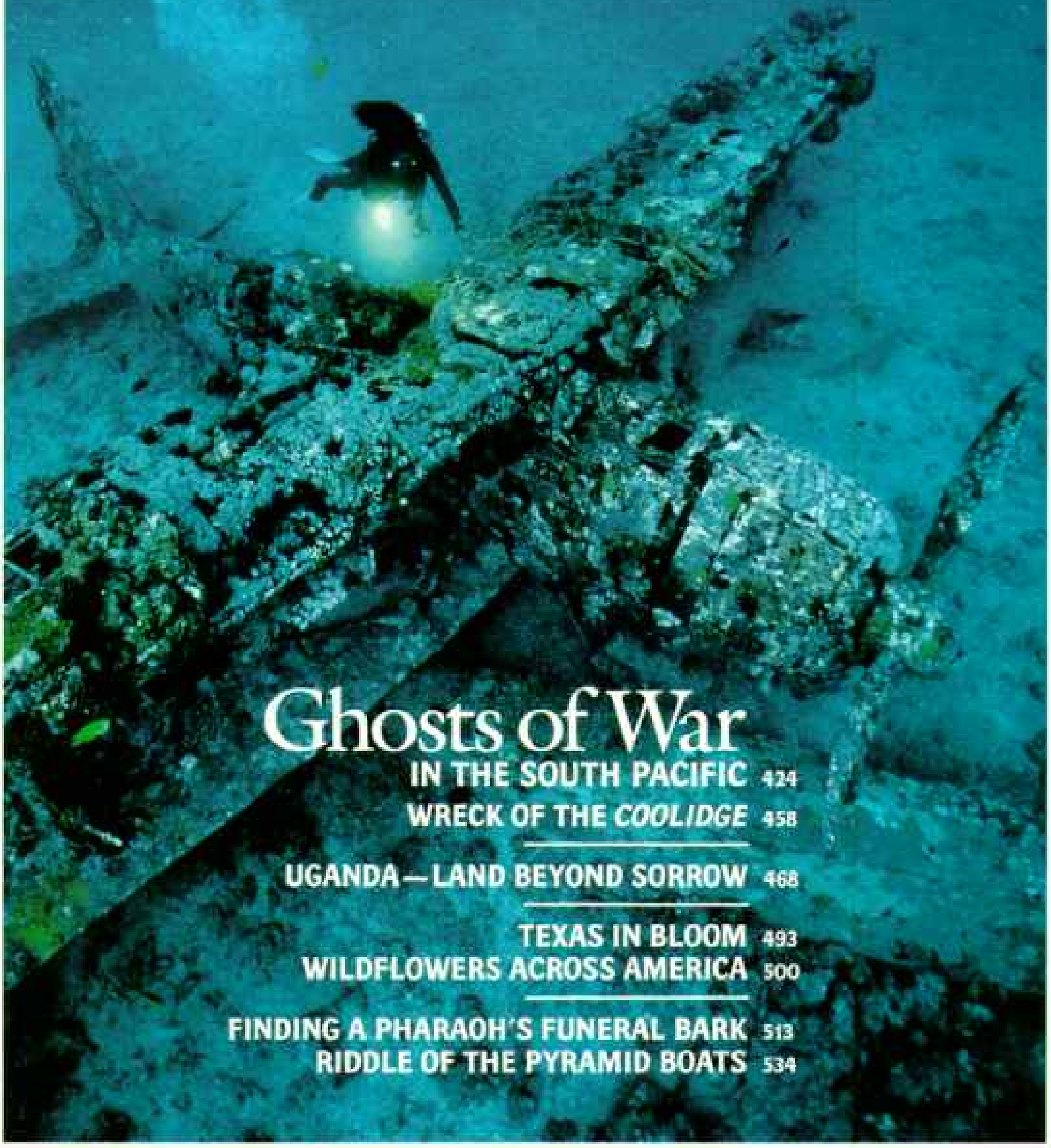
VOL. 173, NO. 4 APRIL 1988

# NATIONAL GEOGRAPHIC



## Ghosts of War
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# NATIONAL GEOGRAPHIC

APRIL 1988

**Ghosts of War in the South Pacific** 424

*During World War II hundreds of aircraft and ships went down in the South Pacific. Peter Benchley recounts the action and, with photographer David Doubilet, discovers that marine organisms have transformed wrecks into magnificent living memorials.*

**Wreck of the *Coolidge*** 458

*David Doubilet takes us on a tour of the President Coolidge, luxury liner turned troop transport, which sank in 1942 at Espiritu Santo en route to reinforce Allied forces at Guadalcanal.*

**Uganda—Land Beyond Sorrow** 468

*Death has become a way of life in this once prosperous East African nation, ravaged by two decades of anarchy, chaos, and massacres, and now by the specter of AIDS. Robert Caputo reports.*

**Texas in Bloom** 493

*The Lone Star State finds a place in the sun for wildflowers, says the First Lady of beautification, Lady Bird Johnson.*

**Wildflowers Across America** 500

*Artist Jack Unruh captures the astonishing color and variety of the blooms that nature plants from eastern woodlands to high mountain meadows. With text by Michael E. Long.*

**Finding a Pharaoh's Funeral Bark** 513

*Scientists penetrate a crypt near Egypt's Great Pyramid to reveal a sacred craft unseen for 4,600 years. By Farouk El-Baz, with photographs by James P. Blair and Claude E. Petrone.*

**Riddle of the Pyramid Boats** 534

*Why did the ancient Egyptians disassemble and bury two full-size royal ships near the tomb of the great pharaoh Khufu? What purposes did the vessels serve? Peter Miller investigates the puzzle. Photographs by Victor R. Boswell, Jr.*

**COVER:** *Lost off northeast New Guinea during World War II, a Japanese biplane used for scouting lies encrusted with corals and sponges. Photograph by David Doubilet.*

A HUNDRED YEARS AGO George Eastman put roll film in a box camera, called it a "Kodak," and sold the idea that "you push the button, we do the rest." He didn't invent photography, he popularized it. That same year, the National Geographic began popularizing geography, and the camera soon became its basic tool. Ever since we've been putting rolls of film in little boxes, taking them from mountaintops to ocean floors, and printing the results.

This month we bring you the results of not taking but sending these photographic partners into a sort of time capsule. Together with Egyptian archaeologists, we designed the tools to send a camera into a sealed chamber at the foot of the Great Pyramid. We sent light into the chamber via fiber optics, so that no heat or bulky equipment entered the sealed space. We included a tiny remote video eye that weighed less than that first roll of film Eastman used. And thus we discovered a 4,600-year-old funeral boat of the pharaoh Khufu, or Cheops.

Making images where man cannot or should not go is an old trick, but new technology has made it an invaluable technique for many fields. In many cases film has given way to electronic imaging that can see well beyond the power of the human eye. Before the camera entered the chamber, ground-penetrating radar had shown that there was indeed a chamber down there. Airborne radar can penetrate vegetation and reveal ruins hidden in jungles for centuries.

Recently Emory Kristof of our staff remotely recorded, in stereo color video, shark behavior 2,000 feet down in the blackness of the ocean. Two years ago we printed a prehistoric human skull in three dimensions using holography—a sort of photography that uses no camera and can, in its pure form, only be seen using laser light.

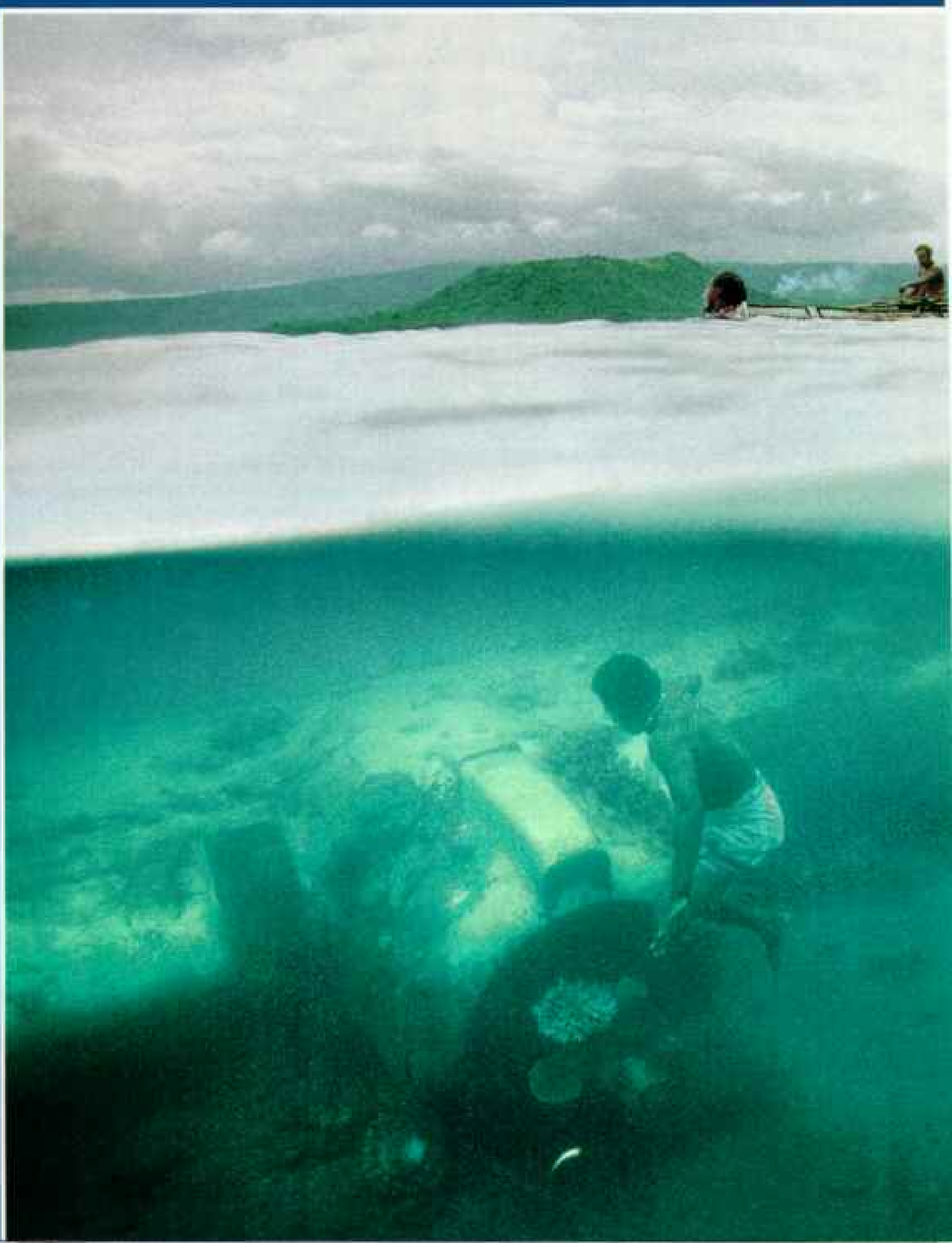
Last year we showed how electronic pictures of the surface of stones can distinguish real jade from fake. Our medical-imaging article explained the new tools used in medicine to "photograph" inside the body without making an incision. In a future issue we'll present an article on computer imaging, which can produce pictures that never existed except in the mind of the operator.

A hundred years from now there's no telling what will happen when we push the button, but whatever it is, we'll find a way to print it.

Wilbur E. Garrett

EDITOR

# *Ghosts of War in the South Pacific*

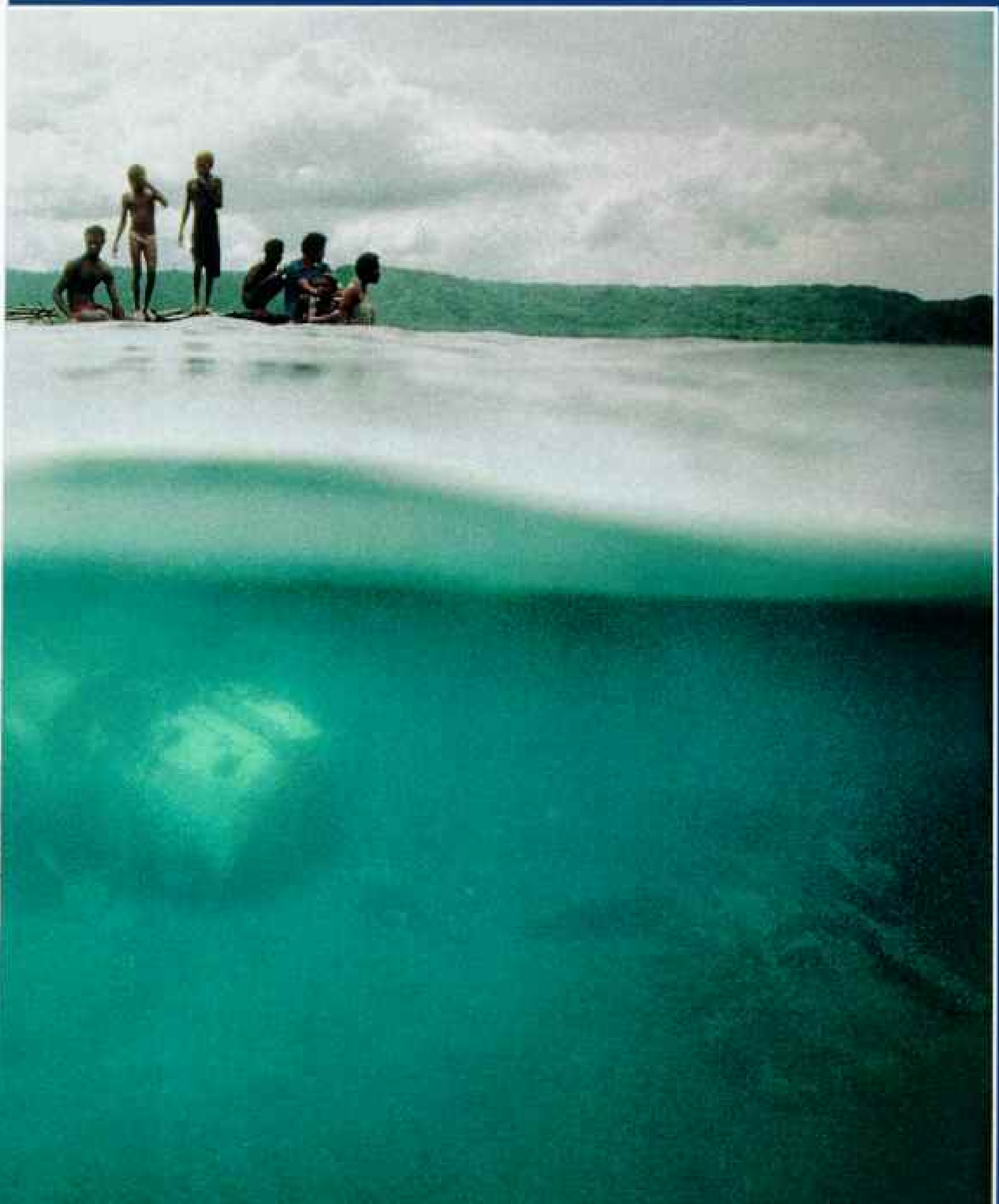


By PETER BENCHLEY

Photographs by DAVID DOUBILET

*Japanese eye in the sky, a World War II Kawanishi flying boat is now a playground for Papua New Guineans at Rabaul. In the southwestern Pacific shattered engines of war bloom with marine life—and history.*





*"It was the blackest of black nights . . . the worst flying weather I'd ever seen in my life."*

FROM RALPH DELOACH

*RALPH DELOACH has not forgotten those evil winds of July 11, 1943. Trouble shadowed his B-17F, dubbed* Black Jack, *as it roared from New Guinea's Port Moresby to bomb an airstrip at the Japanese fortress of Rabaul some 500 miles northeast on New Britain Island. Near the target severe weather struck. With both starboard engines crippled, the crew still managed to drop their bombs. Although they "worked every moment to keep the ship in the air" while returning, they finally had to ditch off a southeastern New Guinea beach near Boga Boga. Aided by its villagers, all survived. Forty-four years later, divers found the plane 150 feet deep, saluted by a lone strand of whip coral (right). DeLoach is shown above, second from left in front row with an earlier bomber crew, and below in a museum's B-17 today. Such planes were used in skip bombing, a low-altitude tactic to explode bombs near or against a ship's hull.*

PHOTOGRAPHED AT THE PLANES OF FAME MUSEUM, CHINO, CALIFORNIA



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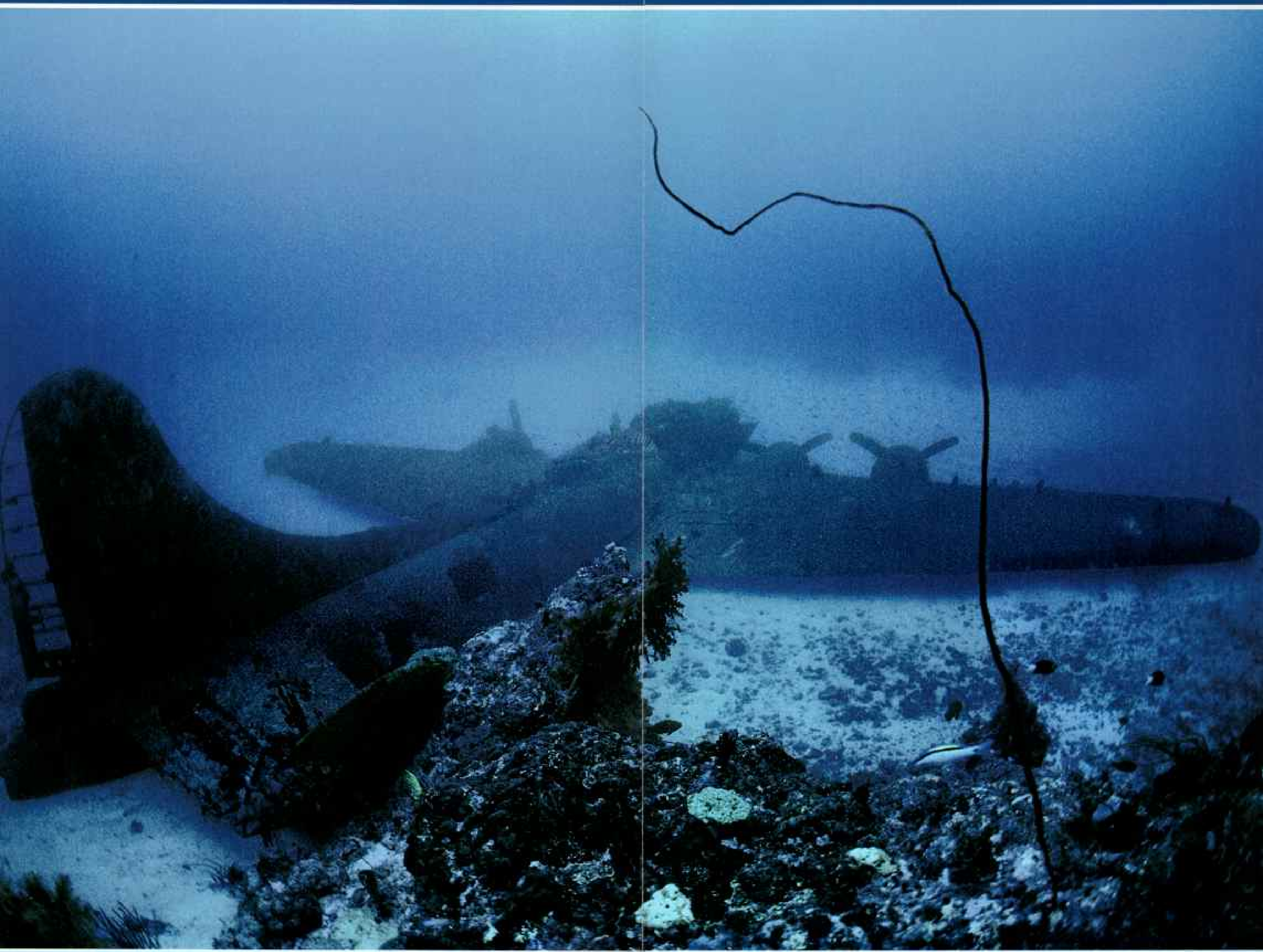
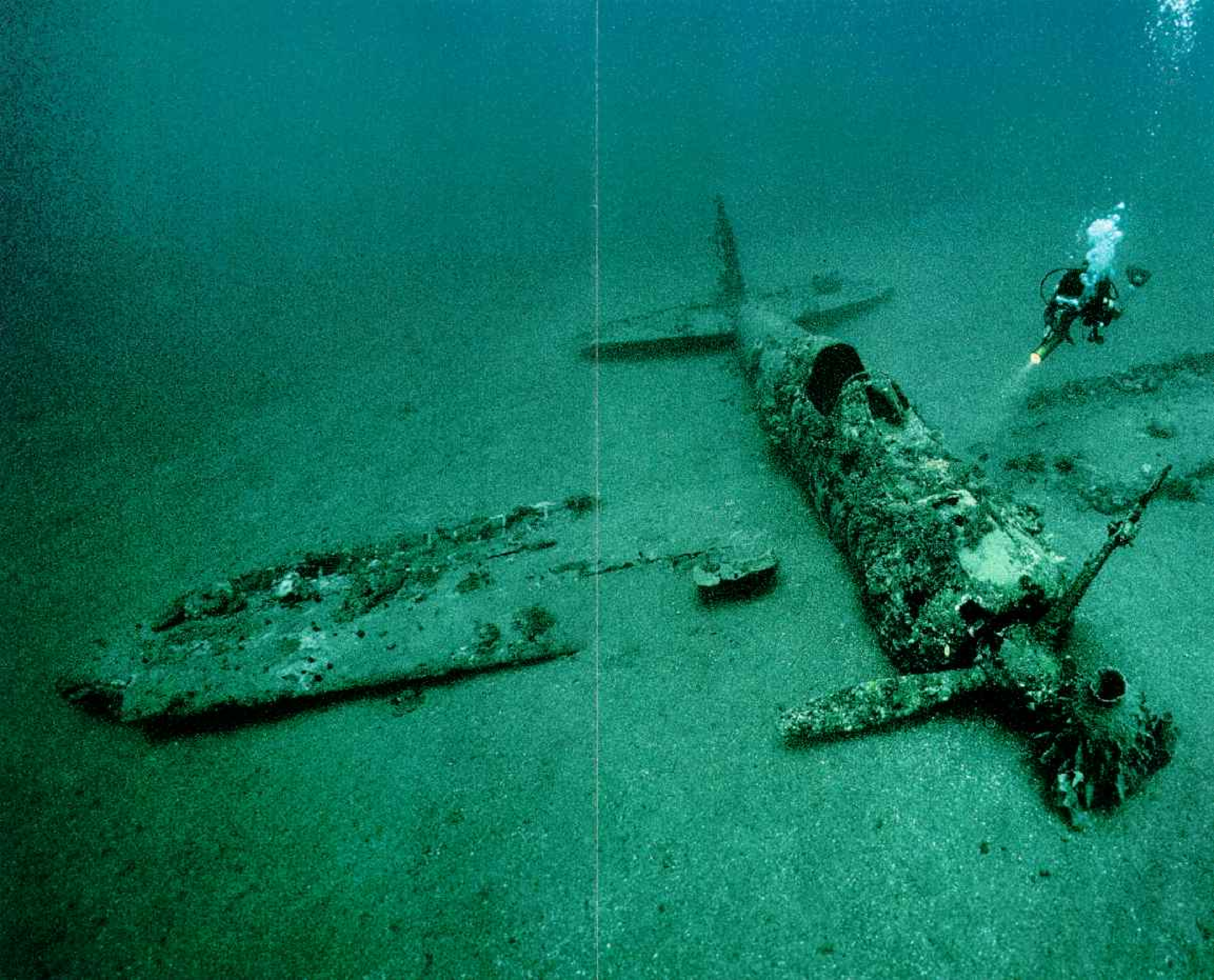
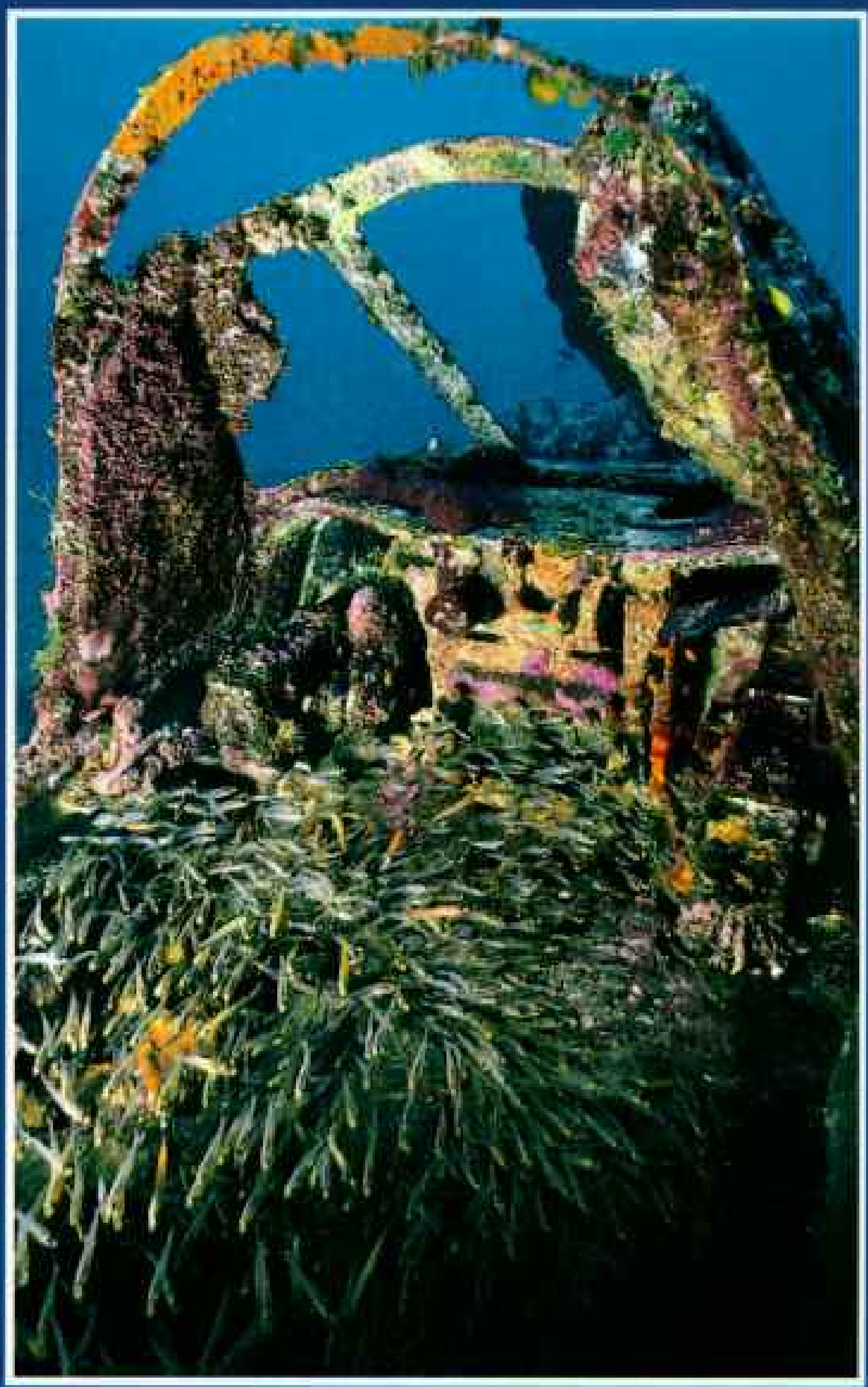




*LIVING HEADSTONE, a barrel sponge grows in front of a Japanese Zero downed near Rabaul. Silversides teem in the cockpit (below) where sponges and coralline algae encrust surfaces such as the butts of two 7.7-mm machine guns.*

*Perhaps the pilot, reportedly rescued by New Britain natives, was outmaneuvered by a F-4U Corsair or a P-38 Lightning from a Solomon Islands base: From October 1943 to March 1944 alone, 200 to 300 Japanese planes were destroyed in and over Rabaul. The Zero's superior range and performance won early battles for Japan, but its aircraft industry could not match improved Allied fighters that later ruled the air.*



# Battlegrounds of the Pacific

*This map was published in our July 1942 issue with an article extolling the effectiveness of carrier-based warfare and theorizing a future, massive U.S. offensive. An American flag, the first illustration to appear on the cover of our magazine, graced that issue.*

**Carrier Men's Vision of the Future**

The dramatic attack of Brig. Gen. James Doolittle and his squadron of U. S. Army bombers struck at the heart of Japan, April 18, 1942. Unexpectedly, like a bolt of lightning, these fast planes hurled the factories and shipyards from which came the planes, tanks, and ships that laid waste the face of Asia.

If the United States had today a great fleet of aircraft carriers, it could send against Japan continuous waves of bombers in overwhelming masses.

Our last task forces which have operated so successfully in Micronesia and the Coral Sea consisted of only one or two carriers with accompanying cruisers and destroyers. Think what damage they could do if they operated with two of carriers and hit at many scattered places at the same time.

Also, we would have spares (or replacements because aircraft carriers fight offensively and, of course, suffer losses and injuries.

In the accompanying diagram the cartographic artist has portrayed the aviators' dream of the future" (page 73).

SEA OF OKHOTSK
OSTROV SAKHALIN
KARAFUTO
HOKKAIDO
Hakodate
Petropavlovsk
Komsomolsk
Magdagachi
Harbin
Vladivostok
SEA OF JAPAN
Changchun
MANCHUKUO
Mukden
CHOSEN (KOREA)
Keijo
Pyongyang
Tientsin
Nagoya
Tokyo
Kyoto
Kobe
Yokohama
Shimonoseki
Nagasaki
Sasebo
JAPAN
Nanking
Shanghai
Ogasawara (Bonin Islands)
Marcus
Yungkia
Kinhwa
Changsha
Chungking
Kunming
Canton
Hong Kong
TAIWAN (FORMOSA)
Saigon
Lashio
BURMA
Hanoi
SOUTH CHINA SEA
LUZON
Manila
PHILIPPINES
FRENCH INDO-CHINA
HAINAN PENINSULA
Rangoon
THAILAND
Bangkok
MINDANAO
Davao
Palau Islands
CAROLINE ISLANDS
MARIANAS ISLANDS
Saipan
Tinian
Rota
Guam
Truk
Ponape
MARSHALL ISLANDS
GILBERT ISLANDS
ELLICE ISLANDS
FIJI
MALAY PENINSULA
MALAY STATES
Singapore
BORNEO
CELEBES
NETHERLANDS INDIES
TIMOR
Batavia
Tjilatjap
Christmas
Darwin
Cape York Pen.
Port Moresby
NEW GUINEA
Rabaul
New Britain
Solomon Islands
Bismarck Archipelago
Admiralty Islands
Cairns
NEW CALEDONIA
Noumea
Wyndham
Broome
Perth
Derby
Bendum
Alice Springs
Darwin
Brisbane
Lord Howe
Sydney
AUSTRALIA
OCEAN

Big carrier (lac) brings mobile airports within easy range of Japan's industrial heart, launches and flushes the carriers never strike twice from the same spot.

Sea force air attack strikes handle at three (also) "flying wing" rather than its many tail-flung ends.

Result: Japan draws in its scattered forces to protect the homeland like a shot drawing in its horns when threatened by an enemy.

Jap planes hop from island to island along their main axis of plane whip to attack United Nations lines and supply routes.

Entire Jap-held island area is subject to sudden sea-borne air attacks.

AREA ENLARGED

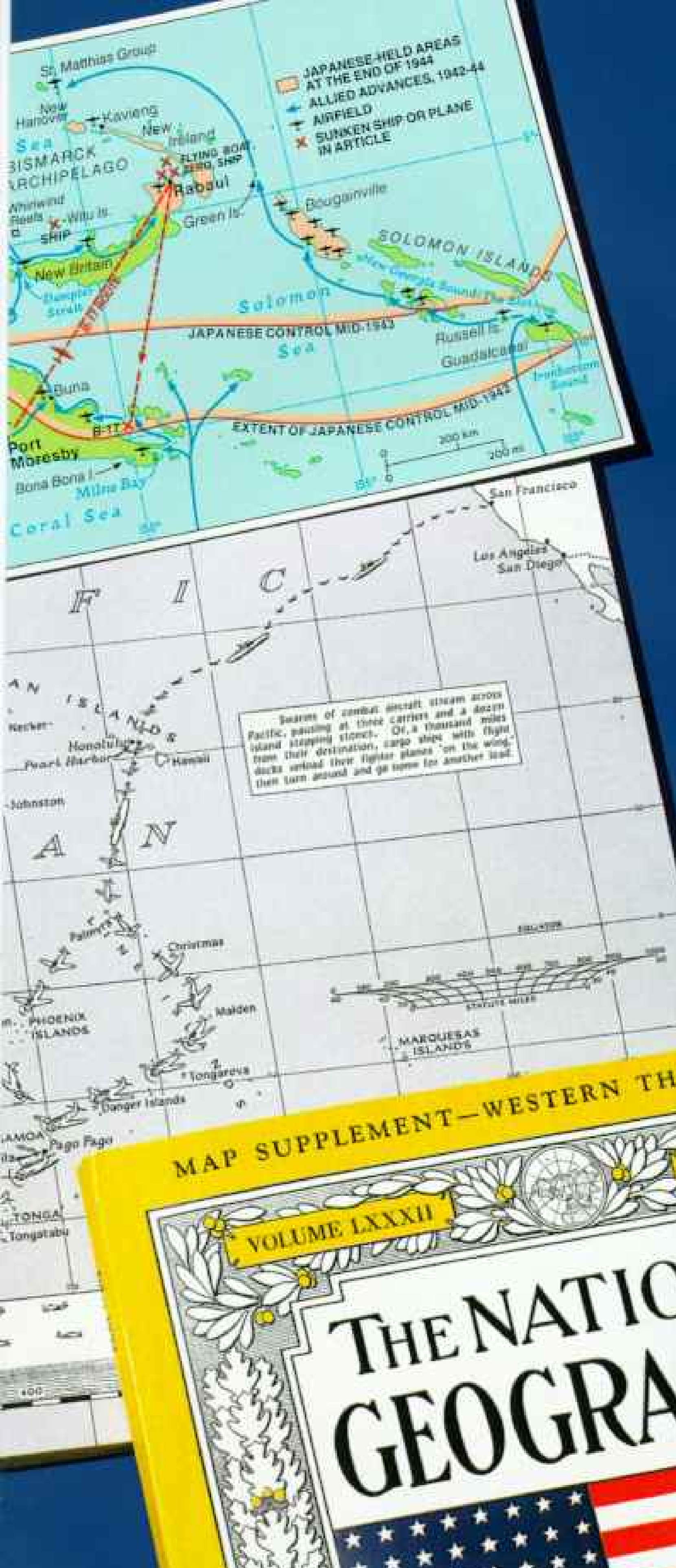
Aircraft carriers formed spearheads of Jap advances through the Indies.

Combat planes ready for action arrive via stepping stones in a few days after leaving U.S. Those shipped in crates require six to eight weeks and then must be unpacked and assembled after arrival.

Coolidge wreck
See page 69

PAPUA NEW GUINEA
Independent since 1975, it includes Bougainville, half the island of New Guinea, and the Bismarck Archipelago.

AUSTRALIA




*BRUTAL FIGHTING raged from New Guinea through the Solomon Islands during the Second World War. Hundreds of ships and aircraft that went to the bottom now attract marine life in amazing diversity in the Solomon and Bismarck Seas.*

*In January 1942 Japanese forces took Rabaul on New Britain Island and set up a garrison of 100,000 troops, five airstrips, and a naval base. From there a Japanese force attempted to invade Port Moresby, an Allied base in New Guinea, but was turned back in the Battle of the Coral Sea. When Japanese troops landed on Guadalcanal in the Solomons in July, U.S. Marines followed a month later and held on for 26 weeks, as wrecks littered a channel called Ironbottom Sound. American reinforcements came from Espiritu Santo in the New Hebrides.*

*In the Battle of the Bismarck Sea of March 1943, 6,900 Japanese troops from Rabaul tried to reach New Guinea. Allied forces led by skip-bombing planes cut the convoy to pieces. The Allies finally ringed Rabaul with bases and bombed it into impotency.*

MAP SUPPLEMENT—WESTERN THEATER OF WAR

NUMBER ONE

VOLUME LXXXII

# THE NATIONAL GEOGRAPHIC

NATIONAL ARCHIVES

*FRANTIC Japanese warships streak Rabaul's Simpson Harbor as they flee for the open sea during a November 1943 attack by U.S. aircraft from the carriers* Saratoga *and* Princeton. *The harbor has regained its beauty (right), but its bottom entombs a host of ships such as* Hakki Maru, *a naval vessel sunk by B-25s on January 17, 1944.*

# *War and Peace in a Coral Kingdom*

AS WE DOVE through 40 feet, then 50, then 60 feet of silty waters that seemed like tepid shampoo, we could see her lying on her side like a mortally wounded bird come to final rest on a coral slope. One of her wings was fractured, one of her engines gone. Had the engine been blown away by fighter fire? Was its loss the cause of her fall from the tropical sky more than 40 years ago?

She was a B-25 (below), a workhorse of World War II in the Pacific, and my imagination did not have far to stretch to see her ready to fight again. Twin .50-caliber machine guns were poised to fire from her shattered nose, their racks of bullets still stacked and ready though yellow now with growths of coral and algae, patched here and there with red gorgonian coral. The radio direction finder was still mounted, bomb-shaped, on the top of the fuselage, though it had become the home of two giant razor clams whose eely mantles recoiled from my touch.

The cockpit escape hatch was open, slid back as it had been on the August day in 1943 when the pilot pancaked his bomber onto the Bismarck Sea in this narrow strait between Wongat Island and mainland New Guinea. I floated into the pilot's seat and pressed my flippered feet against the rudder pedals and wrapped my fingers around the coral-encrusted controls and gazed through the murk at the windshield. I tried to feel what the hapless crew must have felt on that awful day.

One American had died in the crash—the top turret gunner. The captain (The "old man"! How old had he been? Twenty? Twenty-one?) and the rest of the crew had swum to Wongat Island. There the Japanese captured them. They shipped the command pilot to a prison camp on Rabaul. But the fate of the other men is unknown.

SEA FAN, MELITHAEIDAE, A #1 (OPPOSITE)

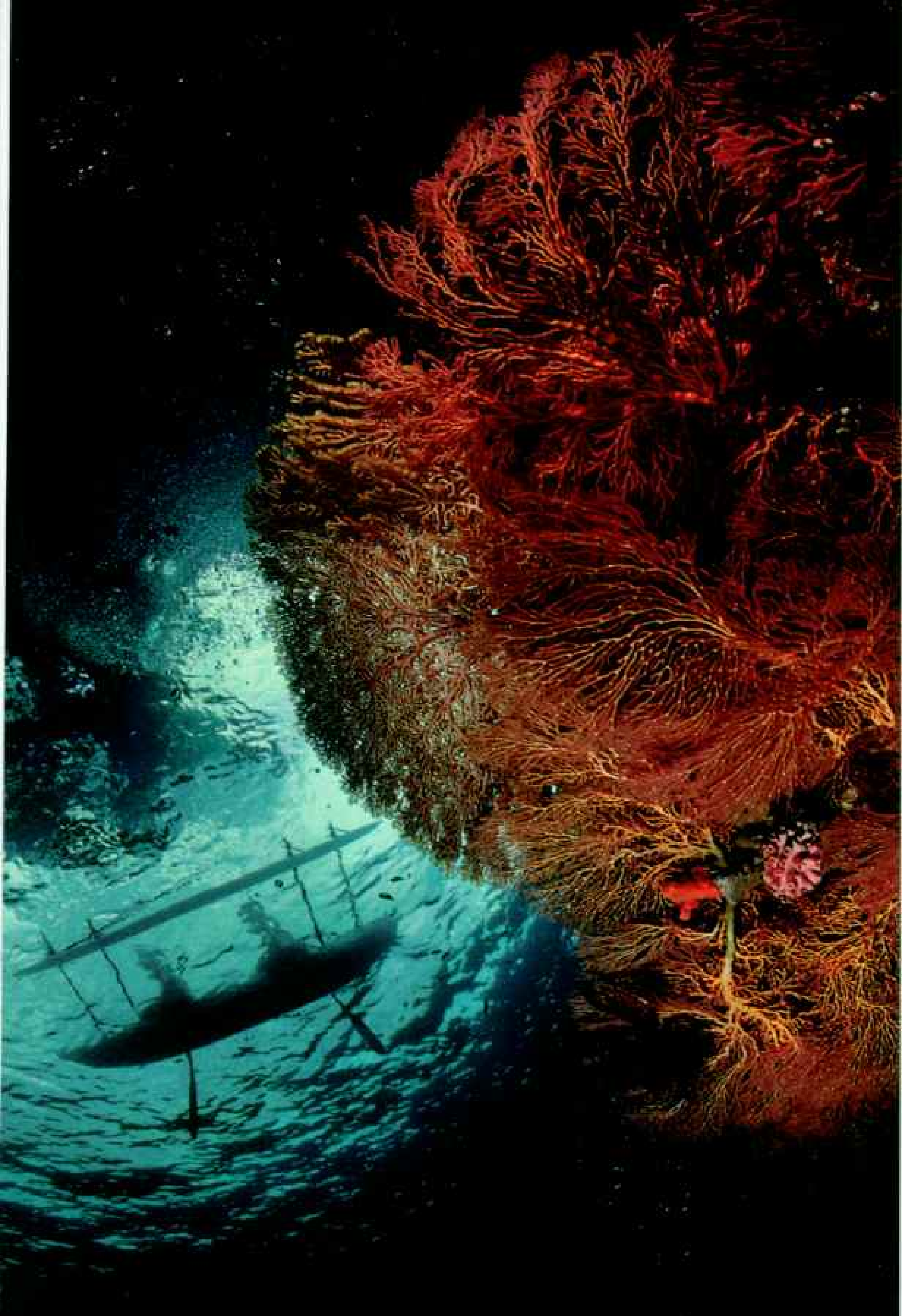
*FANTASY GROTTO of sea fans and other gorgonians luxuriate in the shade cast by trees on a bank overhead, as young Papua New Guineans paddle their outrigger (opposite). The Solomon and Bismarck Seas are among the world's richest coral cradles.*

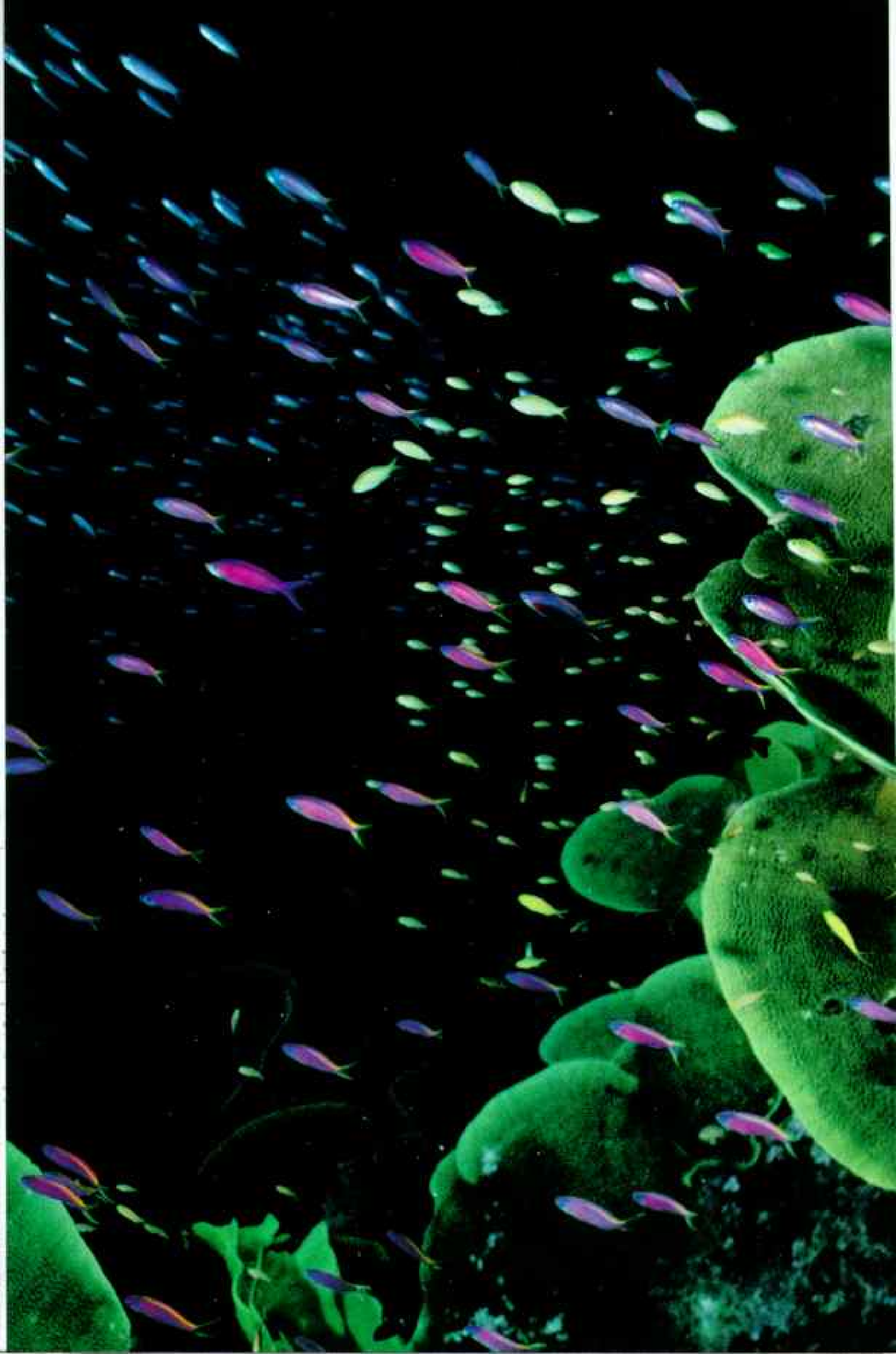
Their epitaphs were stark words in dispatches: "Last seen between Bona Bona and Dumpu . . . Lost at sea near Buna . . . Burning out of control over Madang."

I began to have the uncomfortable sensation that I was sitting inside a coffin.

But then a parrot fish darted in front of me and gnawed happily on the coral crust on a machine-gun barrel. Two angelfish fluttered out of the darkness of the bomb bay behind me. A translucent shrimp traversed the rusty face of the altimeter gauge.

PETER BENCHLEY, well-known author of novels and nonfiction works, wrote about the Cayman Islands in the June 1985 issue of the GEOGRAPHIC. That story was also photographed by underwater specialist DAVID DOUBILET, one of 23 he has done for the magazine.





OVERLEAF

*EXQUISITE TAPESTRY, purple anthiases and yellow damselfish stream past chalice coral in a quest for plankton near Milne Bay. Papua New Guinea's waters teem with some 2,000 species of coral-reef fish.*

ANTHIAS TUKA, 3 IN; DAMSELFISH, AMBLYGLYPHIDODON AUREUS, 4 IN

I realized then that death had not prevailed here for decades. Almost as soon as the B-25 had died, the sea had begun to give it a new life, and now what had once been an engine of war was a living monument to the endurance of nature. The plane had become a reef, a festive garden home for thousands of creatures.

Purple sea fans grew from the tail rudder and waved in the current's surge; feather-duster worms, anchored to the steel skin of the plane, spread their leafy feeding arms and gleaned plankton from the green mist; crabs scuttled through the deep silt in the belly of the plane, shouldering aside bullets that the shifting sands had polished to mint newness.

I rose from the cockpit and hovered above the plane, and the current eased me up and away. Within seconds contours of the B-25 blurred, and in a minute it was gone, last seen in eerie resurrection from its grave ten fathoms beneath the Bismarck Sea.

WE HAD SET OUT from Madang on the north coast of Papua New Guinea—photographer David Doubilet, Australian naturalists and photographers Ron and Valerie Taylor, and I—in search of the lost and the never-known. The roughly 20,000 square miles of the Bismarck Sea are a contradiction wrapped in a curiosity. In the early years of the war the waters off eastern New Guinea were among the most active, most tumultuous, most violent on the planet. Hundreds of ships and planes were lost; thousands of men died here and in the battles for Guadalcanal in the Solomons and Rabaul on New Britain. And yet as soon as the war was over, the Bismarck Sea was all but forgotten.

The names of its islands (Palitolla, Baluan, Wuvulu) ring with exotic musicality, stirring dreams of fancied paradise—dreams that conveniently ignore the grimmer realities of illiteracy, endemic diseases, and an infant mortality rate so high that many children are not named until they have survived for at least a year.

Much of the area has never been dived by human beings, yet some of it is already being destroyed by men who trade away their natural heritage for dynamite and beer.

For the most part, it remains a sea of Eden, placid, too close to the Equator to be frequently storm torn, populated by animals who have never seen man. But it is also a sea seething with natural violence and sudden dangers, in which some of the inhabitants—thousands of species live in these waters—can kill a man with a single touch, some with a single taste.

SAILING FROM Madang aboard the Taylors' 57-foot *Reef Explorer*, we crossed the Isumrud Strait and headed north for the volcanic peaks of Bagabag and Karkar. Like many of the islands in the Bismarck Archipelago, Bagabag and Karkar reflect cultural hybridism: Bagabag is the local name for the island, for example, but its two bays are named Christmas and New Year, for the holidays on which English and Dutch explorers first anchored there in the 17th century. The Germans named the sea for their chancellor Otto von Bismarck, when they annexed the islands in 1884.

We dropped anchor in New Year Bay and gazed at the emerald rain forest that soared high into the perpetual cloud cover caused by the heat rising from the dot of land into the sea air. On the shore was a small cluster of thatched huts—the homes of Bagabag's community of copra workers.

Our first dive was in the Isumrud Strait, and for a moment we feared it might be our last. The current raced between the islands at an indomitable 2.5 knots. The only way we could keep from being swept through the strait and into the open sea was to moor ourselves to rocks and crawl along the bottom hand over hand. What was an obstacle for us air-breathing land creatures, however, provided a cornucopia for the reef residents. They did not have to hunt. They hung steady in the strong current and let their food come to them.

As I clung to a pumpkin-size brain coral, I was greeted by a phalanx of huge green parrot fish, creatures three or four feet long that weigh 50 or 60 pounds, each sporting on its forehead what looked like a radar dome. Known as bumpfish or bumphead parrot fish, these megacephalic monsters paid no attention to me but, on some secret signal from one of their number, lowered their heads to the reef and began to eat coral with their horny beaks.

sending through the water a sound reminiscent of hobnailed boots on a gravel driveway.

A speckled gray-brown Pacific cuttlefish danced before my mask, its sleepy slit eye making it look like a weary roué. I reached out a hand, expecting it to flee, but it hovered unafraid and permitted me to run a finger along its side—which, as if in indignant comment, changed color instantly to a vivid lavender.

The reef became an explosion of species, a gathering of nature's clans, all of whom came to explore these aliens who had plunged noisily into their neighborhood. Sergeants major and angelfish swarmed around the divers, sensing neither danger nor prey, merely curious.

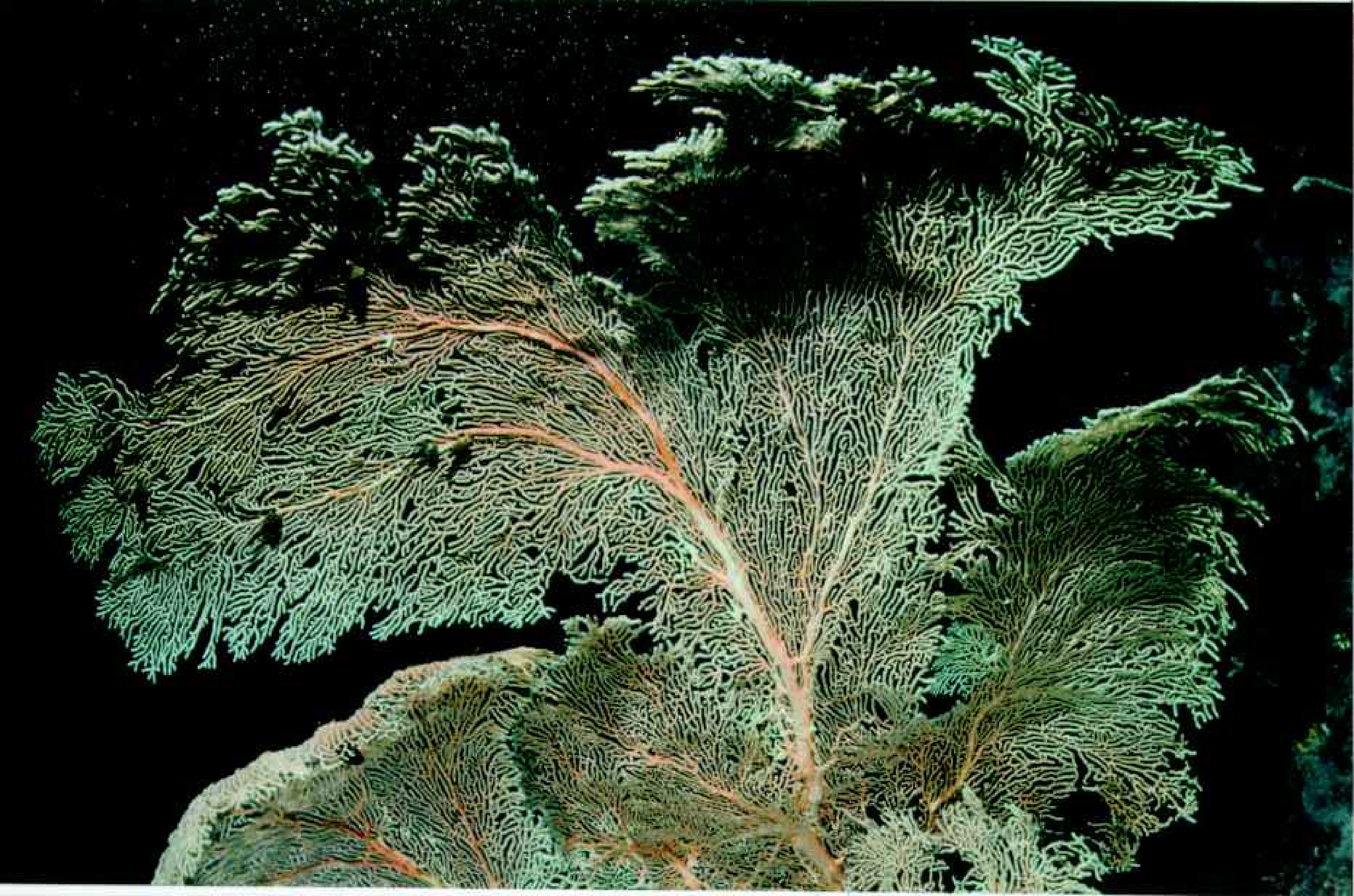
Three small silvertip sharks rose up the reef face from the violet deep, like a patrol of outriders scouting the borders of their territory. They eyed each diver, as if appraising him as a potential competitor, then moved on. The other reef fish manifested no alarm at the arrival of the sharks and did not scatter or flee, for apparently the sharks had emitted no chemical or electromagnetic advertisements that they had come to feed.

Watching the sharks glide away down the reef, I had the feeling *I* was being watched. I refocused my eyes onto the brain coral and there saw, peering at me like an impatient hide-and-seek player wondering why he has not been found, a tiny rainbow: a harlequin tusk fish, five or six inches long, with repeating vertical stripes of red, orange, black, and yellow. It looked at me, flicking its pectoral fins just enough to keep it stable, and I looked

*SHY MASKED BEAUTY, a yellow-faced angelfish off New Ireland Island grazes sponges with its tiny sharp teeth. Vivid hues help angelfish claim a territory. Trespassers are threatened with a twisting display.*

POMACANTHUS ARCUATUS, 12 IN

*STEPPING-STONES for the "Tokyo Express" of Japanese naval maraud-ers that tormented U. S. Marines, three fragments of the Russell Islands march toward Guadalcanal, veiled by a towering thunderhead. "You may search the seven seas in vain for an ocean graveyard with the bones of so many ships and sailors," wrote naval historian Samuel Eliot Morison, "as that body of water . . . named Iron-bottom Sound," located just north of Guadalcanal. It holds many of the 48 Japanese and Allied ships lost during the six major naval engagements of the six-month cam-paign. After securing Guadalca-nal in February 1943, U. S. forces moved into the Russells and set up a base on Mbanika Island. A trac-tor dumped into the harbor (below) probably once hauled pallets of 90-mm shells. Children from the same island (right) paddled up to photog-rapher Doubilet's dive boat to trade limes for candy. "They tool around in outriggers the way Western kids do on bicycles," he reports.*



OVERLEAF

*TRUE CHILD OF GORGON, the Greek monster for whom gorgonians such as sea fans were named, a seven-foot-wide specimen dwarfs guide Bob Halstead near Milne Bay.*

MELITHAEIDAE

*FURTIVE MASTER OF CAMOUFLAGE, a goby hides among branches and polyps of gorgonian coral. The diminutive fish, which has the uncanny ability to change its color to that of the coral it adopts for protective habitat, feeds on plankton.*

at it, wondering what kind of cruel joke nature had played on it. Many animals' coloration provides them with camouflage; it seemed to shriek, "Here I am! Eat me!"

I pulled myself closer. The tusk fish shivered once and vanished into the reef. A vast school of iridescent blue fish swooped by, their brilliant yellow tails flashing in the shafts of sunlight that dappled the blue-green water. Valerie told me later that the fish are called fusiliers and that the name probably derives from the blue-and-yellow jackets worn by the fusiliers of some 18th-century colonial power.

"Some fish are very loyal," she said. "Back in the early days I speared a turrin for shark bait. It got off the spear and fluttered down toward a hole in the reef. Another followed it and tried to cover it with its body, to protect it. It flattened itself over the hole where its wounded friend was. But the shark got it. Ron and I swore we'd never spear one of them again."

That evening we dined on New Zealand lamb, and it occurred to me that here we were, anchored atop an endless supply of fresh fish, eating frozen meat transported from 2,000 miles away. I asked Pip Beatty, the statuesque New Zealander who served as the *Reef Explorer*'s cook, which of the local fish she preferred.

"None," she said.

"You don't like any of it?"

"I don't trust any of it. Down on the Barrier Reef we know what has ciguatera and what doesn't. Up here, everything may have it. We had fish once last trip, and the whole crew got hit. Never again."

Ciguatera is a toxin, which can enter the food chain through algae, is then consumed by the small herbivores, then by carnivores, all the way up the chain to the apex predators—you and me. It seems not to affect the fish, but a man who eats a fish carrying ciguatera may suffer—depending on his size, his health, and the amount of fish he eats—everything from flu symptoms to numbness, ferocious itching, violent gastrointestinal cramps, and perhaps even death. Symptoms usually last for several days, but they can then lie dormant and, upon consumption of even a minuscule amount of alcohol, blossom again.

I knew that in the Caribbean the traditional (though unscientific) test for ciguatera in

barracuda was to drop a silver coin into the pot with the fish: If the coin tarnished, the fish was ciguatoxic. I asked Valerie if there was any local test.

"Oh yes," she replied. "Here they put the fish out in the sun, and if the flies don't walk on it, they don't eat it."

The lamb was delicious.

FROM BAGABAG ISLAND we sailed to Cape Croisilles and a shipwreck. Local divers believe that the ship was recruited after the war to sweep mines along the Papua New Guinea coast, and broke down one day in 1946. She drifted, helpless, onto the coral cleavers that line the shore. She lies today less than a hundred feet from shore, in 60 to 120 feet of water, a spectral hulk resting upright on the sloping, rocky bottom.

On old maps when describing unknown lands and seas—presumably so as to seem more knowledgeable than they possibly could have been—cartographers would often scrawl, "Here be dragons." On my chart of this area off Madang I scrawled, "Here be villains," for there we found a huge gathering of some of the most venomous fish in any sea.

Lumped together scientifically in the family Scorpaenidae, they are known as scorpionfish, lionfish, and stonefish. Specific locales have dubbed them more dramatically: horrid stonefish, fire scorpionfish, and so on. All have dorsal spines that, when touched, emit a poison virulent enough to cause (at best) discomfort and (at worst) death. The best that can be said about the Scorpaenidae is that they are shy and unaggressive, and many of them are spectacularly visible—with Aubrey Beardsley wings and great flourishing tails.*

The worst that can be said about certain varieties—especially about stonefish—is that they are *in*visible. They are called stonefish because, nestled into the rugged contours of the sea bottom where they wait patiently to swallow unwary passersby, they are indistinguishable from mottled rocks.

We had been warned never to wade ashore without wearing heavy-soled shoes, for any misstep, a stagger caused by a breaking wave, could impale a bare foot upon the spines of a buried stonefish.

One day Valerie beckoned me to a small cave on which she was focusing her camera. I peered inside and saw nothing. She pointed again. I peered again. Nothing. I reached out to pull myself deeper into the cave . . . and

*IN A REDDISH WEB of sponge strands, a tiny fish called a triplefin lurks like a loose end in a drawer full of thread. Males and females of this species are alike in color and remain so; other triplefin males take on vividly different hues when spawning.*

*See "Scorpionfish: Danger in Disguise," by David Doubilet, in the November 1987 GEOGRAPHIC.

Valerie struck me on the arm with her camera housing. I looked quizzically at her and saw in her eyes an alarmed assumption that she was dealing here with a varsity lunatic.

Cautiously Valerie pushed her camera housing into the cave and touched the rock I had been about to grab. It quivered, showering sand over its scrofulous-looking body, then arched the venomous spines along its back, opened a gash that must have been its mouth, and gazed our way with a dark and baleful eye.

Rivulets of sweat ran down my forehead and fogged the faceplate of my mask.

THE WATER was so warm that several of us scorned heavy neoprene wet suits and dove instead in light Lycra bodysuits. (I, afflicted with chronic clumsiness and an uncanny ability to encounter the one razor-sharp stone, stinging jellyfish, or flesh-rending coral on an otherwise innocuous reef, persisted in wearing neoprene.) That afternoon four Lycra-clad divers went down to photograph a pair of moray eels Valerie had lured out of a cave and was feeding bits of fish.

The divers encircled the mouth of the cave and lay on the bottom on a carpet of gray anemone—no different, they thought, from the scores of other anemones they had encountered on scores of other bottoms. They photographed until the poor eels were strobe-stunned, then came to the surface.

Within half an hour all four divers were in agony. Their arms and legs itched and burned; their fingers swelled so that their hands resembled catchers' mitts; rashes, sores, lumps, and welts rose on their buttocks and bellies. They washed themselves with alcohol, with ammonia, with antiseptics; they smeared themselves with meat tenderizer and cortisone creams. Nothing helped. They suffered for almost a week.

The anemone had contained virulent nematocysts, which had fired into the divers through their Lycra wet suits, injecting them with poison.

For every creature that inspired fear, however, there were a dozen that filled us only with awe. One day I found David Doubilet poised, as usual, motionless before a patch of reef. His focus was a plate of bright green coral, which

FIRE URCHIN (ABOVE); ASTHENOSOMA VARIUM, 6 IN; GHOST PIPEFISH, SOLENOSTOMUS PARADOXUS, 4 IN

*POP-EYED AND PUGNACIOUS, a mantis shrimp peers from its sandy burrow off New Ireland Island. Between two green appendages, an extremely powerful pair of claws lies folded, each like the blades of a pocketknife. Its appearance suggests a praying mantis, for which the shrimp was named. Some species grow to a foot in length. When prey such as a fish, worm, crab, or mollusk comes within range, the claws snap out with incredible speed and smash through the victim's shell; smaller limbs then extract the contents. So strong is the shrimp's punch that when placed in a test tube, it can shatter the glass, as startled marine biologists have found.*

*An unwary young shrimp or similar morsel might blunder into the mouth on the left side of a ghost pipefish (left)—related to sea horses—blending into a web of gorgonian coral off Papua New Guinea. There, glowing like a fresh lava cinder, a fire urchin bears a highly reflective surface studded with hundreds of venomous spines.*

SHRIMP, ODONTODACTYLUS SCYLLARUS, 9 IN

was home to two small fish—one bright orange and tiny, the other purple and slightly larger—that were feeding off the plankton-rich soup swept in by the strong current.

The fish were pretty but, to an amateur like me, not particularly thrilling. I shrugged. David pointed to his lips, then up at the surface: He would explain later.

"They're called anthiases," he said when we were back on the boat. "The female's the little orange one, the male's the purple one. They're the ultimate survivors."

"What do you mean?"

"One male services a whole crowd of females. If the male dies or disappears, if he's eaten by something . . . ," he paused for effect, "the dominant female will begin a gradual transformation into a male. She'll become a male and will be able to breed with females."

"Come on. You don't exp—"

"Yes!" David smiled. "Nature protects the colony in a wonderful way."

There are said to be a thousand species of corals here, and as we dove off Crown Island, 70 miles east of Madang in the southern Bismarck Sea, I believed it. We came upon a giant patchwork meadow of hard corals that stretched far beyond the limits of our vision. From above it looked like a multicolored political map of a whimsically gerrymandered state. There were squares of orange and circles of green, triangles of yellow and rectangles of blue, splotches of mustard and brown and red and gray that descended deep to the end of life-giving light.

Growing from the rocks amid the corals, looking like alien flowers, were countless varieties of crinoids—feather stars and brittle stars and animals for which I had no name—of every color in the spectrum, that extended their sticky arms to gather microscopic food from the water and pass it back to the mouth hidden in the cradle of the arms.

From the coral walls hung bizarre beings that could have sprung from the mind of Edgar Allan Poe—miniature human hearts, I concluded (ascidian sea squirts, I would learn), yellow with blue veins, blue with white veins, purple with yellow veins. They pumped like human hearts too, taking in the water of the sea through an aortic tube in the side, gleaning its nutrients somewhere in an interior

chamber, and expelling the water from a vent at the top.

After a break for lunch we moved to another reef, no more than 200 yards away, to see if it was a twin of the first or if it had its own peculiar character and characters. We found devastation, as if a secret war had been waged on this reef alone. There were no patches of color, no live corals at all, no fish, no worms, no shrimps, no sea cucumbers. The reef was as dead as Mars.

I surfaced behind the boat and found Valerie sitting on the diving platform.

"What is it?" I asked her. "A blight?"

"Yes, a blight," she answered with a bitter smile. "The Japanese want to log these islands. They have to get permission from each village chief to log his part of the island. The chiefs trade away the logging rights for beer and dynamite—and use the dynamite to blast fish to the surface. They think the reefs go on forever. They don't know that when you kill a reef like this, it takes a generation or more for it to come back."

So isolated are the islands from one another, so isolated are the tribes that share the larger islands from one another, that cautionary tales about the long-term destruction wrought by short-term conveniences like dynamite can take years to circulate.

There are said to be more than 700 linguistic groups in Papua New Guinea, and often the people of one village neither speak nor understand the language spoken in the village over the next hill. Pidgin is the common tongue, the passport between tribes. It is a marvelous

mélange of English, Australian slang, onomatopoeia, and local lore. The word "piano," for example, is *Big fella bockus, teeth alla same shark, you hitim he cry out*—a big box, with teeth all the same size, and if you hit it, it makes a noise.

Many signs are written in pidgin and English, and it was fun to translate. The pidgin for "Intoxicated persons will not be admitted" is *Spak man ino kumin* ("spak" is a variation on the Australian "spark" or "sparky," slang for being drunk, so the sentence reads, "Spark man he no come in.")

The people of Papua New Guinea may have to struggle to communicate, but the more we dove the more we marveled at the speed and fluency with which marine animals seemed to send messages to each other.

SCIENTISTS are just beginning to comprehend the astonishing sophistication of communication between sea creatures. Of course they have long known that whales and dolphins "talk" among each other fluently and constantly, but the remarkable capacities of the brains of the so-called lower animals, the cold-blooded fishes, have been relatively ignored.

On Whirlwind Reefs, a submerged shoal 80 sea miles east of Crown Island, the unheard babble between and among species was lively, frantic, and, at times, deadly.

An enormous school of jacks, so numerous that they cast a solid shadow on the reef, cruised by overhead, swimming routinely, unhurriedly, neither hunting nor being hunted.

Beyond the jacks, in the deep water over the

ANEMONEFISH, AMPHIPRION SANDARACINOS, 4 IN; CARPET ANEMONE, STICHODACTYLUS HADDONI, 3 FT

*SNUGGLED into their protective bed of stinging anemone tentacles to which they are immune, a pair of orange-fin anemonefish (left) and their red eggs gain safety from predators. A carpet anemone shelters other fish in the Solomon Islands.*

OVERLEAF

*MISTRESS TO A MAGICAL DANCE, naturalist Dinah Halstead is ringed by barracuda rotating in a slow ballet off New Hanover Island. "It was one of my most wonderful moments in the ocean," says photographer Doubilet, who has had plenty.*

SPHYRAENA JELLO, 3 FT

edge of the wall, a school of perhaps 20 or 30 dogtooth tuna—shining silver bullets—swam in the opposite direction.

The two schools would pass safely, like trucks on a turnpike.

Suddenly, faster than the blink of an eye, the entire school of tuna turned *as one*—the sound underwater of the turn was like a shirt tearing—and charged into the cloud of jacks.

In seconds that attack was over. Puffs of blood and shreds of flesh were the only testimony that remained. The tuna re-formed and continued on their way; the jacks—their numbers reduced by a few—resumed their casual cruise along the reef.

Whirlwind Reefs was entirely under eight or ten fathoms of water and miles from the nearest island, so it was possible that the reef had never been fished and probable that no one had ever dived it.

I lay on the bottom and isolated a six-inch square of reef and sought every creature who lived within its boundaries. Because water magnifies objects by approximately 25 percent, I was able to find even infinitesimal tenants of my 36-square-inch preserve.

A hermit crab, no bigger than a match head, plodded across a piece of coral like a palsied pensioner, dragging one leg after another.

A transparent worm, thin as a credit card, undulated out of the sand, its bow searching for something while its stern waited patiently behind. Within the waving arms of a yellow crinoid were two pinhead-size yellow shrimps, probably unique in the world, for I understood that crinoid dwellers adapted themselves to their environment, never left it, and bred only with themselves.

A quizzical blenny, one inch long, poked its head out of a hole in the coral and eyed me, as irritated as an inconvenienced concierge.

A feather-duster worm fed from the flowing water until, sensing the approach of my finger, it snapped its floral feeding machine back inside its tubular apartment.

A mottled pink crab the size of an American nickel crouched on a prong of staghorn coral and pugnaciously waved its claws at me, like a fighter in the early rounds getting the measure of his opponent.

The current was racing over the reef, and I reached out to grab a piece of coral to steady myself. The coral flinched. I yanked back my hand, horrified that the next sensation I would

SNAKE EEL, BRACHYSOMOPHIS CROCODILINUS, 3 FT; MORAY EEL, GYMNOTHORAX JAVANICUS, 10 FT.

*ALWAYS OPEN FOR BUSINESS, jaws of the reef are regularly serviced at cleaning stations where certain fish and shrimp remove parasites, growths, and food scraps from the skin, mouth, and gill chambers of other species. A cleaner shrimp grooms a Java moray eel (below left) near Milne Bay. Shrimp advertise that their shop is open by waving their long antennae, as do fish by performing specialized dances. One carnivorous impostor known as a false cleaner or saber-toothed blenny mimics a cleaner wrasse's colors and movements, then viciously attacks its client. Near Vanuatu, a lizard fish—apparently never serviced by cleaner wrasses—was not fooled (right).*

*Near Milne Bay another grinning denizen of the bottom, a crocodile snake eel (above left) usually hides with eyes and snout protruding from the sand until small fish swim within range.*

LIZARD FISH, SAURIDA GRACILIS, 8 IN.

feel might be the searing pain of a stonefish's venom. But it was just a clam that had closed in alarm at the touch of my hand.

Even at night the flurried activity on Whirlwind Reefs didn't cease; it changed. As I lay in my bunk, I heard through the steel hull of the boat a sound like a campfire crackling: Colonies of shrimps were cracking their claws 50 feet beneath my head.

THE *REEF EXPLORER* employed as interpreter, boat boy, and general factotum a young native of Rabaul named Michael. Michael worked to put his brothers and sisters through school, and his salary was sent directly to the school as a means of evading a nationwide custom known as *wantok*, under which an individual has an obligation to the entire community and anyone who asks for anything must be accommodated. The system worked in primitive subsistence societies in which everyone performed a supportive function. But now that people were going away and returning supplied (magically, apparently) with something called money that could produce exotic goods, it had degenerated.

"Some people don't work," Michael said. "Wait for me come home, they ask my money and I have to give it. A man I know drink all his money. Why not? He take it home, someone ask it from him and *he* drink it."

Whenever we arrived at an inhabited island, Michael would inquire in pidgin if the residents knew of any wrecks nearby—ships or planes from World War II. More than 300 American and Australian planes (and an untold number of Japanese aircraft) are still officially listed as missing.

In the Witu Island group we anchored in the volcanic crater of Narage Island. Before the anchor had hit the black sand bottom, a dozen dugout canoes set out from shore, bringing robust men and happy children who delightedly circled the boat, chattering about the pasty-faced strangers who came to swim under the water and had an endless supply of sweet soft drinks and English biscuits.

While Michael jabbered his questions in pidgin, David and I stood on the bow and gazed at the jungle-matted mountainside that rose from the water's edge. Natural hot springs bubbled up amid the dense growth, sending ribbons of steam into the sapphire sky.

There was a Japanese patrol boat here, Michael reported, across the crater in 25 feet of water. Three of the islanders came aboard and, soda pop in hand, guided us to a spot beneath an overhanging jungle canopy.

The patrol boat lay on the bottom, as if it had been scuttled there and had simply settled into a peaceful slip beneath the sea. But it had collapsed upon itself, its iron rusting to oxide. It was no more suggestive of life than the husk of a horseshoe crab bleaching on a beach. And because corals did not grow there in the lava crater, it was creating no new life. The B-25 off Wongat Island had told tales of the past and offered promise for the future; this barren relic spoke only of death.

THAT EVENING WE MOVED to the crater of Garove Island, also in the Witu group. A pristine Roman Catholic church sat atop a jungle hill, and we wanted to see it. The boat put us off on a table rock, and we clambered up a six-inch-wide trail on the sheer face of a rock cliff. Easy enough, in daylight.

But by the time we returned from the church, night had fallen. We had a flashlight, and the lights from the boat 30 or 40 feet below cast a helpful glow on the cliff face. But the trail was tiny, and it seemed to disappear every few feet in the shadows of jungle growth that overhung the cliff.

I shone the light on the path for the others to make their way down to the first turn, then started down myself. I had been standing off the path, and to regain it, I put my foot on what appeared to be a patch of grass or moss. It turned out, instead, to be the topmost branch of a tree growing out of the cliff face way beneath me.

I saw my foot disappear.

I flailed out with my hands and grabbed air.

And then I was falling in darkness.

I struck water, feet first, straight as an Olympic diver, and I felt a rush of relief and gratitude. The light vanished. My glasses vanished. My shirt billowed up around my head. I bobbed to the surface.

Now came the blood, seeping, oozing, coursing down my leg from a cut that exposed the bone, and dripping into the night sea.

Bronwyn Stewart, the ship's nurse, hosed me down, shoved me into the shower, and, when I was clean, washed the seven-inch-long wound with a strong astringent, doused it with antibiotics, and bandaged it.

"Your diving is done," she said.

BRONWYN WAS RIGHT: My diving was over. The wound began to heal nicely, but I wasn't willing to expose it to the organic soup that was the Bismarck Sea, where it might become host to things that would feast on it or burrow into it.

So while the others dove for another couple of days, I became a traveling sideshow for the local islanders. The word had spread that some tall Yankee had been so inept as to fall off the cliff on Garove Island and, most incredible of all, his colleagues were treating him like a wounded man, bandaging him, applying medicines, offering sympathy and solace. To them an injury was to be endured or ignored. If it killed you, too bad; if it didn't, lucky you.

On our last morning in the Witu Islands I awoke early and hobbled topside for a cup of coffee. The sun was just beginning to peek over the horizon when I went outside.

There, perched on the rail like expectant ravens, were half a dozen island children. They stared at me in awed silence, the whites of their shiny eyes as large as quails' eggs. Then one of them whispered something, and another giggled, and a third pointed at my bandaged leg, and a fourth made a saucy "hoo-hoo" noise. Then they all laughed and pointed and whistled and cooed.

I laughed, too, and reached into the galley for a tin of biscuits.

We left the Bismarck Sea on a sparkling day, passing through the Dampier Strait to the west of New Britain. We were escorted by a fleet of dolphins and overseen by a squadron of birds. It was hard not to think of other fleets and other squadrons that had passed this way 40-some years ago.

Their bones lay below us now, lost but not forgotten. Like the crew of the B-25 off Madang, never forgotten. □

*BLESSING OF THE SUN, life giver to the Pacific's gardens of coral, pours over diver Chris Deacon through a hole in the roof of a 50-foot-deep cave in the Russell Islands. For the terrible war that still lives in the minds of so many, the sea has created a remarkable living memorial.*

# Wreck of the


LIGHT SEEPS DIM and blue from the surface of the southwest Pacific 135 feet above us. We are diving on the *President Coolidge*, and the promenade deck is littered with equipment discarded in mortal haste by the ship's last passengers: rifles, gas masks, metal boarding ladders. My diving partner Kev Deacon, an Australian underwater cinematographer, examines steel helmets (right). Kev's wife, Chris, acting as safety diver, hovers above us. The sea has coated the ship with marine growth and has spread a veil of wet, brown-green dust over everything.

The *Coolidge* was a luxury liner converted into a troop transport for service in World War II. During her seventh military mission, on October 26, 1942, as she entered the harbor of Espiritu Santo in the New Hebrides Islands (now Vanuatu), the ship struck two U. S. mines and sank.

Today, nearly half a century later, her hulk seems full of voices, shouted orders, curses, the clump of boots.



# Coolidge

*Text and photographs*

*by DAVID DOUBILET*

"SHE WAS a grand ship," notes Allan Power, an Aussie diver who fell under the spell of the *Coolidge* 19 years ago and stayed on as a kind of keeper of the wreck.

The 22,000-ton luxury ship was built to sail from San Francisco to the Orient. Her interiors were paneled in rare woods, draped in silk, lit by skylights of cathedral glass. When she went to war, the finery was ripped out—"all but the 'lady,' " notes Allan. "I'll show her to you."

We swim into what was the main smoking lounge (below). The lady is an Elizabethan figure with a unicorn (right) atop a marble fireplace. The rare woods have been eaten by teredo worms.

Survivors of the *Coolidge* remember that bright October morning. With 5,440 men, mostly from the 43rd Infantry Division, plus arms and equipment, the ship had crossed the Pacific in 14 days and was now entering Espiritu Santo, staging base for hard-pressed Allied troops on Guadalcanal.

First Lt. Web Thompson was near the bow, admiring the harbor. "I saw a blinker light flashing on shore," he says, "but the code was too fast for me to read." Others missed the same message: a warning that the *Coolidge* was headed straight for a minefield. The fog of war, some call it. Someone didn't get the word.

"I heard an explosion—and then another," says surgeon Henry M. Farmer. "The ship began listing at once." The time was 9:30, and the second mine killed fireman Robert Reid.

Engines stopped. Belowdecks, lights and communications went out. An oil slick began spreading on the water. "But the first word we got was that the ship wouldn't sink," remembers Bill Stebbins, then a major. "We were ordered to our duty stations."

Web Thompson returned to his station belowdecks. "I had 200 men to take care of—in the dark with water coming in."

FROM KEY DEACON (TOP AND ABOVE)

THE CAPTAIN of the *Coolidge* promptly ran the ship aground, but she listed dangerously to port. "It was about 20 minutes later when we got the word to abandon ship," says Bill Stebbins. "We passed the word belowdecks, and men got life jackets and started using the rope and metal ladders. Fortunately we'd had two months' training in amphibious operations. Discipline was excellent."

The list to port complicated things. Starboard ladders didn't reach the water, and some life rafts, already lowered, began drifting away.

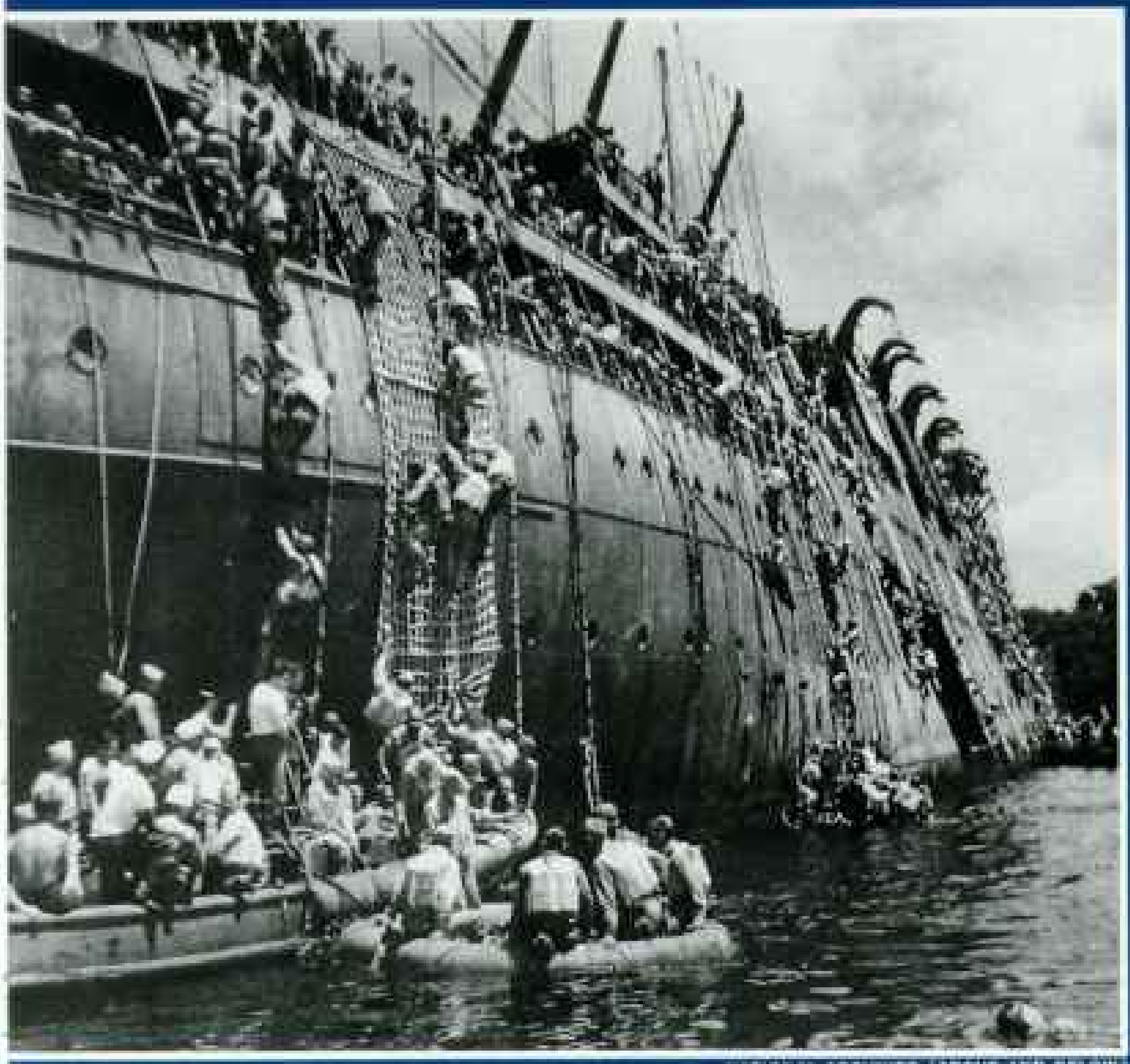
On D deck, Capt. Warren K. Covill and mess officer Capt. Elwood Euart found a rope. "Euart held one end and I held the other, so the men could pull themselves along it," says Covill (far right, as he is today).

Belowdecks near the head, Web Thompson could hear "water rushing in through the toilets and guns sliding around—but no panic."

"The ship was tipping over more all the time," says Joseph Parsons, then a staff sergeant. "Finally, I was able to walk down the starboard side and jump into water that was covered with oil." He swam toward shore.

Stebbins recalls that "most of the men got off the ship in the last 20 minutes. I climbed into one of the last boats from a bow rope ladder."

Dr. Farmer also crawled down a net and into a boat.



NATIONAL ARCHIVES (ABOVE AND BELOW)

Web Thompson and two noncoms slid down a rope off the fantail—and into an empty raft: "When I got ashore, I still had a crease in my pants," he recalls.

On D deck, having pulled all their men to safety, Captains Euart and Covill scrambled toward the exit. "I thought Euart was right behind me. Everyone else had jumped off. I was still on board when the ship slid off the reef and went down stern first. I was underwater. But in a minute I came up. They told me later I had been in an air bubble."

Captain Euart went down with the ship; he was posthumously awarded the Distinguished Service Cross.

At 10:55, just one hour and 25 minutes after hitting the mines, the *Coolidge* settled onto the channel floor, with empty lifeboat davits reaching upward as they do today—sprouting growths of black coral like strange tufts of hair (below).

BRETON LITTLEHALES

HARBOR BOATS picked up the oil-soaked men swimming toward shore. Amazingly only five lives were lost, fireman Reid and four soldiers—5,435 were saved. Dr. Farmer treated the injured, "mostly cuts and scratches when they jumped from the ship. But more serious was the Atabrine we lost. The ship was carrying all the medicine available for malaria on Guadalcanal."

In fact, the stranded men needed everything. "We had 900 men with nine rifles," says Web Thompson. "We borrowed a hundred mess kits from the Seabees stationed ashore."

Next day Bill Stebbins flew out of Espiritu Santo "to scrounge supplies—enough for a couple of months." But reequipping the troops for battle took much longer. "We didn't get to Guadalcanal until March of 1943," notes Dr. Farmer. Loss of the *Coolidge* delayed Allied operations by weeks.

The much needed equipment still lies in that silent hulk of history. Allan Power and I float into enormous holds, where we see a jumble of crushed jeeps (left) mixed in with piles of tires and the body parts of trucks, artillery pieces, and typewriters.

Allan finds a Thompson submachine gun, its cleaning rod still in the barrel. Marine growth makes the gun resemble a plush toy (top right).

Off the promenade deck again, Allan beckons me into another compartment, the enlisted men's starboard head. Ranks of toilets line the walls. Marine animals are not growing on the porcelain, yet the toilets are filled with the ocean's detritus, an abysmal vision of ultimate gas station grime (right).

We swim back along the starboard rail until we reach the forward guntub. The long-quenched three-inch gun aims into the depths. I circle it and find the ready ammunition locker filled with a barrage of tiny

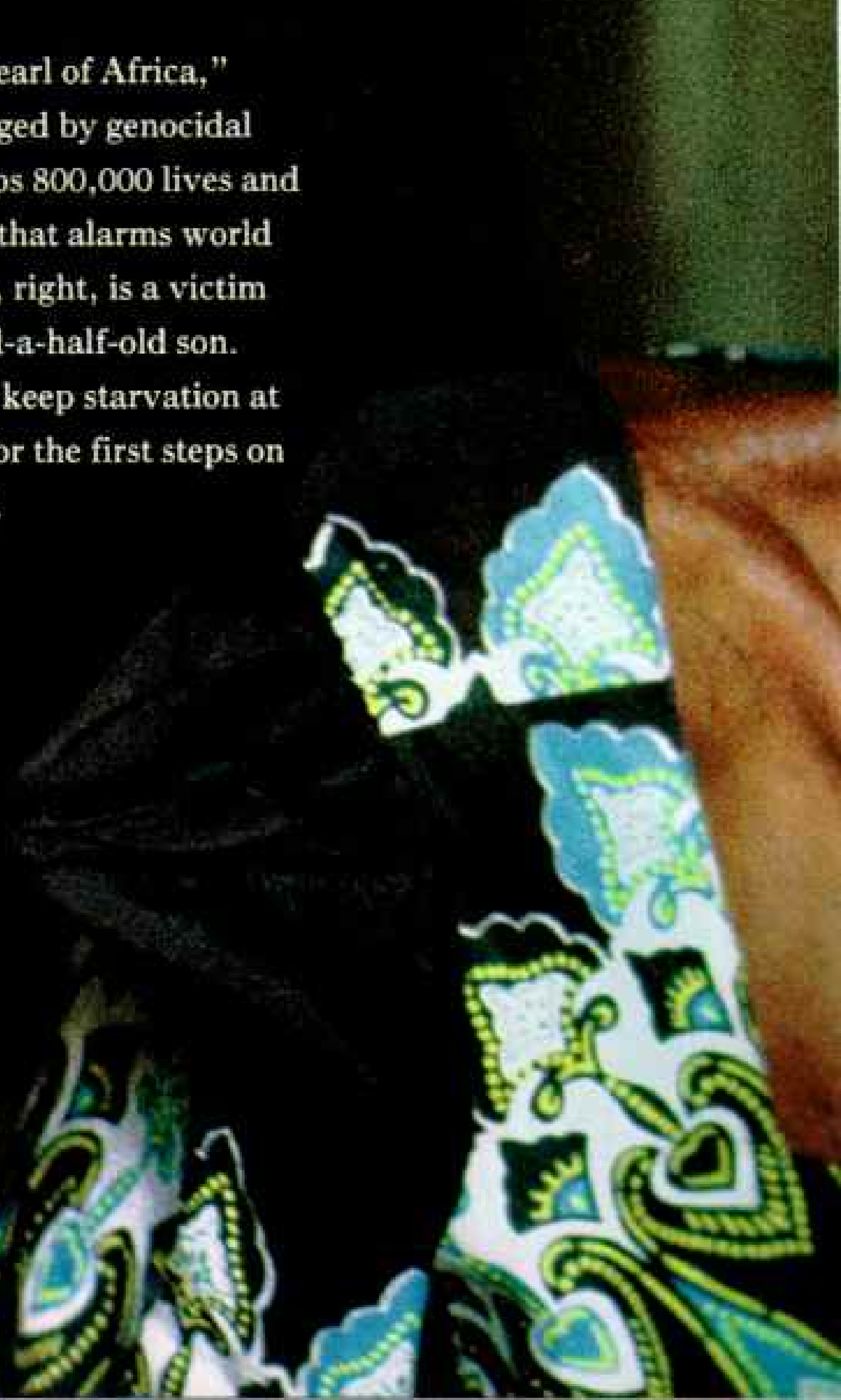
fish. Allan turns his light on the gun's breech, which is coated with red sponge. An angelfish swims between Allan and Kev and plays in the bubbles from our tanks.

We rise and the ship fades, bathed with a blue light. The *Coolidge*, once a luxury liner and then a warship, has become a museum of war's great waste. □

# UGANDA
## Land Beyond Sorrow

ARTICLE AND PHOTOGRAPHS BY ROBERT CAPUTO

ONCE KNOWN as "the pearl of Africa," Uganda has been ravaged by genocidal warfare costing perhaps 800,000 lives and is stalked now by an AIDS crisis that alarms world health officials. Jane Nakarima, right, is a victim of the disease, as is her year-and-a-half-old son. Yet fertile soil and good climate keep starvation at bay, while the nation searches for the first steps on the long and difficult road back.



JANE NAMIRIMU was 22 years old. When I went to visit her, she was lying on the floor of her parents' house near the town of Kyotera, her thin frail body cushioned from the cold concrete by only a torn piece of old foam rubber. A rash covered her body, she had chronic diarrhea, and she vomited when she tried to eat. Her breathing was shallow and short. There was no ointment to soothe her skin, or even aspirin to cool the fevers that gripped her. She was too weak to walk, and spent her days staring out the open door at children playing in the yard.

Jane was pregnant with her first child. She was the tenth victim of AIDS I had visited that day in Kyotera, a town of about 2,000 near Lake Victoria (map, pages 474-5).

"Jane has been sick for about six months," her father told me. "We took her to the hospital, and to a traditional healer. She did get better for a time. But then it started again. And what can we do? I do not have more money, and everyone just dies with this slim."

"Slim" is the word Ugandans use for AIDS because of the skeletal appearance of victims in the last stages of the disease. AIDS has reached epidemic proportions in this strife-torn country in which perhaps 800,000 people have been slaughtered in 20 years of intermittent civil war.

The government officially reports 2,369 cases of AIDS, but the real number is undoubtedly far higher. Nobody knows. The breakdown of communications and health-care systems makes it impossible to compile reliable numbers, but informed sources estimate that one in every five sexually active adults in Kampala, the capital, may be infected. When a Ugandan dies on a remote homestead, the cause of death goes undiagnosed. Like Uganda's ongoing civil wars, AIDS claims primarily those between 18 and 40 years old.

In the countryside near Kyotera I stopped at almost every house I came to, and in every one the scene was the same: Someone had recently died, or was dying, of AIDS. Hospitals are few in Uganda and cannot cope with the numbers of patients; most are cared for by their families. In house after house I saw mothers and grandmothers keeping vigil over loved ones who were slowly wasting away. I went to funerals almost every day—sometimes several in the same day. I often saw scores of mourners winding their way through the fields, on their way from one funeral to the next.

*IN THE GRIP of an unseen killer, Jane Namirimu was 22 and pregnant when she became ill with AIDS, which spreads in Africa mainly through heterosexual intercourse and affects men and women equally. When author-photographer Bob Caputo first saw her last May, Jane needed help from her mother to walk (facing page); when he returned three months later, she and her baby were buried in the fields behind the family's Kyotera home.*

The underlying numbers are staggering: About half of the adult medical patients examined at a Masaka hospital tested positive for the human immunodeficiency virus (HIV) that causes AIDS, as did 40 percent in Kampala's Mulago Hospital, which admits five new AIDS patients a day. A survey of truck stops showed about 70 percent of the prostitutes and 33 percent of the truck drivers to be infected. In a 1986 survey at another Kampala hospital, seven out of every 50 pregnant women tested positive for HIV antibodies, and the same was true for adult male blood donors. A more complete picture of the extent of the disease awaits results of a national blood survey just begun.

"It is already a disaster," one foreign doctor working in Uganda told me, "and it's going to get worse. We don't know enough about the disease to make firm predictions—there are many possible scenarios. It could be that hundreds of thousands of people are going to die. They may already be infected."

"I don't know what to do," said Jane Namirimu softly while I sat with her. "I want to have a family, and a farm, and a home like this one. But I feel I am haunted by ghosts that will not leave me. I can just pray that things will be the way they should be."

NOTHING is the way it should be in Uganda. As independence from Britain approached in 1962, it seemed that Uganda, "the pearl of Africa," was well on its way to a long and happy life as a modern state.

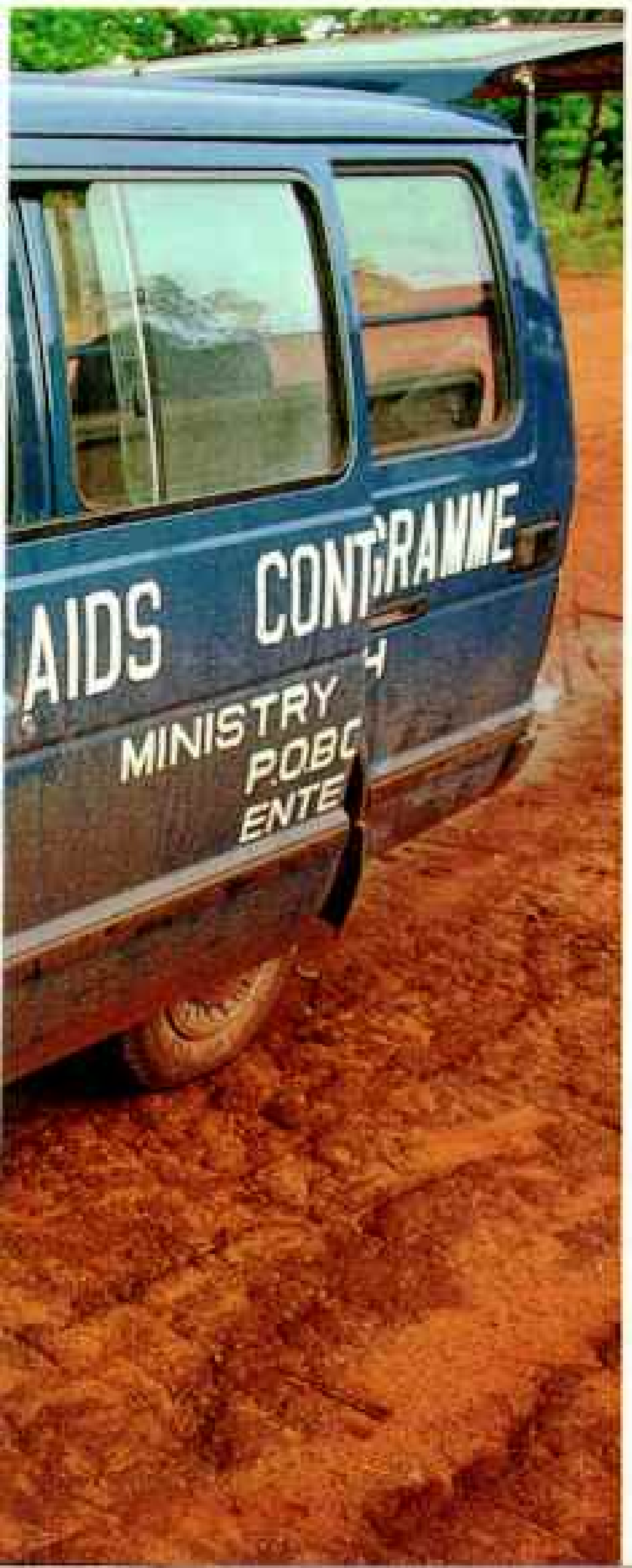
Photojournalist ROBERT CAPUTO has produced many articles on Africa for the NATIONAL GEOGRAPHIC, his most recent being "Journey Up the Nile," May 1985. He lives in Washington, D. C.

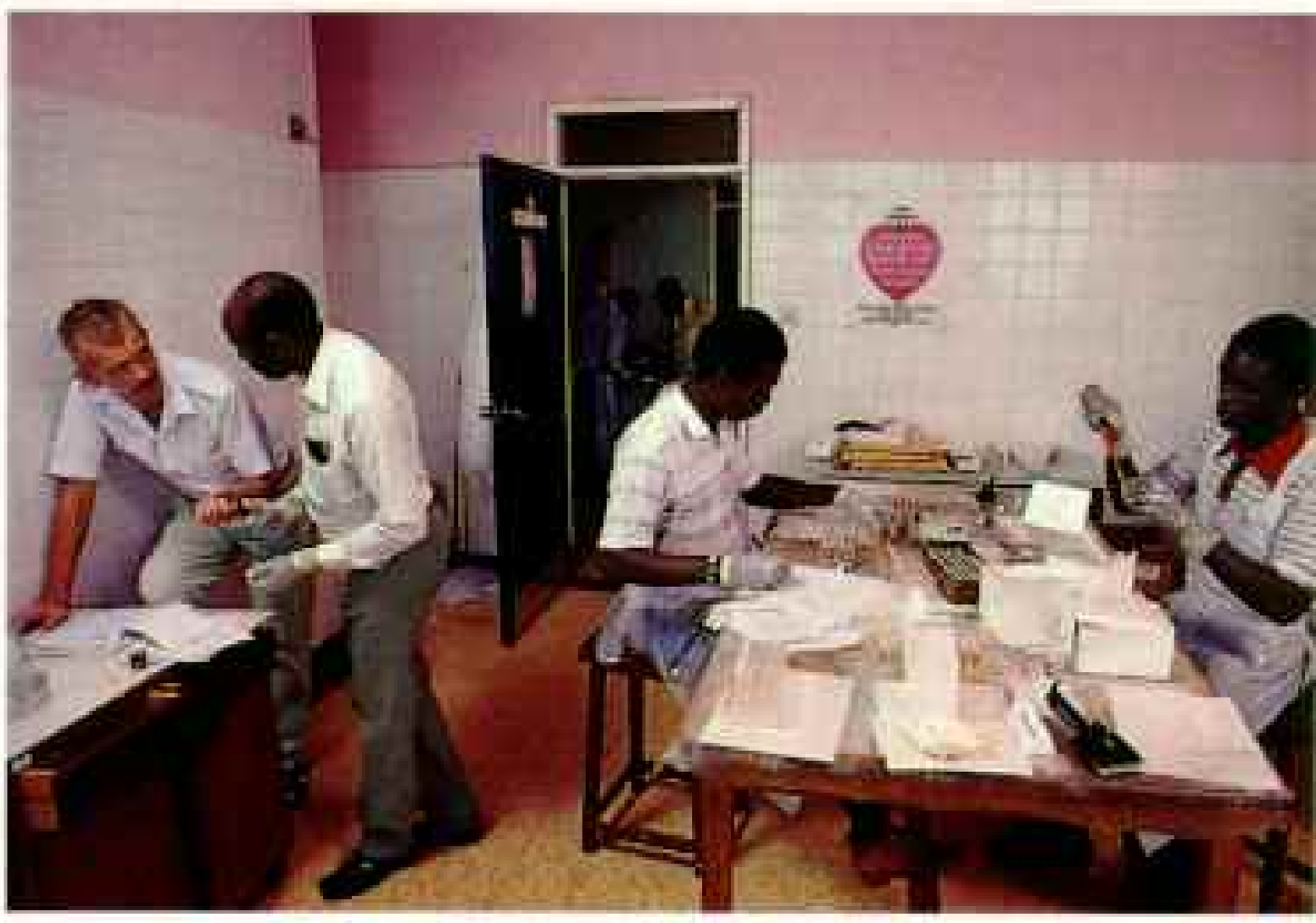
The fertile south, populated by the Baganda and other Bantu-speaking peoples, was highly developed. Kampala swelled on a tide of economic activity based on agricultural riches. Cotton, coffee, and tea exports earned foreign exchange that repaid the farmers with roads, schools, hospitals, and manufactured goods. Southerners made good livings as businessmen, bureaucrats, and professionals.

In the north, where the land is poorer, development was slower. To make up for this, and to take advantage of the Nilotic tradition of warriorhood, the British recruited northerners into the army and police. Thus both groups had avenues for advancement.

But the dream of independence became a nightmare of insecurity, brutality, and economic collapse. Milton Obote, of the northern Langi people, was elected prime minister. He

*FIGHTING AN EPIDEMIC of ignorance along with the disease, Ugandan and World Health Organization officials train laboratory technicians from remote districts to help prevent AIDS (called "slim" by most Ugandans for the victims' symptomatic weight loss). Collecting data for a regional AIDS survey, workers with the Institute of Public Health at Makerere University interview Ugandans about their sexual habits and take blood for tests (left and bottom). The blood is sent to the Uganda Virus Research Institute in Entebbe (below) for analysis. They also distribute educational leaflets and counsel Ugandans to "Love Carefully." AIDS has been reported in every district of Uganda, although Kampala and areas west of Lake Victoria are hardest hit.*



soon ousted President Sir Edward Mutesa, the hereditary Baganda king, and made himself president. Obote's corrupt regime was overthrown in 1971 by another northerner, Idi Amin, who embarked on an orgy of bloodshed in which an estimated 300,000 Ugandans were shot, tortured, and battered to death.

In 1979 Amin was driven out by the army of neighboring Tanzania and the Uganda National Liberation Army (UNLA), and Obote returned. But the UNLA did not liberate Ugandans from savagery. Things got worse.

In 1981 the UNLA sought revenge on Amin's Kakwa people and other groups living in Nile Province. Obote's soldiers laid waste the land, slaughtered untold thousands of people, and drove almost 450,000 more into Sudan and Zaire as refugees.

In 1982 the UNLA was drawn into the Baganda heartland in force by southerners fighting to overthrow Obote's regime. In what must rank with the worst atrocities in human history, men of the UNLA ravaged the countryside and slaughtered between 200,000 and 500,000 people before they were defeated by the National Resistance Army (NRA), whose leader, Yoweri Museveni, is now president.

The scene of this carnage was the Luwero triangle, a wedge of rich farmland that points at Kampala, a few miles to the south. It is hard to imagine that the massacres went on there, a 30-minute drive from the foreign diplomatic missions, for more than two years before the outside world knew about them or would believe they were occurring. But the evidence is there for all to see, as I discovered when I visited the town of Nakaseke.

JOSEPH KARIANGO, an old Baganda farmer, crouched to stare at something in his field that was not visible from where I stood. I went nearer. Lying in the dirt was a small pile of bones. Joseph looked up at me.

"It is my wife," he said.

Joseph pointed to a pair of rusty shock absorbers lying next to the skeleton. "The soldiers killed her. The men of Obote beat her with those things."

Joseph motioned me to follow him to the edge of the field. He pushed aside some of the tall elephant grass with his hoe. There was another skeleton.

"This is my daughter. They shot her when she tried to run. And my son was killed when the soldiers caught him in my shop. I myself

# UGANDA

THE VERDANT HILLS around Lake Victoria were "darkest Africa" to Europeans in 1862, when British explorer John Speke came seeking the source of the Nile. Here lived linguistically and culturally distinct peoples, often at war with one another. These were gathered into uneasy alliance by the British in 1894 as the Uganda Protectorate.


When independence came in October 1962, Uganda was filled with promise—raising cotton, coffee, tea, and sugar for export—and an optimistic, if culturally divided, populace. Euphoria was short-lived as tribal hatreds were rekindled in the give-and-take of national politics. By 1966 Prime Minister Milton Obote of the Langi had driven into exile President Edward Mutesa of the Baganda.

Gen. Idi Amin, of the Kakwa, seized power in a 1971 military coup and unleashed his thugs on all who opposed him. By 1979, when invading Tanzanians and Ugandans forced him into exile, Amin had slaughtered some 300,000.

Obote regained power in 1980 and sought to exterminate guerrillas led by Yoweri Museveni. The Luwero triangle became an unimaginable killing ground as the army slaughtered hundreds of thousands.

Obote was overthrown in July 1985, and six months later Museveni's forces took control. Although President Museveni seeks tribal reconciliation, his once disciplined army now appears out of control in the fight against rebels in the north. The area has been closed at times to foreigners, including the International Committee of the Red Cross, and reports in the capital indicate widespread atrocities.

**AREA:** 236,036 sq km (91,134 sq mi). **POPULATION:** 15,500,000. **CAPITAL:** Kampala, pop. 500,000. **RELIGION:** Christian, traditional, Muslim. **LANGUAGE:** English, Bantu, Nilotic. **LITERACY:** 52%. **LIFE EXPECTANCY:** 50 years. **ECONOMY:** Food processing, mining, textiles. Export crops: coffee, cotton, tea.

*Since 1980 more than a million Ugandans have fled their homes, seeking refuge from tribal violence and outright genocide. Of the 450,000 who crossed Uganda's borders, roughly half have returned since the 1985 overthrow of Obote.*

*More than 40 distinct ethnic groups inhabit Uganda. The historically powerful southern tribes speak Bantu, the language family of southern Africa, while the northern tribes speak Nilotic and Sudanic languages related to neighbors to the north.*

SUDAN
ZAIRE
SUDAN
KENYA
LOGO
BARI
TOPOSA
LOTUKO
KIDEPO VALLEY NATIONAL PARK
Kidepo
KAKWA
LUGBARA
Moyo
Yumbe
NILE PROVINCE
MADI
ACHOLI
Kitgum
TURKANA
KARAMOJONG
Swamp
Albert Nile
Arua
AJAI GAME RESERVE
NORTHERN PROVINCE
MATHENIKO GAME RESERVE
Gulu
BOKORA CORRIDOR GAME RESERVE
Moroto
KARAMOJA PROVINCE
ALUR
Pakwach
MURCHISON FALLS NATIONAL PARK
KAFUNA GAME RESERVE
Lira
Soroti
EASTERN PROVINCE
PIAN UPE GAME RESERVE
DUGUMBE GAME RESERVE
LANGI
Victoria Nile
Lake Kwania
Lake Albert
BANYORO
Masindi
ITESO
TESO
Holma
Lake Kyoga
LESE
WESTERN PROVINCE
TORO GAME RESERVE
LUWERO TRIANGLE (Approximate area)
Kamuli
BUSOGA
BAGWERE
Mbale
Mount Elgon 4,321 m 14,178 ft
Luwero
Nakaseke
NORTH BUGANDA PROVINCE
Bombo
Kiganda
BUSOGA PROVINCE
Tororo
Malaba
Margherita Peak 5,109 m 16,763 ft
Fort Portal
KIBALE FOREST CORRIDOR GAME RESERVE
BAGANDA
Jinja
Busia
BATORO
Kampala
CENTRAL PROVINCE
Entebbe
LUHYA
KASESE
QUEEN ELIZABETH NATIONAL PARK
Lake George
KATONGA GAME RESERVE
EQUATOR
Kisumu
Lake Edward
KYAMBURA GAME RESERVE
Masaka
BANYANKOLE
Mbarara
SOUTH BUGANDA PROVINCE
LUO
RUGEZI GAME RESERVE
LAKE MBURO NATIONAL PARK
Rakai
Kyotera
SOUTHERN PROVINCE
LAKE
VICTORIA
KISII
BANYA-RWANDA
Kabale
Kagera
KENYA
TANZANIA
TANZANIA
RWANDA
HAYA
Bukoba
GORILLA GAME RESERVE

*Uganda has reported 2,369 cases of AIDS, but actual numbers may be at least ten times higher. The looming epidemic finds Uganda with only one doctor per 22,000 people. Hospitals and public services have been stripped bare by 20 years of civil strife.*

## ETHNOLINGUISTIC GROUPS

BANTU
WESTERN NILOTIC
EASTERN & SOUTHERN NILOTIC
CENTRAL SUDANIC

■ Refugee camps (November 1987)
▲ Areas of displaced persons (November 1987)
□ Refugee reception center

0 50 km
0 50 mi

NGS CARTOGRAPHIC DIVISION
DESIGN: NANCY SCHWEICKART
RESEARCH: MAUREEN FLYNN, LINDA KRUTE
PRODUCTION: HARVEY MURRAY, BARBARA CARRIGAN
MAP EDITOR: GUS PLATIS

ran fast into the bush, and I was very lucky to get away from them. Everybody that the soldiers did catch they would kill. Everybody! In all this Luwero area there was nobody—everybody was killed, or they ran away. I want to bury my family, but you see, we fear to bury just bones like that. Unless the body is whole, we cannot bury it."

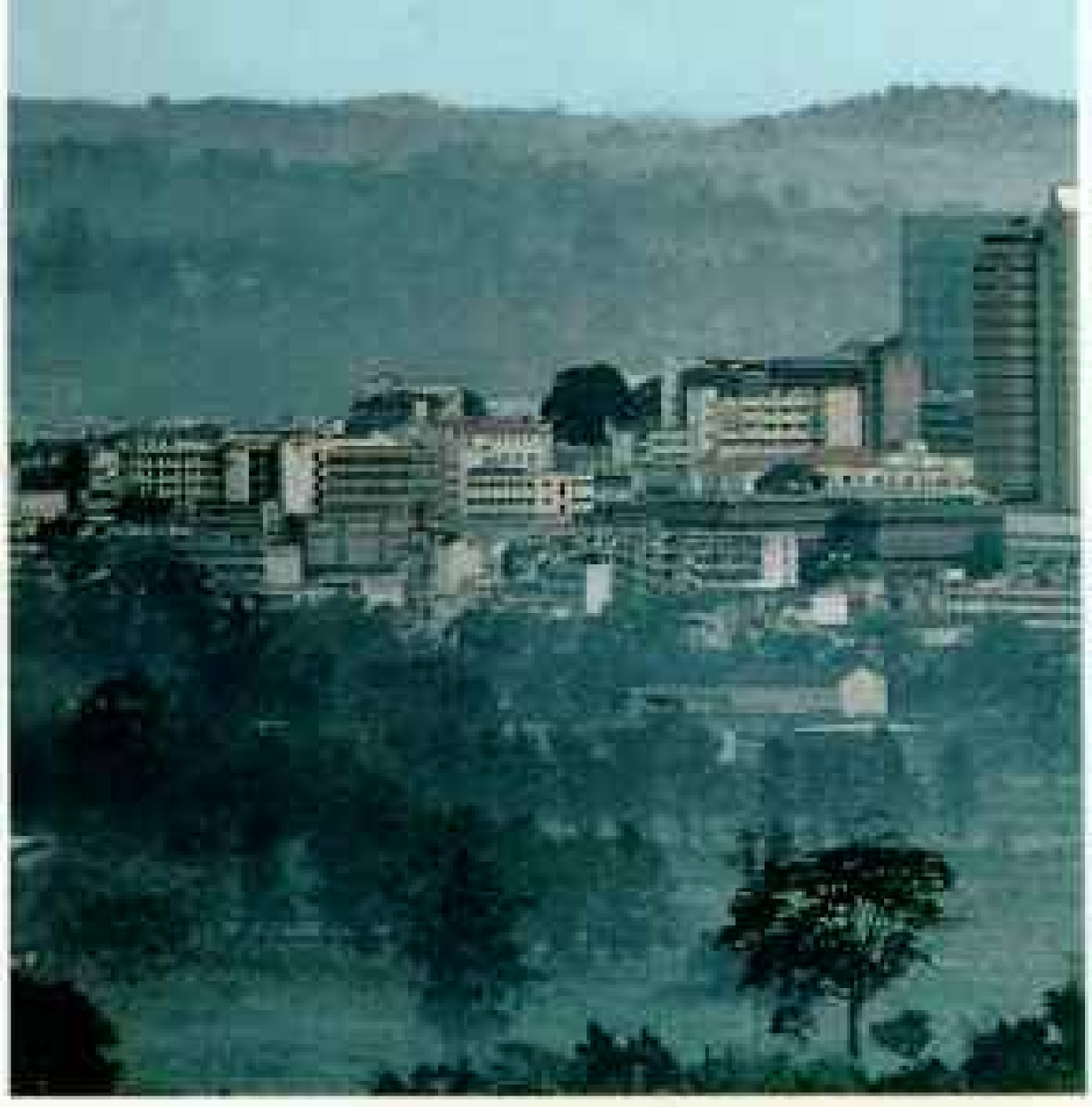
The Nakaseke Hotel, a brown, three-story structure, served as UNLA headquarters in Nakaseke. Bullet holes pockmarked its walls and those of nearby houses, mostly abandoned. Only 50 people had returned to a town where more than 300 formerly lived. Above the doorway to an abandoned shop next to the hotel, some UNLA soldier had written the theme of their occupation: "A good Muganda is a dead one."

I went into the hotel. The walls were covered with graffiti: boasts of prowess in battle or love, drawings depicting torture methods—dripping molten plastic from a jerry can onto a victim's face, or the "three-point," in which the victim's elbows were tied together behind his back so that he could not breathe.

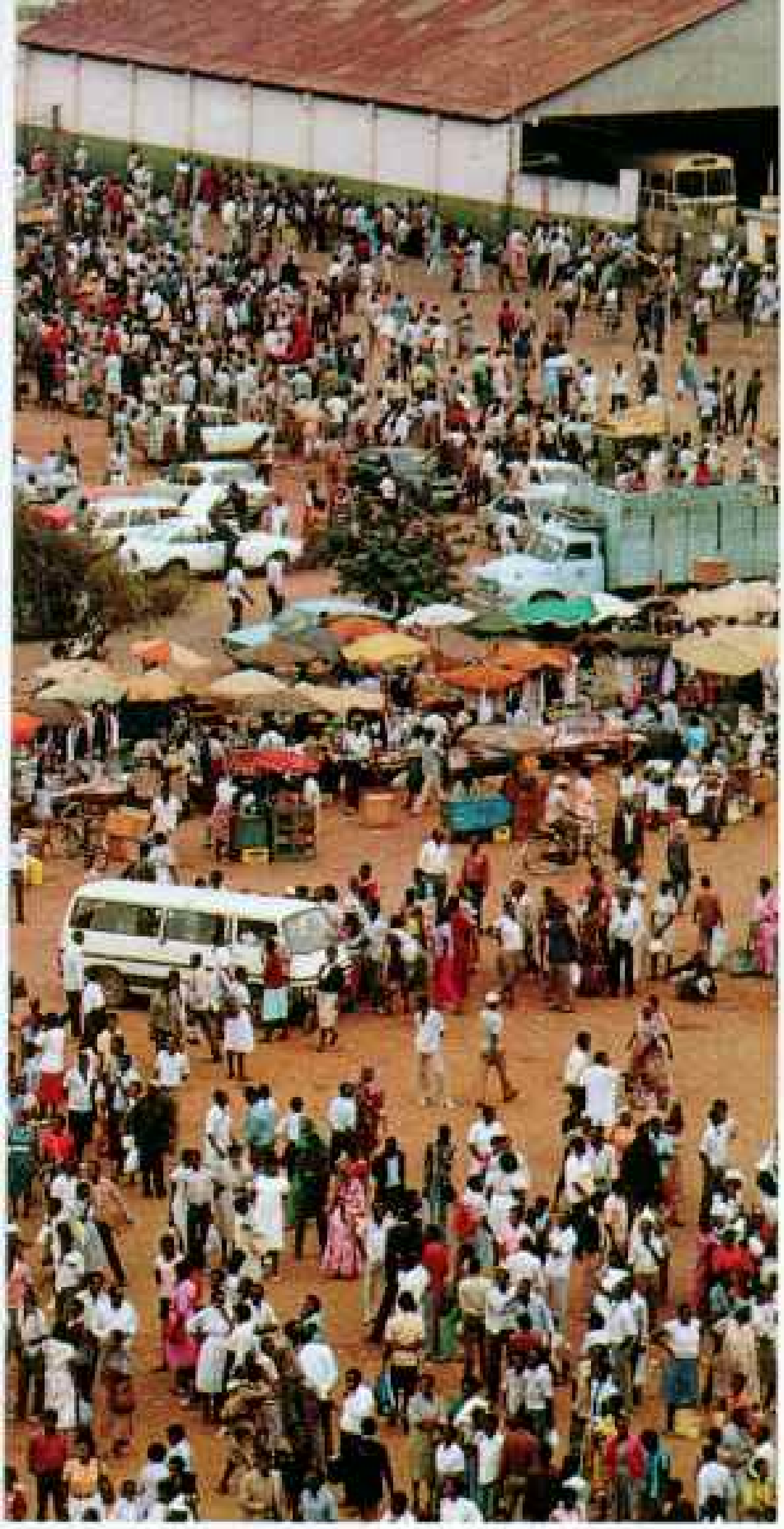
From the roof I could see Joseph's fields and the reach of ruined shops along the road. They, the idle power lines, and derelict gas station indicated what used to be.

A companion, Fred Wamala, pointed to the grassy field below: "Those soldiers, they used to bring people here. Especially they would catch young girls, girls of 12, 14. They tied their arms with wire. Then they raped them, and when they were finished, they threw them off this roof."

The evidence was clearly visible: skulls, small piles of human bones, bits of rotting clothes, the twisted wire that had bound the victims' wrists.



*CROSS-FIRE CAPITAL of Kampala, once among the most beautiful of African cities, became a war zone during the years of anarchy that began after Idi Amin's takeover in 1971. Rampaging soldiers—often intoxicated—looted stores, turned local hotels into torture chambers, killed at will, and set up roadblocks to extract "soldiers' pay" at gunpoint from motorists. At this writing, Kampala's streets are quiet again. But with few funds for repairs the capital is filled with telltale signs of Uganda's long ordeal, such as bullet-riddled government offices (right).*



*COMMUTER'S NIGHTMARE occurs daily in central Kampala (above), when rush hour brings a mad scramble for seats on one of the city's matatus, or privately owned small buses. Many commute to work from countryside farms; crops supplement typically meager salaries. Large city buses, upper right, aren't the only things in disrepair after nearly 20 years of civil war. Electric power is unpredictable, visitors are advised to drink only boiled water, and once paved boulevards, now filled with potholes, present an obstacle course for the well-dressed pedestrian.*

In Luwero, the story is everywhere the same. This is beautiful country: swamps of papyrus and reeds nestle between gently rolling hills of dark brown earth and luxuriant green foliage. Anywhere else in Africa such fertile land would be crowded with people. Luwero's eerie emptiness is evidence of the multitude of the dead.

Small stands, originally built to display tomatoes, bananas, and other produce, exhibited human skulls gathered from the killing fields. At Kigoogwa, only 18 miles from Kampala, I stopped to photograph one of the racks of skulls and bones.

"Yes, yes, yes," said a man who introduced himself as Katende Sserunjogi, a local official. "You make your photos. You take your photos back to America and show your people what that man Obote did. There are no soldiers there," he said, pointing to the rows of skulls. "No soldiers, just people."

REMNANTS OF THE UNLA fight on in the north, and the ongoing guerrilla war eats up as much as 40 percent of the country's budget and diverts energy and manpower from the pressing needs of reconstruction. President Yoweri Museveni's government, which took power in January 1986 after driving the UNLA out of the south, is determined to pursue a military solution. "We have to kill them all," one high-ranking official told me.

Ugandan and international groups allege that Museveni's government is torturing prisoners, that thousands of political opponents and suspected rebels are being held indefinitely without charge. The army is accused of destroying houses and crops, of raping and massacring civilians in the north and east.

It is difficult to know what the situation really is. Despite Museveni's personal promise to arrange a trip for me, I was unable to visit the north and east—only reporters from the government newspaper were allowed. Even the International Committee of the Red Cross had been barred, presumably because the regime does not want witnesses.

"These people in the north are defeated really, thoroughly," President Museveni assured me. But the war rages on. The NRA claims overwhelming victories; northerners recently arrived in Kampala speak of government defeats and NRA atrocities. Somewhere in between, perhaps, is the truth.


*HEART OF DARKNESS for Ugandans is the Luwero triangle, a farming region just north of Kampala. Roadside vegetable stands bear the bones of families slaughtered when Milton Obote's mostly northern army declared war on humanity—especially members of the rival Baganda tribe living in Luwero. Raping and looting for their "salary," Obote's forces murdered perhaps 500,000 people in their search for anti-Obote activists from 1980 to 1985. Many victims were tortured, as depicted on a prison wall (left), then clubbed to death.*

*Joseph Kariango (above) narrowly escaped the soldiers who murdered his wife, son, and daughter. When he returned home recently, he found the bones of his wife in the bean field behind his house. Near her skeleton lie the rusty shock absorbers that soldiers used to beat her to death.*

*National Geographic, April 1988*

ORPHANS, WIDOWS, WIDOWERS: The exact death toll is impossible to determine. Now AIDS adds its numbers of dead and dying. As one Ugandan put it: "It is as if we have been cursed for all the terrible things we have done to each other."

Though it is probably no harder hit than other countries in central and eastern Africa—Rwanda, Burundi, Tanzania, Zaire, and Zambia—Uganda's willingness to allow foreign journalists to cover the AIDS epidemic is unique. A National Committee for the Prevention of AIDS is in place, as is a program coordinated by the World Health Organization (WHO), to which donor nations have pledged 7.5 million dollars for education, medical equipment, and supplies. Public meetings are held to discuss AIDS, and a curriculum incorporating AIDS education is being prepared for the schools. Warning leaflets have been printed in ten languages. Slogans of the campaign are "Love Carefully" and "Zero Grazing," an agricultural metaphor.

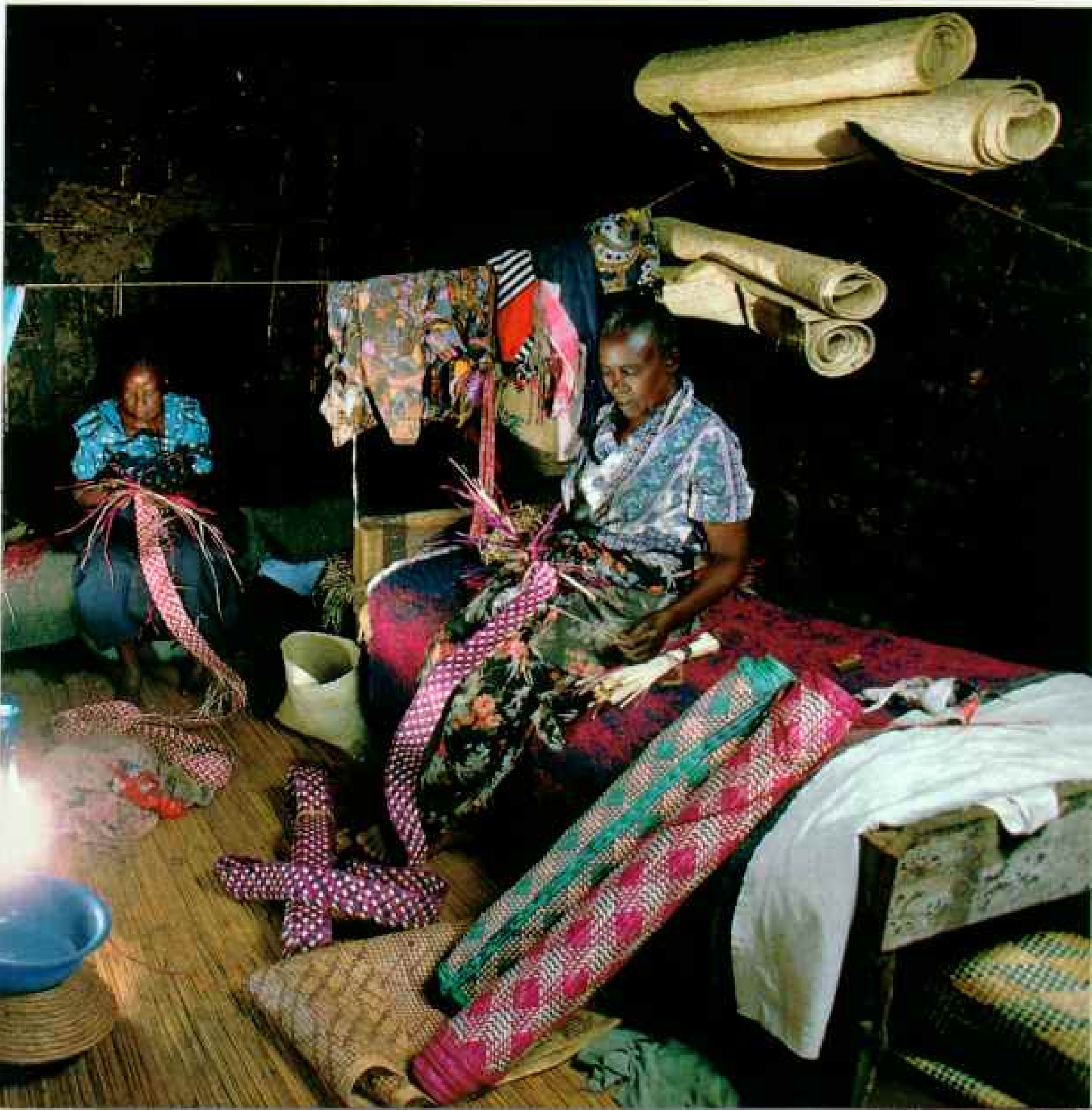
"To not be open about AIDS is just ignorant," President Museveni told me. "This is an epidemic. You can only stop it by talking about it—loudly, so that everybody is aware and scared, and they stop the type of behavior that encourages the spread of this disease."

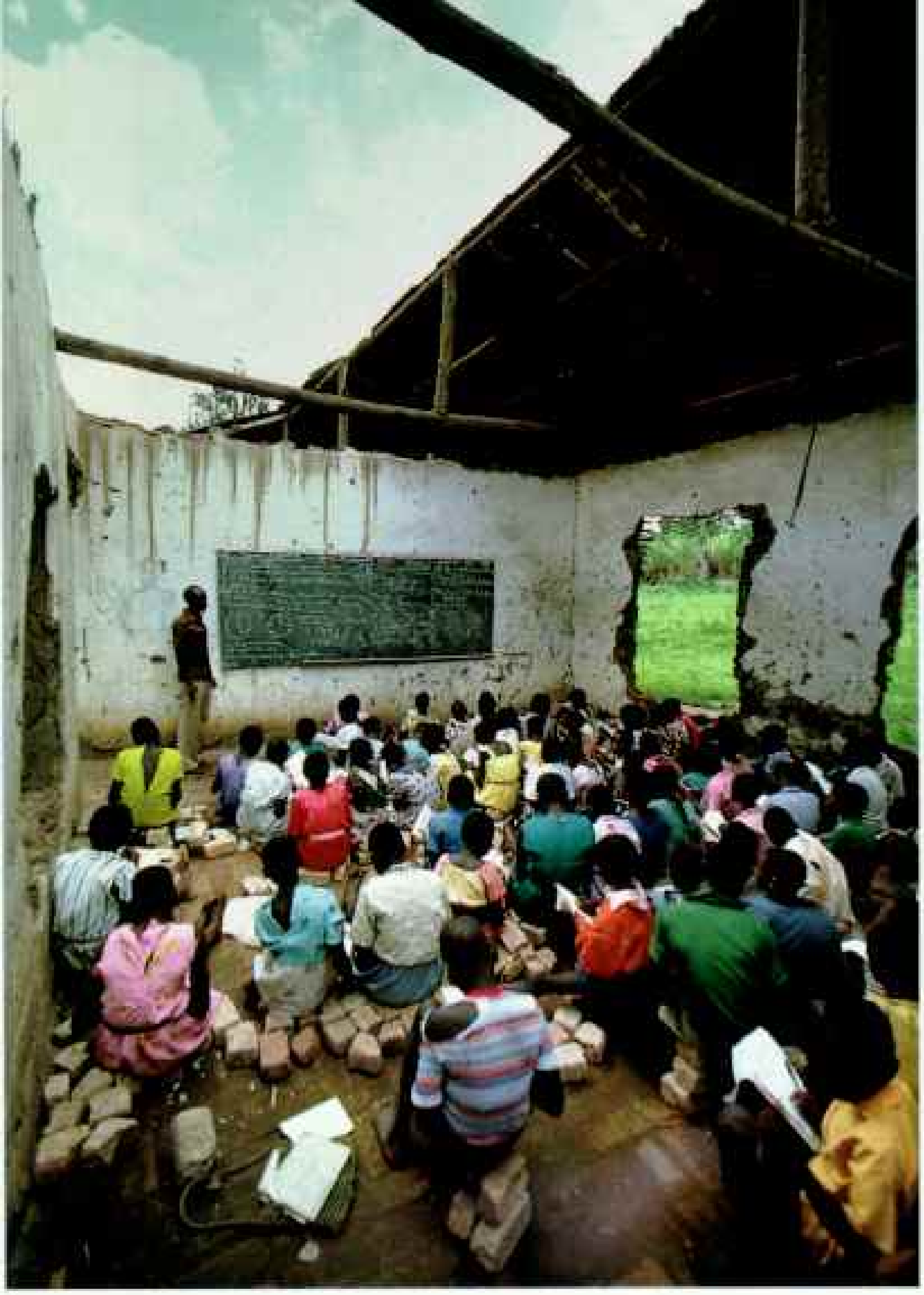
In Uganda, AIDS affects both sexes equally. The ratio of male to female AIDS patients is one to one. "There is every indication," a foreign doctor working in Uganda told me, "that AIDS is a heterosexual disease spread primarily through genital-to-genital contact."

The second largest category, about 10 percent of reported AIDS cases, is the transmission of the disease from mother to infant. There are some cases of AIDS infection through blood transfusions and unsterilized needles, but Ugandans' access to health care has been so disrupted that these play a marginal role.

AIDS was first noted in Uganda in the early 1980s by people in small fishing and smuggling villages along Lake Victoria. Smuggling was a major economic activity, and these ramshackle mud-hut villages, where the odor of drying fish hangs in the air, throbbed with commerce. Boats traveled between Uganda, Tanzania, and Kenya, and lorries traveled along the roads between Uganda, Zaire, and Rwanda. Bars and hotels sprang up, local breweries went into production—and prostitutes by the hundreds descended on the lake, attracted by the free-spending, hard-drinking traders.

*EVERYTHING WAS DEAD OR GONE when widows Gladys Narubuam and Abusaga Mukuma returned to the large home (right) near Nakaseke where they had lived with their family. The husband they had shared and their children were dead, the house looted and burned. "The soldiers took everything," says Gladys, left. "Even the photo of my husband. And it was so quiet—not even a bird sang when we first came. I had to cry when I first saw our home." The two elderly ladies built a small mud hut to live in (below), next to the house. "To start over as an old woman—it is too much," says Abusaga. "Maybe it is better to die."*





According to this theory, the traders returned to their homes carrying the organism with them, as did truck drivers from as far away as Mombasa, on the Indian Ocean. These men infected their wives, lovers, or other prostitutes, who passed the organism on to other partners. The lines of AIDS concentration in central and eastern Africa follow very closely those of commerce.

But AIDS is not limited to the high-risk group of prostitutes and truck drivers. It has been reported in every district in Uganda, and it strikes farmers and townspeople alike. One of the hardest hit areas lies west of Lake Victoria in the Rakai District, a poor, rather isolated area of gently rolling land where the first case in Uganda was diagnosed in 1984. Most people eke out meager livings on small farms scattered across the countryside. Barefoot, they carry their *matoke* (cooking bananas) and beans to market in the district's main town, Kyotera, which was bustling in the smuggling days but is now rather somber.

"Really, it is not possible to know how many people have died from this slim around here," Badru Rashid, the local government official, told me. "In the last week ten people that I know of died. I myself have lost two brothers and a sister. And our town, it used to be so busy. But a lot of the traders died, and others left here because they were afraid. Can you see all the empty shops? So many orphans have come into town, but there is nothing for them, and they start to steal to get food."

As I wandered through the streets, I was

continually approached by young men. They see few foreigners in Kyotera and assumed that my visit must have something to do with AIDS. They seemed desperate for reassurance: "You must find some medicine for this. It is a real curse. We are all going to die—we are always burying people!"

Many people asked me about condoms, which are new to them, as is any information about AIDS. The question I was asked most frequently was, "Is it true that slim is gotten through sex?"

"When the local people first noticed this new disease," Badru Rashid explained to me, "they thought it was witchcraft. They believed that Tanzanians were cursing people who had cheated them. Even now, a lot of people still think it must be witchcraft because one

*SIGNS OF LIFE are slow to reappear in Nakaseke, a once thriving Luwero triangle town where soldiers were stationed during the worst Obote years. Most of Nakaseke's citizens were murdered—many thrown alive from the roof of the local hotel—but shopkeeper Christine Bulungi and her children and mother were among those who escaped. Recently they returned to her ruined store (above right) and began trading bananas, fish, and staples trucked in from Kampala. In Uganda's inflated, barter-driven economy, a stalk of her bananas might cost the teacher in nearby Kigoogwa a year's salary—or provide a meal for orphans at his ravaged school (left). Thanks to fertile soil and plentiful rainfall, Uganda has never been threatened with mass starvation despite years of turmoil.*

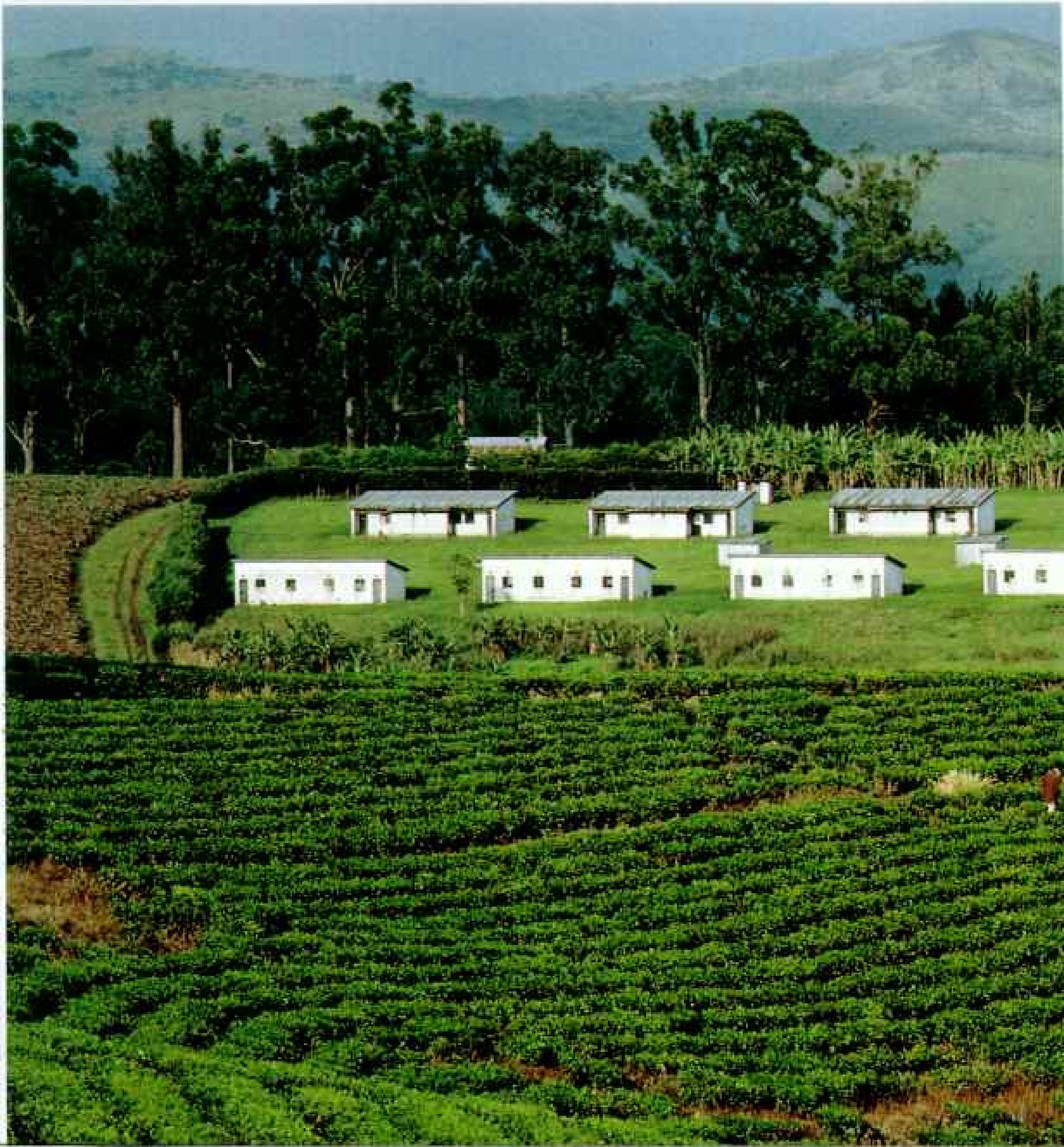
person in a house gets sick and dies, and then others. Like a curse on the family."

THE HEALTH OF PEOPLE in Rakai is generally poor—nutrition is inadequate, malaria is endemic, and so are a host of debilitating parasitic diseases. There is no hospital in the district, and the single clinic seldom has drugs. People's immune systems are constantly under assault, making them susceptible to new infections.

Sexually transmitted diseases are widespread, and mostly go untreated. Many of the doctors with whom I spoke speculate that the open lesions caused by untreated sexually transmitted diseases such as syphilis may increase the risk of transmitting AIDS. Even though people in Rakai have begun to learn that AIDS is spread through sexual contact, they are reluctant to change their behavior.

"You see," Badru explained to me, "a man has a wife, and a woman has a husband. But they also have many, many good friends."

Most of the people in Rakai spend all the daylight hours digging in their fields and doing the chores—fetching water and firewood, cooking—that enable them to survive. It is a hard existence with few rewards.



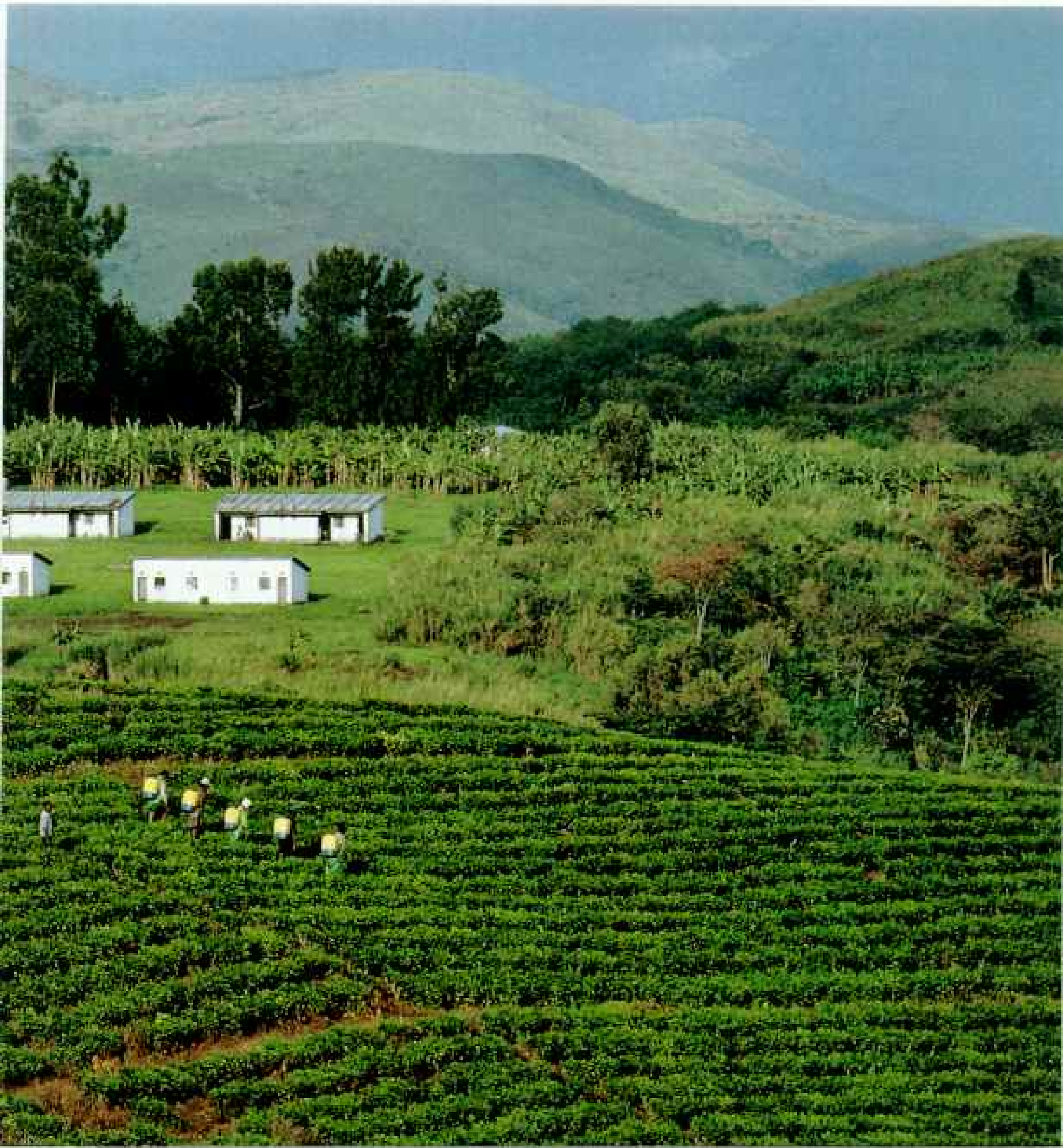
"We cannot live without sex," one man put it. "What else is there, where is the enjoyment? We might as well be dead."

These words were spoken during a conversation one evening in the bar of the Milano South View Inn, where I had a room. I was drinking beer with some of the men from town. A dim bare bulb cast a ghostly light on the bar. Girls leaned forlornly on the counter. Disco music blared from poor speakers, its tempo varying with the fluctuations of the power supply.

The manager of the bar had committed suicide because he thought he had AIDS. In

*TENDING AN OASIS of agriculture near the Ruwenzori Mountains, workers at the Kahuna tea estate have reclaimed fields overgrown during years of war. Reopened by a British firm in partnership with Uganda, Kahuna is one of many foreign-owned plantations confiscated by Idi Amin in 1972.*

*Tea, coffee, and cotton all grow well in Uganda. Economists venture that unlike famine-stricken African countries, Uganda has the resources to rebuild its economy, given a few years of peace.*



Uganda the infection is often marked by weight loss, chronic diarrhea, fever, and skin rash. Some other diseases, which are treatable, may have similar symptoms. But because so many people have been dying of AIDS, a tendency has developed to assume that anyone who gets sick has that disease.

"You see," Badru explained, "people get sick with something like tuberculosis—something that has the same symptoms as slim. They think they have that disease, and so they do not try to get treatment because they know slim cannot be cured. They just stay home and they die. But they did not have to die."

The conversation—about condoms, sexual practices, whether people should be told the results of their tests—was punctuated by long and deep silences. When one of the men remarked that last year there were many more bar girls, one of those present looked up from idly drawing rings on the wet countertop. "It is doomsday," she said.

THE ENTIRE TIME that I was in Uganda, where the cars are in poor condition, the roads are abysmal, and people drive like demons, I was frightened by the prospect of getting into an automobile accident and needing a blood transfusion. In some parts of the country I was worried about the general lawlessness and large number of guns.

In Kyotera, despite my understanding of the ways AIDS is spread, I was afraid of mosquitoes in my room, of the sheets and blanket on the bed, and, most of all, of the unspeakable toilet at the end of the hall. But these fears, I had been assured, were unfounded.

Much more difficult to overcome were the periods of depression and the part of me that wanted to withdraw from the people I spent all day with. I was in Kyotera for two weeks, and every day I went to funerals or to the homes of people who were dead or dying of AIDS. The population of Rakai was scared and confused.

Though death is no stranger to Ugandans, they did not understand this disease that struck down people in their prime. But I have never met people who were kinder or more generous to one who was intruding on their most intimate and sorrowful moments.

The patients gave me some of the precious little time they had left. The families allowed me to sit with them at wakes, while they cried and wailed over the loss of a son or daughter raised with years of care and love. They let me

*THE ROAD BACK to a normal life crosses the border from Sudan, as Ugandans who fled for their lives during the Obote years return to their homes in Nile Province. The United Nations High Commissioner for Refugees operates frequent truck convoys and reception centers like the one at Yumbe (below), where returning refugees are given food, blankets, and farm tools to help them rebuild their lives.*

*Relief officials estimate that more than a million Ugandans were displaced between 1980 and 1985, as Obote's forces exacted revenge on Idi Amin's home territory within Nile Province before focusing their attention on the Luwero triangle.*


C892620

go with them when they carried the bodies, shrouded in bark cloth, to their graves.

I felt helpless. Famines or wars have solutions, however elusive. The situation in Rakai was hopeless. There was nothing to be done for the people who were dying of a disease for which there is no cure, and they knew it. I remember especially sitting on the floor with Jane, holding her hand, listening to her soft

*DEATH ON WHEELS is a common sight in Nakaseke, where another body shrouded in bark cloth is moved to its final resting-place in the fields outside town. Ugandans struggle to find signs of hope in a land where visions of apocalypse have become commonplace.*

fading voice, her eyes lit with a strange inner light, like a candle flame swollen by the wind in the moment before it goes out.

I MADE A SECOND TRIP to Kyotera, three months after I had first stayed there. All but one of the patients I had visited earlier were dead, and by the time of this writing he too had died. Jane had given birth to a baby who lived for only a few days, and then she herself had died. Her mother took me out into the matoke field behind the house. There were two new graves: Jane's, and beside it the smaller one of her infant child.

"I have nothing to do," Jane's mother said. "This life is not good since my daughter died. Every time the memory of her comes to me, I have to cry." □

# *Texas in Bloom*

BY

LADY BIRD JOHNSON
FOUNDER, NATIONAL WILDFLOWER RESEARCH CENTER

ONE OF LIFE'S enchanting pleasures for youngsters in Moravia, Texas, is searching for Easter eggs under bluebonnets and Indian paintbrush at the Ascension of Our Lord Catholic Church.

I knew the excitement of discovering wildflowers as a child when I explored near our house in "deep east" Texas. Violets bloomed on the creek banks, wild roses climbed the fences, and black-eyed Susans nodded beside the road. Trumpet vines with brilliant red blossoms twined around the cypress trees by Caddo Lake.

I've never forgotten that gift of my childhood, and since then it has been my joy to learn the diversity of wildflowers throughout our country: alpine columbines in a high mountain meadow of New Mexico, dogwood and rhododendron of Virginia, blue flags of a New England wetland, and goldenrod of the tallgrass prairie—in fact, the many species of goldenrod are among the most widespread of any wildflower.

I'm no botanist. I'm just an "enjoyer." But I feel a sense of urgency when I see the fields

THE AUTHOR STANDS IN A FIELD OF BLUEBONNETS NEAR THE LBJ RANCH OUTSIDE AUSTIN. PHOTOGRAPH BY DAVID KENNEDY; CHARLES O'REAR (FACING PAGE)

and wild meadows of yesteryear turning into a grid of shopping malls, a spaghetti network of highways, and houses chock-a-block in subdivisions. If we don't incorporate native plants, shrubs, and trees into our planned landscapes, we might forfeit this precious heritage.

I take my hat off to survivors, and wildflowers are survivors. Many are native only to this continent. Others, like people themselves, were originally "immigrants." They crossed the nation on the wheels of covered wagons, the hooves of Spanish horses, perhaps even in the pockets of children.

These survivors do more than delight our eyes. When we plant them beside our highways or in city parks, they reduce mowing and watering costs.

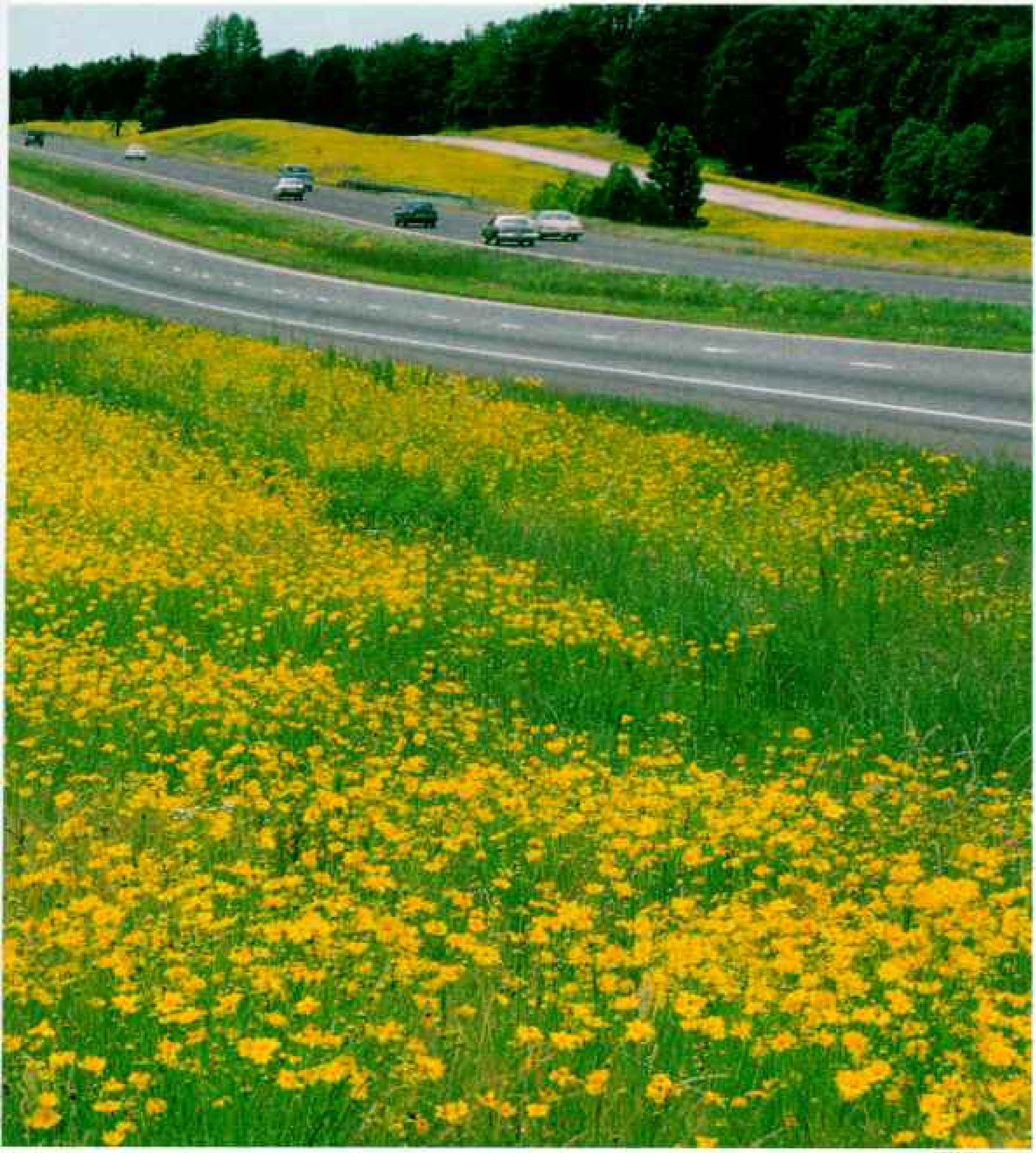
Astonishingly, only 200 of our 20,000 species have been studied in depth. There are 5,000 in Texas alone. So working with many devoted friends, I established the National Wildflower Research Center near Austin five years ago. Some might ask: With the big bomb and a host of other potential calamities hovering over us, how can anybody spend time and resources on flowers? But for me the question is, how can anyone not? Since time began, people who have lived in the shadow of disaster have been enriched by the beauty around them.

I think there is a constituency that cares about wildflowers and the whole diverse pattern of the growing things. One woman wrote to me: "All my life I have liked wildflowers, but I felt embarrassed talking about them so much. You have let me out of the closet."

HIGHWAY, or garden, or both? On either side of Interstate 20 near Tyler, Texas, golden coreopsis stretch as far as the eye can see. This is no accident. Years ago farsighted officials of the Texas Highway Department began spreading wildflowers on rights-of-way by simply mowing where a heavy stand had gone to seed and pitchforking the mulch farther up the road. In addition to pleasing the eye, the flowers reduce maintenance, saving millions of dollars a year.

The program attracts a growing number of visitors who come to see our spring wildflowers, along with officials from highway and parks departments in other states. Some officials return home to begin similar programs in their jurisdictions.

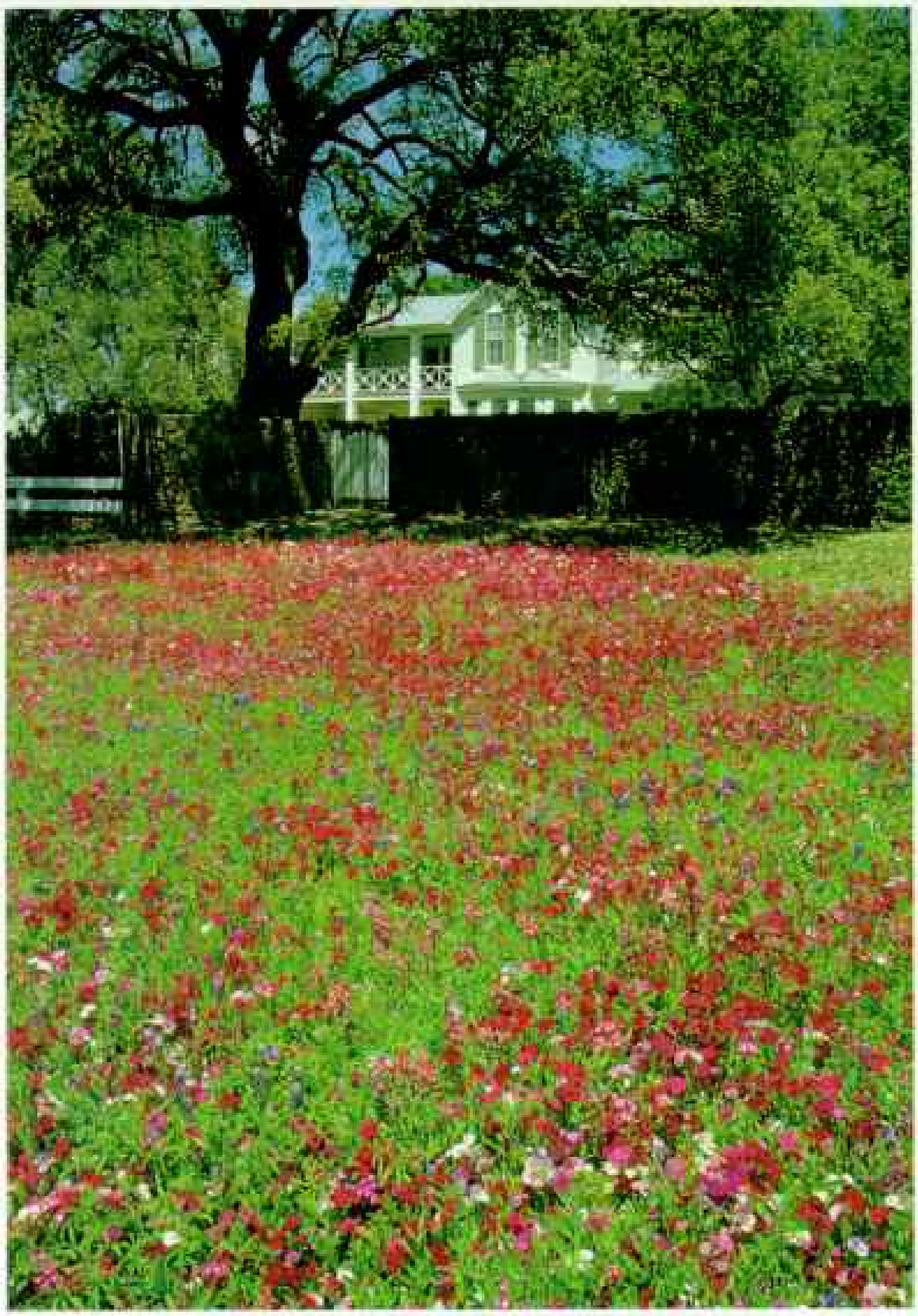
For 18 years I have sponsored an awards program recognizing outstanding performance by our highway maintenance people, the pick-and-shovel crews who do the real work in establishing these stands of wildflowers. The celebration includes a barbecue at the LBJ State Park, western music, and a first-place prize of $1,000 to the person who has



done the best work during the year. We want them to know that we appreciate them and salute their efforts. There are 73,000 miles of highways in Texas. Together with the systems of other states, the acreage is potentially the biggest garden in the world!

Last year a provision of the federal highway act recognized the benefits and grace of using what belongs to each region. The act mandates that 25 cents of every 100 dollars earmarked for landscaping be spent for native plants.

If we want to keep this heritage of natural beauty, it's important that we incorporate wildflowers, native grasses, shrubs, and trees into landscaping plans—not in the manicured yards of Potomac, Maryland, or River Oaks in Houston but in suitable areas such as parks, highway rights-of-way, and the roughs of golf courses. I have found Persian carpets of wildflowers in churchyards, cemeteries, even vacant lots. Vacation homes are good places for plantings—indeed, anywhere that you want some color and don't want to water and mow all the time.



THREE DAYS in the life of a wildflower meadow in front of my home show the random palettes of changing blooms. Behind the live oak tree lies the LBJ Ranch, once known as the Texas White House, now administered by the National Park Service.

The cherry red of Drummond's phlox dominates the first picture, taken on April 15, though some bluebonnets are still flourishing. A month later Indian blankets have taken over, along with a few pink evening primroses. By June 15 they are giving place to purplish lemon mint, while black-eyed Susans are beginning to flower.

Some 30,000 visitors pass by in tour buses every year, and I thought the meadow would make a pretty good wildflower showcase. At 15 miles an hour they are obliged to see the flowers. This is the spectacle that visitors will encounter on our highways if we have a good spring, with the alternating sun and rain that make flowers flourish. If there is a drought, the flowers will come up anyway because they are tough, but it takes rain to make a brilliant show (I must confess I water when absolutely necessary).

By July, when the flowers have gone to seed, they are scruffy, rough, and unkempt. Most of us don't like that; we are used to well-tended lawns. But if the flowers don't make seeds, they won't come up next spring. We need to look with new eyes and new patience to next year, when they will be back in glory.

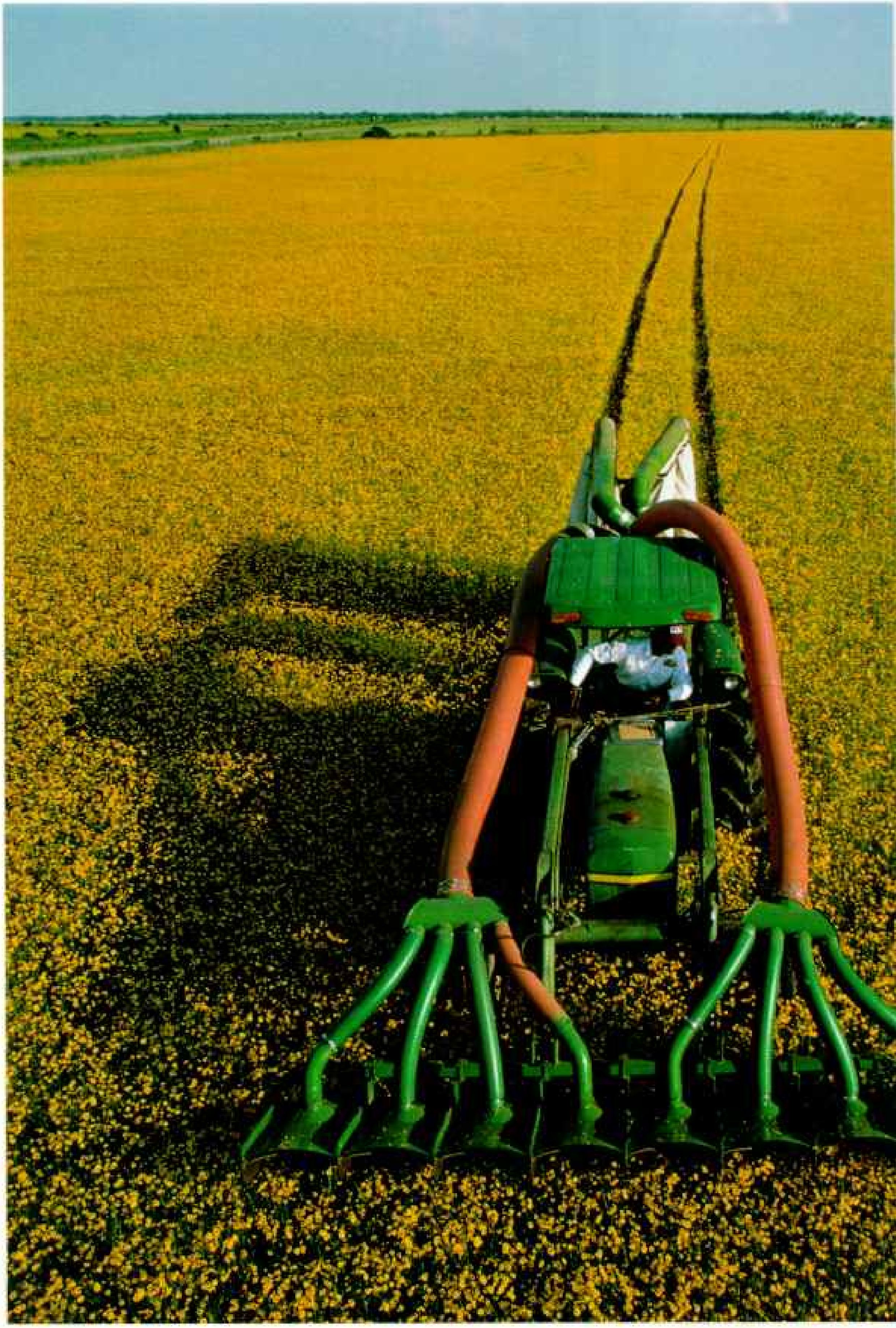
I don't want to give you the impression that growing wildflowers is easy, that you just scatter seeds "like feeding the chickens" and get magnificent results. You *must* have seed-soil

ALL BY BILL BALLENBERG

contact, you *must* have some rain, and then it may take two or three years to get things well established.

Even then it still can be frustrating, because we don't know their secrets, and that's the purpose of the National Wildflower Research Center. Here botanists (left) press a bluebonnet to make a record of the plant. We do tests in a greenhouse and on outdoor plots. We want to know germination rates, water and soil requirements, when to plant and how to plant, and—so very important—how to combat the invading weeds. Because if people don't get reliable, consistent results, they will become frustrated and give up.

The center also acts as a clearinghouse for wildflower information. So, if you have any questions, or if you'd like to know about the wildflowers of your state, please write to us, and we'll do our best with the information available—so much remains unknown! Send your questions and a self-addressed 9-by-12 envelope with 66 cents postage to: National Wildflower Research Center Clearinghouse, 2600 FM 973 North, Austin, Texas 78725.



INTEREST in wildflowers in the past few years has been burgeoning. From our clearinghouse we know that the number of major wildflower-seed producers has increased from a handful in two states to more than 25 in 15 states, in every region of the country. There are many smaller ones as well. Five of the largest are Native Plants in Utah; Applewood Seed Company in Colorado; Clyde Robin Seed Company and Environmental Seed Producers, both in California; and John Thomas's Wildseed of Texas, which developed this Vacuum Seed Retriever (left). The machine gently vacuums ripened seeds, here from plains coreopsis, without disturbing the plants. This process enables growers to make seed more plentiful and less expensive.

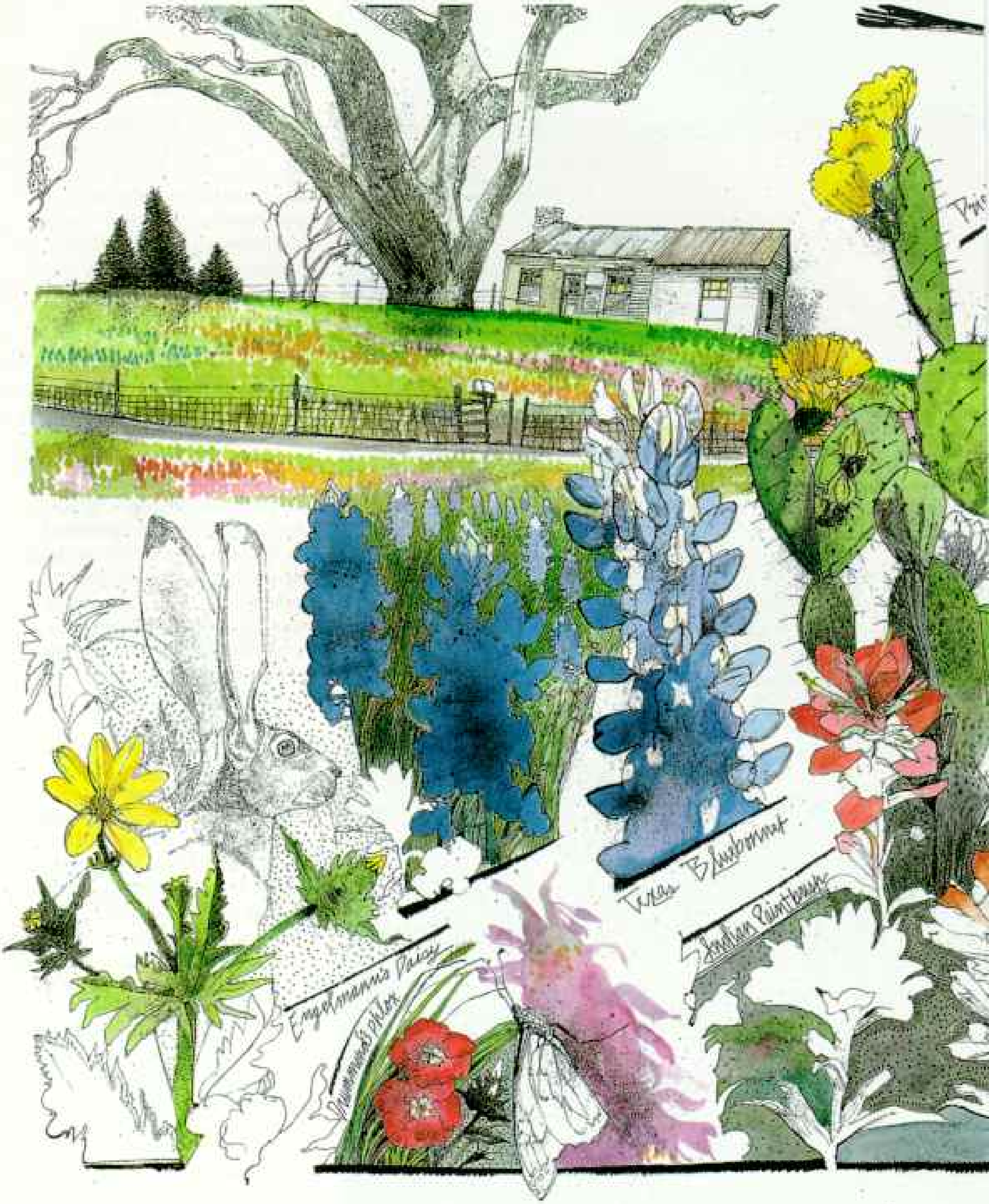
Today's seed producers remind me of Texas wildflower pioneer Carroll Abbott, who gave up newspapering to gather seed with his bare hands. Those seeds were a novelty then; now they're big business. He expressed his love for wildflowers in poetic language, communicating a great sense of excitement, while at the same time being quite realistic about how hard it can be to get rid of the weeds.

Working with a widening network of enthusiasts in the effort to keep a place for wildflowers and native grasses, trees, and shrubs in our nation's landscapes has been deeply satisfying—it gives me what an old friend has described as "psychic income"!

* * *

*Wildflowers Across America*, by Lady Bird Johnson and horticulturalist Carlton B. Lees, will be published in May by Abbeville Press.

CHARLES O'REAR




# *Wildflowers Across America*

A PORTFOLIO BY JACK UNRUH

TEXT BY MICHAEL E. LONG
NATIONAL GEOGRAPHIC SENIOR WRITER


STEADY AS SOLDIERS, the wildflowers of rolling central Texas survive drought years and flourish in wet ones. From left to right in this May scene, a bright yellow Engelmann's daisy contrasts with a cherry red Drummond's phlox.

Texas's state flower, the bluebonnet grows in the poorest of soils, using nitrogen from the air to help make food. Together with Indian paintbrush, it heralds spring. Prickly pear cactus tempts pollinators with yellow blooms and punishes intruders with spines. Night-blooming pink evening primrose offers a lemony scent to insects. Indian blanket is also called fire wheel; Mexican hat recalls a sombrero.


# *Southern Woodland*

TOLERANT OF SHADE, the wildflowers of a Georgia woodland in April make the air heavy with scent. A mayapple at left recalls an earthy mountain maxim: A woman who pulls it up by the root will soon become pregnant.

The delicate atamasco lily blooms quickly after spring rains. Blazing invitation, the fire pink exudes a sticky substance that traps insects. Indians made a poultice of the roots of the crested dwarf iris to treat sores. Disdained by bees and

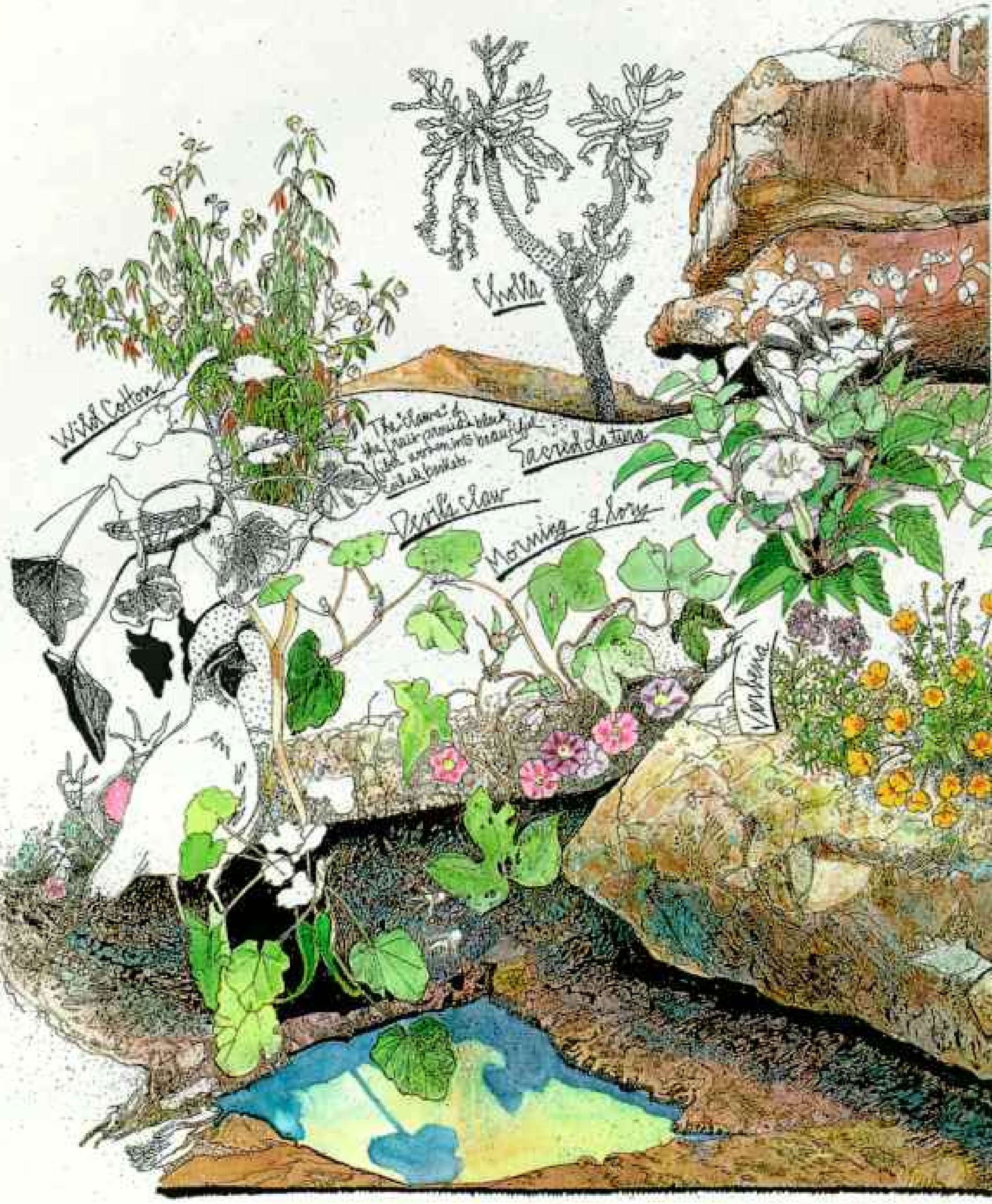
*National Geographic, April 1988*


butterflies, the plain wild ginger is pollinated by a beetle.

In demand from plant nurseries, piedmont azaleas tower ten feet above blue star, trillium, and nodding trillium, whose blooms droop in the breeze. Indian women claimed that boiled trillium root could arouse a man's love. The wild columbine was regarded as a symbol of cuckoldry; to present the flower was a great insult.

In the fiddlehead stage a cinnamon fern can be boiled and eaten. The bird-foot variety of violet is regarded as the most beautiful. Violet leaves are high in vitamins A and C and make a pleasant addition to a salad.

Bracts of the flowering dogwood show rust-colored stains, said by legend to be symbols of the wounds of Christ.




# *Southwest Desert*

WILDFLOWERS make the most of an arid environment. Wild cotton, unlike its domesticated cousin, bears just a hint of fuzz. The fruit of devil's-claw attaches to passing animals to spread seeds.

The cholla's spiny joints fall and take root to create another plant. Coaxed into bloom by summer rains, the morning glory is related to a species

*National Geographic, April 1988*


cultivated by flower children of the 1960s for its LSD content. Avoided by Indians for its reputed supernatural properties, sacred datura can induce hallucinations and even death.

Diminutive verbena is prized by gardeners for its color. Bright Arizona caltrop resembles poppies. Pollen from the male stalk of the desert spoon is windborne to a female plant stalk. In Mexico, mescal sap is used to make liquor.

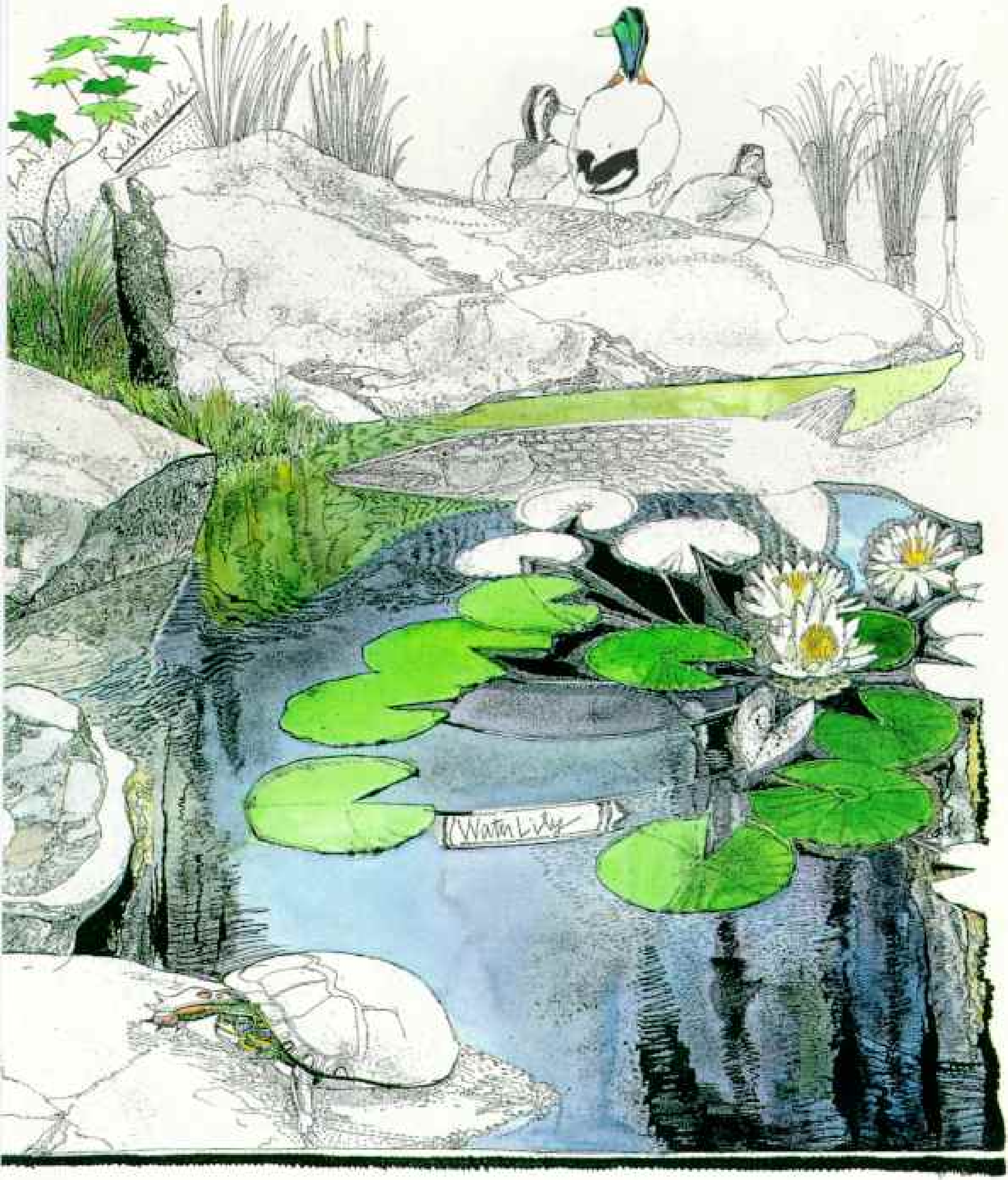
Barrel and pincushion cactuses store water in their succulent stems. Desert marigolds are brilliant by the roadside.

# *Eastern Wetland*

GETTING THEIR FEET WET, many wildflowers of a Connecticut pond and stream root in water. By late July a slender blue flag—from the Middle English "flagge," for "reed"—rises above a Virginia meadow beauty, whose urn-shaped fruit Thoreau once likened to a tiny cream pitcher.

A cluster of pink flowers tops joe-pye weed, which exudes a vanilla odor if bruised. Joe Pye may have been an Indian medicine man; another legend says *jopi* was an Indian word for typhus, whose fever could be broken by the plant. In the

*National Geographic, April 1988*




southern Appalachians it is called queen of the meadow.

Floating duckweed, from a family containing the smallest of flowering plants, trails its root in water to absorb nutrients.

Deer feed on pickerelweed, named for the fish cruising at right. The common cattail was a supermarket for Indians and colonists. Young shoots were eaten like asparagus; flower spikes were served à la corn on the cob; root sprouts were served as salad; the root itself was ground into meal.

A marauder from Europe, purple loosestrife flourishes aggressively to crowd native plants. A nearby red maple sapling seems to hold its own.

To feast on the starchy tubers of the arrowhead, ducks plunge into the mud to find "duck potatoes." Flowers of a water lily, as much as six inches wide, remain open for several days.

# *Tallgrass Prairie*

AS BEFITS RESIDENTS of the tallgrass prairie, these August wildflowers stand tall themselves, from two to six feet in height. Colors often whisper rather than shout for attention. The gray-headed coneflower stands as high as five feet, offering its pendant yellow rays to the wind. Though sneezing allergy sufferers may blame stiff goldenrod for their miseries, the culprit is ragweed. Lore holds that whoever carries a goldenrod will find treasure and good fortune.

*National Geographic, April 1988*


Monarch butterflies head for a favorite nectar in flowers of the rough blazing star. Maximilian's sunflower likes to migrate from roadside ditches into planted fields, causing farmers to fret. To the right of the sunflowers stands a sheaf of bluestem, the native grass reaching six feet in height that once dominated the prairie.

Leaves of the smooth aster are almost waxy. Preferring wet sites in undisturbed prairie, the swamp thistle grows to six feet and offers magenta blossoms. Tall blazing star also prefers a moist habitat. In recent years the flower has achieved increasing popularity with florists.

Meanwhile, meadowlarks throng among the flowers to eat insects and sing melodious and loud thanks.

# *Alpine Tundra*

ON THE HEIGHTS of a Colorado mountain there are precious few days in the July sun for wildflowers to be pollinated and propagate. They tend to grab for a foothold and play it close to the ground. The five-inch-wide flower of old man of the mountain sits atop a six-inch stem matted with dense hairs that can give the flower a bearded appearance.

The alpine forget-me-not and moss campion spring from cushiony beds just inches high. Tall interloper, sneezeweed is usually found at a lower elevation. Livestock enemy number one in the mountains, sneezeweed

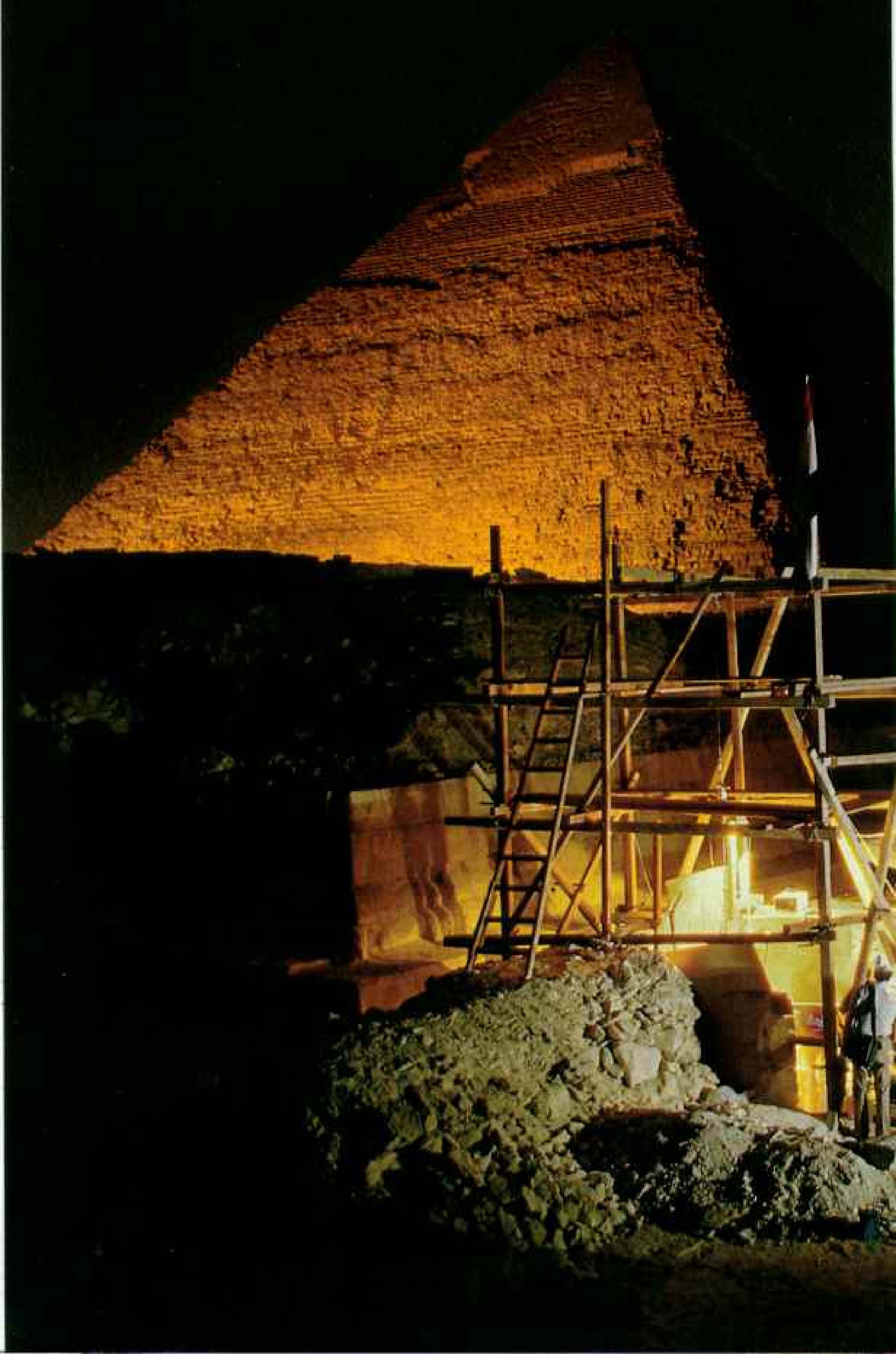
*National Geographic, April 1988*


contains a chemical that can blind and kill sheep and cattle.

The dwarf columbine rises only four or five inches and grows only in Colorado. Dressed in bright purple, fringed gentian blooms in late summer, giving rise to a mountain promise: When you see a gentian, a hard frost will soon follow.

The pleasant fragrance of a sky pilot changes when the leaves are crushed, to the odor of a polecat. Impatient to bloom, the snow buttercup thrusts through the snow. A nearby alpine spring beauty is another early bloomer.

Plain Jane among showy beauties, viviparous bistort spreads by dropping a tiny bulb that takes root—if not claimed by voracious marmots that feed on wildflowers and grasses. Parry's primrose is a hummingbird favorite. Columbine thrives in the alpine climate, but with the crackle of frost all the flowers die, to await the warmth of another spring. □



# Finding a Pharaoh's Funeral Bark

*An international team of scientists, using a specially designed drilling system, has unveiled a 4,600-year-old ship in the second of two underground chambers beside the Great Pyramid of Khufu (Cheops) in Giza, Egypt. The disassembled vessel closely resembles one found in the first chamber in 1954, ending years of speculation. The team, sponsored by the Egyptian Antiquities Organization (EAO) and NATIONAL GEOGRAPHIC, took great care during its investigation not to disturb the ship or its environment. Working day and night, the scientists employed an air lock to prevent pollutants from infiltrating the pit. When they were finished with their work, they resealed the chamber, leaving it as it was before. As chairman of the EAO, I would like to commend their nondestructive approach, which follows the rule "Look, but don't touch." I believe it holds great promise for future archaeology.*

—AHMED KADRY

BENEATH THE PYRAMID OF KHUFU'S SON KHAFRE (CHEPHREN), TEAM MEMBERS ANTICIPATE THEIR FIRST LOOK INTO THE SEALED BOAT PIT. NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR

By FAROUK EL-BAZ

Photographs by JAMES P. BLAIR and CLAUDE E. PETRONE

BOTH NATIONAL GEOGRAPHIC STAFF

WHEN the royal bark of Khufu was unearthed from a pit near the base of the Great Pyramid in 1954, one of those present smelled "vapors, perfumes of the wood, sacred wood of the ancient religion." The pit had been so effectively sealed by the ancients that it had preserved the aroma of cedar timbers imported from Lebanon some 4,600 years before.

Most of the timbers were in a near-perfect state of preservation. The pit—102 feet long, 11.5 feet deep, 8.5 feet wide—was overlain with huge limestone blocks joined by thick mortar.

The disassembled boat, made up of 1,224 components, was fitted together and the 142-foot-long craft displayed in a specially built boat museum near the Great Pyramid of Khufu, known to Westerners as Cheops from the writings of the Greek historian Herodotus.

Evidence of a second pit, very near the first one, was noted at the time of the original excavation. Egyptologists speculated that the second pit might contain another boat. They wondered also whether the ancient air trapped inside the chamber had some property that aided in the preservation of the wood.

The Egyptian Antiquities Organization (EAO) called for a plan to measure the temperature, pressure, and humidity of the second pit and sample its trapped air.

For years NATIONAL GEOGRAPHIC had been interested in finding a way to photograph and otherwise study the interior of unopened tombs and other archaeological sites without sending people inside or admitting air or pollutants that might damage the contents. A team led by Claude "Pete" Petrone of the GEOGRAPHIC's photographic division had long been working on this problem.

Ahmed Kadry, then Chairman of the EAO, and Wilbur E. Garrett, Editor of NATIONAL GEOGRAPHIC, agreed on a plan to insert sensors into the pit.

Drilling through the ancient rock was an enormous technical challenge in itself. Bob Moores of Black & Decker Corporation, an engineer specializing in the technology of drilling (right, wearing white cap), went to work on the problem, together with a team of other scientists and technicians representing 41 organizations in Egypt, the United States, Great Britain, and the Netherlands.

I was familiar with the technology involved as a result of several years' work in the U. S. space program and later at Boston University's Center for Remote Sensing, which I direct. NATIONAL GEOGRAPHIC asked me to coordinate the scientific plan, working with Elie Rogers, who was chairman of the committee carrying out the project. Elie had spent his boyhood in Cairo, and his knowledge, his witty Arabic, and his Egyptian manners were special assets as our team worked together long hours at the site.

A SAMPLE from a stone block from the first pit was delivered for study to Nafi Toksöz at the Massachusetts Institute of Technology. He found that the sample was composed of easily drillable limestone with 24 percent porosity and that the mortar attached to it had been made of limestone powder, crushed gypsum, and specks of ground potsherds.

To ascertain the thickness of the block to be drilled and the shape of the pit's contents, we called upon ground-penetrating radar. However, when the instrument was trained on the sealed pit, no usable reflections resulted, owing to moisture trapped in the limestone. Stronger radar antennas would be tested later; we knew only that we would have to drill through

NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES L. AMOS (OPPOSITE) © JAMES P. BLAIR

***Preparing to penetrate the underground chamber, team members steady a drill shaft over the pit's limestone roof. Touhamy Mahmoud Ali (left), foreman of the Egyptian work crew, stands transfixed by the first video pictures from inside the chamber. Touhamy was also present in 1954 when the first pit was opened.***

a block about six feet thick.

Once we drilled, naturally, we would photograph the contents in detail. But what instruments would we use? The question was posed to NATIONAL GEOGRAPHIC experts, and it became clear that both a video system with a zoom lens and a still camera would be required, together with a means of lighting the interior of the pit without raising the temperature.

A remote-control video system that appeared well suited had already been manufactured by Rees Instruments Ltd of England for inspecting the interior walls of nuclear reactors. An ingenious modification by Pete Petrone's GEOGRAPHIC team and Rees's Tim Taylor added a Diaguide light source, a bundle of fiber-optic threads producing "cold light."

After the video system and 35-mm camera were tested in Washington, we knew that the system would work if we could just get an air lock to exclude the outside air from inside the pit. Bob Moores soon provided one.

FINALLY we were ready to drill into the second pit. Touhamy Mahmoud Ali, the *rayyis*, or foreman, of the Egyptian work force, built the scaffold to support our equipment—a happy marriage of ancient and modern technology.

With a felt-tipped pen, Moores began marking the surface from premeasured sheets of paper. He drew the location of the steel ring and its eight anchor bolts and marked the circle for the drill bit.

The National Oceanic and Atmospheric Administration's Pieter Tans followed Moores in the same tiny work space and connected the stainless-steel tubes of the gas purging system to air-lock valves. The tubes led to the already assembled bottles and pumps for air sampling. Then Tans checked the system for leaks, using a soap solution—a leak would initiate telltale soap bubbles. "Not very high tech, but it works fine," he observed.

As a member of the Explorers Club, I had brought its flag with me. Elie Rogers had provided National Geographic Society flags. Touhamy realized what we were up to. "Abdallah," he called to his ever present

FAROUK EL-BAZ, former science adviser to the late President Sadat, wrote about the Aswan Dam in the May 1985 GEOGRAPHIC.

# Exploring a 4,600-year-old boat with space-age technology

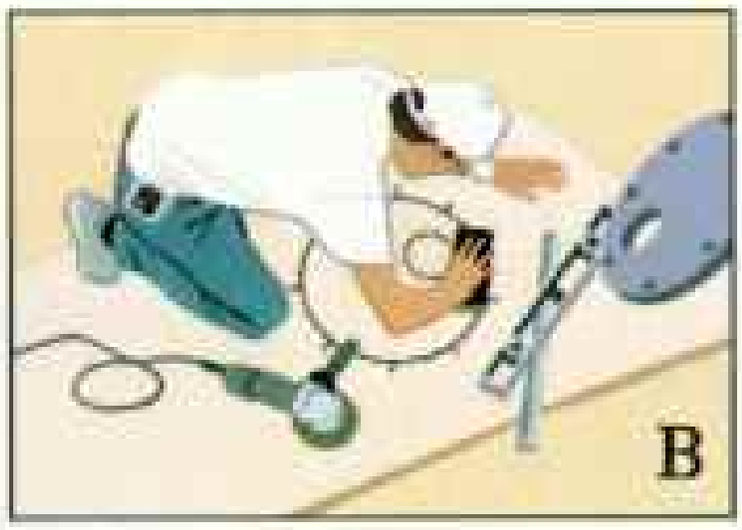

*To view but not to spoil: That was the challenge confronting the team. They had to insert into the chamber a camera assembly that was 80 millimeters (three inches) in diameter. No lubricants or cooling fluids could be used during drilling. And no transfer of air could be permitted between the pit and the outside.*

*It was hoped that analysis of air trapped inside might provide valuable information about the best conditions under which to store ancient artifacts. There was even speculation that the air could have been 4,600 years old. If so, it might have revealed much about changes in earth's atmosphere. Unfortunately this was not to be. A study later showed that the air had mixed with air from above ground. Unknown to the team at the time, the chamber's seal—if ever there was one—had been broken sometime in the past.*

*To determine the best location for drilling, a profile of the pit was obtained with ground-penetrating radar (A). An area in the center of one block (B) was leveled with a mason's adz, sanded, and treated with epoxy resin before being fitted with the air lock. A specially designed drill bit was used, driven by a heavy-duty drill (C).*

*Two elements formed the basis of the air-lock system (far right) designed by Bob Moores of Black & Decker Corporation: (1) A circular steel plate, fixed and sealed to the limestone block, and (2) a rotating assembly. When the assembly was moved over a hole in the plate, it provided an opening through which the drill shaft (3) or camera assembly could be lowered. When it was rotated away from the hole, it sealed the hole tight.*

*The team drilled the hole an inch at a time, removing stone powder with a vacuum cleaner after each*

seventh child, "fetch an Egyptian flag!" Soon from the top of the scaffold many colors flew.

"*Bism Allah al-rahman al-rahim.*" I spoke the Arabic phrase—"In the name of God, the compassionate, the merciful"—and with a big American grin Moores started the drill. The screeching sound of the drill teeth biting the limestone rock would be heard off and on for the next 48 hours, as we had decided to drill right through the night.

Moores stood on two wooden slats and pulled the trigger on the drill handle to crush one inch of rock in just over a minute. "This stuff cuts like butter," he proclaimed.

He then descended to remove the drill bit from the air-lock guide, place the hose of an industrial-strength vacuum cleaner to suck up the dust, lower a specially designed core breaker to fragment the rock pieces sticking out on top of the rock, enter the vacuum again to remove the fragments, and reinsert the bit to drill another inch.

Moores only had to go through the motions once for two of Touhamy's men to realize that he would need help. Haggag Fathi Hassan from Nubia took over the drill and the core breaker. Mohamed Dhahi Mahmoud, a quiet and thoughtful worker, joined him by taking over the raising and lowering of the drill. Soon he was also operating the vacuum cleaner.

INCH BY NOISY INCH, the drill's shaft sank into the rock. Moores worried that the shaft he had designed might not be long enough. We took a break to remeasure the thickest blocks removed from the first pit and found that the drill had nearly a foot to spare. Meanwhile, a pool was started for guessing the exact depth of penetration. Egyptian pound notes piled up as people hurried to get in on the wager.

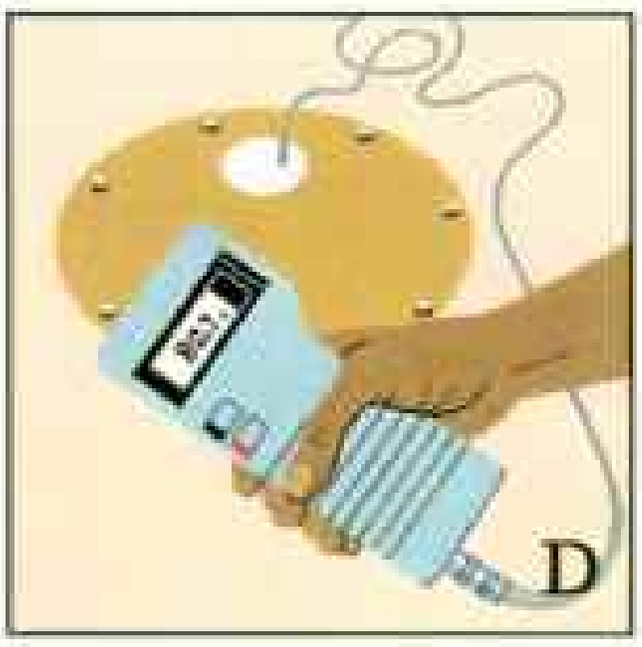
Suddenly a thump was heard. The drill bit had reached the bottom of the block at 63 inches. Cries of *Mabrouk!*—Congratulations!—clapping, and laughter drowned the steady drone of the air pump. Even the wager was forgotten in the jubilation—until Touhamy triumphantly claimed his prize.

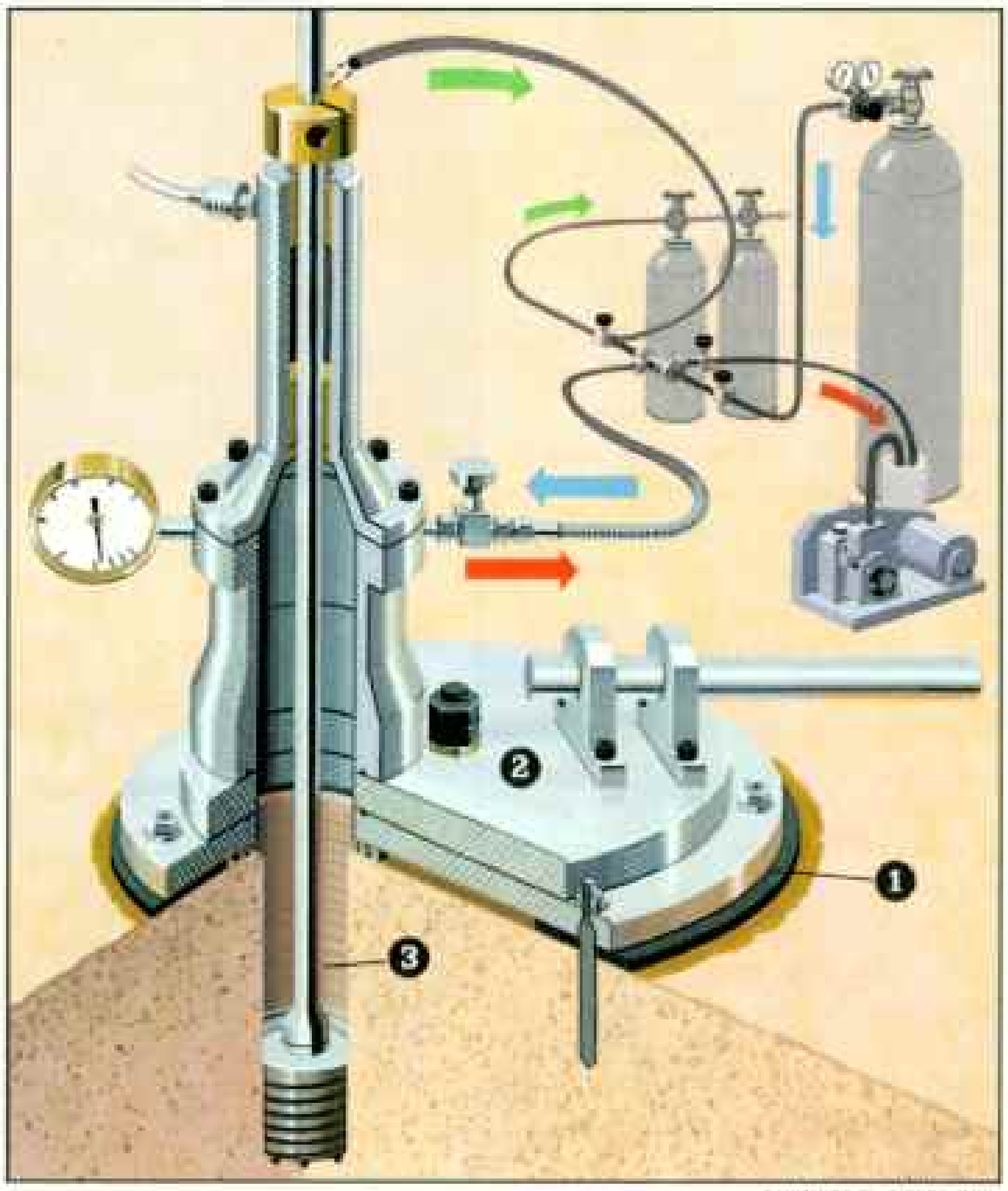
Then came a disappointment. "I don't think this pit is sealed," said Tans, who had been monitoring the pressure gauges. He explained that as the

*stage (red arrows). As breakthrough appeared imminent, the hole was purged continually with uncontaminated air (blue arrows). Once the hole was completed, the drill was replaced with a tube that drew air samples (green arrows) from the pit into collecting tanks.*

*A similar procedure was used for the camera probes. After six days of documenting the pit's contents, the team replaced the air lock with a semipermanent seal fitted with sensor probes (D) to monitor temperature and humidity.*

*"With suitable modifications," says Moores, "this system could have broad applications, not only in archaeology but also in other exploratory investigations, such as submarine rescue, nuclear-reactor probing, and earth-resource studies."*




PAINTINGS BY PIERRE MION

drill broke through there was no change in pressure—"not even 0.1 torr."

This was the first sign that we were not entering a hermetically sealed chamber. Nevertheless we proceeded as if the seal were intact.

A stainless-steel tube was carefully lowered into the hole through the air lock and attached to a pump. Samples were taken at three different levels (7, 37, and 57 inches) below the pit's ceiling, just in case the air inside had stratified. Seventy liters of air went through the flow meter and into six canisters for shipping to the United States for laboratory investigations.

As he pumped air samples, Tans released a bit through a valve to sniff. He grimaced and declared: "I don't smell history —maybe only staleness."

Tests of the air samples in Egyptian and U. S. laboratories confirmed our fears that the pit's seal—if ever there was an airtight seal—had been broken. Measurements of chlorofluorocarbons and carbon dioxide at the NOAA laboratories revealed that the ancient air inside the pit had been mixed with the surrounding atmosphere. Tans calculates that the air pumped out of the pit for the samples was replenished at the rate of about four liters a minute through fractures in the mortar. The samples were indistinguishable from the air over Cairo, with one notable difference: The amount of carbon dioxide was double that above ground, perhaps as a result of organic matter decaying inside the pit.

Powerful microscopes at Boston University failed to detect any pollen grains or bacteria in the air samples, and samples tested at Al-Azhar University, Suez Canal University, and the Egyptian Atomic Energy Authority showed that the samples were free of microbial contaminants. This may have been because air was pumped from three feet or more above the bark, and organisms may have settled to the bottom.

IT WAS NEARLY MIDNIGHT, starry and cold, when the air sampling was completed and the imaging equipment was laid on a table ready for the removal of the protective covers. The work was being conducted in near silence.

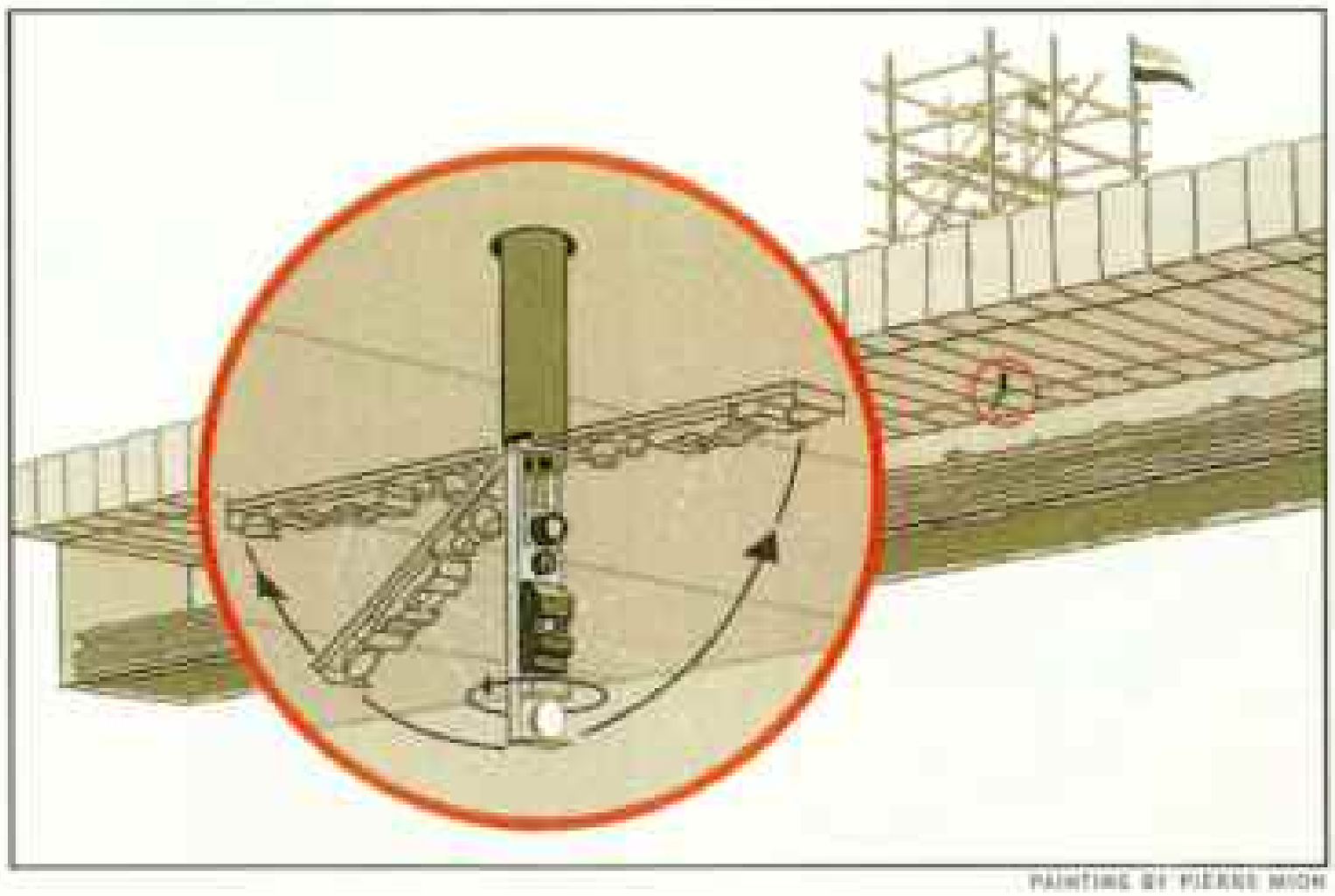
Two people were visibly shaken in anticipation of seeing into the ancient world through the eyes of the cameras. The first of these was Touhamy, who had worked on the removal of the blocks of the first pit and stayed in the area ever since. He had helped during the assembly of the first boat and its placement inside the museum. He seemed certain that the second pit also contained a boat, and he wanted to be among the first to see it. He chain-smoked impatiently. The other was Mona Rahouma, director of the boat museum.

Finally, at 2:45 a.m. on October 20, the video camera was ready. Slowly the camera head was inserted into the hole. As it softly touched the walls, a snowy powder left over from the

JAMES P. BLAIR

*Camera wizard Claude "Pete" Petrone of* NATIONAL GEOGRAPHIC *(left) readies the probe he designed to make the photomosaic on pages 525-28. Rigged with a video camera, strobelight sensor, 35-mm still camera, strobe light with ultraviolet filter, and viewing light, the assembly pivots 180 degrees and rotates 360, permitting full documentation of the pit's interior.*

*Gathered around a video monitor in the predawn hours of October 20, team members get their first view of the pit's contents. "Markab!" shouts Touhamy, third from left. "Boat!"*



PAINTING BY PIERRE MION

drilling fluttered downward.

Suddenly a clear, sharp image flashed on the screen. *"Markab, markab!"* shouted Touhamy—"Boat, boat!"

There was the second royal bark come to life again—a dense stack of wooden panels set within frames and held together by cross braces.

At the western end of the pit the camera found chips of mortar that had fallen from between the ceiling blocks, some copper loops, and more pieces of wood.

A swing of the camera arm revealed the eastern end of the pit, and thus in a few moments the whole upper surface of the boat was surveyed. Ours were the first eyes to behold it since the 26th century B.C.

By a stroke of luck the camera suddenly glimpsed a moving object on top of the wood. "A bug!" cried GEOGRAPHIC writer Peter Miller. A black beetle scuttled over the boat. Its existence dealt the final blow to any hope that we had penetrated a pristine environment.

Hag Ahmed Yousef, who directed the assembly of the first boat, was moved by the images but not surprised by the pit's condition. He asserted that the seal must have been unintentionally violated during the building of the museum in the 1960s. He recalled that a brick-making machine and a cement mixer had been positioned above the second pit, vibrating and spilling water. He had protested vehemently at the time.

All the same, the excitement was great. Mrs. Rahouma's seven-year-old daughter, Yasmin, had been very sleepy, but when the first pictures flashed on the TV screen, she clapped her hands in delight.

MORE IMAGES were obtained using a still camera, strobe, and ultraviolet filter. Chisel marks

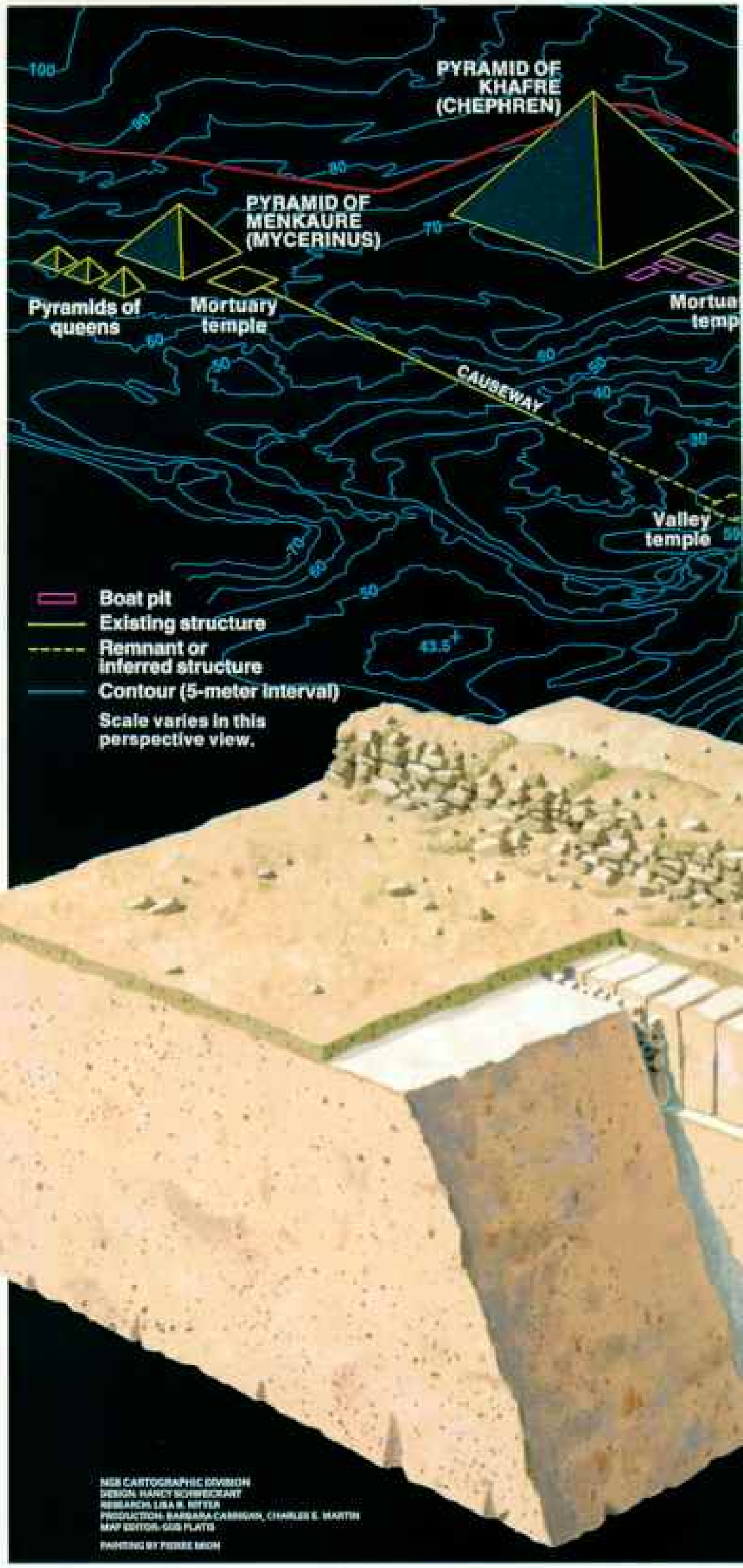
NATIONAL GEOGRAPHIC EDITOR WILBUR E. GARRETT

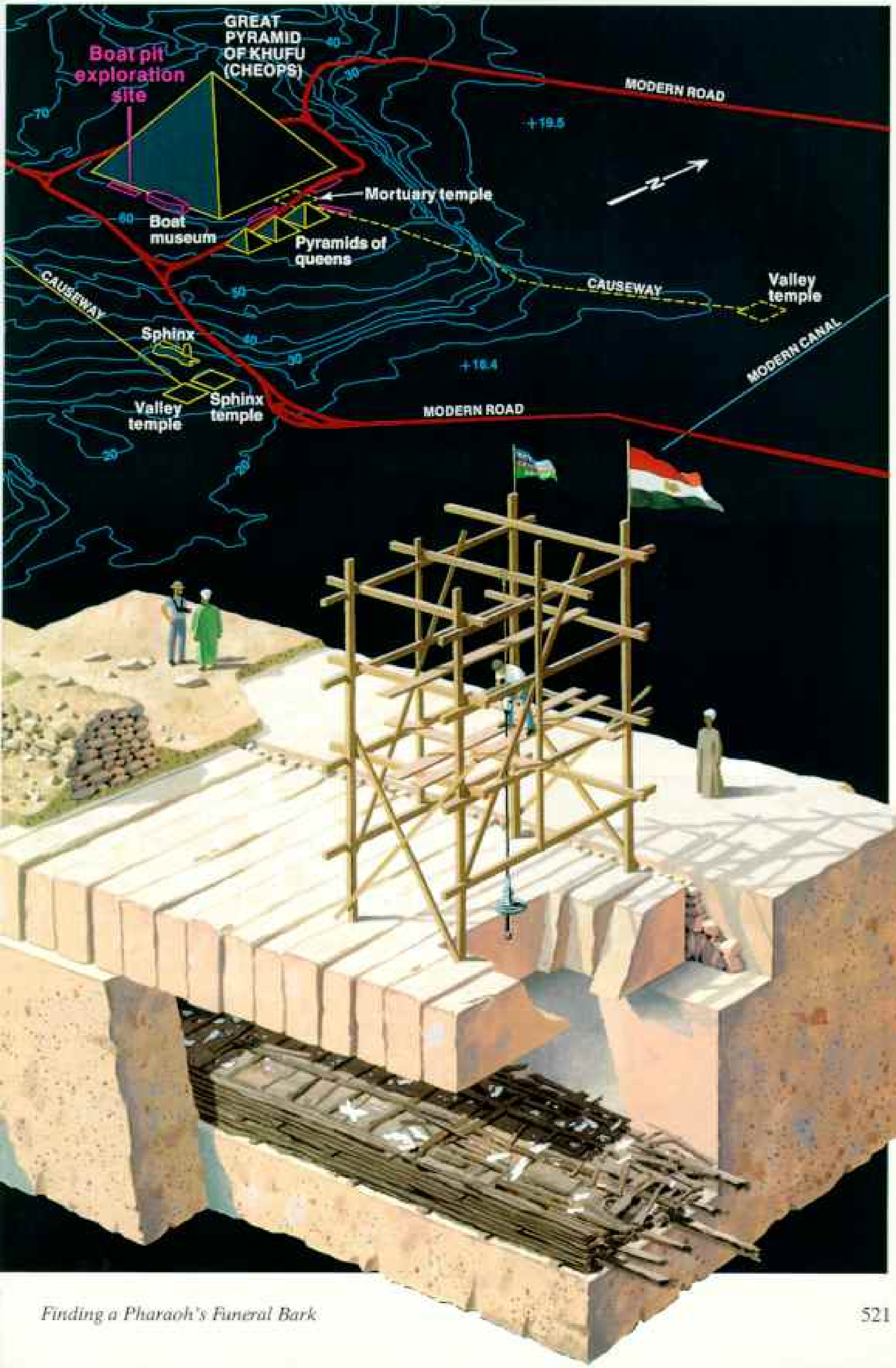
# Necropolis on the Nile

*Testaments to ancient ingenuity, the three main pyramids of the Giza necropolis were wed to the Nile, source of life itself for Egyptian civilization. Built on the Giza plateau, an escarpment that abuts the west bank of the Nile, each pyramid was the focus of an intricate complex of subsidiary tombs and temples. A high boundary wall surrounded each complex, restricting entry to all but the ritually clean priests and officials.*

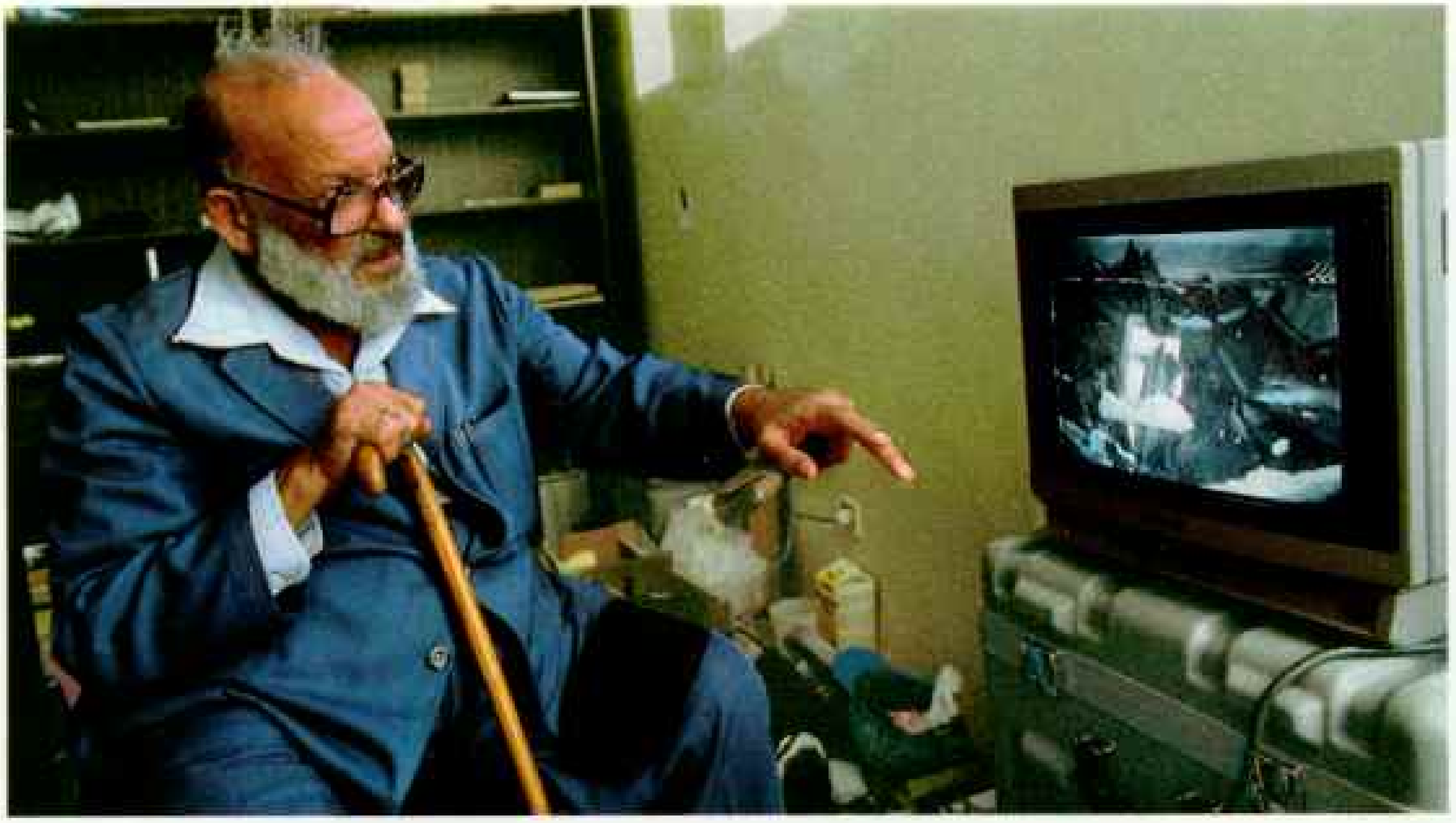
*Access from the Nile was provided by a valley temple constructed at the height of the river's floodplain. Here funeral boats would arrive, one of them bearing the dead king's mummified body, which would be carried up a walled causeway to a mortuary temple at the base of his pyramid, where the body would be entombed for eternity.*

*In 1954 a mountain of debris was cleared from the south face of the Great Pyramid, revealing a previously unknown section of wall and the tops of some large limestone blocks. Removing a portion of the wall, investigators discovered two pits carved into the bedrock. Not until 1985, 31 years after excavating the first pit, did Egyptian authorities decide to investigate the second one, with assistance from* NATIONAL GEOGRAPHIC. *Similar to the first pit, it was covered with blocks of limestone laid on edge, each weighing about 15 tons and measuring five to six feet thick.*






*Finding a Pharaoh's Funeral Bark*



JAMES P. BLAIR (TOP); HAG AHMED YOUSEF (ABOVE)

# Inside the pit: bad news and good

*An unshakable conviction that all patterns eventually reveal themselves guided Hag Ahmed Yousef (above) through excavation, restoration, and reconstruction of Khufu's first royal ship during his 13 years as chief restorer for the Egyptian Antiquities Organization. Now retired, he views the first videos of the sister ship, noting the similarity between its timbers (right) and those that confronted him in 1954 (far right), when the first pit was opened. Unfortunately, the condition of the second ship appeared more degraded than the first. If the pit's gypsum mortar had ever provided an airtight seal, it had been broken, possibly by surface disturbances. (In 1966 Hag Ahmed had complained to authorities about a cement mixer and a brick-making machine [upper left] that had been positioned over the pit during the construction of a museum to house the first ship.) Camera probes of the interior revealed not only water marks on the ceiling (left) but also a live desert beetle. Though the air was not ancient, as hoped, the timbers appeared relatively intact. More important, the technology developed for this probe should prove invaluable for protecting artifacts sealed in tombs in places as far away as Guatemala and China.*

CLAUDE E. PETRONE (ABOVE AND RIGHT)

on the wall were revealed, together with mason's marks (page 525)—hieroglyphs much like those inscribed on ceiling blocks in the first pit.

Further evidence emerged suggesting that the pristine environment had been disturbed: The presence of dark streaks emanating from between blocks along the walls suggested water seepage down the sides, and the state of the wood appeared more deteriorated than in the first boat. In addition, the original wood level appeared to have been at least four inches higher, as indicated by scrape marks on the walls of the pit.

The last task was to insert the environmental sensors that were to remain inside the pit. The temperature measured 27°C (81°F). The relative humidity was 84 percent; that measured at the first pit was 88 percent.

When it was time to seal the drilled hole as planned, we decided not to fill it completely, to allow easy access for treatment of the internal environment or for additional studies.

An aluminum cork was inserted into the upper part of the hole, leaving four inches to be filled by mortar. We had originally planned to seal the hole with a modern sealant, but instead gypsum mortar was used and the pit sealed with the recipe of the ancients. The only visible evidence of our investigation was the wire connected to the environmental sensors below.

TO GAZE at Khufu's second boat without disturbing its resting-place was a most demanding endeavor. It was a long scientific journey fraught with a thousand worries. But the memory of that sight will live with the entire team forever.

"What we have done here," said Kadry, "might help in the preservation of archaeological sites worldwide."

"It was a little bit like a moon launch," added Garrett, who also spoke of the possibilities of a new era of archaeology in which unopened tombs and other sites elsewhere in the world could be studied without being violated. "Except that we were launching down instead of up, and into the past rather than into the future."

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National Geographic EXPLORER will telecast "Pharaoh's Voyage for Eternity" at 9:25 p.m. EDT, Sunday, April 24, on SuperStation TBS (check cable listings).

CLAUDE E. PETRONE

DAVID DOUGLAS DUNCAN, LIFE MAGAZINE

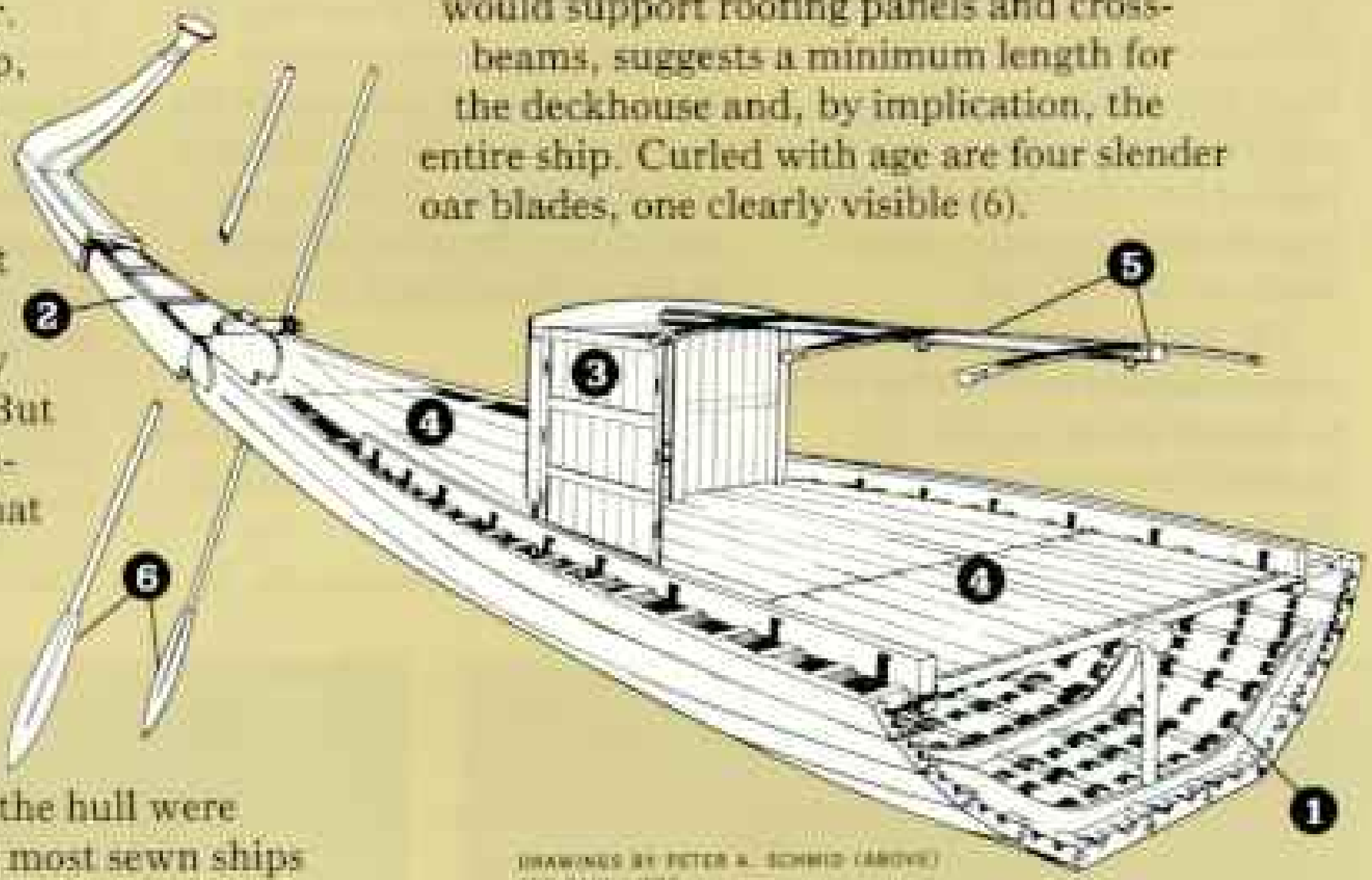
# A craft for eternity

Hidden for millennia, a glorious heap of ancient wood lies revealed in a balloon-perspective mosaic of ten images. Directly below the camera lies the round core that dropped when the drill broke through. Scattered about are pieces of white mortar that have fallen from between the 40 stone blocks capping the chamber.

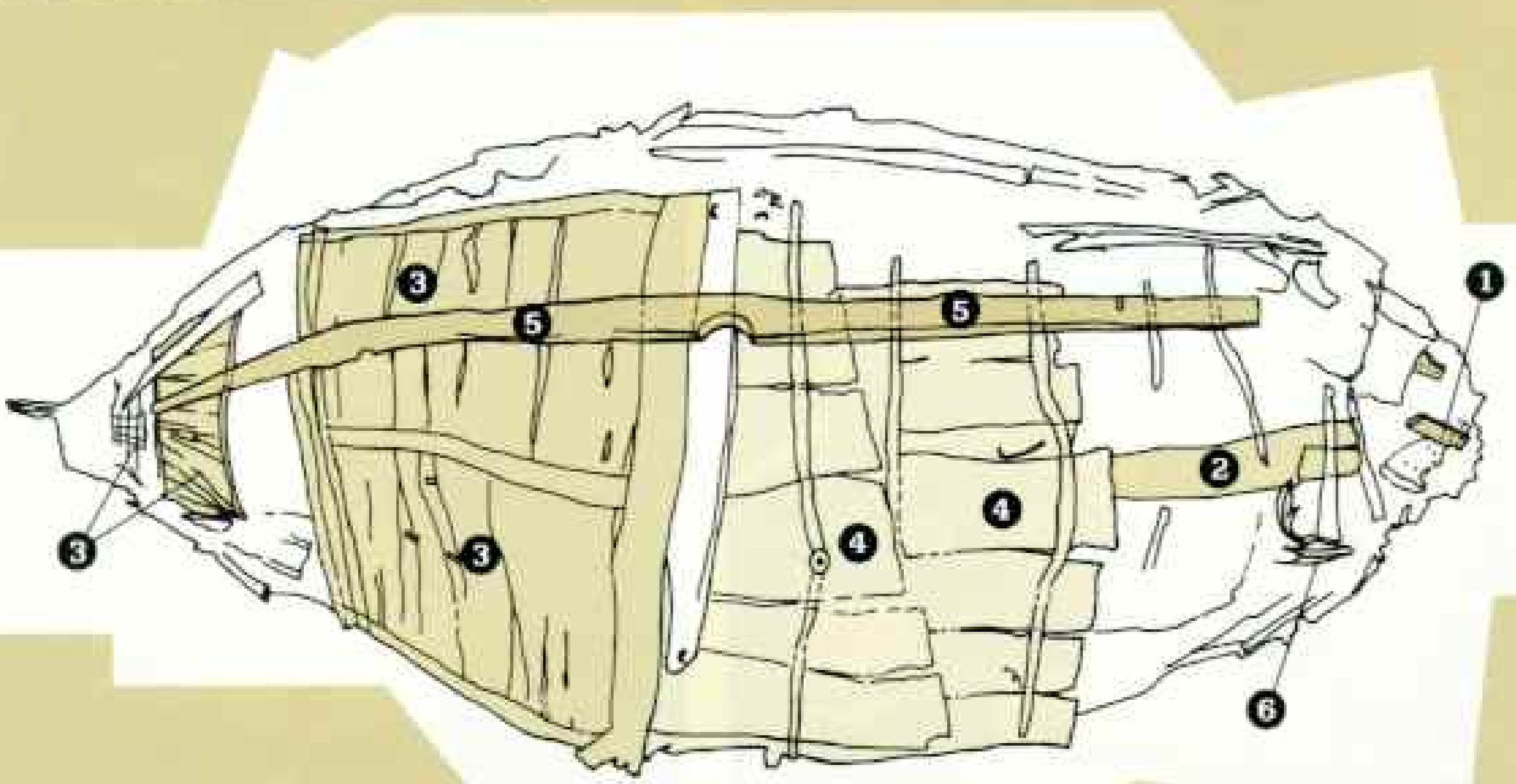
As with Khufu's first ship, the dismantled timbers are probably stacked in a sequence related to the vessel's finished form. Most of the hull's structural elements are hidden from view by parts of the deckhouse. But similarities between the timbers of the first ship and what is seen here support the theory that the two were sister ships.

One of the most distinctive features of the first ship was that the planks of the hull were sewn together transversely; most sewn ships are lashed longitudinally. From faintly visible V-shaped grooves on a plank to the far right (1), researchers can tell that the second ship was lashed together in the same way.

A backing timber (2), with a sleeve to accommodate an ornamental end post, helped determine the long, narrow proportions of the hull. The width and height of the ship's superstructure can be estimated from the deckhouse panels (3); other panels (4) may be part of the deck. A carrying beam (5), which would support roofing panels and cross-beams, suggests a minimum length for the deckhouse and, by implication, the entire ship. Curled with age are four slender oar blades, one clearly visible (6).




DRAWINGS BY PETER A. SCHMID (ABOVE) AND PAUL LYPKE



*Much like quarry marks found in the first pit, hieroglyphs on the ceiling give block measurements beneath the symbols for height, width, and length.*

*Egyptian glyph for "mast" is also the symbol for "height."*

*Broad cup indicates width.*

*Backbone with a spinal cord means length.*

*Cubit (approximate length of a human forearm) with four vertical bars signals four cubits.*

*Crescent moon indicates the width of a palm; four vertical bars equals four palms.*

ALL BY CLAUDE R. PETRONE

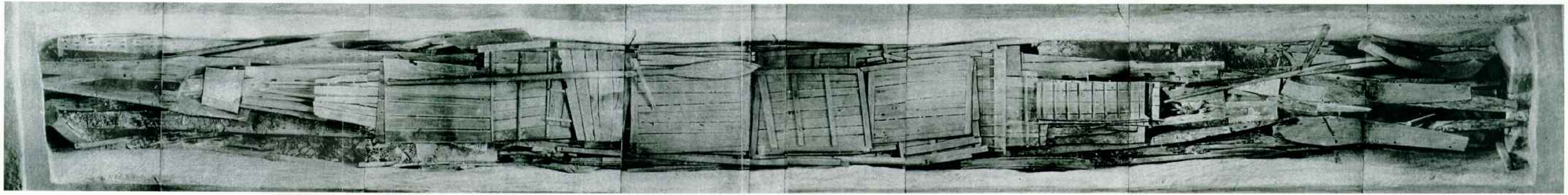
*More than two dozen loops and other pieces of green copper are visible on the timbers.*

# The world's oldest ship



*Djedefre, son and successor of Khufu. Life-size sandstone portrait, the Louvre, Paris.*

JAMES P. BLAIR

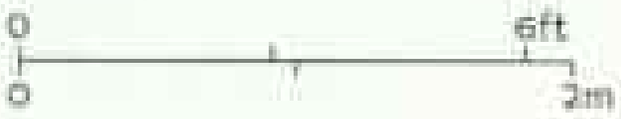


HANS HANNES FOUCET

VICTOR R. BOSWELL, JR.

*Almost perfectly preserved by the sealed tomb in which they were placed 46 centuries ago, the cedar timbers of Khufu's first ship (left) stand resurrected. Like working a monumental jigsaw puzzle, fitting the 1,224 components together required years of painstaking effort. About 142 feet long, the ship displays a level of ancient skill that rivals the great pyramids themselves.*

*Many believe that this was a sacred boat, buried near Khufu's tomb by his son Djedefre for use by the dead pharaoh in the hereafter. It may have carried the king's body during a funeral procession. Notable are its narrow beam and its high, elegantly tapered stem- and sternposts. These identify it as a papyriform boat, a vessel evolved over centuries from Egypt's most ancient craft: papyrus river rafts whose ends were raised and bound. In wooden form these end pieces probably served a strictly symbolic function. Whether the royal barks ever served practical purposes remains a point of speculation. If so, their slender shape would have been well suited for navigating the Nile's swift currents.*



# Riddle of the Pyramid Boats

By PETER MILLER

Photographs by VICTOR R. BOSWELL, JR.
BOTH NATIONAL GEOGRAPHIC STAFF

Enigmas wrapped in mysteries, the royal ships of Khufu were astonishing finds. Given what little we know of the Fourth Dynasty ruler—seen here in his only known likeness—or of the religious rites of his time, the purpose of the vessels remains obscure. One of many such models from later dynasties, a funeral boat from a tomb at Barsha carries a mummy ready for burial. Was Khufu taken to his pyramid in one of his ships in such a manner? And why were there two?

STATUETTE ACTUAL SIZE; BOAT MODEL 31 IN.; BOTH FROM CAIRO MUSEUM

"IT LOOKS DIFFERENT," said Kamal El-Mallakh, as he studied the images on the video screen. Thirty-three years before, as a young architect, he had used a shaving mirror to shine sunlight into one of two pits newly discovered at the southern base of the Great Pyramid of Khufu (Cheops), just outside Cairo. In its beam he had glimpsed the disassembled parts of a 4,600-year-old ship.

Now he was taking his first look at the contents of the still unexcavated second pit. The pictures had been recorded earlier by a miniature video camera that had been lowered into the chamber through an airtight hole. (See the preceding article by Farouk El-Baz.) They revealed a jumble of timbers, wooden panels, and pieces of plaster, which seemed more disorganized to him than had the contents of the first pit.

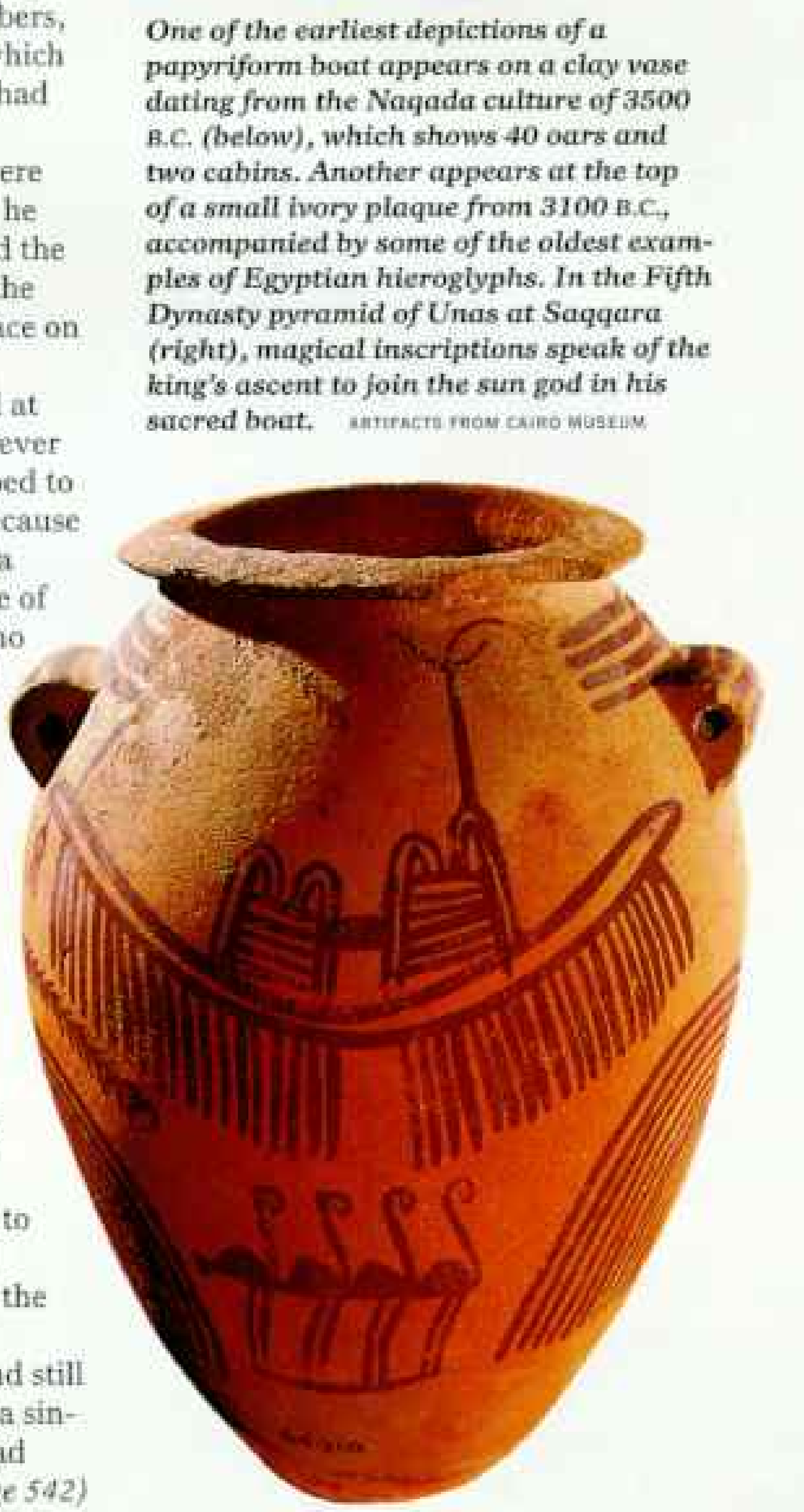
"In that one, the pieces of the boat were carefully stacked, like a Japanese toy," he explained. "This one is not so neat. And the wood looks deteriorated. The wood in the first pit was so smooth I could see my face on its surface."

A week later Kamal El-Mallakh died at age 69, after a brief illness. He would never learn the outcome of the story he'd helped to start in 1954. That was unfortunate, because in the years that followed he'd become a novelist, critic, and deputy editor of one of Cairo's leading newspapers—a man who appreciated a good story. And this tale presents enough mysteries to keep any storyteller happy.

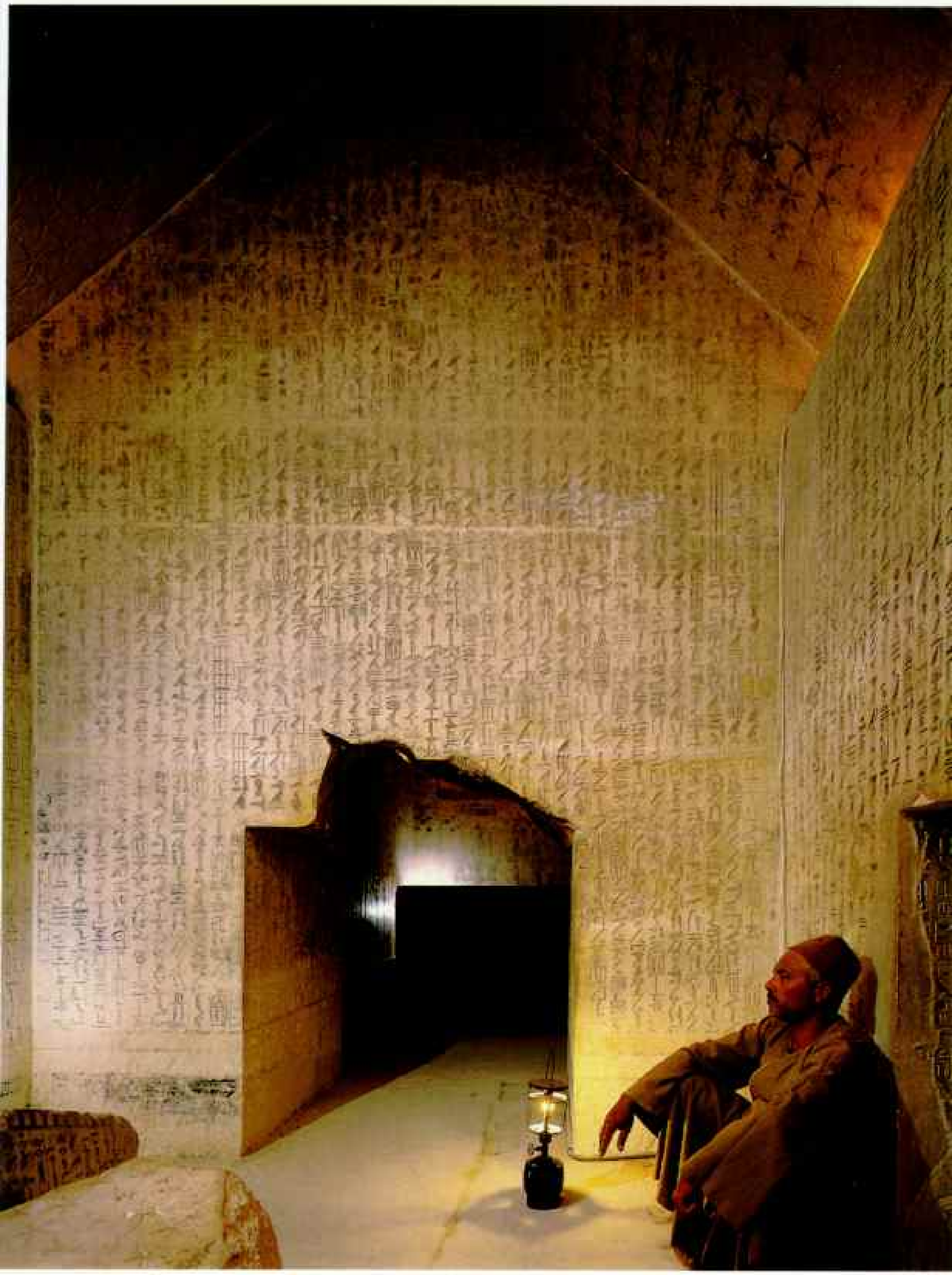
The central one, of course, is why the ancient Egyptians disassembled and buried two full-size royal ships at the base of the Great Pyramid. What purposes did they serve? What do they tell us about the people who built them?

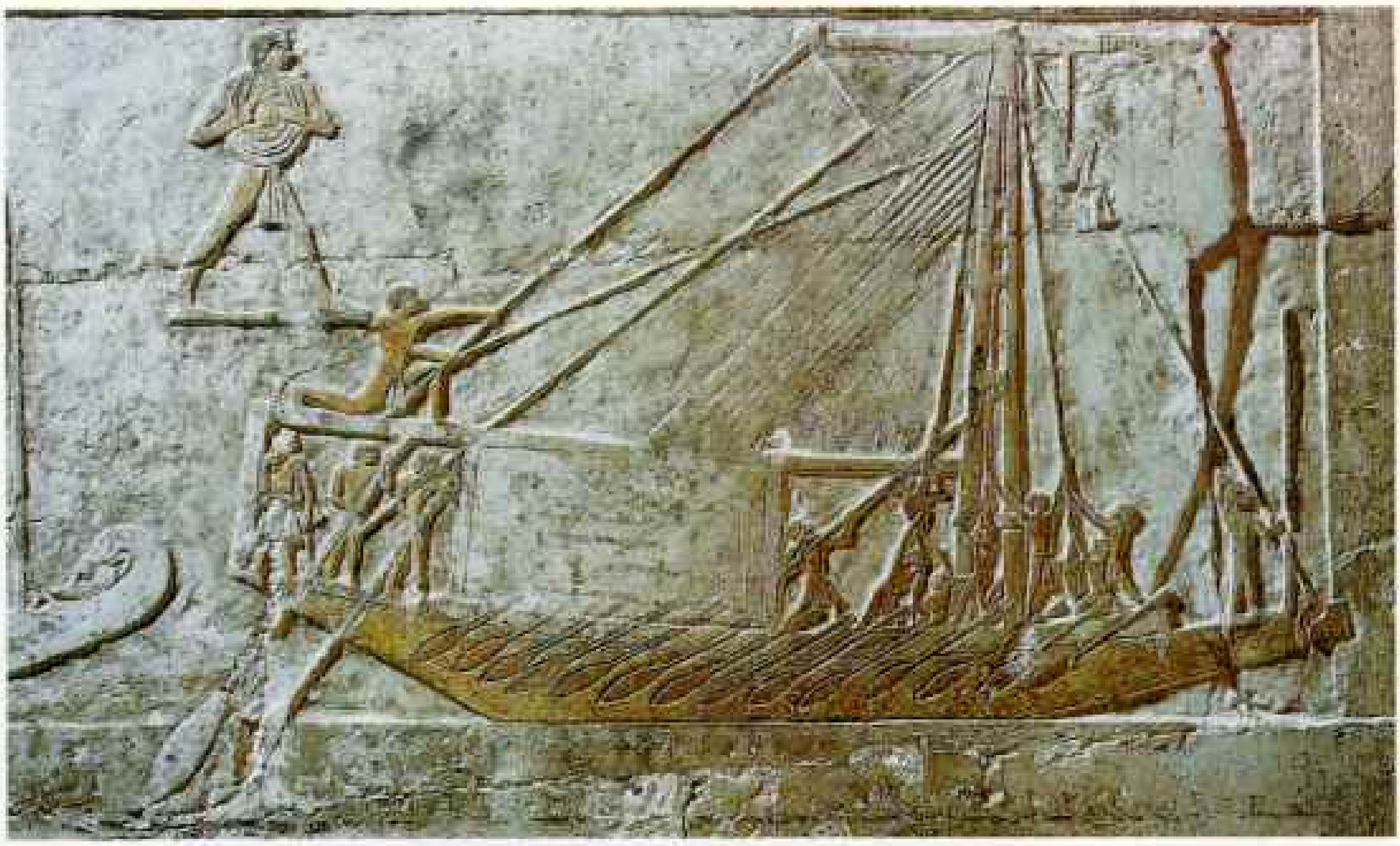
Everyone who saw the pictures from the second pit felt sure it held another royal ship, because they revealed several pieces that closely resembled those found in the first. But we needed to know more: What had the ship looked like? How did it differ—if at all—from the first one?

The only evidence was videotapes and still pictures made by cameras restricted to a single viewing point. The video camera had been able to zoom *(Continued on page 542)*



***One of the earliest depictions of a papyriform boat appears on a clay vase dating from the Naqada culture of 3500 B.C. (below), which shows 40 oars and two cabins. Another appears at the top of a small ivory plaque from 3100 B.C., accompanied by some of the oldest examples of Egyptian hieroglyphs. In the Fifth Dynasty pyramid of Unas at Saqqara (right), magical inscriptions speak of the king's ascent to join the sun god in his sacred boat.*** ARTIFACTS FROM CAIRO MUSEUM



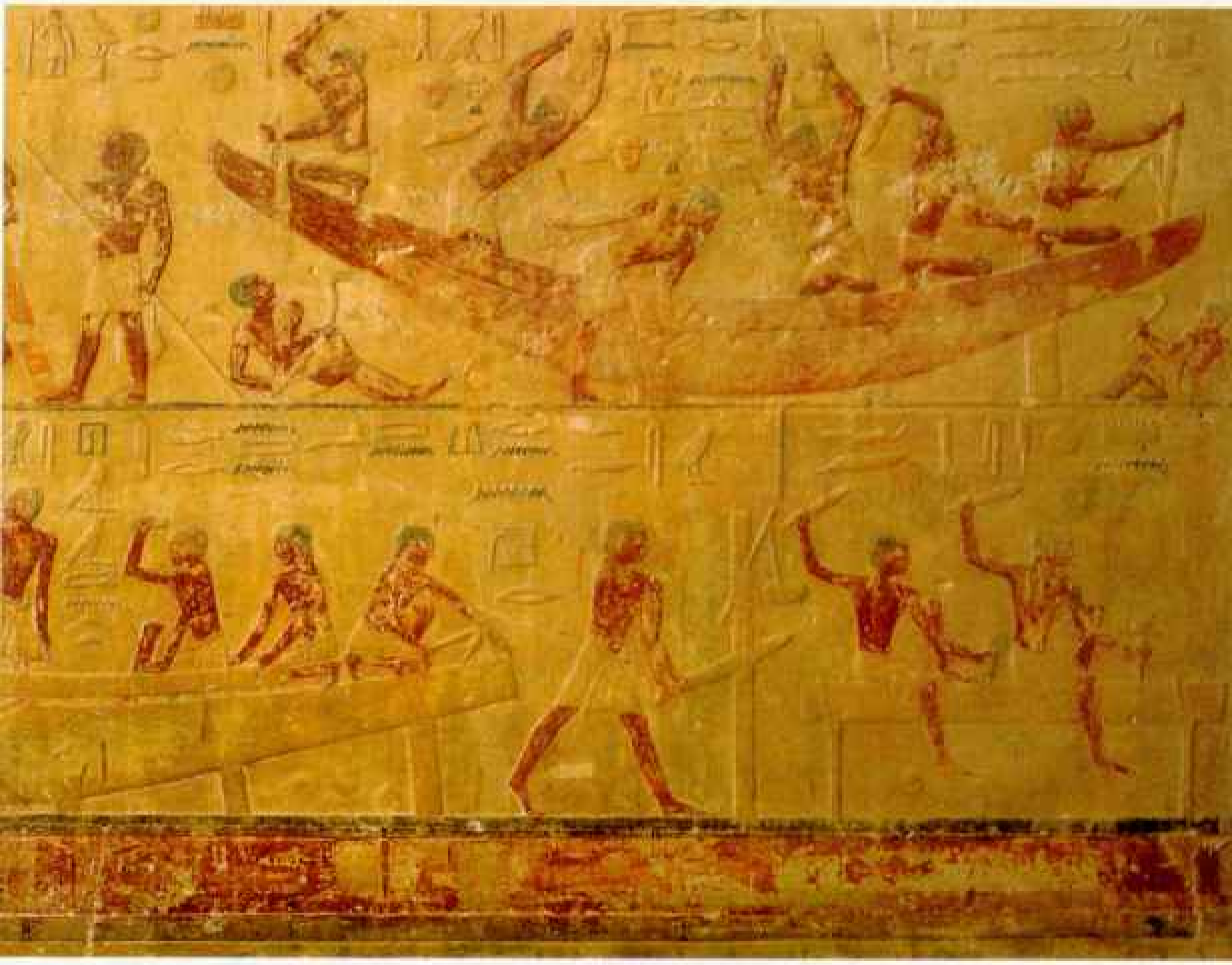


*From the tomb of Ti, a Fifth Dynasty official buried at Saqqara, wall reliefs (below) provide a wealth of information on ancient Egyptian boat building. Three vessels, portrayed under construction, are probably similar to working craft that plied the Nile in Khufu's time. The workmen may be depicted out of proportion to the craft, which are thought to have been large ships.*

*As two men, at bottom left, trim a tree trunk, another smooths it with an adz, an ancient tool still used by boat builders (right). Another man, at bottom right, saws a log, while others with chisels and mallets cut holes for pegs in a plank. On the ship at center a plank, probably the gunwale, is being affixed.*

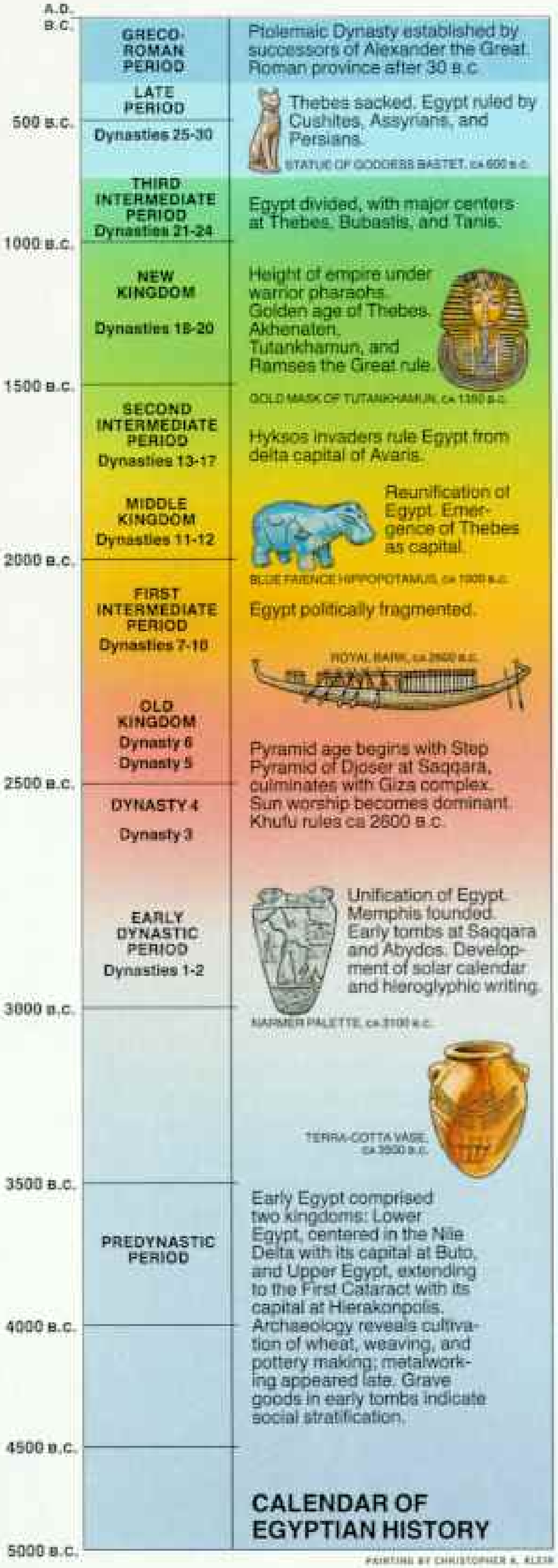
JAMES P. BLAIR

*The vessels' truncated ends resemble those in many other depictions of ancient Egyptian sailing craft, like this relief (far left) from the Fifth Dynasty tomb of Nefer at Saqqara. At the stern, sailors man steering oars as others hoist the sail. The ship's bipod, or A-frame, mast is thought to date from the time when men sailed the Nile on papyrus rafts. Those craft would have required such masts to distribute weight across the fragile hull.*



*Divine transport for the spirits of kings, miniature "solar barks" were buried in Egyptian tombs over the millennia. Always they bore symbols of the sun god, with whom the deceased kings associated themselves. Symbol of rebirth, representing the sun god at dawn, a dung beetle appears on a jewel-encrusted pendant (left) belonging to King Tutankhamun. The disk it bears aloft represents the rising sun, while those over the worshiping baboons represent crescent moons. Ibex heads adorn an alabaster boat (above) also found in Tutankhamun's tomb.*

LEE BOLTIN, PICTURE LIBRARY (LEFT); ARTIFACTS FROM CAIRO MUSEUM




*(Continued from page 536)* in on various objects to inspect them in detail. And yet we could still see only the upper surface of what was obviously a layer cake of stacked pieces.

Paul Lipke, a maritime preservationist and former museum curator, had published a detailed analysis of the first boat found near the pyramid. His interest in the project had grown out of a friendship he'd developed with Hag Ahmed Yousef, the gifted restorer of that ship.

"We hit it off from the start," Paul told me at his home in Plymouth, Massachusetts. "I was the first person he'd ever talked to who had built boats and could view the ship from a boatbuilder's perspective."

After studying the videotapes and photos from the second pit, Paul concluded that it did indeed contain a sister ship to the first.

Cheryl Haldane, a nautical archaeologist at Texas A&M University, agreed. Her master's thesis was on the only other ancient Egyptian vessels ever found, the Dahshur boats, a group of six small craft discovered in 1894 near the pyramid of Senusret III, who reigned about 750 years after Khufu.

From the heap of ancient timbers Paul and Cheryl managed to detect four pointed oar blades, two side panels for the deckhouse, a notched beam to support its roof, two pieces of hull planking with the same V-shaped holes as those in the first ship, a timber to support a tall stem- or sternpost, what may be two large deck panels, and at least twice as many bright green copper loops as were found in the first pit.

From what they could tell, the vessel was probably a bit smaller than the first. There was no sign of a mast, sails, or rigging, nor any further clue about the ship's purpose.

ONE OF THE most exciting moments during the probe of the second pit came when the video camera swung up toward the ceiling and showed markings on the limestone blocks. Some of them resembled symbols found in the first pit, which had been identified as quarry marks. Others were different. Perhaps they could tell us something new about the ship.

Ann Macy Roth, a research assistant at the Museum of Fine Arts in Boston, instantly recognized some of the hieroglyphs. "This looks like a *st* sign to me," she said. "That's the name of a team of royal workers,

probably the one responsible for quarrying the block, hauling it, and putting it into place."

Khufu's laborers were highly organized, she explained. Each work crew was divided into groups, and each group into subgroups, all of which had names.

"The crew names tended to be lofty ones like 'The Pure Ones of Khufu' or 'Those Who Know Unas.' But some were less lofty, like 'The Drunks of Menkaure.' "

I showed her a picture of what I suspected was a cartouche—a king's name in hieroglyphs. "Yes, that's Djedefre," she said, "Khufu's son." His name had appeared many times on the blocks covering the first pit, confirming scholars' belief that it was he, and not his brother Khafre (Chephren), who buried the ships beside their father's tomb and succeeded him as king.

Despite Khufu's fame as a pyramid builder, next to nothing is known about him. There is gossip repeated by the Greek historian Herodotus some 2,000 years after his death. Herodotus wrote that Egyptian priests remembered Khufu as impious and as an oppressive tyrant. He closed all the temples in the country and compelled his subjects "without exception to labor as slaves for his own advantage." We know for sure only that he was the second ruler of the Fourth Dynasty, following his father, the "good king" Snefru. And that his reign lasted 20 years or more.

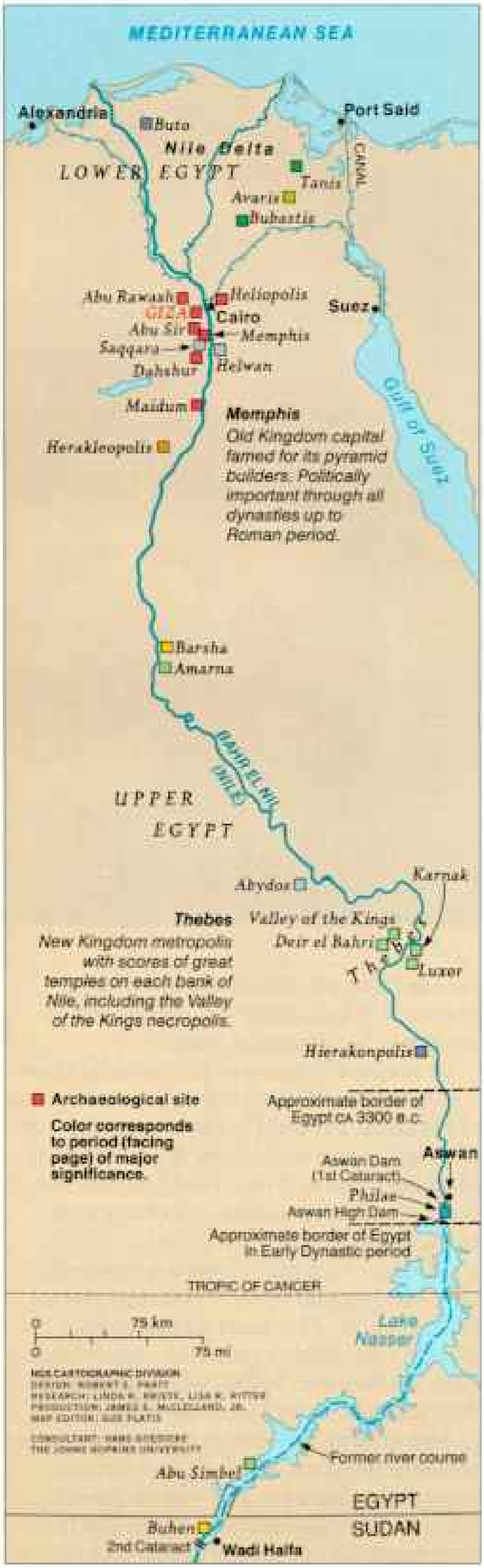
"These marks have to do with measurements," Dr. Roth said, pointing to symbols that looked like bars with vertical stripes above and below them. "They give the length, width, and height of the block in cubits."

Similar measurements were found in the first pit, although archaeologists noted that they did not seem to coincide with the actual dimensions of the blocks on which they appeared.

Was there anything that suggested how the ships might have been used?

I took the question to Lionel Casson, professor emeritus of New York University, an authority on ancient vessels.

"The simplest theory," he said, "is that you bury with the dead king everything he will use in the afterlife. He did a lot of traveling up and down the Nile when he was a live pharaoh. Presumably he's going to travel



up and down the Nile when he's a dead pharaoh, or he's going to do some kind of traveling. So he needs a vessel."

Or perhaps as many as five vessels. Three other pits were discovered on the eastern side of the Great Pyramid in the 19th century, all filled with sand and debris. A few fragments of gilded wood and rope later found in one of them suggested that it too may have once contained a boat.

Of all the boat graves known, however, only Khufu's and those at Dahshur yielded full-size ships. Five more pits lie beside Khafre's pyramid at Giza (the second largest one), another next to Djedefre's pyramid at Abu Rawash, three beside the tombs of queens at Giza, and several more at the cemeteries at Saqqara, Helwan, and Abu Sir, some dating from the predynastic period. Scholars have speculated that some of these were intended not to hold actual boats but to serve as resting-places for symbolic ones.

Until recently most of what was known about ancient Egyptian ships came from depictions in tombs. Because watercraft played so many important roles in their lives, the ancient Egyptians liked to be surrounded by pictures of them for eternity.

"They had vessels of all sizes," Professor Casson said. "Egypt was crisscrossed with little canals. There were tiny ferryboats all over to carry two or three people. And those would probably have been papyrus rafts. We see them in many reliefs."

The same boat-shaped papyrus rafts were used in the marshes for hunting and fishing. There were also wooden vessels, including quite elegant yachts, to carry passengers up and down the river, and cargo ships of all sizes.

The ancient Egyptians also built seagoing ships for trade with other Mediterranean

*Birthplace of the papyrus raft, the fertile marshes along the Nile were nature parks for Egyptian nobility, who hunted birds, hippopotamuses, and other wildlife from watercraft. Such scenes as this one from a tomb at Thebes abound in Egyptian tombs.*

cultures. One entry in the Palermo stone, an early record of ancient events, states that Khufu's father, Snefru, sent an expedition to the coast of Lebanon to obtain cedar and other valuable woods. Forty vessels returned with enough logs to construct three 170-foot-long ships and a number of barges.

Egyptian ships plied the Red Sea, journeying to the exotic land of Punt, probably somewhere near present-day Somalia. A fleet sent there by Sahure, who ruled about a century after Khufu, returned with 80,000 measures of myrrh, 6,000 units of electrum (an alloy of gold and silver), 2,600 units of wood, and 23,020 measures of unguent.

FEW OF THESE SHIPS, however, would have been in the same class as the ones buried with Khufu. The distinctive shape of the tall stem- and sternposts on the first ship, carved to resemble the tightly bound ends of the reed rafts long associated with boats of the gods, sets it apart from common craft. These were ships built for a king who was treated as a god, and they reflect styles that were both royal and sacred. The bow of a sailing ship belonging to Sahure, depicted in a relief at Abu Sir, has essentially the same shape as that of Khufu's reconstructed bark, as does the hull of a model buried with King Tutankhamun at Thebes 1,250 years after Khufu.

One theory on the purpose of Khufu's ships comes from Saqqara, the royal necropolis of Memphis, the ancient Egyptian capital. Unas, the last king of the Fifth Dynasty, who reigned about 200 years after Khufu, built a pyramid there that contains an unusual treasure—walls of the burial chamber are covered with magical inscriptions. Those hieroglyphs are the earliest examples of the Pyramid Texts, a collection of spells intended to secure a happy afterlife for the king.

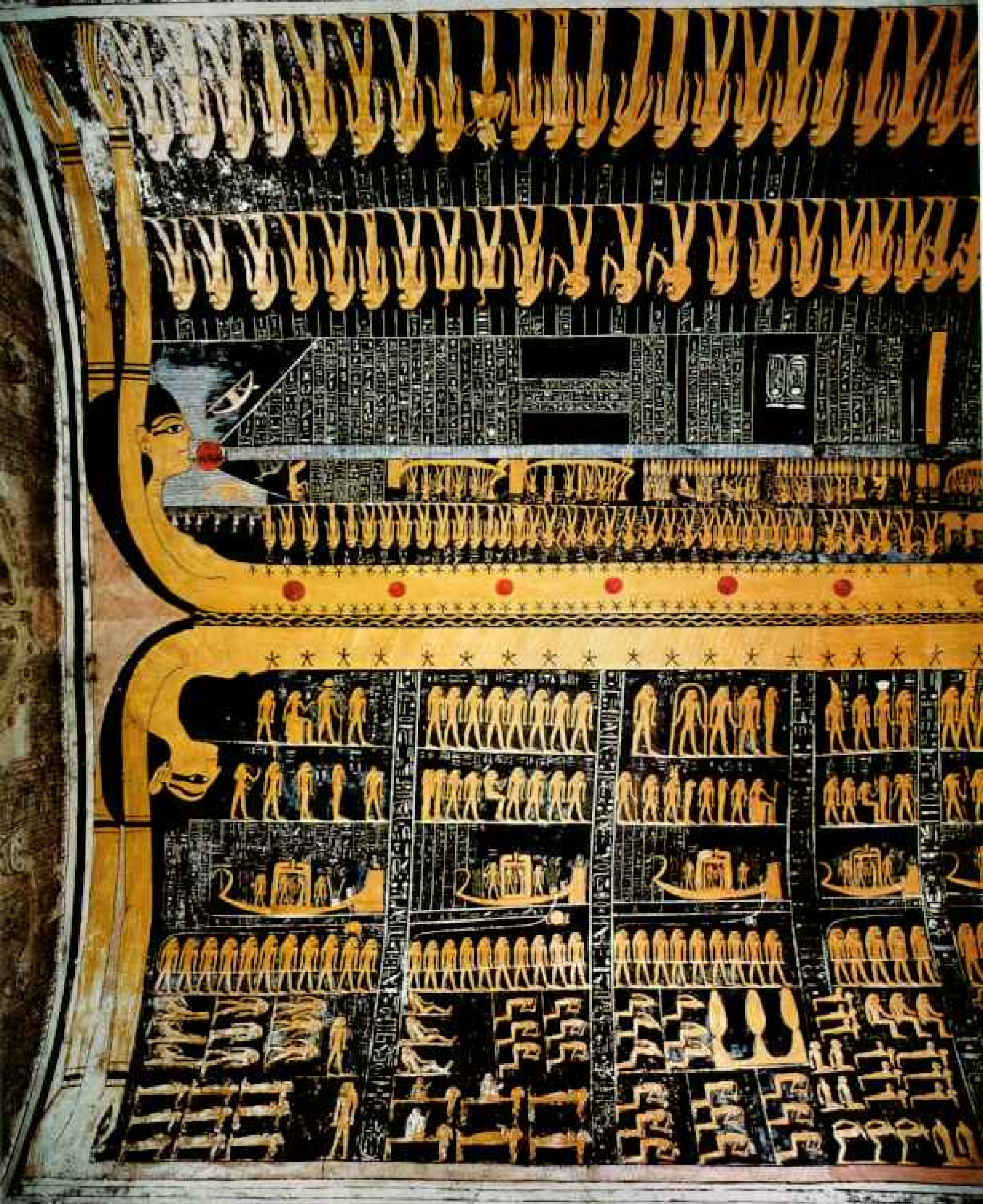
Among them are phrases describing the king's hope to join the sun god Re-Atum in his eternal journey across the sky. "The king comes to Re and is proclaimed king of earth. He ascends with Atum, rises and sets with Re and the solar barges."

The sun was thought to travel from east to west in a "day boat," changing to a "night boat" for the return trip through the underworld. To take part in this journey and the rebirth it implies, Unas would have needed two boats, and some archaeologists point to two empty pits near his pyramid as places where they once might have been buried.

Picking up on this theory, Kamal El-Mallakh applied the same idea to the ships at Giza. The first pit contained Khufu's day boat, he said, the second his night boat.

El-Mallakh had predicted that we would find sacred gifts buried with the second ship at Giza, which he called "carrier of the offerings." But none were visible.

Nor does the first ship, in the opinion of some scholars, match traditional depictions of the day boat. Its shape is similar, but it



*Wheeling through the heavens, the sun god Re was thought to travel in two sacred barks: one by day, another by night. From this myth comes the idea that Khufu's two boats may have been buried with him for his night and day journeys through the cosmos with the sun god.*



*National Geographic, April 1988*

*As depicted in a ceiling mural in the Twentieth Dynasty tomb of Ramses VI at Thebes, the sun is swallowed each evening by the sky goddess, Nut, who gives birth to it each morning as the rising sun. Below the horizon she does the same with the stars.*

lacks important details such as a boxlike structure on the bow that identifies a vessel as belonging to the sun god.

There is also disagreement about whether the kings of the Fourth Dynasty had come under the full influence of the sun cult, which was still gaining strength at this time. Most depictions of solar boats appear in later periods.

***Monument to immortal longings, Khufu's Great Pyramid overlooks Cairo by night from the Giza plateau. At its foot can be seen the air-conditioned museum that houses Khufu's reconstructed ship; the pit containing the second ship lies just to the left of the museum.***

ANOTHER THEORY about the ships' purpose comes from the man who put the first one together by hand. Ahmed Yousef believes that this magnificent craft was built not as a symbol but to serve a function. It was a funerary bark, he states, to carry Khufu's body from his palace at Memphis to his tomb at Giza.

As evidence he points to marks on pieces of wood left by the ropes used to bind the ship together. These marks could only have been made if the ship had been in water and in motion, he says.

Although he remains skeptical of any theory thus far, Lionel Casson favors this view. "If you're going to make a guess about how

these ships were used," he says, "you ought to consider the many pictures from the Old Kingdom in which we see a rowed vessel pulling a barge that carries the dead."

To make his point, he reached for a copy of Charles Boreux's 1925 study of ancient Egyptian ships, *Etudes de nautique égyptienne*, and began to translate from the French. "Ordinarily, when the representation involves two funerary barks, each is towed separately," he read. "One occasionally finds, however, the bark enclosing the sarcophagus and that which contains the funerary coffin attached, one behind the other, and the two towed together."

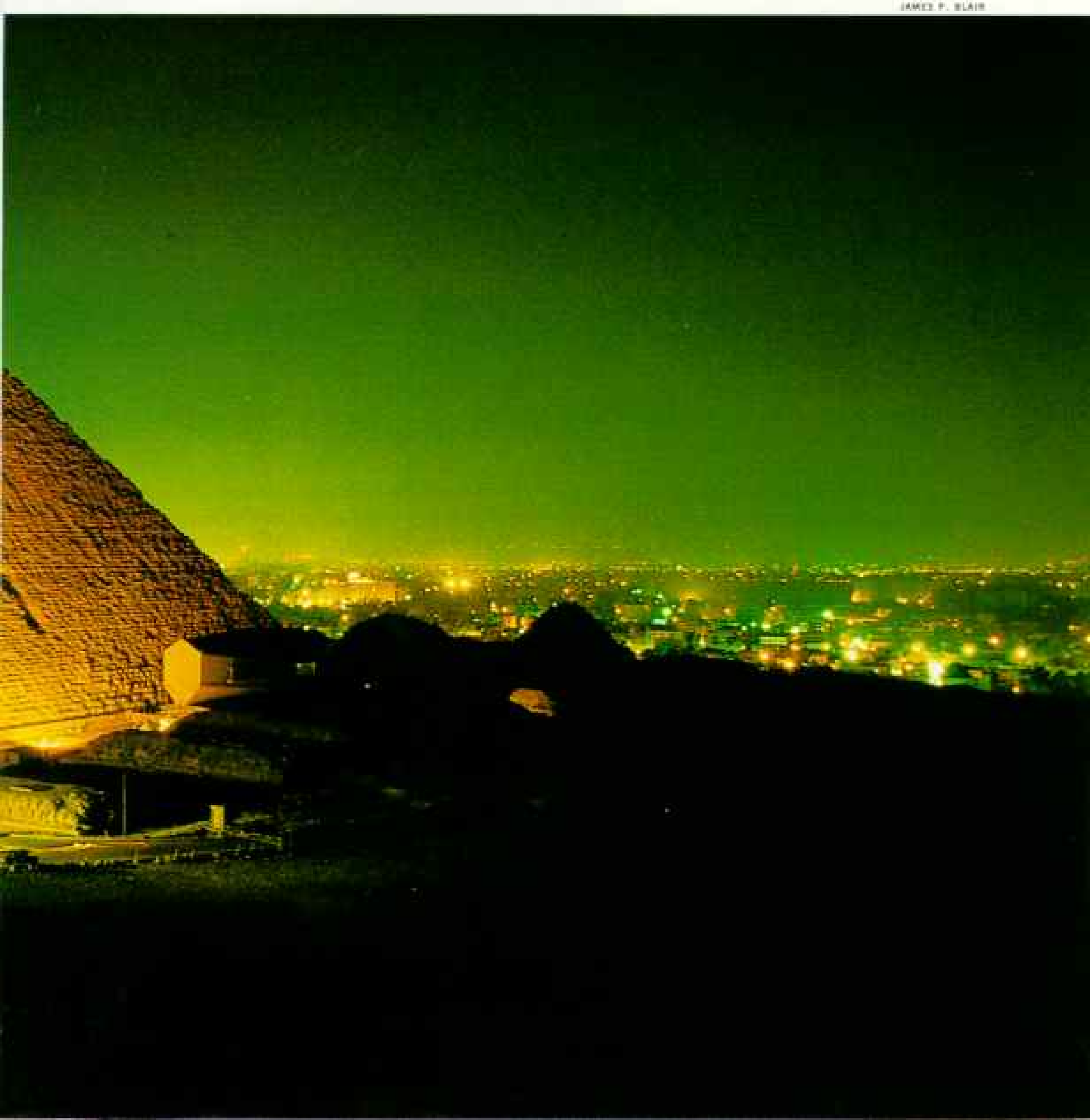
Perhaps that's how these ships were used, Casson said. "One might have towed the other, or perhaps they were pulled down the Nile together in a royal funeral procession."

Some scholars have proposed a variation on this theory. They say the ships probably carried the king's body not only to Giza but also on a pilgrimage to holy cities such as Abydos—one ship rowing north with the river current, the other sailing south with the prevailing wind.

Damaging to the funerary bark theory, however, is the lack of appropriate decorations on the ships. The boats at Dahshur, says Cheryl Haldane, were covered with clues about their funerary function.

"At least one was painted green," she

JAMES P. BLAIR



said, "and funerary boats typically were green. All the Dahshur boats had stripes associated with death painted on their gunwales. And their steering oars were capped with hawks' heads and decorated with lotus-leaf designs, strongly associated with funerary rituals."

The Dahshur boats were buried 750 years after Khufu's, which may account for some differences. But the ancient Egyptians were extremely conservative, and it is unlikely that they changed the design of their funeral boats very much over the centuries.

At present, we simply don't know enough to determine beyond doubt the function of these marvelous ships.

PUZZLING TOO is why the ships were buried the way they were. Were they disassembled, stacked, and tightly sealed inside their pits to preserve them for eternity, so that the dead king could use them whenever he wanted? Or were they taken apart and hidden after his burial as part of some purification rite to make sure that no one could ever use them again?

Whether they were solar boats, funerary boats, pilgrimage boats, or simply royal boats, they played a part in an extraordinary quest for immortality. They were built to carry a king who aspired to become part of the heavens.

And we also know, says Paul Lipke, that the craftsmen who supported this quest demonstrated a remarkable level of achievement. "They showed a lot of sophistication in their engineering," he said, "and a great deal of style."

Hag Ahmed put it best one day as he and Paul considered the first Giza vessel: "Other periods have their high points, but none compete with the Fourth Dynasty for beauty and for knowing when to stop. The workmanship and finish were of the finest level, and yet the craftsmen achieved a simplicity of detail and line that is an inspiration."

WILBUR E. GARRETT

***Shedding light on the past with an aluminum foil mirror, a tomb guard at Thebes directs a beam of sunlight at a mural of ancient sailing craft. Our understanding of his ancestors' nautical history has been greatly illuminated by what we are learning from Khufu's royal ships.***

As for me, I consider the ships an ongoing mystery. The Egyptian Antiquities Organization has no plans at present to excavate the second pit, so we cannot expect new information from there soon. And yet a discovery as exciting as this one develops a momentum. Who knows where the next clue may come from—one that may solve the whole riddle? □

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CAREFULLY STORED AWAY in the Geography and Map Division of the Library of Congress lies a little-known national treasure: the original 1791 plan for the nation's capital by Pierre Charles L'Enfant.

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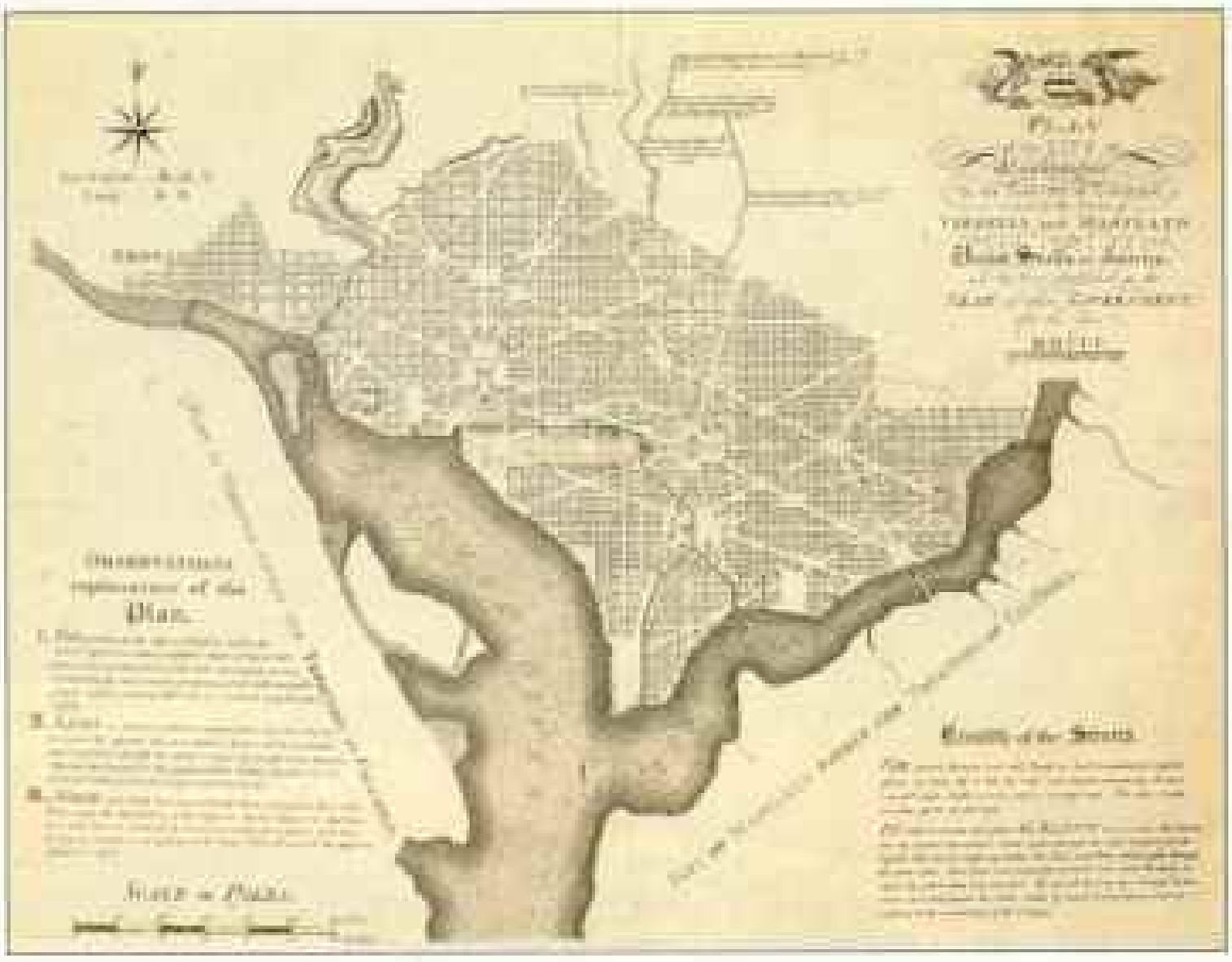
Disturbed by L'Enfant's delays in producing an engraved map to show potential developers, President George Washington dismissed the French-born architect before his drawing could be printed. In its place a plan based on L'Enfant's work, but changed slightly by surveyor Andrew Ellicott and his brother Benjamin, became the city's first official map (right) in 1792.

This story and many others are told by some 2,000 maps and atlases of the Washington, D. C., area, now being restored in a joint project between the Library of Congress and the National Geographic Society.

We want to preserve these maps for future generations and make them available to the widest audience possible. To this end, we are contributing $348,250 in one of the largest public-service grants the Society has ever made.

The first phase of the work is nearly complete: to identify the maps and catalog them in the Library's data base, which is accessible to computer networks worldwide. The Library will then publish a detailed carto-bibliography of the collection.

Next will be the repair of the



L'Enfant plan, which has not been on public display since 1966. The ink has faded, the paper has become brittle, and the varnish covering it has turned dark brown. After a facsimile has been made, steps will be taken to correct these defects and prevent further losses.

An examination of the plan under infrared and other light sources some years ago showed notes made by Thomas Jefferson, then Secretary of State. Wherever L'Enfant had written "Congress house," Jefferson substituted "Capitol." New photographs made with advanced films and filters may reveal additional details. There are also plans to digitally scan the drawing and enhance the image by computer.

Eventually all the maps will be restored and put on microfilm. Among them are Washington's original drawings of Alexandria made in 1748 and 1749, Andrew Jackson Downing's landscape plan for the Mall from 1851, and Albert Boschke's 1861 topographic map of the District, which was confiscated by the War Department in fear that the Confederacy might use it to plan raids on the capital.

The four-year project will culminate in 1991 with the publication of a historical atlas and the staging of a major symposium and exhibit to mark the bicentennial of the L'Enfant plan.

We're proud to be partners in this endeavor with the Library of Congress, which was created in 1800, the same year the federal government moved from Philadelphia to the new capital. We've enjoyed a special relationship with the Library over the years and look forward to celebrating together the founding of our beautiful city on the Potomac.

Gilbert M. Grosvenor

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# Wildlife as Canon sees it

One of the greatest roles of photography is to record and preserve images of the world around us worthy to be handed down as a heritage for all generations. A photograph of the Madagascan plowshare tortoise captures the intricate pattern and distinctive texture on the shell of this extremely rare and little-known tortoise.

Concealed for most of the year, the plowshare tortoise emerges from its hideout with the first signs of the wet season to search for food and a mate. Males become particularly active, engaging in head-to-head combat using a bony projection beneath the neck, which gives the species its common name. Found only in very small numbers around pockets of bamboo and scrub forest, the plowshare tortoise requires continuous protection and the preservation of its habitat if it is to survive. Like most endangered species, its future depends on mankind's ability to live in harmony with the natural world.

An invaluable research tool, photography can contribute to a greater awareness and understanding of the plowshare tortoise and how it lives within its natural environment.

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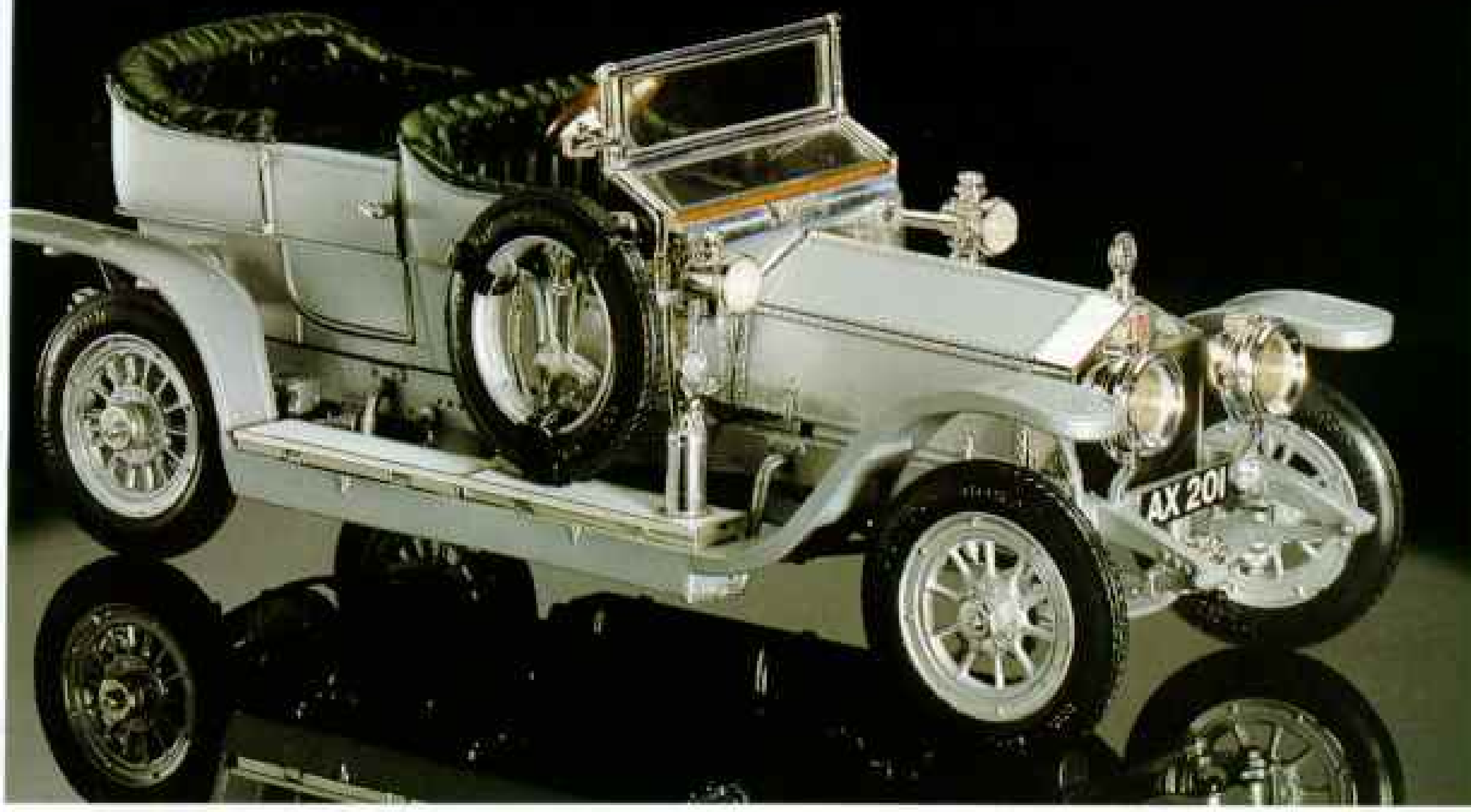


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# Members Forum

## Sleep

As someone who is fascinated by the subject of sleep and who also lost a firstborn son to sudden infant death syndrome (SIDS), I read "What Is This Thing Called Sleep?" in the December 1987 issue with great interest. A caption suggests that monitoring can save babies from SIDS, but this has not been borne out by the evidence. In fact, a 1987 National Institutes of Health report does not recommend monitors for SIDS siblings. It is important that the public not be lulled into complacency by the mistaken impression that SIDS has been solved. We now know that this tragic phenomenon is more complex than originally appreciated.

HEIDI LLOYD-PRICE
*Calgary, Alberta*

Congratulations to Michael E. Long. His is by far the best story on sleep that I have ever seen. It was accurate; it caught the major issues; it differentiated fact from theory; and it was alive. Has he ever considered a career in science?

ALLAN RECHTSCHAFFEN
*Sleep Research Laboratory*
*University of Chicago*

*Long is a science writer on the magazine staff.*

Why do many animals sleep? Because it gets dark at night. Hunting, foraging, nest building, and other activities that rely on vision must come abruptly to a halt. On a dark night even we humans have difficulty walking, as anyone caught camping without a light source has discovered. It seems to me that the behavior of sleep is an adaptation to our environment rather than the fulfillment of some unknown physiological function.

MELANIE HUNT
*Berkeley, California*

I suggest the reason we sleep is related to the fact that human young are dependent on their parents for a large portion of their lives. The feeling of tenderness to a sleeping child is phenomenal. A child who never slept would not allow this renewal of a parent's protective feelings. As the mother of a young child, I picture one who never sleeps, and wonder if anyone would want the job of parenting if it wasn't for the nightly respite from exploring young minds and active little bodies.

REBECCA C. CHAKY
*Kent, Washington*

I have a kind of epilepsy that occurs only in my sleep. Your article gave me real help with understanding what happens during sleep and also a new clue as to the specific causes of my seizures.

LAURÉ KENDRICK
*Carpinteria, California*

What a great pity to waste 35 pages on a dull topic like sleep, which is well outside the realm of geography, while allotting only slightly more to the highly interesting oldest shipwreck.

JACK CARLISLE
*Montrose, Colorado*

## Bronze Age Wreck

One year ago we were conducting research for an exhibition on underwater discoveries. Our path began with the world's most famous treasure hunter [Mel Fisher] and gradually led us to the Institute of Nautical Archaeology, where we spent a few days with Dr. Bass and his students. Like many people, we were misled by the treasure hunter's gleam of fool's gold. It took us months to learn that Dr. Bass and his crew were painstakingly extracting something far more valuable from their sites—knowledge. Thank you for sharing the potential of underwater archaeology. Your expedition support and extraordinary coverage of the results are a gift to the world far richer than precious metals.

DAVID GOWELL
KENT DAVIS
*Mount Holly, New Jersey*

Could it be possible that the resin found on the sunken ship was for mummification processes practiced by the Egyptians? The resins were used in molten form for temporary packing of the body. Due to lack of arboreal vegetation, the Egyptians relied on such trade, especially important to ensure afterlife for pharaohs and royalty.

KAREN M. EVANS
*Woodacre, California*

I take issue with the statement that "most Cypriot pottery was not wheel-made. It was therefore not quite symmetrical." Pottery made by the Pueblo Indians in New Mexico is recognized as being of the finest quality, beauty, and symmetry, yet it is made not with the wheel but with the coil technique. Scores of renowned potters use the method, most notably the late Maria Martinez of San Ildefonso Pueblo.

HUGH S. ESPEY
*Quincy, Illinois*

Your December issue is truly your finest hour. First George Bass's incredible discovery. Then that delightful non sequitur by Sorrel Wilby; because college was repugnant, she would walk across Tibet.

SUE S. MCCANN
*Arnold, Maryland*

## Tibetan Trek

Sorrel Wilby's article on her Tibetan trip was superb. Her adventurous spirit reminds us that we can learn much about ourselves when we take a chance and make ourselves dependent and vulnerable. The developed world seldom causes us to extend ourselves. Her trek gives meaning to the expression "getting back to basics."

JOHN W. SOULE
*San Diego, California*

Congratulations to Sorrel Wilby for her refreshing article on Tibet, full of youthful enthusiasm, plenty of humor and excitement, fraught with peril, and crowned with spiritual enlightenment.

KATHLEEN PFAFFLIN
*Gatineau, Quebec*

This young lady was an accident waiting to happen. Ill-trained, poorly equipped, and with no sound planning or preparation, she apparently relied on the graciousness of the people of Tibet. Her conduct leaves a negative image of the foreign hiker that others will have to contend with when walking in her footsteps.

RICHARD E. NETHERWOOD
*Alameda, California*

If half as much space had been given to the aches and pains of the writer, we could have learned twice as much about Tibet.

TYSON PECK
*Emden, Illinois*

## Sea Islands

Congratulations to Karen Kasmauski on the excellent photographs she took of us accompanying the very good article by Charles Blockson on the Sea Islands (December 1987). I remember vividly the great pains she took not to offend while photographing, and her many trips to catch people in the natural mood. Everyone I have spoken to is very happy with the story, and we are getting wonderful comments from around the country.

In a recent development we have been visited by scholars from Sierra Leone searching for connections with American blacks. During slavery times Africans skilled at rice growing were sought to develop the rice industry along this coast. One linguist is finding links between Gullah and his country's Krio language; another is tracing the American roots of South Carolina blacks who returned to Sierra Leone in 1822. This spring we look forward to a visit from that nation's President Joseph S. Momoh.

EMORY S. CAMPBELL
*Penn Community Services, Inc.*
*St. Helena Island*
*South Carolina*

I extend my deepest appreciation to the magazine for sympathetically exposing the destruction of Sea Island culture. For me it was not only heartwarming but also heartbreaking. I was able to

see the unique culture of my father's side of my family. But it was heartbreaking to learn it is being washed away by unconcern for the traditions of Afro-Americans. My children should be able to experience this rich culture, and not in some museum exhibit. If this culture does disappear, it will be a loss for all Americans.

BLAIR WILLIAMS
*Los Angeles, California*

Sapelo is not as idyllic as Blockson leads us to believe. Currently, the beauty of the island and the life-style of Hog Hammock residents are threatened by the very agency controlling it. The Georgia Department of Natural Resources wants to develop parts of the island to enhance tourism. The University of Georgia is seeking to keep life as it is. Sapelo is as wonderful as Tracey Walker says. It must not become another Hilton Head.

MARGARET A. CROWDER
*Auburn University, Alabama*

It was a terrible shock to learn that Pat Jones-Jackson had died, as she and I were friends at the University of Michigan. My husband typed her dissertation, and somewhere in my photo albums is a picture of her in a rocking chair with my daughter cuddled in her lap. Pat was beautiful, inside and out. I remember how impressed she was with the Sea Island people; it was obvious she not only studied them but loved them too.

Was a scholarship fund set up?

MARTHA F. KRIEG
*Ypsilanti, Michigan*

*A fellowship for graduate students in English is accepting contributions: Dr. Patricia Jones-Jackson Fellowship Fund, Department of Development, Howard University, 2900 Van Ness Street N.W., Washington, D.C. 20008.*

## Editor's Page

It is ironic that yet another editorial condemning the removal of artifacts from *Titanic* appears in the same issue describing in a positive light the removal of artifacts from the oldest known shipwreck. Why is one act criticized while the other is applauded? Perhaps what is at issue is not so much the fact that *Titanic*'s artifacts are being removed, but the manner in which it is done. There is a certain respectability to the professional scientific approach taken to the oldest wreck.

IAN MACNEIL
*Ottawa, Ontario*

*We agree.*

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*Letters should be addressed to* **Members Forum,** *National Geographic Magazine, Box 37448, Washington, D.C. 20013, and should include sender's address and telephone number. Not all letters can be used. Those that are will often be edited and excerpted.*

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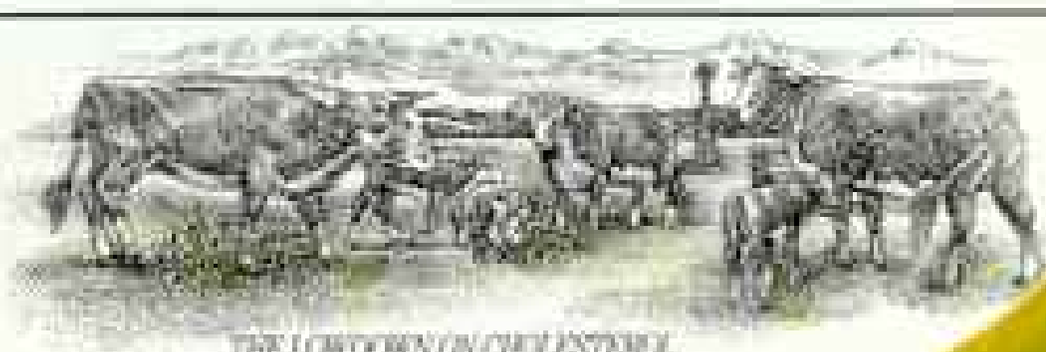
# Good News For People Who Eat.

If your taste buds are not altogether excited about a future of organic fiber flakes, the beef industry would like a few words with you. Even a few from the U.S.D.A. Because the lowdown on beef is probably less than you think—lower in calories, leaner on fat, lighter on cholesterol than you would ever imagine. It's even faster to fix than your mother knows. So read on. And hang on to your forks.

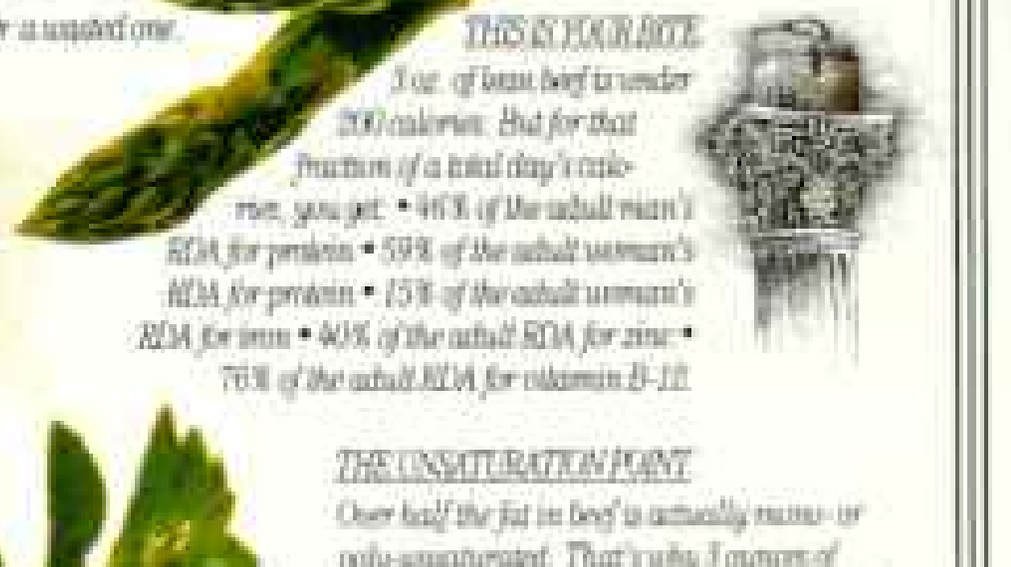


*THE LOWDOWN ON CHOLESTEROL*

*True fact: beef has only 76 milligrams of cholesterol in a 3-ounce serving. That's only average. Wonderfully average.*

*GOOD NEWS FOR PEOPLE WHO COOK*

*No sauces, no fussing, no fuss-fuss. Beef doesn't need much help in the kitchen. To cut time, just cut big things in pieces. With stir-fries, sautées, kabobs and marinades, there's never a dull moment. Or a wasted one.*

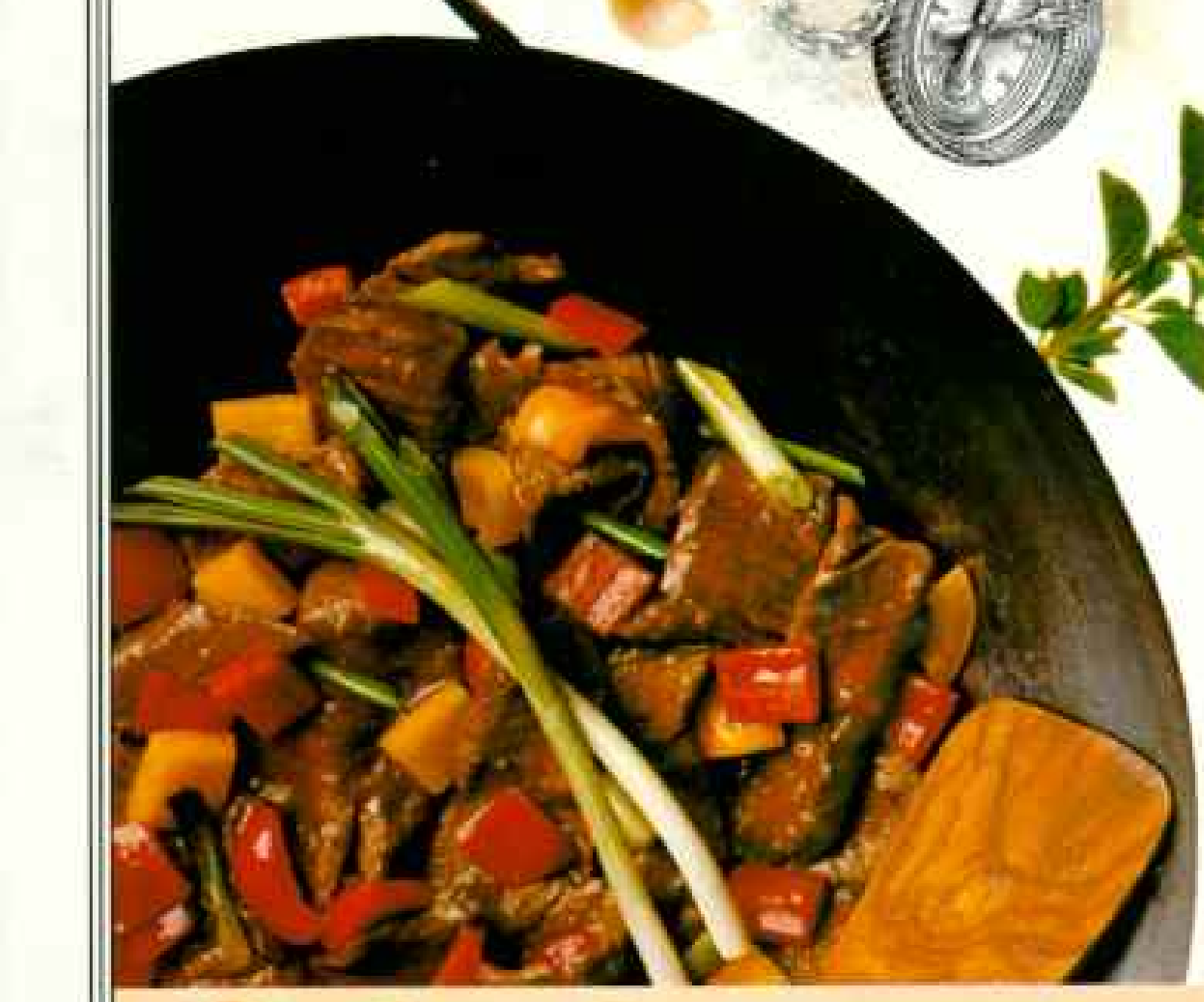


*THIS IS FOR BITE*

*3 oz. of lean beef is under 200 calories. But for that fraction of a total day's calories, you get: • 46% of the adult man's RDA for protein • 59% of the adult woman's RDA for protein • 15% of the adult woman's RDA for iron • 40% of the adult RDA for zinc • 70% of the adult RDA for vitamin B-12.*

*THE UNSATURATION POINT*

*Over half the fat in beef is actually mono- or poly-unsaturated. That's why 3 ounces of tenderloin have only 3.1 grams of saturated fat out of 7.9 grams total. May your body and your taste buds make peace.*



*TERIYAKI BEEF STIR-FRY*

*Preparation: 15 min.*
*Cooking time: 10 min.*
*Cut 1 lb. top round steak in thin strips. Marinate in 3 Tbs. teriyaki sauce, 1 Tbs. oil and 2 tsp. cornstarch 30 min. Stir-fry 2 bell peppers (¾" cube) and 6 green onions (2" pieces) in 1 Tbs. oil 3 min.; remove. Stir-fry beef (½ at a time) 3-5 min. Return all ingredients. Cook until hot. 4 servings.*

*Calories: 247 per serving; 102 from beef.*

*Figures are for 3-ounce servings, cooked and trimmed.*



*ROUND TIP*
*6.4 gms total fat* (2.3 gms sat. fat) 162 calories*

*TOP LOIN*
*7.6 gms total fat* (3.0 gms sat. fat) 172 calories*

*TOP ROUND*
*5.3 gms total fat* (1.8 gms sat. fat) 162 calories*

# Beef.

## Real Food For Real People.

Source: U.S.D.A. Handbook No. 8-13

*EYE OF ROUND*
*3.5 gms total fat* (2.1 gms sat. fat) 155 calories*

*TENDERLOIN*
*7.9 gms total fat* (3.1 gms sat. fat) 179 calories*

*SIRLOIN*
*7.4 gms total fat* (3.0 gms sat. fat) 177 calories*

# The Mazda 929.

## "...has the manners and looks that promise to get European makers working much harder..." *AutoWeek*

Compare its performance and luxury to the world's finest sedans and you'll be impressed. Compare its value and you'll be amazed.

Comparisons with other makes based upon available competitive data. Availability of vehicles with specific features may vary.

**Fuel-Injected V6.** At the heart of the Mazda 929's performance lies an 18-valve, 3.0-litre, 158-horsepower overhead cam V6 engine with electronic fuel injection.

**Exceptional Room and Comfort.** The Mazda 929 offers more interior room than a Mercedes-Benz 300E or BMW 528e. You also get an automatic climate control system, 6-way adjustable driver's seat with lumbar support. Rich velour upholstery. Plus the peace of mind of Mazda's new **36-month or 50,000-mile "bumper-to-bumper" warranty.** Leather interior is optional.

mazda

An intense commitment to your total satisfaction. That's The Mazda Way.

For a free Mazda 929 catalog, write to: Mazda 929 Catalog Offer, Box 5960-NG, Orange, CA 92668. Or call this toll-free number: **800-424-0202 ext. 727.**

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When the English came to the New World, they brought one of their oldest institutions:

Their local pub.

Yet, after a century or two in North Carolina, it evolved into something even better:

Our country store.

Walk in the door, and time slips into another dimension.

You can join in a game of checkers, which some of us still play with bottle caps.

Meet everybody from the blacksmith to the barber.


# d to the English pub when

And take home a maple walking stick, a fly swatter, or a sack of moon pies.

All across North Carolina, you'll find places that continue to dwell happily in the past.

Like Wilmington, the port city where Cornwallis spent a two-week vacation. Here, you can explore 200 blocks of historic district, and a restored Victorian waterfront.

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And to the little village of Southport, where the pace is so relaxed, it takes three days to celebrate the fourth of July.

So, come soon. To our shore, our midlands, and blue-misted mountains.

And you'll find that, even though the English discovered us four hundred years ago, we're worth discovering again.

North Carolina

*For our free travel package, write North Carolina Travel, Dept. 854, Raleigh, North Carolina 27699. Or call toll-free, 1-800-VISIT NC, Operator 854.*

# On Assignment

"We HEARD a thump, and our hearts stopped." FAROUK EL-BAZ (top, upper right), Egyptian-born director of the Center for Remote Sensing at Boston University, recalls the moment of penetration into a 4,600-year-old boat grave. Sharing the success are GEOGRAPHIC Editor Bill Garrett, top center, and camera expert Pete Petrone, left. Bob Moores, third from left, designed the ingenious air lock that made this project possible. Involved in the design of the lunar-sampling drill for the Apollo program, the Black & Decker engineer had more than a passing interest in the boat pit. An avid amateur Egyptologist, he has long pondered "how the Egyptians built pyramids with primitive technology, how the stones were raised, and how they created rooms in those mountains of stone."

SHOT TO PIECES by Allied aircraft during World War II, a Japanese Mitsubishi bomber intrigues author PETER BENCHLEY, who traveled to Papua New Guinea to investigate submerged wrecks for this issue. Veteran Caribbean and Atlantic diver, he calls his experience in the Bismarck Sea "unparalleled. The marine life had none of the reticence you expect around human beings. Almost everything would come right up to us." Benchley, 47, who drew on his diving expertise for his novels *Jaws* and *The Deep*, turned to his days as a speech writer for President Lyndon B. Johnson for the setting of his most recent novel, *Q Clearance*.

JAMES P. BLAIR (TOP) AND DAVID DOUBILET

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# FUEL MUST BE AN EXTENSION

It used to be an engine was a simple machine.

But as the automakers have squeezed more and more performance and efficiency out of fewer and fewer cubic inches, engines have reached remarkable levels of sophistication and precision.

Fuel injectors are run by microprocessors and feed gas through clearances as small as 2/1000".

A new device, called a knock sensor, has been introduced to compensate for octane deficiency. When it hears a knock, its computer retards the spark, eliminating the knock. But at the expense of hesitation due to an immediate drop in power.

Even the most advanced engine is still at the mercy of the weather.

On a hot day, gasoline can evaporate in the fuel lines before it ever gets to your engine. In cold weather, your car may not start or accelerate because the gasoline doesn't vaporize enough.

All of which leads us to conclude that the more sophisticated the engine is, the more sophisticated the fuel must be.

And why engines designed to aerospace

# OF THE ENGINE.

tolerances should have a fuel that's equally exacting.

Presenting Exxon 93 Supreme, unleaded premium gasoline.

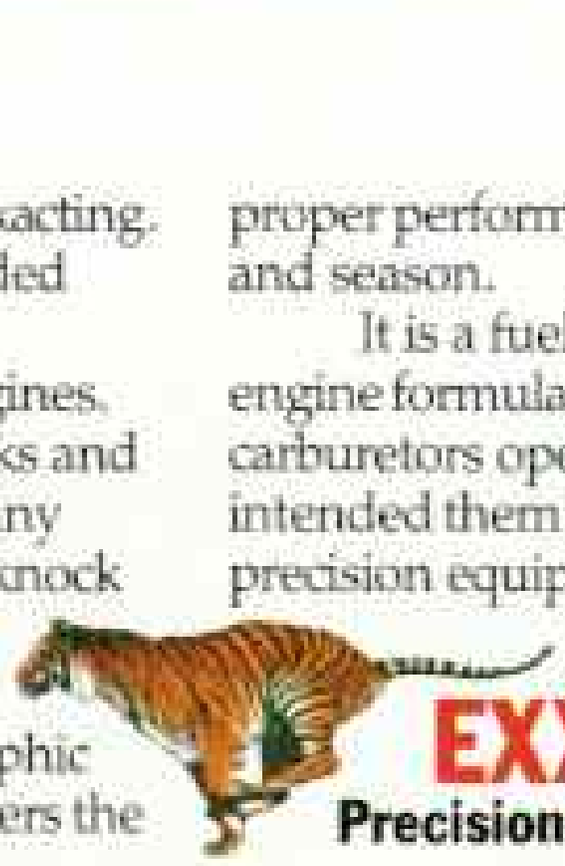
Precision equipment for precision engines.

Its 93 octane virtually eliminates knocks and pings. And as a result, virtually eliminates any sudden loss of power due to your engine's knock sensor cutting in.

It is a fuel that's fine-tuned for climates as well as engines. Fine-tuned for 21 geographic regions every month to ensure the fuel delivers the proper performance, regardless of weather, altitude, and season.

It is a fuel designed with our XCL-12® clean-engine formula to keep precision fuel-injectors and carburetors operating the way their computers intended them to perform. Exxon 93 Supreme is the precision equipment that precision engines need.

Just turn the key.



**EXXON 93 SUPREME.**

**Precision equipment for precision engines.**

# *Car and Driver* calls it one of the ten best cars in the world.

## We simply call

The experts have been saying a lot about the Ford Taurus. But then, there's a lot to be said for an automobile that offers world-class style and performance as well as world-renowned value.

It's driven *Car and Driver* magazine to name it one of the ten best cars in the world three years straight. It moved *Road & Track* to call it one of the ten best values in the world

out of cars sold in the U.S. (including the Honda Accord LXi, Mazda 626, and Nissan Maxima SE). And as *Motor Trend* simply put it: "We should all stand up and applaud."

People, like *Road & Track*, are impressed by its available V-6 power (along with its new 3.8L engine) and its sophisticated 4-wheel independent suspension. So many people, in fact, that Taurus now outsells every single ca

**Buckle up–together we can save lives.**

# *Road & Track* calls it one of the ten best values in the world.

# it Ford Taurus.

the competition makes (based on '87 model year manufacturers' reported retail deliveries). Proof that its celebrated design has impressed more than just automotive editors.

And with Ford's continuing dedication to design leadership, we fully expect the success of the Taurus sedan and wagon to go on and on. And so, we imagine, will the experts' praise.

For more information on Ford's award-winning Taurus, call 1-800-622-4511, 9 am to 9 pm EST.

## Ford Taurus.

**Have you driven a Ford...lately?** Ford