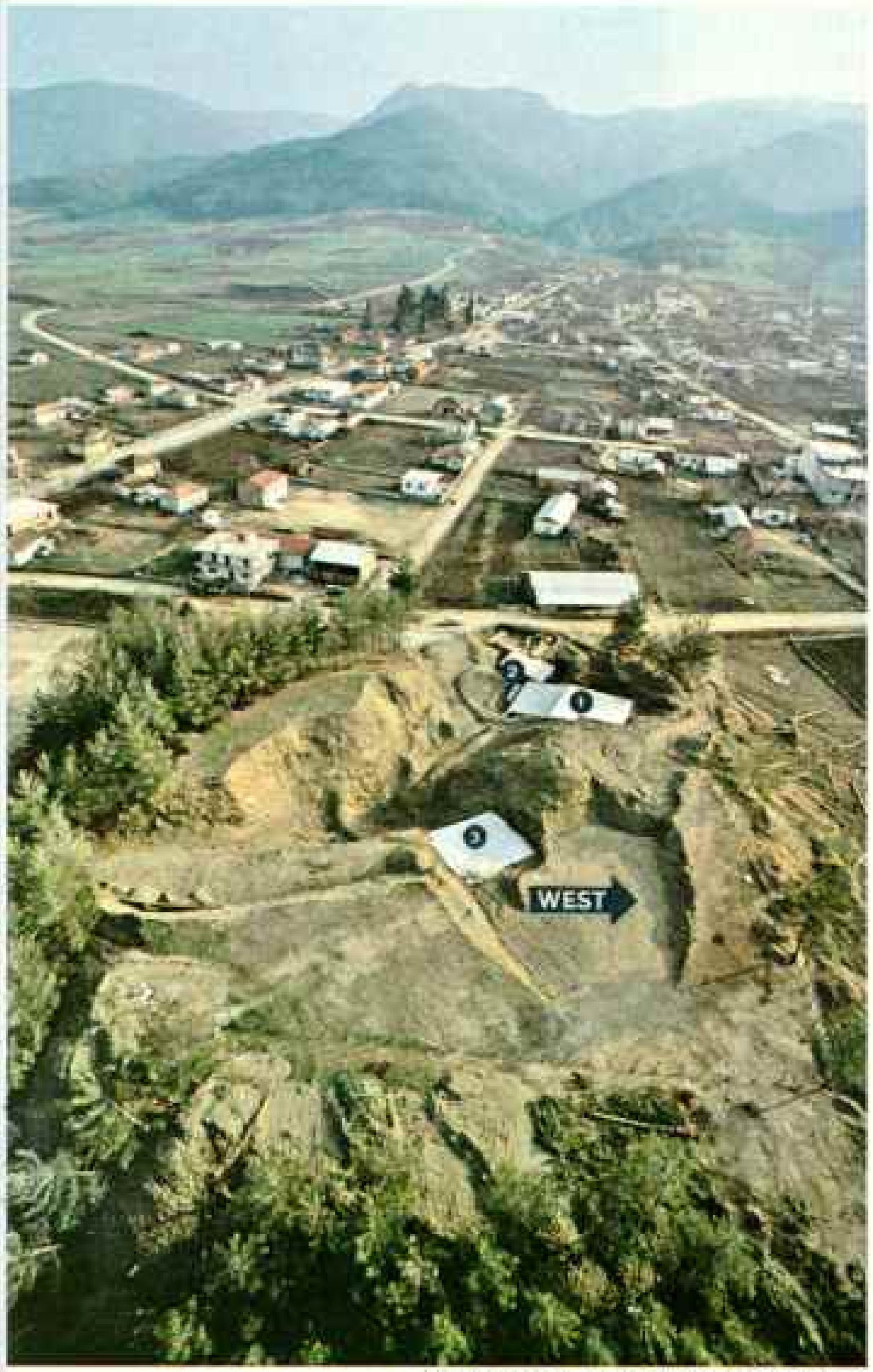
That was three o'clock on the afternoon of November 8, 1977, in Vergina, a northern Greek village now identified as the ancient burial place of Macedonian kings. Of that long line of monarchs, one had stood head and shoulders above the rest—until his own son eclipsed him.

He reigned 23 centuries ago, lost an eye and was lamed in battle, and had a strong appetite for *(Continued on page 62)*

EKDOTIKE ATHENON, S.A., BIBLIOTHEQUE NATIONALE, PARIS

*Clues to kingship: Although no inscription has yet confirmed that the remains of Philip II lie in the golden casket, discoverer Manolis Andronicos believes the evidence points to the Macedonian king, who had conquered most of Greece and was planning to lead an invasion of Asia Minor when he was assassinated in 336 B.C.*

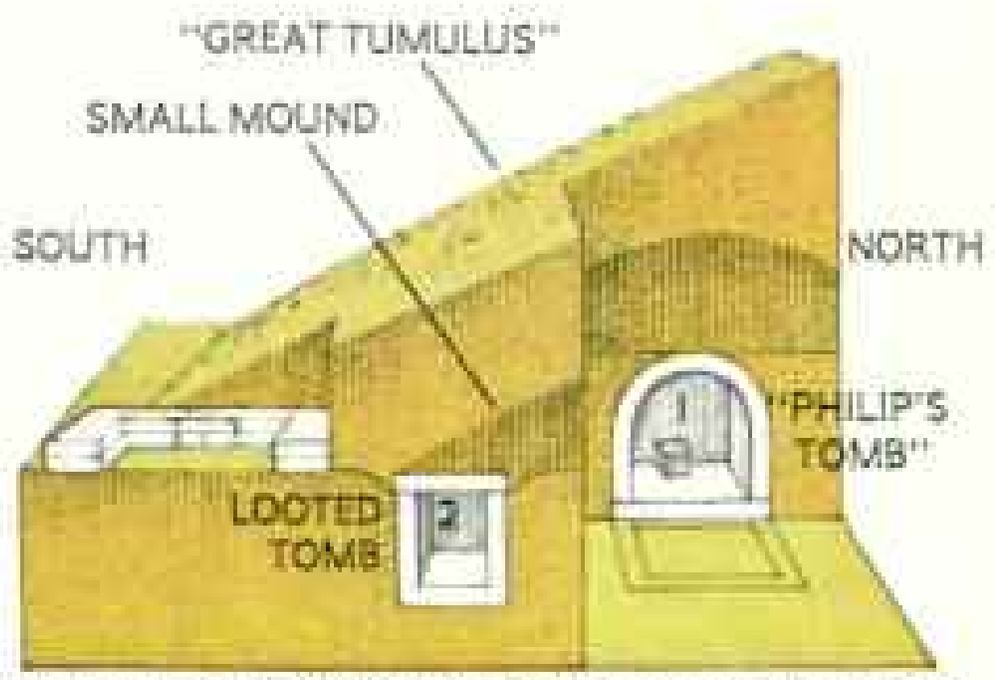
*Less than an inch high, an ivory head* (facing page) *found in the tomb resembles the face—thought to be Philip's—on an ancient medallion* (above). *The medallion portrait is adorned by a diadem used by Macedonian royalty and much like one from the tomb* (below).




NATIONAL GEOGRAPHIC PHOTOGRAPHER GORDON W. GAHAN

*"Everything is intact!" exclaimed Dr. Andronicos as he lowered himself through the roof of a buried tomb at the Greek village of Vergina. His flashlight, trembling in his hand, shone on regal treasures sealed from human eyes for 23 centuries.*

*For several seasons the author had been digging trenches into a large, man-made mound, or tumulus, on Vergina's outskirts. The tumulus, he theorized, seemed a likely burial place of Macedon's kings, who once reigned in ancient Greece* (map, below left). *Then, just as his 1977 dig seemed to be ending in disappointment, he noticed a small, older mound under the southwestern slope of the "great tumulus." On a hunch he dug into it and, to his joy, discovered two tombs. The larger* (1), *a two-chambered burial vault* (cutaway, right), *is believed to be the*

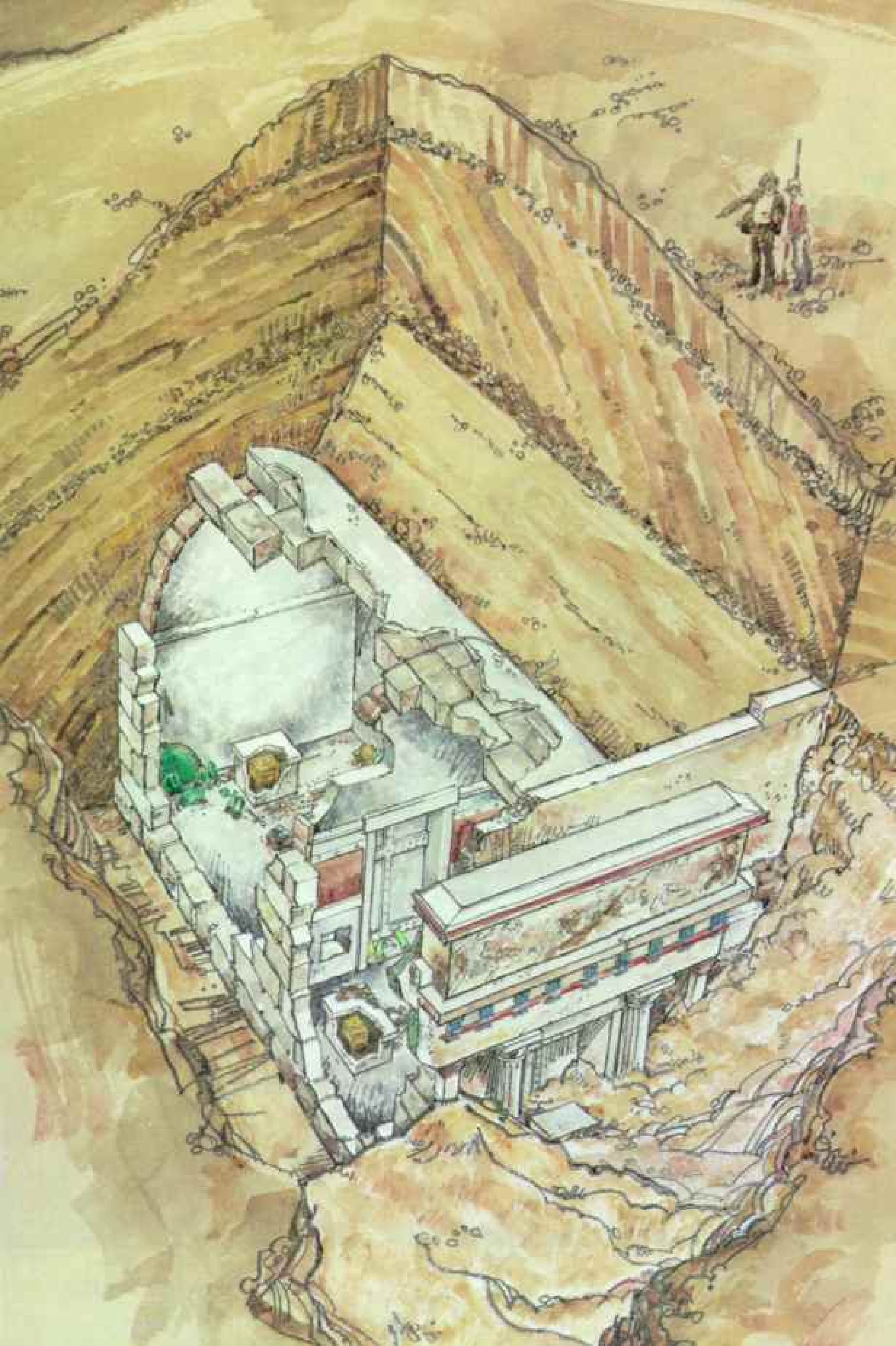



VIEW IS TO THE WEST IN DIAGRAM AND PAINTING


*first unplundered tomb of ancient Macedonian royalty ever found. The smaller tomb* (2) *had been looted but featured extraordinary frescoes.*

*Tin roofs cover the two tombs, and a plastic sheet shields another promising site nearby* (3). *The latter could conceal the tomb of a third-century B.C. ruler, Antigonus Gonatas. The author speculates that he may have built the tumulus over the smaller burial mound containing "Philip's tomb."*

J. ROBERT TERINO, NATIONAL GEOGRAPHIC ART DIVISION (RIGHT)



GORDON W. GAHAN

*Patina of millennia encrusts a rich trove of bronze vessels and armor in a corner of the main chamber—seen here exactly as the archeologist discovered them.*

*The large circular object is a cover thought by the author to have encased a ceremonial shield of ivory and gold. Between the shield cover and the tripod-supported bronze vessel, at left, stands a perforated bronze lantern. A bit of cleaning reveals the lantern's original luster and exquisite craftsmanship* (above).

*Other objects seen here include a warrior's bronze greaves, or leg armor, lower right; just above them, the gold-and-silver diadem pictured in cleaned condition on page 57; and, to the left of the diadem, the only Macedonian iron helmet ever found. Brownish object, center foreground, is an ordinary though ancient sponge—still soft and squeezable.*

EXCOTIBE ATHENON, E.A., MUSEUM OF THESSALONIKI

*Royal family: Philip's fourth wife, Olympias* (above), *gave birth to Alexander the Great, whose image the author sees in the small ivory portrait* (below) *found in the tomb. About 20 years old when Philip was assassinated, Alexander took his father's mantle of conquest and flung it across the Middle East and central Asia. Some suspect that Olympias, estranged from Philip, may have induced a disaffected bodyguard to murder him.*

*(Continued from page 57)* rich banquets, good wine, and women—he took seven wives. Philip II, whose 23-year Macedonian reign began in 359 B.C., was endowed with immense personal courage and powers of leadership, and with a goodly portion of the military genius that reached such phenomenal expression in his son Alexander. First and foremost a politician, Philip was also a cultivated man, one who surrounded himself with Greek artists, authors, and actors.

Tough, yet capable of being magnanimous, Philip sallied forth from his capital at Pella to conquer or cajole the warring factions of the Greek mainland until he controlled almost the whole region (map, page 58). His dream of standing at the head of the Greek world virtually realized—he did not subjugate Athens after defeating her, but bound the city-state to him by alliance—Philip turned his attention to the invasion of Asia Minor.

In the spring of 336 B.C. Philip sent out an advance army 10,000 strong, postponing his own departure until after the summer marriage of his daughter. But at the wedding he was stabbed through the heart by an assassin's sword, the victim possibly of a palace plot.

THE DUST OF CENTURIES buried monuments and a wealth of pottery and other artifacts from the days of Philip and his royal successors. But the greatest prize of all, an unlooted regal grave, eluded discovery—until that November day in Vergina.

Before that tale unfolds, I must backtrack. In the mid-1850's the brilliant French archeologist Léon Heuzey, exploring Macedonia, discovered in the northern foothills of the Pierian Mountains the ruins of a glorious colonnaded palace. The closest village then was Palatitsia, a site adjacent to today's tile-roofed village of Vergina.

Heuzey returned in 1861 aboard a warship that Napoleon III put at his disposal, reaching the shores of the Thermaic Gulf close to Palatitsia and the ruins. Aided by the warship's sailors and some peasants, Heuzey uncovered a flank of the third-century B.C. palace and its once splendid entrance. He also excavated a barrel-vaulted Macedonian tomb with a beautiful

Doric facade. It had been looted in antiquity.

Investigation at this important site, however, was not resumed for many years. In 1937 Professor Konstantine A. Rhomaios of the University of Thessaloniki (Salonica) began excavating at Vergina. It was my good fortune to be one of his student helpers.

The next year we began digging at the palace, ascertaining its size at more than a hundred meters long and almost as wide.

World War II interrupted the work at Vergina. I went to the Middle East to serve in the army of the exiled Greek Government. Upon returning to my liberated country four years later, I was appointed Curator of Antiquities in Veroia, which encompassed responsibility for Vergina also. In a rather emotional state I went back to the scene of my student experiences. We found mines planted in the palace.

Prominent at the edge of the village, a large mound, 12.5 meters high and 110 meters across, rose in a pine-studded whaleback. Heuzey had noted a crater at the top of this "great tumulus," perhaps a cave-in over the collapsed dome of a buried building.

WITH A FUND provided by the Archeological Society of Athens, I began excavating in 1952, high hopes fueled by youthful enthusiasm. From the crater we dug down seven meters with no significant results. But the materials excavated left no doubt that the mound was man-made. Greater funding was required for a long-term dig, and so for the time I turned my attention elsewhere in the area.

A great many small mounds dot the plain northeast of Vergina. They form a vast cemetery, unique in all Greece. Excavating 32 mounds here between 1952 and 1961, I found a treasure trove of clay vases, iron weapons, and bronze jewelry from women's graves. I dated the objects between 1000 and 700 B.C. and published the results in *Vergina I: The Cemetery of the Mounds*. I knew that further volumes would follow.

Professor Rhomaios had resumed his work at the palace, but he was getting on in years. So two younger professors at the University of Thessaloniki took over—George Bakalakis and I. We uncovered the ruins of the entire palace, in its day one of the finest buildings of the early Hellenistic period.

Now I could return to my original desire, excavation of the great tumulus. In 1962 and 1963 I dug a large ditch (about 35 meters long, 15 meters wide, and 11.5 meters deep) from the eastern side toward the center. Once again I unearthed little of value, but found broken pieces of marble tombstones among the debris.

I began to think that the city here must have been an important center of ancient Macedonian civilization. But which one was it? Heuzey presumed this place to have been Balla, a town known only through rare references in ancient writings. However, I was nagged by doubts.

SEVERAL YEARS PASSED. Then, in the fall of 1976, I set out to open a large area near the center of the mound, reaching down to natural ground level. Using heavy earth-moving equipment, we dug a trench deeper than 12 meters. We found nothing. Then, east of the mound's center and about four meters below the surface of the slope, we suddenly began finding pieces of tombstones. Thirty-three pieces fitted together into one gravestone bearing an exquisite bas-relief athlete and an inscription. Other pieces bore only names of the dead. I dated all these fragments to the fourth or beginning of the third century B.C.

But who could have committed such a sacrilege as to smash the gravestones? Greeks, even during their fiercest encounters, respected the graves of their enemies. Puzzling over this question, I recalled the theory of Professor Nicholas Hammond, the British scholar. He maintained that the first capital of the Macedonian kingdom, Aegae, was not, as commonly believed, in modern Edessa but at Vergina.

I consulted Hammond's ancient sources. Thus, in Plutarch, I read how Pyrrhus, third-century king of Epirus, had invaded Macedon, defeated Antigonus Gonatas, and conquered many towns—including the old capital, Aegae. There, according to ancient tradition, Macedonian kings were buried. Pyrrhus left there a garrison of mercenaries from Gaul. Plutarch goes on to say that "being insatiably desirous of wealth," they dug up the tombs of the kings, sacked them for riches, and "insolently" scattered the royal bones to the winds.

Here was an invaluable clue. It nurtured my thought that the Gauls not only plundered the royal tombs but destroyed the cemetery as well. Indeed, all the tombstones I discovered were older than 274 B.C., when the sack took place. Hammond therefore was right, I decided, and Vergina could be identified with Aegae.

We can surmise, when Antigonus recaptured Aegae the next year, that he took an interest in rehabilitating the royal tombs. It would have been natural, too, for him to forestall future looting of intact tombs, and of his own intended resting place. Therefore, I reasoned, he may well have given instructions to have the area, upon his death, covered under the massive 12-meter-deep mound. I had written in 1976, "If all these hypotheses are true . . . we can hope for the most incredible reward in the course of the excavation: the discovery of the graves of the Macedonian kings."

These were my expectations when I began to dig again on August 30, 1977. After 35

GORDON M. GAHAN

*"It's like a detective story," says Dr. Andronicos, trying to correlate evidence from the tomb with known historical data. "I'll be the first to announce any facts disproving my hypothesis that the tomb is Philip's," he says, "but according to my findings the artifacts date from between 350 and 325 B.C., and Philip was the only Macedonian king to die in that period."*

*Examining a magnificent golden quiver* (left *and* above) *found in the antechamber, he asks, "Who else but a king would own this?" Next to it lie two greaves. "One is shorter than the other, and we know that Philip was lame."*

days of work, and after removing about 18,000 cubic meters of earth—almost 40,000 tons—I reached the natural ground level near the center of the tumulus. I then drove five test trenches. Nothing. The soil was undisturbed, with no evidence of construction or human labor.

GREATLY DISAPPOINTED, I resigned myself to waiting until the following summer. I was preparing the ground for that later excavation when, suddenly, I noticed that the southwestern slope of the tumulus enveloped an older, smaller mound (diagram, page 58). Digging into it, we came upon the corner of a wall that was roughly covered with lime plaster on one side and on the narrow top. Finally we had found an undisturbed structure in that enormous mass of earth!

Searching nearby we unearthed well-defined rows of large stones, clearly the foundation of another building. Probing the area further *(Continued on page 70)*

*A second mystery: Within the antechamber of the tomb another sarcophagus* (left) *was discovered, slightly bigger than the one in the main chamber, which held the large golden casket. Atop the covering slab lay decomposed feathers—possibly a queen's trappings. Pushing aside the cover* (top), *Professor Andronicos discovered another gold casket, also displaying the Macedonian sunburst symbol but somewhat smaller than the one he believes to be Philip's. Within, he found purple fabric threaded with gold* (above) *wrapped around charred bones—perhaps, the professor suggests, those of Philip's last wife, Cleopatra, chief rival of Olympias. According to one ancient source, after the death of her polygamous husband, Olympias killed Cleopatra and her infant "by dragging them over a bronze vessel filled with fire."*

*Bones of contention—the cremated remains of Philip II of Macedon, according to Professor Andronicos—lay undisturbed within the larger of the two gold caskets for 23 centuries. Though somewhat charred from a funeral pyre, the bones were apparently carefully washed, perhaps with wine, then covered with a golden wreath of oak leaves and acorns.*

*Among the fragments were two teeth, which an anthropologist says belonged to a man past his early thirties. Philip died at 46.*

*Blue and purple stains on some of the bones and on the floor of the casket were caused by the disintegration of the purple fabric that wrapped the bones.*

*But are they Philip's bones? Lack of proof has led some scholars to challenge the professor's identification. The fact that the main chamber of the tomb was less lavish than might be expected has also sown doubts. Dr. Andronicos counters that, since Philip was assassinated with the possible complicity of Olympias, the burial may have taken place hastily, without time for the usual finishing touches on the tomb's inner walls.*

*Whatever the ultimate identification, the find at Vergina remains a triumph of modern archeology.*

(Continued from page 65) we discovered yet another building, a small masonry tomb.

We had found three adjacent structures! One had been destroyed, except for the foundation, but carefully laid out next to it were beautifully carved marble pieces from its superstructure. This was tangible support for my hypothesis that some attempt had been made to bring order to the chaos caused by the Gallic mercenaries.

THE SMALL TOMB was well constructed. It had been opened and apparently looted. I'm convinced that the grave robbers thought this was *the* tomb of the tumulus. Looking no further, they failed to find the grave I believe to be Philip's. Uncovering the small tomb, we experienced unexpected joy. The entire upper part of the northern inside wall, 3.5 meters across, bore a magnificent fresco. A man of noble bearing holding a scepter is driving a four-horse chariot, or quadriga. In one arm he holds a beautiful girl, who is straining to escape (page 54).

The painting's theme was unquestionable: Pluto, god of the underworld, was abducting Persephone. The power of the drawing, its stunning composition and sensitive coloring moved us deeply. More important, we were seeing a rare example of Greek wall painting of the fourth century B.C., an art style that so enchanted the Romans that they imitated it on the walls of their homes and in their mosaic floors.

We know from the writings of Pliny the Elder that this subject had been treated by Nicomachus, a famous fourth-century artist. I think we are on solid ground in attributing to him this incomparable painting.

Two other walls of the tomb were decorated with paintings—a seated woman on one wall (page 74) and a group of three female figures on another. The single figure may be the lady buried in the tomb, or perhaps the goddess Demeter, mother of Persephone. This assemblage of female likenesses and the finding of ivory comb fragments make me virtually certain that this was the tomb of a woman.

Returning now to bare the plastered wall that we had encountered first, we found a clump of potsherds and burned bones of small animals, possibly birds. Potsherds are archeologists' most important dating tools. I believe these came from vases made about 340-330 B.C., certainly before 325 B.C. Construction of the wall was typical of the same period. We were now sure it was the front of a large tomb.

As we uncovered the facade, the end of a frescoed surface came to light. When we cleared away the earth, an unsurpassed fourth-century B.C. Greek composition stood forth. The painting, spanning the full width of the tomb, showed a hunt for wild boars and lions. Three hunters holding spears and five horsemen and their dogs pursue the game in a winter landscape, the season signified by three leafless trees (page 72). The rendition of the figures and the excellent perspective and coloring reveal a great artist—possibly Philoxenus of Eretria, a student of Nicomachus.

Until these thrilling discoveries, only a few fourth-century Greek wall paintings had been found. But several Roman copies and imitations in Pompeii, Herculaneum, and Boscoreale suggested their beauty. Of immediate significance, the quality and scale of these frescoes alone suggested that the graves that they decorated were royal.

As more earth fell away from the facade, the metopes and triglyphs emerged, the latter in a brilliant blue pigment. Two Doric columns and two pilasters supported this entablature; they were made of limestone overlaid with snow-white plaster.

When we reached the central entrance, we gratefully observed that the elegant marble doors were still tightly closed. The probability that the grave had not been disturbed was now greatly increased!

ENTERING THE TOMB, however, posed a problem. The massive doors could only be opened from the inside, and then only if the entire facade were excavated. We decided instead to clear the roof and then emulate the ancient grave robbers by removing a keystone.

Near that entry point we found bricks from a square enclosure that had collapsed under the earth's weight. From the rubble we eased out two iron swords, the point of a Macedonian spear, and many iron bridles, all burned. In the Homeric tradition the weapons and stable gear, retrieved from the

*A warrior's heart once beat within this corselet, or body armor* (above), *seen just as it was found. Golden adornments in the shape of lions' heads, lying beside the piece of armor, were later restored to their original luster* (left).

*The corselet itself consists of iron plates covered with cloth and leather on the outside and cloth alone on the inside.*

funeral pyre, would have been placed upon the grave following the burial.

Finally, as I have related, we opened the tomb and entered. What emotions and astonishments fell pell-mell upon us!

As in other barrel-vaulted tombs found in Macedon, the main chamber, in this case 4.46 meters square, was linked with the somewhat smaller antechamber by marble doors hung from bronze bolts.

The funerary objects had been placed on either side of the sarcophagus. In front of it lay scattered remains of one or more pieces of wooden furniture. Among these fragments of what may have been a wooden bed, we found sheets of ivory. These perhaps had formed an ornamental band on one side of the bed. From the same side, or possibly from a wooden box laid on the bed, had fallen a decoration of ivory-and-gold human figurines only about 15 centimeters tall, judging from the intact heads, which measured two centimeters high.

Personal belongings of the deceased came to light: his body armor, sandals, greaves (leg armor), sword, scepter, and—most significant—his regal diadem, or headband. These had probably fallen off the bed as the wood decayed.

STANDING with my back to the door of the chamber, I saw in the left rear corner a cluster of bronze vases, and by the right wall another group, most of them silver. With the vases we also found the dead man's armor and weapons: a shield, points of spears and javelins—one spearpoint still stuck in the wall—as well as the first Macedonian iron helmet ever found. Near it lay a beautiful sword in a sheath of ivory and wood.

The body armor, or corselet, and shield

*Touched by sunlight after two millennia, the facade of the tomb bears a time-dimmed fresco across its entablature. The barely visible painting depicts three hunters with spears and five horsemen with dogs pursuing their prey, wild boars and lions. This and three other paintings discovered in the adjacent tomb are among the few extant examples of fourth-century B.C. Greek frescoes.*

are quite unique. A small gilded plate with a depiction of Athena in relief, eight golden lions' heads, and golden bands and rings brighten the corselet's surface. On a leather fringe at the bottom, 56 strips of the same metal, adorned with fine palmettes, add to the sumptuous decoration of this priceless relic (page 71).

While the corselet lasted out the millennia in relatively good condition, the shield, which must have been built on a frame of leather-covered wood, had disintegrated. It is possible to imagine it, though, from the surviving pieces. The outer ring was fashioned of ivory inlaid with a wave pattern of dark glass. Concentric to that was a round golden band, and the center of the shield must have displayed a small figure of Victory in high relief, made of gold and ivory. The shield's grip was of gold-plated silver that ended in palmettes. On the top rode a pair of winged Victories in repoussé. Such an impressive and delicate work of art, I believe, would never have been exposed in actual combat. Rather, it was encased in a bronze cover, which we had initially taken for the shield itself.

The weapons bore witness that the tomb could not have belonged to a commoner; these were valuable pieces, made with supreme skill and care.

THE SAME OPULENCE and superb quality are revealed in the silver vessels. Aside from the rosettes, the wave-like moldings, or *kymatia*, and the palmettes that cover their surfaces, almost all the vessels show at the base of their handles small decorative heads in relief. Heracles, Pan, Sileni, and other figures offer us wonderful examples of fourth-century B.C. Greek metalwork.

*Kingly cache of vessels, many of finely wrought silver, lay in a heap against the north wall of the main chamber when Dr. Andronicos entered the tomb. "Incredible! Marvelous!" he murmured when he first glimpsed the array, which included more than 70 objects of gold, silver, bronze, and iron—masterly examples of the ancient art of Greek metalworking.*

On our first day in the tomb my assistants and I had simply noted and marveled at all the visible splendors. The second day, trying not to disturb anything, we measured, sketched, and photographed.

Only on the third day did we open the marble sarcophagus. When we lifted the covering slab, we gasped—an urn was what we anticipated. There lay a larnax, or casket, of solid gold, measuring, without the legs, 40 centimeters long, 33.5 wide, and 17 high. The casket and its contents weighed 10,800 grams, almost 24 pounds. The lid was embossed with a sunburst, or star with rays, while the sides were richly chased with palmettes, rosettes, and vines.

WITHIN, the burned bones of the deceased lay as clean as if they had been washed, covered with a golden wreath of leaves and acorns from Zeus's sacred tree, the oak (pages 68-9). Two teeth, a molar and a wisdom tooth, have been judged by an anthropologist as belonging to a man of more than 32 years. (Philip was 46 at his death.)

A deep-blue color suffused certain bones, and a purple tint stained the bottom of the casket. These hues, our experts said, came from disintegration of the purple cloth with which the bones had been wrapped.

Surely our discoveries had reached their zenith! But a still more thrilling surprise awaited us. I have noted that the wooden bed or piece of furniture bore a decoration of gold-and-ivory figurines, deduced from the heads, arms, and legs that we found in the rubble. I had at first looked at these relics quickly. But when I examined one of the heads more closely, I could not believe my eyes: It was an excellent portrait of Philip. Here was a mature man with a somewhat fatigued expression, an injured eye, but clearly with great strength of character (page 56).

Shaken by my discovery, I picked up a second head and searched it carefully. It seemed impossible that I could be mistaken; this was the most beautiful sculpture of Alexander the Great that I had ever seen (page 62). His neck stretched and turned, his vivid eyes looked upward. A third head resembled him, but belonged to a woman. This must have been Alexander's mother, Olympias. Of the other two heads, one was a man's and the other a woman's, strong faces but apparently unknown.

My mind went back to the gold-and-ivory statues of his family that Philip had commissioned from the great sculptor Leochares after the decisive victory at Chaeronea in 338 B.C. They were taken to the sanctuary of Zeus at Olympia and placed in the Philippeion, a round building designed to house statues of the Macedonian royal family. We know that those statues depicted Philip, Olympias, Alexander, and Philip's parents. The king was feeling proud of his son, who at 18 had brilliantly commanded the cavalry in the historic battle that assured Philip's control of the Greek mainland.

I believe that in these ivory miniatures, possibly the work of Leochares himself, we have the best and most authentic portraits of Philip and Alexander.

THE ANTECHAMBER still awaited us. Unable to open the door, we worked like thieves again, removing a stone from the dividing wall. A second marble sarcophagus, a little larger than the one in the main chamber, stood next to the wall. An elegant golden wreath patterned in leaves and flowers of myrtle lay on the floor next to the sarcophagus.

Turning, we drew in our breaths to see standing in a corner near the connecting door a golden artifact magnificently decorated with two bands of scenes in relief, seemingly depicting the sack of a town, perhaps Troy. It was a quiver (pages 64-5). Not only had the bronze points of its arrows been preserved, but even the wooden shafts.

Leaning against the door was the fourth pair of bronze greaves we had found. These,

*Lost and found: The exquisite style of fourth-century B.C. Greek wall painting had been known primarily from descriptions in ancient Greek literature and from Roman reproductions—until the Vergina tombs were unearthed. The delicately drawn figure may be a portrait of the woman who was buried in the looted chamber. This painting and the others from the tombs constitute finds of major significance.*

however, were gilded and their dimensions were uneven. The left one measured 38 centimeters and the right 41.5 centimeters. This difference of 3.5 centimeters (1.4 inches) could not be attributed to the craftsman's carelessness, as the two greaves also differed in the modeling of the shank.

Lifting the covering slab from the sarcophagus, we saw yet another golden casket, slightly smaller and simpler than the first, but with the same sunburst on the lid. Opening this priceless ossuary, we saw that the burned bones were wrapped in a rich purple fabric interlaced with threads of gold. Beside the bones lay a superb diadem of intertwined golden branches and flowers belonging to a woman. Could the bones be those of Philip's last wife, Cleopatra?

All our precious finds were removed to the Museum of Thessaloniki for conservation and restoration. It will take time to arrive at definite interpretations and conclusions.

I THINK THAT THE REWARDS from this excavation will be enormous. Unmatched are the large wall paintings created by great artists of the fourth century B.C. The silver vessels with relief heads offer valuable material for the study of Greek metalwork and sculpture. The array of weapons fills gaps in our knowledge of Macedonian culture. The amazing ivory portraits and the two golden caskets are unparalleled. Finally, the tomb itself, with its well-preserved bright colors, presents us with an important early example of ancient Greek construction.

I will set modesty aside to suggest that the Vergina finds surely rank among the most important of the postwar years. That could, perhaps, be satisfaction enough. Yet, as an archeologist, I must raise a critical question: To whom did the tomb belong? A very rich commoner, or even a high official?

I mentioned earlier an object—circular, adjustable, and with a round cross section—which I consider to be a diadem. One part depicts plaits of hair in relief. In preserved portraits a similar headband is worn by Antigonus Gonatas of Macedon, Antiochus III of Syria, and Attalus III of Pergamum. All reigned over portions of Alexander the Great's empire following his death in 323 B.C. Some portraits exist of Alexander himself wearing such a diadem.

I believe that the conclusion is unquestionable that this is a royal headband. Near the diadem, we found traces of a disintegrated scepter. Then there are the sunbursts on the caskets—a special emblem appearing on Macedonian shields and coins.

Everything we have found reinforces the hypothesis that we uncovered the tomb of a king. Accepting this assumption and the dating of the grave between 350-325 B.C., I arrive at an awesome conclusion. Over that whole span of years, only one king died and was buried in Macedon—Philip II. This, in all probability, must be his tomb. My belief is strengthened by the presence of the portraits of Philip and Alexander the Great. I'm convinced that nobody else would have possessed a piece of furniture embellished with these two figures. The only other possible candidate, Antipater, died in 319 B.C., but he was a regent of Macedon, not a king, and I'm certain our tomb predates his death by at least five years.

ONE ADDED SURMISE: Can it be accidental that the difference in the length of that pair of greaves reminds us that Philip was lame? All the evidence seems to point to the Macedonian king. As a scholar, however, I know that only indisputable testimony, an inscription for example, will establish absolute certainty. If our research should bring forth facts reversing this conclusion, I will announce them immediately—and with great relief that the truth, final goal of all scientific research, has come to light. □

*Spiritual home and burial place of ancient kings, the old Macedonian capital of Aegae, where Philip was assassinated, has been linked to these ruins near modern Vergina, background. Here stood a grand palace, perhaps built by Antigonus Gonatas, greatest Macedonian king after Philip and Alexander. Dr. Andronicos believes the tomb of Antigonus may lie within the "great tumulus" nearby—offering the hope of other stunning finds in the months ahead.* GORDON W. GAHAN

A FOLK FESTIVAL IN RURAL JAPAN

# Day of the Rice God

Photographs by H. EDWARD KIM

Text by DOUGLAS LEE

BOTH NATIONAL GEOGRAPHIC STAFF

THE GOD SMILES on his festival day. Chanting and drumming and wailing of pipes summon Sanbai-sama to his divine duty, and so the Shinto deity of the rice fields descends again to the valley town of Chiyoda in southern Japan's mountainous interior. Here townsfolk gather to welcome his return with a centuries-old pageant.

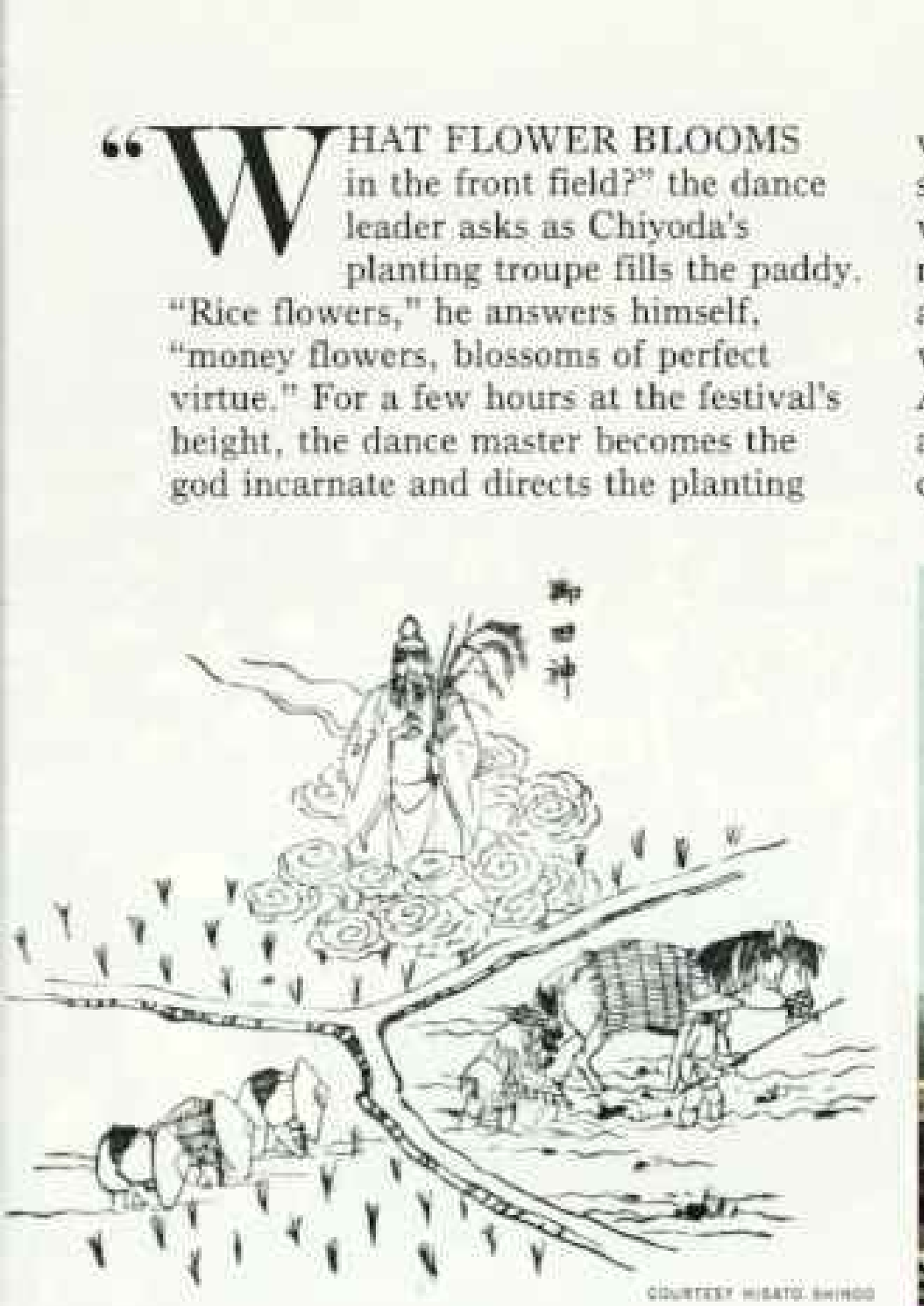
Rain had fallen in the night, borne on the winds of the Asian summer monsoon, but the day dawns clear as veiled flower-hat dancers dip and swirl in procession (**right**). Thus begins the Mibu Ohana-taue—a rice-transplanting ritual preserved by the Japanese Government as a national "folk-culture asset," a day of old beliefs and old ways of working the earth, a prayer in dance and music begging the boon of another year's fruitful crop.

The flower-hat dance was once performed later in the season to drive worms from the rice fields. Costumes recall a classic ruse staged in 1578, when a local warlord dressed his men as flower-hat dancers and led them into his enemy's castle. Samurai steel flashed from silk kimonos, and the dancing warriors won the victory.

MYTH AND HISTORY intermingle in festival events. Demons revel in their evil doings in a school yard as children act out kagura (**left**)—classic dances depicting legendary events, traditionally staged in shrines to entertain the kami, or spirits, of Shinto belief. As the sun reaches its zenith, ornately decorated oxen amble down Chiyoda's main street (**right**), wearing silken banners bearing the owners' family emblems atop "flower saddles" of silver and gold.

Legend holds that the festival originated in Kyoto some 800 years ago, but spread to Chiyoda (then called Mibu) by order of its 16th-century lord, who decreed: "Let my workers turn the long day of transplanting into one of finery and music." Celebrators still obey on the first Sunday of June. Rice straw crackles, and flames bear prayers heavenward as women planters (**below**) summon the god's presence.

"WHAT FLOWER BLOOMS in the front field?" the dance leader asks as Chiyoda's planting troupe fills the paddy. "Rice flowers," he answers himself, "money flowers, blossoms of perfect virtue." For a few hours at the festival's height, the dance master becomes the god incarnate and directs the planting with his chant. The women of Chiyoda stoop and plant in unison (**bottom left**) while drummers and bamboo-clacking musicians set the tempo for pipers' trilled accompaniment (**right**). "Plant all in a row without leaving one out," the leader sings. A cord stretched across the field aids in aligning each rank of seedlings, and the carefully spaced sprouts soon dot the paddy.



COURTESY HISATO SHINDO

Rice cultivation probably first appeared in Japan's narrow valleys and seaside alluvial plains in the second or third century B.C. Intensive labor was rewarded with high yields, a necessity on rugged islands where even today only 15 percent of the land is farmed.

As villages developed, communal labor on days of greatest need became widespread. In a 19th-century print from northern Japan (**upper left**) men prepare a field for planting and women work in a straw-hatted line while the rice god hovers beneficently overhead. Land reform around 1900 abolished the feudal system that created the Ohana-taue, but Chiyoda's residents revived the celebration in 1930.

DRUMSTICKS FLAILING, the men of Chiyoda quicken the pace as the festival hits full stride (**left**). Plodding oxen till the ground while a midday sun draws a canopy of parasols over surrounding throngs. Sound and spectacle infect onlooker and participant alike with the spirit of festival (**above**).

The rice god departs at day's end, according to myth, and flies back to the peaks, where he reigns in another guise as the god of the mountains. The planters call out to Sanbai-sama to remember and return next summer, when the rains will again make glinting mirrors of the empty paddies.

But months of great hazard still lie ahead. Drought may lay the stalks in withered clumps on cracked dry earth, or typhoons sweep bare the bowl of the valley. So the farmer casts a weather eye to the clouds as rice cakes are laid on family altars. And the round of festivals and supplications that have ringed the seasons since earliest times moves on to rites of growth and harvest. □

# Yesterday Lingers on Lake Erie's Bass Islands

ARTICLE AND PHOTOGRAPHS BY
TERRY and LYNTHA EILER

"THAT'S ABOUT THE END of it," gruffed Charlie Mahler when Lyntha and I joined him on the tailgate of his faded blue 1954 pickup truck on South Bass Island. A continuous blast from a ship's horn cut through the late summer haze to sound the annual passing of the last tourist ferry from the Lake Erie islands to the Ohio mainland.

"Another summer, and another bunch of tourists gone," declared the 82-year-old retired commercial fisherman.

"Minnow Charlie" has earned his nickname by supplying island anglers with live minnows and crusty comments, all for one fair price. As he kneaded his special mixture of oatmeal, flour, water, and tobacco juice into minnow bait on the dock, he peered at us over his thick glasses (page 92).

"Commodore Perry came to these islands and beat the British," he said. "Rich people and Presidents came here for vacations, but they all went back to run the country. Young people with long hair and city folks have tried it, but they only lasted a couple of years. Now they're putting salmon into these waters, but they won't stay either. "Islanders, bass, and minnies," he said with a chuckle, "those are about the only things'll stay around these islands."

Each summer more than a quarter of a million people visit South Bass, the best known of Lake Erie's islands. Like Middle Bass, Kelleys, and North Bass Islands, South Bass is inhabited year round. These are all public islands, and during the summer months hourly ferryboats carry 300 people a day to their crowded isolation.

There are seven smaller islands as well. Ballast, Rattlesnake, and Sugar are given over to private seasonal residences. Gibraltar is owned by Ohio State University. Green, Starve, and Mouse are uninhabited.

All 11 islands seem to cluster around a granite column that rises 352 feet above the village of Put-in-Bay on South Bass Island (pages 90-91). This Doric monolith, erected in 1915, commemorates Commodore Oliver Hazard Perry's victory over a British squadron in these waters in the War of 1812. "We have met the enemy and they are ours: two ships, two brigs, one schooner, and one sloop"—that was the message Perry sent on September 10, 1813.

**Fresh as paint,** a steamboat-Gothic house recalls 19th-century elegance at Put-in-Bay, South Bass (**above**). Daniel K. MacBride (**right**), former commodore of the Inter-Lake Yachting Association, looks back on a lifetime of freshwater sailing.


Today, once the tourists have left, the islands are a quiet slice of Americana surrounded by the noise and industry of mainland Ohio, Michigan, and Ontario (map, facing page). People like Minnow Charlie have called these islands home for more than five generations.

"Used to be lot of fish in this ocean," Charlie said as he pulled up his minnow nets with hands callused by a lifetime of fishing. "I had my own boat then, and we caught 5,100 pounds of whitefish and 6,200 pounds of perch in a good day. Now it's all overfished, and pollution's no help. Today you can hear 'em brag when they catch a ton."

Minnow Charlie added two more minnows to his day's catch, saying, "That makes nine dozen. Now'day, you got to catch 'em when they're out of school—at recess." He winked. "Yup, used to be a lot of fish in this ocean."

As he loaded the nets into his truck and



**Call it Serenity Square.** Tourists from the mainland (the *Ohio* mainland) bask in the bygone glory of Put-in-Bay's clapboard hotel and a circular bar, each more than a century old (**left**). Once the summer haunts of the rich and the rowdy, the Bass Islands (map, **above**) have known Presidents and financiers as well as bootleggers and gamblers. The five-cent slot machine is long gone, but a nickel still buys a lemonade (**below**).

In nearby waters Commodore Oliver Hazard Perry defeated a British squadron during the War of 1812.

rattled off into the dusk, I wondered about all the changes he and the other old islanders must have lived through.

"These islands have seen a lot of history," 87-year-old Lena Market told me. We sat on the porch of her family home on South Bass in the late afternoon of a September day. She sipped some of the island's sweet red wine as she rocked in a white wicker chair and remembered her youth.

"During the summer I would take care of

children over there at the Victory," she said, pointing a hundred yards away to the wooded acreage that had once been the grounds of the 825-room Hotel Victory.

"The Victory was a beautiful place, with ballrooms, gardens, and trolley cars that ran the two miles to the village. But the hotel was always in financial trouble."

As I watched the sunlight streak across her timeworn face, I tried to imagine the elegance of the huge wooden structure that had taken 350 master craftsmen more than three years to complete in 1892.

"It was August 14, 1919," she said. "I was downtown walking around when I heard someone say the Victory was on fire. I rushed the two miles for home. When I got here, my father said if I wanted to save anything in my room, I had better get into our house right away. Sparks and debris were falling all around us, and my father thought our house was a goner. But we were lucky.

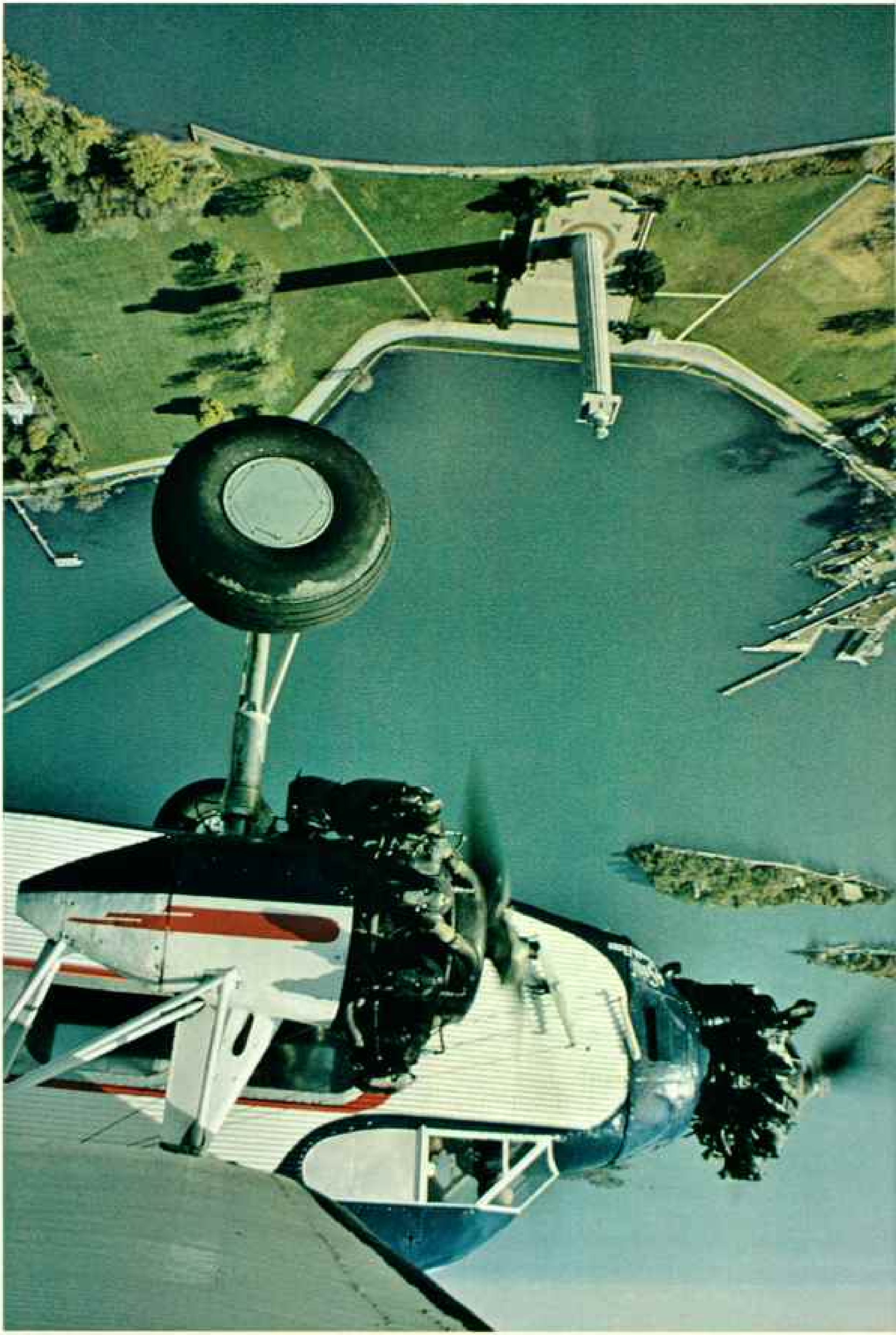
"The Victory burned all night and there was nothing anyone could do. It was just like losing a good friend. We all cried. That was about the end of the islands as a fancy place for the rich folks."

### Even the Tin Goose Has Bad Luck

A series of disasters followed the burning of the hotel. Prohibition almost destroyed the wine industry. The turn-of-the-century resorts fell into decay. The sturgeon and sauger were fished out. And the lake began to choke on the mainland's waste.

As if all that were not enough, an event as traumatic to islanders as the burning of the Victory occurred last year when the Tin Goose fell out of the sky. This flying red-white-and-blue antique, the Island Airlines' Ford Tri-Motor known as the Tin Goose, was an important contact with the mainland once the lake froze over. Since 1935, when it first came to the islands, the Goose had

**Rare old bird,** the Tin Goose of Island Airlines roars over Perry's Victory and International Peace Memorial on South Bass. The venerable Ford Tri-Motor served islanders as school bus, taxi, ambulance, and moving van from 1935 until it crashed last year. Now undergoing repairs, the aircraft may return to the skies this fall.



"They come for my minnies," says Charles Mahler (**above**), known as "Minnow Charlie" to the schools of sport fishermen who buy the bait he nets. At Put-in-Bay a bather drapes herself with algae (**facing page**), an unwanted harvest fertilized by runoff from mainland farms, homes, and industries. Still, Lake Erie leads the Great Lakes in producing food fish. The crew of the *Sonny S.* sorts perch and drum (**below**).

carried everything from schoolchildren to sightseers and carousel ponies.

When the Goose crashed on South Bass Island on July 1, 1977, seriously injuring pilot Dave Martin, islanders feared they would never see its like again. The Goose was the best machine for its job. Its short-takeoff-and-landing capabilities, oversize balloon tires, and tail-dragging landing gear made it perfect for island-hopping on unimproved strips with heavy payloads.

Dave Haberman, president of Island Airlines, refuses to let his relic be killed. "If this were an ordinary airplane, I'd have written it off as a total loss," he said. "But this is one of the last Ford Tri-Motors flying—it is history. It must be rebuilt."

With the help of a "Save the Goose" fund, the old bird was sent to the shop. If Mr. Haberman's predictions are realized, it should be flying again soon, with now recovered pilot Martin back at the controls.

### Catawba Wine—Island Treasure

Just a few months before the crash, I had ridden the Goose over Victorian homes surrounded by the vineyards of this freshwater archipelago. I found the vineyards even more impressive from the ground.

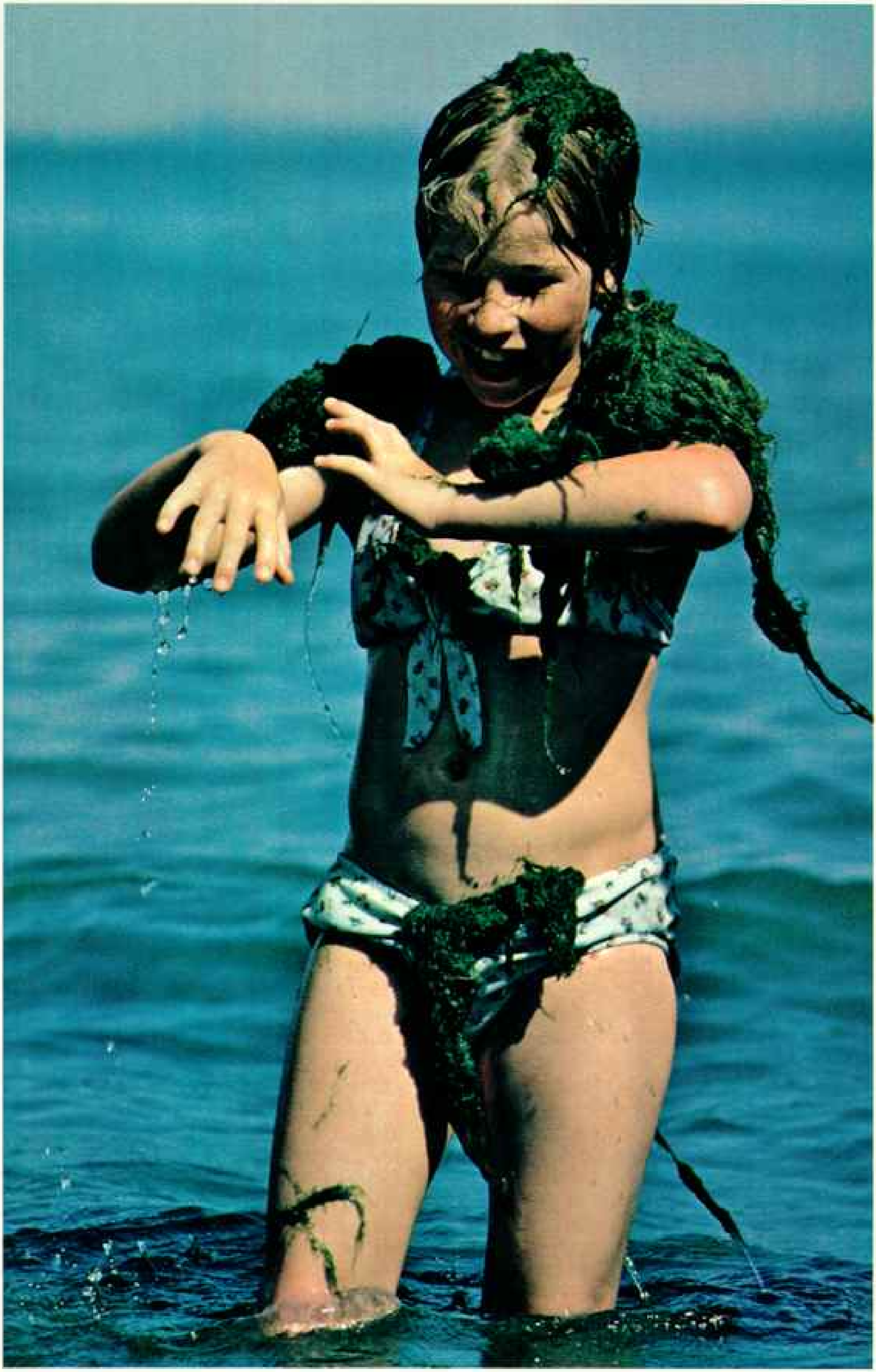
The morning light enhanced the vivid autumn hues of trees bordering the grapes as I hurried down a row of plump Catawbas to catch up with Louis Heineman.

"Try this," he said, holding out a cluster of grapes. I tasted a burst of sweetness followed by the tart rush of pulp.

Louis, a middle-aged man with a fatherly smile, is the owner of Heineman Vineyards on South Bass. He is also cellar master, chief field hand, salesman, and janitor.

Like the fishermen, South Bass winemakers have seen bigger harvests. By 1880 more than 600 of the island's 1,300 acres were planted in grapes and served 12 wineries and five brandy distilleries. These family operations flourished until Prohibition and the Depression. The largest winery, the Put-in-Bay Wine Company, produced more than 150,000 gallons a year, compared with Heineman's current annual production of less than 30,000 gallons.

"When I was a kid, everyone picked grapes in the fall," Louis told me. "I worked for Tom Duff after school for 20 cents an



**Esprit de *crops*** beaming from their faces, the entire population of North Bass stands before a field of Catawba grapes grown for wine and champagne (**right**). Vineyards cover more than half the island.

Friends gather at the home of Louis and Barbara Heineman (**below**, near the TV) for Ohio-lottery results and to catch up on the latest Put-in-Bay news. For Mary McCann (**left**), happiness is a pair of pet rabbits and her schoolmates, whom she knows as well as some city kids know their brothers and sisters.

hour and was glad to get it. Now the Duff vineyards and ours are the only ones still in production on this island. Meier's has a big operation, of course, on North Bass."

North Bass is a 700-acre company island half a mile south of the Canadian border. The home of Meier's Wine Cellars, Isle of St. George Vineyards, it has about 35 residents, 400 acres of grapes, and two mechanical grape pickers.

"These are the largest continuous Catawba vineyards in the world," said Dale Burris, as he scanned the endless rows of vines, "and we are always trying to improve them. This year we've put in a European type of grape—a vinifera. The island will produce an outstanding harvest of Riesling grapes because the climate is the same as in the Rhine Valley, where the best Rieslings are grown. We have the same cold winters and cool summer nights."

As twilight replaced the last wisps of warm sunlight, I watched the towering mechanical grape pickers straddle rows of grapes and shake the fruit from the vines.

"It used to take a lot of hand labor," said Burris, "but now we can ship 60 tons of grapes a day to our mainland winery."

Radically different is the tiny winery of the islands' most revered wine maker, Leslie Bretz of Middle Bass. At 84, Leslie, a small man with white hair, moved purposefully about the old wooden pressing barn, checking gauges, hoses, and pumps. He oversees

each step of his 10,000-gallon-a-year production, and islanders talk with deep respect about his wines and champagne.

### Comeback for Lake Erie Waters?

As the islands still nourish the vine, the lake water provides fish for a hardy few.

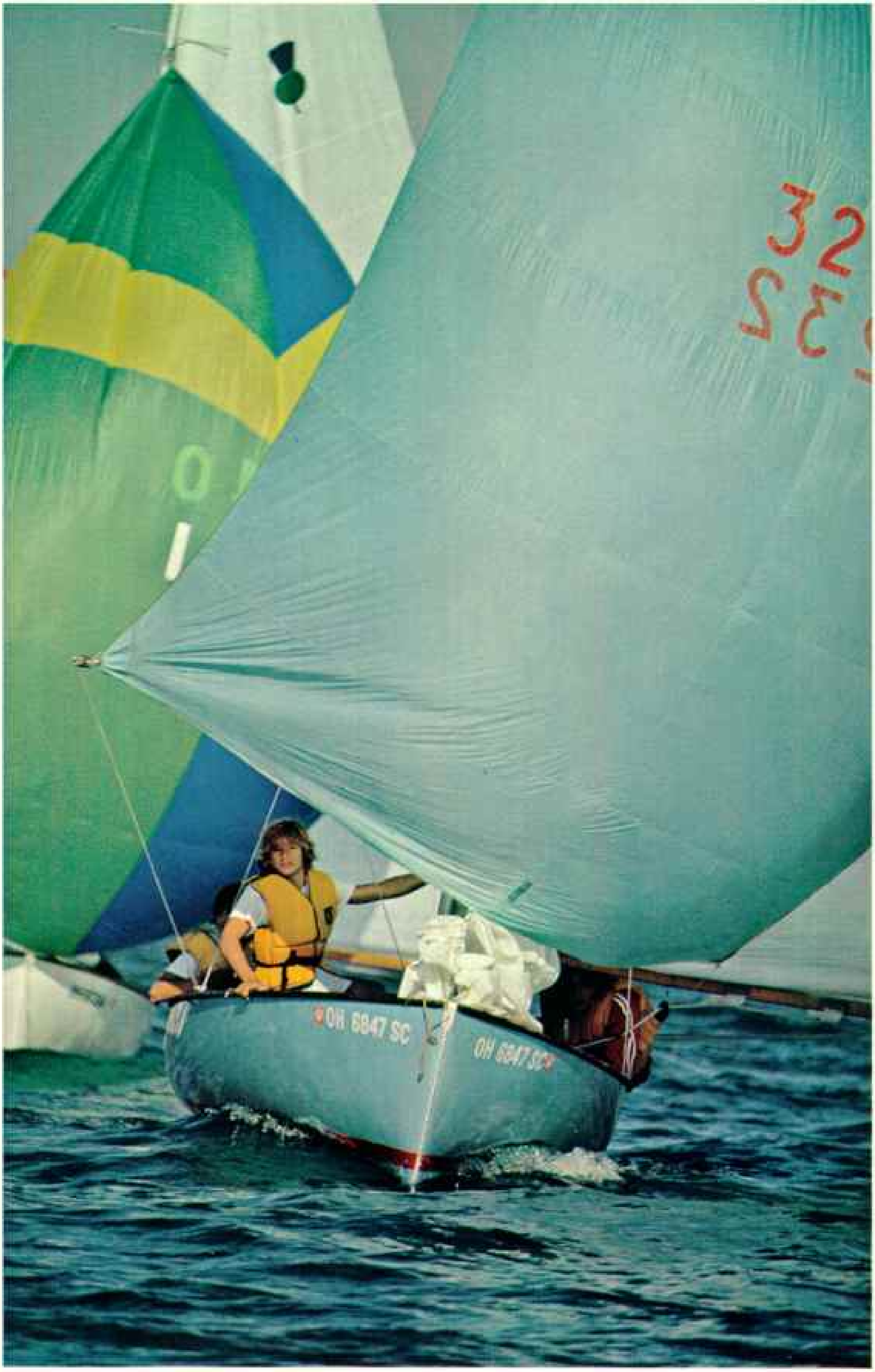
"When my father was young, there were 300 commercial fishing boats and three fish buyers working out of these islands," said fisherman Sonny Schneider, a man with a weathered face and friendly smile. "Now, this is it. Mine is the last commercial fishing boat that calls the islands her home port."

Sonny actually works out of Vermilion Harbor on the mainland; waters around the islands themselves lie within vital breeding grounds that the Ohio government has closed to commercial gill netting.

It was a blustery morning in November as Sonny's boat headed for the open lake. We were hitting ten-foot swells, and I struggled to keep my balance on the slippery deck while the five crew members prepared to haul in the first string of nets.

"Yesterday we pulled over a ton of perch in this weather," Sonny said, as he watched the first of his near-empty nets emerge. "I guess you can't win every day. Anyway, commercial fishing is getting better, and I think the water is getting cleaner."

Lake Erie was once the world's largest producer of freshwater fish, but pollution and overfishing *(Continued on page 99)*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**On a beachhead** near Put-in-Bay, the assault wave of tourists begins to stir to a sunrise reveille (**above**) on Memorial Day. Reinforcements will soon arrive on this first big weekend of the summer season, swelling South Bass's population from 350 to several thousand.

Some folks cruise over from the mainland and just drop anchor. Gail Jellison (**right**) ferries guests to a raft party; her parents have spent weekends aboard their yacht in Put-in-Bay for nearly thirty years.

Running with the wind (**left**), Thistle-class sailboats sprint for the finish line during Junior Race Week, an event for younger sailors that precedes the Inter-Lake Regatta, one of the premier races in U. S. yachting. As many as 500 boats compete, from as near as Sandusky and as far as Argentina.

**Nearly pancake flat,** the Bass Islands received their name from the smallmouth bass that spawn along their shores. Perry's monument (**above**) rises over Put-in-Bay on South Bass. Middle Bass and North Bass, the other major islands, lie toward the horizon. The tower marks the harbor where Perry hoisted sail to confront the British on September 10, 1813. His flagship dead in the water from enemy fire, the determined commodore transferred to another and won the day.

On friendlier missions, ferries churn between island and mainland (**below**).

have led to its decline. In the past few years fishing has improved, largely because of the ban on gill netting.

The Franz Theodore Stone Laboratory, an Ohio State University research station on Gibraltar Island, is helping to define the lake's illness through pollution monitoring and the collection of ecological data. I joined Dave Gruet and his crew of young scientists aboard the research vessel *Hydra* for the last sampling cruise before winter's ice closed the lake. Through the laboratory, this converted Army lighter was outfitted as a research center for CLEAR (Center for Lake Erie Area Research).

As the first water samples were taken, I asked, "Is the lake really dead?"

"No!" Dave replied. "It's *too* alive—but alive with many of the wrong things. Industrial waste, urban sewage, and farmland runoff have added more life nutrients and microorganisms to the lake than it can take.

"In the four years we have taken data, the lake has stabilized; it's holding constant—not making a comeback. People don't realize that this small fragile lake still produces more fish for the nation's food basket than all the rest of the Great Lakes combined. It must be treated with great care."*

### Islanders Relish Winter's Isolation

Winter comes hard to the Lake Erie islands. The sky turns a depressing gray, and bitter-cold winds whip across ice that stretches from the Canadian shore.

Snow blew in swirls from the corniced roofs as I walked the empty streets of downtown Put-in-Bay. The shops that had been crowded with summer people were closed. Winter is a quiet time. Lifelong friendships, family life, community spirit come to the fore, displacing the noisy, fevered activities of a summer resort.

Swinging across the ice between Middle

*See "The Great Lakes: Is It Too Late?" by Gordon Young, NATIONAL GEOGRAPHIC, August 1973.

**Whiskers of ice** on a rocky outcrop mean old man winter is returning to South Bass (**facing page**). In January, when lake ice thickens to around two feet, island entrepreneurs stake out their canvas-covered fishing shanties (**top**).

Just sittin' and hopin' and warmed by a wood stove, John Kachinski dangles two lines baited with minnows (**above**). He and his brother caught dozens of perch and a couple of walleyes—just fifty miles from their Cleveland home and away from it all.

Bass and Rattlesnake Islands were the headlights of two ice cars nearing a cluster of ice-fishing shanties. I grabbed a ride with state park ranger Art Boyles, and we headed for the west shore of South Bass Island so I could try my luck at ice fishing.

"We take the doors off these junkers and turn them into ice cars," he said as we slid across the frozen lake in his convertible. "If you go through the ice, you have to get out fast. Doors just get in your way."

Ice fishing and the promise of a basketful of perch and walleye bring hardy mainland sport fishermen for brief visits. They provide winter income for the local ice-fishing guides, who maintain nomadic villages of canvas-covered huts on wood skids.

Inside a shanty a small coal stove kept me warm while I waited for an elusive perch or two to find my double hook. The nibbles came quickly, but my score was zero, though all around me people were bragging of a baker's dozen in their morning catch.

### Another Summer, Another Winter

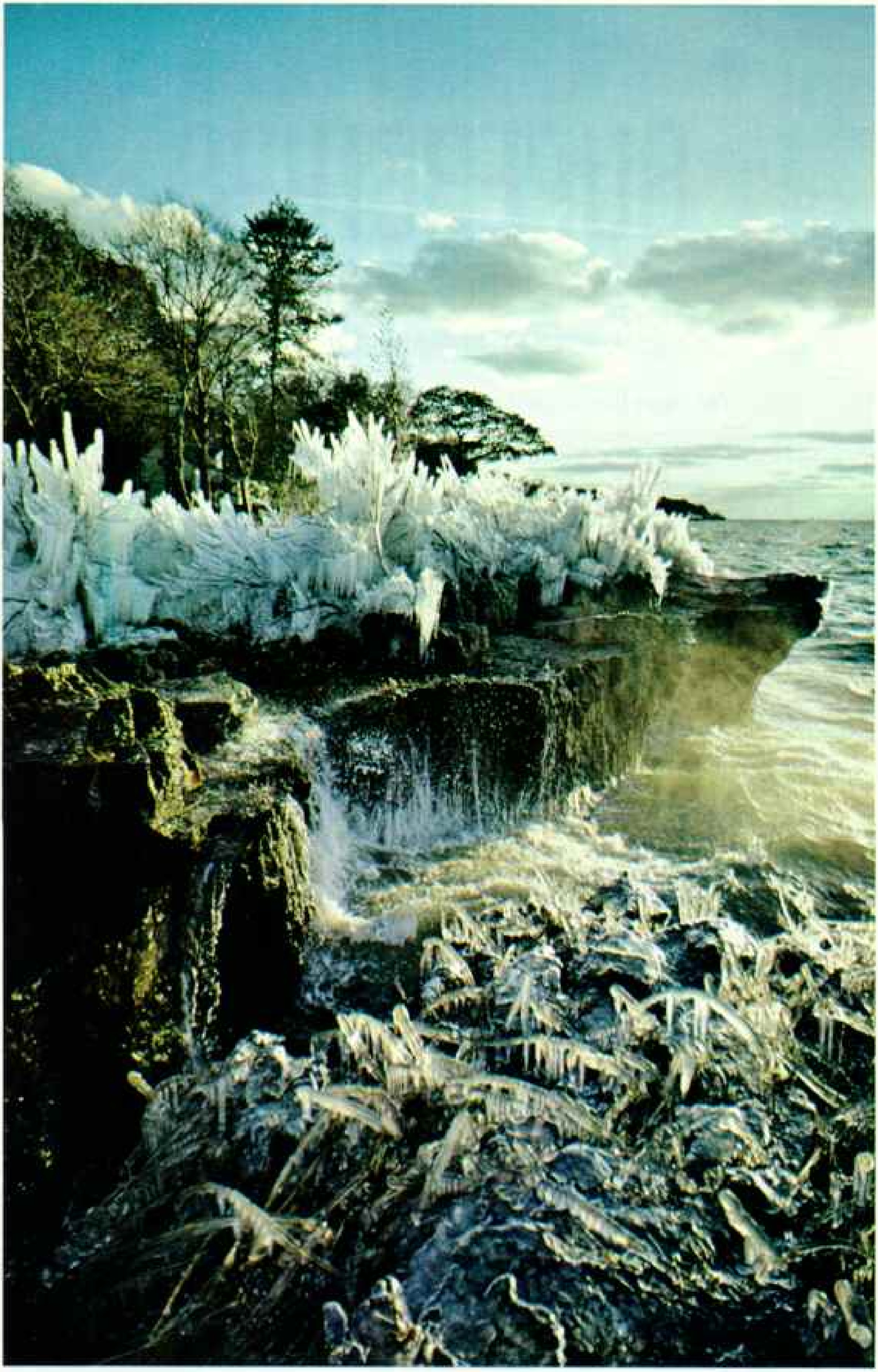
A week later I drove again to the west shore to watch the ice-fishing shanties being pulled off the ice. The thunderous booming of ice breaking up in the channel signaled winter's approaching end.

Carefully I walked out on the honeycombed surface of the lake. Curt Massie and Hank Polcyn, both in their 20's, were stringing a train of shanties to their ice car. Where just days before I had ridden in safety, sea gulls were landing in open cracks.

"Spring's almost here," yelled Hank as I slipped along the ice. "Next thing you know, tourists will be all over the place again."

I helped him hook the last of their 17 shanties to the car, then rode back with them toward solid ground, as the surface creaked and groaned beneath us.

I thought, yes, winter is ending; summer is only 90 days away. The real personality of these water-bound communities would again be eclipsed by summer revelers. But fall would quickly follow, and the old blue pickup truck with fishing nets flapping would rattle down to the docks. There, for anyone within earshot, Minnow Charlie would declare that only islanders, bass, and minnies stay around these Lake Erie islands all year long. □



## Giants That Move the World's Oil

# SUPERSHIPS

By NOEL GROVE

SENIOR EDITORIAL STAFF

Photographs by MARTIN ROGERS

*The bigger they come, the hotter the debates they fuel. Huge tankers such as the*

THE LANTERNS OF Malaysian sampans winked around us like fireflies. Capt. Antonio Cacciuttolo stared at them from the night-blackened bridge of the *Afran Zodiac* and muttered, "Fishermen . . . they are supposed to stay out of the shipping lanes."

He wheeled and strode to the radar platform, where small craft flecked the screen in a green swarm. At the center of the screen was the *Zodiac*, an oil tanker as wide as a football field and nearly three fields long, moving through the swarm like a Goliath among gnats. The lanky captain wheeled again and entered the chart room to check our current position—a matter of even greater concern.

An imminent collision with an errant sampan cannot be avoided by a vessel that requires more than a mile to stop, even at our half speed of eight knots. But we were entering the Strait of Malacca, where the broad and deep thoroughfares of the sea narrow to a shallow alley between Sumatra and the Malay Peninsula, a passage where navigational errors of ships are engraved on a granite seafloor.

The *Zodiac*, chartered by Gulf Oil, rode



FRANK MULLER-MAY, STERN

**Islands under power,** today's supertankers require pilots whose seafaring savvy is matched by their technological know-how. Shepherding a 1,040-by-164-foot colossus, the captain of the *Afran Zodiac*, en route to Korea with Kuwaiti crude oil, takes a bearing by squinting through an azimuth circle (**left**). The wake of the 121,000-ton *ARCO Fairbanks* (**right**) points back to tricky Valdez Narrows as the tanker makes a test run over the route where Alaska-pipeline oil is now shipped.

the waves like an iceberg. Sixty-eight feet of her ponderous belly hung beneath the surface, loaded with 70 million gallons of Kuwaiti crude—enough to produce a tank of gasoline for every car in Chicago.

In the two weeks since photographer Martin Rogers and I had boarded the ship in the Persian Gulf, I had witnessed the skillful seamanship of the 38-year-old boyish-faced captain. And yet, this night I could feel the quiet, professional concern as he drifted back to the wheelhouse to gaze out at the winking lantern lights.

"The sampans," I asked, reluctant to intrude upon his concentration, "aren't there patrol boats to keep them away?"

"Yes, but . . . ," I sensed the shrug of acceptance beside me in the dark, "there are so many, and the fishing is good here."

Economic need. It explained the presence of both supership and sampan in an area where the margins of safety had grown thin. Just as the fishermen hungered for a good catch, the world hungers for petroleum. Gargantuan oil tankers have become the mobile pipelines that carry it from the oil-rich Middle East to the oil-hungry industrialized nations.

The mind gropes for superlatives, for comparisons to describe these superships. The largest of them, upended, would stand higher than the Empire State Building. The paint alone on the huge *Globtik Tokyo* weighs 400 tons. For volume, imagine two floating Houston Astrodomes joined together. In the evening, as the tropical sun sank into the sea, I often used the deck of the *Afran Zodiac* as a jogging track. Once around the ship: nearly half a mile.

Tankermen rank vessel size not by length or weight of the ship or by its displacement but by deadweight tons, the total weight of cargo, stores, and fuel that the ships carry. The T-2 tankers of the 1940's were ships of 16,000 deadweight tons (dwt); *Afran Zodiac's* 16 cargo compartments hold 13 times more than that. Yet there are many modern tankers bigger than the *Zodiac*, whose 228,000 tons rank it as middle-sized among superships.

### Lagging Oil Market Hobbles Fleet

I boarded tankers of many sizes in a ship-hopping, ocean-hopping exploration of these seagoing giants. In the worldwide tanker fleet of 4,200 vessels, superships over 200,000 tons number some 700, roughly 17 percent of the total. They move more than half the oil around the world.

Both at sea and ashore I talked with officers and crewmen, owners, fleet managers, and designers. I saw their pride as they talked of the huge vessels, the largest moving objects ever built by man. But I heard tales of concern as well. Roughly a fifth of the superships now sit idle, and the rest operate at reduced speed, as a result of a depressed oil market.

I also heard concern from those who fear the environmental consequences of supership accidents. When spilled into the sea, oil can be toxic to marine plants and animals. In

a massive spill, such as the wreck of the 229,000-ton *Amoco Cadiz* off the Brittany coast early in 1978, the effects are immediate and devastating. (See pages 124-135.) Scientists disagree on the long-term effects of a large spill. But no one questions whether more will occur. The U. S. now imports nearly half its oil. Western Europe imports 95 percent of its supply, Japan virtually every drop.*

### Super Detour a Boon to Supership

The closing of the Suez Canal in 1967 assured the proliferation of giant tankers. When sunken ships littered the passage after the Arab-Israeli six-day war, westbound tankers from the Persian Gulf had to sail around Africa to reach their markets, a detour of 9,600 miles (map, following pages).

Much as a jumbo-sized soft-drink container may lower the price of a drink by replacing six small bottles, one jumbo ship can haul oil at lower cost than several small ones. Fuel costs do not increase in proportion to the size of the ship. A tanker of 32,000 tons burns nearly 75 tons of fuel a day, while one of half a million tons burns 330 tons. Hauling 15 times more oil, the larger ship uses less than five times the fuel.

Nor do tanker crews increase with size. I sailed on one ship of 75,000 tons that carried a crew of 47. The *Zodiac*, more than three times that tonnage, carried 36.

Lower costs, bigger volume—little wonder that tankers have ballooned beyond the Ancient Mariner's wildest nightmares.

"When people saw what money could be made, some went to oil companies and got commitments to haul oil before they owned a tanker," I was told by Capt. Ralph Maybourn in British Petroleum's 32-story Britannic House in London. "Then they went to a banker and said, 'Look, I've got the business, let's build a ship.' Some of those ships were paid off within a year or so."

In the early stages of growth, they were called "supertankers," but each generation dwarfed the last (pages 113-15). The name has been dropped by tankermen, who now usually refer to vessels between 200,000 and 300,000 tons as Very Large Crude Carriers (VLCC's), and anything over 300,000 as Ultra Large Crude Carriers (ULCC's).

They may be the most international commercial enterprises ever devised. The *Zodiac*, for example, was built in Japan, owned by Americans, registered in Liberia, insured by a British firm, run by an Italian crew, and, when I sailed on her, carried Kuwaiti crude oil to a Korean port.

Few of the large ships, and none of the largest, have been built in the United States. Owners claim that construction costs can be more than halved in highly automated Japanese shipyards.

Economy often dictates the nationality of tanker crews as well, and the registry of the ship itself. By law, American-flag ships

**A tanker's not a town,** but crewmen can go to the movies, take a dip in a pool, or drop by for a checker game aboard the *Bellamya* (**above**), world's largest ship at 541,000 deadweight tons. Crew and officers can bring their wives; one passes time on the bridge (**facing page**) while electronic eyes and ears keep the *Bellamya* and its 50-million-dollar cargo on course.

*See "Oil, the Dwindling Treasure," by the author, NATIONAL GEOGRAPHIC, June 1974.

Pacific Ocean

Some Alaskan crude oil arriving by supertanker at the Panama Canal is transferred to "floating storage" in a 300,000-tonner before passing through in smaller tankers.

Panama Canal locks are 1,000 feet long, 110 feet wide, and 70 feet deep, barring the largest tankers.

The largest oil spill along the U.S. coast occurred December 15, 1976, when the Argo Merchant ran aground off New England and broke into three parts, spilling her entire load of 7.5 million gallons of heavy fuel oil.

UNITED STATES
8

CANADA

Gulf of Mexico

The biggest oil disaster in history happened March 16, 1978, when the 229,000-ton Amoco Cadiz lost her steering and struck rocks near Portsall, France, dumping 69 million gallons. This doubled the 34-million-gallon spill by Torrey Canyon off the coast of Cornwall in 1967.

BERMUDA
3

PANAMA
23

NETHERLANDS ANTILLES
7

Atlantic Ocean

U.K.
81

NORWAY
92

SWEDEN
31

DENMARK
5

FRANCE
43

NETH.
3

EUROPE

W. GERMANY
16

PORTUGAL
1

SPAIN
6

ITALY
21

GREECE
24

ALGERIA
1

LIBYA
1

Suez Canal—limited to loaded ships of no more than 38-foot draft.

IRAQ
2

KUWAIT
7

IRAN
4

SAUDI ARABIA
4

LIBERIA
264

NIGERIA
1

AFRICA

BRAZIL
3

SOUTH AMERICA

Atlantic Ocean

Indian

Dark-tinted countries and the numbers that accompany them indicate where superships of the world are registered. Width of the arrows indicates comparative volumes of oil shipped along the most frequented routes.

MAJOR OIL SPILLS 1967-1978

SUPERTANKER PORTS 200,000 DWT AND OVER

AZIMUTHAL EQUIDISTANT PROJECTION CENTERED ON SAUDI ARABIA

The sister ships Venoil and Venpet collide December 16, 1977, spilling 6.5 million gallons of crude and 819,000 gallons of bunker fuel off the coast of South Africa.

Stranded at the tip of South America August 9, 1974, Shell Oil's Metula dumped 15.5 million gallons of crude into the Strait of Magellan.

ANTARCTICA

must carry American crews, whose wages reflect their country's standard of living. An Italian captain may earn $20,000 a year, an American captain, $60,000.

"The average cost of an American crew is about $1.8 million a year," a fleet manager for a major oil company told me. "An Italian crew might cost about $800,000, and we have Filipino crews at about $400,000."

The repeated involvement of Liberian-registered ships in tanker accidents has raised public concern about the so-called "flags of convenience."

"By sheer numbers of ships registered, it is logical that many accidents involve Liberian tankers," explained Arthur McKenzie, who operates a tanker-casualty data service in New York City. "A quarter of the world's tankers and a third of the tonnage are Liberian-registered. But in percentage of accidents by fleet size, they are only slightly above the American and lower than the British. Furthermore, their percentage rate is improving.

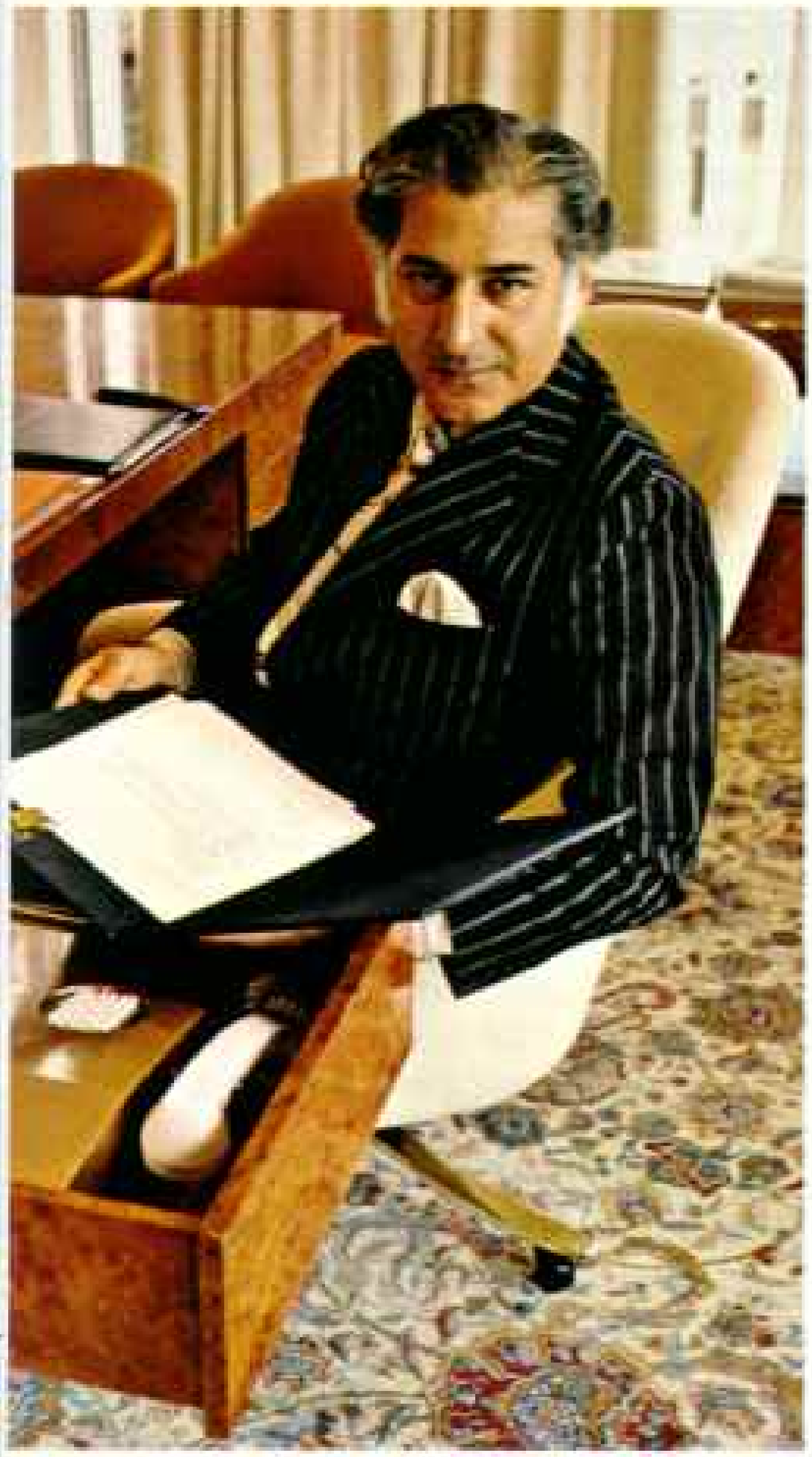
"It's true that many substandard ships are drawn to Liberian registry," he added. "But so are some of the best. The reasons are crew flexibility and no income tax, not easier ship inspection, as many people think."

### Tanker Crews See Mostly Sea

Boredom and loneliness, the by-products of confinement, are the enemies of crews on big tankers. Turnaround time at the end of a voyage lasts long enough for oil to be pumped in or out of the vessel, but rarely long enough for anyone to go ashore. The oil transfer may take place at a "sea island" of metal framework miles from land. Limited to deep water by their extreme draft—as much as 94 feet—the big tankers wander a seemingly shoreless ocean, floating habitats creating their own drinking water in 40-ton-a-day desalinators, processing their own sewage, conditioning interior air to suit changing latitudes, and taking on fresh stores by helicopter or launch.

For sea duty rivaling in length that of the old whalers, supership sailors need not endure cramped quarters and salt-pork rations. Single- or double-occupant cabins are customary. Swimming pools on afterdecks have become the rule.

Dinner one *(Continued on page 117)*



**Floating lodes of black gold** made super fortunes for transportation tycoons such as Ravi Tikkoo (**above**). The India-born shipping magnate is taking his biggest step yet: building the first nuclear tankers. Facing tough environmental obstacles and a current worldwide surplus of tankers, Tikkoo plans three 600,000-ton atomic ships, each costing 325 million dollars. His British firm owns four ships. Two are among the world's largest, including the 476,000-ton *Globtik Tokyo*, unloading into a tank farm at the Kiire, Japan, deepwater port (**right**). Since virtually all U. S. ports are too shallow for superships, loads are pumped into smaller ships in deep water. Environmental concern delayed plans for a U. S. superport in the Gulf of Mexico, now under construction.


GLOBTIK
TANKERS

### *ESSO ATLANTIC, 1977*

*At 509,000 tons the* Esso Atlantic *— together with her sister ship, the* Esso Pacific *— is among the world's five biggest ships. The 1,334-foot Japanese-built* Esso Atlantic *sails mainly from the Persian Gulf to ports in northern Europe and also lighters in the Gulf of Mexico.*

### *MANHATTAN, 1962*

*In her day — through the '60's — the 115,000-ton* Manhattan *was the largest ship under U.S. flag. She pioneered a sea route to Alaska's North Slope through the ice-packed Northwest Passage, but a pipeline across Alaska to Valdez proved more economical.*

### *SUPERSTRUCTURE*

*Like those of most modern tankers, the* Esso Atlantic's *bridge and crew facilities are clustered at the stern, giving pilots a full view of the ship.*

### *POWER PLANT*

*The* Esso Atlantic's *45,000-horsepower steam-turbine power plant looms 16 stories high. The five-blade, 30-foot-diameter propeller gains high efficiency at a relatively slow 80 rpm.*

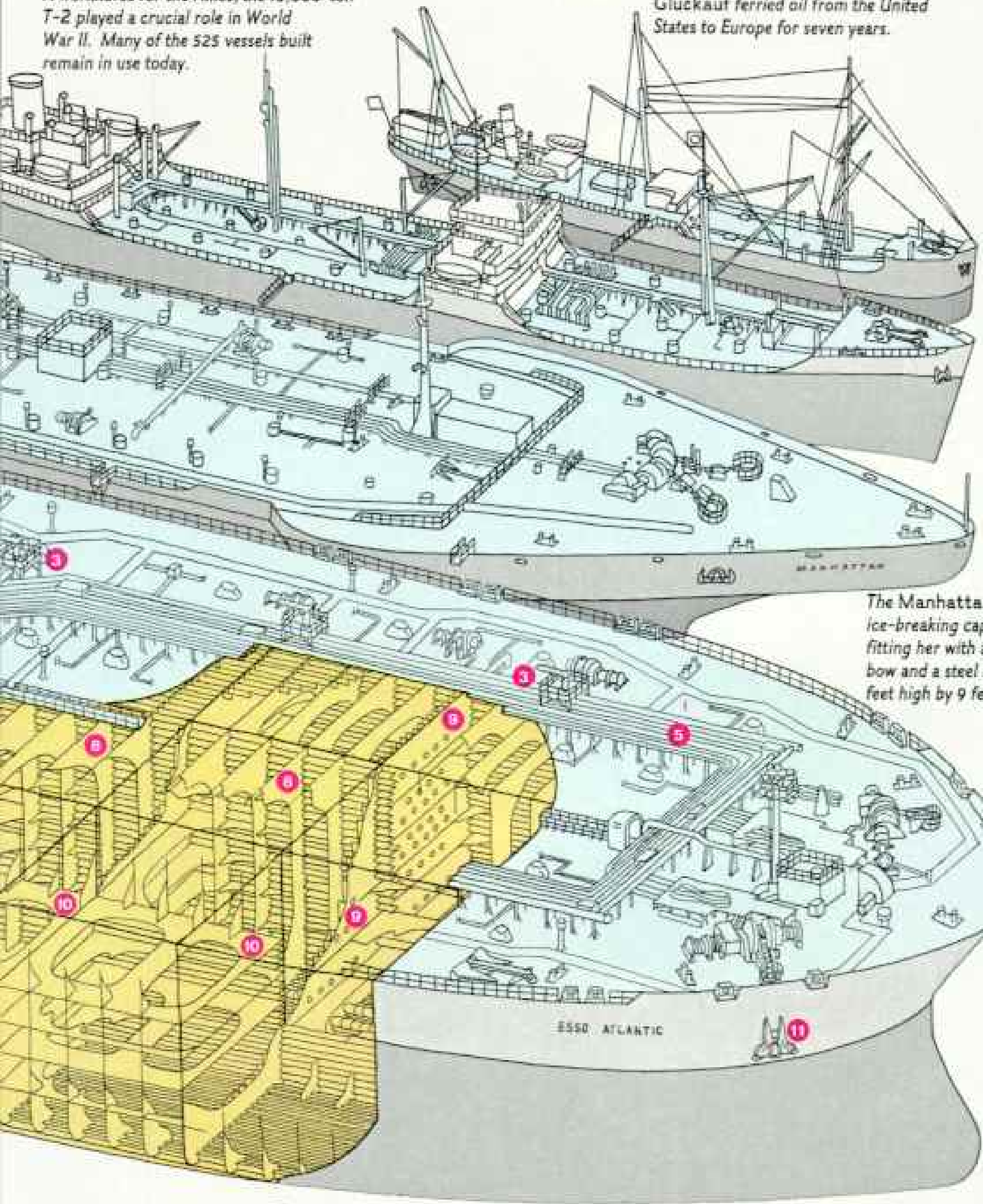
1. BRIDGE
2. LIFEBOAT
3. FIRE-FIGHTING PUMP STATION
4. CARGO PIPELINES
5. MISCELLANEOUS SERVICE PIPELINES
6. CARGO LOADING AND UNLOADING VALVES
7. HELICOPTER LANDING PAD
8. VERTICAL FRAMING
9. INNER BULKHEAD
10. HORIZONTAL FRAMING
11. ANCHOR
12. RUDDER
13. PROPELLER
14. ESCAPE LADDER
15. BOILER EXHAUST
16. MAIN BOILERS
17. ENGINE CONTROL ROOM
18. PROPULSION SHAFT
19. MAIN REDUCTION GEAR
20. LOW-PRESSURE TURBINE
21. HIGH-PRESSURE TURBINE
22. CONDENSER
23. AUXILIARY CONDENSER
24. CARGO PUMPS

### T-2, 1945

*A workhorse for the Allies, the 16,000-ton T-2 played a crucial role in World War II. Many of the 525 vessels built remain in use today.*

### GLUCKAUF, 1886

*First prototype tanker, the 3,000-ton Gluckauf ferried oil from the United States to Europe for seven years.*




*The Manhattan was given ice-breaking capability by fitting her with a 5,000-ton bow and a steel belt 32 feet high by 9 feet wide.*

*The cargo space of the Esso Atlantic holds more than 17,000 times as much as this 9,000-gallon fuel truck.*

# EVOLUTION OF A GIANT

PAINTING BY JAY H. MAISEL
RESEARCH BY GUNARS J. KUTINS
NATIONAL GEOGRAPHIC ART DIVISION

(Continued from page 109) typical evening on the *Zodiac* included pasta, asparagus soup, an entrée of beef *alla pizzaiola*, dessert of several excellent cheeses and fresh fruit. Beer if desired, coffee after. Martin Rogers and I sent our compliments to the chef one evening for his rich cream puffs. He emerged from the galley, round face crinkled in a huge smile: "*Grazie tanto, signori!*" More cream puffs followed. My daily jogs around the deck became imperative.

The comforts do not totally make up for the confinement. An Italian captain who had been at sea almost continuously for 11 months told me, "Nobody likes the big ships. Nobody but the owners."

On the bridge of the *Zodiac* one day an officer stared pensively over the long, wide deck, and said, "Did you ever drive a small, fast car, and feel you were a part of it? That's why I prefer a tanker of 50,000 tons."

The big tankers certainly need more room to maneuver. To make up for the ungainliness, they rely on sophisticated navigation, docking, and collision-avoidance systems. The last indicates speed and direction of moving obstacles and sounds an alarm whenever it computes a collision course.

The *Zodiac* chart room includes Loran C, Decca, and Omega navigational aids, which receive radio waves from transmitting stations scattered around the world to determine the ship's position. Officers also check the accuracy of modern technology by shooting the stars with an instrument predating Lord Nelson—the sextant.

### Oil and Water Shouldn't Mix

I was on the starboard bridgewing when I first saw a slick of phlegmy, caramel-colored oil, a couple of ship lengths wide, floating on the gray-blue sea.

"That is nothing," said Captain Cacciutolo, after the *Zodiac* had cut through the patch. "It is tan, which means it has been mixed with water. Real oil pollution is black; I have sailed through it for miles."

The tan color suggested that a ship had washed its cargo tanks with seawater and disgorged the results. Sludge clinging inside a tank must be cleaned out after unloading, with a high-pressure stream of liquid. Today responsible tankers pump the washings to a slop tank, and allow oil and water to separate before pumping out the water. A more recent technique called crude-oil washing uses oil sprayed at high pressure to clean the emptied tanks. New ships will have segregated oil and ballast tanks. Nevertheless, tank washing with water still contributes at least a sixth of the six million tons of all the oil that pollutes the oceans annually.

### Proposed Port Harbors Controversy

At Singapore the *Zodiac* coasted for a few minutes while a launch nudged against her to take us off. Our trip would have been longer aboard a bigger ship; tankers near half a million tons must bypass the Strait of Malacca and circumnavigate most of Indonesia to reach Japan.

That trip could be shortened if a proposed supertanker port and refinery center were built in the Palau Islands, a remote sprinkling of coral reefs and volcanic and limestone hills east of Mindanao. (See "Dazzling Corals of Palau," beginning on page 136.)

A battleground between Japanese and American troops in World War II, Palau has become the scene of an environmental confrontation. The reefs are a marine biologist's paradise, teeming with life that could be decimated by pollution, says Robert Owen, environmental officer in the United Nations Trust Territory. But the deep bays with sheer underwater cliffs invite the world's biggest tankers, whose great drafts leave them with few harbors to call home.

Except for a new facility in Alaska, no ports of the world's largest consumer of energy, the United States, can accommodate the big vessels.

More than half the oil imported by the U. S. comes from the Middle East and Africa, across distances that make superships economically attractive.

**Deep in the belly of a giant,** Lilliputian workers assemble a 3.8-million-gallon cargo tank in the *Esso Pacific* during construction in Japan last year. A welder crouches on one of the steel frames that encircle the tank to give strength and stability. The 515,000-cubic-foot cargo hold is among the vessel's 36 of varying sizes.

To enter port, however, a VLCC of 250,000 tons requires a safe-water depth of about 75 feet, and some ULCC's require more than 100 feet. No East or Gulf Coast port offers more than 45 feet, and West Coast ports offer little more. Superships park 50 miles or more from land to be unloaded, or lightered, by smaller tankers.

At a refinery on the Mississippi near New Orleans I boarded the *Sepia*, a tanker of some 69,000 tons, bound for a rendezvous with a ULCC in the Gulf of Mexico. "When she was built in 1961, the *Sepia* was among the biggest tankers in the world," said marine superintendent Philippe Hubert.

After an eleven-hour trip down the river channel and four more hours on the open sea, she nestled up to the 310,000-ton *Limopsis* like a hopeful nursling. Lashed together, with six-ton rubber balloons between them as fenders, the two ships drifted while crude oil flowed through transfer pipes.

### Government Leery of SPM's

Another answer to shallow-draft harbors is the Single Point Mooring (SPM). SPM's allow deep-draft vessels to hook up to a buoy often 20 to 30 miles offshore and have their cargoes pumped ashore through submerged pipelines. More than 80 SPM ports exist around the world. The first one in U. S. waters is only now under construction off Louisiana, and probably won't unload its first ship until the early 1980's. "The deliberateness with which approval was given reflects national concern for environmental matters," I was told by Kenneth Biglane, chief oil-spill expert for the Environmental Protection Agency. Even after governmental approval, the project stalled when the oil industry objected to antitrust measures that it considered excessive.

This nation's first port for superships now operates at Valdez harbor—a glacier-carved finger extending from Prince William Sound, and end point of the Alaska pipeline.* Entry to the spacious harbor, bordered by mountain peaks that begin at the water's edge, is through a 900-yard-wide bottleneck called the Valdez Narrows. The narrows would hardly seem to justify the name were it not for Middle Rock, a pinnacle that juts out of the channel like an obstacle post on a pinball machine. Add to that

frequent low visibility and winds that can gust to a hundred knots and you have a superport that harbored a controversy long before it received its first big ship, the *ARCO Fairbanks*, in April 1977 (page 105).

"The most catastrophic spill out of the pipeline would be 60,000 barrels," points out Charles A. Champion, Alaska's pipeline coordinator and an advocate of strict safety standards for the harbor. "A 165,000-ton tanker carries about one *million* barrels."

The threat has not been lost on the U. S. Coast Guard. One of the most modern vessel-traffic systems in the world has been set up in the town of Valdez, just across the harbor from the oil-loading berths.

Only one-way traffic is allowed through the bottleneck, explained Coast Guard Lt. Comdr. Ken Thompson. Ships in Prince William Sound must follow traffic lanes, like a divided highway on the sea. In the narrows, high-resolution radar constantly monitors the exact location of each ship.

*See "Alaska's Troubled Colossus," by Bryan Hodgson, NATIONAL GEOGRAPHIC, November 1976.

**One false move** by a navigator at the National Maritime Research Center tanker simulator (**above**) can bring illusory disaster—and a lesson cheaply taught. The Long Island facility uses computer-generated images to simulate real-life situations. Near Grenoble, France, captains maneuver mini-tankers around a training lake (**below**) complete with ports, buoys, and man-made waves.



DAVID DOUBILET

**Murky waters** of economic and environmental uncertainty cloud the future of tankers such as this 226,000-tonner, whose 30-foot propeller dwarfs a frogman on cleaning chores. The resolution of such issues as oil spills, building more pipelines, and tapping alternative energy sources will determine whether these behemoths survive or go the way of the dinosaur.

"But the backbone of the system is communication," said Thompson. "We are in contact with every ship in the sound."

Radar, traffic lanes, perfect communication—none can guarantee an accident-free port. "You could be heading into the narrows and lose your steering mechanism," said Capt. Wayne McKee, with 27 years of seamanship. "But what are you going to do, stop running tankers because of accidents? Hell, no! People have decided that the damages are acceptable."

### Oil Spills: More and Bigger

Acceptability wore thin in 1977 and 1978, dark years in peacetime tankering. "Last year shaped up as one of the worst years on record," said Arthur McKenzie, the tanker-data collector. "Fourteen total losses in the first six months. And the total tonnage of oil lost has been going up every year."

In numbers of wrecks, the safety record of big ships is superior. Of 1,513 tanker accidents from 1973 through 1976, only 77 involved tankers of 200,000 or more tons.

Safety would seem to be on the side of the superships. But disaster rides with their gargantuan cargoes. The *Argo Merchant*, a ship of 28,000 tons, stirred concern when it poured seven and a half million gallons of heavy fuel oil off Nantucket in late 1976. The supership *Cadiz* dumped *69 million gallons* along a rugged coast that is important to France's fishing and tourist industries.

Scientists sponsored by the American Petroleum Institute, an oil-industry group, claim that marine life is only temporarily damaged by a massive spill. Even EPA's Kenneth Biglane said at a 1977 oil-spill conference in New Orleans, "I've never heard of a permanently crippled environment because of an oil spill." The EPA continues research into the matter, he added, because "we do know there are long-term and dangerous effects on the environment."

Scientists at the Woods Hole Oceanographic Institution on Cape Cod felt they were close to an answer after the *Argo Merchant* spill. "In the first days following the grounding of the tanker, we established a series of bottom stations in spots where the spilled oil would be likely to accumulate," said Dr. Howard Sanders, one member of the team. "Two months later we returned to

the area; oil had covered it and we found only a third as many marine animals. Studies by others of the spread of the spill over the Georges Bank indicated severe mortality to fish eggs at the surface of the sea."

When is a supership safe? The tanker industry has spent millions on safety devices for ships turned out in the past few years; a collision-avoidance system alone costs $125,000. Critics say more is needed: twin propellers for greater maneuverability; double hulls to provide an extra shell around the cargo; more crew training and certification. The industry agrees on the last point.

"Human error is responsible for the majority of tanker casualties," said an executive. "Better training and stricter enforcement of regulations, not equipment changes, is the answer to most of our problems."

Still, who can train to control human emotion? Fatigue, boredom, anger—all can affect critical navigation judgments at sea. Tension between captain and chief officer may have contributed to the disastrous 34-million-gallon spillage from the *Torrey Canyon* off Cornwall, England, in 1967.

Simulators, using computer images of busy oil terminals, can prepare supership captains for a variety of emergencies.

At the National Maritime Research Center at Kings Point, New York, skippers can sail in and out of Valdez Narrows in 100-knot winds, or experience steering failure while approaching Middle Rock.

### Mini-Tankers Help Super Captains

About 125 miles from the sea, in the rolling hills near Grenoble, France, captains practice supership maneuvers in small-scale models (page 119). On an eight-acre lake called Port Revel are miniature piers, single-point moorings, and a wave-making machine. Like their huge counterparts, the 20-to-50-foot models are heavily weighted and underpowered. Trainees operate the mini-ships in two-man crews—a captain perched in the little superstructure, murmuring instructions to his colleague who operates the controls from a cockpit.

"This model weighs 18 tons and simulates a ship displacing 286,000 tons," explained one of the French instructors at the school, Philippe Delesalle, when I asked him for a turn at the helm. "The engine develops two-tenths horsepower and time lags are built in, so it reacts exactly like a big ship, only five times faster."

With Captain Delesalle at the controls, I ordered: "Half astern." The model, representing a fully loaded VLCC, backed away from the pier.

Nothing had prepared me for the drama and tension in supership command. Rudder response, I found, was agonizingly slow, and the sideslip on turns reminded me of a car spinning on ice. At last I headed uneasily for a berth.

"You are half a mile from berth and making six knots," warned my engineer. Too fast. I stopped engines, but the ship barely slowed, so I called "half astern." The tiny propeller futilely churned in reverse. "One hundred fifty yards," was the impassive call of my instructor-engineer.

"Full astern!" I said, my voice rising, my hands gripping the sides of the tiny bridge. Too late. My mini-tanker swept onward, and its rubberized prow struck the pier with a meaningful *bonk!* Had I commanded a real tanker, the sound would have been of rending concrete and screaming steel.

"You made the mistake that all new masters on big ships make," said Captain Delesalle. "Too impatient. Remember, speed is your enemy."

### What Happens When the Oil Runs Out?

Patience, these days, is needed by supership owners as well as captains. Demand for oil slackened after the 1973 embargo and quadrupling of oil prices. Roughly a tenth of all the world's tanker tonnage is now idle, lining the fjords of Norway, or sitting at out-of-the-way moorings off Borneo. Many of the ships have never hauled a cargo.

James Lee, president of Gulf Oil, believes the oil market will revive, but slowly. "If you're going to have economic growth in the world, you're going to have demand for oil. But it's going to be well into the 1980's before the available ships are fully used again." Even after that, their future is in doubt.

"When the oil declines by the end of this century, what will the big ships haul?" said Bert Graper of Verolme Shipyards in Rotterdam. Outside his office window a medium-sized hull rose on the ways, but the company's last supership left in late 1976.

**Waves of straining limbs** get the day off to a limber start for Japanese building the *Esso Pacific*. Less flexible is the industry itself. Long construction periods mean a ship

buyer may be stuck with a white elephant if the market wanes before delivery.

"You need long, steady runs to make big ships economical. What besides oil can offer that? Maybe liquid gas," he added. "But how would you unload steel, coal, or food 20 miles from shore?"

"It might be possible to slurry coal and pump it," suggested William O. Gray, senior adviser on tanker affairs for Exxon. "But with the finite supply of oil, it's doubtful a massive tanker-building program will be repeated. And the big ships we have now may be the last we will ever see."

If so, French Marine Shell's *Bellamya* may hold onto its claim as the biggest in the world, at 541,000 tons. Since 1955 the title has been claimed by more than ten vessels. One held the honor for a mere seven days.

When the *Bellamya* is fully loaded her keel hangs 94 feet below the surface of the water, her deck rises 24 feet above. Envision an 11-story building, 206 feet wide and more than a quarter of a mile long, surging through the sea with a cargo worth 50 million dollars.

### Computer Mans Helm of Biggest Ship

Martin Rogers and I boarded *Bellamya* offshore at Anglesey, Wales, where she was lightering off oil on her third stop since leaving Kuwait a month earlier. Now she rode high enough to enter port at Rotterdam. She sailed after midnight on the three-day leg, an island of technology, an oilberg, steady as a rock in the restless North Atlantic.

Radio waves that were bounced from a satellite constantly updated her position. For two days I saw no one touch the wheel. "The ship is steered by autopilot, on a course programmed into it by the officer on watch," explained the chief officer, Philippe de Pastres. "An alarm sounds if there is any deviation from the intended course."

Capt. Arsene Foursin, the dapper master of the *Bellamya*, smiled confidently. "We have the safest ship in the world."

On one side of the bridge a display screen showed a computerized image of the hull, with shaded areas indicating which of the 40 tanks were loaded. "By simulating load distribution on the computer," explained the chief officer, "we can sight dangerous stresses before they occur."

"What would happen if you overloaded the center of the ship?" I asked. He punched

that false information onto the typewriter-like keyboard. Lights blinked, an alarm sounded, and stress lines on the screen flashed through the side of the hull. The chief turned to me with a Gallic shrug. "We just broke in half."

Still in one gigantic piece, we approached the entrance to Rotterdam's Europort, where five tugs churned out to meet us. With two tugs at the stern, two at the bow, and one alongside, they coaxed the *Bellamya* to berth like impatient children.

World's largest port, Europort receives a quarter of the oil used by all western Europe. Tankers and cargo ships—more than 30,000 each year—share the narrow channels. A new traffic-monitoring system will offer a 24-hour video display of the entire port, with computer capability that, it is hoped, will predict possible collisions.

The system, said R. K. Bleekrode, coordinator of the port management project bureau, will protect the big tankers, which constitute 4 percent of the traffic. "The consequences of an accident with one of them would be enormous," he told me in his office overlooking the crowded and almost perennially hazy port.

"We used to live in a time of high risk and low consequences. Now we live in a time of low risk but high consequences."

**Will Sampan's Fortune Mirror Our Own?**

I remembered that night in the Strait of Malacca when the course of the *Afran Zodiac* was lined by the lanterns of sampans. I had peered ahead into the black until I spied a single, feeble light directly in our path.

Leaving the bridge, I walked the deck to the darkness and quiet of the bow. By then the light was quite near and, yes, just slightly to port. We drew even, and I could barely make out a tiny, shadowy figure, and a bamboo cabin aft.

I imagined standing there with him as the great mountain of a ship passed at the edge of his lantern glow until there was seemingly no beginning and no end to it, only the gray wall moving and the hiss of water against the hull. I'm sure the sight filled him with awe, and gratitude that the huge vessel that caused him temporary concern had passed him without lasting harm. We can only hope for the same. □

SUPERSPILL

# Black Day for Brittany

Photographs by
MARTIN ROGERS

Text by NOEL GROVE
SENIOR EDITORIAL STAFF

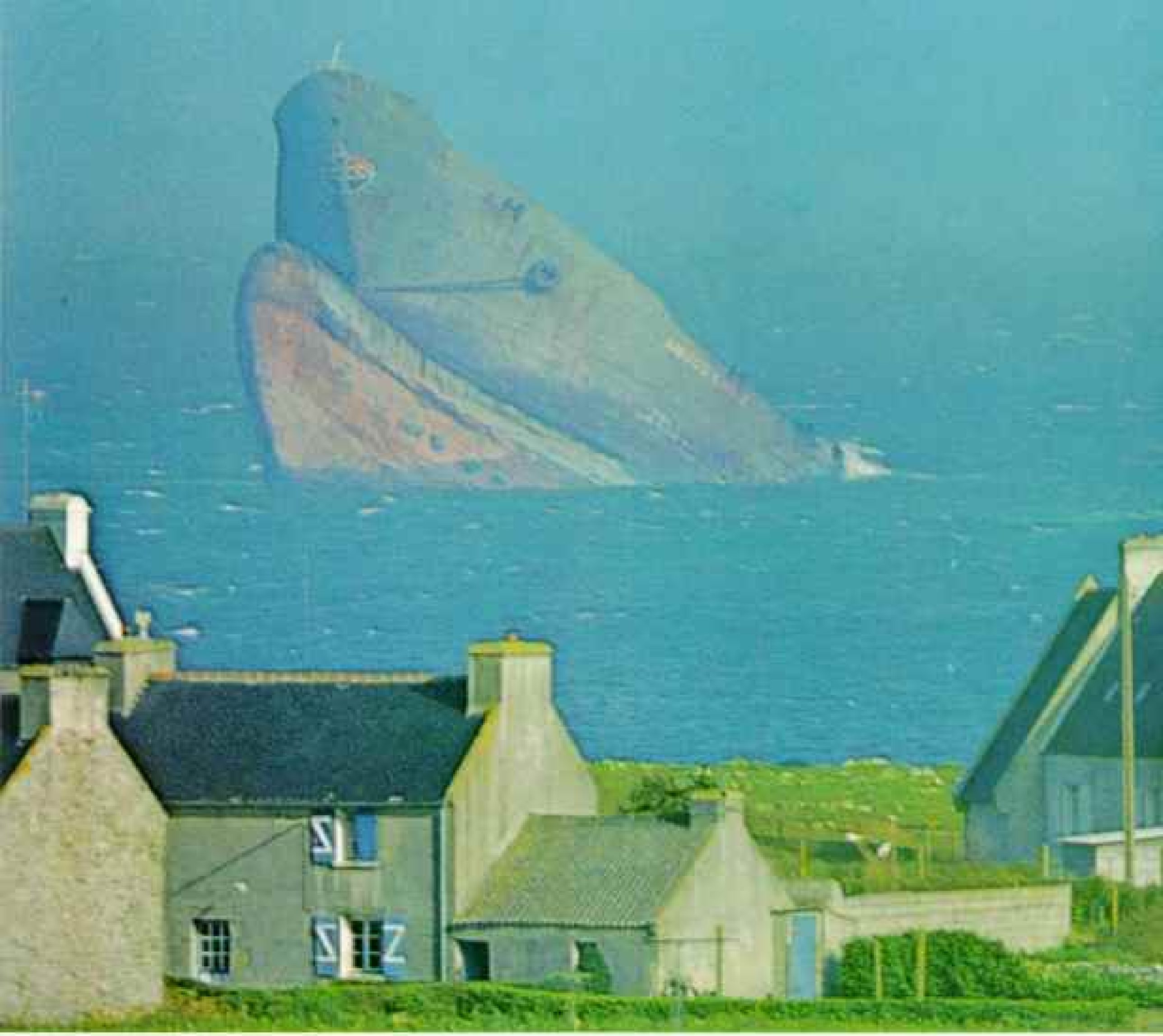
TARRED BEACHES. Chocolate seas. Under smothering muck, waves break near the shore with muted sounds. Fish float belly up, and oiled birds spot the beaches.

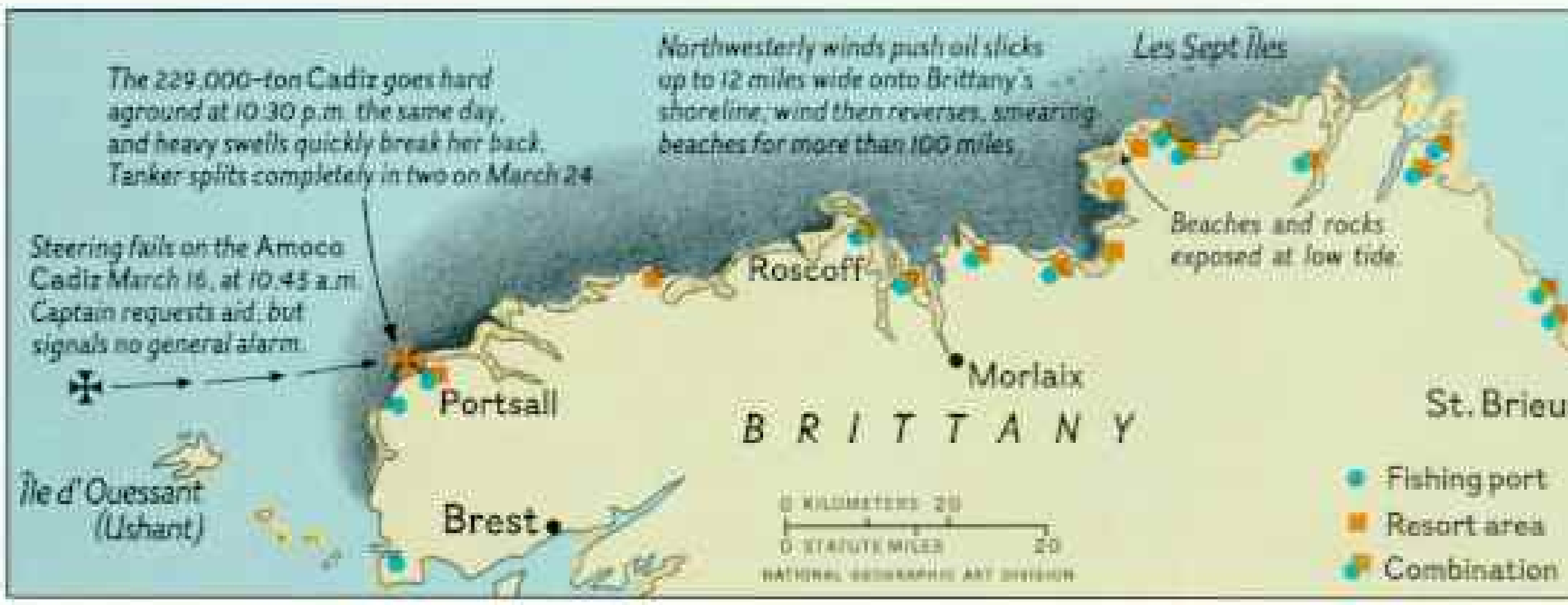
The maritime nightmare feared by tanker friend and foe alike came alive on March 16, 1978, when the *Amoco Cadiz*, 229,000 deadweight tons, lost her steering off the Brittany coast. Twelve hours later, after heavy swells thrice snapped the towing cables from a large tug, the ship drifted onto rocky shoals. Some 69 million gallons of Arabian oil flowed into the sea, more than double the amount spilled in the *Torrey Canyon* disaster 11 years earlier, almost to the day.

Dark tentacles, turning russet in seawater, spread over Brittany shores, triggering a massive man-powered cleanup (**right**). Some biologists predicted that the damaged areas would quickly regenerate. Local residents, their fishing economy stymied, posted hand-painted signs that read, "*La mer est morte*—the sea is dead." The truth may not be known for years.

AS AWESOME IN DEATH AS SHE WAS IN LIFE, the grounded *Cadiz* spews oil from ruptured tanks as waves break over the bridge. The Liberia-registered ship had passed inspection by the American Bureau of Shipping ten months earlier. A British safety inspector described the vessel's last moments: "The stern sat solid, but the bow was twisting and heaving in front of us," said Leslie Maynard, who stayed on

board with Capt. Pasquale Bardari that first night, after the Italian crew had been airlifted to safety. "Then she broke her back, with a screech of metal and a shower of sparks that lasted about ten minutes. As water rose and fell in the stairwell, it created wind currents that blew doors off their hinges and sent wall panels flying around the bridge. Finally, I saw the helicopter coming back to get us."





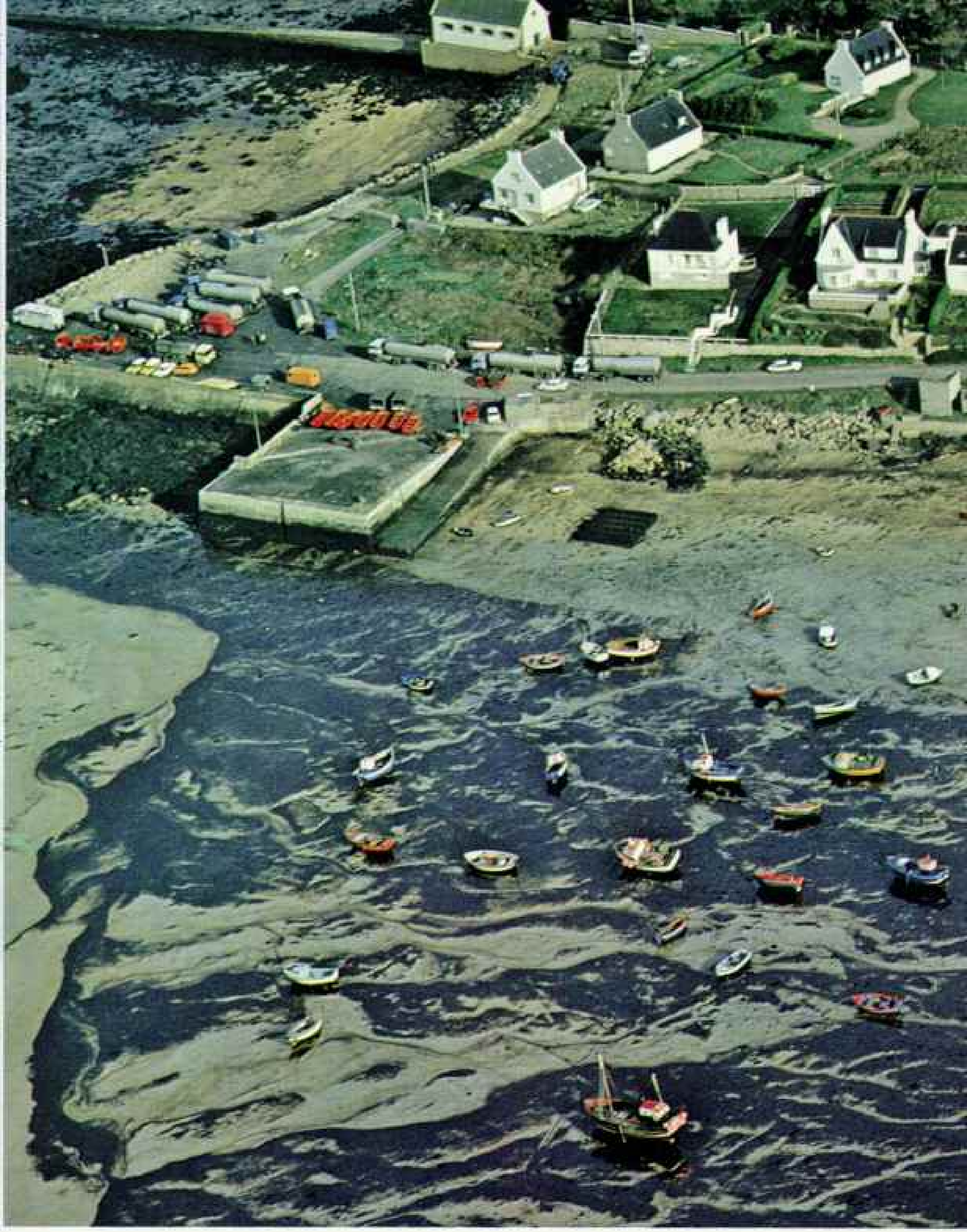

**History's largest oil spill** tainted more than a hundred miles of a coastline known for its vigorous fishing industry and a rustic charm that attracts tourists from all over Europe. Marine life had recently weathered two smaller 1976 spills in the waters of this storm-tossed entrance to the English Channel.

SIPA-PRESS/BLACK STAR

LIKE A HUGE TOWN-EATING SHARK, the bow of the *Cadiz* rears from the sea some two miles off Portsall (**top**), a distance foreshortened by the camera's telephoto lens. A threat more real, gradual leakage from the 13 cargo tanks delayed efforts to clean up the lethal oil. A depth charge dropped from a helicopter explodes near the bow (**above**) in an attempt to empty the compartments quickly.

SIPA-PRESS/BLACK STAR (ABOVE AND RIGHT)

AT THE FRONT LINES of the battle against pollution, soldiers and volunteers string an inflatable boom in shallows to protect the beaches of Roscoff. High wind and waves drove oil past the barrier. Oil coalescing with water forms a "chocolate mousse" that smothers limpets in a toxic sauce (**right**).



EBB TIDE PAINTS A BLACK MOSAIC on the Portsall harbor, where oil-fouled engines have crippled local fishing boats. "It took me seven years to pay for my boat," said fisherman Jean François Moullet. "Now it sits idle." Oil doused some 2,000 acres of oyster beds in the rich Brittany fishing grounds, the source of a third of France's seafood. A multimillion-dollar seaweed-chemical industry was seriously

threatened. Adult finfish were poisoned when the highly toxic crude permeated the water below the surface. On the beaches, cleanup crews armed with shovels, pails, pumps, and farm tractors attacked the awesome mess spilled from a modern ship equipped with the latest electronic gear. "The technology for cleaning up oil lags far behind the technology for carrying it," observed an American oceanographer.

LICKING SEAWARD, tongues of oil stranded by the receding tide creep down the white sands of a Brittany beach. Stung by their fourth oil spill in 11 years, Bretons called for rerouting tankers farther from their coast. Internationally, the accident renewed demands for stricter inspection procedures and navigational regulations.

"Seven to ten years may pass before the shores regain their natural balance," said Dr. Norman Holme, a British marine biologist who has studied effects of the *Torrey Canyon* spill. "Even then, some rare species may be gone," he added. "Seabird populations appear to suffer the most." Thousands of birds died soon after the *Cadiz* spill, although volunteers cleaned and force-fed oiled victims at *hôpitaux des oiseaux*—bird hospitals. "They are not hospitals, they are morgues," said Kenneth Biglane, American oil-spill expert on the scene. A lichen-covered rock serves as a stone bier for a dead cormorant (**right**), part of the price paid for the world's energy appetite. □

SIPA-PRESS/BLACK STAR (ABOVE AND BELOW)

Photographs by
DOUGLAS FAULKNER

Text by THOMAS O'NEILL
NATIONAL GEOGRAPHIC STAFF

# Dazzling Corals of Palau


FLUNG OUT along a 93-mile line in the western Pacific, the Palau Islands have seldom attracted widespread attention. In the past few years, however, like gulls flocking to a fishing boat, an assortment of scientists, skin divers, oil executives, and environmentalists have been showing up at this isolated island chain east of the Philippines. Their common interest: the spectacular coral reefs. Their common question: What effect would a supertanker port have?

To scientists, the reefs of this United Nations Trust Territory present one of the richest marine environments in Oceania. The profusion of animal and plant life rivals that of Australia's Great Barrier Reef.

ELLISELLA, 1 1/4 LIFE-SIZE

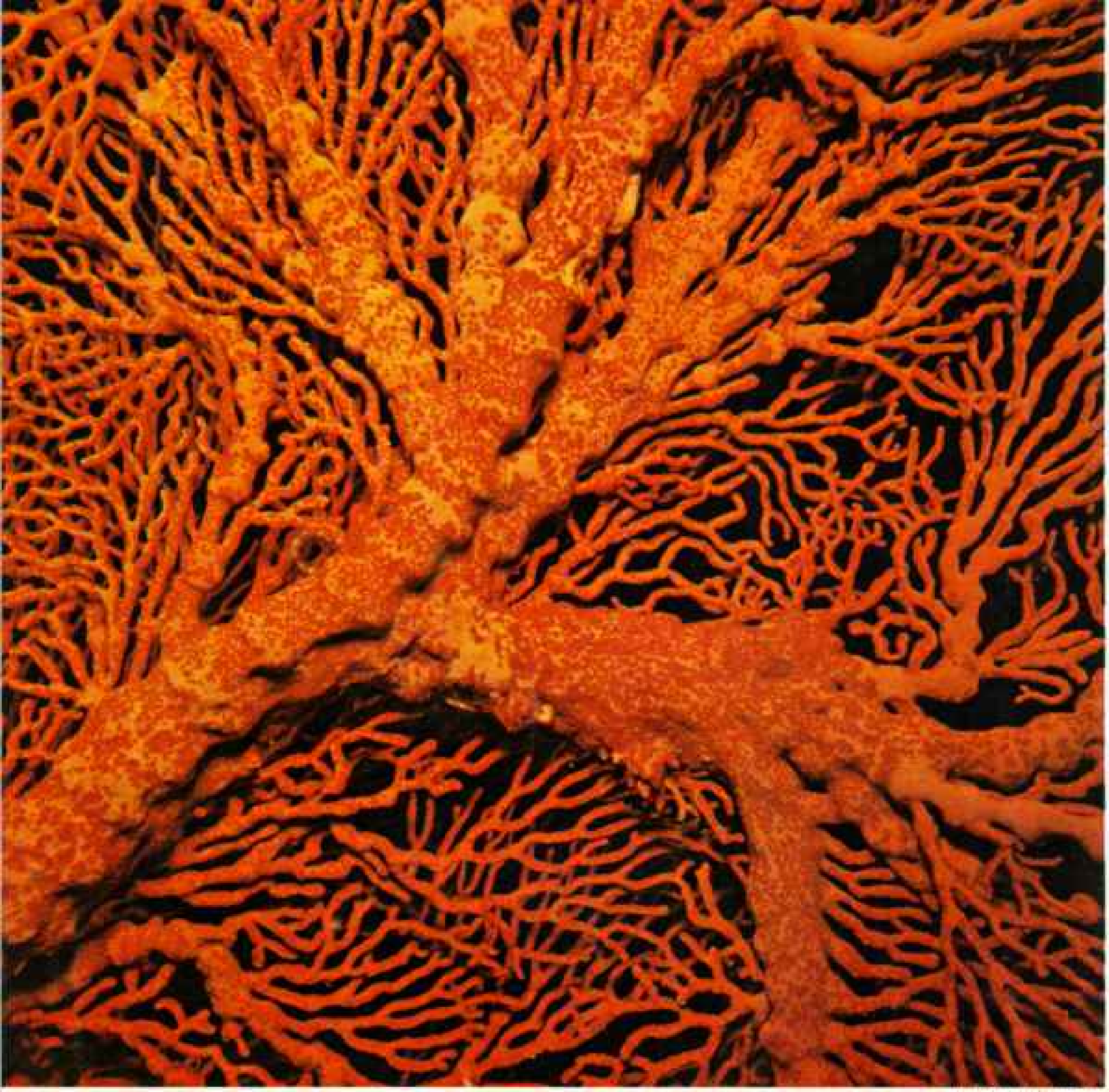
At least 300 species of coral—reef builder and foundation of marine life—have been found here, more than four times the number seen in the Caribbean.

Plantlike in appearance, but actually simple animals, corals grow in countless shapes, forming a sculpture garden laced with vivid colors and swarming with fishes, crustaceans, and mollusks. A sea whip coral (**above**), red as a Pacific sunset, inhabits an outer reef where a wrasse swims.

These waters were not pacific in World War II, when bloody fighting erupted. Today Palau faces a different kind of battle. It began with an international business consortium's proposal to build a giant, multimillion-dollar supertanker port in a deep harbor here (**map, facing page**). Such a port would facilitate the passage of oil from the Middle East to fuel-hungry Japan.

Environmentalists have sounded the alarm. If dynamiting and dredging were to happen, "there would be total destruction of the reef in the area of construction, and considerable damage in other areas in the vicinity due to sedimentation," warns Dr. Robert Johannes, marine biologist at the University of Hawaii. Palau's traditional fishing industry would be seriously affected.

Environmental and financial misgivings have stalled a feasibility study up to now. Political and legal maneuvering persist. Meanwhile, in the quiet waters, the beautiful corals continue to flourish.

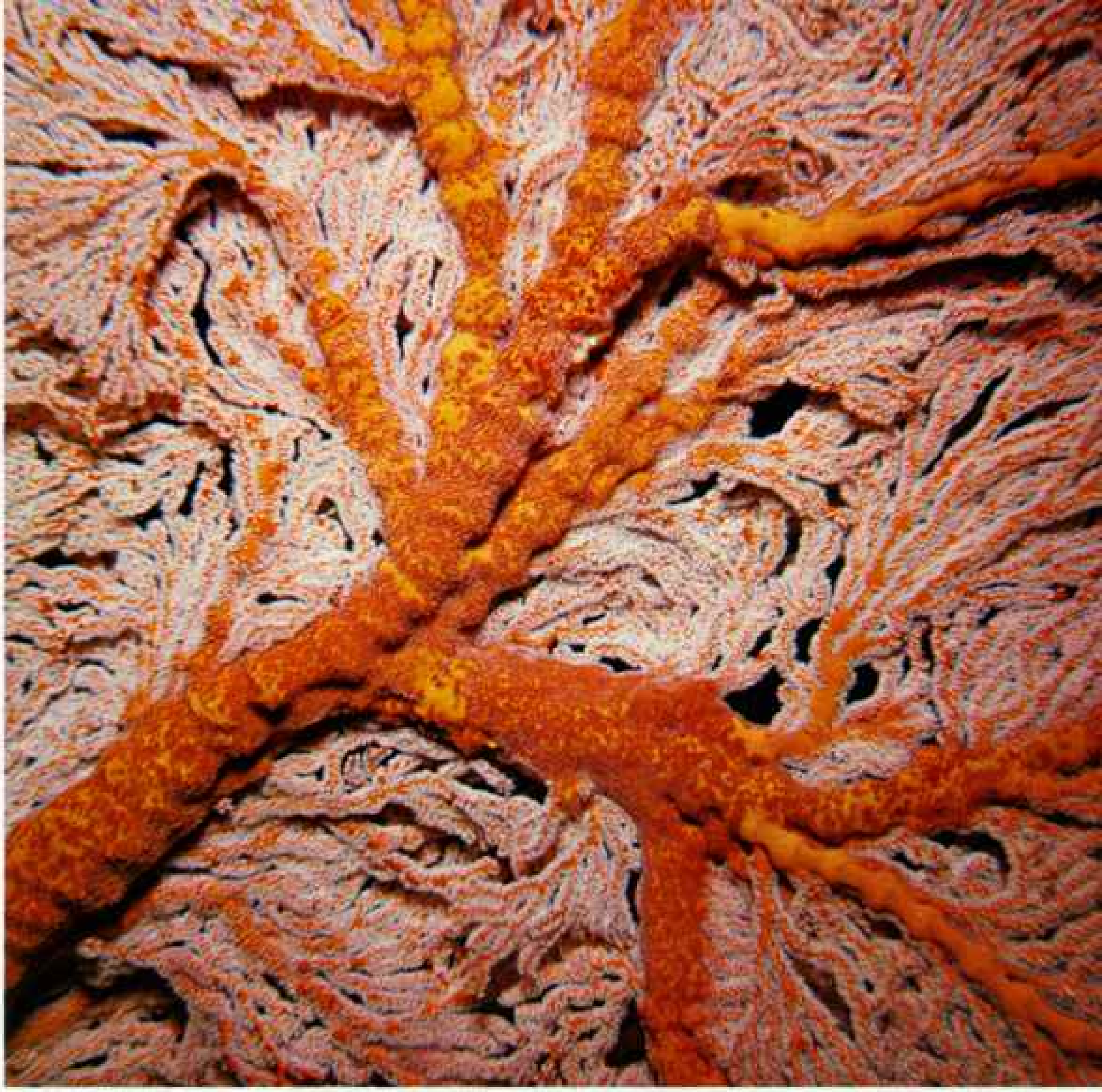


MELITHAEA, 1/2 LIFE-SIZE

PLEXAURA SIMILIS, 1/2 LIFE-SIZE

# Tidal feast

Life is skin-deep for corals with hard skeletons. The living matter is a thin surface layer of cells in the form of predatory animals called polyps, which expand when feeding. At slack tide the contracted polyps on a sea fan appear as red dots on the flesh (**above**). Come the changing tide with its delivery of organisms called zooplankton, hundreds of small, translucent polyps emerge (**above, right**), softening the brilliant orange of the skin.



# Shifting shapes

Plain to fancy describes the change that takes place in "bubble" coral. Contracted, a polyp reveals a ring of skeletal ridges (**far left**). More often the flesh has filled with water, swelling into a shape resembling a cluster of mushrooms (**left**). Nutrition could explain this behavior. Many corals gain nourishment from algae that grow inside their tissue. By increasing the area exposed to light, corals may be aiding the production of more interior food.

**The death of reefs** meant the birth of islands across southern Palau more than a million years ago. At Seventy Islands Preserve, above, limestone islets are the

remnants of an ancient living reef forced out of water and now deeply eroded and covered by jungle. A new colony of coral grows at the islands' feet.

# Beauty by the inch

An underwater corsage, made of coral, blooms (**left**) on a World War II shipwreck. Expanded for feeding, polyps of this "daisy" coral are crowned by rings of tentacles that kill sea organisms and serve them to the polyps' mouths. Stony corals grow by absorbing calcium from seawater to build rock-hard skeletons. From 1967 (**below**) to 1970 (**bottom**) the turrets of a "castle" coral fattened noticeably. Some corals grow as much as three inches a year.

PACHYSERIS RUSSEA (ABOVE AND BELOW). 1/8 LIFE-SIZE

HOMOPHORA (LEFT). 1/3 LIFE-SIZE

SARCOPHYTON PAUCIFLORUM, 1 1/4 LIFE-SIZE (LEFT); 1/2 LIFE-SIZE (ABOVE)

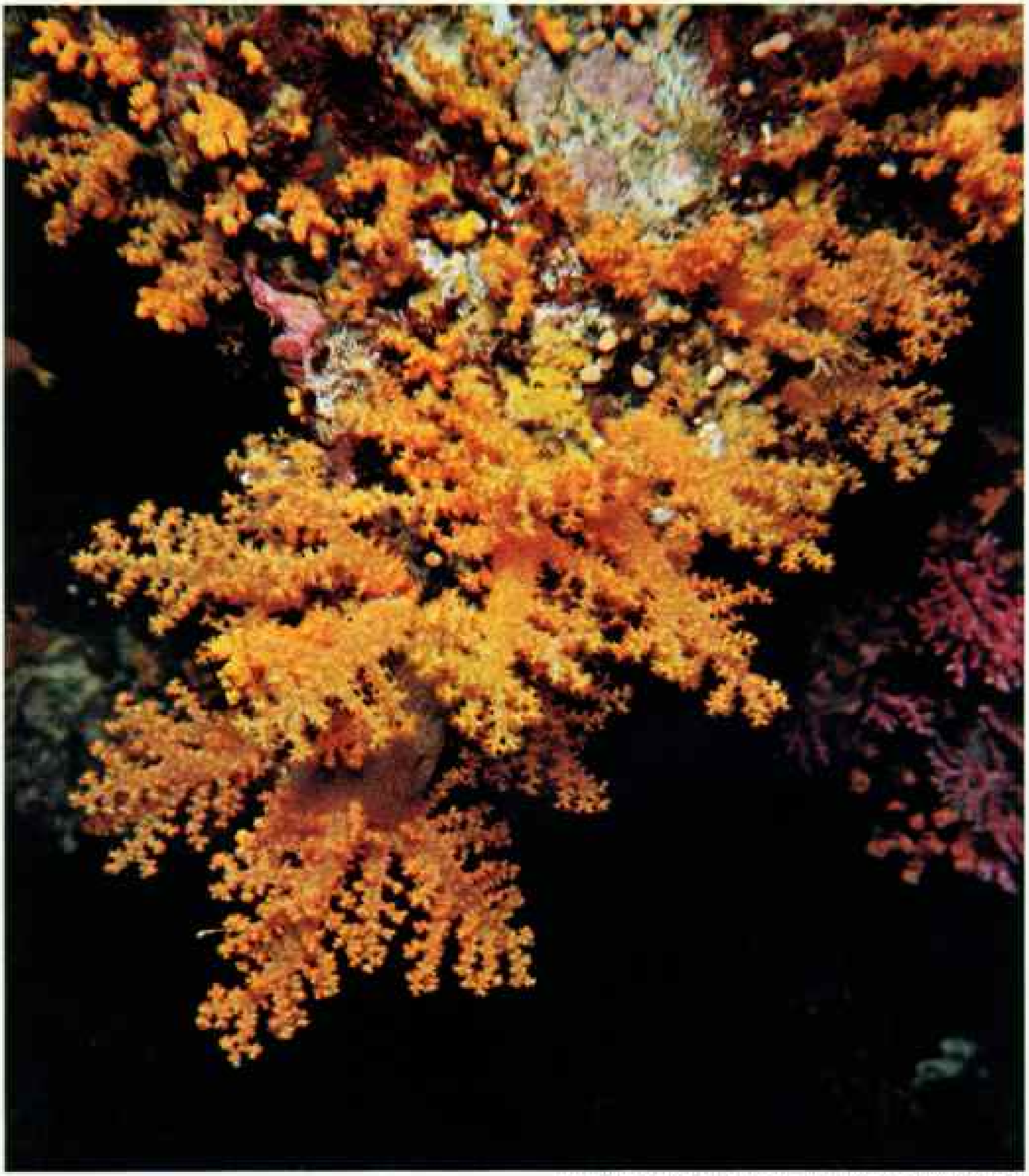
# Made of flesh

An eerie landscape befitting a fairy tale turns out to be a section of "leather" coral (**left**). Unlike stony varieties, this soft coral lacks a hard skeleton. Spicules embedded in the ample flesh and the ability to pump its tissue full of water lend it stability. Because of the spongelike consistency, leather corals can withstand strong currents on the outer reef.

Polyps extended, the leather coral resembles a display of pincushions (**above**). Corals' main enemies include certain fishes and sea stars that feed on polyps. Under crowded conditions, a coral may even be attacked and eaten by one of its own kind.

*Unveiling of the reef occurs on days of extremely low tides. It is a time of beauty,*

*and vulnerability. Rainstorms could damage this reef; an oil spill could destroy it.*



DENDRONEPHTHYA, 2/3 LIFE-SIZE (ABOVE); BELLONELLA INDICA, LIFE-SIZE

# Expansive feeding habits

A touch of autumn brightens the reef when the vivid tree coral expands for a meal (**above**). Stony corals extend only their polyps. This soft coral inflates its entire body. The enlarged size may increase the odds for trapping food.

Unlike tree corals, which dilate whenever the current is running, another soft coral feeds only at night. Still contracted, it is a small knob, as seen at the top of the picture (**right**). Below, others have swollen with water to six times their normal size, and polyps have come out to feed.

# Making do in the depths

Spiraling out from a cave, a "wire" coral seeks food-bearing currents fifty feet down. Not a reef builder, this species lacks the growth-inducing algae that bulky, shallow-water corals contain. A member of the black-coral order, it is highly prized for its dark, hard skeleton, which can be cut and polished for jewelry.

Talk of a supertanker port has now made all Palau coral, deepwater and shallow, seem precious. Coral is the mainstay of reef life, and if one issue is without argument on these islands, it is that coral thrives best when man is but a spectator. □

CIRRHIPATHES SPIRALIS, LIFE-SIZE

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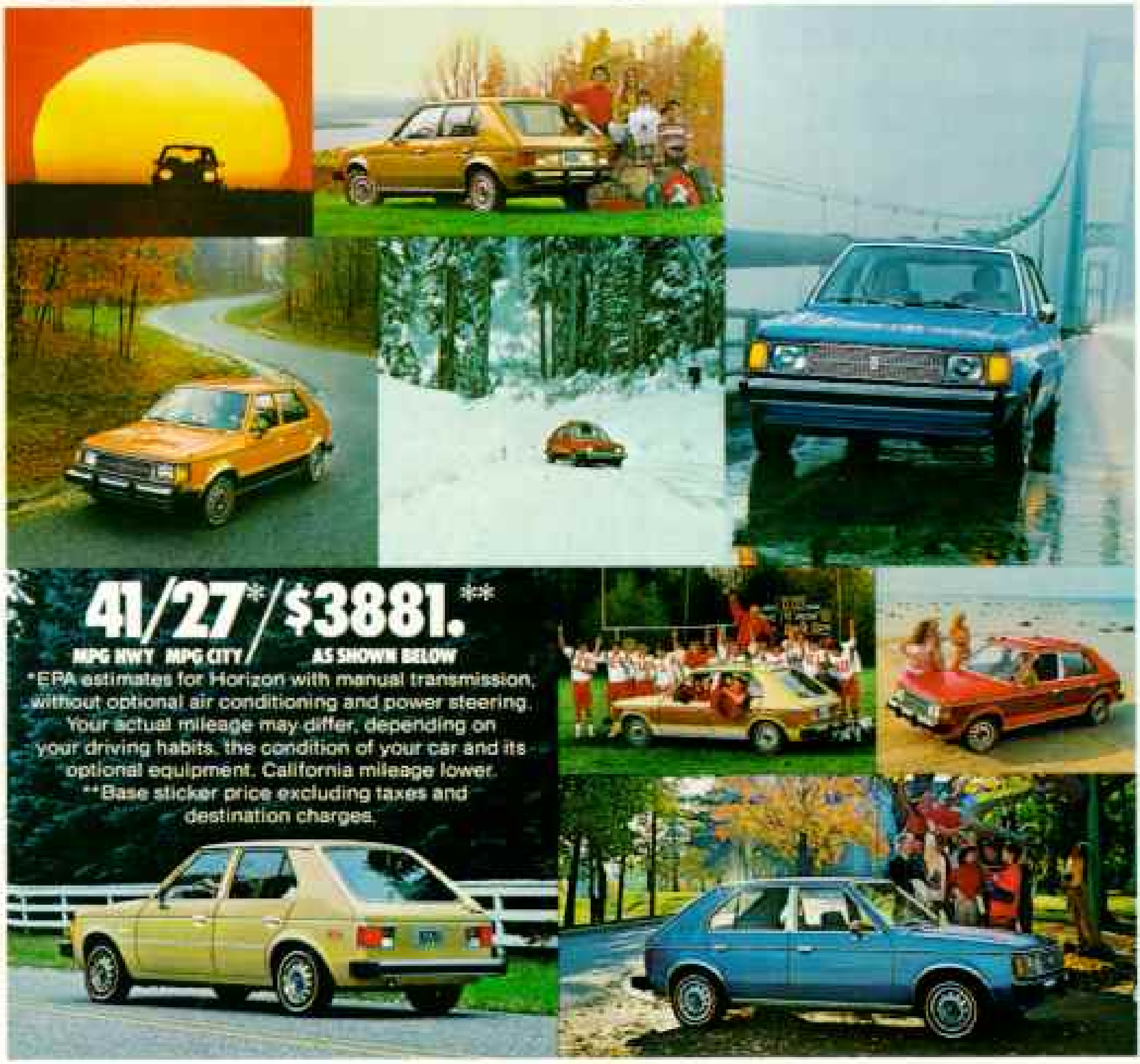
# Stain over paint?

Now you can give your home the beauty of Olympic Stain, no matter how many times you've painted it before.

Olympic Acrylic Latex Stain hides paint beautifully with soft, solid color. It gives your home a rich mellow look, along with a tough acrylic finish that lasts for years. Cleans up easily with soap and water, too.

Olympic Latex Stain is also perfect for redoing any solid color stain. Available in 30 colors. Just follow easy label directions. For more information, see the Yellow Pages for your Olympic dealer, or write: Olympic, 2233 112th Ave. N.E., Bellevue, WA 98004.

# AMERICA TAKES TO THE HORIZON.




New Plymouth Horizon. People are taking it everywhere. On any kind of road, in any kind of weather, on every kind of trip. Front-wheel drive is one reason why. It gives Horizon great stability and it gives you a great feeling of confidence.

And people are taking it because Horizon can take a lot of people. Four big adults can ride in comfort. And there's plenty of room to take all the things that people need.

Horizon gives you a lot of unexpected standard features, like front bucket seats, AM radio, whitewall radial tires, rack and pinion steering and front disc brakes.

And at $3881, it's easy to take.

Plymouth

A PRODUCT OF CHRYSLER CORPORATION

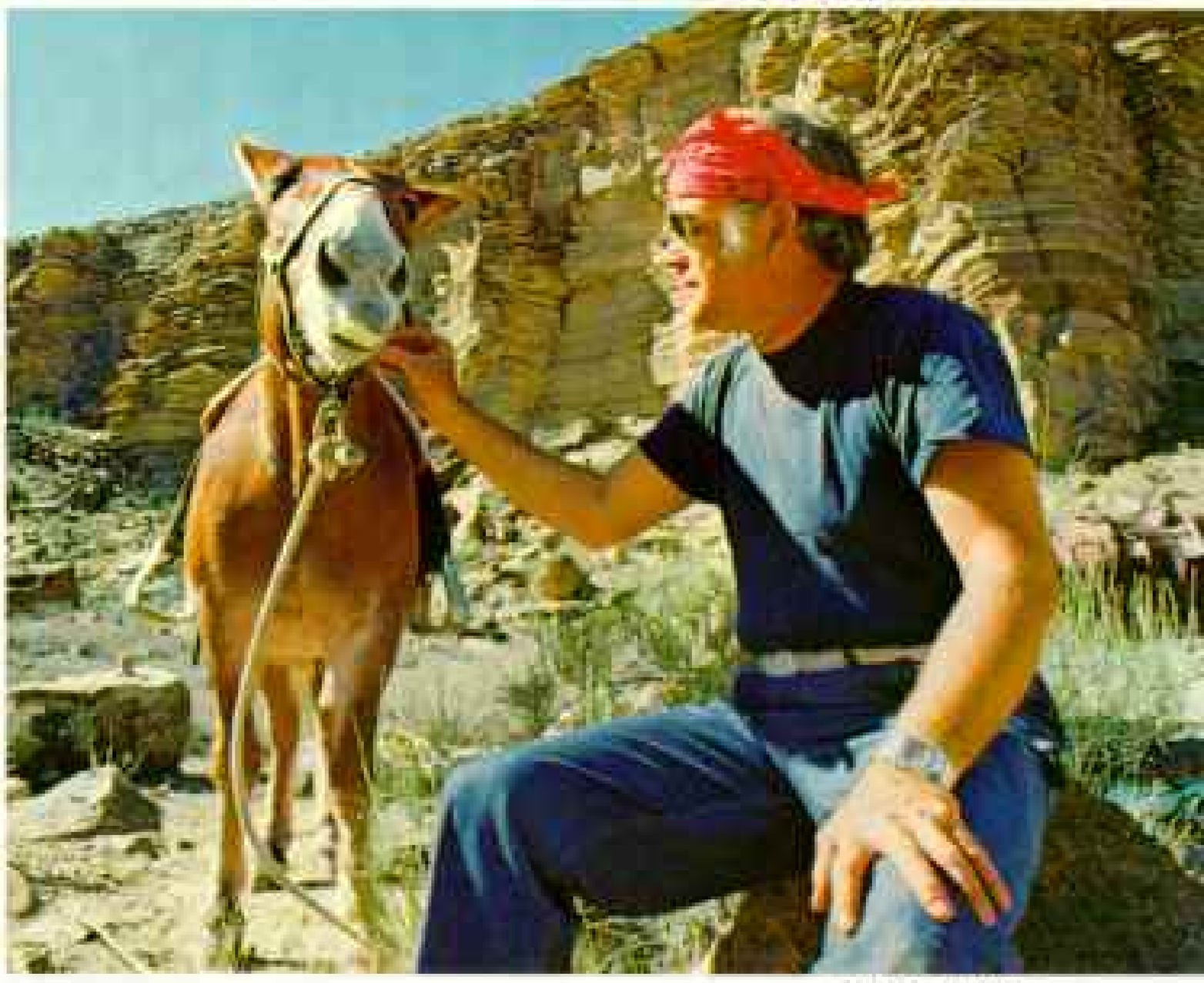
**WHEN YOU WANT TO GO ANYWHERE IN COMFORT AND CONFIDENCE.**

# RELAX. PLYMOUTH HORIZON CAN HANDLE IT.

# "... for Distinguished Service in Journalism"

THE CIRCLE was closed in April when Associate Editor W. E. Garrett stepped forward to receive the Honor Award for Distinguished Service in Journalism of the University of Missouri (**below, right**). When Bill Garrett was a journalism student there 24 years before, he met then editor Gilbert H. Grosvenor, who was accepting the same award for NATIONAL GEOGRAPHIC. That meeting led to a job that became a career in photojournalism and included stories, in the words of the citation, "from Vietnam and Laos, from Quemoy and Guantanamo, from Alaska and Guatemala." The award also recognized Bill Garrett's contributions to journalism education throughout the country.

A world away from the black-tie decorum of an awards banquet, Bill recently shared an apple with a companion in the Grand Canyon. He was there to record on film and report in words the clouded outlook for what may be America's best-loved park, an analysis that begins on page 2 of this issue. Such experienced and perceptive reporting can be shared with friends by completing the form below.



DAVID C. DOHENER

## 18-MONTH NATIONAL GEOGRAPHIC SOCIETY MEMBERSHIP

**JULY 1978 THROUGH DECEMBER 1979**

Mail to: The Secretary
National Geographic Society
Post Office Box 2895
Washington, D. C. 20013

CHECK ONE

EIGHTEEN-MONTH DUES in the United States and throughout the world are $13.75 U. S. funds or equivalent. To compensate for additional postage and handling for mailing the magazine outside the U.S.A. and its outlying areas, please remit: for Canada $20.29 Canadian or $17.25 U. S.; for the British Isles, Australia, and New Zealand $20.20; for all other countries $20.00 by U. S. bank draft or international money order. Upon expiration of the 18-month term, memberships are renewable annually on a calendar-year basis. Eighteen-month membership starts with the July 1978 issue. Eighty percent of dues is designated for subscription to the magazine.

LIFE MEMBERSHIP is available to persons 10 years of age or older. The fee for U. S. (including its outlying areas) is $250 U. S. funds or equivalent; for Canada, $325 Canadian funds ($275 U. S. acceptable); for all other countries, $300 by U. S. bank draft or international money order.

☐ **I WISH TO JOIN** the NATIONAL GEOGRAPHIC SOCIETY and enclose my dues $_____
(FILL IN NAME AT LEFT)

☐ **(GIFT MEMBERSHIP)** I nominate and enclose $_____ for dues of the person named at left.

Send gift card signed: _____

☐ **I NOMINATE** for Society membership the person named at left. (Use separate sheet for additional nominations.)

**NEW MEMBER** PRINT NAME OF AN INDIVIDUAL ONLY (MR., MRS., MISS, MS.)

STREET

CITY, STATE, ZIP CODE

**MY NAME** PLEASE PRINT (MR., MRS., MISS, MS.)

STREET

CITY, STATE, ZIP CODE 007-79

Announcing

# The Official State Flowers Bell Collection

- **For the first time . . . 50 exquisite little bone china bells portray all of America's official state flowers.**

- **Each bell will be decorated with a specially commissioned original painting and hand-decorated with 24 Kt. gold.**

- **A uniquely designed unit to display the complete collection will be provided at no additional cost.**

- **Final order deadline: July 31, 1978.**

America the Beautiful is blessed with magnificent flowers. A carpet of color and fragrance that stretches from sea to shining sea — reminding us of the bounty that nature has bestowed upon our nation. And of all the lovely flowers that flourish on our native soil, the very favorites have been named the official flowers of the 50 states.

Now, at last, all 50 of these official state flowers will be faithfully portrayed on exquisite little bells of fine bone china — an unprecedented artistic tribute to our 50 states . . . a joyous celebration of our love for the land we live in.

## Fine Bone China — The Perfect Art Medium for This Unprecedented Collection

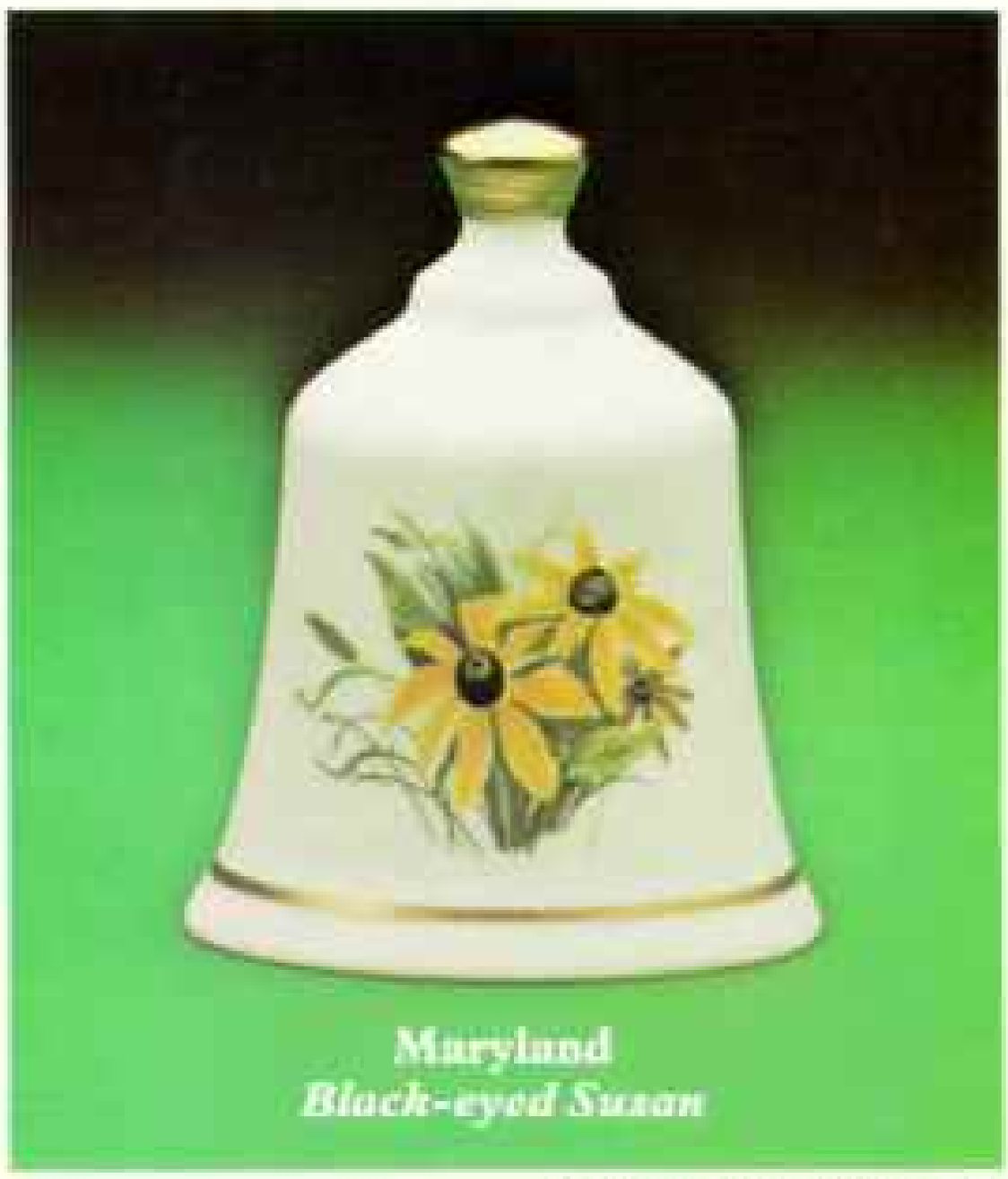
The special qualities of imported fine bone china are perfect for portraying these beautiful flowers. Bone china is renowned for its pure ivory-white color and remarkable translucence — qualities which enhance the vivid colors of each flower. Fine bone china is also famous for its light weight and delicate appearance — qualities which perfectly correspond with the delicacy of the flowers themselves.

Very few china makers in the entire world have mastered the necessary skills to produce bone china. This is why bone china is found only in a few countries — and why it is treasured by collectors on every continent. It is rare to find an exclusive, privately commissioned bell collection in fine bone china — and rarer still to find a collection consisting of fifty exquisite little bone china bells.

## Original Paintings by One of America's Most Distinguished Nature Artists

To create the original art that appears on each of these bells, a special commission was awarded to the prominent American nature artist, Jo Polseno, whose work has been shown in leading galleries and has appeared in Audubon Magazine. Working in fields, plains, and mountains across America, Polseno has created a striking series of original floral watercolors expressly and exclusively for this collection. These paintings have never been seen before — and will never appear again in any form.

The flowers include the sweetly scented Massachusetts Mayflower, beloved of the Pilgrims . . . the Mississippi



**Maryland**
***Black-eyed Susan***

Continued on next page ►

**Minnesota**
*Showy Lady's-slipper*

**California**
*California Poppy*

**New Hampshire**
*Purple Lilac*

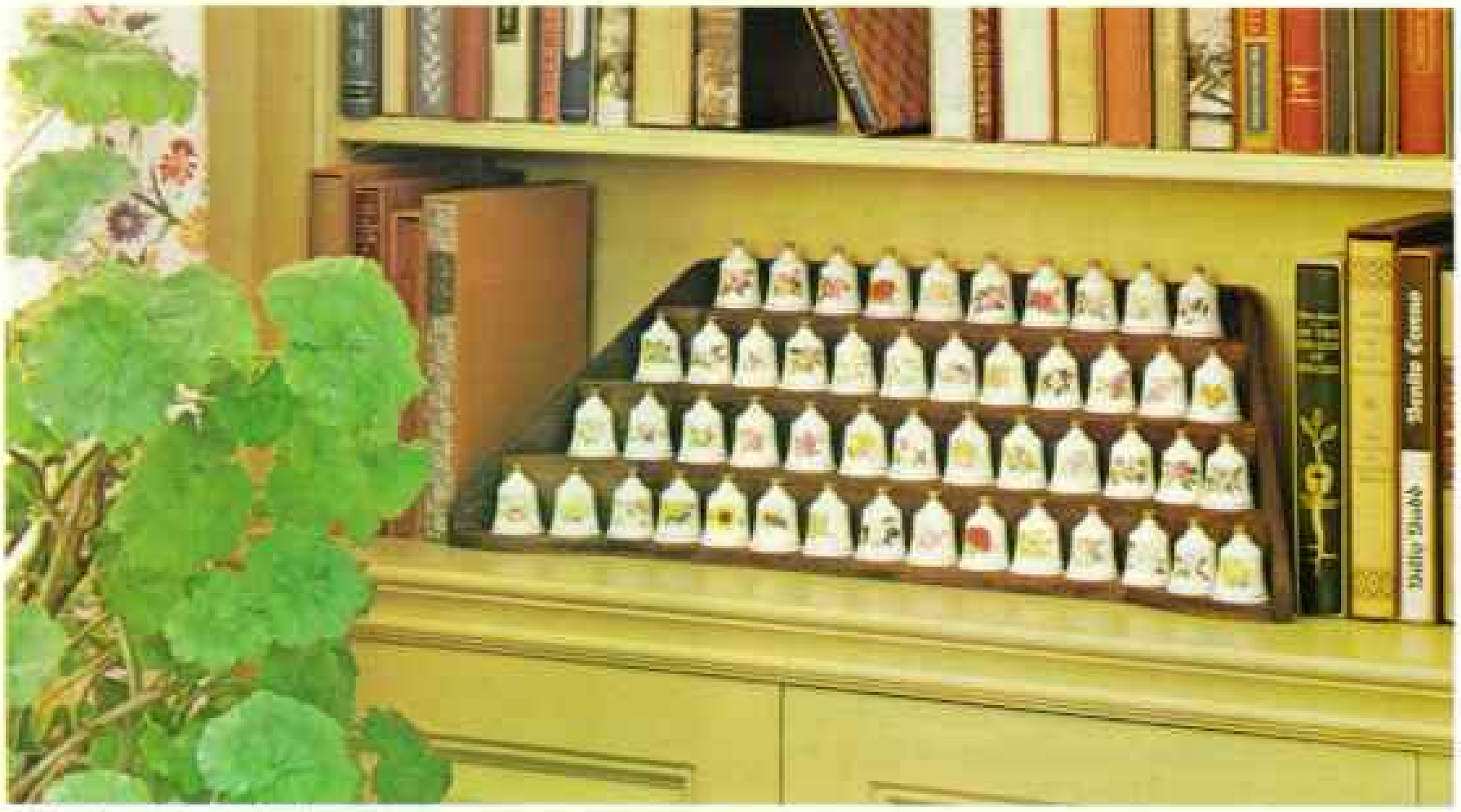
Magnolia, fabled flower of the Deep South . . . the vibrant California Poppy . . . the lovely pink and yellow wild rose of Iowa. In all, 50 lovely flowers . . . authentic down to the most minute detail . . . vibrant in all their natural colors.

**Each Bell a Handcrafted Work of Art**

To create a bell collection worthy of our official state flowers and the fine bone china, a specially designed bell shape was created. To produce this unique shape, each bell will be individually cast by hand. Then the original Polseno water-colors will be transferred to each bell using techniques involving many separate colors. As a crowning touch of luxury, each bell will be hand decorated with precious 24 Kt. gold applied to both the handle and base. Each bell will also bear the name of the state and its official flower, as well as the Danbury Mint hallmark.

**Display Accessory at No Additional Cost**

A custom designed display unit will be furnished at no additional charge. This



◄ Continued from preceding page

**Tennessee** *Iris* | **Texas** *Bluebonnet* | **Alabama** *Camellia*

Bells shown actual size.

beautiful unit may be placed on a table or book shelf (as shown on opposite page) or hung on a wall — to display all 50 bells to best advantage.

## A Strictly Limited Edition

*The Official State Flowers Bell Collection* will be available only directly from the Danbury Mint by advance reservation. Reservations for this limited edition offering must be postmarked by July 31, 1978.

## Convenient Acquisition Plan — Guaranteed Satisfaction

To reserve your subscription to *The Official State Flowers Bell Collection* simply complete the Reservation Application and mail it to the Danbury Mint by July 31, 1978. You need send no money now. You will be billed for each of your bells prior to shipment.

*The Official State Flowers Bell Collection* consists of 50 individual bells to be issued at the rate of two bells per month. Subscribers are guaranteed the same, low original issue price of just $9.00 each for every bell throughout the entire collection.

Should you receive any bell that you are not completely satisfied with, you may return it within 30 days for replacement or refund. Naturally, you may cancel your subscription at any time.

## Prompt Action Needed

Remember, subscriptions for this offering must be postmarked by July 31, 1978. Please act promptly.

Reservation Application FTG

The Danbury Mint
47 Richards Avenue
Norwalk, Conn. 06856

Must be postmarked by July 31, 1978

Please accept my reservation to **The Official State Flowers Bell Collection.** I understand there will be 50 bone china bells in this limited edition series and that the bells will be issued at the rate of 2 new bells every month at the guaranteed price of $18.00 per monthly shipment (plus $1.50 for shipping and handling costs).

I need send no money now. I will be billed for the first 2 bells prior to shipment and invoiced for subsequent bells on a monthly basis. I may cancel this subscription at any time and any shipment may be returned for a full refund if upon receipt I am not completely satisfied.

Name _____

Address _____

City _____

State _____ Zip _____

Signature _____

☐ Check here if you want your bells charged, as they are shipped, to your:

☐ Bank Americard/Visa ☐ MasterCharge

_____ _____

Credit Card Number Expiration Date

# "The Enegrens' home had increased in value. Thanks to Allstate, so had their insurance coverage."

"When that tornado struck Olathe, the Enegrens' house was completely wiped out. Only six months before, I had encouraged them to increase their coverage by $10,000 to bring their insurance closer to the value of their home.

"At that time, I called them to review their homeowner's policy. I explained that not only had the value of their house gone up, but also the cost of rebuilding it, if disaster should strike.

"After the tornado, the Enegrens used the money we paid them to buy another house. As an Allstate agent, I always try to make sure my customers keep their insurance up to date, so that a disaster like this will never leave them out in the cold."

Barney Bobrow
Senior Account Agent
Mission, KS

Help when you need it. That's a promise from the good hands people.

**Allstate**®

Allstate Insurance Company, Northbrook, IL

# It's never been easy to predict the energy of the future.

One hundred and fifty years ago, when our chief source of fuel was wood, few people guessed it would someday be coal.

Seventy five years ago, when we depended mainly on coal, few people foresaw our present dependence on petroleum.

Now, as petroleum becomes more difficult to find, it's similarly difficult to predict the energy of the future.

But one thing seems certain: The next several generations will be characterized by the use of *many* forms of energy—some familiar and some new.

Today, Conoco produces oil, natural gas, coal and uranium. And what we learn from this effort helps us develop tomorrow's energy. For instance, we're working on ways to change coal into other useful forms, such as synthetic gas and oil.

Thus we can help bridge the time gap until still newer forms of energy, such as solar, can make an important contribution.

At Conoco, we're not certain what the future of energy will be. But we're helping create it.

CONOCO

**Doing more with energy.**

To learn more about what we're doing with energy, write Dept. F, Continental Oil Company, Stamford, Conn. 06904.

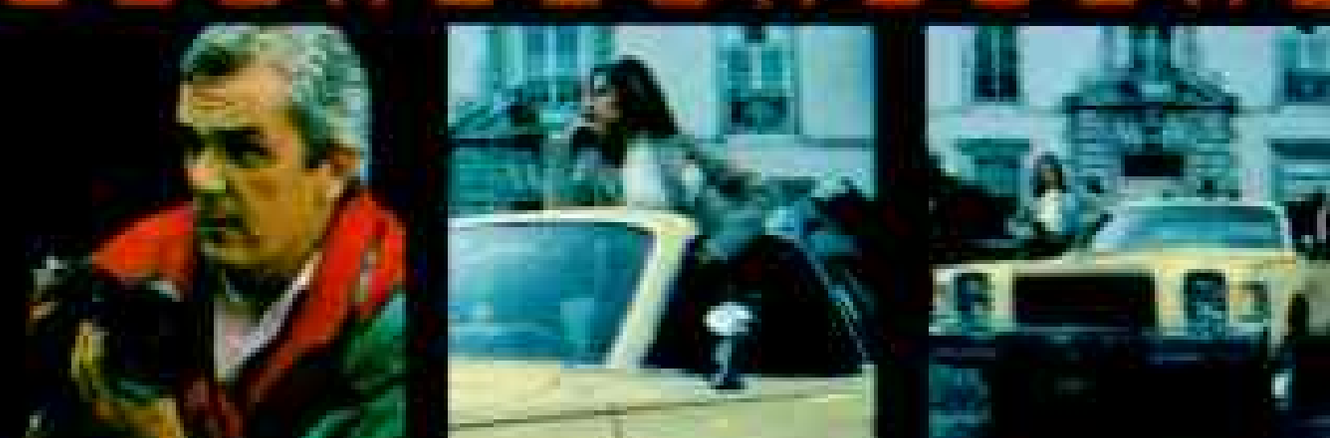
# 1978 Chrysler Cordoba

## "The picture of style and taste."

*Anthony Edgeworth,*
*contributing photographer, Esquire Magazine*

We asked New York fashion photographer, Anthony Edgeworth to show you a new Cordoba the way he sees it.

*"To me . . . Cordoba is classic. Look at the proportions. Look at the unbroken reflective surfaces . . . an absence of chrome. There is a thrust to the hood . . . a strong look. The framing of the grill is unpretentious and clean. I like that. I like the interior too. It's uncluttered . . . strong. The car looks very special . . . like it would fit a very special way of life. Cordoba? It's the picture of taste."*



That's the way one of the nation's leading photographers sees Cordoba. Now put yourself in the picture when you buy or lease a new Cordoba at your Chrysler-Plymouth dealer.

CHRYSLER

A PRODUCT OF CHRYSLER CORPORATION


# Mike Little works like four insurance agents for the Stalls.

"I'm a neatnik," says schoolteacher Gary Stall of Zanesville, Ohio. "I want everything in its place. Right there when I need it. If it's insurance, I just call Mike. Whether it's car, life, home or health insurance."

"He's made us feel like he's our own full-time agent," says Sharon Stall. "He makes it feel like it's never an imposition to call him."

If you need help with any kind of family insurance, call your nearby State Farm agent. You'll be talking to four of the best agents around.

STATE FARM INSURANCE

**Like a good neighbor, State Farm is there.**

STATE FARM INSURANCE COMPANIES Home Offices: Bloomington, Illinois


# BE GOOD TO THE FOLKS IN EUROPE FOR ONLY $6.75 OR LESS. (THAT'S NOT BAD.)

It's only $6.75 (plus tax) for a station-to-station call to most West European countries. That's for 3 minutes. Add $2.25 for every additional minute.

Many countries have nighttime and Sunday rates that are less.

Money aside, a letter can't make you (or your relatives) feel good the way talking together can.

They don't live in Europe? Well, it's only $9.00 or less for three minutes to Japan, Israel, Australia, or Brazil.

Bell System

# "THE BEST REASON FOR BUYING A NEW GE REFRIGERATOR IS AN OLD GE REFRIGERATOR." —The Steele Family.

**Jane Steele, Verona, New Jersey**

GE refrigerators are really built to last. And my old "Monitor" is lasting proof!

Talk about a great investment! I got it in 1957, when it was 23 years old. And it still works like a charm.

Of course, it doesn't have all the improvements and innovations General Electric's added over the years. But it shows how dependable GE refrigerators are. As I told my daughter Mary Ellen, they just can't be beat!

**Mary Ellen Steele Burns Totowa, New Jersey**

General Electric is a name you grow up with. You know it's dependable.

So we felt confident that our lower-priced GE refrigerator would give us the same quality and reliability as the most expensive model.

My mother told me GE refrigerators were the best kind, and of course we did a lot of shopping around. No other brand had the features GE did for the same money.

**Great Aunt Agnes Spina, West Orange, New Jersey**

I've spent nearly half a century depending on GE refrigerators.

We bought one of these in the mid-fifties, after giving away the faithful "Monitor" Jane has now.

What a workhorse! Soda was always cold, ice cream was hard, and it never needed any service. So naturally when we modernized again five years ago, we went right back to GE for a big, beautiful side-by-side.

General Electric refrigerators really hold up. We've had enough of them to know!

**Suzanne Steele Walsh, Morristown, New Jersey**

Having had GE refrigerators in the family for so long impressed me more than any brochure or sales talk.

So when we buy our new refrigerator, it won't be a question of "whether GE," but of "which GE." Like this gorgeous dream of a side-by-side!

It has plenty of space, important with our five children. And adjustable glass shelves, great for cleaning up spills.

Separate temperature control for the meat pan. Automatic defrosting. And the GE dispenser that gives you chilled water, ice cubes, even crushed ice. I love the "New Naturals"™ colors, too—so soft!

The reliability General Electric's been building into their refrigerators since Great Aunt Agnes bought hers makes me feel really confident.

**THE APPLIANCES AMERICA COMES HOME TO.**

**GENERAL ELECTRIC**

# TOYOTA'S MILLION-DOLLAR-DASH FOR THE 1980 OLYMPIC GAMES.

## SOMETHING FOR THE U.S. OLYMPIC ATHLETES... A $1,000,000 DONATION.

As you may know, our Olympic athletes are not government subsidized. So they need money to train now if they're going to win in Moscow in 1980.

**Here's our plan:** Toyota and your participating Toyota dealer will make a donation for the U.S. Olympic team every time a new Toyota car or truck is sold through June 30th, 1978. Help us make our sales goal, so we can give $1,000,000 or more, to help build a tough U.S. team. When you buy a new Toyota, you'll also get a specially designed Olympic pin, patch, and a certificate thanking you for your support. Now you can get a tough Toyota, and a tough Olympic team.



## SOMETHING FOR YOU... A CHANCE AT $1,000,000 IN PRIZES. ENTER NOW!

**Three "Gold Medal" first prizes, worth over $134,000 each.** How'd you like to win all of this? A $100,000 condominium in Snowmass, Colorado. Two brand-new Toyotas. $5,000 in AMF Sports Equipment. A Nikon FM Camera. A $1,000 Levi Shopping Spree. A 3-week trip for two to Moscow, Munich, and Montreal, with $10,000 in pocket money. And a Sony Color TV, in case you get bored. That's just the first prize. Three lucky people will win them. Good luck!

**Ten "Silver Medal" second prizes.** Every "Silver Medal" winner will receive a Toyota Corolla SR-5 Liftback, a $1,000 AMF Sports Shopping Spree, a Nikon FM Camera, and a one-week trip for two to the European Track and Field Championships in Prague, Czechoslovakia. And $2,500 cash.

**1000 "Bronze Medal" third prizes.** A Nikon FM 35mm Camera with 50mm F2 lens. Nice to have around even if you can't make it to the games.

**How to enter:** Just go to your participating Toyota dealer and fill out an entry form. There's nothing to buy, no sentences to complete. But do it soon. Your Olympic-sized chance to win it big ends June 30th. The Million-Dollar-Dash for the Olympic Games. You asked for it. You got it. Toyota.

Contests rules available at participating dealers. U.S. licensed drivers only. Sweepstakes void in Missouri, Maryland, and where prohibited by law. See participating dealers in Missouri and Maryland for special offer.

**TOYOTA** SELECTED BY THE U.S. OLYMPIC COMMITTEE

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# SHUTTLE DIPLOMACY.

## THE NEW DODGE DIPLOMAT WAGON GETS YOU THERE AND BACK IN STYLE.

Dodge announces a great way to shuttle people and things from one place to another in unaccustomed comfort and style.

It's called Shuttle Diplomacy.

And it features the elegant new Diplomat wagon.

Optional leather seating

### PRICE SHOWN $5846.*

But for $5538,* you'll get a Diplomat wagon with simulated wood-grained exterior trim, power front disc brakes, power steering, and much more.

Naturally, there are a number of exotic Diplomat options, too. Such as 60/40 leather seating. Luggage rack and air deflector. Or station-seeking Search Tune AM/FM stereo. And so forth.

### 25 MPG HIGHWAY/17 MPG CITY.†

Shuttle Diplomacy also features some pretty good mileage figures. 25 MPG highway. 17 MPG city. Of course, your mileage may vary according to the condition of your car, its equipment, and your driving habits.


California mileage is lower. That's according to EPA estimated mileage figures.

Your next move is to your local Dodge Dealer's. Where you can buy or lease a new Diplomat wagon.


*Sticker prices, not including taxes and destination charges. †EPA estimates for 225 two-barrel, six-cylinder engine and manual transmission.

# DODGE DIPLOMAT.


Representative rate may vary slightly, but seldom more than a dollar or two.

# NATIONAL GEOGRAPHICS
## kept neat, clean, handy

Magazines and maps slip into these handsome files to become valuable library reference volumes. Look like fine books on the shelf. Leather-like book-red fronts beautifully embossed in gold. One file holds 6 issues (12 are too heavy) or many maps. Gold foil for adding dates included. Money-back guarantee.

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Send $7.74 ($9.95 outside U.S.A.) for minimum order of 6 magazine files or 5 magazine and 1 map file (specify). Ask for catalog of magazine files, library supplies.

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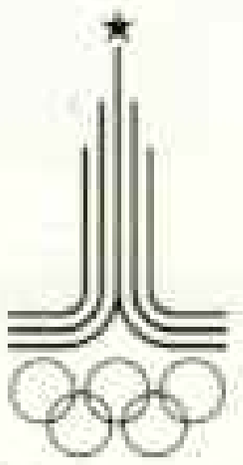
WASHINGTON, D.C. 20036

GET THE FIRST THREE 1980 OLYMPIC STAMPS FREE — You pay only $1 shipping/handling — and find out about the 1980 Olympic Stamp Program!



This program is endorsed by the U.S. Olympic Committee.

We'll send them in a handsome booklet and include descriptive literature on 1980 Olympic stamps. Just send $1.00 to cover costs. Write to:

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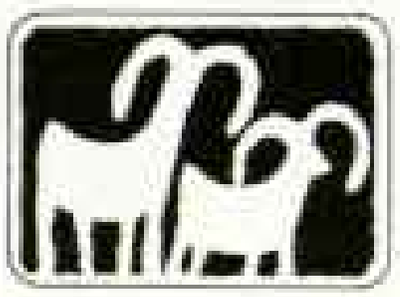
Dept. 5183 • One Paramount Plaza
Englewood, Ohio 45323



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# Free. The kit that will move you, in no uncertain terms, to a decision on a company airplane.


In deciding what your company should do about the rising cost of business travel, the worst decision is indecision.

Unfortunately, getting the information you need to make a good decision can be very difficult.

But now, in one comprehensive kit, you can get all the information you need to make an objective initial decision on the fastest growing mode of business travel today: the company airplane.

It's the Beechcraft Business Flying Kit and it's free. All you have to do is send for it.

But be prepared for a few surprises when your kit arrives. To begin with, you won't be getting just another pretty piece of sales literature.

Instead, you'll receive a straightforward, easy-to-read businessman's kit designed for one purpose. To help you make a realistic initial evaluation of what a business airplane can do for your company. In terms of time savings, fuel savings, and overall cost efficiency.

And you'll get up-front answers to the real questions you have about a company airplane. How do you determine the need for one? What financing plans are available? How do you select the right size aircraft?

The kit even helps you determine the net capital cost to your company of owning a business airplane, like the Beechcraft Super King Air shown here.

The Beechcraft Business Flying Kit. After you've read it, you'll have a good idea as to whether or not a business airplane is right for your company now.

Send for it.

Get the kit that will inform you, excite you, and challenge your every thought on business travel. Write on your company letterhead to: Beech Aircraft Corporation, Dept. A, Wichita, Kansas 67201. Ask for our free Beechcraft Business Flying Kit, and please mention if you're a pilot.


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*The jetprop Beechcraft Super King Air. The world's best selling turbine powered corporate aircraft. It can carry 8 to 15 people in unquestionable elegance at nearly half the speed of sound.*

Know any friends who want to learn to fly? Tell them about the General Aviation Manufacturers Association **Take Off** Sweepstakes. They could win a $50,000 airplane just for earning their private pilot license. Have them call TOLL FREE, 24 hours a day, any day and ask for the BEECH "TAKEOFF" operator. USA 800-447-4700 (in Illinois, 800-322-4400). Canada 800-261-6362 (Toronto, 445-2231).

# Energy for a st

# Nearly a third of the world's coal lies under the U.S.

# Dolly Monte is down there helping to get it out.

The U.S. has about 250 billion tons of coal that's economically minable with today's technology. This represents more than twice the energy in the proven oil reserves of the Middle East.

The coal that lies under the United States will help serve as a bridge between the world's finite petroleum reserves currently being depleted and the unlimited energy sources of the future—large-scale solar power, nuclear fusion and other advanced technologies.

A lot of coal lies close to the surface. But a significant amount is deep underground. And, since it can't be pumped out the way oil can, people have to go down and bring it up.

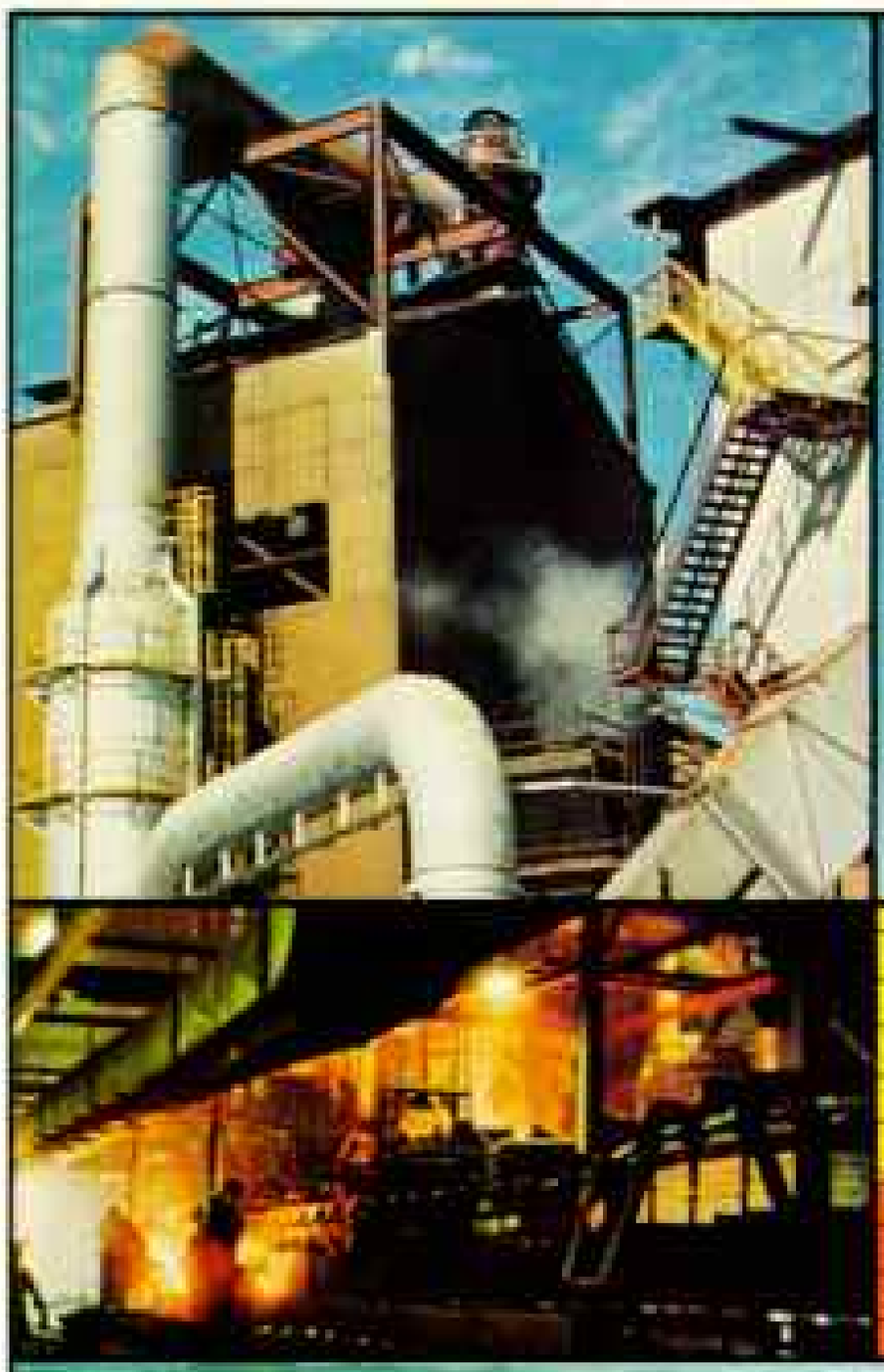
Dolly Monte is one of 500 employees in Exxon's modern mine in Carlinville, Illinois. She began as a general laborer, then joined a production crew as a shuttle car operator. "I'm really a truck driver," says Dolly, "but my 'truck' is 300 feet underground."

The mine doesn't look as you might expect. The walls are sprayed with white powdered limestone. The work areas are large and well ventilated.

In order to more than double coal production by 1990, the U.S. will need 200 new coal mines, producing an average 5 million tons a year. The work force will have to double. Thanks to modern technology, mining is becoming a job that many people, including an increasing number of women, are choosing.

Exxon has a growing commitment to coal production and research. For more information on coal as an alternate energy resource, write to Exxon Corporation, Dept. C, Box 4125, Grand Central Station, New York, N.Y. 10017.


# rong America









# NAR: A Story of Commitment to the Future

North American Royalties, a company based in the South. A company of proud growth spanning 112 years. A company meeting present and future human needs.

**The need for new domestic energy sources:** NAR carries out oil and gas exploration, development and production in areas from the Gulf States west to New Mexico and Colorado and north to Montana and North Dakota.

**The needs of industry and transportation:** NAR's Wheland Foundry produces grey iron castings that serve industry and are a part of more than half of all the automobiles made in America.

**The need for protection of the environment:** NAR utilizes equipment which keeps the air and water clean at its operations.

**The need for preservation:** NAR's headquarters occupy three historic structures nearly a century old, examples of its restoration efforts and good corporate citizenship.

**North American Royalties, Inc.** A company whose story is of interest. For more information write

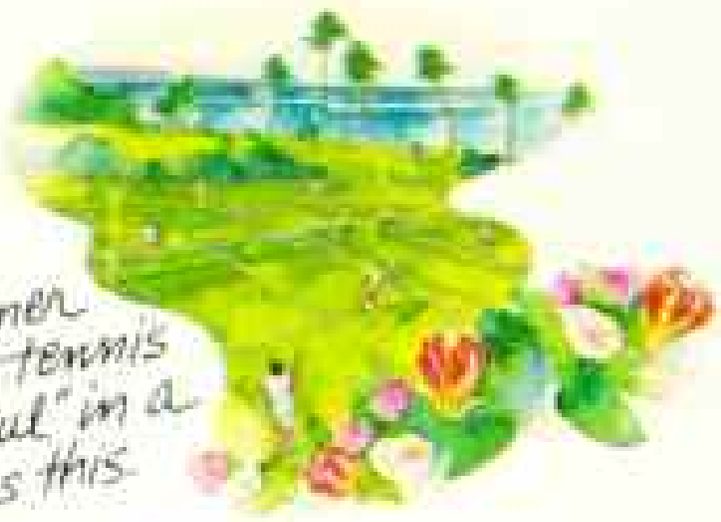
**Corporate Communications**
**North American Royalties, Inc.**
**Chattanooga, Tennessee 37402**

Listed on the American Stock Exchange and the Pacific Coast Stock Exchange. (Symbol: NAR)

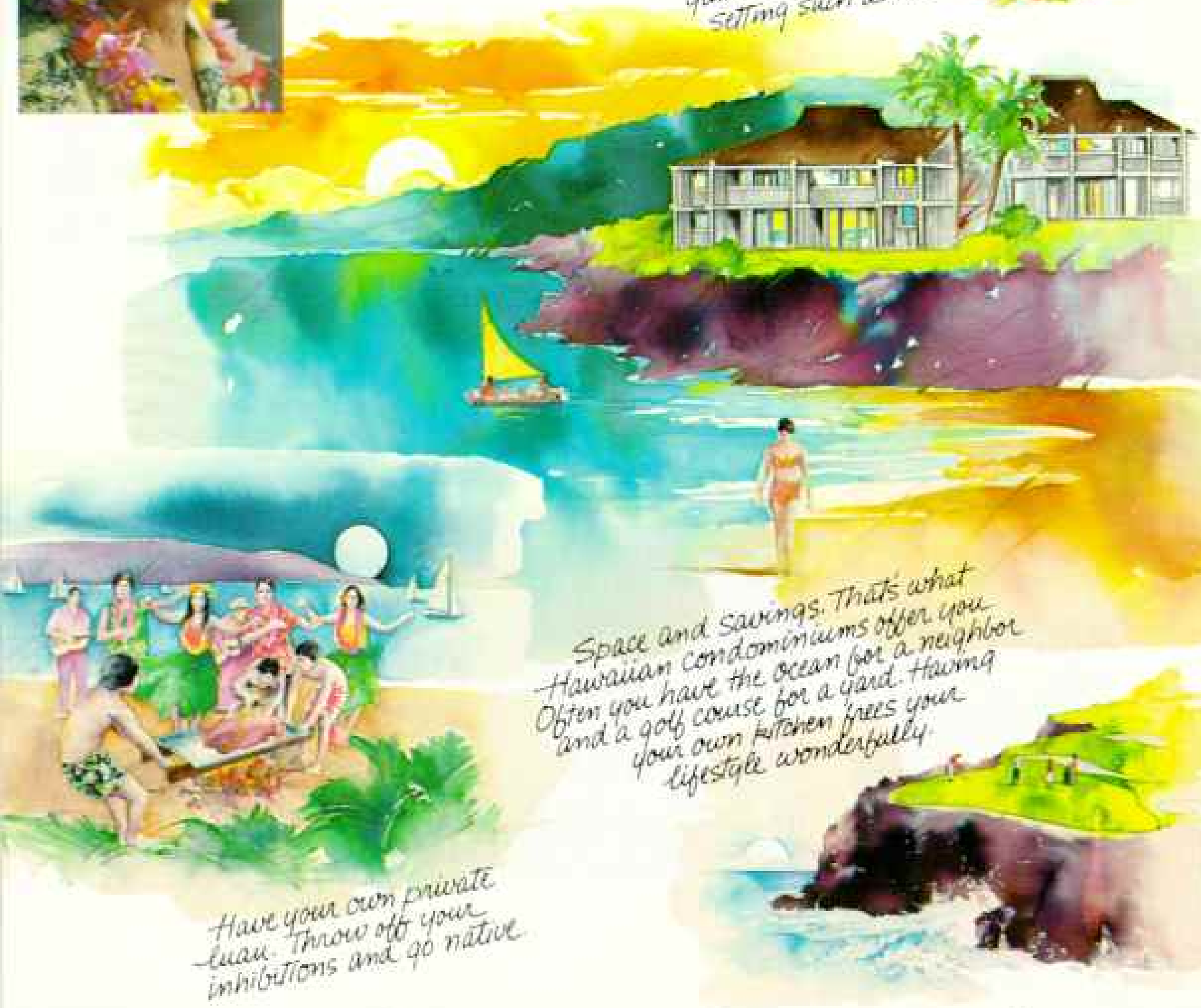
# "A condominium vacation brings you closer to the sea, closer to the mountains, closer to what life in Hawaii should be."

James A. Michener

There are many Hawaiis. For families, the finest one may begin in an economical condominium. A private place from which you go out and discover a paradise you can call your own.



Even a beginner could claim his tennis game is "beautiful" in a setting such as this.



Space and savings. That's what Hawaiian condominiums offer you. Often you have the ocean for a neighbor and a golf course for a yard. Having your own kitchen frees your lifestyle wonderfully.

Have your own private luau. Throw off your inhibitions and go native.

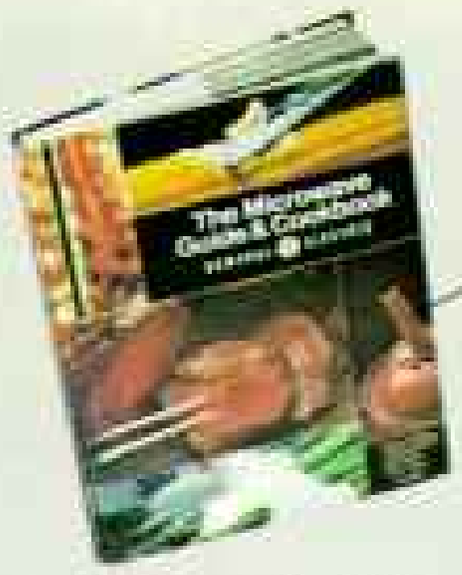
# Fly the friendly skies of United®

United has many condominium vacation plans, on five different islands. Choose a home or apartment, secluded or close to everything. On the way to Hawaii and back, you'll enjoy United's exclusive Royal Hawaiian Service on a roomy 747. For information, call your Travel Agent or United.

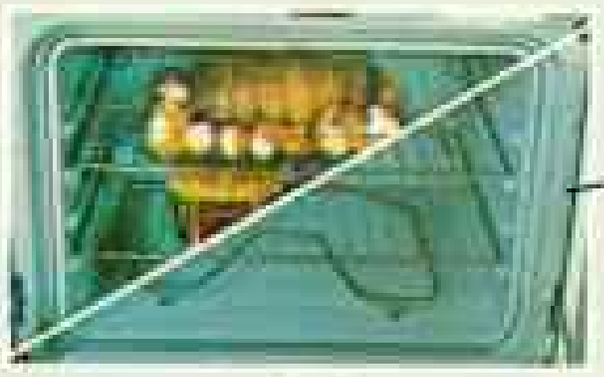
# YOU CAN COUNT ON GENERAL ELECTRIC FOR GREAT IDEAS IN COOKING.

# THE GENERAL ELECTRIC MICROWAVE COOKING CENTER.

At General Electric, we know what makes America cook, as you can see from all the cooking versatility we've built into one superb appliance. The Microwave Cooking Center combines the speed and convenience of microwaving with the traditional benefits of conventional cooking, and fits comfortably in your current kitchen space.




General Electric's "Microwave Guide and Cookbook" that comes with the Cooking Center is much more than a recipe book. It's a complete how-to guide that takes the mystery out of microwave cooking with simple step-by-step lessons, recipes and 450 color photographs.



The conventional oven not only gives you the convenience of General Electric's P-7* self-cleaning system, but an automatic oven timer. There are also settings for bake, time bake, broil, and clean, in addition to temperature control.

The upper microwave oven features the General Electric Micro-Thermometer™ control. Just insert and set the desired temperature and the oven shuts off automatically when it's done. It also has digital time control and gives you the cooking flexibility of multiple power levels.

The surface units are engineered to give you an infinite choice of heat settings. The range is also available with ceramic glasstop cooking surface. The controls are conveniently placed at eye level next to the upper oven.

THE APPLIANCES AMERICA COMES HOME TO.

GENERAL ELECTRIC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