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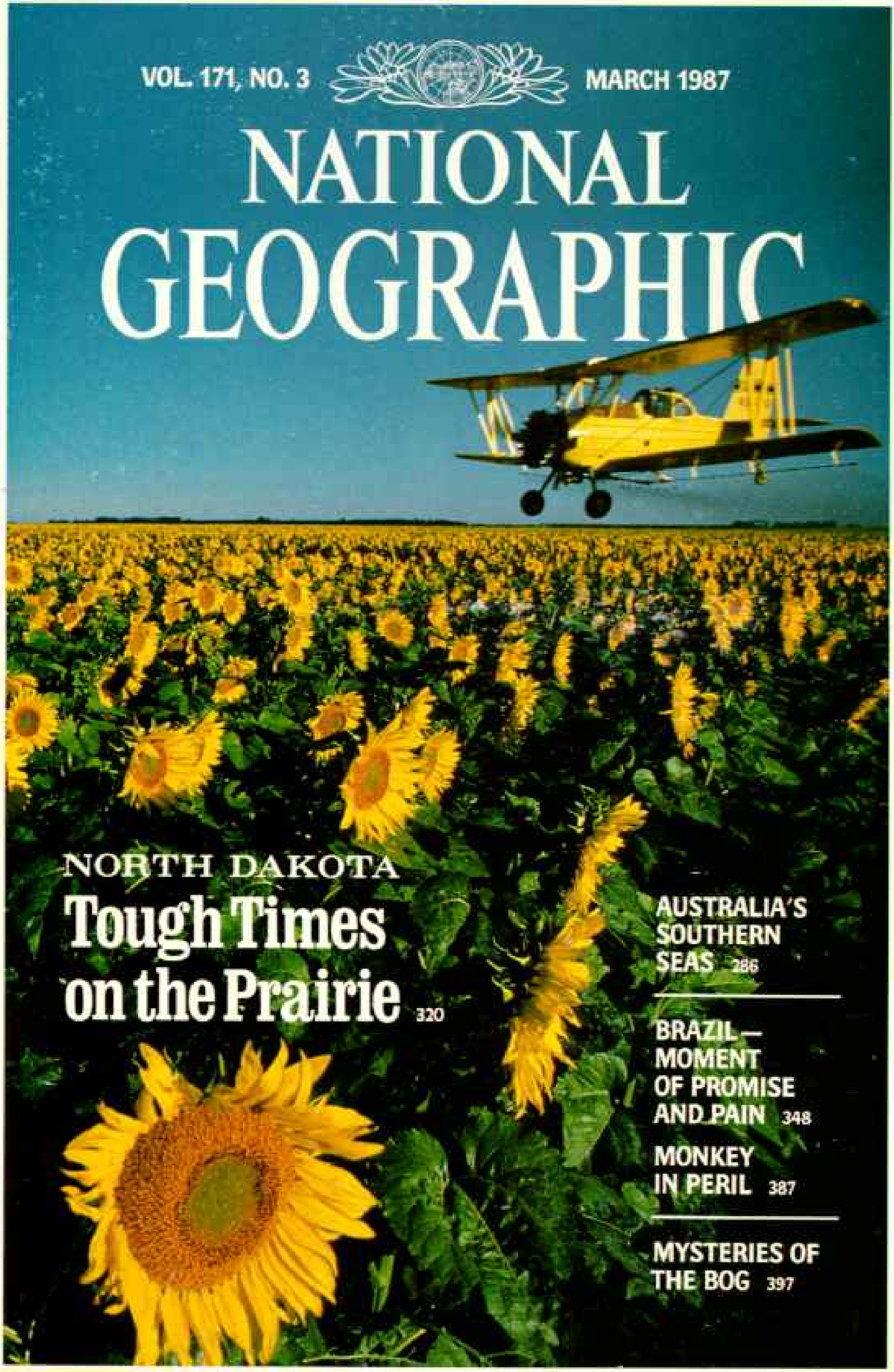
NATIONAL GEOGRAPHIC



NORTH DAKOTA
Tough Times on the Prairie 320

"THERE MAY BE as many people who have a defective sense of smell as there are people who wear glasses for vision problems."

This comment by my friend Dr. Robert Henkin set in motion the editorial process that resulted in our September 1986 article "The Intimate Sense of Smell" and the accompanying Smell Survey. One and a half million of you made this the largest such scientific survey in history by taking the test and sending it in. And a record flood of letters leaves no doubt about the power of the little-understood sense of smell to evoke sharp memories and powerful emotions and occasionally to cause physical, mental, and emotional anguish.

Some members complained that the encapsulated scents were offensive even before the patches were scratched to break the tiny plastic capsules in which they were sealed. We naively expected smell defects to be mostly the partial or total loss of smell. Hundreds did write about such problems and the curse they can be. But we were not prepared for hypersensitivity. Apparently some of you have sensitivity that would rival a bloodhound's—a problem that can make life as unpleasant as the loss of smell.

The four pregnancies of an Illinois woman caused certain odors to become unusually acute to her. During one pregnancy, she writes, "I craved the smell of car exhaust—dangerous, to say the least!" During her last pregnancy the smell of the family dog made her sick, and she repeatedly bathed it with scented shampoo.

However, the man who claimed his wife could smell beer on the telephone went too far. A Texas woman wrote, "I can smell things I see on TV. Everyone tells me I'm crazy. What do you think?"

Since we consider the test completed, we can now reveal the chemical scents included: 1. Androsterone—a steroid occurring in human urine and sweat; 2. Banana oil; 3. Galaxolide—a sweet musky scent; 4. Clove oil; 5. Ethyl mercaptan—the warning odor added to natural gas; 6. Roses.

We will report on why these particular scents were selected and the findings as soon as possible. Meanwhile, scientists at the Monell Chemical Senses Center have responded to many urgent letters asking for help while they continue to collate and analyze the 23.8 tons of surveys that you answered and returned.

Wilbur E. Garrett

EDITOR

NATIONAL GEOGRAPHIC

MARCH 1987

COVER: *Spraying for weevils, a crop duster swings low over sunflower fields in North Dakota's Red River Valley. Photograph by Annie Griffiths.*

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A Cold, Rich World
Beneath the Southern Cross

Australia's Southern Seas

By RICHARD ELLIS

Photographs by DAVID DOUBILET

AS OUR DINGHY approached Hopkins Island, off the arid, lonely coast of South Australia, the sea lions came out to meet us. On the beach they waddled. But as they plunged into the chilly water, they were instantly transformed from clumsy, out-of-place land mammals into supremely graceful amphibious creatures.

We joined them underwater, intentionally overweighted so that we could sit on the bottom and watch the pinniped ballet—big black eyes and whiskery faces and flickering supple beige figures against a glittering backdrop of green water and filtered sunlight. Then they stopped swimming and sat on the bottom to stare goggle-eyed at their audience—bubbling human apparitions from an alien world.

This corps de ballet belonged to a small colony of the rare Australian sea lion, *Neophoca cinerea*. *(Continued on page 295)*

A dry coast and a fertile ocean rim a face of Australia that looks across 2,000 stormy miles to Antarctica. These waters harbor a vivid gallery of marine life.

Once hunted intensively by man, now a protected species, Australian sea lions are often prey for great white sharks.

NEOPHOCA CINEREA

Accustomed to mastery, a 15-foot great white nears an abalone diver's mobile cage, developed specifically for work in these waters.

CARCHARODON CARCHARIAS

Teeth meet metal as a great white bites a boat's swim step. More of these giants are sighted off the southern Australia coast than in any other waters.

(Continued from page 286) Photographer David Doubilet and I had come to Spencer Gulf, lying between the horse latitudes and the roaring forties at the bottom of the world, in search of their deadliest natural enemy, the great white shark—the largest flesh-eating fish and one of the most dangerous predators in the world. Though this shark is not common anywhere, it seems relatively plentiful in South Australian waters, and the sea lion is probably the reason. From the scars often seen on the sea lions, we can deduce that the sharks attack them, and that the sea lions escape—sometimes.

Rodney Fox, an Australian man of the sea who had guided us to this spot, knew about white shark attacks and miraculous escapes at first hand. In 1963, while participating in a spear-fishing tournament off Aldinga Beach south of Adelaide, his hometown, Rodney was nearly bitten in half by a great white. Held together by his wet suit, he was rushed to a hospital, where 462 stitches were required to sew him up. Rodney was back in the water less than three months afterward. Today he is regarded as one of the world's foremost authorities on the behavior of the great white shark.

For the most part, white sharks do not eat their human victims. Rodney Fox is living proof of that. But a young woman, bitten in half and devoured off a public beach at Peake Bay by a great white in 1985, provided recent, tragic evidence that this shark does not play by the rules—even its own.

Scalloped by erosion and backed by tabletop scrublands, cliffs tower 300 feet and stretch nearly unbroken for more than a hundred miles on Australia's southern coast. A fishing boat wrecked on Wedge Island (facing page) was borne ashore by a rogue wave, frequent in these seas.

WHY THEN does the great white attack? For many reasons, some of which are still not clearly understood, sharks are sensitive to smell, sound, movement, electrical impulses, and even the magnetic field of the earth. They can also see a lot better than we thought they could. The shark that killed the woman at Peake Bay may have heard the commotion caused by her shallow-water diving and moved in to investigate. Only then did its other faculties come into play.

That we might observe the sharks in their own habitat, we had brought along shark

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Richard Ellis is a writer and illustrator who specializes in the natural history of the sea. **David Doubilet** has photographed underwater life for the GEOGRAPHIC since 1972.

cages—yellow boxes the size of elevator cars made of welded steel mesh. Actually these are man cages. When the cage is in use underwater, the diver is inside and the shark is outside the mesh. Stacked on the deck of our chartered fishing boat, the *Nenad*, the cages looked substantial enough. But how would it feel to be in one underwater, face-to-face with the shark the Australians call "white death"?

In a sense I already knew the answer to this question. En route to view the sea lions, I had asked Rodney why we were going to Hopkins Island instead of heading straight for Dangerous Reef, where white sharks are often to be found. He replied, "Once you see the sharks, you'll never want to go in the water again."

In light of those words Dangerous Reef seemed aptly named. Following Rodney's instructions, we ladled overboard an odoriferous slumgullion of tuna meat, dried blood, fish oils, and other secret ingredients that he guaranteed to be tantalizing to sharks. We hoped that the bloody slick would be carried by tides and currents to a great white, which would then backtrack on the scent to our boat. Then we would descend in the cages.

Our first shark appeared less than five hours after we dumped the chum into the water, but the sea was too rough for diving. The great fish swam around the *Nenad* for almost two days as we fed it four-pound chunks of horsemeat and an occasional 20-pound tuna to whet its interest. On the morning of the third day the gray skies cleared, and we lowered the cages.

Breathing my air supply much faster than I usually do, I tried to see through clouds of tommy roughs—foot-long fish that were also attracted by our blood-and-offal soup. Then the shark appeared. At first I could make out only a vague shadow that appeared in the green distance, but the phantom soon solidified into a gray, cone-nosed mass of muscle, cleaving its way through the tommies and heading straight for my cage.

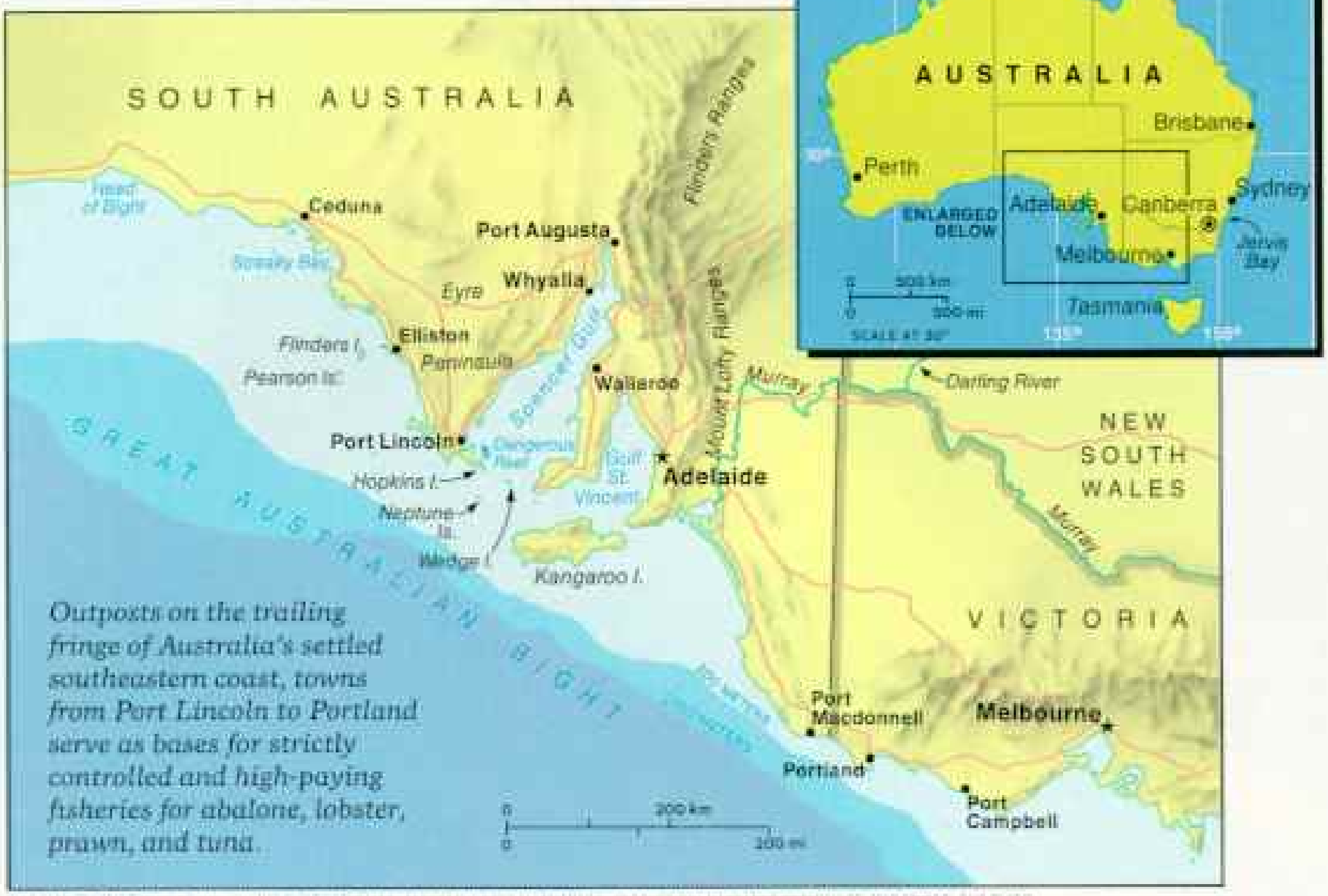
The shark came steadily, majestically, irresistibly. Without pausing, with perfect efficiency, it opened its mouth and bit one of the steel flotation tanks attached to the cage. The tank may have been the first inedible object the shark had ever encountered. My scientific objectivity vanished. I was only a couple of feet from the most famous jaws in the world, and they were chewing solidly on the cage in which I cowered, my scuba tank clanking noisily against the mesh as I tried to get as far away as I could from this remorseless man-eater.

After the first shock and terror, an unexpected calm came over me. I looked out through the viewing port—a section of the cage, face-mask-high with no bars at all—and saw only the shark and the cloud of tommies. It was as if I were truly a part of the shark's element, and not a clumsy intruder in a cage.

My breathing slowed to something approximating normal rhythm. I was not frightened now but awed. I saw the shark for what it was—a powerful state-of-the-art predator, as modern as the latest jet fighter, but with an ancestry that can be traced back 300 million years. Another shark appeared out of the gloom and circled our bubbling, artificial world. For the first time during this dive, I looked at my watch. I had been down for more than an hour, mesmerized by the physical grace and terrible power of these silent, slack-jawed eaters of seals and sea lions—and other large animals like me.

Most of South Australia's 1.37 million inhabitants live along its coastline, and most that I met work on or under the water—some in fearsome proximity to great white sharks. But there's a lot of land beyond the beach. South Australia, the fourth largest (or fifth smallest) of the island continent's eight states and territories, is nearly the size of Texas, Oklahoma, and Louisiana combined. Yet it has the same number of people as metropolitan New Orleans. The hot, lightly peopled interior is the driest part of the driest state in Australia. Adelaide, the state capital, is a sparkling city of 990,000, bisected into northern and southern sections by the meandering Torrens River and facing Gulf St. Vincent to the west and the Mount Lofty Ranges to the east.

Whereas New South Wales, England's first colony in Australia, was originally populated by convicts transported to the continent some 12,000 sea miles from their



homeland, South Australia was to receive no convicts. According to the original prospectus, published in 1832, South Australia was destined to become a model state where free men could engage in commerce and agriculture. Land sold for 12 shillings an acre, and there was an abundance of exportable commodities, such as wood, bark, salt, fish, seals, and the products of the sperm and right whale fisheries.

In 1836 eight ships arrived from England, and late that year John Hindmarsh, South Australia's first governor, landed to proclaim the province. During the next 20 years more than 100,000 colonists arrived, and the future of the new state was assured.

To get from Adelaide to Port Lincoln by road, one has to travel north to Port Augusta at the head of Spencer Gulf and then south through Whyalla—a 415-mile drive along the flat coastal roads that separate the inland scrub from the waters of the gulf. I made the seven-hour journey with Rodney Fox, whose car is equipped with a roo bar. This device, mounted on the front bumper, protects the vehicle from collisions with kangaroos. Usually at dusk, when they come out to feed after lying up in the shade all day, kangaroos will bound toward the lights of a car. A smashup between a fast-moving car and a 150-pound buck can be fatal to the roo, and more than a little dangerous to the car and its occupants.

We didn't see any kangaroos on this drive, but I did see some of the rich avian fauna that characterizes the region: black swans, Cape Barren geese, pelicans, and flocks of galahs, the crested pink-and-gray parrots that are as common in Australia as pigeons are in America and Europe.

BUT I VIEWED THE STATE of South Australia chiefly as a base camp. It was the wet parts of southern Australia that I really had come to see. Its deep cold waters are a marine Eden whose gleaming inhabitants were revealed to me during an earlier voyage aboard the *Nenad*. On that occasion, a fortnight before I met up with Rodney Fox's sharks at Dangerous Reef, the honest workboat had been fitted out as a prawn trawler. This kind of fishing can be immensely profitable, but it is blind work—prawn fishermen say that their catch hates the light, so they sail out only on moonless nights. *(Continued on page 304)*

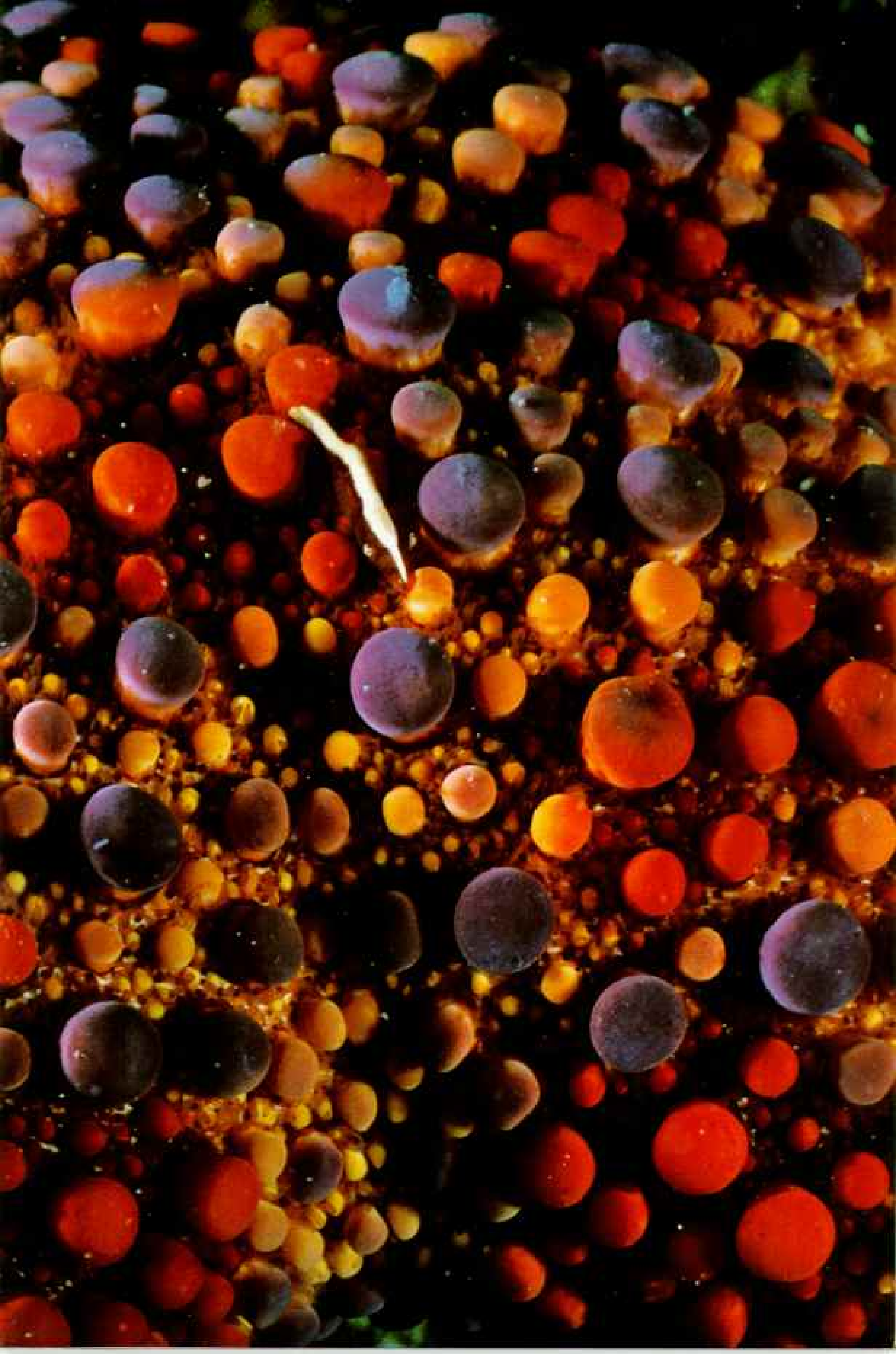
CLINGFISH, GENUS COCHLEOCEPS, 1 IN; ASCIDIAN, PYURA SPINIFERA

Sea tulips in local nomenclature, ascidians (above) festoon an ocean garden in Jervis Bay. A clingfish (left) of a species not yet described by science shelters amid bumps on an ascidian's surface.

STARFISH, ASTEROIDISCIDES TRUNCATUS; 2 IN. SHRIMP, PERICLIMENES SORDR

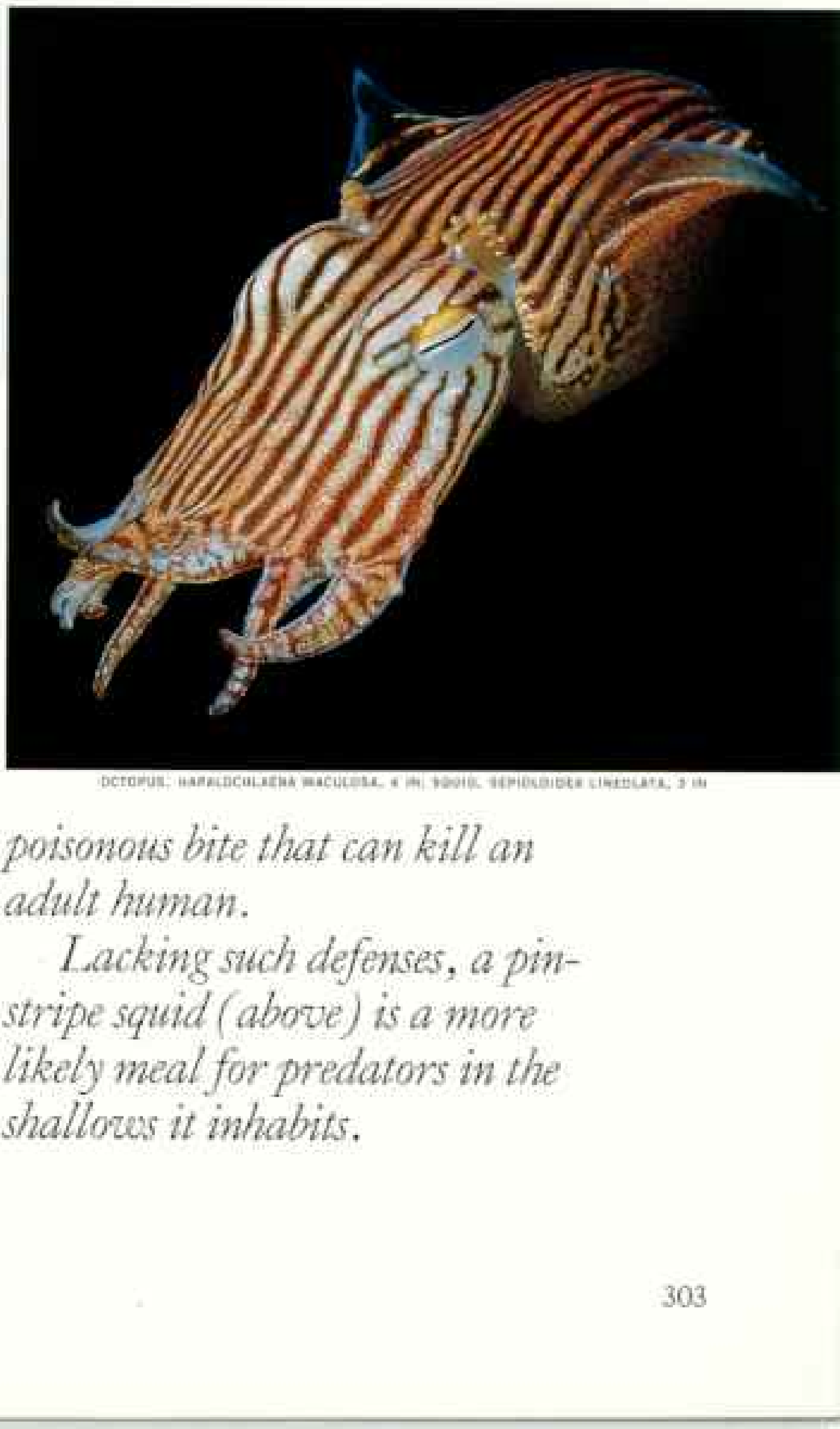
Grazing a rocky bottom, studded starfish (above) are well protected from most predators and parasites by an armored surface whose studs are actually modified spines. A periclimenes shrimp (right) finds protection amid the studs.

Vivid coloration, which may help creatures blend with their surroundings, seems muted underwater. "In the gloom at 50 feet," says photographer David Doubilet, "you fire your flash and this theme park lights up."



Jetting away, a blue-ringed octopus (left) shows an intense deep blue that indicates its distress at being disturbed — as does a specimen galloping across a sandy stretch of bottom (below left). Diminutive but deadly, the octopus possesses a poisonous bite that can kill an adult human.

Lacking such defenses, a pinstripe squid (above) is a more likely meal for predators in the shallows it inhabits.



OCTOPUS: HAPALOCHLAENA MACULOSA, 4 IN; SQUID: SEPIOLOIDEA LINEOLATA, 3 IN

Seemingly fragile beauty belies the tough exoskeleton of a leafy sea dragon, a relative of sea horses, usually found on weedy bottoms or in kelp forests.

About 3:30 on the morning we sailed, I stood on the rolling deck, just able to make out the flickering lights of Wallaroo, on the east coast of Spencer Gulf. Flights of muttonbirds and gulls fluttered like enormous moths around the mast lights of our little fleet of 30 boats. A muttonbird with a three-foot wingspan, blinded by the lights, crashed into the bridge and fell to the deck with a soft thump. I picked up the mouse gray creature in both hands—it was softer, lighter, and somehow drier than I thought it would be—and launched it underhand into the air. It flapped erratically, then dipped one of its graceful wings and flew.

We were fishing for western king prawns, *Penaeus latisulcatus*, the seven-inch shrimp that is one of the world's great seafood delicacies, but our 40-foot-long, chain-weighted nets picked up everything in their path. Helping out at the sorting tables, I recognized great flat rays with white undersides that reflected the floodlights back into the black skies. There were curious little bullhead sharks, *Heterodontus portusjacksoni*, that feed on shellfish. The three-foot-long varied cat shark, *Parascyllium variolatum*, wrapped itself around my wrist like a snake. Little octopuses changed color from pale beige to tortoiseshell. The tiny but deadly blue-ringed octopus, *Hapalochlaena maculosa* (preceding pages), whose bite can paralyze or kill an adult, and the spiny little fishes known as "happy moments" were the reasons we wore thick rubber gloves.

We sorted out cowfish, leatherjackets, and pipefish. There was also the occasional whiting. "Wait till Spike cooks them up for breakfast," said Capt. Bob Britcher, a brawny, red-bearded man. "Whiting is the best-eating fish in Australia."

And finally the nets yielded the object of our effort, the king prawn, kicking all ten legs at once and snapping its indigo-tipped tail. It is a sleek, pinkish shrimp with bright pop eyes like two bubbles of red caviar. We plucked the prawns from the squirming, flapping, crawling bouillabaisse, shoving everything else down a chute and back into the water. As the catch was safely stowed and the decks cleared, the nets were lowered for another shot.

This was the fifth haul of the night, and so far we had collected 580 pounds of prawns. The catch is reckoned in pounds per minute, and in this particular shot, lasting about an hour, we netted 90 pounds, or one and a half pounds a minute.

So far it had not been a great night—Mateo Ricov, co-owner and co-captain, told me of times when the *Nenad* hauled in five pounds a minute—but it had not been a bad one either. It was still early in the season,

and the fishermen had not established their rhythm or found the best spots in the gulf. Coming into Wallaroo to unload, we had 3,575 pounds of prawns. At $3.60 Australian ($2.55 U. S.) per pound, that meant that the *Nenad* had grossed nearly $13,000 in four nights.

LIKE ALL COMMERCIAL fisheries in South Australia, the prawn industry is licensed by the state and operates under stringent restrictions. The Spencer Gulf prawn fishery, the most lucrative of all, is regulated by time and by location, according to the breeding cycle of the prawns. The 39 prawn trawlers working Spencer Gulf pay the Department of Fisheries more than half a million Australian dollars in fees annually. Prawn fishermen work about 120 days a year. The value of the prawn catch in Spencer Gulf for the 1985-86 season was $14,169,000.

"Everyone wants to be a prawn fisherman," Mateo Ricov says. "It's a good living—easy work, very secure." To get into this "easy work" (which didn't seem very easy to me in the middle of the night when the *Nenad* was rocking so badly that we couldn't position the nets over the sorting tables), Mateo, a Yugoslav émigré who had come to Australia penniless after World War II by way of Italian refugee camps, mortgaged everything he owned. The *Nenad* cost Britcher and Ricov about $360,000, including the permit. She is now worth something like 1.1 million dollars—$200,000 for the boat and an incredible $900,000 for the license. "We're not about to give our license up," says Mateo.

Ordinary fishermen go down to the sea in boats—an arduous and dangerous life by any standard. In South Australia I encountered a new breed of fishermen who go down into the sea in cages.

Waving a warning, a giant cuttlefish brandishes its arms (above) at a diver off camera. Found only in Australian waters, it is the largest of the world's hundred cuttlefish species, chiefly differentiated from their relatives, squids and octopuses, by a calcified internal shell, or cuttlebone. A reaper cuttlefish, arms together, swims by jet propulsion (right).

GIANT CUTTLEFISH, SEPIA APAMA, 3 FT; REAPER CUTTLEFISH, SEPIA MESTUS, 8 IN

The first abalone divers simply jumped into the water with homemade scuba gear and face masks. In time they developed more sophisticated techniques for diving, eventually perfecting the methods now in use. The divers breathe air supplied by an on-board compressor, and they can stay down for as much as seven hours at a time. They pry the "abs" off the rocks, then pop them into a net bag. When the bag is full, the diver takes his air hose and inflates a "parachute" that takes the bag to the surface. There it is picked up by the sheller, whose responsibilities include keeping an eye on the compressor and driving the boat so that it is always above the diver; the sheller knows where the diver is by watching his bubbles. And of course shellers do the job that names them—removing the abalone from the shell and packing the meat in ice-filled coolers. If the shells are good enough, they are sold to craftsmen who use the nacreous interior for mother-of-pearl inlay work. If not, they are chucked overboard. But some are retained—every ab diver's house has at least one abalone shell ashtray in it.

Until 1975 the divers swam unprotected. Then a diver named Jim Ellis designed a one-man, motorized shark cage, and now almost all the divers own one. Not only does the cage protect the diver from shark attacks, it also provides another advantage over free diving: By driving the cage instead of swimming, the diver can conserve precious energy, which is quickly sapped by the chilly waters.

NO OTHER GROUP of people in the world have as much firsthand experience with great whites as these ab fishermen. Neil Williams, the first full-time ab diver, started in 1964, selling the meat of the abalone for a shilling (11 cents U. S.) a pound.

In December 1983, while Neil was diving off the Neptune Islands in about 90 feet of water, a white shark approached him head-on. "The only thing I could think of," he told me, "was to shove the bag of abs right into his mouth. It was bloody lucky the bag was half full. What if I had just begun to fill it?"

The shark chomped on the bag, lacerating Neil's fingers badly. Evidently not finding a bag of rock-hard shells to its liking, the shark turned and swam away. Neil crouched on the bottom, cradling his bleeding hand and trying to figure out how to get to the surface without attracting the shark again. He held one hand with the other (and also tried to hang on to his bag of abs; he wasn't going to have gone through this for nothing), as he watched the great shark circle around him.

His main fear—other than whether the shark would come back and eat him—was that the shark would attack and chew through his air hose. When he saw—or rather hoped—that the shark was not coming back, he shot to the surface without even a thought of decompressing and tumbled into the boat.

At age 50 Neil has lost none of his enthusiasm, but he does feel that 22 years underwater may be enough. Today he lives with his wife and three daughters in a large, sprawling house overlooking the harbor of Port Lincoln, and on his 200 acres raises horses, a few cattle, and a lot of scrub.

Two species of abalone are sought by the divers: the blacklip *Haliotis rubra* and the greenlip *Haliotis laevigata*. "Blacks" and "greens" inhabit the same waters, but they occupy different niches. The greens live on low-relief rocks and limestone outcrops in proximity to the grasses on which they feed, while the blacks inhabit underwater caves and crevices, making them more difficult to find, and therefore more difficult to collect.

Waterloo Bay, located just off the small town of Elliston on the Great Australian Bight, was once popular with ab fishermen, but in 1982 it was designated a research area and is now usually closed to divers—except for Scoresby Shepherd, a lawyer turned scientist who conducts the abalone research program for the South Australian Department of Fisheries. Shepherd dives about 50 days a year, studying the life cycle and habits of the greenlip and blacklip abalone.

"Abalone are marine snails, of course," Shepherd told me, "but their habits are quite unusual. Instead of crawling along the bottom looking for something to eat, they position themselves in a current or surge and wait for bits of algae or eelgrass to float by."

The waters that the abalone live in are not very deep, usually no more than 120 feet, but from a boat you can see only the surface

of the sea. How then do the divers know where to look for their quarry, which even up close looks like nothing more than a weed-covered rock?

Since the divers have been working these rocks and reefs for 20 years, they are as familiar with the underwater landscape as they are with their own living rooms—some of them even more so. Besides, as some of them joke, it would be impossible for anyone to keep a good spot secret very long, because the divers work right under their boats. When I asked John Kroezen how to find abalone under all that water, he laughingly replied, "Easy. Just look under an ab diver's boat."

Ab divers are the most compulsive map drawers outside a cartographers convention. No matter where they are, one or another of them will be drawing a map of some reef or bommie. They draw maps in the dust on the hoods of their cars, in the dirt of the roads, and especially in restaurants, where saltshakers, Vegemite jars, and knives, forks, and spoons are deployed to represent islands, reefs, gullies, boats, and divers.

"This whole business depends on the weather," Don Black told me. "It determines if you fish for blacks or greens, or whether you fish deep or shallow. For a diver the weather is more important than his wife." Blackie is divorced.

BOUND FOR FLINDERS ISLAND, where there are lots of abs, we followed John Kroezen's "big tinny," a V-hulled aluminum boat powered by twin 70-horsepower engines. The tinny, capable of making 35 miles an hour through crashing seas, sent up a rooster tail of spray that often hid the hull completely. There are no *(Continued on page 314)*

Caught far out at sea and blast-frozen in the hold, southern bluefin tuna are off-loaded for shipment at minus 55°C to Japan as a delicacy. Demand and strict control have enriched local tuna fishers, most of them Yugoslav Australians.

Red sky at morning presages a storm as prawn fishermen complete the Nenad's *dawn trawl. Licenses for the lucrative catch (right) are few and coveted, and yield rich rewards. But fishermen of every sort face competition with a volatile and unpredictable sea.*

PENAEUS LATISULCATUS, 7 IN.

Whisked away from the ocean floor in a trap (right), rock lobsters will later travel by air to gourmet tables in Hong Kong, Singapore, and Japan, kept alive in coolers for maximum freshness. Diners there unknowingly share a taste with the banded wobbegong (below right), a shark

that includes the crustacean in its diet. A closeup lobster portrait (above) shows mouth parts and the base of antennae and other sense organs.

LOBSTER, PANULIRUS NOVAECHOLLANDIAE, 12 IN; ROBBERDOG, CRECTICOBUS ORNATUS, 8 FT

Usually shy of divers, a pod of bottle-nosed dolphins briefly investigated photographer Doubilet, then departed. "A magical moment," he recalls.

seats in an ab diver's boat, so John and his sheller stood up in their slickers and life jackets for the whole bone-jarring trip—two hours out, two hours back. Just to show that he could, John ran circles around us, laughing raucously as he passed our effete pleasure boat fore and aft.

Underwater, however, all of us are equipped alike in full wet suits as we follow John's lifeline—air hose, hot-water hose, and hydraulic hose, all taped together into a thick, sinuous bundle. John sits calmly on the bottom. It is late afternoon, and the water is lighted only by oblique shafts of sunlight and by David Doubilet's flashing strobes.

We communicate by hand signals. David wants Rodney and me out of the picture so he can get shots of John at work, prying abs off the rocks with his chisel-shaped ab iron. I am surprised to see that John does not actually work from inside his cage but rather hangs on to it, one hand slung through the steel bars, as he pries up the abs and pops them into a mesh bag. He signals me to approach him, and when I get close enough, he pulls the end of the hot-water hose out of his wet suit and jams it down the collar of mine. It is a startling and wonderful sensation, like taking a hot shower in the middle of a cold rain. When John has collected a decent catch, he climbs into the cage and rises toward the silhouette of his boat; we also head for the top.

"The hot water is fantastic," I shout at him, as soon as I spit out my mouthpiece. "That's why I only let you have it for a minute," he answers. "I need it more than you do. I'm working for a living, mate."

Indeed he is. He spends six or seven hours a day underwater, and even with a hot hose wrapped around him, it is not easy labor. But it is precisely the danger and the discomfort—and the money, of course—that make this way of life so attractive to the ab divers. They are free spirits, working at a dangerous yet romantic job.

But even ab divers must retire eventually. Some hand down their licenses to sons. Others sell out and regard the proceeds as a hard-earned pension. When Rodney Fox left the business ("I have only one body, and I nearly lost it already"), he sold his permit for $95,000. The going rate nowadays is closer to $500,000. The buyer will earn a good living, but he will also face the possibilities of the bends, an air embolism, bone necrosis, brain damage, or being attacked by a great white shark.

John Kroezen lives in a house on a hill overlooking the Port Lincoln harbor. The most unusual thing about this house is not the location or the view but the backyard. In a large fenced enclosure John's wife, Chris,

TURSIOPS TRUNCATUS, 10 FT

rehabilitates kangaroos that have been injured or abandoned. There were about 20 roos of all sizes, from small joeys to full-grown bucks and does.

"Would you like to hold one?" asked Chris. Somewhat reluctantly I accepted a half-grown red kangaroo and cradled it in my arms. Holding a kangaroo is a very surprising experience. The animal is enormously bottom-heavy because of the great mass of the hind legs and tail, and it takes a while to adjust to its peculiar weight distribution. While I held the kangaroo, Rodney Fox fed it almonds.

"TEN YEARS AGO we called them crayfish, but now that you lot are buying them, we have to call them rock lobsters." The speaker was Don McBain, a lobster fisherman based in Port Macdonnell, not far from the Victoria-South Australia border. "We have another crustacean that is similar to your crayfish, but we call it a yabby. Is that clear now?"

It was, since I had already talked to the fisheries people in Adelaide about *Jasus novaehollandiae*, the object of another of South Australia's lucrative commercial fisheries. Unlike abalone, which most Australians do not fancy, lobster is very popular here, and only its high price keeps it all from being consumed locally.

Again we were fishing at night, but not because of the lobsters' aversion to light. We boarded the *Pamela J* at 3 a.m., "because all those other blokes are going out now—see all those lights over there?—and we wouldn't want them to get the jump on us, would we?" All seagoing poachers would have to do is make sure there is no other boat in sight, pull someone else's pots, remove the lobsters, and dump the pots back.

This is a two-man operation, the entire crew consisting of McBain and his deckie,

Life rides on life in the carousel of the deep. A pair of isopods cling to a blue devil (right) with a hooked grip that will last the fish's lifetime. The parasites probably feed on the fish's blood and may weaken but are not known to kill their host.

A scorpionfish (below, far right) lies in ambush on a sponge. Venomous tissue in grooves along the spines of its dorsal fin releases a potent poison.

A striped mor-wong (right) yawns, possibly a threat warning, in one of the myriad signals that guide the submarine merry-go-round.

BLUE DEVIL, PARAPLESIOPS MEGACRIS, 8 IN, AND ISOPODS, RENOCILA LATICAUDA

MORMONS, CHEIROGRACTYLUS RHOMPHEA, 11 IN; SCORPIONFISH, SCORPAENA CARDINALIS, 11 IN

Outriders of a continent, the Twelve Apostles—limestone sentinels off Port Campbell—were shaped by the breakers, attesting the power of Australia's southern seas.

Peter Jones. I can see nothing on this wet, moonless, black night. It is cold out here even though it is February, the middle of the austral summer. For warmth I crowd into the wheelhouse. McBain fishes 98 pots in South Australian and Victorian waters, working every day during the season from October to April. Lobstermen are limited by law as to the number of pots they may set. There are strict rules about the size of the lobsters that may be taken. Each lobsterman is issued a bronze, C-shaped object with which he measures the carapace of the lobster as he removes it from the pot. Fishermen are also supposed to throw back females that are carrying eggs, but some unscrupulous types brush the eggs off (a female lobster carries her fertilized eggs *outside* her body, under her tail), an illegal practice known as plucking or stripping.

As we reach the first pots about 5:30, I can just make out the thin line of the horizon separating the gray sea from the gray sky. Abreast of a float, Peter grabs the line with a boat hook, then throws a turn of the line around a winch. McBain removes the lobsters from the wire pot as Peter puts in new bait, today consisting of the head of a barracuda and a whole bream.

Then McBain retreats to the cabin to consult his color echo sounder. This machine gives him a picture of the bottom. Rocks show up as orange, coral as yellow, and the whole image looks like some sort of undersea video game that might be called Space Fisherman. McBain tells me, "The crays like to hide under coral or rock outcrops, and when I see the right shape on the screen, I want the pot dropped right . . . there!"

Rock lobsters sell at the dock for $7.75 a pound. Since some of these lobsters weigh well over four pounds, we have been catching $35 lobsters—and this before they are marked up by the restaurants. Part of the catch will be shipped to Far Eastern markets. These lobsters are kept alive in frigid saltwater, then packed in coolers and airfreighted to Tokyo, Manila, or Singapore. There they will be eaten scarcely 36 hours after scuttling into one of Don McBain's pots.

McBain's pleasure ashore involves restoring and flying antique light airplanes. From the sheep pasture that he calls Stringbag International Airport, we took a thrilling ride in a Tiger Moth, an open-cockpit World War II British trainer that McBain had lovingly restored. We overflew a flock of emus, the first I had ever seen in the wild. They ran with their two-legged lope into the bush.

AFTER OUR ABALONE DIVE off Flinders Island, John Kroezen had promised us "something very special, something magical." Beneath a cloudless sky, across 15 miles of

bouncing swells, we followed his boat to the Pearson Islands, a jumble of rocks that seemed to assume strange and wonderful shapes—the head of a camel, a hippopotamus perched improbably atop a Greek column.

A white-breasted sea eagle wheeled overhead, its black-and-white plumage vivid against the electric blue of the sky. The Pearson Islands are a preserve. No human being lives here. There are no houses, no fences, no litter—only the rocks, the eagles, the lizards. I had the feeling that no other person had ever set foot here.

But as we climbed up the rocks, shirtless in the broiling summer sun, we became aware that we were being watched. There! Above that rock—a pair of furry ears, then a doe-eyed face. It was a toylike kangaroo, the black-footed rock wallaby, *Petrogale lateralis*. Probably because they had seen so few people, the wallabies, no larger than fox terriers, seemed practically fearless. Ears pricked forward, forepaws tucked neatly into their chests, they thumped audibly as they bounded nimbly over the rocks.

Instinctively we lowered our voices so as not to disturb the magic of this enchanted place. "No one will ever settle here," said John Kroezen. "It's like the beginning of the world."

With their love of the sea and the rich bounty they draw from it, the fisherfolk of Spencer Gulf and the Great Australian Bight may well represent an important lesson for their country's future. The combination of respect for their marine world and control of its exploitation can lead to a "fair dinkum" integration of man and the ocean. If this union between *Homo sapiens* and the rest of nature is ever going to happen, surely it has a good chance of happening here. For the southern Australia coast itself is like the world in the beginning. □

NORTH DAKOTA

By BRYAN HODGSON
NATIONAL GEOGRAPHIC SENIOR WRITER

Tough Times on

Photographs by ANNIE GRIFFITHS

the Prairie

An island of faith gleams amid the abundance of North Dakota's Red River Valley. These lush fields speak eloquently for the practical, hard-working people who face high risks, a harsh climate, and a stormy economic horizon.

ON A TIMELESS North Dakota Sunday under whipped-cream clouds, I follow the Lewis and Clark Trail north from Bismarck, the state capital, and park on a bluff overlooking a broad, braided stretch of the Missouri River. Cottonwoods shimmer on the far shore, and a warm prairie wind ruffles the water. Upstream, I know, the river vanishes irretrievably behind Garrison Dam. But here it still looks very much the grand continental waterway that carried those early explorers through an almost unknown wilderness some 180 years ago.

For weeks I've been exploring that one-time wilderness, navigating by latitudes and longitudes of narrow roads over an incredibly tidy land. Vast wheat fields are stitched into the prairie like machine-made carpet. Regiments of sunflowers gaze so uniformly east that I've felt compelled to glance that way too. Along the Red River, which flows north toward Hudson Bay, the state lies flat as a map, with grain elevators and solitary farms penciled on a razor-thin horizon.

But heading west, I discovered places where the state remembers its wilderness heritage. Here was Little Yellowstone Park, where white-tailed deer roamed the delightful Sheyenne River Valley. Beyond, in rolling, glacier-formed hills, I found a sea of small lakes called potholes, where ducks, pelicans, and gulls share one of the most productive waterfowl hatcheries in the world.

Small towns were islands of individuality in this agricultural archipelago, each with its siren billboard song. Hazelton enticed me with "22 Friendly Business Places," while Edgeley offered "Fine Food and Friendly People." Gackle's six churches welcomed me ecumenically. Kulm modestly proclaimed itself "Flax Center of the World." I entered Napoleon between a pair of graveyards where neighbors lay separated by doctrine, if not by death, and found nearby a careful arrangement of 15 antique threshing machines that bowed rusty heads in memory of harvests past.

Gradually I began to notice other patterns. In the towns, many stores and homes were empty. In the countryside I saw many empty farmhouses, an ironic contrast to hundreds of silvery new grain silos that sprouted everywhere.

Across this prairie panorama marched gleaming machines at work on one of the mightiest harvests in North Dakota's history. A parade of trucks with red, white, and blue color schemes hauled grain to elevators and on-farm storage bins that helped contain some 400 million bushels of wheat worth almost 1.5 billion dollars, in addition to 250 million bushels of barley, oats, and corn and 800,000 tons of sunflower seeds.

BUT THIS ENORMOUS productivity lay like an invisible blight upon the land. United States agriculture exports had tumbled almost 40 percent in five years as Europe, Australia, Canada, and Argentina competed in a world market glutted with food. Even India had begun exporting wheat. North Dakota's 33,000 farmers had plunged some 5.7 billion dollars in debt. Now 17 percent of them were delinquent in mortgage payments, and as many as 5,000 were expected to be out of business before the state centennial in 1989.

In a state of only 685,000 people, where half of all workers depend on farming, it was a bleak harvest indeed. Moreover, in the cause of productivity, hundreds of thousands of acres of fragile prairie had been set to the plow. Drainage of potholes to create more farmland had caused increasingly destructive flooding and brought a catastrophic decline in the annual hatch of wild ducks.

"The boom came when the Russian harvest failed in the early seventies," I was told by farmer Bruce E. Viker, who with his brother, Dewel, produces wheat, barley, sunflowers, and sugar beets on 5,000 family-owned acres in the Red River Valley near Hillsboro. "Wheat went from $1.70 to $5.96 a bushel. An acre of land jumped from $300 to $1,500 and $1,700. Now we've gone from six-dollar wheat and $15,000 tractors to three-dollar wheat and $45,000 tractors, and you can't sell an acre of land for $900."

He showed me four brand-new Duetz-

***Cruising the main drag** of Enderlin takes from three to five minutes, say experts from Enderlin High's senior class—here out for a spin in Sherm Syverson's jeep. But with no movie theater and Fargo an hour away, what else is there? "We spend a lot of time on school-related stuff," says Nikki Fey, far left. "Most of us are going to college."*

Enderlin is better equipped than many small North Dakota towns to weather agriculture's ups and downs, thanks to the invigorating presence of the railroad and a sunflower processing plant that employs more than a hundred.

Allis "Gleaner" combines that the brothers recently purchased, bringing their total equipment investment to about $900,000. Two 25,000-bushel aeration bins with powerful electric fans ran constantly, drying grain that had been harvested with too much moisture for proper storage.

"Forced-air drying really makes your meter spin," said Mr. Viker. "But it gives us better control over variables like weather. The traditional way to harvest is swathing—cutting the grain, letting it dry in the field, then threshing it. That protects your crop from being knocked down by harvest-season thunderstorms and hail. But damp weather will make the wheat sprout on the ground, which can cost you a dollar a bushel, or sometimes your whole crop."

When I met them, the Vikers had some 200,000 bushels of wheat and barley in storage on the farm, with room for about 150,000 more. Their farm was a model of meticulous order.

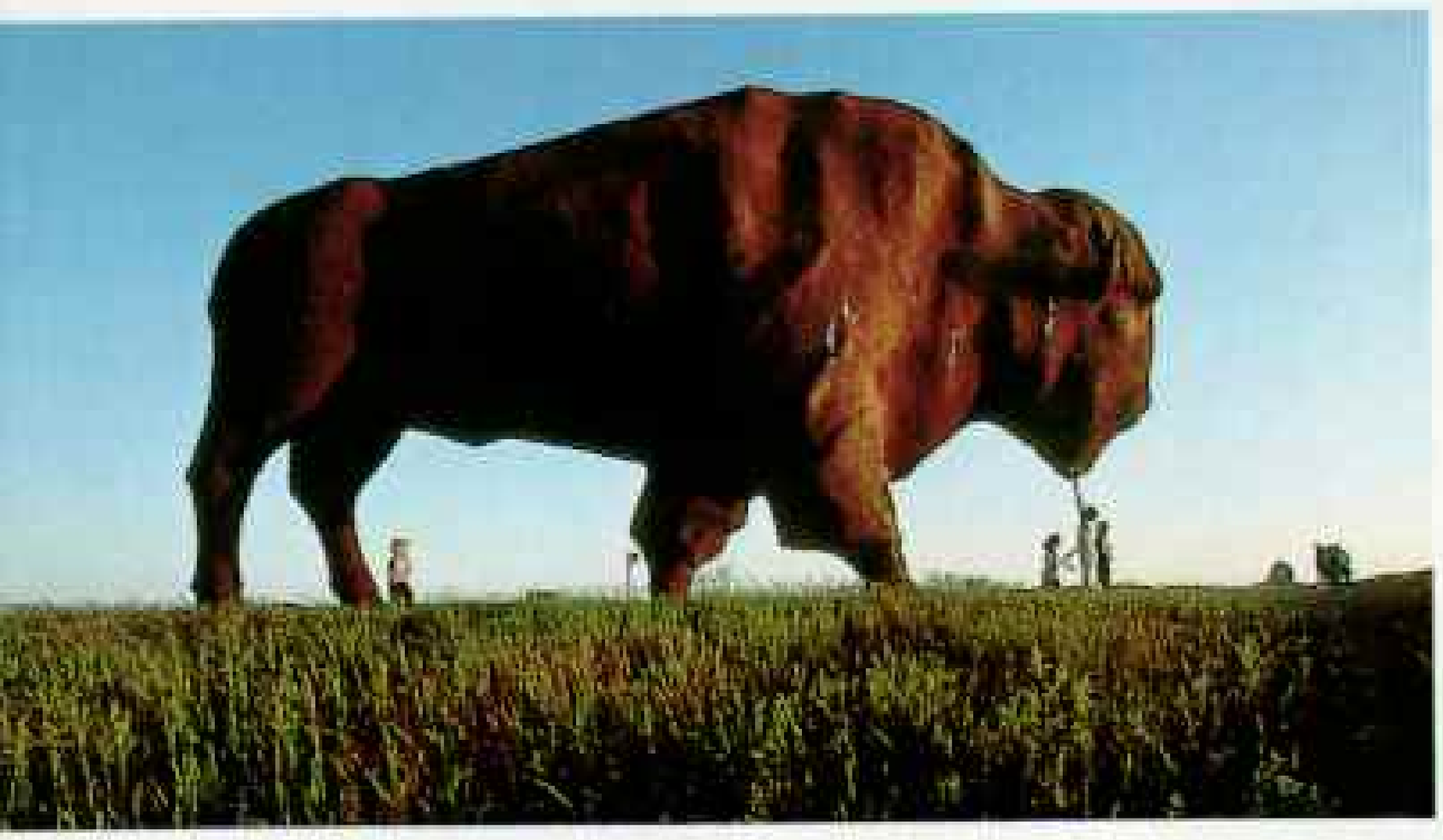
By contrast, the economics of agriculture seemed an incomprehensible mess. For years the federal government had guaranteed minimum prices for wheat and other grains, with additional "deficiency"

*A January blizzard—with a wind chill of minus 80°F—didn't stop the late Helge Holte (**above**) from tending the cows wintering in his barn. Maybe it was his Norwegian ancestry, says his wife, Amy, who still*

lives on their farm near McGregor. "Even in the dead of winter he loved to work." A neighbor says simply, "In my next life I want to come back as one of Helge's cows."

subsidies that gave individual farmers up to $50,000 more income a year. In 1985 Congress raised these deficiency payments to a level that would cost taxpayers some 25 billion dollars in 1986. In the second quarter of 1986 the subsidies helped boost North Dakotans' average personal income by 13.4 percent—the highest increase in the country.

Now, there were rising complaints that only large farms benefited. And there were



World's largest buffalo *looms outside Jamestown, in central North Dakota* ***(above)****. Commissioned by the chamber of commerce, the concrete statue weighs 60 tons and draws 250,000 tourists a year. The road leads west from here to the Badlands, stomping grounds for Gary Riley of Bismarck* ***(facing page)****. "If you want to gather your thoughts, that's the place to go," he declares.*

signs of abuse. Some farms were being split into smaller units, each eligible for a $50,000 payment. While wheat farmers in North Dakota had agreed to take 30 percent of their acreage out of production to qualify for subsidies, in 1984 they had planted 765,000 of these "withdrawn" acres in barley, oats, and other grains, already in huge surplus. Nationwide, over 6 million acres were similarly overplanted.

It was not the first time that massive government programs had affected North Dakota. The Vikers' land once was part of the 63,000-acre Grandin Farm, one of many so-called bonanza farms assembled by speculators in North Dakota during the 1870s from government land granted to the Northern Pacific Railway. The company sent agents throughout northern Europe to recruit settlers and sold them land for $2.50 an acre when they arrived. By 1890, according to state historian laureate Elwyn Robinson, North Dakota had 50 towns, 125 newspapers, and 125 banks. By 1915 population had risen to 637,000, and there were 75,000 farms, most of them planted to wheat.

"But big merchants and bankers in Minnesota came to dominate the state's economy. Many homesteaders were forced out because they couldn't get a fair price for their crop," I was told by Larry Remele, of the State Historical Society in Bismarck. "That early farm crisis stirred up a wave of populist politics. In 1919 a farmers' legislature fought the outside control by setting up a state grain elevator and flour mill and founding the Bank of North Dakota, the nation's only state-owned bank. Drought and low market prices forced many more farmers out in the 1930s. Since then we've lost many of our small towns. And the average farm size has grown from 375 acres to about 1,200 acres. But the population hasn't changed much since 1915."

BISMARCK SEEMS TO ME the quintessential American hometown. I vividly remember the annual Folkfest Parade, when pretty girls rode through the streets on a fleet of restored 1930s and 1940s cars, while World War II airplanes like the B-17, B-25, and the F4U Corsair thundered overhead as part of an air show at the local airport. High-school marching bands provided counterpoint to the basso profundo rhythms of an old steam tractor, and floats sponsored by two large downtown hospitals called Medcenter One and St. Alexius seemed like advertisements for television shows engaged in a ratings war.

I discovered that Bismarck has German flavors to match its name. At the Bakers Dozen, I found *Kneifla*, a cream soup with

chunks of dough. At Keichla Korner, a German fast-food café, Judy Rivinius introduced me to a dish called *Fleisch Keichla*, deep-fried dough filled with spiced meat. We theorized that this might have been the origin of the hamburger.

Bismarck owes much of its ethnic flavor to German settlers, many of whom came there from Russia, descendants of those who had colonized the Black Sea region in the early 1800s at the invitation of Tsar Alexander I. Rising Russian nationalism caused thousands of them to leave for the United States in the late 1800s and early 1900s, and most of them settled the state's central and southern regions.

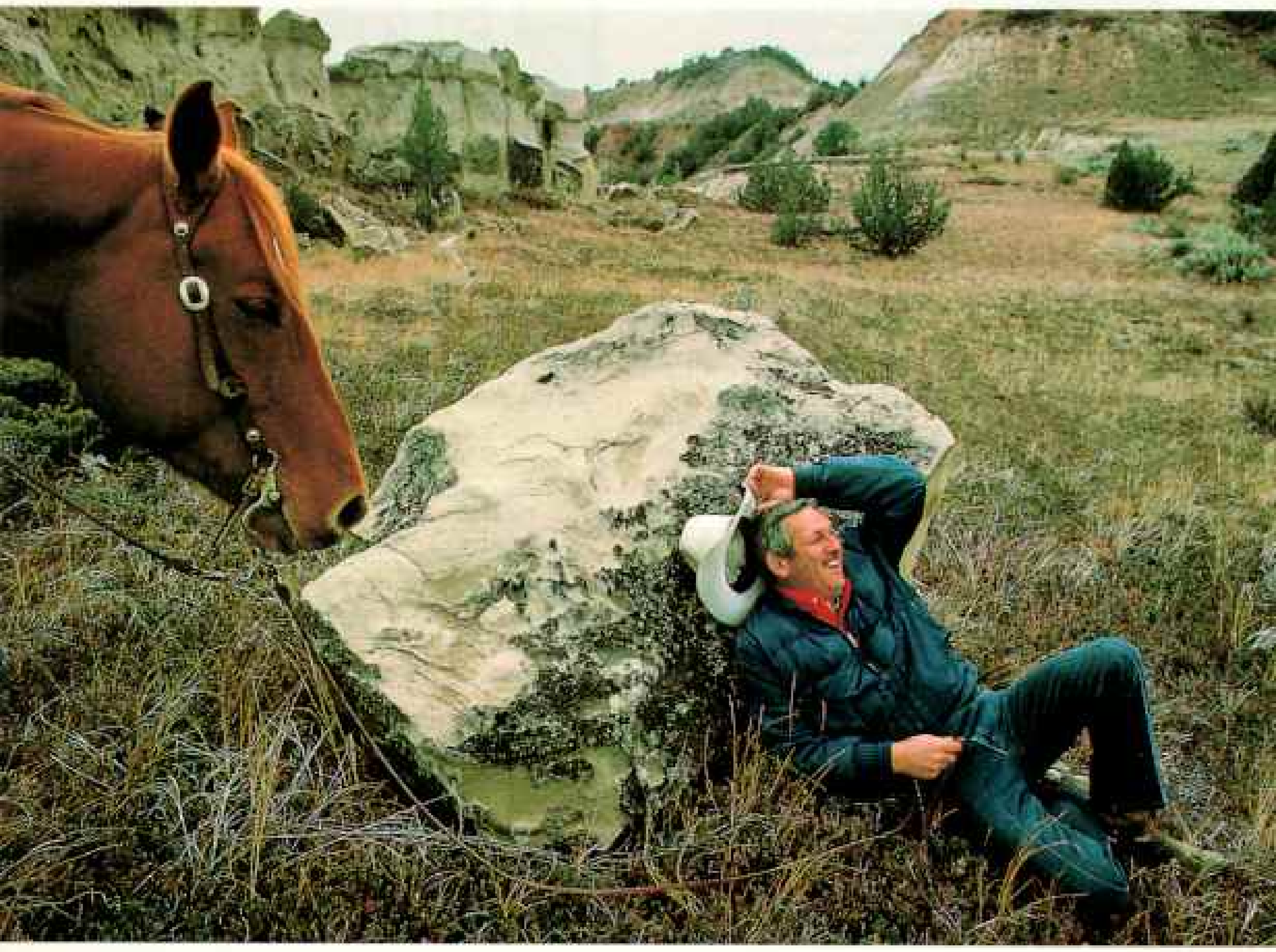
One of their descendants is Dr. Armand Bauer, soil scientist at the Department of Agriculture's Northern Great Plains Research Center at Mandan. Dr. Bauer was born at Zeeland, where his paternal grandfather, from the Crimea, homesteaded in 1884. He came to Mandan from North Dakota State University at Fargo in 1976 to do a long-term study on the effects of farming methods on soil quality. Traditional ways, it seemed, had taken a serious toll.*

"Wind erosion of heavily cultivated topsoil is a principal cause of damage," Dr. Bauer told me. "So far our soil tests indicate an average loss of 59 pounds of organic nitrogen an acre over 25 years. To replace it with commercial fertilizer would cost about $220 an acre. That's about 40 percent of the value of all land sold in the state in 1981.

"In addition, four to five million acres of grassland that never should have been cultivated were added to the plow in the past seven or eight years in North and South Dakota, Montana, and Colorado. It was partly to get more subsidies but also speculative, for the added value of plowland."

Today, he told me, many of North Dakota's farmers are switching to "no-till"

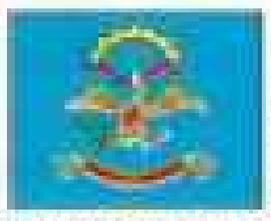
*See "Do We Treat Our Soil Like Dirt?" by Boyd Gibbons, NATIONAL GEOGRAPHIC, September 1984.



North Dakota

IT TOOK hardy, optimistic settlers—many of them Norwegians, Germans, and German Russians—to prosper in this prairie state located at the geographic center of North America. The weather is dry, freakish, and colder on an average day (40°F) than in any state except Alaska. Yet 77 percent of its annual rainfall comes during the growing season. Crop production is high in the rich Red River Valley, low in the arid southwest. Ironically, farmers are suffering from their own productivity in a glutted world market. Many are deep in debt, foreclosures are at record levels, and economic shock waves ripple throughout a state heavily dependent on farming.

Migratory waterfowl paths



AREA: 70,702 square miles.
POPULATION: 685,000.
MAJOR CITIES: Fargo, 66,000, Bismarck (capital), 48,000.
INDUSTRY: Mining, food processing, machinery, printing. **AGRICULTURE:** Wheat, cattle, sunflowers, barley, flax, dairy products, sugar beets, potatoes.

Farmers cash income by county, 1984

$ 71-184 million
$ 36-70
$ 13-35

Includes subsidy payments; excludes payments by barter and non-marketing income

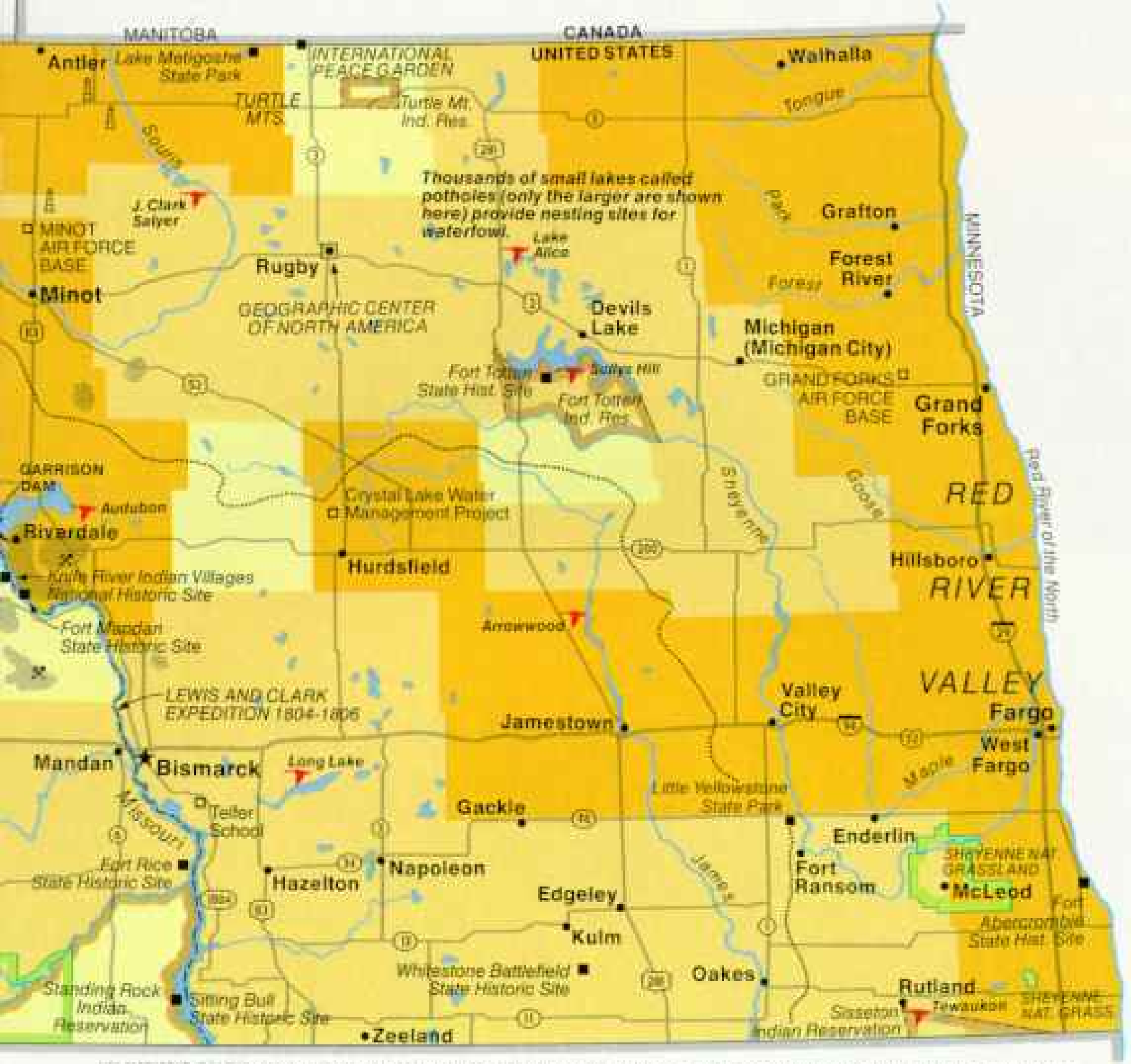
National wildlife refuge
Lignite deposit
Mine
Oil field

techniques, in which herbicides are used instead of repeated cultivation to eliminate weeds. New seeds are planted directly in the stubble of last year's crop.

"This method can reduce wind erosion losses by 50 percent. Just as important, it reduces evaporation of soil moisture. A two-inch stubble keeps the equivalent of 2.4 inches of rain from evaporating. The stubble traps snow that would otherwise blow away, providing an additional 1.5 inches of water. In a semi-arid climate like ours, that's like increasing annual rainfall as much as 25 percent. And there's another benefit—the snow cover keeps the ground warmer and makes it less risky to plant winter wheat.

"The idea isn't new. Farmers experimented with it in the good rainfall years of the 1920s and early '40s, but then the 'big iron' came along—the huge tractors that let them plow every shred of vegetation under. They developed what I call the 'clean surface syndrome' and laughed at the Peter Tumbledown look of conservation tillage. But now there are almost one million acres under no-till cultivation in North Dakota alone, and there will be a great deal more when farmers can afford to invest in the special machinery required."

In downtown Fargo a heroic sculpture of a plowman and his oxen commemorates the settlers who first broke the soil of the Red River Valley. Most of them were Norwegians who came to North Dakota from settlements in Minnesota and Wisconsin. One of their kinsmen is Howard Dahl, 37, whose Norwegian ancestors homesteaded near



Fargo in 1882. His grandfather, Edward G. Melroe, invented a windrow pickup attachment for combines that is still manufactured in North Dakota. Howard's father, Eugene, was chief executive officer of Steiger Tractor in Fargo, which makes some of the largest tractors in the world. Howard is founder and president of Concord, Inc., which manufactures a new no-till machine.

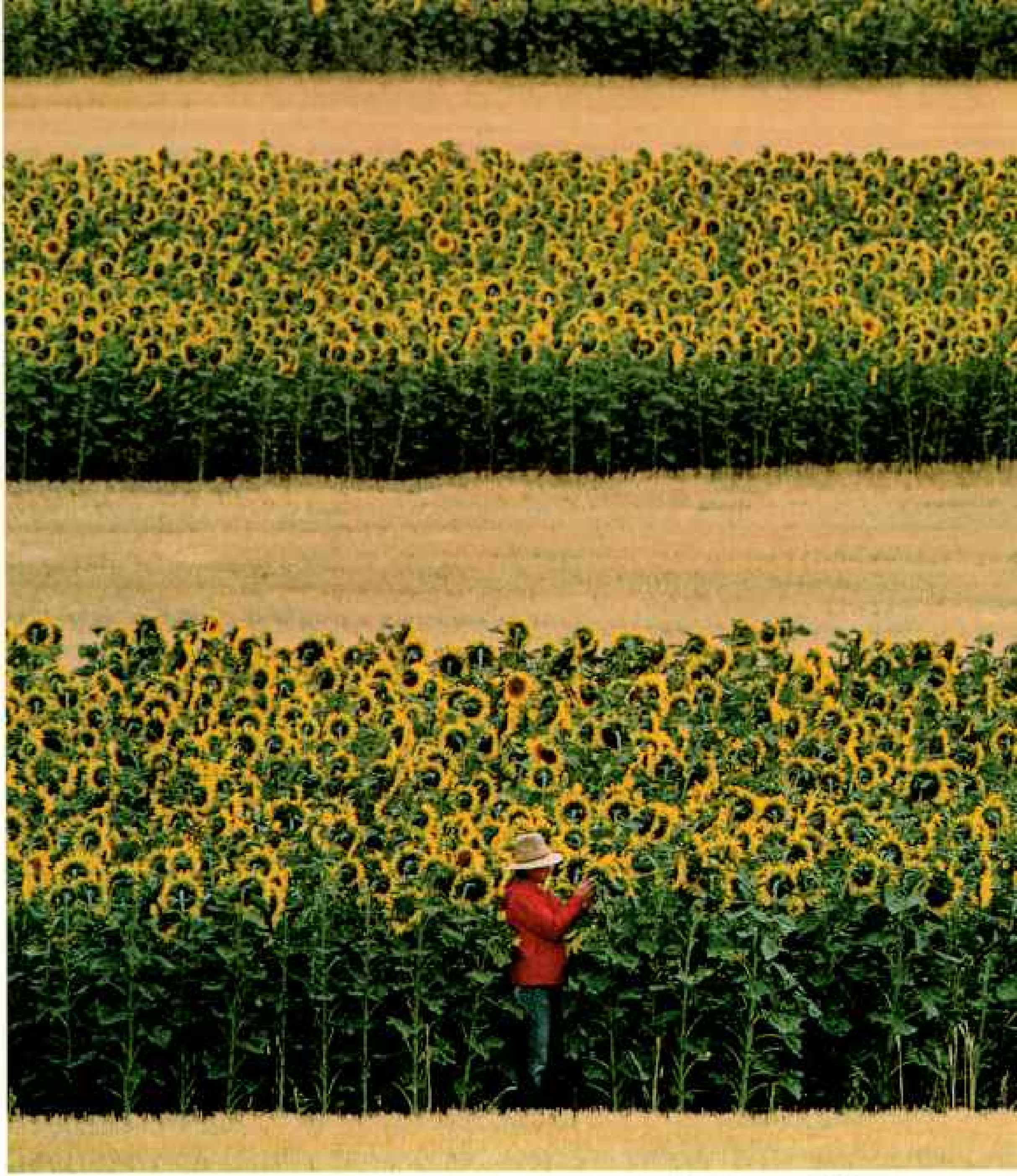
I met him at the annual big-iron farm-equipment show in West Fargo, amid gigantic eight-wheel tractors and air-conditioned combines that looked like vehicles designed to colonize another planet.

The Concord machine was enveloped in the octopus-like tentacles of a pneumatic system that simultaneously applied fertilizer and two bands of seed to incisions made in the ground by sharp discs. Large wheels closed up the incisions, leaving the ground almost undisturbed.

"We make a 20-foot seeder for $22,000—enough for the average North Dakota farm of 1,000 to 1,100 acres—and a 40-footer for $48,000," Mr. Dahl told me. "But there's a good return on investment. This system can decrease use of fertilizer by 20 percent compared to broadcast application. And since it does several jobs at once, farmers can save as much as 400 tractor hours a year."

One of Mr. Dahl's clients is Mike Wyum, 36, of Rutland. He and brothers Steve and Mark and their father, Robert, have separate farms totaling some 5,500 acres and switched to no-till cultivation in 1981.

"We had a very dry spring with high winds, and we were just watching our land blow away," Mike Wyum told me. "Now

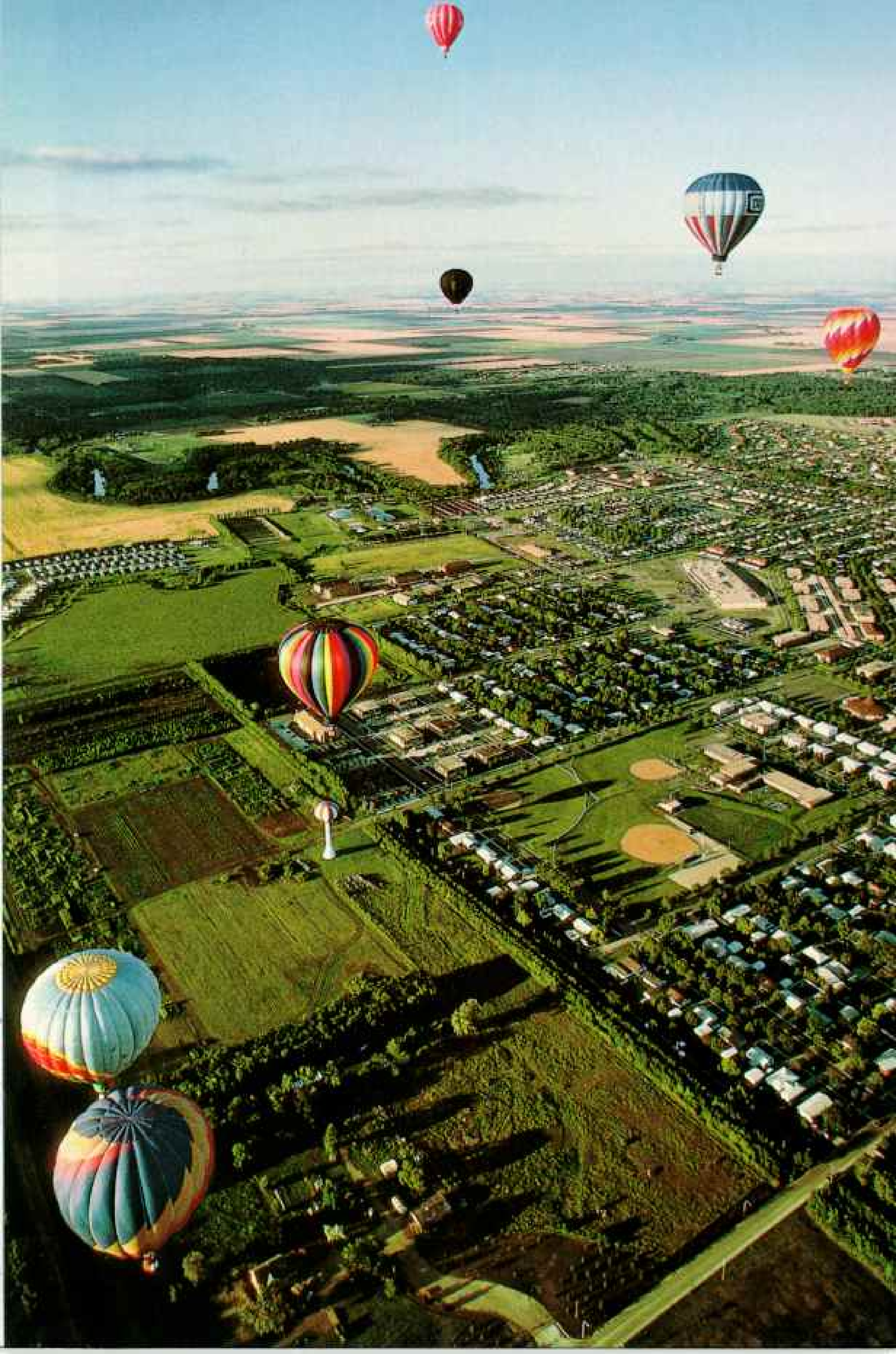


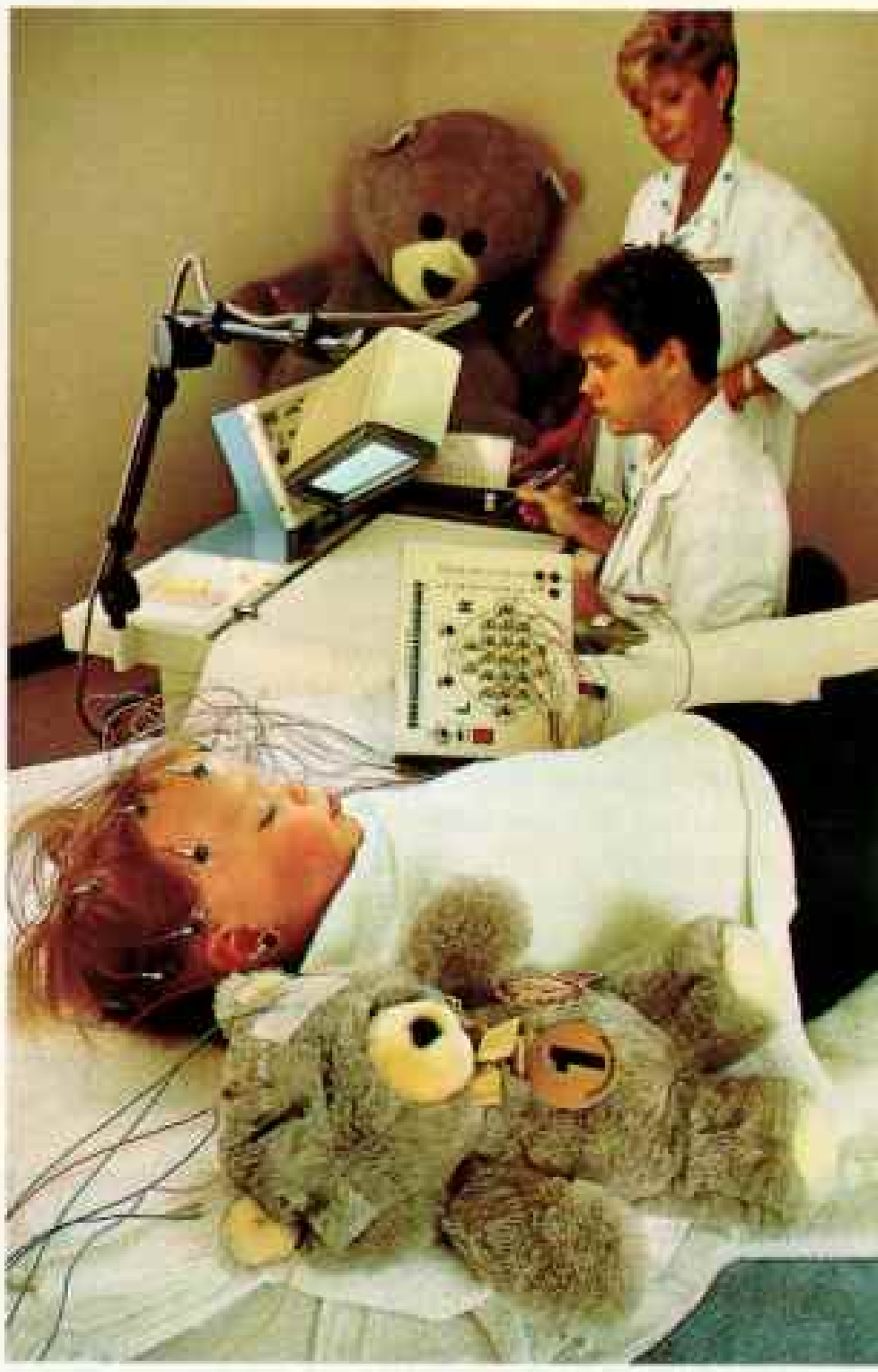
we've basically eliminated erosion. You can't take that savings to the bank right now, but we know the land will be there for our children."

THE WYUM FIELDS have produced another promising crop, according to U. S. Fish and Wildlife Service researcher Harold Duebbert of the Northern Prairie Wildlife Research Center in Jamestown. In a two-year study performed with the help of the Wyums and 64 other landowners, Mr. Duebbert found that no-till winter wheat provided a good nesting ground for ducks, including blue-winged teal, pintail, mallard, gadwall, and shoveler.

"Good news? Yes! We found one successful duck nest per hundred acres. That's some of the best news about ducks in 20 years," he told me. "Once people farmed around the wetlands and left enough native grassland for nesting. But mass-production

Facing uniformly east, *sunflowers between fields of spring wheat* ***(above)*** *protect the grain from wind. But neither crop can survive a hailstorm like the one that strafed the farm of Ken Lang* ***(left)*** *west of Fargo in August 1985. Stones the size of peaches leveled his wheat and half of his sunflowers. "We'd be broke and gone if we hadn't looked for every possible way to save money. Or if the man upstairs weren't looking after us."*





Pals for life, *Megan McCleary* ***(right)*** *and her personal "Meddy Bear" undergo a brain-wave test for meningitis at Medcenter One in Bismarck. The test proved negative. Designed to comfort young patients, the hospital's two-year-old program has so far put 10,000 bear therapists into action.*

To the east, Fargo ***(left)*** *ranks as one of the windiest cities in the U. S., with winds averaging 12.5 miles an hour. The presence of balloons means a calm day; pilots won't launch with the wind above 8 mph.*

farming has totally changed North Dakota's landscape. Only about two million acres are left of the original five million acres of potholes. People say many of them aren't useful to ducks anyway, because they dry up in summer. But that drying cycle helps recycle nutrients critical for the production of protein-rich insects that nourish breeding ducks in the spring."

DRIVING SOUTH ONE DAY from Hurdsfield, I found myself sailing a sunset sea of potholes, surrounded by graceful hills alive with fall colors of the grasses. I realized then how an inelegant name—pothole country—obscures the unity of a region that covers large parts of Alberta, Saskatchewan, and Manitoba in Canada, as well as the north-central region of the United States.

About half of all wild ducks in North America are produced in the prairie potholes. Two to three million are hatched in North Dakota.

In 1961, to protect this resource, the Fish and Wildlife Service began a program to buy outright 328,000 acres of wetlands and adjacent uplands, and to pay half the land value of another 1,250,000 acres to owners who agreed not to fill, burn, or drain their wetlands. In 1977 local politicians whipped up resentment against such federal "interference," and the North Dakota legislature passed laws that made it almost impossible to acquire easements. After six years of legal battles, the U. S. Supreme Court overturned the ban. Even so, the Fish and Wildlife Service has been reluctant to get started again without the state's consent.

How crucial the problem has become I learned from Dale Henegar, North Dakota's game and fish commissioner.

"The autumn flight of ducks from North Dakota is expected to be down as much as 50 percent this year. In all the central flyway, it will be down by 30 percent. And this will get worse before it gets better. From 15,000 to 25,000 acres of potholes in the state are being lost each year on private land, which produces most of our waterfowl, even though state law requires a permit to drain potholes of 80 acres or more.

"And you can't measure the loss in wetlands area alone. Ducks are being forced to nest in ever shrinking islands of upland habitat, favoring predation. Red foxes alone kill about 900,000 mallard hens annually, in addition to their young.

"We need bio-politicians today, not bio-activists," Henegar told me. "We're making a new effort to get farmers, wildlife people, and water *(Continued on page 338)*

Caring is its own reward, *says Janice Herbranson* (**right**)*, who until last June served as one of the lowest paid teachers in America. Here she listens to kindergartner Jodi Sagvold, one of five children who attended her one-room school in McLeod —a town of 40 located in cattle country southwest of Fargo. After three of her students graduated and Jodi's family moved away, the school was closed. "It just didn't make sense to keep it open for one student," she says, recalling the pain of the last day of class* (**facing page**)*.*

After 20 years in McLeod, Janice plans to teach in Alaska come fall. But she intends to keep her share of the Sand Dune Saloon, McLeod's only bar (**below**)*. She bought it in 1974, after losing her husband in a 1971 plane crash and, three years later, her 14-year-old son in a fire. The tragedies led her to the bottle. "I was a mess," she says. "I stopped teaching for four years, finally hit bottom, then went to AA. I haven't had a drink since 1980."*

She considered selling the Sand Dune, but soon found the bar to be a blessing in disguise. "I've been able to help a lot of people because of it—and turn those terrible experiences of mine into something good. Nothing's so bad that it isn't good for something."


READING TIME

A barbed wire fence on the Canadian border is all that stands between North Dakota and the Arctic, say local farmers. It often feels that way during winter, when the wind howls in from the northwest and piles

up huge drifts—here packed around an abandoned car. Actual snowfall averages only 32 inches a year. "Cold keeps the riffraff out," venture the diehards to anyone who will listen.

interests together for joint action to save potholes. The Crystal Lake Water Management Project in Wells County, just north of Hurdsfield, is a good example. It includes seven square miles and a dozen landowners in some of North Dakota's best pothole country. Wetland drainage was flooding farmers downstream, and the whole thing was headed for court.

"I went to them and said, 'Let's sit down and talk—heal old wounds.'

"So we got agreement between all the people involved—the State Water Commission, the Wells County Water Resource District, the federal wildlife people, and the North Dakota chapter of the Wildlife Society. The U. S. Fish and Wildlife Service will buy some small parcels to develop as habitat and acquire perpetual easements for others, including restoration of some previously drained potholes. In return, local people will design some eight miles of new drainage channels to protect downstream land from spring flooding.

"Our aim isn't to stop change. It's to stop wildlife loss."

WHILE private wetlands have suffered the greatest damage, national controversy has centered on the Garrison Diversion Unit, an elaborate water project begun after the two-mile-wide Garrison Dam was completed across the Missouri in 1953. Congress authorized the 1.2-billion-dollar project in 1965 to carry Missouri River water to irrigate some 250,000 acres on 1,200 North Dakota farms. Conservation groups protested that the cost, averaging 1.2 million dollars per farm, far outweighed the benefits, particularly since 220,000 additional acres would be required for roads, canals, reservoirs, and to mitigate damage to critical wildfowl nesting areas.

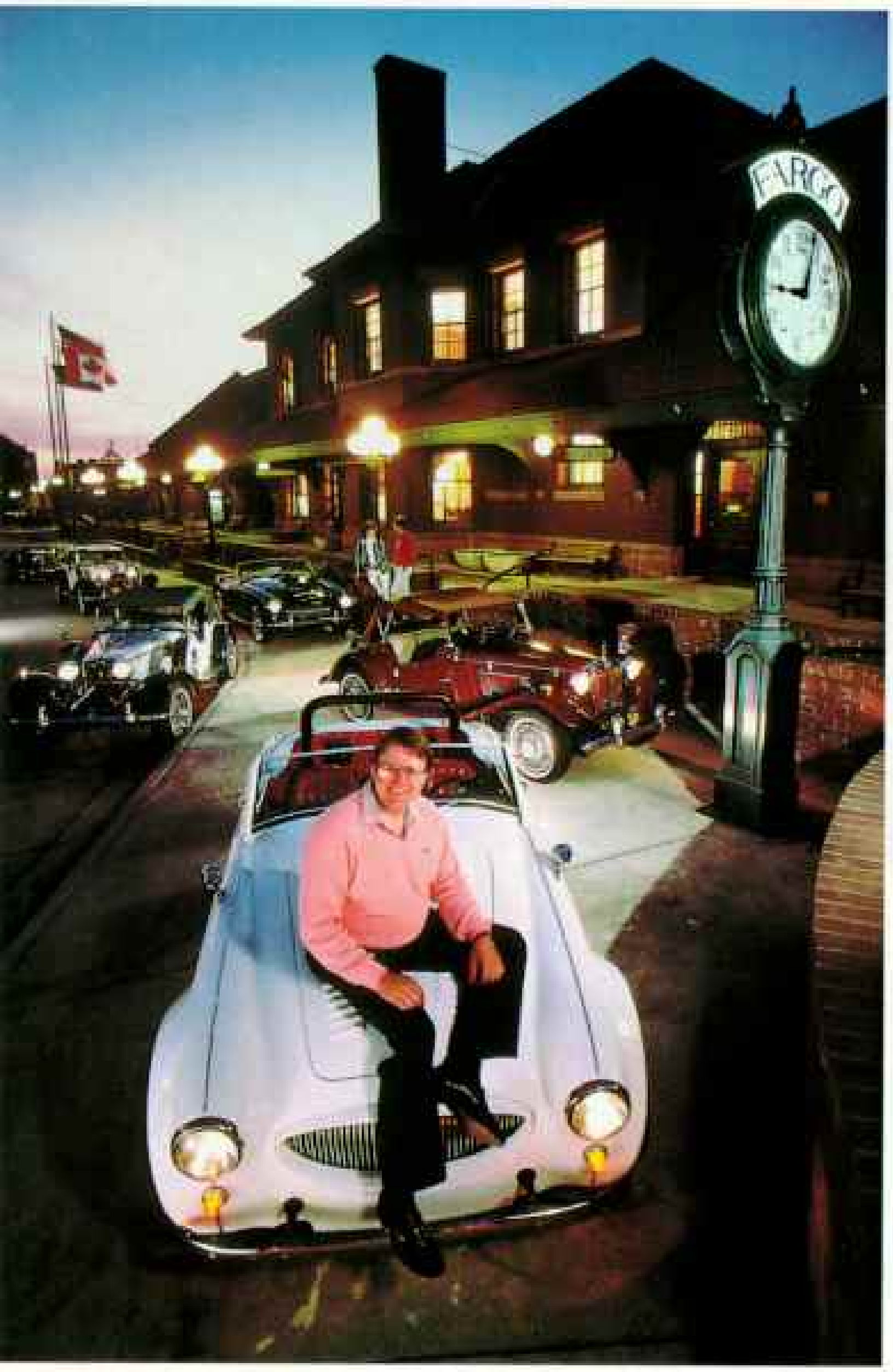
Their arguments failed, and construction was well along when it was discovered that two proposed irrigation areas, on the north side of a low-lying ridge dividing the state diagonally from northwest to southeast, would have allowed Missouri River water to flow into Hudson Bay via the Souris and Red Rivers. Under the Boundary Waters Treaty of 1909, Canada refused to risk potential damage to its own fisheries and wildlife by Missouri biota. The international furor prompted Congress to re-examine the project's cost, environmental impact, and goals. In early 1986 the spending authorization was cut almost in half, irrigated land was limited to 130,000 acres in central and southeastern North Dakota, and project managers were ordered to restore or protect an acre of wetland for every acre destroyed. A two-year feasibility study was ordered on a new canal and other irrigation facilities.

More important to a majority of North Dakotans, the new legislation funded a 200-million-dollar project to provide potable water to some 130 towns and surrounding farm areas where groundwater has long been dangerously contaminated with natural salts, arsenic, and other chemicals.

FOR YEARS North Dakota's most often voiced justification for the Garrison Diversion irrigation scheme was that the Garrison Dam had forced the sacrifice of prime North Dakota river-bottom land to provide flood control in other states. Much of the land—some 155,000 acres—contained the farms and villages of Fort Berthold Indian Reservation, home of the Mandan, Hidatsa, and Arikara. The tribes received 12.6 million dollars for the land, for the loss of eight communities, and for the cost of relocating on upland prairie.

"Money couldn't replace what we lost," I was told by Gerard Baker, a Mandan-Hidatsa who serves as district ranger of the north unit of Theodore Roosevelt National Park. "Before the dam we made a good living farming the bottomlands. Our society was intact. After our lands were flooded, communities were broken up and people relocated to land that was totally unsuitable for vegetable farming and livestock. The government built housing and promised there would be jobs on the reservation or in the white community. But there were never jobs enough even for whites. So people just sat in the houses. All sense of an extended family relationship was gone. The government gave them welfare. And once that happened, they were spoiled."

Mr. Baker has more reason than most to measure how much his people have lost. After earning degrees in criminology and sociology at Southern Oregon State College, he spent years organizing archaeological and



ANNIE GRIFFITHS BELT WITH BILL BEIGER

Farm-boy entrepreneur *Gary Rutherford poses with the vintage auto replicas manufactured by his company, Classic Roadsters, in both kit and finished form. Raised near Hillsboro, Rutherford found farming too risky ("I actually saw my dad lose 20 pounds one summer waiting for rain") and left North Dakota for a business career. Years later he returned. Like many others from the farms and small towns of eastern North Dakota, he was lured by Fargo's economic diversity and something even less tangible—"Hope. It's in the air."*

cultural displays at Knife River Indian Villages National Historic Site, about ten miles south of Garrison Dam. North Dakota's first farmers had built a highly sophisticated culture there long before Lewis and Clark first encountered them in 1804.

"When I grew up, it seemed like learning to be an Indian was mostly learning how to fight," Mr. Baker told me. "After that I went through a militant period. But when I started learning our history, I realized that without our own religion we're lost. In the old days young men of the tribe went into the wilderness on 'vision quest.' They stayed alone and fasted until they received a vision of their future. That is what we need today."

We go off to feed the park's resident herd of tough, rangy longhorn cattle, and Gerard Baker strides among them fearlessly, ignoring their aggressive pursuit of the grain sacks he carries. Later he pours a few handfuls of feed outside the storehouse door.

"For my rabbits," he says. "Our religion asks that we give something back to nature in thanks for everything we use—the crops we grow and the birds and animals that share our world. For us the Spirit and the commonplace are one. If we lose that knowledge, we lose ourselves."

Mr. Baker's clan name is Yellow Wolf, and he is brother to Eagle Woman, otherwise known as Mary Baker, 35, vice president for academic affairs at the United Tribes Educational Technical Center at Bismarck. Some 300 students come there from 26 reservations in North Dakota and throughout the U. S. to earn certificates in such vocational skills as licensed practical nursing, medical record keeping, police science, and building and automotive trades.

Bird factories *for the continent, North Dakota's prairie potholes provide crucial habitat for 140 species of birds, including the white pelican (**above**) and half of all wild ducks raised within the contiguous 48 states. Yet less than half the state's original five million acres of potholes remain. Each year more vanish as debate rages among conservationists and government as well as farmers, who often drain the shallow, glacier-cut ponds instead of plowing around them (**right**).*

Among the students are 56 young couples whose children attend an on-campus nursery, day-care unit, or the center's elementary school.

"Between 70 to 80 percent of our graduates get jobs," Mary Baker told me. "We teach survival skills for the white world. But that doesn't mean teaching them to become like whites."

Mary Baker became dean of Fort Berthold Community College in 1975 after earning a master's degree in education at Penn State University. Now her goal is a doctorate in curriculum development, with emphasis on a realistic portrayal of Indian history and cultural values.

"In white education Indians are always the losers. Either we're portrayed as the bad guys or there's too much 'noble savage' nonsense. Each tribe is different, with its own history and tradition. We have our own rivalries and our own bad guys and good guys. It's important that white teachers understand Indians without stereotyping them."

NORTH DAKOTA suffers its own stereotypes—that it's purely a farming state, for example. Along scenic

Highway 200 south of Lake Sakakawea, I encountered the energy belt, where huge strip mines produce some 26 million tons of lignite a year, most of it burned in mine-mouth generating plants that export two-thirds of their power to other states. To the west, hundreds of slow-flowing wells produce some 51 million barrels of oil a year. But falling oil prices have brought depression to oil towns like Dickinson and Williston, and higher quality Montana and Wyoming coal helps utilities there undercut North Dakota's electricity prices.

The most impressive energy site of all is the two-billion-dollar Great Plains Coal Gasification plant at Beulah, where underground lignite mines once supplied fuel for prairie dwellers who had no trees. The huge facility was conceived in the energy crisis of the early 1970s, when Washington analysts predicted that the United States was running out of natural gas. Now it produces about 135 million cubic feet of synthetic gas daily. The Department of Energy took over the plant in 1986 after the five energy companies that built it defaulted on a 1.6-billion-dollar loan from taxpayers. To repay that loan, its output would have to sell at about

ten dollars per thousand cubic feet—five times higher than natural gas flowing from Williston Basin wells only 80 miles away.

Another North Dakota stereotype falls flat if you travel the northern border, where the Turtle Mountains rise abruptly as high as 2,500 feet. Hardwood forests shelter Lake Metigoshe State Park, and nearby lie the woodland trails and ceremonial vistas of the International Peace Garden, which spans the border to symbolize the long friendship of Canada and the United States.

CLOSE TO THE SAME BORDER are less visible symbols of a nuclear age. Driving on a dirt road near Antler, I came on a chain-link fence surrounding what seemed to be a small parking lot in the midst of deserted countryside. I approached close enough to read a small sign warning intruders away. "Use of Deadly Force Authorized," it said, and I realized I was trespassing on the site of an underground silo containing a U. S. Air Force Minuteman III intercontinental ballistic missile. The state shelters 300 such missiles, each capable of carrying three nuclear warheads. Together with B-1 and B-52 bombers at Strategic Air Command bases at Minot and Grand Forks, they give North Dakota one of the largest concentrations of nuclear weapons in the world, aimed at the Soviet Union.

It seemed ironic that part of the bountiful wheat harvest stored in North Dakota's farm silos had been targeted on the Soviet Union as well—at cut-rate prices that would subsidize a floundering Communist economy while undercutting the farm exports of Canada, not to mention other U. S. allies all over the world.

Such problem-laden solutions to the farm crisis don't always square with North Dakotans' streak of prairie common sense.

"We just can't save all the farmers," I was told by Joe Lamb, president of the state-owned Bank of North Dakota. "But we have to take care of the good ones, because that's where progress will come from."

Mr. Lamb is a small-town banker appointed in 1985 to effect a reorganization of the bank, which had to write off a staggering $8,328,000 in bad loans.

"There are 177 banks in North Dakota, plus I don't know how many savings and

***Nearly a ghost town** today, Riverdale **(below)** was built for workers on the Garrison Dam, top. Completed in 1953 to control Missouri River floods, it impounded 368,000 acres. To compensate, the government approved irrigating 250,000 acres elsewhere in the state. Two decades later, the unfinished project has been trimmed to 130,000 acres, with an overall cost to taxpayers expected to reach 1.2 billion dollars. Ironically, today's surplus-producing North Dakota farmers do fine without irrigation. They consistently rank among the leading recipients of federal payments for not growing crops. Many, including those who whittle in downtown Fort Ransom **(right)**, are against the plan. "We're dryland farmers," says one. "And we're growing too much as it is."*

The missile crop *lodged beneath the North Dakota prairie numbers 300 Minutemen—enough, some say, to make the state the world's third largest nuclear power. They are stored in 90-foot-deep steel silos like the one used for training* ***(facing page)*** *at the Grand Forks Air Force Base. Protecting the sites, specially trained security forces* ***(below)*** *practice stalking intruders with M16 rifles equipped with lasers that simulate hits.*

ANNIE GRIFFITHS WITH BILL KEISER (FACING PAGE)

loan companies and credit unions," he told me. "There's been a pattern of loans based on insufficient research, too much local boosterism. Local lenders mistakenly advanced money on inflated land values, on net worth that existed only on paper. They were trying for growth, but going too fast. Now there's a world of hurt out there, and we've all got to take our hit."

MR. LAMB'S GRANDFATHER and granduncles founded the northern town of Michigan City in the 1880s. I remembered the town vividly because I'd had three cups of coffee and a notable homemade date cookie in the Kite Cafe for 31 cents. How a business could survive at such prices I didn't know. But in many North Dakota communities I found that methods of survival have a similarly homegrown air.

Driving south from Bismarck on Route 1804, I stopped at the two-room Telfer School, where principal Patricia Stein, 42, presides over grades one through five, while Montana-born Ann Beddow, 30, teaches grades six, seven, and eight. Mrs. Stein attended a one-room school herself for eight years in Morton County.

"We have 26 students in all," she told me. "Last year our fifth grade scored at high-school level on the National Iowa Basics Test. All of our kids are above average. They get along, help one another, there's a lot of interaction between the age groups. We're very much like a family."

The present Telfer School was combined from former school buildings number two and number three. School number one stands on the farm of Elvira Rogstad, whose son bought it at an auction when the district retrenched a few years ago.

"I guess we're kind of sentimental," she told me. "All eight of my kids graduated from Telfer—and so did I. It's always been part of our heritage. At the school centennial in 1984 the oldest graduate at the celebration was 81, and the youngest student was six."

Keeping the heritage going isn't easy. "We have 320 acres, and we raise horses, cows, ducks, chickens, wheat, and corn," Mrs. Rogstad told me as we talked in her spotless farm kitchen. "But there's no way we could make it on farming alone. My husband is a carpenter. Our sons rent land to farm, but one is studying architecture, two are ironworkers, one is a mechanic, and one sells farm implements. One daughter married a rancher, one deals blackjack at a casino in Bismarck and works for a lawyer as well. The youngest is still in high school.

"So far we've been lucky—everyone has managed to stay in North Dakota."

On another day, driving through the yellow clay canyons of Badlands country near the Montana border, I come to Marmarth, which seems to be an almost perfect ghost town, lost in a forest of cottonwoods

on the banks of the Little Missouri River.

I'm badly mistaken. On one building a sign says "Mert's Cafe, Good Food, Open 7 Days a Week." Inside, proprietor Mary Ann Lecoe is presiding over Sunday smorgasbord. While eating an excellent hamburger, I meet Mayor Patti Perry, 40. She fetches the town's "family album," which contains a panorama photograph of huge crowds and a multitude of steaming trains, shot during an anniversary celebration in 1919.

"Marmarth was a big cattle-shipping station and division point of the Milwaukee Road, which had a roundhouse, maintenance yard, and a large bunkhouse for crews. The Milwaukee went broke running too many tracks to too many small towns. Burlington Northern took over and closed everything down in 1982. But there are still 180 of us living here. The school still operates, and the volunteer fire department too. We're working to make Marmarth a real railway museum. Burlington has given us the bunkhouse, and we'll get first option on sale of other railway property."

She takes me on a walking tour of downtown, with its crumbling brick bank, old bars, and a hotel that had its last guest in 1970. On Main Street I find the real treasure of Marmarth: the tiny Mystic Theatre, built in 1914 as one of the earliest motion-picture houses in the United States. Refurbished in 1976 by the Marmarth Historical Society, it now is listed on the Department of the Interior's National Register of Historic Places.

"We use it every April for our annual variety show. Last time we did 'Ten Nights in a Barroom.' We don't need much heavy drama. Mostly ranching is all that's left, and this year was a whole bunch of hoppers and damn little rain. But this is the greatest 'next year' country in the world. If you come back, we'll still be here."

ON A FLAGRANT prairie day when rain slashes through brilliant sunlight and a rainbow leaps across a vast black palisade of cloud, I find the city of Carson looking very much like a pot of municipal gold. New houses are going up, old ones getting painted, and the main street gleams with new Western-style buildings, complete with hitching posts, rough-cut siding, and covered sidewalks.

This rural renaissance is the work of Mitchell D. Bohn, a native son who six years ago co-founded a California-based company called LSI Logic, Inc., which designs custom computer chips. Since then he has invested some 3.5 million dollars of silicon-gotten gains in his hometown. A new professional building houses the pharmacy, together with state and federal offices and the city hall. Nearby stand a new grocery store, a clothing store, and a family recreation center.

"We had things like this when I was young," Mr. Bohn told me. "I wanted the town to have that benefit again. Now others feel the same way. One man has come back to open a welding business. There's a new beauty shop, a craft shop, and a garage. We've even found a young doctor to reopen our medical clinic."

New jobs enable some Carson young people to stay. For those with wider aims, Mr. Bohn funds three college scholarships each year for top local students.

"Small towns aren't necessarily for young people," he said. "They want action. Later they can come home again—like me."

That sort of tenacity, I decided, may be North Dakota's most abundant crop. I saw it expressed quite differently a few days later in a publicity photograph of scores of cheerful young men and women apparently sprouting from a golden wheat field near Fargo. They formed the entire staff of Great Plains Software, a company that produces a nationally marketed accounting program for small businesses. At its head was Douglas Burgum, company president, who had worked his way home to North Dakota via a business degree at Stanford University and a management career in Chicago.

"I was the youngest of the youngest in my family—so I had to go into another field than agriculture. I had to leave North Dakota to work, and I didn't like that. Now I recruit exiled North Dakotans from large companies and catch the best young graduates before they leave. One of the most important things in the software business is helping users who need advice. We have a hundred young people who grew up on farms in North Dakota and Minnesota, and they help answer more than 2,500 phone calls a week. They've made our reputation. Small-town

Praying in German, *children of the Forest River Hutterite colony give thanks after the evening meal. Like their brethren across the western U. S. and in Canada, the colony's 75 members stress selflessness and collective values on their 3,000-acre chicken and dairy farm. "Rugged individualism would have little part in our community," says schoolteacher Tony Waldner, far left. Their non-Hutterite neighbors, no strangers to the virtues of community, are likewise pulling together to find the faith—and solutions—that life on the prairie demands.*

values and high-tech education are not such a bad combination for the future."

Whatever that future brings, North Dakota will never let itself be taken for granted. It is still a part-time wilderness where tornadoes and hailstorms and drought can tip the most carefully computed balance sheet. And however domesticated the land might seem, hunters will take more than 50,000 deer and gun down myriad game birds as well, in a final crimson harvest of the year.

I went to North Dakota last in winter, when the land shimmered like a mirage beneath a snowfall that seemed as wide as the earth but only inches high. Invisible beneath the snow were the young shoots of winter wheat, and I knew they would be measured in something more than bushels when their time was ripe.

John and Bob Dunnigan summed things up for me in Walhalla, where they grow certified seed potatoes famed in Argentina and Honduras as well as over the United States.

"Winter is when we sell and ship the crop and repair equipment," John said. "And then we sit down with a calculator and figure out how to get enough money to do it all over again." □

BRAZIL

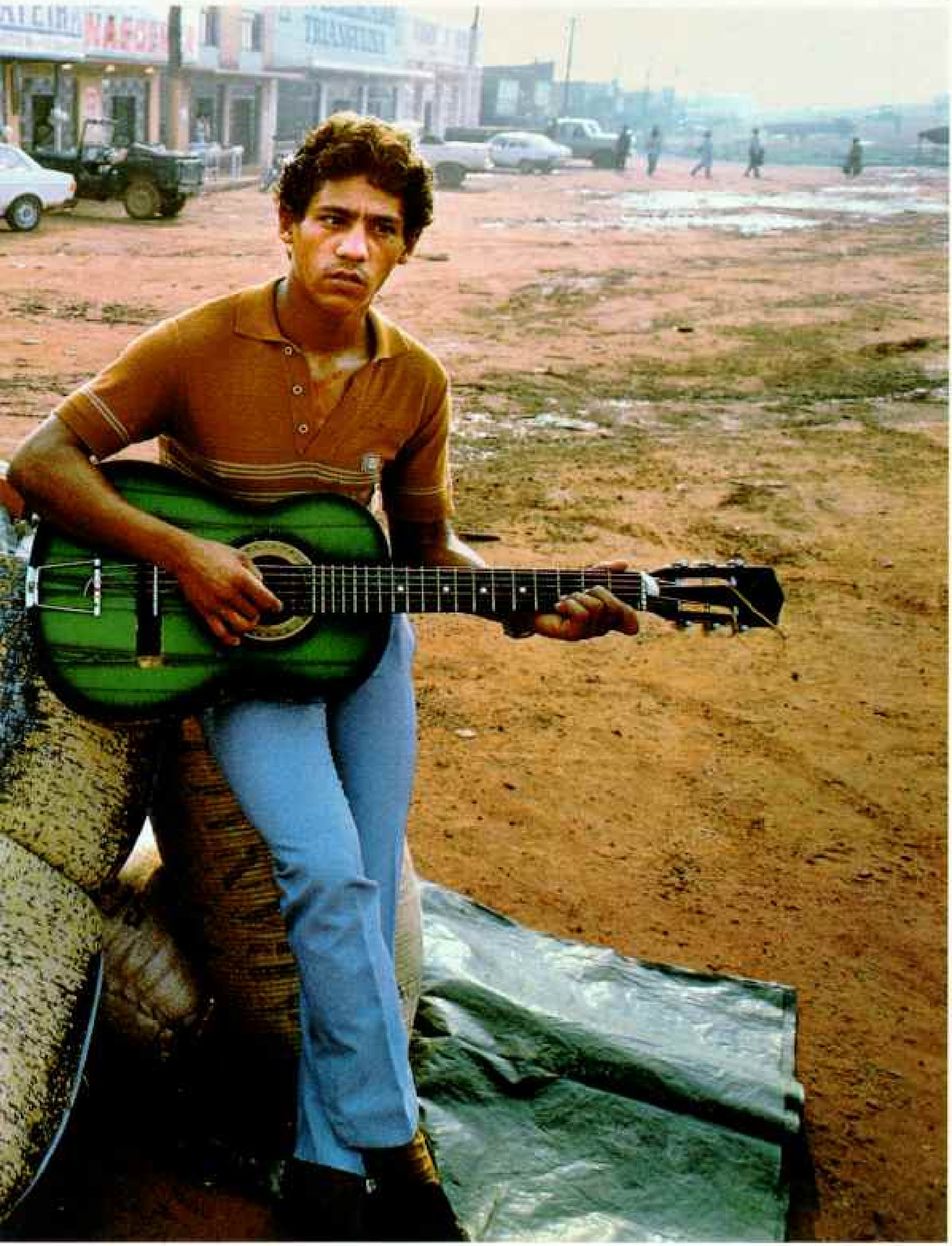
Newcomers to Brazil's wild west, settlers console themselves with music in a new town in Rondônia,

Moment of Promise & Pain

By
PRIIT J. VESILIND
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by
STEPHANIE MAZE

magnet for those left out of the nation's economic boom.



Escapist mecca *for Brazilians and foreigners alike, Rio de Janeiro draws splendor from a natural setting indelibly stamped on the imagination of romantics and libertines the world over. The nation's second largest city,*

as well as its cultural capital and a principal port, Rio is but one of ten Brazilian metropolises with more than a million inhabitants, the result of massive urban migration over the past generation.

BEHOLD THE BRAZILIAN whooping crane: Roberto Gaspar de Oliveira, wealthy landowner, an endangered species, and a man struggling to contain his fury.

It was *his* land. His *land*, you must understand. An undeveloped part of his family property in the northeastern state of Ceará was to be taken away under a new agrarian-reform act and divided among landless peasants. The government would pay for it, but the terms were unacceptable to Gaspar. He had demanded that federal mediators examine the case.

I met Gaspar in Fortaleza, capital of Ceará. He was a tall, rather engaging businessman, boyish at 34, with dark-framed glasses, shiny black hair, and good manners. But his color rose quickly as he talked of his land, and his fingers tapped an indignant staccato on the tabletop.

"My tenants have been incited by the church," he said. "They want to be the owners of the land now! The padre told them the land belongs to God, and the workers feel they have a right to pick my fruit!"

Gaspar clearly felt the victim, betrayed by the institutions that had nurtured him. "If this mediation fails," he said, "we're going to arm ourselves and defend what we have. We're going to make war!"

He stood up to his considerable height. "I'm very macho," he said without a hint of self-mockery. "And I'm not afraid of any government or any progressive church!"

The privilege and influence of the Brazilian landowner-politician, backbone of the nation since colonial times, has been withering for decades. Big-city corporations have become the landowners of power. And now agrarian reform has shaken rural Brazil by the scruff. Tenant farmers are demanding their due, and Brazil's new civilian government, installed in 1985 after 21 years of right-wing military rule, has begun to give them hope.

All across the nation there is a shedding of the authoritarian skin. Democracy is afoot. Brazilians are proud to be Brazilians again. Political exiles have returned. Community action groups and labor unions have regained their voice. For Brazil, emerging into the First World of nations, now is a moment of promise.

At the Rio de Janeiro offices of FUNABEM, Brazil's juvenile-welfare agency, director Ana Filgueiras was aglow with possibilities. "There's tremendous excitement," she told me. "Big, big optimism! Brazil was a country ruled by people (how can I say it in a soft way?) without morals, who stole money. The big change in Brazil is that the government will now listen to the needs of society."

It would be a change indeed. There has never been a solid democratic tradition in Brazil, a nation that has tried to sustain technological growth and feudalism in the same century. The gap between rich and poor, educated and ignorant, has widened to tragic proportions. Eighty percent of the land is held by only 5 percent of the people. Twenty million Brazilians labor at a minimum wage of less than $60 a month. A fourth are jammed into urban slums where the social fabric has been torn into random threads, where thievery is no longer even confessed as a sin, and where heroes are often racketeers or dealers of cocaine.

For the poor, government has meant only repression. Out of 138 million inhabitants of Brazil, as novelist Antonio Callado told me, "only a small group is living in this century and this time."

And yet Brazil has no history of mass violence or revolution. Change has always come from above; popular movements have been quickly aborted. Slavery lasted until 1888. Even military coups are bloodless.

"Ours is a timid country," Callado said wryly, "a bit of a *bobo*, a big fellow, but not really matured."

Brazil is the fifth largest country in the world (map, pages 354-5). It measures 4,300 kilometers (2,700 miles) from the northern Amazon basin to Uruguay—the distance from London to Tehran. Metropolitan São Paulo, an economic colossus, is practically a nation in itself. With 15 million inhabitants

Rivers of wheat *stretch to the horizon in the fertile southern state of Parand. Now the world's second largest exporter of agricultural products, after the United States, Brazil depends heavily on exports from huge farms to help service a staggering 105-billion-dollar foreign debt.*

it rivals Mexico City as the most populous city in all the Americas.

Yet Brazil has no clear global role or duty. The Portuguese language isolates it from Spanish South America, and distance buffers it from the East-West tensions of the Northern Hemisphere. International affairs seem irrelevant. For the average Brazilian, as for the average American or Chinese, his own country is enough.

Brazil's worst enemy has been itself, but there is an underlying optimism here that recalls the United States of a hundred years ago, when the eastern cities were still wretched with immigrants and the Wild West beckoned to free men. Brazil, like the U. S., is a nation of newcomers, and there is still room to grow—and to make mistakes. It often teeters on the edge of an abyss, it is said, but never falls in . . . because Brazil is bigger than the abyss itself.

FOR TWO DECADES Brazil's military government virtually ignored the poor. It concentrated on building the national product, on the theory that you can't divide poverty, you can only divide wealth. Borrowing heavily from abroad, the generals invested in grandiose projects such as a nuclear power program and the Trans-Amazon Highway. They created Brazil's "economic miracle" of the late 1960s, but the new wealth failed to trickle all the way down. Around each gleaming city remained a Calcutta of social misery. "Belindia," worried intellectuals called their country—half Belgium and half India.

When rising interest rates and the oil crisis of the 1970s forced the nation into recession, the financial gains of the Brazilian middle class were eroded, and international bankers turned off the tap. In 1984 Brazil labored under a foreign debt of a hundred billion dollars, a sum so enormous that the nation's trade surplus could barely pay the interest.

The International Monetary Fund got tough, demanding monetary and fiscal austerity programs that humiliated Brazilians, kindled a backlash against international bankers, and finally helped drive the military from power.

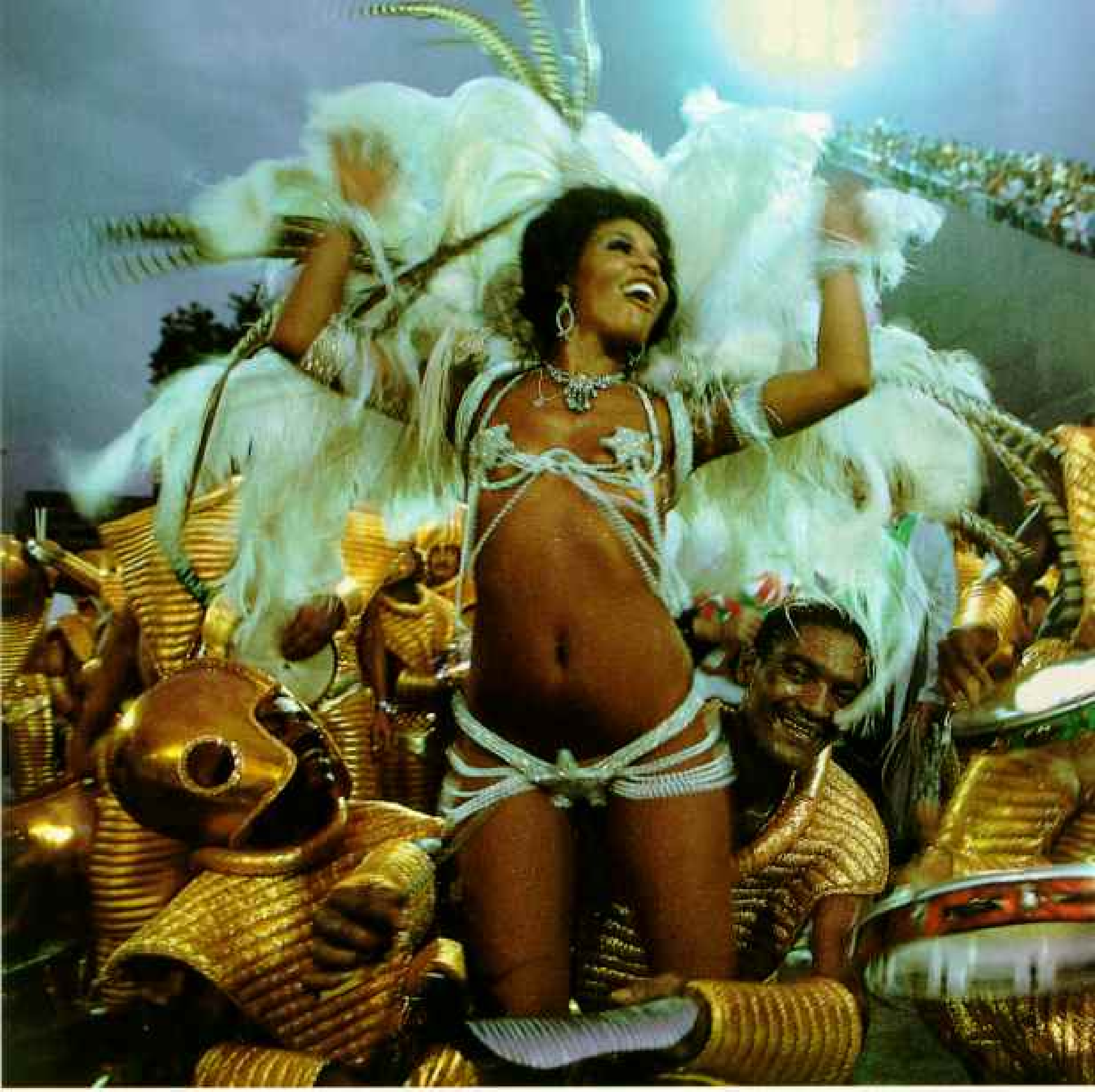
" 'Military' is a dirty word now in Brazil," one prosperous civil servant told me. "I know soldiers who change clothes in their

Millions on the move

BRAZIL

A sleeping giant awoke to its potential in 1960, as Brazil moved its capital from Rio de Janeiro inland to Brasília. The prosperous São Paulo region fuels the economy. Recent governments have sought to accommodate the poor majority by opening the plains and rain forests of the interior to development.

AREA: 8,511,965 sq km (3,286,488 sq mi). **POPULATION:** 138,400,000. **CITIES** (metro areas): São Paulo, 15,300,000; Rio de Janeiro, 10,200,000; Belo Horizonte, 3,100,000; Pôrto Alegre, 2,600,000; Recife, 2,500,000; Salvador, 2,100,000; Fortaleza, 1,900,000; Curitiba, 1,800,000; Brasília, 1,600,000; Belém, 1,200,000. **LANGUAGE:** Portuguese. **ECONOMY:** Agriculture, 13% of gross domestic product; industry, 35%; services, 52%. Per capita income: $1,710. **LITERACY:** 78% of adult population.



barracks because they don't want to be seen. And children don't brag to their schoolmates that their father is a general."

The new president, José Sarney, was an anticlimax. President-elect Tancredo Neves died in 1985 before he could be inaugurated, and Sarney, a low-key running mate with military connections, was elevated.

The Sarney Administration talked a liberal game. It announced that the era of big projects was over, that the welfare of Brazilians was more important than the foreign debt, and that its goal would be social justice. Few believed it. The "new republic," full of old faces, was met with skepticism.

But Sarney resurrected agrarian reform, a measure passed in 1964 but largely neglected by the generals. And on February 28, 1986, in a surprise decree, he slapped a radical anti-inflation package on the nation—the Cruzado Plan. He lopped three zeroes off the cruzeiro currency and declared it the cruzado, froze prices and wages, and established Brazil's first unemployment-compensation program.

Brazilians rallied behind their president. Shoppers mobilized to monitor retail stores for illegal price hikes. Merchants slow to catch the spirit were jailed. Even Roberto Maksoud, owner of the fanciest hotel in São

Flesh and fantasy *reign in the streets of Rio for four days and nights of Carnival, the world's premier pre-Lenten celebration. Now largely the domain of the city's poor, the event culminates a year's planning and thrift by samba club members* ***(left)****, who compete fiercely for prizes awarded at the final parade in the new Sambadrome* ***(above)****, built especially for Carnival in 1984.*

Paulo, the Maksoud Plaza, was arrested for inflating the price of soft drinks.

Before the reform many Brazilians were content to live off financial speculation and inflated interest on savings accounts. "Here is the change," a machine-shop owner told me: "Last month you could count on your fingers the number of people who thought that hard work would result in a better life—that you could actually gain something by working. Now it's just a step for them to believe that they can change the whole system. They will have the economic power, therefore the political power."

In a circus of expectation, I found Brazil's most revered and irreverent economist, Maria da Conceição Tavares. She gripped me by the shoulders in her Rio apartment and glared over her half-frame glasses, trailing cigarette smoke.

"People don't realize the profundity of this revolution!" she shouted. "Now there is hope. This is the first moment in the history of Brazil that is not against the people, but against the bankers and the financial capitalists!"

By the end of 1986 the Cruzado Plan was into its second phase of adjustments. Demand had outdistanced supply. Farmers, accustomed to collecting higher and higher

prices each year, withheld cattle and poultry from slaughter. Long lines formed at supermarkets just to buy eggs. Brazil was forced to import meat.

Beset by an overheated economy, the administration raised some prices in November. Angry crowds stormed through Brasília in protest. But inflation had fallen to 25 percent from 250 since the Cruzado Plan, while the economy had grown by 8 percent, among the highest rates in the world.

Today, business is brisk again, lubricated by fallen oil prices and lower interest rates. And continued industrial success may give the Sarney government enough space to begin the social assault.

"It's the best thing that's happened to Brazil," São Paulo art dealer Benjamin Steiner told me. "It has brought a sense of nationalism—not patriotism, not *against* anything—but a sense of nationhood."

NATIONHOOD has offered little to the poor. In the past half century the search for a decent wage and a better life has meant immense migrations of people. They have fled the cycles of flood and drought in the northeast for the coastal cities. They have been lured by the economic promise of the south. And, in this decade, they have been enticed to the land of last resort—Rondônia and the Amazon basin—a wilderness of fearsome proportions and sudden disasters. My own three-month-long journey through Brazil took the same, almost circular route.

A cultural institution *in his native city, Antonio Carlos Jobim relaxes at home in Rio de Janeiro with his son João Francisco* **(above)**. *Composer of "The Girl From Ipanema," Jobim first gained fame collaborating on the score for the 1958 French film* Black Orpheus, *about love in one of the city's 300 favelas, or shantytowns. The 50,000 favelados of Rocinha* **(facing page)** *are slowly transforming one of the city's largest slums into a neighborhood, by gaining land rights, water, and electricity.*

Portuguese explorers first landed in Brazil in 1500, not far from what is now the city of Salvador, in the state of Bahia. Salvador became Brazil's colonial capital and remains its spiritual heart. Here is where the slave merchants discharged their sad cargoes for three centuries, where explorers and soldiers, Jesuits, and cattle ranchers staged their assaults on the continent.

The peasants who worked the plantations of northeast Brazil gradually found themselves captive to an exhausted land. In the past 40 years 3.5 million of them have fled. Those who remain in the *sertão*, the interior, are mired in one of the most poverty-stricken areas in the Western Hemisphere. Half are illiterate; most are malnourished.

In Itapipoca, in Ceará, hundreds of families from the surrounding hills have sought refuge in mud-and-wattle huts on the outskirts of town. Fernando Silva Pontes, a physician and priest, rides the mountainous roads on a motorcycle. Sanitation, he told me, is the big problem. And food is scarce.

"All they have is farinha and beans, and some mothers are too sick to supply milk,"

he said. "In one house a baby was crying and crying. The mother was in tears. I told her to give the baby milk, but she didn't want to, and I almost forced her. And then I saw the baby suck blood from the mother's breast."

MORE THAN 500,000 people from the sertão have migrated into Fortaleza, most elbowing into flood-prone riverbed slums. The mayor of Fortaleza, Maria Luiza Fontenele of the left-wing Workers Party, has the heart but not the funds to accommodate the influx. The conservative state government, petulant over the mayor's victory last year, has declined to help.

"Our problem is how to save the children," she told me wearily at her home one night. "Fortaleza has one of the highest infant mortality rates in Latin America. Two out of ten kids die before the age of one."

Since the early 1960s, clerics like Bernardo Holmes, a priest who lives in a Fortaleza slum, have picked up where governments have faltered. They have helped organize grass roots groups among the poor, and they have advocated peasants' rights, often with the lexicon of Marxism.

"Right now there's freedom in the air," Father Bernardo told me. "We aren't needed as much. But in the 1970s we were all the people had. Life was being destroyed before our eyes, and the traditional way of handing out alms didn't solve anything."

The Brazilian government, however, has seen only subversion, and the Vatican has balked over the politics of this "liberation theology." Brazilian clerics have been disciplined, and bishops called to Rome for papal ear bendings.

Bernardo sees only compelling need.

"The people in these shantytowns have come from the countryside after years of hard, grinding work," he said. "Here they are out of their natural communities—thrown into promiscuity, where all their values collapse and they lose their work ethic. It's the bottom of the pit."

He took me to the city dump, where about 800 men, women, and children survive by picking through the garbage for recyclable cans, paper, and metal. The stench nearly overpowered me, but for Bernardo, with his red beard, T-shirt, and fatigue pants, it was routine. He comes here, he said, "to chat up the workers."

For me it was a lesson in liberation theology. I learned the meaning of hell. Hell is when you are eight years old and you

Alabaster trim *on Brazil's great bulge, pristine beaches and sand dunes, like these west of Fortaleza, adorn the northeast coast and are a refuge for Brazilian vacationers. Brazil's shores, only 2,000 miles from Africa, were a destination of slave ships, mostly Portuguese, during three centuries of colonial rule. Freed in 1888, blacks today represent a major element in Brazil's racial mix.*

compete side by side with vultures for food. Hell is when you face bulldozers pushing ten-foot-high mounds of rancid, dripping garbage, and you must wade into it, knee-deep, clawing for tin cans or pieces of tomato. Hell is when you do this every day. And when it seems normal—when you are eight.

IN BAHIA, where the powerful black culture of the African took hold and came to dominate Brazil, there was a military encampment called Favela, named for a local cactus, that was razed in the war of 1897 between rebels and soldiers of the new Brazilian republic. The survivors, homeless and facing an uncertain future, moved south and added to Brazil's great immigration to the cities.

Favela lent its name to the shantytowns that formed around cities like Belo Horizonte, Rio de Janeiro, and São Paulo. In these *favelas* you will still find entire neighborhoods from the same villages in Bahia and Ceará, practically transplanted.

In the past decade the favelas of Rio have organized effective associations to press for electricity and sanitation. As more *favelados* gain title to their land, they are willing to improve their homes; cinder block and brick are replacing sheet metal and cardboard. And if the favelas are not yet prosperous, they are at least free.

Freedom is the Rio intoxicant. Nothing is savored more in this sensuous city of party lights and brighter hopes, a city perpetually forgiven and blessed by the towering statue of "Christ the Redeemer," who stretches His arms from the summit of Corcovado, one of the sharp, dark peaks that define the shape of Rio.

Rio remains one of the world's most glamorous tourist destinations, especially during Carnival, the pre-Lenten celebration of the flesh. Carnival was once a purely European tradition, but in Rio it has been co-opted by the poor and black. Parades of favelados press their way through fashionable streets with an almost disturbing power and momentum: wiry black musicians with drums and brass and the manic, yelping instrument called the *cuica;* transvestites in lingerie and fishnet hose; and a nucleus of tightly packed, strutting young men venting a year's worth of frustration. For four days they rule Rio.

"Twenty years ago *we* danced in the streets," said a middle-aged woman who lives in the prosperous neighborhood of Urca. "Now it's the lower classes. It's changed. We leave town during Carnival, drive to the country. There is an exchange of people."

This "carnival of democracy," as the 1986 celebration was labeled, quickly reverted to parody and satire. Once again the government could be safely lampooned. Even the United States was vilified in the elaborate parades of clubs called *escolas de samba* from Rio's poor neighborhoods. Uncle Sam shared one float with an exploited Brazilian worker wearing only a barrel.

"I am the Rio canary," sang the Caprichosos de Pilares group, "and the [American] eagle will not close my beak."

More disconcerting to some Cariocas, as those who come from Rio are called, was the accurate timing of Carnival events, in a city where most appointments are treated only as suggestions.

"Carnival was run on Swedish time this year," my guide and colleague Tetê Moraes complained. "A lot of my friends were quite angry. Why, they said, was *Carnival* organized, and not housing or the economy or agriculture? If we're going to start *organizing*, why start with Carnival?"

IT IS KNOWN that somewhere in the center city, commerce grinds on through these madcap days, and businessmen still toss down their 20 shots of black coffee, the ubiquitous *cafezinhos,* with their paperwork. But most of Rio is on the beach.

Soccer fields and chinning stations stretch along the five-kilometer crescent of Copacabana. Dark young men with tight stomachs play foot volley: volleyball with no hands, only soccer rules. The *tanga* bikini, not outrageous enough for this season, has given way to the *fio dental,* the dental floss. And the "girl from Ipanema?" "Now she has a daughter who is in this year's Miss Ipanema pageant," said the man who wrote the song, Antonio Carlos (Tom) Jobim.

"For me Ipanema has become a nightmare," he added wistfully at his whitewashed hillside home. "The other day there were a million people there. That is crazy! It's like Coney Island in 1948. Forty years ago it was a paradise—just a strip of sand, a desert. And the fish were so big we were afraid to dive into the water."

The main beaches are now polluted, and an urban haze obscures the stars, but the evenings still shine with a soft, pastel luminescence. On the beach at São Conrado you can watch hang gliders settle like butterflies from the overhanging bluff. And lovers still sit pressed together, waiting for the offshore islands to melt into darkness.

The beach is democratic, everyone likes to say, but special groups have staked out their own sections. Surfers, intellectuals, bureaucrats, teenyboppers, all know, with great precision, where to meet their friends. Thus it was that beach society was disrupted when the populist governor of the state of Rio de Janeiro, Leonel Brizola, set up bus route No. 461. For the first time, poor black families from the north side had direct access to the affluent beaches in the south.

Much of the resentment has been racial, for the nation's unspoken caste system is rigid and pervasive. Society's top echelons are almost exclusively white. Sometimes even the Portuguese are disparaged as a sort of swarthy, inferior brand of European.

"There is a certain regret that the Dutch didn't stay in Brazil," said Antonio Callado, referring to a brief period of colonization in the 1600s. "It's a feeling that we are

Living by their wits *and petty crime, millions of abandoned children run wild in the nation's cities. In São Paulo these youths—who live under bridges—sniff glue and scuffle over small change. Few escape the urban slums, where family planning is virtually nonexistent and the infant mortality rate is a national scandal.*

backward because we weren't colonized by fair people. It's something fundamentally weak and disgusting—trying to explain away why we don't *do* things.

"Very few Brazilians could prove they don't have Negro blood. We look at faces here. If you're white enough, you're white. If you have black skin, you'd better be Pelé; otherwise you'll suffer for it."

The ambitious Governor Brizola, champion of the poor, built more than 50 critically needed schools for favela children, only to be accused of political grandstanding.

"He's ruined the city," said one Carioca matron. "He appeals to young boys who steal watches. Everything's decaying in Rio. The streets are full of holes. We've never had so many beggars, so many assaults.

"And," she said, hurling the ultimate insult, "he is not even a Carioca!"

Orderly times were badly shaken by the recession of 1981. Crime swept darkly over Rio and the other large cities of Brazil and rippled to the doorsteps of the rich. The jobless, without an adequate federal social-welfare net, took to the streets in desperation. On the beaches, on the sidewalks of Copacabana, families living in cardboard boxes slept overnight in dark corners. In Urca, residents got extra police protection, built a guard shack, and barricaded their streets against thieves.

A woman named Vera Castelo Branco told me this story: "In the bus a man came up to me and said, 'Give me your ring or I will kill you.' No one moved to help me. I gave it

to him. When he slipped out, I thought the people would be sympathetic. But they were mad at me. 'Why should we be responsible for you?' they asked. 'Everyone knows you can't carry jewelry in the bus.' "

Brazil's more tragic social dilemma is the millions of children who are simply abandoned in the streets, living in gangs, sleeping under bridges, surviving by petty crime.

"I think this is the worst problem in Brazil," said Emir Sader, a counselor for the president of FEBEM, São Paulo's juvenile-detention system. "The most scandalous of a country full of scandals. Every day 130 boys arrive here. The police beat them to make them confess to crimes they didn't commit.

"The city government is very weak, not very democratic, and not strong enough to fight the police," said Sader, smiling grimly at my discomfort. "We think the police kill one child each day in São Paulo."

"Wouldn't the press publicize these things?" I demanded.

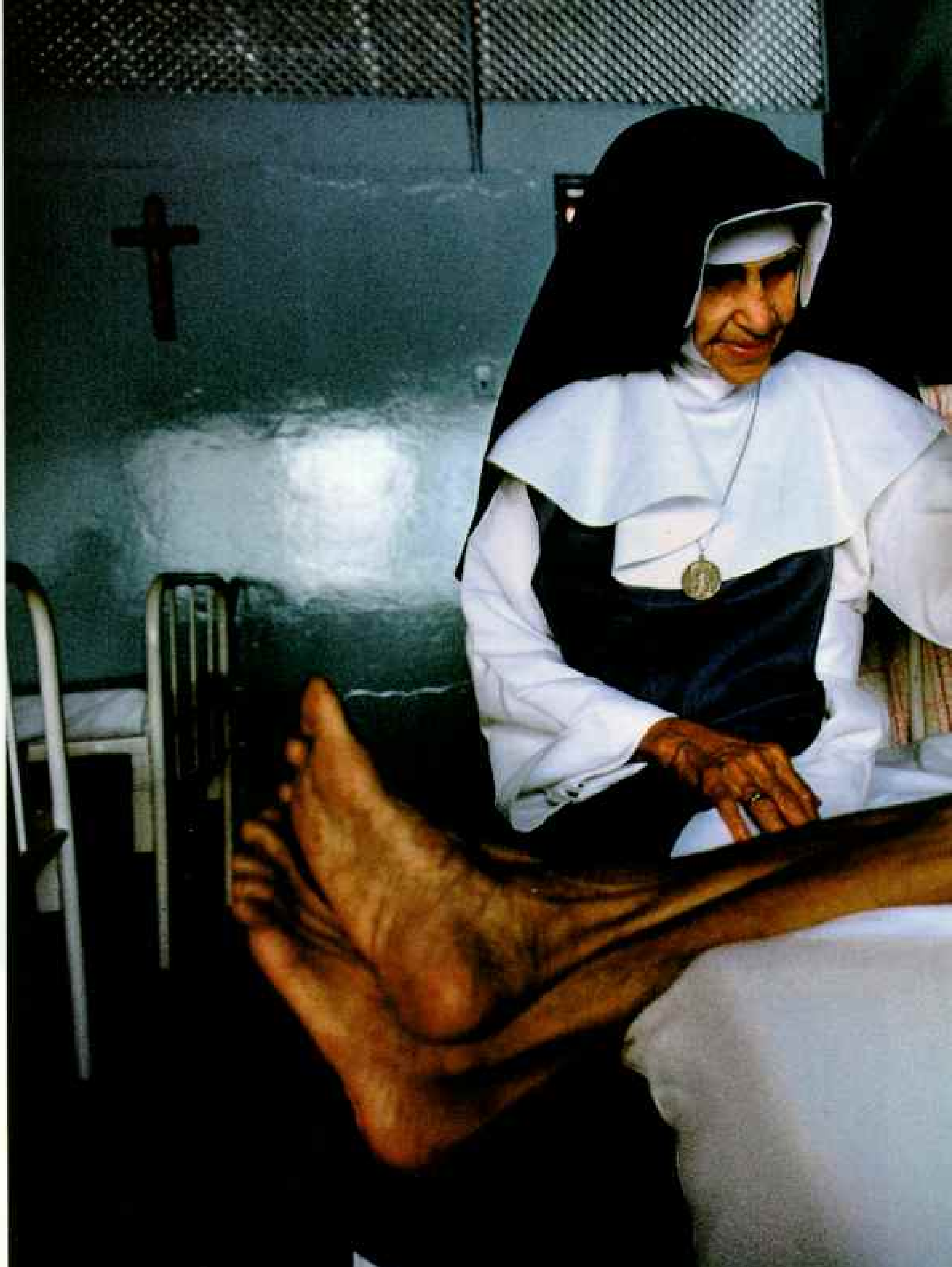
"It's normal," he said, "not news. If somebody could stop this, then it would be news."

In the six months after the Cruzado Plan was decreed, 160,000 new jobs were created in metropolitan São Paulo, perhaps sparing some children the barbarism of the streets.

SÃO PAULO is the engine that drives Brazil's raw capitalism. Its growth from seven million to 15 million people in 20 years has been swift and unsentimental. It has absorbed nearly two million migrants from the northeast alone. Along the imposing and stylish concrete-and-glass lined Avenida Paulista, you can still glimpse a few garden-mansions of the wealthy coffee growers who once ruled the city; but don't blink.

São Paulo's high-rise towers march across an improbable breadth of the horizon like an advancing army. Corporate buildings line the highways—Yamaha, Siemens, Johnson & Johnson, Scania, Quaker. Boxlike apartments perched on concrete stilts, with parking space underneath, accommodate Brazil's best paid workers. The city center sets nerves jangling with its honking traffic, acrid air, and hammering construction. But the fine arts flourish, and university scholars are honored and heeded. And business gives the city an international dimension.

Looking to the 21st century, *futuristic chambers of Brasília's National Congress highlight the capitol complex where workmen refurbish the marble terrace* ***(above)****. Following the untimely death in 1985 of President-elect Tancredo Neves, who would have been the first civilian president in 21 years, Vice President José Sarney was catapulted to chief of state. Sarney (***right****, at left), in his jet with officials from Rio Grande do Sul, has won both praise and criticism for his bold Cruzado Plan, aimed at slashing inflation by freezing wages and prices.*



*"**The angel of Bahia,**" 71-year-old Sister Dulce comforts an aging patient in the Hospital of Santo Antônio, which she established in 1960 for the indigents of Salvador, Bahia's capital city. For 50 years the dynamic, diminutive nun*

has been begging money and equipment from home and abroad to run a host of services for Salvador's poor, sick, and homeless, including many refugees from northeast Brazil's frequent droughts.

The Maksoud Plaza is crowded with three-piece suits from the nations of the world, filled with sleek men spearheading, consolidating, scheming, and selling over power lunches. The restaurant offers "American coffee," a minor heresy.

Today Brazil has much to sell. It produces armored vehicles and candy bars, orange juice and computers, surgical supplies and mahogany, bombs and ballpoint pens, rockets to launch its own satellites. Even coffee. It produces 95 percent of its needs.

Brazil is a world leader in iron ore production and hydroelectricity. Brazilian business, engineering, and construction now reach throughout the globe. Brazilian computers are being used in China. Brazilian engineers are laying out streets in Nigeria. Brazilian shoes fill American shops. TV Globo, the world's fourth largest television network, exports soap operas to Europe.

The Brazilian mining company Vale do Rio Doce has successfully developed the world's largest reserve of high-quality iron ore in the mountainous jungle of the Amazon basin. And in ten short years Brazil has vaulted into the international aeronautics and arms market with a range of weaponry from grenades to jet fighters. By some accounts Brazil is the fifth largest exporter of

Life at the top *of Brazil's economic ladder, where 10 percent earn nearly half the national income, is glimpsed at a wedding reception outside São Paulo. Once the realm of large landowners, Brazil's upper echelons are being taken over by a new industrial class, nowhere more evident than in São Paulo state.*

arms in the world, after the U. S., the Soviet Union, Britain, and France. And Brazil was the only nation to switch successfully from gasoline to a renewable resource—sugarcane-based ethanol—for automobile fuel when the oil crisis hit. More than 90 percent of new Brazilian-made cars use it.

BRAZIL'S agricultural output, too, remains immense. It trails only the United States in the export of food. All the more astonishing, then, that the nation's most immediate problem in 1987 is so chillingly fundamental: how to feed its people.

Traditional food crops such as beans and corn have been supplanted by sugarcane for ethanol and export crops like soybeans that help pay the foreign debt. Farm workers have lost their subsistence gardens as owners have pushed the newly profitable crops to the far edges of their properties. Mechanization has deprived other thousands of a living. Many people whose families have farmed the same land for generations have been forced out.

Twelve million rural families are landless, but 40 percent of private or government property remains underdeveloped. Agrarian reform works on a simple principle: The government, through an agency called INCRA, intends to buy that land and subdivide it among those who need it.

But the reform cuts to the heart. Violence has rattled across the nation between *pistoleiros*, henchmen of recalcitrant landowners, and defiant peasants. At least 130 people died in land conflicts in 1986 alone.

Agrarian reform foot-dragged its way through its first year, with INCRA reacting only on a crisis-by-crisis basis. But on May 10, 1986, Father Josimo Tavares, a 33-year-old priest, was shot in the back in the town of Imperatriz, in Maranhão. He was the fourth church activist, including two nuns, to be murdered in the past two years.

His death was the final catalyst. Two weeks later, under heavy pressure from the church, the president signed seven of the 23 state agrarian-reform plans into law. The program is a watered-down version of the original goal of resettling 10.6 million families by the turn of the century. Now 1.4 million are to be resettled in four years.

Agrarian reform is the riskiest, and the most important, challenge for the popular new administration. Despite the self-defeating fact that most politicians are also wealthy landowners, it must work. The alternative is violence.

***Driven by success**, São Paulo **(above)** attracts immigrants at such a rate it could one day become the world's largest city. The nation's largest corporations are headquartered here; cars, computers, and commuter aircraft **(right)** roll off its assembly lines. Ninety kilometers away, in São José dos Campos, a thriving armament industry has made Brazil a leading international arms merchant.*

For now the landless seem content to protest. Between the lush soybean fields of Rio Grande do Sul, some 8,000 peasants of German and Italian stock have been entrenched for 17 months in a squatters camp of scrap lumber and plastic sheets on the edge of the Annoni estate, near the village of Ronda Alta. Fifteen years ago 9,150 hectares (22,600 acres) were marked for expropriation here, but the case has since been tied up in the courts.

Owner Bolivar Annoni sees red. "It's a criminal invasion that the government supports," he told me in the state capital of Pôrto Alegre. "It's Communist infiltration. People from Cuba and Nicaragua. They are armed, and in a short time they will also have heavy machine guns."

With some trepidation, I drove to Ronda Alta next day with journalist Tetê Moraes.

The road crosses the pampas, a flatland of pasture and eucalyptus trees where gauchos still keep their leathery grip on the popular imagination. But southern Brazil today is more a tropical Europe, the most prosperous region in the nation. Trucks thunder past with soybeans and wheat. Some carry cattle that slosh in the swaying double trailers like liquid, on their way to the grills of *churrascaria*—barbecue restaurants.

Padre Arnildo Fritzen, whose church shepherds the landless in Ronda Alta, offered to take me to the Annoni camp. On the wet red-clay roads between the fields we flew in his Volkswagen.

"The soy culture is supported by the banks," said the padre from under his straw hat. "The *colonos*, the peasants, are left out. Until the arrival of soy, the farmers could manage to buy new land for their sons. Twenty years ago the small farmer produced. Here there was no problem with food. But look! All is soy!"

The mood of the Annoni camp was a mix of sadness and smoldering resolve. Cuban machine guns were conspicuously absent. "The people here are simple rural workers," said Padre Fritzen. "If you talk about Communism, they will be frightened. They are only people trying to get justice—a piece of land to farm."

A volunteer doctor visits the site every few weeks, but the water from the only stream is questionable, and seven women and four children have already died. Diarrhea and conjunctivitis are rampant.

"Why not go to Rondônia or to the cities?" I asked.

"We know the unemployment is already big in the cities," said Darcy Maschio, 27,

"We are sons of small farmers. We have no other profession."

Two days later 200 protesters from the Annoni camp occupied the eighth floor of the INCRA building in Pôrto Alegre. In an agreement battered out at four in the morning, they were promised land in 60 days. They left. A year of protest marches and hunger strikes has passed, and INCRA finally controls the Annoni land, but the colonos are still waiting.

That night, returning late to our hotel in the heart of Pôrto Alegre, we heard loud voices singing beneath an underpass—a family guarding their wooden stand of herbs and medicines. A man with a beaten face took me aside. "We came from the country," he said, "but life has not been generous with my family. And I like to drink. But I'm very worried about my wife, who now is living with a *marginal*, a criminal, and he has cut her with a knife.

"Take this," he said, handing me several herbs. "This is for the heart, and this is good for syphilis. This is to settle your stomach. Yes. I've cured doctors, you know."

I took them all, and slept better for it. And I wondered which I would do if I were a dispossessed farmer—sleep under a bridge . . . or head straight for Rondônia.

***Dirty work** but work nonetheless, gold extraction at the huge federally operated Serra Pelada mine in Pará is still done by hand. Faced with the threat of mechanization, some 60,000 workers, like these* saqueiros *(**above**) who haul sacks of ore from the pits, are fighting for their jobs. At nearby Carajás (**right**) the world's richest lode of high-quality iron ore has pushed Brazil ahead of Australia as the top exporter of the ore, and ahead of the U.S.S.R. as the world's top producer.*

IF YOU LAID A STRING across an acre of grass and visualized it as a road, that would give you a good idea of Rondônia in the western Amazon, a new state seen as an escape valve for the nation's social pressures. Rondônia symbolizes the westward migration of "our bravest, brightest, and best"—a slogan of the late 1970s.

But colonization moved slowly until 1984, when the World Bank financed the paving of BR-364 through Rondônia to its capital of Pôrto Velho. Then the trickle turned into a torrent—homesteaders, tin miners, speculators, and *garimpeiros*, the legendary, rough-hewn prospectors who pan the Amazon's malaria-ridden river valleys for flakes of gold.

I drove this highway with Allison Jones, a Brazilian whose great-grandfather was a disenchanted Confederate colonel who emigrated to what is now the town of Americana in São Paulo state. Mr. Jones speaks Mississippi English, carries a handgun, and knows how to change a tire—all useful skills.

From Cuiabá, in Mato Grosso, a city booming as the staging area for Rondônian settlement, we reached only the fringe of the rain forest by nightfall. Majestic and ethereal trees floated overhead in silhouette, and our windshield became an insect graveyard,

nearly opaque in the glaring headlights of oncoming logging trucks.

In the Rondônian border town of Vilhena, Caetano V. Neto ran the state immigration center, where as many as 30 busloads arrive each night from southern states like Paraná and Minas Gerais, and nervous immigrants line up for mandatory yellow fever shots.

"It's an explosion," he told me. "In the past three months we've had 39,000 immigrants, and 35,000 more who say they are 'traveling.' In four years we've doubled our population to one million people."

INCRA began by parceling a hundred hectares of virgin forest to stout-hearted homesteaders, but it now has a waiting list of 20,000 families. It has suspended registration, but thousands continue to pour in.

"Rondônia has become a dumping ground for the unwanted," said Caetano. "In many towns in southern Brazil mayors lease trucks, give 200 cruzados and some farinha to each person, and send them to Rondônia. That solves *their* social problems but makes it worse here. One bus came with men chained up inside. They filled these guys with *cachaça* [sugarcane liquor] and just stuck 'em in. So much for your 'bravest, brightest, and best.'"

Brazilian by choice, *Haruko Yazaki* **(above)** *teaches children their ancestral language in Yuba, a small community in São Paulo state. São Paulo's 450,000 Japanese, the largest group outside Japan, began arriving 80 years ago as farm workers and are now largely assimilated. Such is not the case for Brazil's Indians; a family* **(facing page)** *awaits medical treatment in Vilhena, Rondônia.*

LANDOWNERSHIP is chaotic with fraudulent deeds and intimidation; cases of gunshot and knife wounds are second only to malaria in frontier clinics. An estimated 80 percent of peasants sell out land within five years for cash, and abandoned shacks litter the roadside of BR-364. Most small plots are consolidated into large ranching and agricultural enterprises, and dislocated peasants push even farther into the forest.

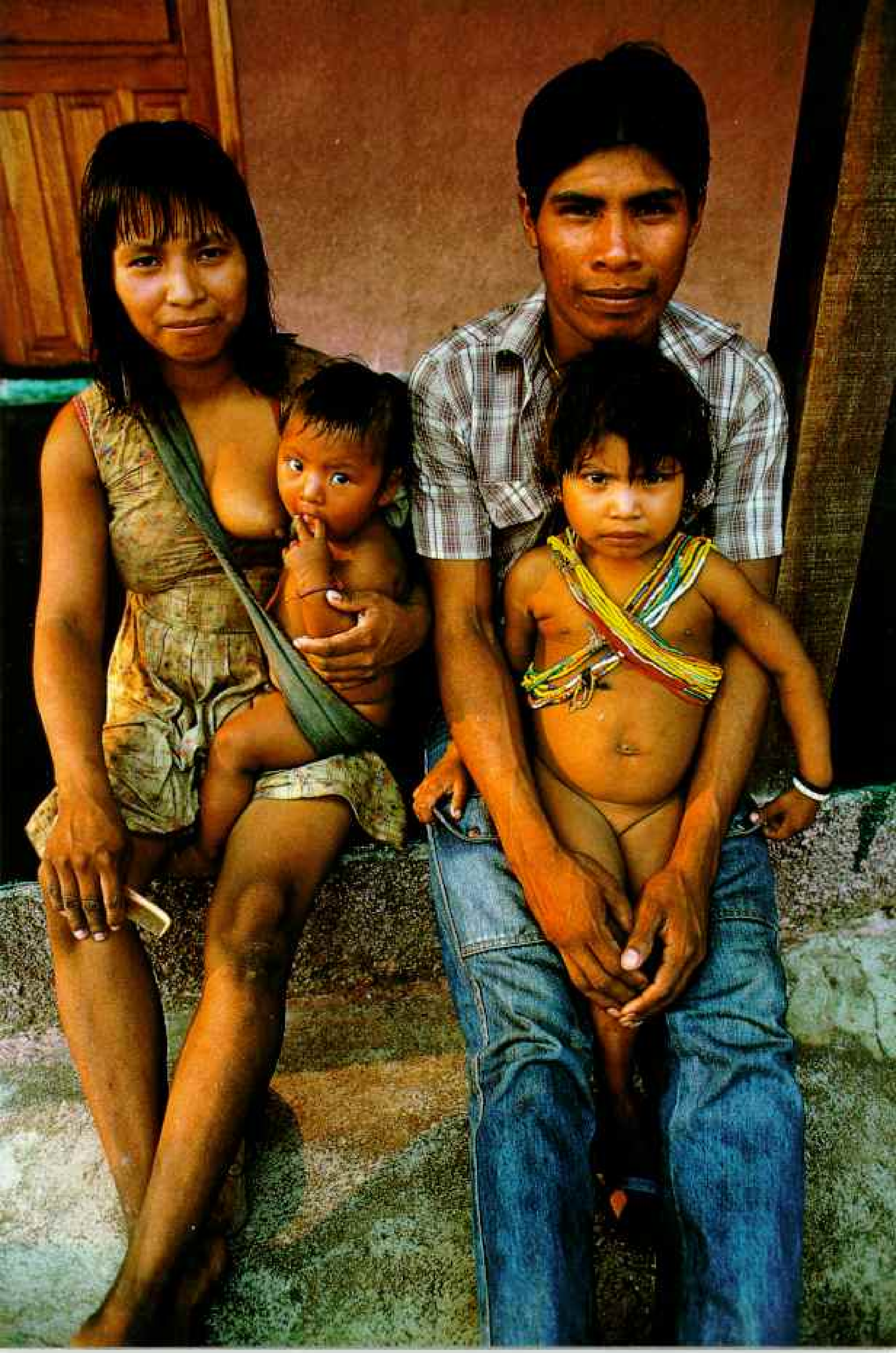
The new state of Acre on Brazil's westernmost edge may be next. A paved road is under construction between Pôrto Velho and Acre's capital of Rio Branco. But Acre has even less infrastructure for immigrants, and 8,000 forest Indians urgently need to be protected by reservations.

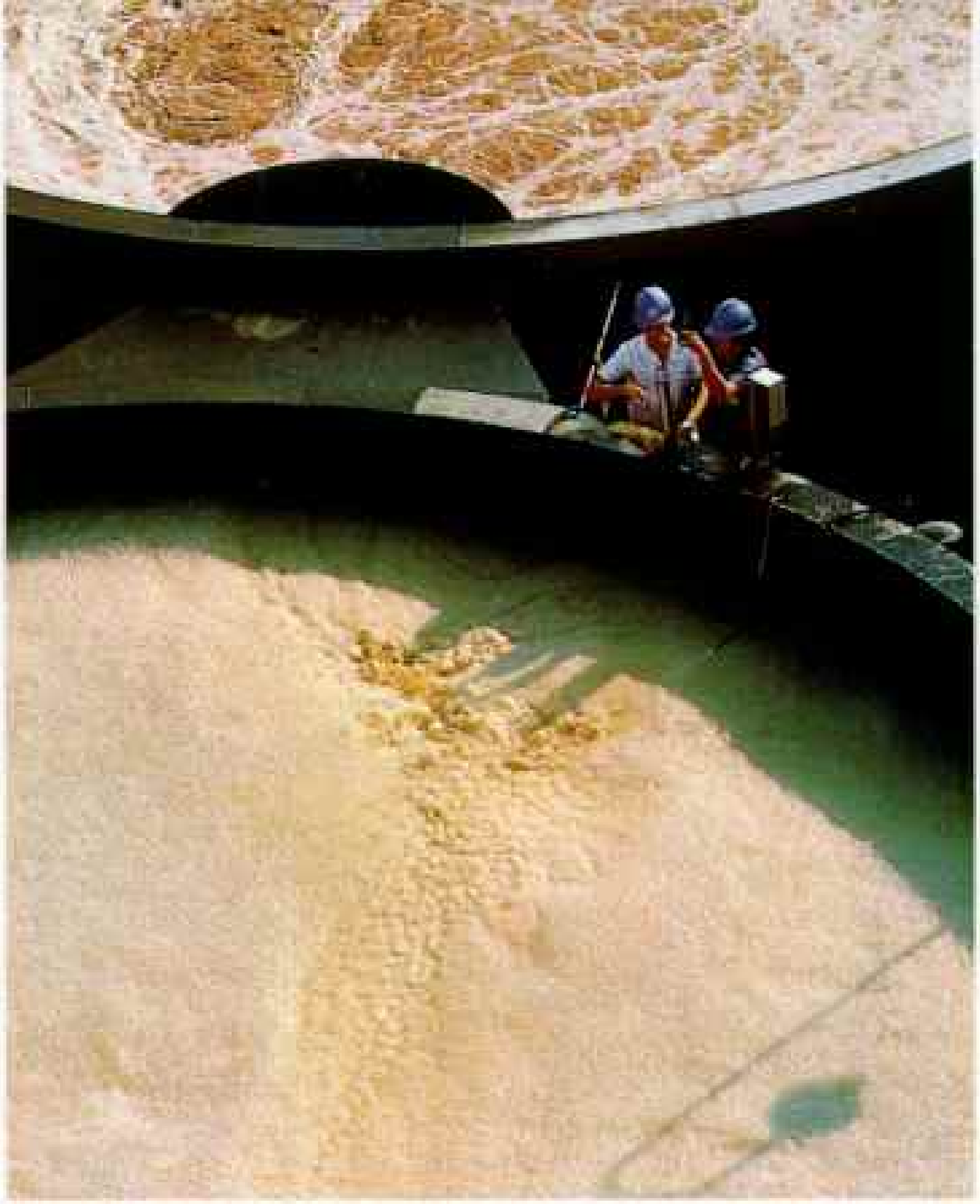
Rondônia is overburdened, says Governor Angelo Angelin, who is lobbying in Brasília to slow the colonization campaign.

"You cannot play with human lives," state government advisor Márcio Raposo Dias told us in Pôrto Velho. "This is a state that has an absolutely hostile climate—this is Amazonia. We have six months of rain—just plain rain—when the rivers will swell to four or five times normal. And many of these immigrants who arrive have the general idea of Rondônia as open fields, open lands, like *their* homes."

We waited the next night in Vilhena for the first Cuiabá bus and met Sílvio Ferreira de Abreu and his family from Minas Gerais, people on the edge of hope. They looked small, shy, and somehow pinched as they stood in the inoculation line.

"People are afraid of malaria," Sílvio told me, "but they would all like to come up. You





"Green petrol," *vats of fermenting sugarcane* ***(right)*** *in São Paulo state attest to the world's most successful alternative energy plan. Undeterred by falling oil prices, Brazil remains committed to its 12-year-old alcohol fuel program, which has saved 12 billion dollars in imports and created some 700,000 jobs. Nearby, vast citrus groves* ***(opposite)*** *testify to Brazil's emergence as the world's biggest orange-juice exporter, garnering half the United States market in 1985. Brazil is also rich in underutilized land. On the fluvial plains of Marajó, an island twice the size of New Jersey at the mouth of the Amazon, water buffalo* ***(below)*** *are the chief source of income.*

A mélange of aromas *fills Ver-o-Pêso market in Belém, gateway to the Amazon. Over its 371 years Belém has weathered many a boom and bust. Sugar, rice, and cotton each had its heyday in this region, before planters moved south. After a brief rubber boom early in the century, Belém languished for decades. Today the city thrives on fish, fruit, nuts, and other Amazon commodities.*

can't find decent work in Minas. I expect to go to INCRA and to find my uncle, who's here. He says it's good here. We got the news that land is available."

From the heights of Vilhena the wilderness stretches north in a ragged stubble, hazy with the smoke of sawmills and burning forest. But civilization holds the highway in a tender and tentative grip. Humpbacked zebu cattle graze around the charred stumps of new pastures, boys wearing team uniforms play soccer on an emerald field, and small but proud farmhouses already nestle in fruit trees and flowers. A sign on a store says: "*Hier Sprechts Deutsch.*"

The Restaurante dos Motoristas has an Arab proprietor. King Hussein of Jordan peers from the wall. "Rondônia will one day be the greatest state in Brazil," the owner announces. "I am very happy here, despite the thieves [politicians]."

BUT THE WILD WEST is still intimidating. Five times Texas would fit neatly into the Brazilian part of the Amazon basin.

Brazilians consider the Amazon a sort of national warehouse where their future is locked, and while they fumble for the key, they fear that the rest of the world eyes their green treasure with plunderous intentions.

The military government, acting on this touchy nationalism and fending off a leftist insurgency that used the forests for sanctuary, built the Trans-Amazon Highway in the 1970s, intending to settle five million colonists south of the main stem. The enterprise floundered. The dirt highway was virtually impassable in the rainy season, and today at least a third of the roadway has been reclaimed by the forest.

Loggers, miners, and cattle ranchers have prospered, but for many poor farmers the

Stout hearts *in a hostile land, a family of* posseiros, *or land squatters, stake out a claim in Rondônia* (**above**). *Braving fever and frontier violence, thousands arrive each month to cut and burn the rain forest* (**right**) *for homesteads. Brazil seeks to alleviate a political tempest over its slow-moving land-reform program by opening up lands here and elsewhere in the Amazon. Critics decry the high failure rate of small farmers, the ensuing human misery, and the environmental costs. Masters at surviving in the rain forest are some 150,000 Amazon Indians, like a cayman-toting Tukuna woman* (**opposite**) *in a settlement near Tabatinga on the Peruvian border.*

In the heart of the sertão, *Brazil's drought-plagued northeastern interior, an old-timer serenades his neighbors in the town of Juázeiro do Norte. A vast island of poverty in Brazil's fast-moving economy, the predominantly black northeast subsists on a per capita income about half the national average.*

lushness has been illusory. Slash-and-burn agriculture often allows only a few years of planting rice or corn before the pounding rains wash away the thin topsoil. Some ecologists believe that the Amazon is losing rain forest at the rate of 13,000 square kilometers a year, an area the size of Connecticut. From satellites that use heat-sensitive infrared sensors, it shines like the night sky, lit up by thousands of small fires.

"People felt the Amazon was like a big desert in the country," said Maria Tereza Pádua, former head of Brazil's national parks, "because it wasn't being used."

THE REAL EXPERTS in rain forest management and agriculture, the 150,000 Indians still scattered around the Amazon basin, are rarely consulted. Their knowledge of forest resources and medicines is legendary and often untapped by Western science. Many Indians speak Portuguese and are in constant contact with settlers and government middlemen; other thousands survive in the forest, lobbing arrows at offending bulldozers.

A few have gained demarcated hunting grounds and reservations, but most native Brazilians have been stripped of dignity and live in confusion and disease. They are the forgotten people.

Manaus, a city of 635,000, molders in the rain forest like a modern archaeological find. In order to stimulate immigration and development, the government made Manaus a duty-free port in 1967, creating an industrial boom that lingers despite the isolation.

Today Manaus is like its own little country, with thousands of visiting Brazilians hauling duty-free appliances and electronics gear past customs officials and airport security. Unemployment is nil, but the cost of living is high. And around it has grown a suburb of planned settlements.

I lingered at the old port, where families laden with supplies strung their hammocks on the decks of ramshackle riverboats for the trip to isolated settlements days away. There the air was moist with the sweetness and decay of ripe pineapple and *cupuaçu*, a fruit the consistency of raw eggs. And you could sit at a one-table restaurant and savor the wondrous fried fish with equally wondrous names—*tambaqui, piraruca, tucunaré, jaraqui*—rarely sampled outside the territory.

BRAZIL GOVERNS ITSELF from afar. Its capital city of Brasília was created in a thousand days out of nothing, on a high plateau in Goiás state. It was inaugurated in 1960, fulfilling the dream of President Juscelino Kubitschek. Brasília was the first reach into the interior, to pry the nation from the coast.

The character of Brasília falls somewhere between a sculpture garden and a lunar colony. Its creators, architect Oscar Niemeyer, city planner Lúcio Costa, and landscape artist Roberto Burle Marx, fashioned a capital shaped like an airplane, with the business district in the center, living blocks in the wings, and the head of government in the cockpit. There is an alien sense of space and proportion, as if a normal city had come apart and its pieces were wandering.

As an international capital, Brasília springs odd surprises at the visitor. At the hotel swimming pool one afternoon I found a group of young people lounging and sunning. They were too pale, and just a bit too

Catholics on Sunday, *spiritists by night, members of Salvador's Candomblé cult honor an orixá, a god, in a rarely photographed ceremony* ***(below)****. Elsewhere in the city, Candomblé priestesses are seen in traditional ceremonial gowns* ***(facing page)****. Brought from West Africa, the cult, like others in Brazil, venerates a pantheon of animist gods and Catholic saints. Chiefly a phenomenon of the black population, the cults appeal to all races and classes of the world's largest Roman Catholic nation, the paradox called Brazil.*

graceful. They were the Bolshoi Ballet Company from Moscow.

But in this navel of the country, Brazil's self-absorption is even more evident. The outside world seems a light-year away. Foreign-language books are difficult to find, and diplomats shuttle back and forth to Rio or São Paulo on weekends.

And Brasília has not escaped the nation's social curse. The city was planned for 600,000 people, but now the area has 1.6 million. The workers who nailed and riveted the city together never returned to their northeast origins, but their fate was not in the blueprints. Today many people live in suburban favelas, sometimes called "anti-Brasílias," with poor sanitation, kilometers from the city. Their lives are so bleak that some reportedly took to poaching and eating animals from the city zoo.

The military governments let Brasília turn a bit seedy, and the Sarney government has invited Brasília's three designers to return and revitalize their capital. They are old but still vigorous, and they have tackled their dream with a new commitment.

And so too has the government of Brazil, perhaps the first in many years to recognize and attempt to heal the great rift between it and the people.

I spoke in Brasília with João Sayad, the Yale-educated planning minister, who had been instrumental in the Cruzado Plan.

"If we want a democracy, we have to build in the social area very rapidly," he said, "and now we have the means. Our technical, economic, and industrial capabilities show we can get there. It's only a problem of organization and political will."

Perhaps this is the time of promise for Brazil, when, as economist Conceição Tavares put it, "we can begin to be civilized." I remembered the words of novelist Antonio Callado: "I don't know of any important nation that hasn't gone through a moment of pain and suffering. Here, ideas are still superficial. The moment when people start thinking that ideas are important—something that you're ready to die for—that moment hasn't happened yet in Brazil."

Not yet. But there were the priests and peasants who had died for ideas. And there was that old man who had been working at the dump in Fortaleza for 15 years, separating tin cans from garbage. He would not go back to the land. He had an idea.

"Where do you come from?" I asked him.

"Itapipoca."

"And which do you prefer?"

"Here," he answered. "In Itapipoca I was a *cativo*, a slave. Here I am free." □

Rescuing Brazil's Muriqui

Monkey in Peril

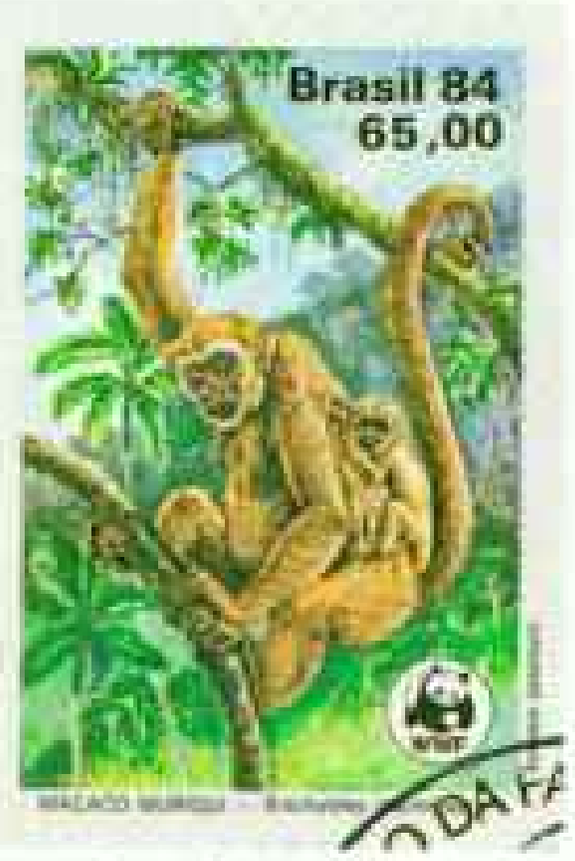
By RUSSELL A. MITTERMEIER

DIRECTOR, WORLD WILDLIFE FUND PRIMATE PROGRAM, AND CHAIRMAN, PRIMATE SPECIALIST GROUP, SPECIES SURVIVAL COMMISSION, INTERNATIONAL UNION FOR CONSERVATION OF NATURE AND NATURAL RESOURCES

Photographs by ANDREW L. YOUNG

WHEN THEY SWING through the trees, branches crashing to earth behind them, the entire forest—what remains of it—seems to shake. The largest mammals native exclusively to Brazil, they are called *muriquis* or woolly spider monkeys (*left*), and they are on the front lines of a battle to preserve the invaluable forests of the tropics.

Worldwide those forests contain much of our planet's biological diversity, our genetic treasury. Brazil is what I call a megadiversity country; it may be home to more plant and animal species than any other nation. While the Amazon hosts much of this biota, there are other, lesser known areas that are no less vital. The muriqui lives only in the Atlantic forest region that extends inland from the coast and once covered about 400,000 square miles—an area the size of Texas and New Mexico combined. But that dense, luxuriant forest was the first part of Brazil to be colonized, and today it contains the enormous cities of São Paulo and Rio de Janeiro. Only about 2 percent of the forest remains.



As a primatologist specializing in the neotropics, I began a survey in 1979 to help determine the status of primate populations in some 50 parks and reserves in the Atlantic forest, collaborating with Dr. Adelmar F. Coimbra-Filho, director of Rio de Janeiro's Primate Center (FEEMA), Dr. Celio Valle of the Federal University of Minas Gerais, and Adm. Ibsen de Gusmão Câmara, president of the Brazilian Conservation Foundation (FBCN). The forest contains 21 species and subspecies of primates. We found that 16 occur nowhere else and that 14 are endangered, some critically.

Of all the imperiled creatures, the muriqui stands out as a monkey of superlatives. From perhaps 400,000 in the year 1500, these largest and most apelike of South America's monkeys, deprived of their habitat, have dwindled to a documented population of 350 to 400 individuals in ten widely separated forest pockets. Amid such dire straits, the muriqui has become the symbol of the Brazilian conservation movement, as visible and popular as the panda is in China. The muriqui's face pops up on posters, bumper stickers, T-shirts, company logos, a phone-book cover, and postage stamps like the one above.

LORD OF THE TREES, a large male muriqui feeds on a monstera plant (***right***). Adult males can weigh nearly 35 pounds and measure five feet long, including the tail. Leaves, fruit, and flowers make up most of the animal's diet. A portrait of a juvenile (***left***) shows the dark face characteristic of youngsters; the skin of some muriquis becomes mottled with age.

The muriqui's tail is prehensile, with a tough pad of skin underneath at the end. A juvenile uses this "fifth hand" to hang upside down while at play (***left***).

All the muriquis shown in this article live in one of the most important remaining fragments of their habitat, a four-square-mile private coffee plantation called Fazenda Montes Claros (***map, above left***). Its owner has protected the monkeys for about 40 years, but it is uncertain whether his children will continue the tradition, and efforts to purchase the land for a government reserve have not been successful. Montes Claros is home to about 50 muriquis. They and all the other remaining populations are isolated from one another, with no gene flow among them, and all are surrounded by development and deforested land. Hunting remains a threat, a tradition that lives on from the days of Brazil's earliest explorers. At times, some lived almost entirely on muriqui meat.

Survey work continues in an effort to locate other muriqui populations that might be hanging on elsewhere in the region. There is no safety valve against extinction, because the animal has never bred in captivity.

IF AERIAL GAPS in the arboreal highway system are too wide for young muriquis, alert mothers step in and build bridges. Using her body weight, one female lowers a branch, allowing her offspring to reach the next tree (***above***). Another mother stretches between branches as a living span for her youngster (***above right***).

A gas station near Montes Claros becomes an open-air classroom for zoologist Carlos Alberto Machado Pinto (***right***) of the Federal University of

RUSSELL A. MITTERMEIER (ABOVE)

Minas Gerais, who uses posters to teach youngsters the importance of muriquis and other primates. These boys were surprised to learn that there are no muriquis—or monkeys of any kind—native to the United States.

While the public-awareness campaign continues, so does scientific research, carried out at Montes Claros since 1982 by Harvard University primatologist Karen Strier (*left*), here collecting muriqui food plants. She says the monkeys sometimes "camp out" at large fruiting trees for days, which provides a respite from the strenuous task of keeping up with them.

Dr. Strier calls muriquis "very unusual, for social primates, in their low rate of aggression." Her studies will eventually help Brazil plan a management program. She believes that the education campaign has been extremely effective at the local level: "Nowadays, if the people think that you don't know what a muriqui is, they'll stop and give *you* a lecture."

FOREST EYES of other animals, some also in desperate need of protection, peer from the trees. South of Montes Claros, in the state of Rio de Janeiro, a golden lion tamarin (***below right***) glows like a sunburst in the foliage of the 20-square-mile Poço das Antas Biological Reserve, established in 1974 partly to preserve this species. Weighing little more than a pound, these beautiful squirrel-size monkeys feed mainly on insects and fruit. They have always been naturally restricted to the coastal lowlands of the state, where in the past decade a new highway and bridge have opened their range to development. So much of their habitat has been deforested that only a dozen or so remnant populations of this species still exist, the largest of them at Poço das Antas. A vigorous conservation campaign now under way includes a reintroduction program in which captive golden lion tamarins, many born and raised in the National Zoological Park in Washington, D. C., are released into the wild. Worldwide, captive animals now outnumber the wild population of about 400.

Companions of the muriqui at Montes Claros include another miniature monkey, the buffy-headed marmoset

(***below left***). Most endangered of the Brazilian marmosets, it has only recently been studied in the wild. Brown howler monkeys (***left***) are sometimes chased by the larger muriquis when the two compete for fruit. Their roars echoing through the forest, brown howlers number more than 600 at Montes Claros.

The three-toed sloth, a vegetarian related to armadillos and anteaters, is still fairly common. Only moments old, this sloth's tiny infant (***far left***) was born in photographer Andy Young's vehicle after the Yale University doctoral candidate rescued the mother from a forest patch being cleared by fire.

BRADYPUS VARIEGATUS (ABOVE LEFT); ALOUATTA FUSCA (ABOVE); CALLITHRIX FLAVICEPS (BELOW LEFT); LEONTOPITHECUS ROSALIA (BELOW)

IN A WARM SUNNY HOLE amid the canopy, an infant muriqui clings to its mother's back. At Montes Claros, Karen Strier, studying the muriqui's flexible social system, has seen males mating with females in the presence of other males, with no competition evident. In fact, males frequently embrace one another, sometimes while suspended by their tails—a delightful image that reminds me of an oversize, animated Christmas tree ornament.

The outlook is increasingly bright for these survivors of a once robust population. Concern for conservation among young Brazilians has grown phenomenally, and Brazilians themselves are doing everything possible to solve their enormous conservation problems. By working together, we can ensure the survival of creatures such as this large, lovable monkey, Brazil's muriqui. □

THE WORLD WILDLIFE FUND has supported more than 30 projects in the Atlantic forest region, including endangered species research, management programs, and training of Brazilian students. Membership information can be obtained from the World Wildlife Fund, 1255 23rd Street N.W., Washington, D. C. 20037.

SANDY FELLENTHAL

Mysteries of the Bog

By LOUISE E. LEVATHES
NATIONAL GEOGRAPHIC EDITORIAL STAFF

Photographs by FRED BAVENDAM

WHO WAS THIS MAN? His head slumped into his shoulders, his face dark and leathery, his trimmed beard stained red from his long slumber in a grave of peat. Known simply as Lindow man, he seemed curiously at peace, but the scientists who examined him in a London laboratory found a startling story of violence and death some 2,300 years ago. He had lived about the time of Aristotle, when a colossus towered over the harbor at Rhodes, when Celtic tribes brought tools and weapons of iron to the British Isles.

It was a peat bog that preserved him through the centuries for us to ponder.

Bogs. These strange wetlands have always haunted us. Misty moonscapes of mosses that quake underfoot. From their soggy depths, steeped in preservative humic acids, have emerged—literally—the faces of our ancestors and a treasure chest of their possessions. Recently archaeologists recovered from a Florida peatland remarkably preserved human skeletons and brains—remains of hunter-gatherers who lived there 8,000 years ago (pages 406-407). The find is changing our views of America's early inhabitants.

Across these forbidding wastelands men have been lured to their deaths by dancing apparitions and mysterious flickering lights. Bogs can be found throughout the world, and everywhere they have been regarded with suspicion and dread.

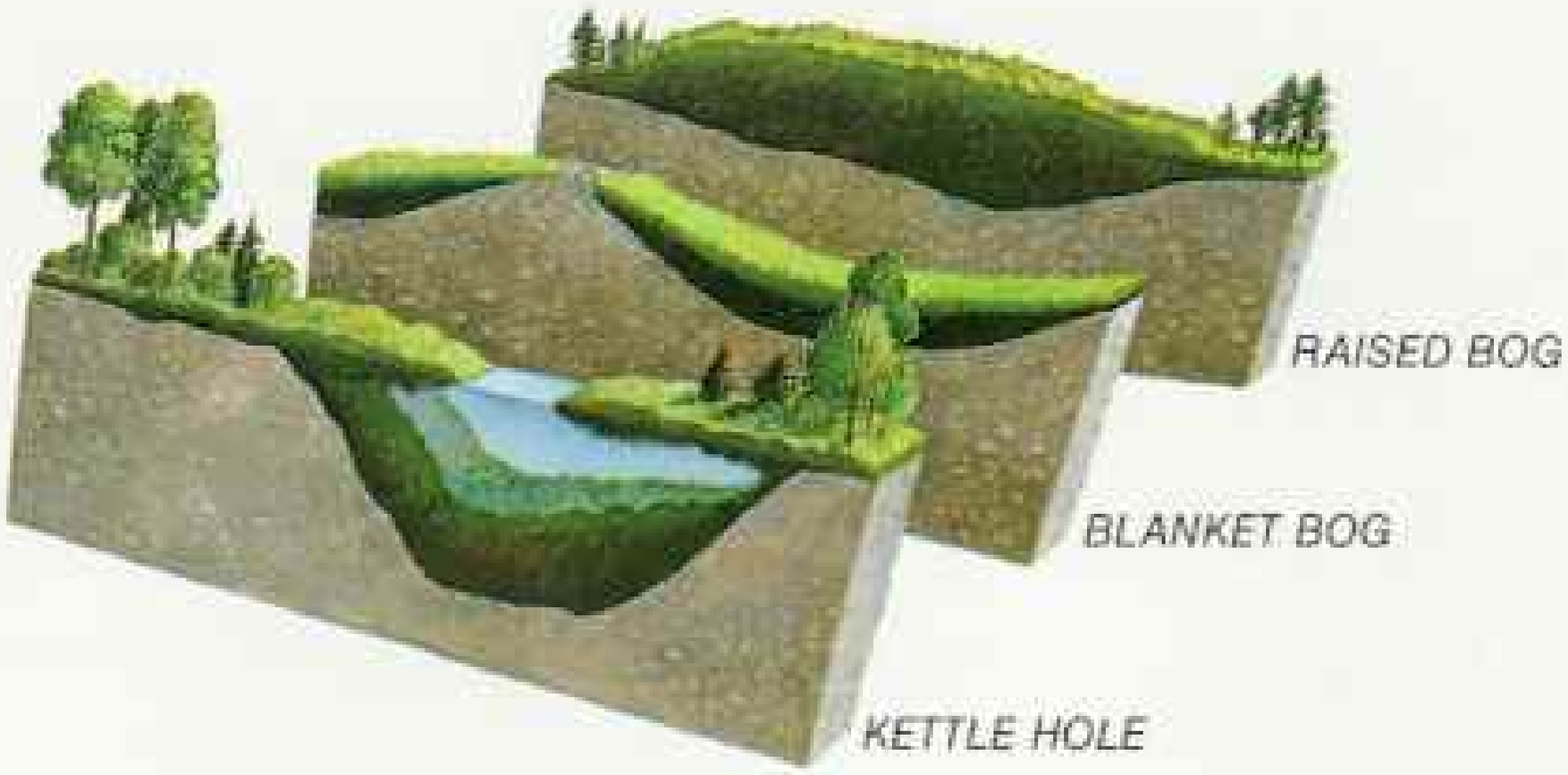
Even today some Irishmen consider them a curse. "Ahrr, from time immemorial the bogs have been worthless except for the snipe and the hare—and to paddies like meself who work them for a winter's warmth."

From under the bog's surface of living sedges and mosses, farmers have traditionally cut sods of black, buttery peat, dried them as hard as bricks, and used them to insulate their cottages

Waterlogged realm, *a bog in southern Maine quakes under an ecologist's boots. Long tapped for energy, in the form of peat, or drained for agriculture, bogs now gain respect as vital wetlands.*

PAINTING BY JOHN DAWSON

Wetland worlds



*BOG, MARSH, SWAMP—poetically used as synonyms—scientifically describe strikingly different wetlands (**below left**). Swamps are dominated by trees, marshes by grasses, and bogs by sphagnum mosses and heaths. Found on all continents except Antarctica, bogs are most common in northern latitudes where retreating glaciers left moist, depressed land with poor drainage. Precipitation is their only water source. If fed by other waters, usually springs, bogs are called fens.*

*Climate and terrain determine bog type (**above**). Waterlogging first lowers oxygen levels and slows plant decay. Dead vegetation settles and becomes peat, a precursor of coal. Swamps and some marshes also produce peat. But accumulation is most dramatic in bogs, where sphagnum mosses excrete antibiotics and raise water acidity. In some parts of New England, glacier-melt kettle holes may simply fill in with peat and vegetation. In areas such as central Ireland, they may climax as raised bogs. Blanket bogs spread across poorly drained landscapes, most often in northern coastal regions.*

*A bog bouquet on a block of sphagnum moss (**left**) gathers plants adapted to this deceptively hostile environment. Water abounds, but anaerobic conditions limit bacteria and fungi from breaking down nutrients in the peat. The thick leaves of leatherleaf **1** and bog rosemary **2** help conserve nutrients from photosynthesis. Acid-loving fungi in the roots of the arethusa **3** release peat nutrients to the orchid. Amid hardy sedges **4**, the carnivorous pitcher plant **5** and sundew **6** catch their own nourishing insect meals. American Indians brewed the leaves of Labrador tea **7** and used the cranberry **8** for medicine and dye as well as food. Folk remedies for arthritis prescribe the roots of false Solomon's seal **9**.*

*Able to absorb many times its weight in water, sphagnum moss (**below**) is valued in horticulture as a soil conditioner. Dried, the fluffy moss once diapered Indian children and served as a surgical dressing during World War I.*

SANDY FELSENTHAL

and fuel their hearths. In this century, peat—partially decomposed vegetable matter and an early form of coal—has been eyed as an alternative source of industrial energy. Germany, Belgium, the Netherlands, and Denmark have cut away virtually all their commercial peatlands, and now the magnificent, dome-shaped "raised bogs," so characteristic of the landscape of central Ireland, are endangered.

The cry has already gone out to save the raised bogs and to preserve representative peatlands around the world. It will be a race against time. Hunger for fossil fuels continues, and ecologists are just beginning to understand the mysteries of these unique wetland ecosystems and to gauge their importance as natural habitats for wildlife.

"We've exploited nearly all the earth's arable land and are now turning to our wetlands," says John Stewart, a botanist at the University of Manitoba in Canada. "Peatlands are truly one of our last frontiers."

THERE WAS A HUSH in the laboratory when Lindow man was lifted from his refrigerated container onto the examination table. Of course, I kept telling myself, he's dead. And half of him isn't here at all. He had been found by workers at a

C. DOYLE WELLS, CANADIAN FORESTRY SERVICE (BELOW)

Exclamation points *on northern Minnesota's vast fens, tree islands of dwarf birch, black spruce, and tamarack* ***(above)*** *are still question marks to scientists. And why does the surrounding sea of sedges grow in waves? Understanding this interaction of water flow, plant growth, and peat accumulation may someday also explain the formation of a ribbed fen in Labrador* ***(left)*** *where sedge spokes radiate in shallow ponds.*

Harvesttime roundup *corrals cranberries in Massachusetts* ***(above)****, where Indians first taught English colonists how to use the bitter bog fruit. Today bogs are drained for vine cultivation and reflooded in the fall. Berries bob to the surface as paddle-wheel harvesting machines clatter through the water.*

The music of a New Hampshire bog ***(left)*** *is a gentle symphony, accented by bird soloists and the percussionist splash of frogs but dominated by the multipitched humming of insects. The still waters are an ideal nursery for mosquitoes, biting flies, and aquatic insects. Acidity and low oxygen level limit the fish population. Small mammals such as voles, lemmings, and mice may rustle near this boardwalk not far from the Appalachian Trail in the White Mountains.*

SAM ABELL

peat moss plant near Manchester, England, but peat-cutting machinery, unfortunately, had reached him first. Why, then, did I expect him to open his eyes and talk to us?

"No different from working on a regular fellow, is it?" said James Bourke, a surgeon, as he leaned over the well-preserved body. "Shall we have a look under the chin?"

A twisted sinew around the bog man's neck had led the British Museum team to suspect that he had been garroted. A ritual killing? An Iron Age criminal execution?

Carefully Bourke lifted the head while George Mann, an ear-nose-and-throat specialist, illuminated the neck area with a light probe. The doctors had already discovered a fractured skull, severed vertebrae, and a possible chest wound in addition to the ominous sinew around the neck. Now the two exchanged startled glances—Lindow man's throat had been cut.

"This certainly looks like a case of overkill to me," said Don Brothwell, a bioarchaeologist. "I wonder what this poor chappie did to have been so brutalized?"

LINDOW MAN is the most studied bog body in history, and yet modern medicine has been able to shed little light on his mysterious death or the strange fates of some 2,000 other bog bodies discovered in Europe. Many, such as Grauballe man and Tollund man, both found in Denmark in the 1950s, are in an extraordinary state of preservation. An absence of oxygen combined with the extremely acidic peat environment stifles the growth of bacteria, which cause plant and animal decay.

Before the time when these eerie bog bodies could be dated, people thought the devil himself had come back to haunt them and arranged hasty reburials with Christian services. Most of the bodies, in fact, date from 800 B.C. to A.D. 400, but it is clear that there were some strange occurrences on bogs well before then.

From the Neolithic period (4000 B.C. to 2000 B.C.) we have evidence of human sacrifice and cannibalism on bog sites in northern Europe. Archaeologists speculate that ritual meals may have been held on the edge of bogs to ensure fertility of crops and animals. Oxen, sheep, and pigs were slaughtered on the spot. Sometimes, clearly, human flesh was included in the food. Life had to be paid for with life.

"Bogs, which covered much of northern Europe then, became sacred because they were the uninhabited part of the landscape," said Jørgen Jensen, curator of prehistory at Copenhagen's National Museum. "People lived on high ground, farmed in the lowlands, and went to deserted places to get in touch with higher beings."

Many of the surviving treasures of the Bronze Age in northern Europe have been recovered in bogs. From Denmark have come gold torques, or neck rings, bronze swords, horned helmets, and exquisite ceremonial *lurs*, long, curved wind instruments. The famous sun chariot, dated at about 1400 B.C., depicts a horse and wagon carrying a gilded disk (pages 414-15), suggesting that a Bronze Age fertility cult may have focused on sun worship.

At the beginning of the Iron Age when cremation was common, people were still executed and placed in bogs for reasons that are unclear. Weapons and war booty, believed to be an offering or tribute to a war god, were also deposited.

The Roman writer Tacitus noted in A.D. 98 the "barbarous rites" of Germanic tribes, including human sacrifices. He tells of punitive practices: "Cowards, those afraid of war, and those guilty of unnatural vice they deposit in the filthy swamps."

With the coming of Christianity, sacrifices at bog sites ceased. Fear of the bogs, however, was not dispelled by the new faith, and folklore of northern European countries is rich with tales of these forbidding lands.

"The peat is the dark casket," wrote contemporary Irish poet Seamus Heaney, "where we have found many of the clues to our past and to our cultural identity."

Will-o'-the-wisp and jack-o'-lantern were the names the Irish gave to the strange lights that led men astray on the bogs. The Finns called these burning gases *virvatulet*, or flickering fires, and believed they showed where gold was buried.

To this day in northern Ireland, farmers still cut three steps in turf banks, some say to avoid the curse of St. Columba. The saint, apparently, was once trapped in a boghole and laid a curse on all those who didn't cut the three steps so that he could get out.

NO ONE is really sure exactly when peat first was used as a fuel. The Romans observed northern Europeans digging "soil" from marshlands, drying it, and then burning it to cook their food and keep themselves warm. The German-speaking people would call this black soil *Torf;* the French, *tourbe;* the Irish, turf.

A strong Irishman working with a wing-tipped spade called a slane could cut enough sods in a week to last the winter. Freshly cut turf sods, which can weigh 20 pounds, are dried on the bog for months, until their moisture content is about 35 percent. The most humified (decomposed) peat burns with greater fuel efficiency than wood, but less than that of coal.

The Germans were the first to mechanize sod production in the mid-19th century. Automatic cutting machines, with mechanical arms that plop down 360 perfectly made sods every 30 seconds, are still used in Ireland. In the 1930s the Soviet Union introduced a process of milling peat that enabled them, during World War II, to run trains and factories on peat. In milling, a steel drum with spikes is dragged over the bog, churning up a half-inch layer of finely ground peat. In good weather it dries in a few days and can be collected by large vacuum machines.

The Soviet Union is now the world's leading peat producer, harvesting 200 million tons annually, some of which fuels 76 power plants around the country.

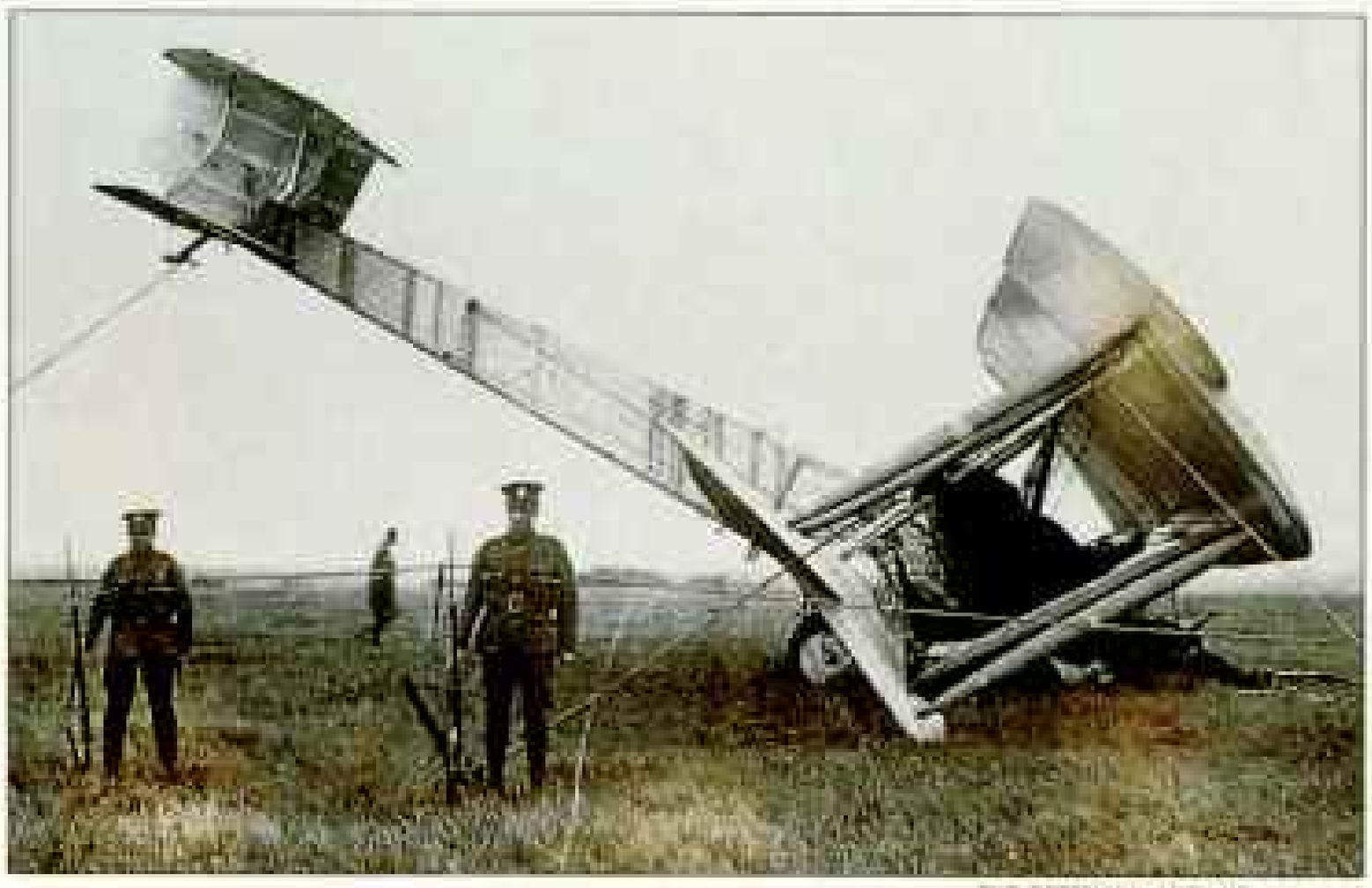
After World War II the Republic of Ireland established Bord na Móna (Irish Turf Board) to centralize the peat industry. Farmers with small bogs were bought out by the government to make large-scale, mechanized peat production economical. Ireland currently meets one-fifth of its energy needs and generates 21 percent of its electric power with peat. More than 200,000 acres of bogland have been drained or cut away, mainly in low-lying central Ireland, where poor drainage led to the formation of raised bogs after the last ice age.

It took some 10,000 years for nature to create these midland bogs, and in less than 40 years most have been destroyed. Only 5 percent of Ireland's three million acres of peatland survive in their natural state.

Machines have come slowly to western Ireland where the bogs are shallower and not as commercially viable. Bogs developed there more recently than in the midlands, about 5,000 years ago, and man may have had something to do with it. In clearing large areas of forest for pastureland, Neolithic and Bronze Age farmers may have contributed to the extensive waterlogging of the soils. In the damp, cool climate mosses were able to invade the swamped farmland, and bogs developed relatively quickly.

These spreading "blanket bogs" now cover much of the hilly country on the western coast to an average depth of ten feet. Sometimes, after heavy rains, bogs lying on steep slopes have become unstable and, like great avalanches of jelly, have engulfed sheep, farms, and even villages.

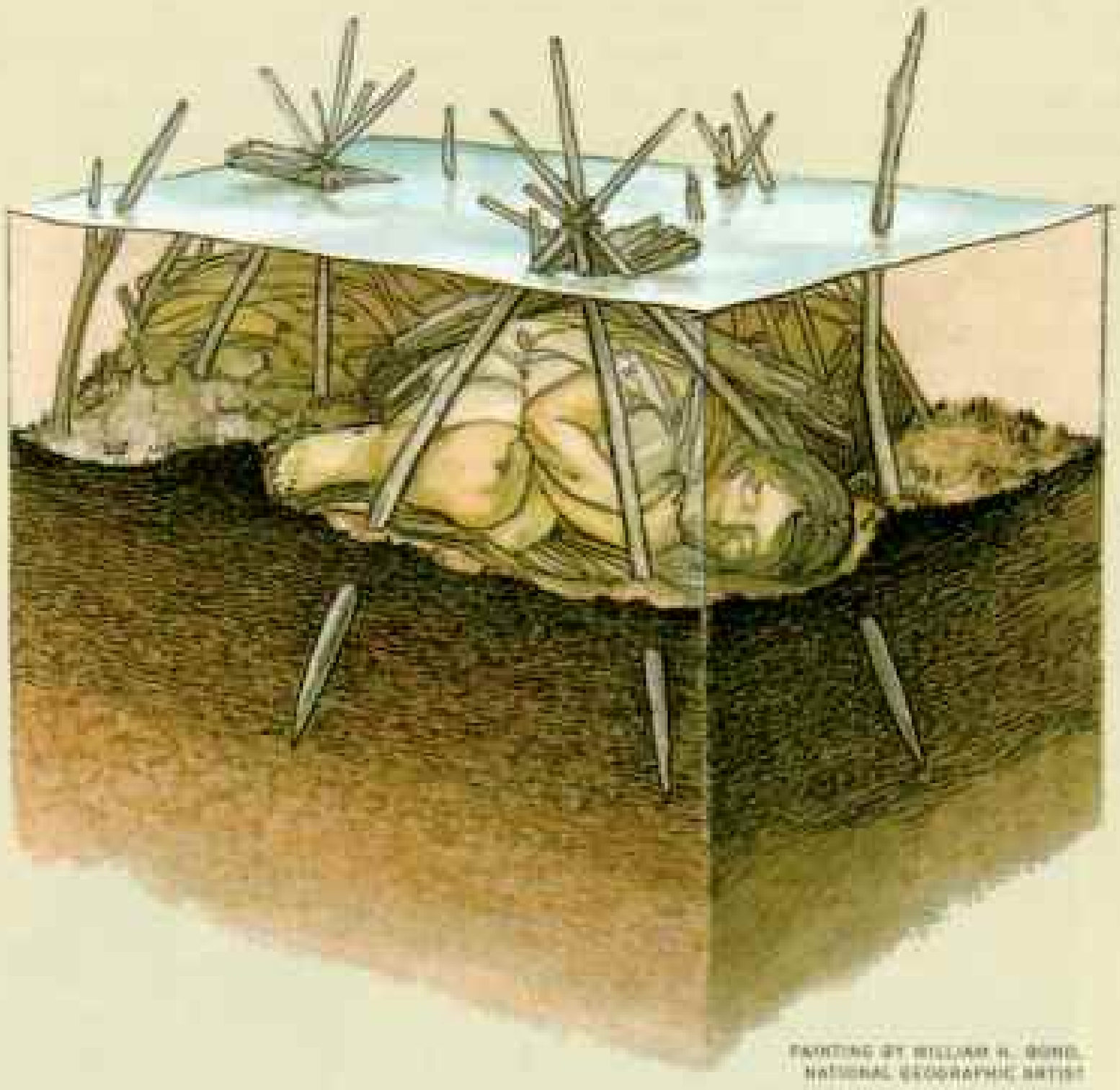
Moving through the west of Ireland, one is seldom out of sight or smell of turf: straight black banks cut into green hills of heather . . . a pile of neatly stacked sods against a stone wall . . . *(Continued on page 410)*



THE BETTMANN ARCHIVE

"Deceived by its smooth appearance," *British aviators Arthur Whitten Brown and John Alcock ended the first nonstop transatlantic flight nose down in a western Ireland bog on June 15, 1919, 16 hours after leaving Newfoundland in a Vickers Vimy bomber, here under guard.*

Peat holds clues to early American life



PAINTING BY WILLIAM H. BOND, NATIONAL GEOGRAPHIC ARTIST

TENDERLY BURIED in a shallow pond in central Florida, the dead of an early American Indian society lay under an ever deepening shroud of peat for more than 7,000 years. Recently resurrected, the bones and artifacts speak poignantly of a little-understood culture and reveal levels of craft previously undocumented in the New World during that era. The site is a genetic gold mine as well—brains preserved in this peat environment have yielded the oldest known human DNA.

Excavation directed by Florida State University began in 1984, two years after a construction crew turned up skulls in a Titusville housing development called Windover Farms. By late 1986 the Windover Archaeological Research Project had uncovered more than a hundred burials dating from 7,000 to 8,000 years ago. Few sites of this age in the Americas have held so large and diverse a group—nearly equally divided between male and female, adult and subadult.

In life they were hunter-gatherers, making seasonal rounds through this region today known for Walt Disney World and the Kennedy Space Center. At death they were placed in the foot-deep pond. Often laid on their side in a flexed position (**above**), they were wrapped in grass mats, then covered with peat and wood. A frame of branches secured the grave.

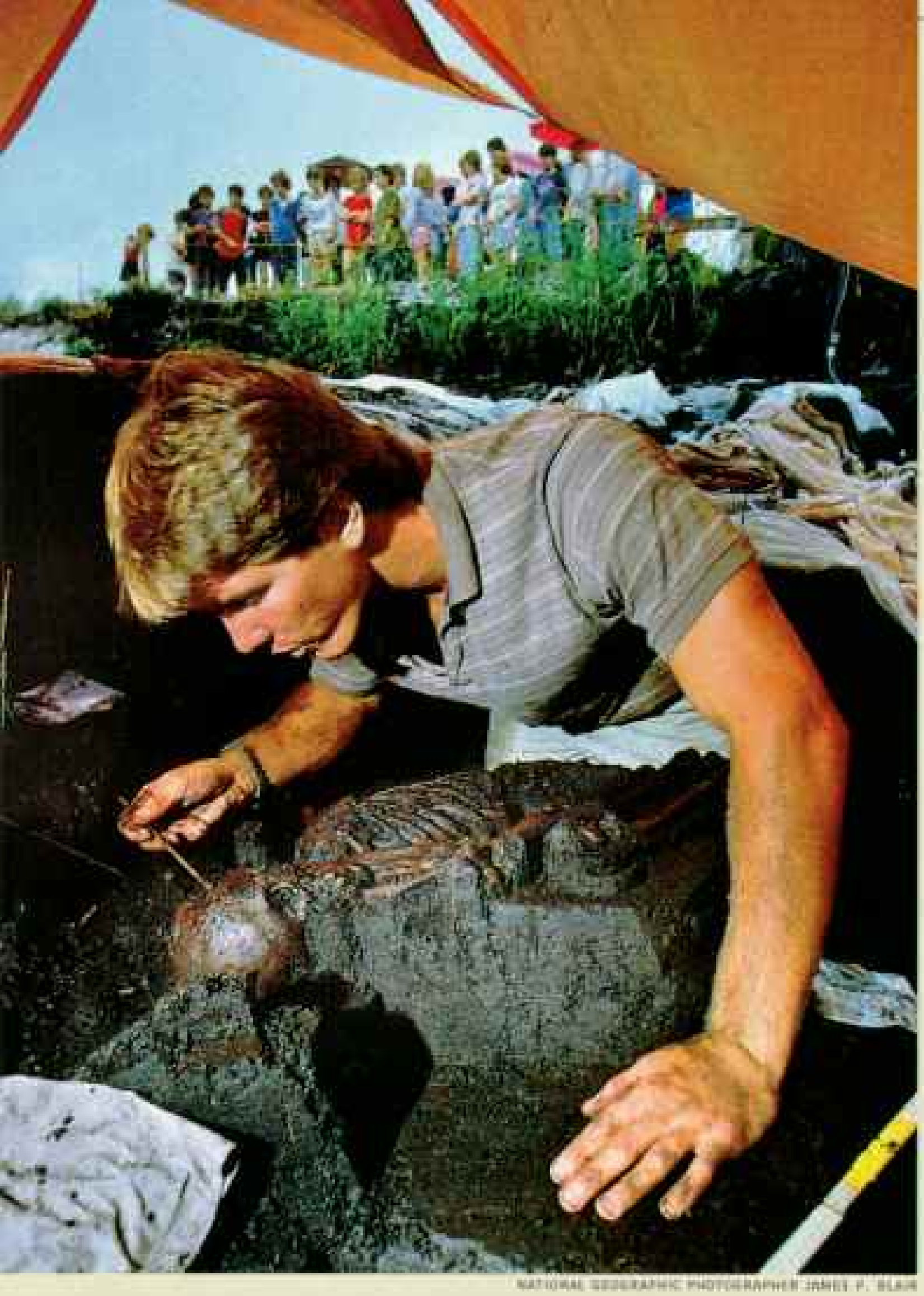
Fabric, perhaps from a blanket or poncho, clung to some skeletons. Analysis by Dr. James Adovasio at the University of Pittsburgh has unraveled five distinct types of weaving more sophisticated than any known in the Americas from that time. Made without a loom, one weave is nearly as tight as a modern T-shirt. "There are lots of simpler ways to make durable cloth," says archaeologist Dr. Glen Doran, director of the excavation. "It challenges our traditional model of hunter-gatherer societies. These people had taken care of the basic necessities of life and had enough time to devote to a very complex nonessential activity." Further evidence comes from the skeleton of a teenager who suffered from a degenerative chronic spinal disorder. "It tells us they could support a nonproductive person for a long time," explains archaeologist and co-director Dr. David Dickel.

"They seem to have been oriented toward doing things for children," says Dickel, noting that the most bountiful grave offerings lie with children and teenagers. Artifacts found include a wooden pestle and a paddle, perhaps used to pound plant fibers for weaving. Antler from deer and bone from manatee, rabbit, and fish were shaped into awls and needles, a small hammer, devices to accelerate spear throwing, and tools of unknown function.

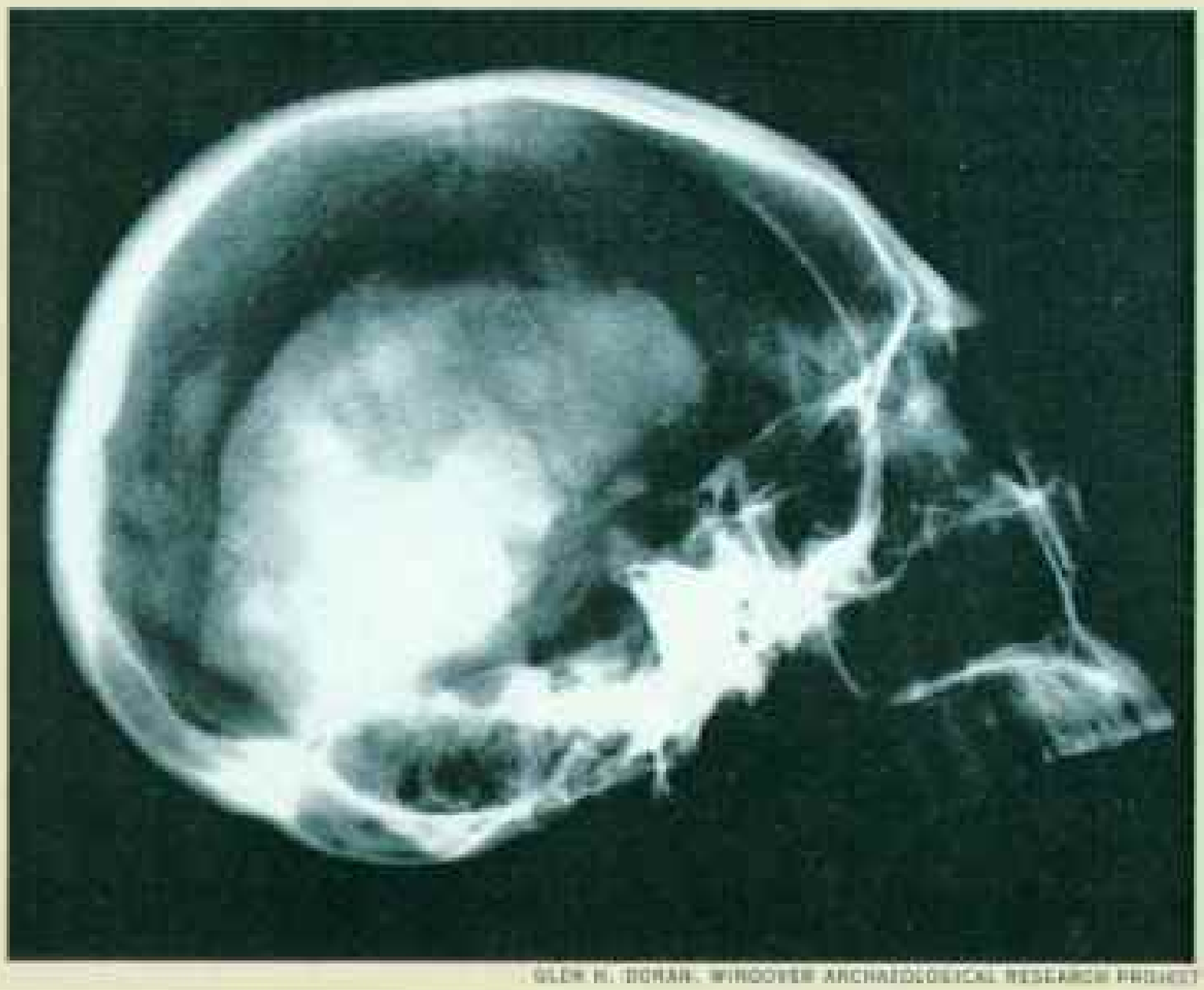
Under a tarpaulin shielding the drained pond, field archaeologist John Ricisak (**above right**) slices peat from the skeleton of a child who died at about the age of the

observing schoolchildren. Even at about 12 years, teeth (***below***) show wear from a diet of rough vegetation such as nuts and cabbage palm.

About ten feet of peat was cleared to reach the burials. Sealed from oxygen and saturated with minerals from Florida peatland waters, the preserved bones contain protein that may reveal diseases this population encountered. Unprotected soft tissue dissolved, but, locked in the skull, a shrunken brain often survived, as seen in this X ray of a middle-aged woman (***below left***). The water's almost neutral pH balance also saved brain DNA. "One of this find's most significant



NATIONAL GEOGRAPHIC PHOTOGRAPHER JAMES P. BLAIR



GLEN H. DORAN, WINDOVER ARCHAEOLOGICAL RESEARCH PROJECT

aspects is that human DNA can be preserved," says Dr. William Hauswirth, a microbiologist at the University of Florida who, in collaboration with biochemist Dr. Philip Laipis, has extracted this genetic-coding molecule from the Windover-site brains. They are trying to clone it. "There are not many things we can do with it now, but it will be a resource for the future when we understand more about human genes."

In anticipation of such advances, the site was not totally excavated. Reflooded, it awaits archaeologists of another generation.

"As if he had been poured in tar, he . . . seems to weep the black river of himself." So Irish poet Seamus Heaney was moved by Grauballe man, found in a bog in Denmark in 1952. His throat deeply slit, he was probably sacrificed about 100 B.C. to bring bounty to his village. Peat acids tanned his skin, reddened his hair, and helped decalcify his bones.

IRA BLOCK, COURTESY MOESGÅRD PREHISTORIC MUSEUM, ÅRHUS, DENMARK

IRA BLOCK, COURTESY SILKEBORG MUSEUM, DENMARK

His last meal *was barley and linseed gruel, an autopsy revealed when 2,200-year-old Tollund man was unearthed in Denmark in 1950. A noose around his neck and the manner of his burial suggest that he too was killed in a fertility rite. Scientists at the time decided to save only his head, covered by an animal-skin cap.*

European bogs have yielded some 2,000 bodies—most dating from 800 B.C. to A.D. 400. Brains preserved there have not retained DNA, probably destroyed by the high acidity of this peat.

pale blue smoke creeping out of a farmhouse chimney. Irish stews are said to derive their special flavor from turf fires. Stories are told and visitors welcomed around the hearth, and omens gleaned from the cooling ashes. At night women bank the fire—bury a burning sod under the ashes to be fanned into flame the next day. Some fires are said to have been burning continuously for a century, or as long as anyone in the family can remember.

"We usually have good weather at Easter, so we cut the turf then," said Eileen D'Arcy. "To tell you the truth, I loathe the work, but it has to be done. We've got good turf in our bog, thank heavens. . . ."

Eileen and her husband, Patrick, live on a rocky peninsula in County Galway on Ireland's western fringe. Nearby is a large bog, which stretches inland for many miles to a wall of mountains called the Twelve Bens.

Here, at the turn of the century, Italian radio pioneer Guglielmo Marconi set up one of the first transatlantic wireless stations. Peat fueled its electric generators. On June 15, 1919, the station notified London of the successful flight of two British aviators, John Alcock and Arthur Whitten Brown, who landed nearby.

Brown later reported: "Suddenly the craft stopped with an unpleasant squelch, tipped forward, shook itself. . . . Deceived by its smooth appearance, we had landed on top of a bog; which misfortune made the first non-stop transatlantic flight finish in a crash. . . ."

The station was burned down in the 1920s during Ireland's civil war, and in the 1940s

the D'Arcys and other families in the neighborhood began to cut turf on the Marconi bog for their own use.

In May, Eileen and her mother-in-law had "footed" the turf—stacked the rectangular sods into small pyramids designed to catch the wind. When I visited on a Saturday late in June, she and her family were going to pile the sods by the side of the bog to be taken home for the winter. I asked her if I might help.

"Another pair of hands is welcome. . . ."

A brisk breeze blew off the ocean, and the clouds moved quickly overhead. For miles in front of us stretched the bog, a rolling carpet of mosses, heaths, and bog myrtle. And when the sun broke through the clouds, the land rejoiced in shimmering shades of purple and vivid greens. Near the D'Arcys' drainage ditch and turf bank, however, the bog was dying. The heath shrubs were as dry and yellow as old straw, and that pleased Patrick. They would be able to support his tractor and wooden cart.

Two of the D'Arcys' neighbors came to give a hand. One, Michael King, 71, whose back was as straight as the handle of a spade, said the bogs had kept him fit all his life. The men could lift a stack of five or six sods and toss them into the cart, but Eileen and I managed only two or three of the five-pound sods with each toss. The dry sods were as rough as coarse sandpaper, sometimes causing our fingers to bleed. No one spoke as we worked. In an hour we had filled the cart with a ton of turf.

"You'll sleep tonight," said Pat.

"I like to see a pile o' turf by the house," he continued. "It means you'll be warm in the winter. I've never minded the work, but I'm not sure how Seán will take to it."

His young son wrinkled his freckled nose. "I want to be a photographer," he said, "and maybe I'll live in Dublin."

"And maybe we won't be cuttin' the turf then," added his father.

Recently, nearby Connemara National Park has acquired the bog and wants to stop all turf cutting on it. The park issued licenses to families like the D'Arcys to make them agree to cut only for their own need and not to pass the turbary rights (the right to cut turf on a specific bank) on to their children. The D'Arcys and their neighbors refused to sign.

"Clearly, turf cutting mars the landscape and is not consistent with the park's principles of conservation," said Connemara wildlife warden Dave Hogan. "My hope is that through education we can increase public awareness about the unique nature of this habitat and save the bog."

IN 1982 a Dutch biologist, Matthijs Schouten, formed what became the Irish Peatland Conservation Council to protect some 109,000 acres of Ireland's remaining virgin bog for scientific research and wildlife conservation.

The bogs are a habitat for snipe and grouse and a wintering ground for white-fronted geese from western Greenland. Certain bog plants are also endangered in Ireland, such as *Sphagnum pulchrum*, a rare moss, and bog orchid. Schouten, who has spent many years studying the Irish bogs, estimates that all unprotected examples of raised bogs will be irreparably damaged in five years and completely destroyed within 17 years.

"I come from a very densely populated country that destroyed its environment," said Schouten. "The price of our industrial development was our landscape. I see the same thing happening in Ireland."

The council's campaign has met with limited success. Though three bog sites have been declared national nature reserves, almost half the raised bogs it designated for conservation have been drained or cut.

I visited Bord na Móna's largest peat-milling operation at Derrygreenagh, 50 miles west of Dublin. It has produced 25 million tons of peat since 1959, mostly to fuel an 80-megawatt power plant nearby. Now the 25-foot peat deposits are nearly depleted, and in some fields the gray clay subsoils have begun to appear.

Ireland's longtime dream of ridding itself of the bogs is close at hand. But now what is to be done with thousands of acres of depleted peatlands?

No one is sure. Afforestation programs have not been very successful. Unlike those of Scandinavia, Ireland's peatlands are too poor in nutrients to support natural tree stands. Pastureland for cattle seems to be more promising. Neither of these alternatives, however, has been as labor-intensive

NATIONAL GEOGRAPHIC PHOTOGRAPHER ROBERT F. SISSON (ABOVE)

It's a plant-eat-animal world *in bogs, where carnivorous flora probably evolved. Captured prey provide much of their nutrients. Digestive enzymes slowly dissolve a young grasshopper* ***(left)*** *in the rain-filled throat of a pitcher plant in North Carolina. Native to the Americas, more than ten species are known. Tiny hairs on the lid of the plant may direct insects, lured by color and the scent of nectar, into the slippery cavern.*

An inopportune fall from taller vegetation lands a caterpillar in the clutches of an English sundew ***(left)****. Mucus glistens from glands on its leaves, which enfold and digest meals—usually flying insects. More than 90 species are found worldwide.*

Buoyed by small air sacs, bladderwort floats among water lily stems in a New Hampshire bog pond ***(right)****. When aquatic animals trigger sac hairs, the sacs open and suck in food ranging in size from microscopic protozoans to tiny mosquito larvae.*

Menacing to no creature, the prairie fringed orchid ***(above)*** *is itself close to being listed as endangered. Draining of its native bogs and wet prairies makes it an increasingly rare sight in the U. S.—and a target for unscrupulous orchid collectors.*

as peat production, and some people worry that dreaded unemployment will return to the midlands once the bogs are gone.

"This was a very depressed area 30 years ago," said Pat O'Connell, works assistant at Derrygreenagh. "People worked 14 hours a day on the farms and were getting nowhere. Bord na Móna changed all that. I hope that we can improve the soil enough to grow trees for pulp to fuel the power plant. Biomass production will require about the same amount of labor and will hopefully maintain the standard of living here."

Bord na Móna is exporting its expertise to other countries. Since 1979 it has sent advisers to Burundi, a small, heavily populated African country whose forests (the main source of fuel) are expected to be depleted in less than ten years. Burundi is now harvesting some 16,000 tons of peat annually. Bord na Móna has a pilot project under way in neighboring Rwanda and has completed feasibility studies in Indonesia, where satellite mapping has identified large reserves of untapped peat resources. Peat may lessen the Third World's costly dependence on imported fuels and spur development.

Finland, a world leader in peat technology, is competing vigorously with Ireland for a larger share of the world market. Clearly impressed with Finland's dazzling modern methods of peat harvesting, the Jamaican government has asked for help in developing two major peat deposits on its western coast, which are expected to supply 30 to 40 percent of the island's current electricity needs.

FINLAND is one of the richest countries in peatland resources. *Suo*, or mire, is typical of the Finnish landscape and may be responsible for the country's name in

Finnish, Suomi. More than half of Finland's 25 million acres of peatland have been drained for forestry. Mature pine, spruce, and birch forests will develop on these nutrient-rich peatlands in less than 50 years. In northern Finland, peatlands are used mainly—as they have been for hundreds of years—for reindeer husbandry, berry picking, and grouse shooting. Here, as in northern regions of Canada, Alaska, and the Soviet Union, a lens of permafrost sometimes forms in the bogs, pushing the peat into cones or strange amoeba-like humocks called *palsas*. Palsas 30 feet high have been reported in central Siberia.

Finland's use of peat as a fuel is minor, but government research is aimed at increasing it to meet close to 10 percent of the country's energy needs in the next decade. With new techniques the peat can be taken off the bog as a wet slurry and then pumped to a processing plant to be dried by means of compression or suction.

"If we can make this system economically feasible," said Timo Nyrönen, director of research and development for the state-managed fuel center, "it will be an important breakthrough in the peat industry. We will be able to guarantee peak supplies without worrying about the weather. And, we can get peat from areas around the world where ditching is now impossible or deposits are too shallow."

Peat seems to be following the course of crude oil, which is fractionated and refined into a host of valuable by-products. In a factory near Minsk the Russians are producing mineral wax from peat to be used in leather polishes, crayons, and plastics. They also make a cream from peat for the treatment of eczema, ulcers, and burns, and an eye medication that they claim can reduce

Sacrifices in the mysterious bog *by the Bronze Age and Iron Age people of Denmark were often buried with ritual offerings. Dating from about 1400 B.C., a bronze horse pulling a gilded disk* ***(left)*** *may be a miniature version of a ceremonial wagon used in a solar fertility cult. Worship later centered on the earth mother. A bronze neck ring from 600 B.C.* ***(below)*** *resembles torques found on statues of the goddess. Peat also preserves pollen grains that help date bog artifacts.*

BOTH BY SISSE BRIMBERG, COURTESY THE NATIONAL MUSEUM, DENMARK

***The sweet aroma of turf**—as the Irish call peat—drifts from the hearth (**below**) as bread bakes in a cast-iron pan topped by the flavor-enhancing embers. Bogs cover about 16 percent of Ireland, and commercially harvested peat supplies 21 percent of the country's electricity. But each spring many families still hand-cut their fuel for heating and cooking. In a blanket bog along the northwest coast, Ann Healy (**right**) hoists sods into a horse-drawn cart. A tractor hauls larger loads. The consistency of butter when cut, and about 95 percent water, sods dry in rows and stacks on the Isle of Lewis in Scotland's Outer Hebrides (**bottom**). The island's weavers have used peat and bog plants to dye their famous tweeds.*

nearsightedness. The Finns and Russians have used peat as an absorbent agent in oil spills; a bad one in the Baltic Sea a few years ago was cleaned up with peat products.

"In 30 years I think we will realize that peat is too valuable to burn," said Nyrönen.

Medical applications of peat go back to ancient times, and in the 19th century mud baths of peat were first used to treat rheumatic diseases in fashionable European spas. During World War I the Germans applied peat mosses as surgical dressings in the field and found them helpful in controlling infection. For the past 20 years a German physician, Dr. F. W. Nebel, has used high-temperature peat baths in the treatment of amputees and injured athletes.

"In peat, heat is transferred molecule to molecule, not by convection the way it is in water," said Dr. Nebel. "Thus, a temperature of 45 to 48 degrees Celsius [113 to 118 degrees F] can be tolerated, which would be unbearable to a person bathing in water. After 30 minutes in a peat bath, a patient's body temperature rises one degree, dramatically increasing circulation of blood to injured areas and reducing pain."

UNTIL RECENTLY the United States was too concerned with developing its rich coal and oil resources to pay much attention to its hundred million acres of peatlands. We were blessed with productive farmland from coast to coast and largely ignored our difficult wetlands, except as a source of horticultural peat.

In 1985, 22 states harvested a total of 839,000 tons of peat moss (with an average sales value of 20.8 million dollars), primarily for use as potting soil and general soil

conditioners. Florida is our leading peat producer, followed by Michigan, Illinois, Colorado, and Indiana. That year more than 30,000 tons of peat went into golf courses, 3,800 tons into mushroom beds, and 1,800 tons into earthworm culture.

Many of our peatlands were turned over by treaty in the last century to American Indians—who had always prized them. The Micmac and Penobscot tribes in Maine used peatland plants for medicines and charms and fashioned strips of dried sphagnum moss into baby diapers. The Minnesota and Michigan peatlands supported woodland caribou, prime source of food for the Chippewa. Although the caribou have moved north into Canada, the Chippewa today still fish on the lakes bordering Minnesota's "Big Bog" and harvest wild rice from canoes. Indians in Wisconsin, Massachusetts, and New Jersey's Pine Barrens taught early settlers to use wild cranberry, a native bog plant, whose cultivation today has grown into a 600-million-dollar annual business.

Ninety percent of U. S. peatlands are too acidic to grow crops. Some 650,000 acres near Belle Glade, Florida, however, are naturally rich in calcium from seepage water. In the early 1900s, when the proper trace elements—copper, zinc, and manganese—were added to the soil, Belle Glade became the largest area of cultivated peatland in the world. Since we stopped importing sugar from Cuba, Belle Glade has been one of the country's major producers of sugarcane.

THE OIL CRISIS of the 1970s made the development of our peat resources for fuel more attractive. Maine, for instance, holds 500,000 acres of peatland, and Minnesota some seven million acres—twice as much as Ireland. As the oil crisis waned, so did the interest in peat as a fuel. Today peat is considered economically feasible only in those regions far away from oil, coal, or gas fields. North America's first peat-fueled power plant is under construction in coastal Maine, and is expected to feed into the Boston Edison grid by 1989.

The threat of exploitation led state and other agencies to take a closer look at peatlands. Maine and Minnesota have identified dozens of "ecologically significant" sites for conservation and are establishing guidelines for development. The National Science Foundation has completed a four-year study of 55 peatlands from Manitoba to Newfoundland. It is the first comprehensive look at a large band of wetlands across North America.

Peatlands are the only ecosystems in which the plants play such a large role in controlling their physical environment. Mosses and sedges can change the water chemistry of a bog, which, in turn, can alter its plant and animal life. The dynamics of this interaction, however, are puzzling.

"Unlike Europe, our peatlands are still in pristine condition, and we have a chance to understand how this ecosystem works," said Paul Glaser, a botanist at the University of Minnesota's Limnological Research Center.

Paul, who worked on the National Science Foundation project, is particularly interested in Minnesota's Red Lake Peatland, which covers 460 square miles and, because of its unusual landscape patterns, is considered of international importance by ecologists. I joined Paul and scientists from Minnesota's Department of Natural Resources on a summer field trip to Red Lake.

The best way to move over this vast and difficult terrain is by helicopter, but few pilots will fly into Red Lake. Lee Andrew, a former bush pilot, had attached flat wooden paddles to the runners of his Hughes helicopter so it wouldn't sink into the peat. After he dropped the scientists off to take a core sample, he swung up to 3,000 feet.

From there the expanse of sedges interspersed with clusters of trees forms distinct patterns. The sedges resemble a mile-wide river that flows east for about 20 miles. In this water track, as the ecologists call it, are dozens of teardrop-shaped islands of tamarack trees with long streaming tails of dwarf

Dairy cows graze on a recycled bog *near the electric power plant in Derrygreenagh, Ireland. Here peat to fuel the power station is scraped into a powder by machine, then allowed to dry. Within 50 years the country's commercial peat will probably be depleted and some land reclaimed for agriculture or pulpwood forests.*

birch. They look like a naval fleet heading out to sea. The track itself is patterned with ridges of higher ground (called strings) and linear pools (flarks), like waves on a choppy ocean. The gradient over this area is about three feet, and the water flow so slight that ecologists haven't found ways of measuring it accurately. Peat has been accumulating for 3,000 years, so erosion is not a factor. Yet formidable forces are at work to create this dramatic landscape. But what forces?

Lee dropped me off where Paul was working at the beginning of the water track. With a bread knife he was cutting out a chunk of peat below the tangled roots of the sedges.

The healing properties *of hot peat soothe a rheumatism patient in a spa in Bad Prymont, West Germany. Touted for diverse disorders—from muscle injuries to female infertility—peat baths can be taken at temperatures that would be close to scalding in water. Steroids in peat may contribute to the therapy.*

"After about 2,000 years there was continuous peat cover here," he said. "And plants, no longer rooted in the mineral soil, received most of their nutrients from water moving through the peat. At that point, water flow patterns became critical in the development of the peatland."

He lifted a block of peat about a foot thick. Water poured out of it.

"Clearly some types of peat are more permeable than others," he continued. "That sets up a channeling system, which, I believe, eventually evolves into well-defined water tracks and denser islands of vegetation. We'll see. These samples along the water track should tell us something."

By late afternoon he had collected his samples. The coring team had also finished, and the men climbed into the helicopter. It would take them months to reconstruct the succession of plant communities in the cores—and perhaps learn more about how the bog complex had developed.

Suddenly Lee revved the copter's engines and shouted to me, "Stay where you are!"

The helicopter was full. He would be back to pick me up.

"You won't forget where I am?" I was half joking. Half not.

"That's the way out," Lee said, half seriously. He pointed east. "About 30 miles."

When the rush of the wind from the rising helicopter subsided, I was assaulted by every fly and mosquito in the area. I felt like an alien invading their world. The truth is, all your senses mobilize on a bog, urging you to get out. The wet, sinking ground is as unsettling as feeling your house shake in an earthquake. I could understand the ancient Europeans' reverence and caution in this somber environment. But it is just that fear, coupled with isolation, that has kept this wilderness pristine.

The sun set against the jagged profiles of the tamaracks. The mosses turned deep red and purple. I saw a mouse move through the tall sedges. And, I thought to myself, what an unspeakable delight it is to look on a landscape unchanged in thousands of years and virtually untouched by man. That is the bog's great gift to the venturous: to experience a profound isolation and a sense of time becoming timeless.

The helicopter returned too soon. □

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BUCKLE UP FOR SAFETY.

Americans and the outdoors

UNDERSTANDING other cultures is at the heart of our work at the Geographic, but I always thought I grasped where my fellow countrymen stood on certain issues. I received some pleasant surprises while serving on the President's Commission on Americans Outdoors, which I discussed in our October issue. Its findings have now been submitted to the administration.

Time after time, in hearings around the

WILLIAM T. DOUTHITT, N.G.S. STAFF

U. S., I was amazed by the enthusiasm people had for the outdoors and by their grasp of the policies that affect it. A nationwide telephone survey produced similar results: Americans know what they want in the way of outdoor recreation, and they are quite clear on where federal responsibility ends and their own begins. More than 80 percent support higher taxes if that means better outdoor opportunities, and they believe that an individual who enjoys a national resource should pay a fee for that privilege.

Grass-roots understanding couldn't come at a better time, for today may be the most opportune time to secure our outdoor needs.

On the one hand, open spaces continue to disappear under the rising tide of development. The loss is particularly keen in the case of our wetlands, which offer recreation as well as nurturing waterfowl and marine life. On the other hand, potential recreation areas are being created by economic change. Anyone who has traveled in once thriving industrial corridors of the 1930s and '40s has seen vacant factory complexes. Why not convert them to parks, playgrounds, and community recreation halls? The commission's study revealed that Americans take their outdoor recreation closer to home than they once did. We need outlets for those energies, especially in our inner cities.

This is not an easy time for governments to initiate costly programs. And in fact, money authorized for outdoor recreation has not been appropriated for that use. In 1965 the Land and Water Conservation Fund was established for outdoor recreation and conservation, drawing its revenue mainly from royalties on oil and gas sales. Unfortunately, most of that money has been frozen to cover deficits in other government sectors. The fund expires in 1989; an ironclad successor could be created.

That sort of thing can happen if people let their governments know what they want. An outdoor renaissance should start at the local level—what the commission chairman, Governor Lamar Alexander of Tennessee, calls "lighting a prairie fire."

That means letting politicians know your priorities. It means forming community action groups to assess local recreation needs and advise local and state governments about planning for them. It means rolling up your sleeves and helping create parks and trails when needed. It means learning to live in harmony with nature instead of watching it be bulldozed into man-made clutter.

I think I've learned something about people in this country through my work on the commission. I think they care enough to light that prairie fire and make it burn for a better outdoors.

Gilbert M. Grosvenor

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Members Forum

Columbus Landfall

The November 1986 issue will certainly become a landmark in geographic history. The Columbus landfall research enhances the position of the Society as the world's leader in the diffusion of geographic knowledge.

A. E. Klamm
Post Falls, Idaho

Can the true landfall location really be such a pertinent issue after nearly 500 years? After all, there can be no final conclusion to the mystery.

John R. Baldwin
Cayce, South Carolina

Congratulations on a superb aggregation of articles and maps on Columbus. I find little to disagree with except Luis Marden's conclusion that the Iberian sea league was equivalent to 2.82 modern nautical miles. The preponderance of evidence points to the equivalent length of four Roman miles of 1,480 to 1,482 meters, or 3.2 nautical miles of 1,852 meters. This is supported by the testimony of Ferdinand Columbus at the Badajoz conference of 1523-24 and by Jaime Ferrer in 1494 when that cosmographer's views were requested by a Spanish crown commission. NATIONAL GEOGRAPHIC has, however, enriched Columbiana immeasurably.

Fred F. Kravath
Tucson, Arizona

Our 2.82-nautical-mile computation based on practical sailors' manuals seemed more convincing. Also it closely matches Columbus's distances on interisland passages as we plotted them.

I was absolutely fascinated with the magnificent job of retracing Columbus's first voyage. I am convinced that Samana Cay is his landfall. My congratulations for the very professional job by all. Is it certain that replicas of the ships will be built and sail in 1992? If so, I will definitely plan a trip to Spain to look at these wonderful ships.

Beto Derat
Burlington, Ontario

You may write to: Luis Yañez, Chairman, Comisión Nacional Española, 4 Avenida de los Reyes Católicos, 28040 Madrid, Spain.

The evidence presented is persuasive with the exception of the purported match between Columbus's *laguna en medio* and the linear lake on Samana. The latter cannot be construed as very

large or in the center of the island. As a geologist, I offer an alternate explanation. Extensive temporary karst lakes may form in limestone bedrock when sinks become blocked by soil, vegetation, or rock rubble, preventing rainwater from pouring into subterranean passages. Such karst lakes, characteristic of north-central Florida, flush out a clay plug irregularly and drain, only to fill at some later date. The laguna en medio may have been caused by this phenomenon.

José J. Valdés
Silver Spring, Maryland

Mr. Judge's article is a decided coup. The thoroughness and comprehensiveness of his work are persuasive. I was glad to see Jack McElroy get his due in the charts, if only in exposure of his errors. That is all we can reasonably hope for: that our mistakes will confer upon us a measure of immortality and not be merely the signs of mortal fallibility.

John C. Broderick
Washington, D. C.

International Red Cross

Your fine article on the International Committee of the Red Cross (November 1986) restored my hope for what seems a desperately hopeless world. Could you include an address for ICRC?

Larry E. Thompson
Chester, Maryland

ICRC
17, avenue de la Paix
1202 Geneva, Switzerland

With the ouster of South Africa, ICRC becomes just one more international, ideological, leftist, anti-West player like UNESCO.

David Carl Kolpacoff
El Cajon, California

ICRC did not oust South Africa. Last October the XXVth International Conference of the Red Cross, which included diplomats from 115 nations, voted to suspend South Africa's delegation from that conference only. Then South Africa asked ICRC delegates to leave its country, a decision since reversed.

One has to admire the fine humanitarian work of the ICRC. And yet I cannot help but wonder, where was the ICRC during the Holocaust?

Carl Bergman
Kew Gardens, New York

The Nazis rejected ICRC's repeated attempts to visit concentration camps from 1939 on. Weeks before war's end, ten delegates were permitted to enter four camps, including Dachau, bringing relief and helping prevent the destruction of the camps as ordered by Hitler. Today ICRC supervises ITS, the International Tracing Service, in

Arolsen, West Germany, which helps survivors certify where and when they were held.

Your otherwise informative map on pages 652-3 depicts the war in Afghanistan as an internal armed conflict. In fact, over 100,000 Soviet troops are inside the country, engaged in violent and continuous conflict against Afghan patriots. Had the Soviet Union never invaded Afghanistan, there would be no war there today.

James Michael Johnson
New Lexington, Ohio

Missing in Action

Your MIA article (November 1986) told the story of Richard Castillo, who was shot down during the Vietnam War. As a former Vietnam vet (USMC 1966-1970), I became a wearer of a POW-MIA bracelet, to be worn until the fate of the POW-MIA was determined. Mine bears the name of Richard Castillo, 3-29-72. Now that I know his fate, I will continue to wear it. Tell his wife at least one American never has and never will forget him.

Joseph T. D'Agostino, Jr.
Manahawkin, New Jersey

Thank you for sending me Joseph D'Agostino's letter. It is so heartwarming to know a stranger cared that much. He is one of several who wore Richard's bracelet. The fact that our country is able to produce such unselfish, caring individ-

uals gives meaning to my husband's sacrifice and makes my own grief more bearable.

Peter White's superb article has received many favorable comments. When the Central Identification Laboratory notified me that Richard's remains were among those recovered, I asked Dr. Michael Charney, a noted forensic anthropologist at the University of Colorado, for a second opinion. After examining the remains and consulting a dental expert, he concurred. That opinion, in addition to your story, provided pieces to the puzzle that I desperately needed in order to finally know in my heart that my beloved Richard did not survive. I am at peace now, knowing he is with God and his remains lie in the country he loved and served willingly.

Elizabeth L. Castillo
Corpus Christi, Texas

Your article had special significance for my husband, a Vietnam vet. After he read it, he handed me the magazine and said, "That was my plane." At the last minute he had been changed to another crew. During that flight he heard that his friends were shot down. I can only imagine his thoughts and feelings. Now he won't have to wonder if his friends were ever found.

Mrs. William L. Davies
West Creek, New Jersey

My uncle Irving Burns Ramsower II died on that plane. The gun shown on page 694 was his. He

was identified by two teeth found at the site. The Air Force gave him a dramatic funeral at Arlington Cemetery last September, with a horse-drawn wagon, four jets screaming over (one missing), and an intense flag-folding ritual. I can't express how important the funeral was for the entire family. I had no idea of all the work it took to recover the few things that they did. I hope others still waiting for their MIAs will see this as a shiny hope for themselves to be free.

Jane A. Howell
Brooklyn, New York

For half my life, since junior high school, I have been wearing a bracelet inscribed with the name Maj. Henry Brauner, 3-29-72. It was the only piece of jewelry I was allowed to wear during boot camp when I joined the U. S. Navy. It was with me for five years of active duty, and when I was courted by a young Annapolis grad. I wore it on my wedding day and will have it on my arm when I give birth to my first child shortly. I have prayed for this man because I know God knows what happened on March 29, 1972. Could this article have been the answer to my prayer?

Norma McClean
Warminster, Pennsylvania

I understand that about 78,000 members of the armed forces were unaccounted for after World War II. Sailors went down with ships; airmen plowed in from the heights; people were blown to smithereens. Sad but true, some decided to quit the war, assume another identity, and never come home. Occasional sightings of Americans in Southeast Asia may represent this category. Let 'em be. It's over.

Frederick H. Krauss
North Andover, Massachusetts

Tokyo

As a traveler who has lived in Asia and understands the weaknesses of Asian cultures, I would strongly suggest that we Westerners take a hard look at the openness, tactfulness, and emphasis on close human relationships that make Asia such a wonderful place in which to live and work. Your articles on Micronesia (October 1986) and Tokyo (November 1986) effused this spirit of togetherness and drive that has brought the Micronesians to independence and the Japanese to social and financial strength.

Samuel A. Cox
West Chester, Pennsylvania

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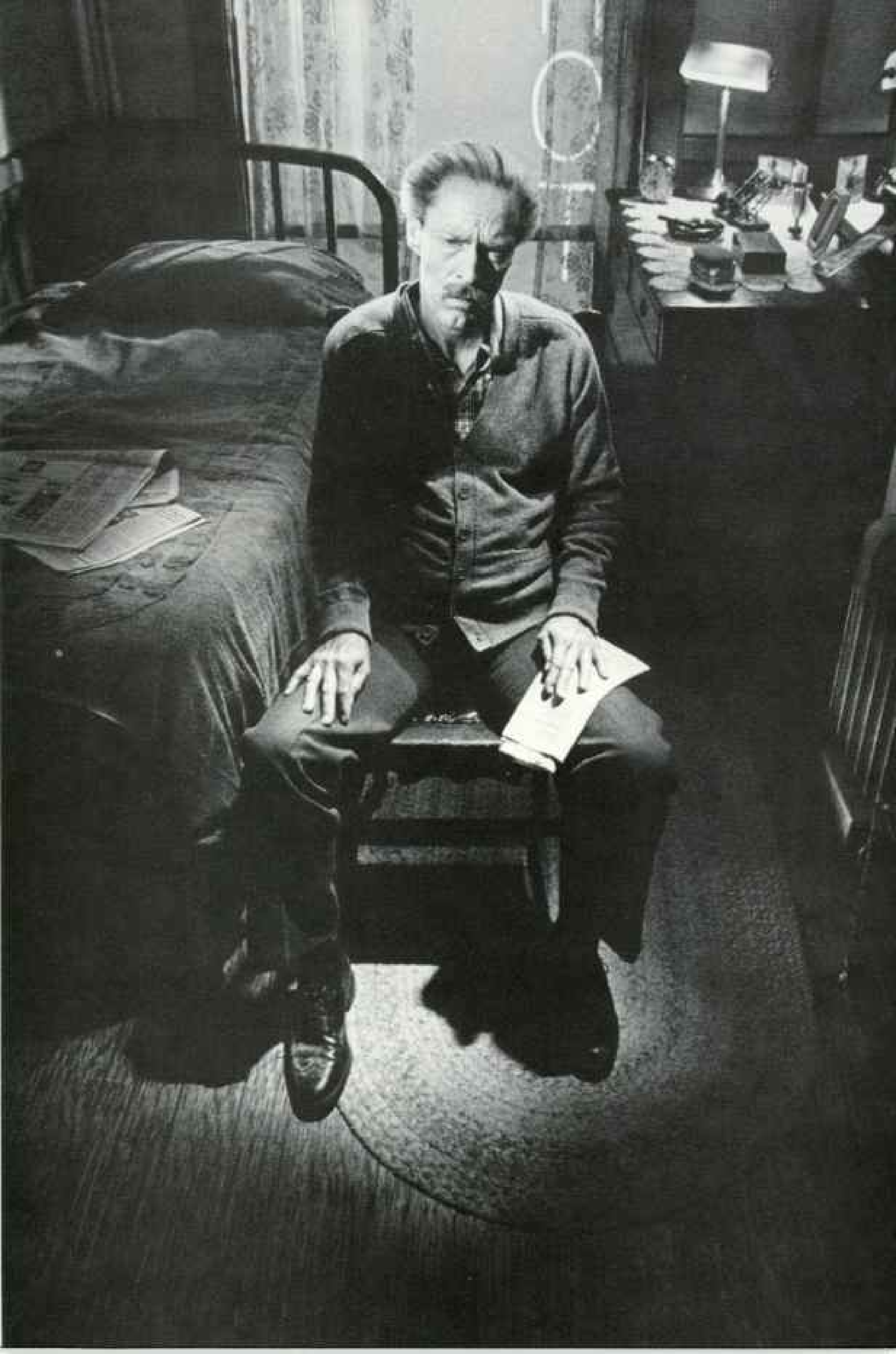

MOST OF US DREAM ABOUT RETIRING SOMEPLACE AND TAKING IT EASY.

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That's human nature. During the years we're making it, most of us are also spending it like there's no tomorrow. And there won't be much of one, if there's too little to retire on.

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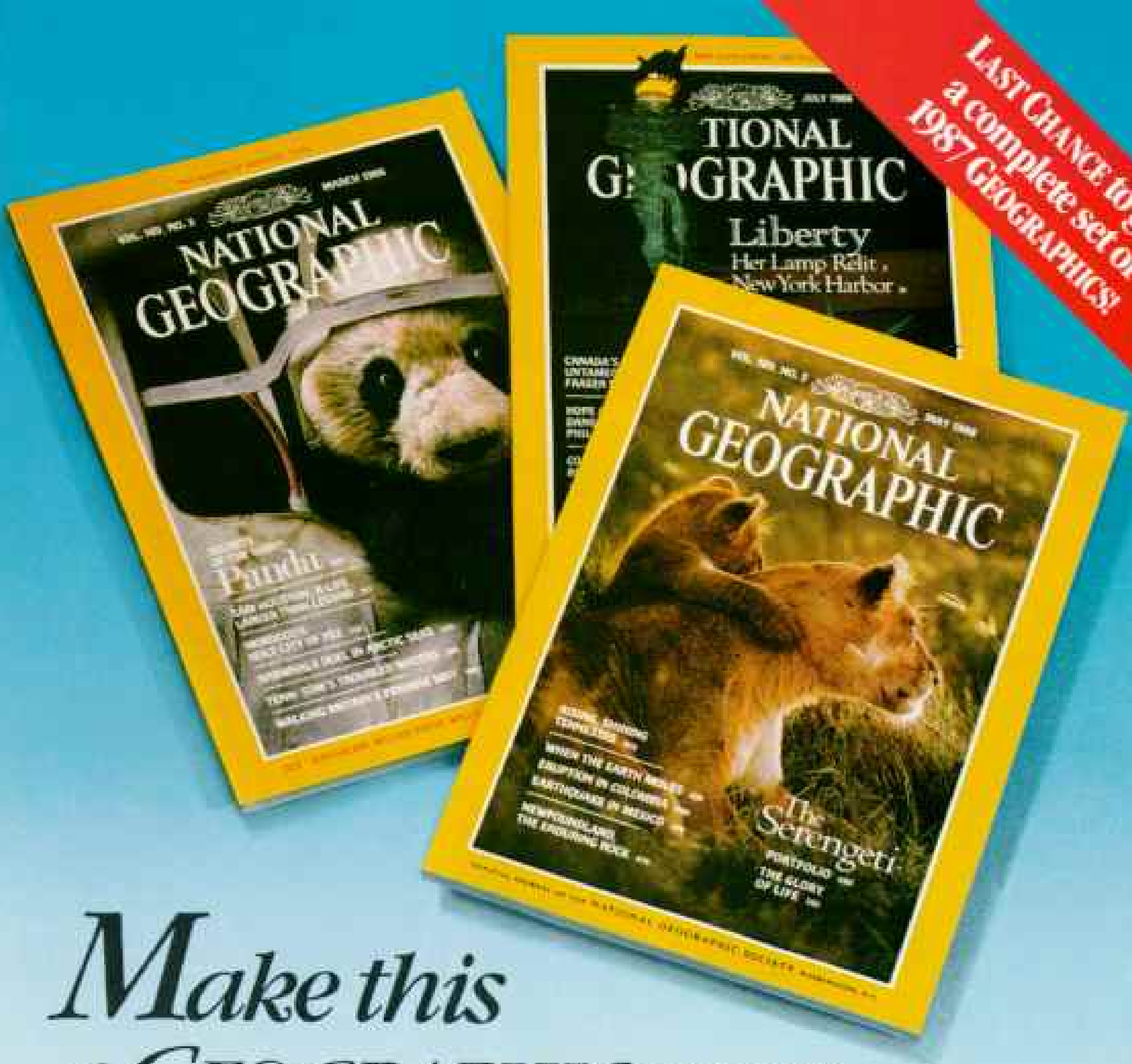
HONDA

Civic 4-Door Sedan



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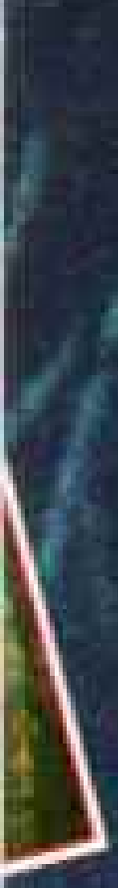

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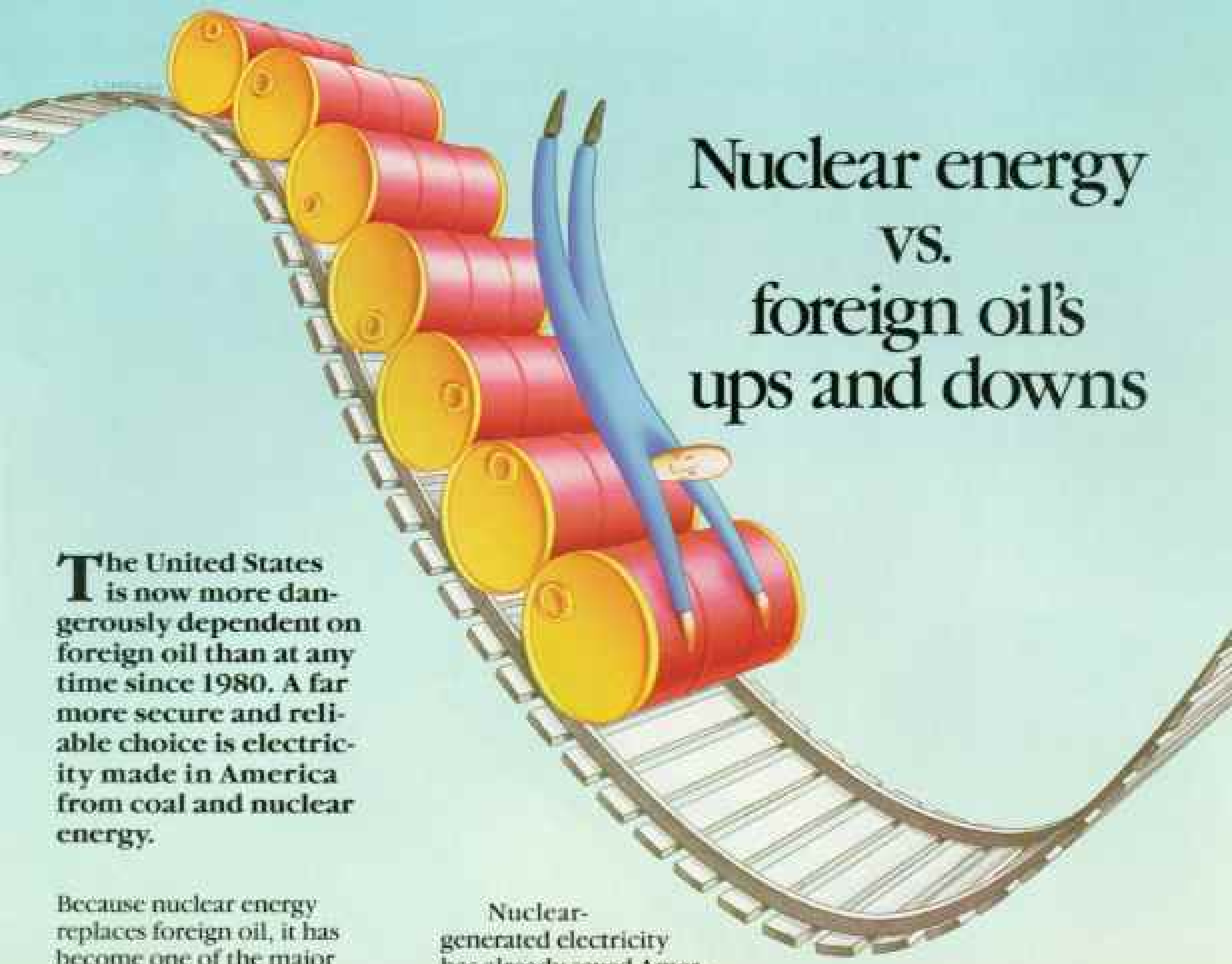
Nuclear energy vs. foreign oil's ups and downs



The United States is now more dangerously dependent on foreign oil than at any time since 1980. A far more secure and reliable choice is electricity made in America from coal and nuclear energy.

Because nuclear energy replaces foreign oil, it has become one of the major pillars of America's energy independence.

Going back to the great energy crises of the 1970s, the price of foreign oil has resembled a giant, dizzying roller coaster ride. The *availability* of foreign oil has also dropped down and shot back up. And we don't even control the roller coaster—others do.

Consider this ominous statistic: in 1986, even at today's low prices, America had to pay about $30 billion for foreign oil. That's a lot of dollars leaving this country, adding to an already huge trade deficit.

Nuclear energy cuts oil imports

Clearly, the more electricity we use from coal and nuclear energy, the less oil we have to import.

Nuclear-generated electricity has already saved America over two billion barrels of oil, with billions more to be saved before the turn of the century. That's why it's so important for our energy self-reliance.

More electricity for a growing economy

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The truth is that nuclear energy is an everyday fact of life in the U.S. It's been generating electricity here for nearly 30 years. Throughout the country are more than 100 nuclear plants, and they are our second largest source of electric power. As our economy grows, we'll need more of those plants to avoid even more dependence on foreign oil.

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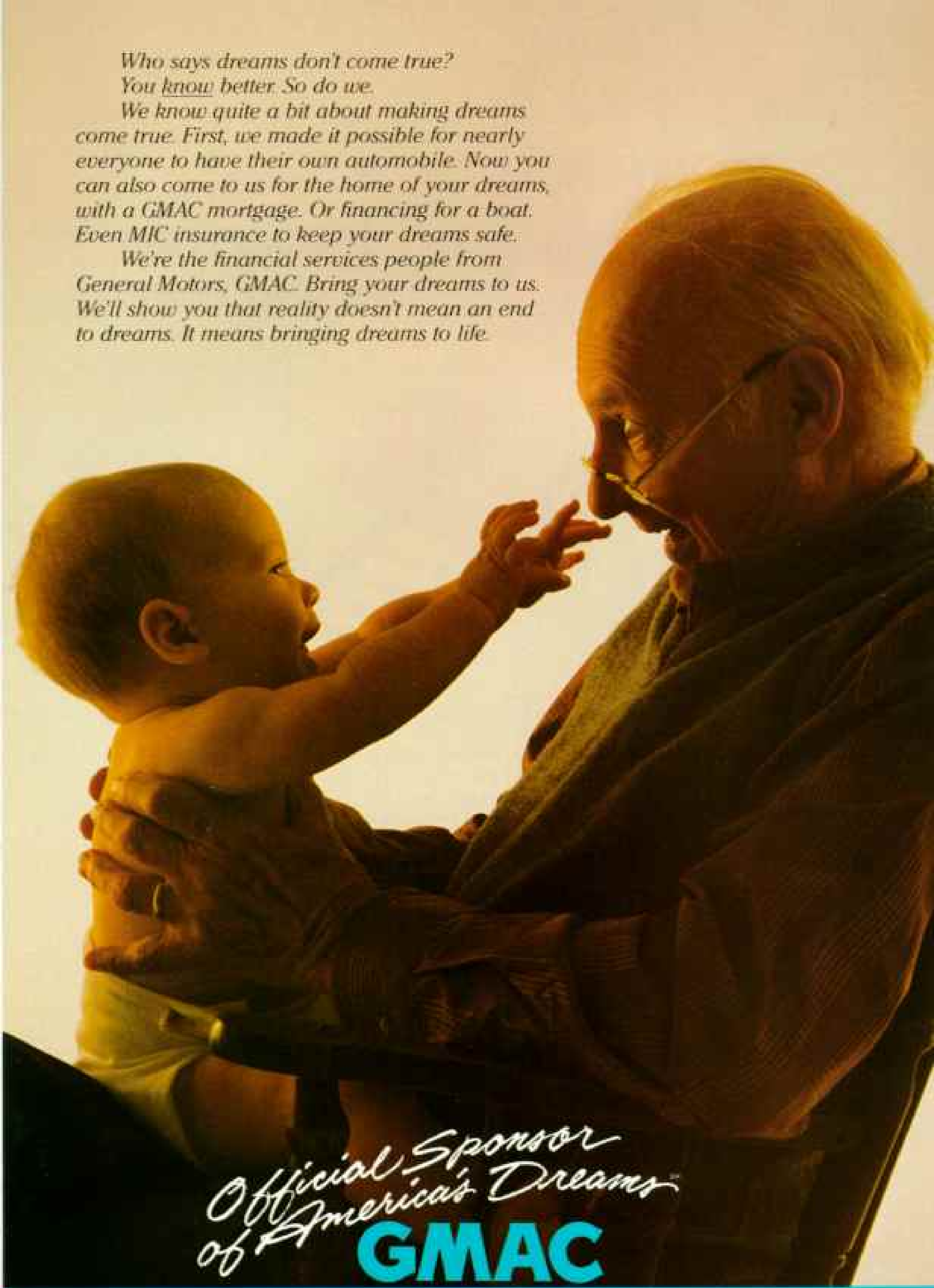

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On Assignment

ANDRÉ MORAES BARROS

THEY CALL IT the "Anthill," and free-lance photographer ***Stephanie Maze*** learned why on a tour of the Serra Pelada gold mine, carved out of a mountainside in northern Brazil. Since 1980 an army of impoverished Brazilians has swarmed over this vast pit. And at the time of Stephanie's visit for NATIONAL GEOGRAPHIC, the tide of humanity consisted solely of men.

"It was the first time I'd ever been alone with 60,000 men," said Stephanie (***above***). "It was an incredible experience. The longer I stayed in one spot, the more men gathered, and work there came to a standstill."

Although the men labored by hand, they feared that mechanization would soon cut back their jobs. "There is a huge need in Brazil for jobs, for land," Stephanie found as she spent seven months traversing the enormous nation for this issue's article. "In the states of Pará and Rondônia, the frontier for new settlement," she says, "it's like the Old West of the U. S. Many people carry guns and take the law into their own hands."

A passion for things Latin has always driven Stephanie. In addition to this, her sixth GEOGRAPHIC assignment, she photographed for us Spain's Catalonia, the Douro River in the Iberian Peninsula, Puerto Rico, Mexico City, and Mexican Americans. Raised in Germany, she has lived and worked in San Francisco and Washington, D. C. In 1976, 1980, and 1984 she served as an international pool photographer for the Summer Olympics in Montreal, Moscow, and Los Angeles.

But Brazil truly changed her life. "In many ways, Brazilians live out their fantasies on a daily basis," she adds. "For the gold miners, it's their dream of El Dorado. For the people in Rio de Janeiro, it's the craziness of Carnival." And for Stephanie herself, it became an apartment in Rio, where she has moved, giving her a central base from which to cover her favorite subjects in Central and South America.