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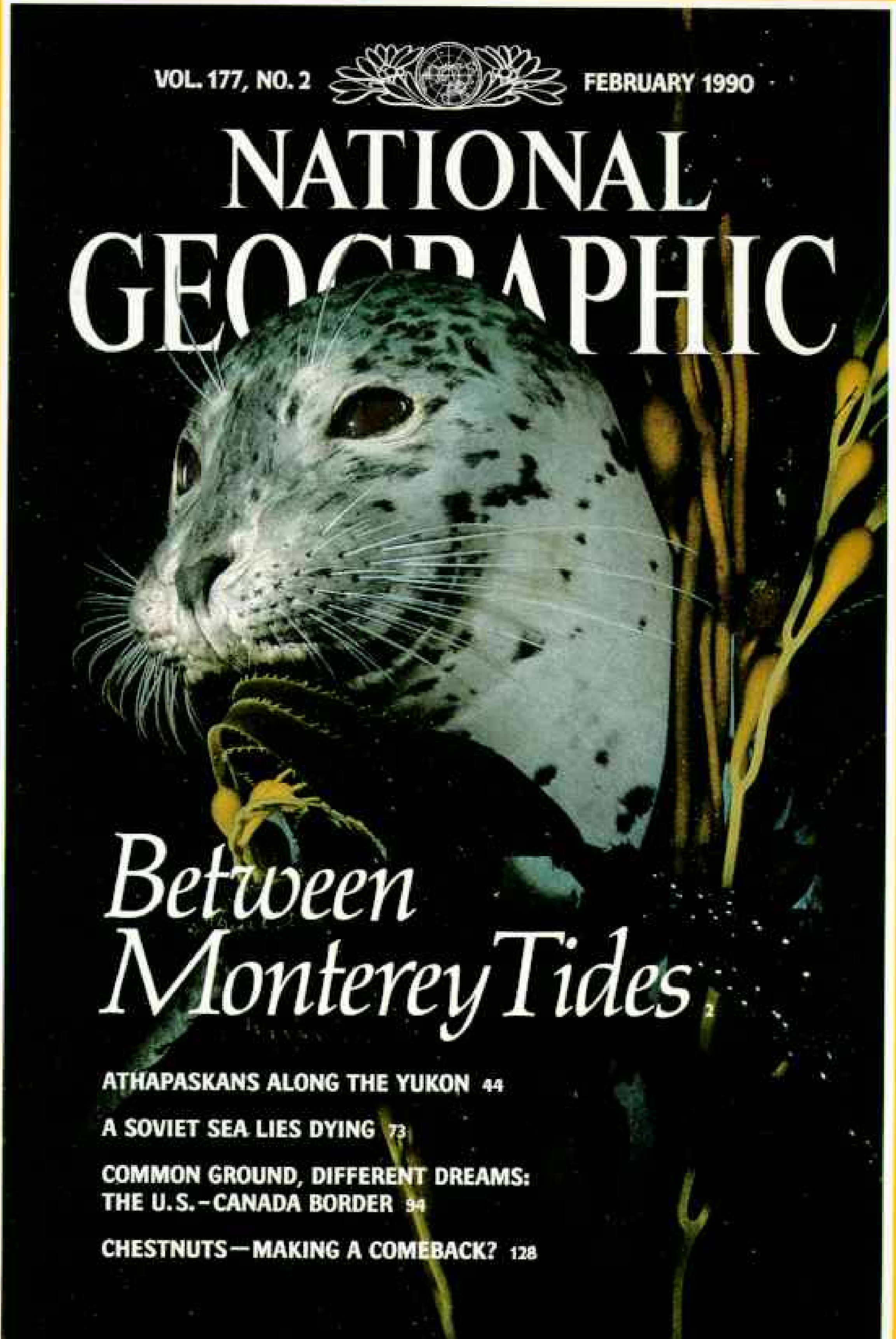

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SWIMMING WITH A SEA OTTER

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Monterey Bay, a spectacular crescent in the central California coast, conceals a submarine chasm as vast as the Grand Canyon. Here an upwelling of cool, nutrient-rich water sustains great kelp forests and marine creatures from anemones to sea otters. Rick Gore joins biologists who seek to unlock the mysteries of this intricate ecosystem. Photographs by Jonathan Blair, David Doubilet, and Emory Kristof.

BATH TIME FOR ATHAPASKAN BROTHERS

Athapaskans Along the Yukon 44

Their ancestors crossed the Bering land bridge to occupy Alaska's interior—fishing, trapping, and hunting game there for thousands of years. Now Athapaskans find their traditional life-style increasingly challenged by the snowmobile, the oil rig, and the commercial fishery, as Brad Reynolds and photographer Don Doll report.

AGROUND IN THE ARAL SEA

A Soviet Sea Lies Dying 73

In 30 years the Aral Sea has lost 40 percent of its surface area and 66 percent of its volume, primarily to the demands of irrigation. William S. Ellis and photograher David Turnley assess an environmental tragedy brought on by economic development in the U.S.S.R.

BAR ON THE BORDER

Common Ground, Different Dreams: The U.S.-Canada Border 94

"Geography has made us neighbors; history has made us friends," said President John F. Kennedy. Now the U. S.-Canada Free Trade Agreement has made both nations pay more attention across the world's longest undefended border. Priit J. Vesilind and photographer Sarah Leen plumb the complex affections and misunderstandings between the neighbors.

INOCULATING A CHESTNUT

Chestnuts— Making a Comeback? 128

Victim of blight, the American chestnut tree has all but vanished from the eastern forests of the United States since 1900. M. Ford Cochran and photographer Gary Braasch chronicle the efforts to save the trees that remain and to breed new resistant strains.

COVER: *Symbolizing the rich sea life of California's Monterey Bay, a harbor seal peers over fronds of towering kelp. Photograph by David Doubilet.*

With the greatest of ease a young harbor seal twirls through a kelp forest in Monterey Bay. In this cool, deep Pacific realm cut into the central California coast, a remarkable variety of marine creatures and environments converge.

Between Monterey Tides

By RICK GORE
ASSISTANT EDITOR

Photographs by
JONATHAN BLAIR,
DAVID DOUBILET,
and
EMORY KRISTOF
NATIONAL GEOGRAPHIC PHOTOGRAPHER

IT TAKES A FOGGY NIGHT to evoke the Cannery Row that was, to blot out the tourists, the gift shops, the restaurants, the fudge factories. A foggy night. When cats still slink between the shadows. When the foghorn blows from Point Pinos at the southern tip of Monterey Bay. When sea lions sing doleful solos from the cold rocks. When brisk air almost wet enough to drink dampens the faint music of a distant carousel. It takes a foggy night. Then the ghosts emerge.

Half a century dissolves. The sleek new Monterey Bay Aquarium becomes its former self—the bustling Hovden Cannery. Across the street the girls from Dora's come out. So do the bums and the "dripping, smelly, tired Wops and Chinamen and Polaks," the restless men and women who worked the packing-houses and peopled the imagination of novelist John Steinbeck.

The sardine fleet arrives, docking here in what once was California's—if not the nation's—busiest fishing port. The cannery whistle blows, and, as Steinbeck recounted, "The whole street rumbles and groans and screams and rattles while the silver rivers of fish pour in out of the boats. . . ."

On a foggy night one ghost dominates my vision. He sits in a weathered clapboard bay-view building. It was called Pacific Biological Laboratories in the 1920s, '30s, and '40s. Today the name is gone, but the building is preserved by a Monterey men's club.

My ghost—he's not just mine; he belongs to every biologist who has prowled the rocks or trawled the waters of this bay—sits with collecting jars filled with briny specimens. A phonograph plays a scratchy recording of a fugue by Bach. A quart of beer sits next to a bottled bryozoan on his desk, while he types out the pages of *Between Pacific Tides*, a treatise that helped introduce to marine biology the then revolutionary idea of ecology—the concept that you can't understand an organism unless you understand where it lives and who lives with it.

My ghost's name is Ed Ricketts, although most everyone here knew him as *Cannery Row*'s "Doc." Ed Ricketts. "Half-Christ and half-goat," his intimate friend and soul mate Steinbeck called him. Ed Ricketts. Who

"CANNERY ROW" PAINTING BY BRUCE ARISS, © 1984 MONTEREY BAY AQUARIUM (ABOVE); RALPH BOOSENAGM COLLECTION (FACING PAGE)

"A poem, a stink, a grating noise," John Steinbeck's memories of Cannery Row open his 1945 novel of the era when sardines made the town of Monterey the top U. S. fishing port. Artist Bruce Ariss painted this waterfront scene from sketches he made during the Depression. He portrayed Steinbeck asleep in the Packard emerging from the Pacific Biological Laboratories of Ed Ricketts, a brilliant naturalist who welcomed struggling artists and freethinkers; one admirer declared he had an "acceptance of mystics." Ricketts, shown in 1934 (right), collected specimens such as squid for his biological-supply business, advancing understanding of the bay's intricate ecosystem.

PHOCA KITOLINA, DAVID DOUBILET (PRECEDING PAGES)

scoured the shores of Monterey Bay. Whose eye for a new sea creature was rivaled only by his eye for a new woman.

Ed Ricketts. Who would tip his hat to a dog. Who would bite into a retchingly vile nudibranch from a tide pool just to understand why nothing ate it. Who was obsessed with "breaking through" to new levels of understanding. Who was hit by a train in 1948, and whose passing seemed to signal the end of the brawling old Cannery Row.

Ed Ricketts devoted himself to the task I've been sent here to describe—understanding the life within this grand, mystical bay. For weeks now I have been with his disciples. A new era in exploring Monterey Bay, perhaps the richest ecosystem on the West Coast, is under way. This intensified exploration has been catalyzed by the opening of the Monterey Bay Aquarium in 1984 and by the establishment in 1987 of the Monterey Bay Aquarium Research Institute (MBARI).

Monterey Bay, a notch in the coast of central California, is only 32 kilometers (20 miles) across. On a clear day from Cannery Row you can almost make out the amusement park and pier of Santa Cruz on the other side. What you can't see is a vast chasm on the scale of the Grand Canyon that cuts through the center of the bay, bringing countless denizens of the deep sea within a few hundred meters of shore. This Monterey Canyon also provides a well of cold, deep water, rich in the nutrients that accumulate from the detritus of organisms above. The upwelling of this enriched water helps bless the many niches of the bay with uncommon fecundity.

The upwelling fed the sardines that built Cannery Row until, overfished, they vanished after World War II. It encourages the growth of great kelp forests—algal jungles teeming with fishes and mollusks, crustaceans and sea otters. This bounty still lures millions of seabirds from rookeries across the Pacific.

Onshore the bay's tempering winds foster a climate ideal for wintering monarch butterflies or for growing the country's best known artichokes and Brussels sprouts.

But mostly Monterey Bay is a poem of the sea, a complex dream with internal rhythms that confound and astonish. How does one set down such a poem to paper? In his novel *Cannery Row* Steinbeck asked that same question about describing the human community along the bay. I like his answer.

"When you collect marine animals there are certain flat worms so delicate that they are almost impossible to capture whole, for they break and tatter under the touch. You must let them ooze and crawl of their own will onto a knife blade and then lift them gently into your bottle of sea water. And perhaps that might be the way to write this . . . to open the page and to let the stories crawl in by themselves."

DURING THE SUMMER of 1929 a teenager named David Packard spent a month near Cannery Row, in the adjacent resort town of Pacific Grove. "I was mostly interested in fishing and being a youngster," he recalls. Nothing back then indicated that in the 1980s Packard would become one of Monterey Bay's most influential figures since Ed Ricketts.

The young Packard would go to Stanford University, become an inventor and a tinkerer, and help found a major electronics firm, the Hewlett Packard Company. In the process he would amass an immense personal fortune. He would serve as deputy secretary of defense and confidant to presidents. Over the

The crescent bay sweeps 40 miles of coastline, clockwise from Santa Cruz, at top, past farmland famed for artichokes, to the north shore of the jutting Monterey Peninsula, holding Monterey and Pacific Grove. Lack of heavy industry, control of agricultural

National Geographic, February 1990

JONATHAN BLAIR

runoff, and a relatively small bay-area population—less than 600,000—have helped keep the water unpolluted. Seen as clouds from 12,500 feet, fog is a near-daily phenomenon from spring to fall as ocean upwelling brings cold, nutrient-rich water.

years Packard would become one of the country's best known philanthropists.

David Packard would also have two daughters who would love the sea. Julie would study marine algae at the University of California, Santa Cruz. Nancy would do graduate work at Moss Landing Marine Laboratories on the bay.

During the mid-1970s Packard decided his family philanthropic foundation needed new directions. "We'd been supporting other people's worthy causes for a long time," Packard recalls. "I wanted to develop some worthy projects of our own."

About this time Nancy, her husband, Robin Burnett, who taught at Hopkins Marine Station in Pacific Grove, and fellow marine biologists Chuck Baxter and Steve Webster were casting about for new focuses for their lives. One night over a bottle of tequila and pen sketches on cocktail napkins they hatched an idea: Why not convert the dilapidated Hovden Cannery near the marine station into an aquarium focusing just on Monterey Bay? An aquarium that would engage visitors with hands-on exhibits and excite them with lifelike re-creations of what divers see beneath Monterey's tides. An aquarium that would do more than entertain; it would educate and encourage research.

The idea intrigued Packard. Never one for whimsy, however, he commissioned a feasibility study. Could such an aquarium attract enough visitors to pay for itself? The answer came back positive, and thus was born what Packard today jokingly calls "one of my boondoggles."

By the time the Monterey Bay Aquarium opened in 1984, Packard personally had invested about 55 million dollars in that boondoggle. "It was a family affair," he says. "Mrs. Packard and I visited every major aquarium in the country for ideas. She designed the cafeteria and gift shop. Julie was a good manager, so we made her director."

Packard himself supervised many design details. He invented—and built in the foundry and shop on his Big Sur ranch—machines that make some of the most exciting exhibits work.

He promoted dynamic displays. At the Rocky Shore exhibit, for instance, a crowd stands behind a window studying a peaceful rock face adorned with sea anemones and limpets. Without warning a foaming wave blasts through a hole in the rock, generating startled squeals. Seconds later, just as along the surf-battered Monterey coastline, peace returns.

The aquarium staff also invented a surge machine, which gives life to the aquarium's most striking exhibit, the Kelp Forest. That huge aquamarine tank, more than nine meters (30 feet) deep, swirls with fish and sways with the golden stalks of the world's grandest seaweed. It re-creates the underwater spectacle that draws hundreds of divers to Monterey on weekends. As soon as you enter the aquarium, the cathedral aura of the Kelp Forest, with sunlight streaming down from above, turns your head and pulls you over, bidding you to slow down and meditate on the majesty that lies hidden just offshore.

"The Kelp Forest was our most challenging exhibit," says Julie Packard. "No one had grown kelp on such a large scale."

The exhibit has encountered a few minor problems. Crevices in the artificial rocks were not made deep *(Continued on page 23)*

The sardine bounty of the 1930s (above) collapsed in the late 1940s, largely from overfishing, sending Cannery Row into decline. In 1986, after a 12-year ban, a limited season was reinstated. Although Capt. Vito Ferrante (right, at left) may strike 60 tons on a good night, the bay holds a fraction of its original abundance.

Interlocking habitats of Monterey Bay

DRAIN THE BAY and a landscape comparable to the Grand Canyon would emerge. Largest submarine chasm along the continental U. S., the Monterey Canyon plunges to 90 meters (300 feet) less than a kilometer off Moss Landing and meanders some 175 kilometers out to sea to depths of more than three kilometers. This map reflects recently declassified data plotted by the National Oceanic and Atmospheric Administration.

Carved from granite, shale, and sandstone, Monterey Canyon was born 25 to 30 million years ago nearly 300 kilometers to the south. Pushed along the San Andreas Fault as part of the Pacific plate, it owes much of its magnitude to continual seismic activity—from tremors to major earthquakes—that triggers four main types of erosion (illustrations below). The 7.1 Loma Prieta earthquake in October 1989 caused seafloor failure in the shallows off Moss Landing. In a process called liquefaction, water permeated the shaking sand and silt; the resulting mud slides flowed into the canyon.

Unmanned remotely operated

Submarine erosion

A Turbidity flow/current: *Set in motion by earthquakes and storm waves, a cloudlike flow of sediment builds into a scouring current of sand and gravel—the major erosive force in the canyon.*

B Rockfall: *A common landslide in the upper reaches of the canyon, where granite and shale prevail.*

C Slump: *A slow-moving landslide that leaves angular contours without triggering turbidity currents.*

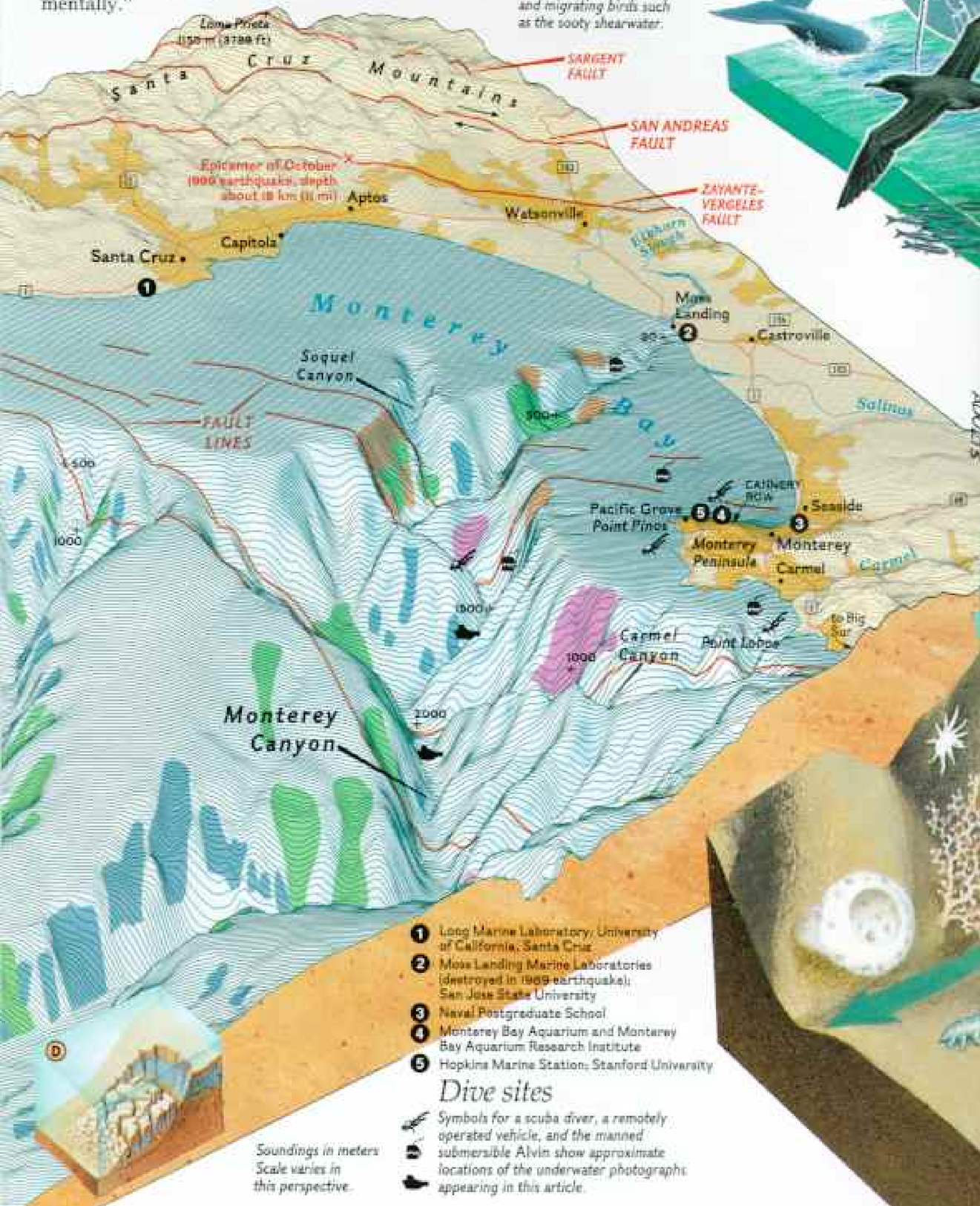
D Freshwater sapping: *Water flowing from an aquifer into the canyon loosens rock, causing landslides. Increased water use by the area's growing population has reversed the process; saltwater now invades the aquifer.*

vehicles have opened the canyon to sustained exploration. "Monterey Bay is a microcosm of the open ocean," says Bruce Robison of the Monterey Bay Aquarium Research Institute, one of five research facilities on the bay. "It's big enough to be an intellectual challenge but small enough to grasp, physically and mentally."

Surface waters ▷

0 TO 100 METERS

Anchors of the food chain, microscopic algae called diatoms bloom in these sunny waters, fed by an upwelling of nutrients from the canyon. They are eaten by zooplankton, such as krill, which in turn feed the world's largest animal, the blue whale. Many open-ocean creatures spend the day in deeper water and rise at night to eat. Seasonal anchovies and squid attract salmon and migrating birds such as the sooty shearwater.



△ Intertidal zone to sandy bottom

0 TO 100 METERS

Built to endure the assault of waves and to feed on food brought in by the tide, a multitude of invertebrates cling to the rocky shores. Hunting at sea, marine mammals such as harbor seals and birds such as cormorants sleep on land. Beyond kelp forests teeming with life, plumy sea pens and other bottom dwellers populate the sandy mud plains that lead to the canyon.

◁ Mid-water

100 TO 3,500 METERS

Weak sunlight fades to blackness in this realm. Like the lantern fish and wide-mouthed hatchetfish, 90 percent of the animals are bioluminescent. Many are transparent for camouflage. Gelatinous siphonophores and larvaceans act as a floating substrate for smaller animals. Much of the bay's sinking organic matter is consumed here.

◁ Canyon walls and bottom

300 TO 3,600 METERS

Relatives of rock dwellers common in the shallows, sea stars, sponges, corals, sea anemones, and tunicates populate canyon walls. Often destroyed by turbidity currents or rockfalls, these communities recolonize on new rock faces. Eggs and tiny larvae — like those of creatures near the shore and in mid-water — drift to surface waters, where food is abundant.

Animals not drawn to scale.

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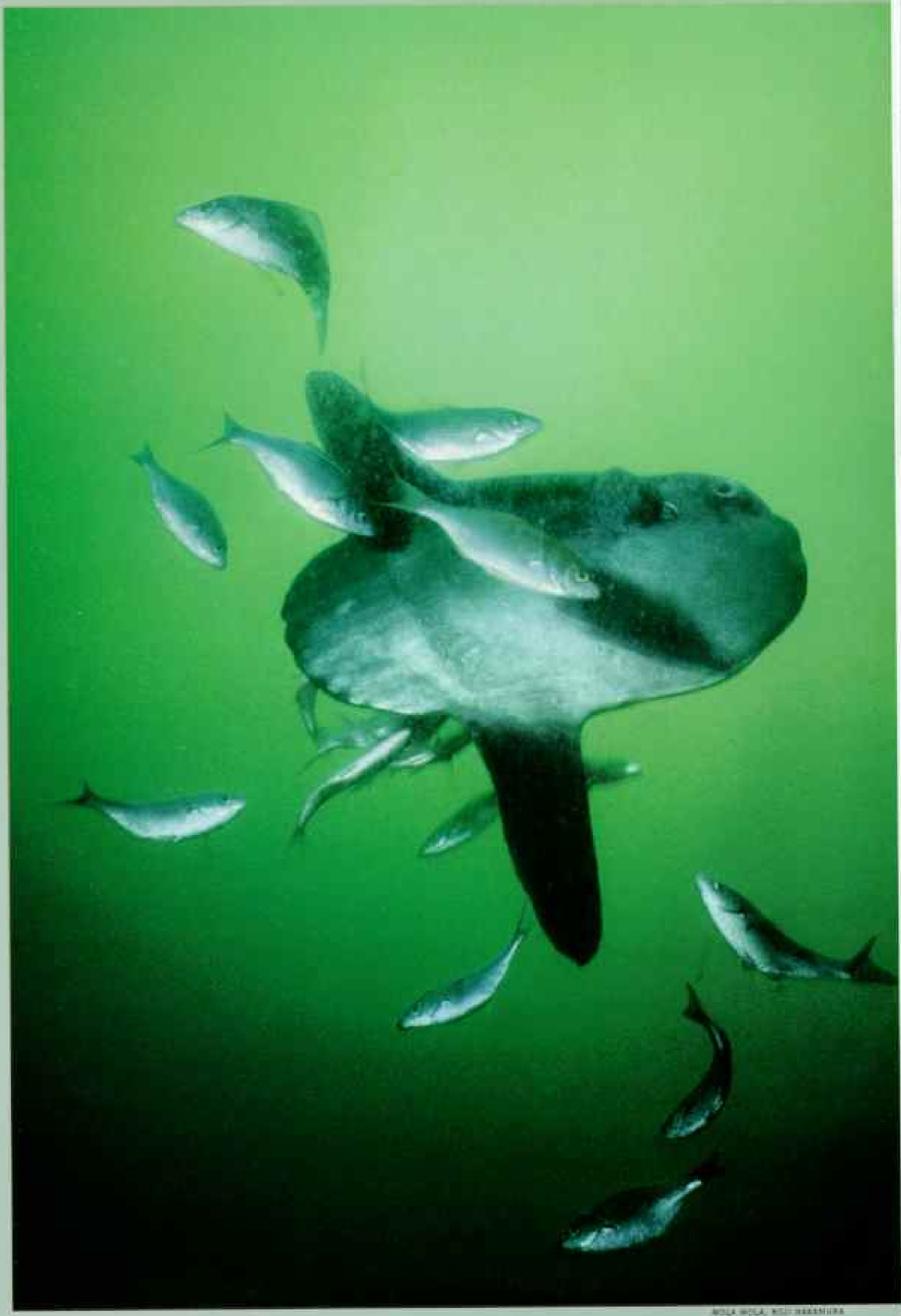
An exuberant kingdom

Jostling for room, sea anemones, corals, and sponges vividly paint the floor of a kelp forest. "These animals are bathed in food," explains David Powell, director of husbandry at the Monterey Bay Aquarium. "The water is rich enough to supply great numbers of filter feeders, and competition for space is incredible."

The upwelling of nutrients released from dead plants and animals is the key to the bay's fecundity. From March to October winds from the northwest help deflect surface waters of the cold, south-flowing California Current, and deep water rises to fill the void. The Monterey Canyon acts as a funnel to bring deep, rich water to the surface.

The pea soup of plankton clears when the winds weaken in fall. This is the season for scuba diving. In January the bay feels the warming influence of the north-flowing Davidson Current. "The bay is a meeting of subtropical and temperate zones," explains Chuck Baxter of Stanford University's Hopkins Marine Station. "Here we get to see more life than in either region alone."

DAVID DOUBILET



MOON JELLY, AURELIA AURITA; PACIFIC BUTTERFISH, PEPRILUS SIMILLIMUS

Still a baby at 300 pounds, a Mola mola (left) may grow to more than 3,000 pounds. Attending surfperches eat parasites. Seasonal visitors in the bay, thousands of young mola—Latin for millstone—arrive in the fall as the water warms. Its tail a rudder, the fish swims by sweeping perpendicular fins side to side. Its diet includes the purple striped jelly (right). Carrying a juvenile crab hitchhiker, this foot-wide specimen will die if unable to regenerate its ravaged stinging tentacles and feeding arms. Pulsating grace, a nonstinging moon jelly (above), eight inches wide, shelters Pacific butterfish.

PELAGIA COLORATA; DAVID DOUBILET (BOTH)

GIANT SEA STAR, PISASTER GIGANTEUS; STRAWBERRY SEA ANEMONE, CORYNACTIS CALIFORNICA

ROUGH KEYHOLE LIMPET, DIODORA ASPERA, BOTH BY NORBERT WU

"Anything that can't run away from it is fair game," Monterey Bay Aquarium biologist Mark Ferguson says of the diet of the voracious sea star Pycnopodia helianthoides *(right). Commonly called a sunflower star, it is one of the fastest sea stars, capable of traveling more than a foot a minute. Its speed and power come in part from its great number of sucker feet, as many as 15,000 on a large, 25-inch specimen. Alerted to the prowling star by its scent, prey such as sea urchins, snails, and crabs try to flee. Overtaking them, the star swallows them whole.*

Arching over strawberry sea anemones, Pisaster giganteus, *the giant sea star (top), grows as wide as a foot. Like the sunflower star, it is covered with tiny pincers that prevent animals such as barnacles from attaching. Though this star can extend its stomach into a shell opened only a tenth of a millimeter, it is no match for the rough keyhole limpet. Touched by the star (left, center), the snail extends its mantle (bottom) and becomes too slippery to grip.*

PTERONOTUS HELLANTHOIDES, DAVID DOWNLEY (ABOVE AND TOP LEFT)

"There may have been 1,000, maybe 1,500." On an overcast October day photographer David Doubilet encountered herds of California sea lions swimming 15 miles offshore, just outside the mouth of the bay. Virtually all Monterey Bay's sea lions are males. In April and May they swim to southern California to

ZALOPHUS CALIFORNIANUS, DAVID DOUBILET

breed in the Channel Islands. Grouped into pods of 100 to 200, these sea lions were probably making the return migration.

The Spanish explorers and missionaries who settled the town of Monterey in the late 18th century called them lobos marinos—sea wolves. Their barking rings throughout the bay.

Camouflaged by algae and corals, a coralline sculpin, here about life-size (right), can lunge at prey with its oversize jaws. "I've seen them holding fish their own size crosswise in their mouth," says Monterey Bay Aquarium biologist Freya Sommer.

The conspicuous three-inch-long nudibranch called a Spanish shawl (below) may rely on color to remind predators of its unpleasant taste. The intrepid Ed Ricketts spat and retched when he dared taste these mollusks. At least 25 nudibranch species live in the bay. The gut of the Spanish shawl extends into its carrot-colored cerata. Stinging cells ingested from a feathery invertebrate called a hydroid lodge in the cerata, further deterring attack.

Grazers of the kelp forest, omnivorous top-shell snails (right) devour colonies of bryozoans and hydroids as well as kelp blades. The purple-ringed top shell, at left, is Calliostoma annulatum, *"most beautiful ringed mouth." Its companion blue top shell is* Calliostoma ligatum, *"most beautiful banded mouth."*

(Continued from page 8) enough. And so sea urchins, important members of the kelp community, cannot escape the jaws of the sheephead in the tank. Nevertheless, the exhibit has succeeded beyond dreams. The kelp grows so well it must be regularly pruned. And, fed by freshly pumped bay water, the tank's rocks have been colonized by at least 80 other local seaweeds.

Likewise the aquarium has flourished, attracting nearly two million visitors a year. The Packard boondoggle can more than pay its way. The aquarium is considering an expansion in the mid-1990s that would feature exhibits on the open sea and deep sea, the only two habitats not now emphasized.

AT EIGHT EACH MORNING, long before the crowds throng through the doors, a cadre of young women and men in colorful Patagonia sweatshirts and blue jeans begins to patrol the exhibits and corridors of the aquarium. These are the aquarists—a job category hard to describe. Caretakers. Handymen. Cleaners. Vets. Scientists. Artists. Stage managers. They make sure the show is ready to go when the doors open.

The aquarists' boss is soft-spoken Dave Powell, who before joining the aquarium, almost at its inception, had become close to a legend among colleagues.

"In his youth he was a phenomenal diver," says a co-worker. "In his 60s he can still dive with the best of us. And catch more fish down there. He has every West Coast invertebrate, fish, mammal, and bird in his head."

Powell has been instrumental in designing each live exhibit. "Taking a piece of the seafloor and making it come alive in the aquarium is tricky," he tells me on a behind-the-scenes walk. "Rocks out there, for example, are completely covered with growth. To duplicate that, we put our exhibit rocks in water for four years."

We stop in the jellyfish lab, where beautiful little comb jellies dance in a research tank.

"These fellows were three times this size a month ago," says Powell. "They shrink when they don't eat. Yet they are one of our picky eaters. They only like a particular type of ctenophore. We'll have to go out and collect some soon."

Many animals are finicky over more than food. The flat sunfish called mola, for instance, need water warmer than most other bay creatures. They flock into the bay from the open ocean only during the fall, when upwelling pauses and the warmer oceanic surface water flows in. Thus they cannot be on exhibit with the other fish.

Powell introduces me to four mola being kept in a special tank in the aquarium's quarantine station. "They are friendly, intelligent fish," he says.

Odd looking, he might add. Round and flat, they seem to be missing their back halves. Two swim up to us on sight and squirt mouthfuls of water. One lets us pat him.

"He does bite, so don't put your finger in his mouth," says Powell. "He'd think it was a shrimp."

Life on the bay is rough for a mola. Surface dwellers, they often get chopped up by boat propellers. Sea lions pose a greater danger.

"They love to rip off the mola's fins and play Frisbee with them," says Powell.

The aquarists face hazards of their own.

"We're always a little wet and cold and working in slippery places," says senior aquarist Mark Ferguson.

As Ferguson sucks a rubber hose to start siphoning water from an exhibit he must clean, he risks another aquarist's lament—a mouthful of "spooge."

"Spooge is anything that's slimy, stinky, or gelatinous," says colleague Dave Wrobel. "For example, if you take a dead anemone and set it in a bucket to decay for a couple of weeks, you'll get vintage spooge."

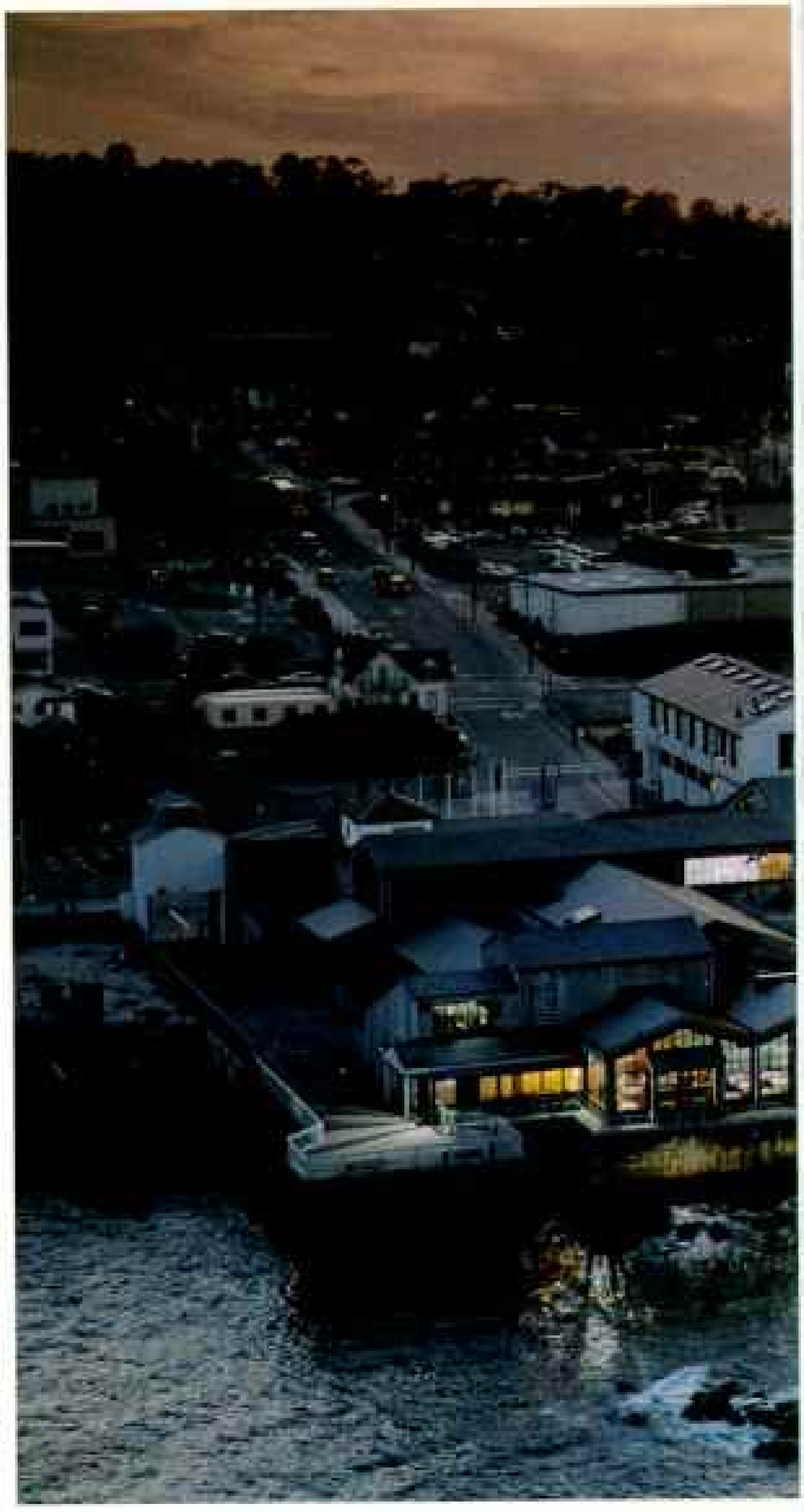
Avoiding spooge comes with experience. So do tricks such as lining the back of the octopus exhibit with Astroturf—about the only surface that those escape artists can't climb.

"I WANT TO SEE A SHARK eat a fish," insists a small boy standing outside the Monterey Bay Habitats exhibit, a great tank only slightly smaller than the Kelp Forest. It brims with dozens of bay species—mackerel, salmon, rockfish, and numerous cruising sharks.

"How *do* you keep the sharks from eating the other fish?" I ask aquarist Steve Brorsen.

"We feed them very well," he says. "Mostly with salmon steaks dangled from a pole. We keep careful track of how much each one eats. They'd raise hell if they ever got hungry."

Occasionally an accidental feeding frenzy does occur. "We released a group of small



Echoing the architecture of the abandoned cannery it replaced, the Monterey Bay Aquarium opened in 1984 "to be a window on the bay," says director Julie Packard. It welcomed 1.7 million visitors in 1989. Exhibited here in fiberglass (bottom), gray whales and other marine mammals swim past the aquarium deck on seasonal migrations.

mackerel, and the bocaccios snapped them up like spaghetti strands," recalls Brorsen.

Then there was the day a giant octopus attacked a six-gilled shark that got too close. "A battle of the titans," he says. "We had to use poles to separate them."

Sometimes being an aquarist means cold nights at sea trawling for specimens.

It is after midnight on the research vessel *Point Sur*, and an aquarist crew led by John O'Sullivan is dragging a trawl net at 300 meters (980 feet) for seldom seen creatures the aquarium wants to exhibit in its expansion. The team hauls the net on deck, and with gloved hands they probe the catch, a wriggling chowder of bay life. Stinging, slimy brown jellyfish dominate the haul. But treasures lurk.

"*Anoplogaster!*" cries out one aquarist.

"Catch of the day!" says O'Sullivan, who rushes to examine a hideous, black, hand-size creature. "Also known as the fangtooth. Look at those fangs!"

"That is a monster," says Dave Wrobel.

"If they had things like that in shallow water, I'd never go in," adds MBARI biologist Kim Reisenbichler.

There is more—arrowworms, snipe eels, dragonfish, eelpouts. Most of the catch is dead or dying due to the extreme temperature and pressure change.

"There's all this great stuff down there, but we don't know how to keep it alive yet," complains O'Sullivan.

EXHIBITING DEEPWATER FISH, a frontier of aquarium science, is the current dream of Dave Powell and his colleagues. Likewise, deep water has become a frontier for David Packard, who sees that habitat as an ideal arena for developing high-tech research tools, such as remotely operated vehicles. These ROVs could rove the unseen depths of the canyon with video eyes, capturing specimens with manipulator arms and beaming up live images to scientists.

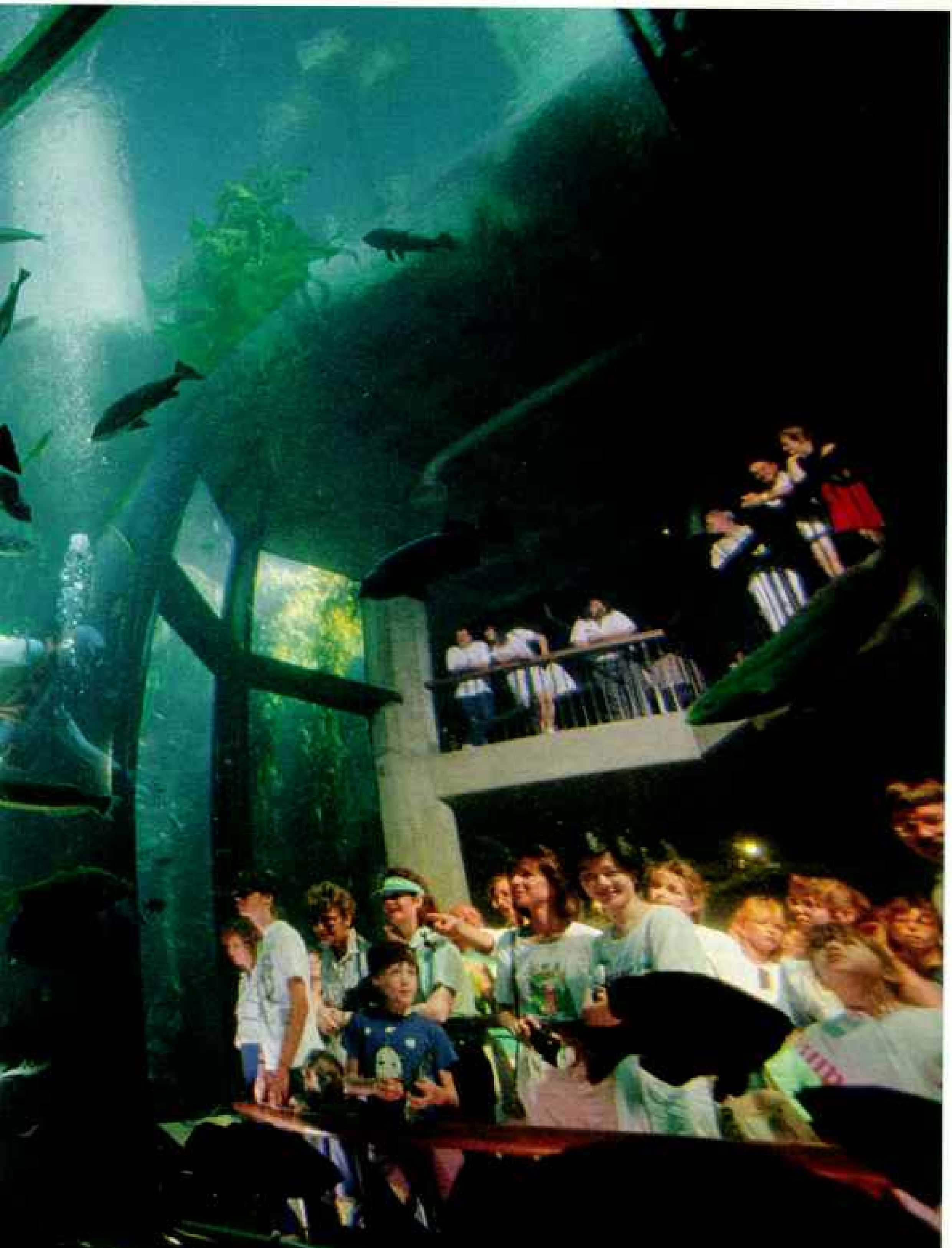
Originally Packard wanted the aquarium itself to develop an ROV, as well as carry out extensive scientific research. He met resistance from his family, who preferred to see excess aquarium revenues go into public education.

"I decided I wouldn't argue with them," he says. "I set up a separate institute."

That separate institute, MBARI, will cost Packard at least another 50 million dollars—enough to endow it with a five-million-dollar-a-year operating budget. It has meant luring an elite team of scientists and engineers away from other institutes. It has meant giving them the enviable freedom to pursue their research unshackled from the time-consuming chore of applying for grants from government agencies. And it has let Packard develop his

BOTH BY JONATHAN BLAIR

How to grow a kelp forest? No aquarium had done it. Monterey Bay succeeded with a 31-foot-deep tank with acrylic windows more than seven inches thick, open to the sky for the light-loving algae. A giant piston creates the surge kelp needs to draw nutrients from



JONATHAN BLAIR

the water, pumped from the bay. Guide-trainer Jackie Petro helps feed the fish, including small sharks. On some feedings she talks with the audience through a microphonic helmet. "They ask if the sharks bother me," she says. "I fold back a finger and say, 'Not much.'"

beloved ROV, which in 1988 made its maiden dives into the canyon.

WE ARE TEN KILOMETERS (six miles) off Monterey, pitching and rolling over the canyon in MBARI's research boat, *Point Lobos*. Minutes ago technicians lowered the black-and-white ROV into the water. In the control room MBARI scientist Bruce Robison studies the video scenes being fed into monitors from the ROV's electronic eyes.

"I'd love to have Ed Ricketts out here with us," says Robie, an excitable fireball of a biologist and a pioneer in exploring the fauna of Monterey Canyon with submersibles. "Lots of people *look*. Ed Ricketts *saw*."

Robie and I are about to see a few things ourselves, things seldom observed—and never studied—before the ROV. We are stalking giant, deep-water larvaceans.

Larvaceans. They sound like creatures from an alien world. And indeed the domain they inhabit seems unearthly. The ROV sinks to this day's working depth of 400 meters (1,312 feet). It has entered a realm lit only by its own spotlights. In this habitat of perpetual night, less than one percent of the sun's light survives. It was once thought to be a biological desert. Now, pulsating, gossamer shapes—the larvaceans—begin to flicker across the monitors, and we can see that life teems in the mid-water of Monterey Bay.

"Fifteen years ago as a grad student," recalls Robie, "I'd go out on mornings like this and trawl the canyon with nets. I had no idea all the fragile animals we are going to see were there. I'd bring up hard-bodied things, fishes and shrimps. But there'd also be this goo all over everything. We called it snot. We knew it came from some gelatinous creatures our nets dragged through, but we couldn't say whether it was one animal or a hundred. We had no idea what it meant biologically."

Then in 1985, while working for the University of California, Santa Barbara, Robie took a one-man submersible and video camera into the canyon 15 times. Going as deep as 650 meters, he glimpsed this gelatinous world often enough to see it was a wonderland of shapes more intricate and behaviors more complex than he had dreamed—a forest of animals. But regular access to a manned submersible is hard to come by, and harder still to finance. In 1987, when MBARI offered him a position that would give him frequent use of its new ROV, he jumped at the chance.

Nothing he had seen in 1985 intrigued Robie more than the larvacean. The animal itself is no longer than a finger. It resembles a transparent sperm. But larvaceans are house builders, spinning around themselves fragile webs of mucus sometimes as large as a person. They circulate water within that mucous shell. Like fine nets, feeding filters trap detritus. When the animal dies or leaves home, its house falls apart, creating a snow of sinking mucus.

For hours the ROV prowls the mid-water, zeroing in on vigorous larvaceans. Sometimes we squirt luminous green dye at one and hover to watch how the animal pumps the colored water. At other times we measure the rate at which larvacean snow sinks to lower depths.

"This is the kind of basic science we could never do before we had the ROV," says Robie, who seldom takes his eyes off the screen. "Also, the ROV has shown us how many larvaceans there are down here. Their abundance is startling."

"These little-known creatures may turn out to be very important," adds his MBARI colleague Bill Hamner. "Their houses agglomerate particles on which local animals scavenge. Then, when their houses fall apart and sink, they become food for animals below."

We meet the larvaceans again the next day. This time Robie and I plunge past them, headed nonstop for the canyon floor in the celebrated deep-diving submersible *Alvin*. In more than 2,100 dives *Alvin* has photographed the *Titanic* and discovered colonies of exotic creatures around deep-sea hydrothermal vents. *Alvin*'s maiden visit to Monterey Bay was organized by NATIONAL GEOGRAPHIC's veteran underwater photographer Emory Kristof in association with the United States Geological Survey, the National Oceanic and Atmospheric Administration, and the Monterey Bay Aquarium.

Already Kristof has been down with scientists to the canyon's greatest depths—3,600 meters, more than two miles—far offshore where it fans into the abyss of the Pacific. Geologists have found clams 15 centimeters across living around seeps of gas, perhaps derived from organic debris buried beneath the sediments. They have seen evidence of massive landslides along the canyon floor.

We will not dive as deep—only 1,533 meters. But we will cruise the steeper walls of

JONATHAN BLAIR

With the genius he brings to electronics giant Hewlett Packard, Monterey Bay Aquarium founder David Packard masterminded exhibits in the foundry of his Big Sur ranch.

the canyon. About the size of a family camper and loaded with electronic gear, *Alvin* was not built for comfort. Robie, pilot Pat Hickey, and I contort our way into the craft and crawl over one another to get into position next to our respective portholes. Three men in a two-man pup tent would have about as much room to maneuver.

We feel ourselves being hoisted, then lowered. Suddenly it's all aqua and bubbles outside my porthole. I pull on my extra wool socks. *Alvin* is unheated, and the water temperature where we are headed is only a couple of degrees above freezing.

We descend at 30 meters a minute. The water darkens quickly to dusky blue. I turn on my floodlight as we pass a long, dazzling curled necklace of a creature called a siphonophore.

"Siphonophores are hugely important because of their numbers in mid-water," says Robie. "They are very diverse. Most have stinging tentacles that capture their prey. They are colonial, like corals. Each element or segment is a distinct individual, yet they combine to form an organism that itself is a complete animal. Some segments are stomachs, some catch prey, some reproduce, some propel. When you try to capture them, they shatter. If you want to understand them, you have to come down here and look."

At 250 meters the sea has grown pitch dark. Yet in my floodlight countless shrimp and myriad swimming, wriggling, coiled spermatoid things sparkle amid the snow of crumbling larvacean houses.

By 440 meters we have entered the world of bioluminescence. Here more than half the fish make their own light. In still deeper water 90 percent of the creatures can be bioluminescent. Some use this light to see, some to communicate. Some attract mates or prey with their light. Others need it for protection, like a lanternfish that glides by. Its belly is lined with luminous organs, whose light keeps the animal from being silhouetted to predators below.

At 907 meters I turn off my light. The sea is now a sparkling firefly world. We pass 1,000 meters. "Sunlight doesn't go any deeper than this," says Robie. But we do. In fact we are making a luminous blue tunnel as we plunge through bioluminescent bacteria along our path. "They glow," he explains, "to improve their odds of being eaten. Being ingested doesn't faze a bacterium. It increases its chances of being transported up and excreted into more productive waters."

AT 1,411 METERS we spot the muddy bottom and head north to seek the canyon wall. An unexpected current buffets us for a few moments. Abruptly it vanishes, and at 1,512 meters we are staring at a wall landscaped with crinoids, sea anemones, sponges, and sea stars.

We are surely the first humans to lay eyes on this wall. But at this moment Robie's mind is back on larvaceans. The seafloor is littered with clumps of larvacean houses. He is excited that so much mucus is making it down without being eaten. An arcane, perhaps bizarre reason to be excited? Hardly.

Scientists who study the flow of carbon through the biosphere have been puzzled. They cannot find all the excess carbon dioxide that their calculations say humans, by burning

fossil fuels, are pumping into the atmosphere. Even though carbon dioxide levels are rising ominously, some process, likely biological, seems to be moderating the buildup.

One way nature removes CO_2 is through photosynthesis in the oceans. Plankton turn dissolved CO_2 into organic matter, which may later be eaten by animals. The animals then return to the atmosphere, through their own respiration, much of the carbon the plankton removed. Organic matter also falls on the seafloor, where it is either buried or eaten by creatures that are unlikely to take it back near the surface.

Now *Alvin* is showing us that larvacean houses carry down more organic matter than suspected. Since larvaceans may inhabit much of the mid-water of the oceans, these unsung bags of mucus could be playing a significant role in helping the biosphere keep carbon dioxide under control.

We cruise the canyon wall, illuminating the life all around us. Brilliant red medusae swim by. Royal purple jellyfish abound. Lobate ctenophores, some of which look like pulsating pieces of Steuben glass, become prisms in the lights from *Alvin*. How odd that life in these lightless depths is so often colorful.

Science explains these bright colors as camouflage. Red wavelengths of light are screened out first by water. Therefore, reds and purples look as dark as the surrounding abyss. They also reflect poorly in the blue light emitted by bioluminescent organisms. Nevertheless, I wonder why such beauty exists in a world that cannot see it. And conversely, to what beauty might our own eyes be just as blind?

Pilot Pat Hickey turns off the lights to conserve power. As we sit, the black, frigid reality of the abyss out there hits me like a surge of claustrophobia. How does life adapt to that harsh reality?

"There's less food available," says Robie, "so they are much more fuel efficient. The fish tend to be sluggish. Many have huge mouths and distensible stomachs that can swallow something larger than they are themselves. They don't get to eat very often, so they take full advantage of every chance they get.

"Their metabolisms are slow. They don't have much bone or muscle. Many are mostly water. It's hard to find a mate down here, so reproductive patterns often are very economical. The males of some species have only one job—to *(Continued on page 38)*

Looking into the deep

Ventana

Paying out its tether, the unmanned remotely operated vehicle (ROV) of the Monterey Bay Aquarium Research Institute begins its descent off Point Lobos (above). The size of a small car, the ROV Ventana can operate as deep as 490 meters (1,600 feet), transmitting video images to the research vessel Point Lobos (right). Founded by David Packard in 1987, MBARI's goal is "to understand this piece of the ocean better than any other, and extrapolate from that to a larger scale," says senior scientist Bruce Robison, seated before the screen.

One major discovery is the prevalence of giant larvaceans at depths below 180 meters. Head down in this photograph (top right), the three-inch-long sperm-shaped animal spins winglike feeding filters to trap detritus. It blows a bubble of mucus as large as seven feet across to strain out larger particles. Once clogged, this outer housing is abandoned. Gaining speed as it sinks, the mucus and trapped organic matter reach creatures of the ocean floor, says Robison, "like rocket ships of food."

ILL BY JONATHAN BLEAK

BASKET STAR, GORGONOCEPHALUS EUCNEMIS; RUBY ROCKFISH, SEBASTES RUBERRIMUS

METRIDIUM SP.

ASTROPECTEN VERRILLI

SeaROVER

Marrying ROV technology with the camera wizardry of the National Geographic Society's research and development lab, staff photographer Emory Kristof hoped to gain access to a world too deep for scuba gear, without the expense of hiring a manned submersible. The result was the SeaROVER, designed and built by Chris Nicholson of Deep Sea Systems with assistance from National Geographic's Al Chandler. Here launched by Jeff Ledda (right), it uses video cameras as the viewfinders for two still cameras, one with a wide-angle lens, the other a single-lens reflex model that permits closeup photographs to be composed and focused remotely.

Just below 60 meters (200 feet) a basket star (left) finds an advantageous perch in the current. Arms grab passing zooplankton and curl to the mouth. SeaROVER's manipulator arm collected basket stars for the Monterey Bay Aquarium. At 80 meters the arm set out bait that attracted hagfish (below)—eyeless scavengers that enter body cavities and devour prey from the inside out. Their slimy secretions bar a rockfish from the feast. A sea star known as the fat star or slime star (bottom center) also oozes slime for protection.

A smaller ROV called a MiniROVER hovers behind Metridium anemones at 80 meters (bottom left).

PACIFIC HAGFISH, *EPTATRETUS STOUTI*; BROWN ROCKFISH, *SEBASTES AURICULATUS*; ALL BY ALLEN W. CHANDLER; MICHAEL COLE; EMORY KRISTOF; KEITH A. MOCKENHAUPT; AND JOSEPH T. STANCAMPIANO; ALL NGS STAFF

Teamwork rounds up a school of young rockfishes; 39 species live in Monterey Bay. The headlights of the Mini-ROVER break the darkness of 76 meters as the fish cavort around the SeaROVER, drawn to its lights. "The machines work together like diving buddies," says Kristof. "If one ROV is performing a tricky maneuver, we can use the other to watch the

cable and release it if it hooks up on something."

Designed to work as deep as 300 meters, the Geographic's SeaROVER is described by Kristof as "the natural evolution of the scuba diver; it has movement, brains, and an eyeball. And it's valuable even at 15 meters because there's no limit to the length of time it can stay down—very useful in recording animal behavior."

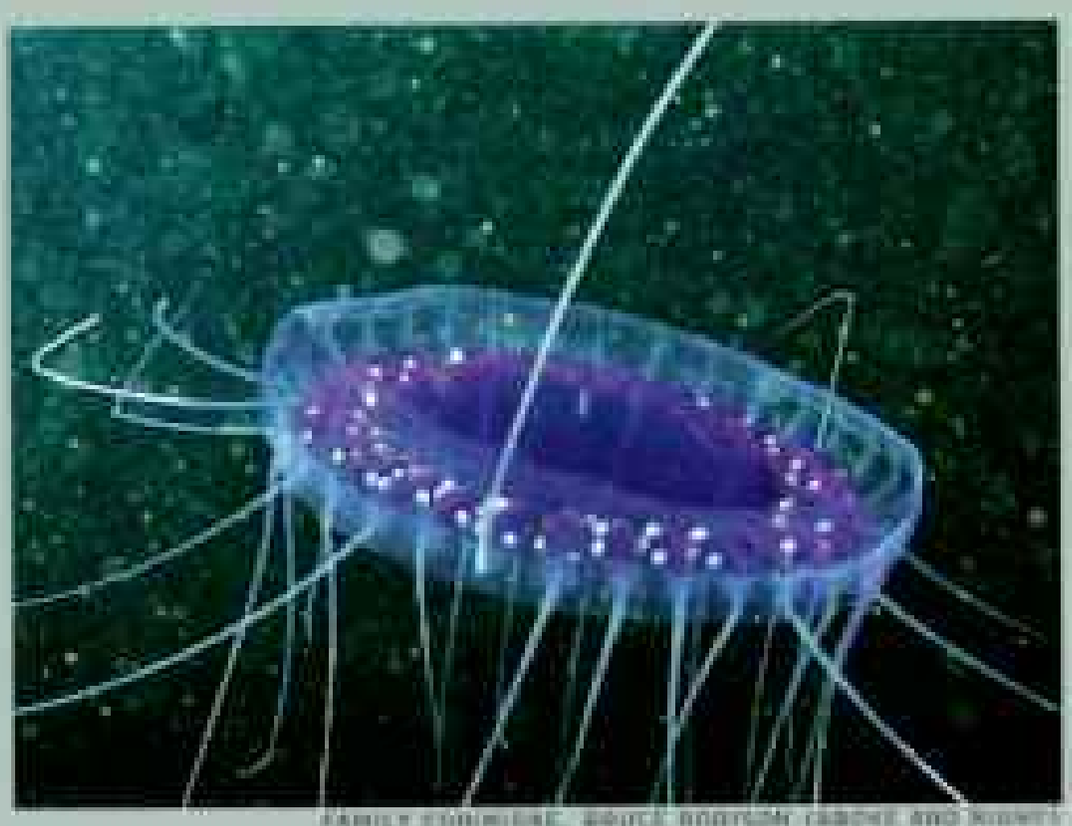
Alvin

"The planet's last big-game hunting," says Emory Kristof of photographing the deep. Helping to organize the first use of the manned submersible Alvin in Monterey Bay, Kristof mounted it with the cameras from the SeaROVER. At 1,600 meters a Pacific sleeper shark (right) takes off in a blizzard of "marine snow," flakes of sinking organic material.

Once thought to be sparsely inhabited, the region below 150 meters is now known to be full of creatures such as this ten-inch-wide, egg-carrying narcomedusa (below left). Some gelatinous invertebrates act as substrate for other animals to "hide behind, ride on, or steal food from," says Bruce Robison.

Riding in Alvin at 1,100 meters, Robison was one of the first to see a live bathylagid (below); dead specimens had been dragged up in nets. About 15 inches long, it was swimming head up, "entirely different than I'd expected," he said. "Its eye is an enormous light collector. Even at this depth it could see silhouettes of prey."

Sixty miles offshore in a valley near the canyon, sea anemones hunt at 3,680 meters (below right) like those John Steinbeck observed in coastal tide pools, "inviting any tired and perplexed animal to lie for a moment in their arms."



FAMILY CORNUCOPIA; BRUCE ROBISON (ABOVE AND RIGHT)

FAMILY PORTRAITURISTS

SOMMERSO RECYCLED, EBONY EXISTENT (ABOVE AND TOP LEFT)

WILLIAM TEGMARK

(Continued from page 30) find and fertilize a female."

Some anglerfish males, for instance, are much smaller than the females they must fertilize. Once they locate a mate, they bite into her. Their bodies fuse, and the male degenerates into nothing but gonads and a surrounding lump of tissue—a permanent, portable sperm supply.

Where the only light is bioluminescence, many animals have large or exquisitely sensitive eyes. Some, like the hatchetfish, have tube-shaped eyes that concentrate photons.

Alvin's lights come on again. We are surrounded by a school of predaceous-looking rattails, fish no prettier than their name. These big red-eyed scavengers have organs on their snouts that let them sense movement and low-frequency acoustic disturbances.

"We undoubtedly made a thump when we landed," says Robie. "They probably came over to see if we were food."

We rise off the seafloor and begin a series of transects, examining as we ascend the life at different depths. It won't be a comprehensive survey. *Alvin* scares off such swift and skittish creatures as squid.

We are cruising at 1,100 meters when I hear Robie exclaim: "Holy cow, it's a giant myctophid." I expect to see something with nightmare tentacles. Instead a pouchy-mouthed fish no longer than a shoe floats upright,

JONATHAN BLAIR

alternating leisurely strokes of its pectoral fins.

"No," he says. "It's a bathylagid. This is probably the first time anyone's seen this species alive in its own habitat. No one's known how this sucker swims. Head up. Look at how big his eyes are. He feeds on all the gooey stuff in the water. It may be that he looks up to see it."

Alvin's manipulator arm accidently touches the bathylagid, and it darts away.

"Oh, wow!" says Robie as we rise to 1,000 meters. "A big narcomedusa!"

We ogle what looks like a rotating purple dinner plate with tentacles reaching upward.

"We're just figuring these guys out," says Robie. "A medusa points its tentacles down—

South of the sheltering bay, the coast marches wildly towards Big Sur. Ed Ricketts saw the force of the sea as the underlying energy of life. "Wave motion gave life its original direction," he said. "It's built into every one of our cells."

to wait for prey to blunder in. But these are active predators. Reaching up and out vastly increases their chances of catching food."

At 800 meters we encounter *Apolemia*, a ropey siphonophore that glistens enchantingly. Tiny fish cluster about its tentacles, either swiping food or seeking protection within its dangerous reach.

"At this depth these creatures become the equivalent of trees and rocks—places where

animals congregate. The distribution of small fish is often determined by the presence of siphonophores. We could never have discovered that without submersibles."

At 700 meters we catch a glimpse of a squid. Then it's time to go home. With lights out again to save energy, the world outside sparkles like the sky on an incredibly black night. A million beacons of life aglow. So much of the living space on our planet is like this—frigid and dark. Yet life goes on here, no less inventively than up top. Such a zoo!

Although excursions into the canyon are at the forefront of research, life in the upper reaches of Monterey Bay poses unsolved mysteries. Many of the marine mammals that abound in the bay remain poorly understood.

One of the most celebrated is the gray whale. Each winter tourists by the boatloads brave the stomach-churning seas to watch the great migrating beasts glide past. If lucky they might also see a killer whale. In summer and fall blue and humpback whales are lured into the deep waters of the bay.

"This is one of the best places in the world to watch marine mammals," says Nancy Black, a biologist at Moss Landing Marine Laboratories. "Whales, porpoises, dolphins, seals, sea lions, sea otters—they're all here. Unfortunately, they're hard to study. The weather's often so bad."

Take today, for example. We were to cruise

BOTH BY JONATHAN BLAIR

With a temper to match his name, Stormy the elephant seal foils efforts to attach a time-depth recorder by Dan Costa of the University of California, Santa Cruz. Elephant seals hold the record among marine mammals for deep diving, reaching more than 1,250 meters.

Aquarium biologists Mark Ferguson and Freya Sommer collect algae and sea stars in a tide pool. Here Ed Ricketts worked in what he called "possibly the most prolific life zone in the world."

the bay on a survey of Black's thesis subject, the Pacific white-sided dolphin. But winds are fierce and seas frenzied. Winter in Monterey.

"They are one of the most common dolphins on the West Coast," says Black, who has observed them in groups as large as 2,000. "And we know almost nothing about them."

Often she has seen the dolphins leap repeatedly out of the water, slapping the surface on reentry. What does this display mean? Is it a herding mechanism, a form of communication, or just plain fun?

Once Black watched a group of four adults keep a dead calf afloat in the water with their snouts for more than an hour. "These are very social animals," she says. "Were they somehow trying to help the calf?"

On another rainy, blustering winter day I see less friendly mammalian behavior. I walk the beach at Año Nuevo State Reserve, which biologists consider the northernmost fringe of the Monterey Bay ecosystem. Dotting the beach are huge hunks of blubbery brown mammal. Most of the hunks are sleeping, but occasionally one rears up and savagely charges another. The two then fight, brandishing fleshy, trunk-like noses. These are male elephant seals, and this is the end of their breeding season.

"They've been fighting and breeding for the past three months," says biologist Burney Le Boeuf of the University of California, Santa Cruz, who has been studying elephant seal behavior for 20 years. "Now they're tired. A dominant male may have a hundred females in his harem. All season other males have been trying to get into that harem. So the big guy can't sleep until the last of his females has returned to the sea. Then he rests up."

"Stormy," reads the name that researchers have bleached into the hair of one of these two-ton, five-meter-long sleeping hunks (left).

"He's bad," says Le Boeuf. "Real aggressive. He chases the students."

Le Boeuf's colleagues Tony Huntley and Dan Costa fill syringes with a Valium-laced sedating drug. Quietly they sneak up on Stormy and expertly inject the potion. A few minutes later we gather to roll the groggy animal onto his belly so the biologists can attach an electronic time-depth recorder (TDR) with marine epoxy. But despite the drugs, Stormy will have none of us. He roars and flails, and we retreat while more Valium injections are prepared.

It's much easier, says Le Boeuf, to put the TDR monitors on females. They are five to ten times smaller and respond better to the sedative. And so far the TDRs the researchers have glued to them have produced some astonishing data. Female elephant seals, they have learned, dive deeper than any other mammal yet documented—1,250 meters, or three-quarters of the depth we went in *Alvin*. Now they want to know if males, with their greater volume of blood, can dive as deep or for a longer duration.

"It's incredible!" says Le Boeuf. "How do they do it? The pressure down there is 125 times that at sea level. At about 400 to 500 meters the nervous systems of some marine mammals become hyperexcitable, creating tremors, convulsions, and ultimately death."

Just as remarkable, Le Boeuf and colleagues are learning, the seals need only two to three minutes on the surface between dives. They dive continuously day and night, spending between 85 and 90 percent of their time at great depths.

"Their lungs collapse and stop working during much of the dive," he says. "They store up a lot of oxygen in their blood. Their metabolism must also be severely depressed. As a result, they may use less energy diving than they use resting on the surface. They may actually be asleep during part of the time they are diving."

Why do elephant seals dive so deep? Probably to feed in the rich zone of bioluminescent animals that *Alvin* showed us. Staying deep may also help the big seals avoid their major predator, the great white shark.

NO EASIER TO UNDERSTAND are Monterey Bay's most endearing marine mammals, the frisky, bewhiskered sea otters. Otters playfully ply the waters of the kelp forests, sometimes cruising within a few meters of Cannery Row.

Although they seem quite at home in the bay, sea otters have only recently returned in numbers. Hunted for their pelts until 1911, they were thought to be near extinction when a raft of them was reported near Big Sur in the 1930s. Not until the 1960s did they reappear in Monterey Bay. Now they are a major research focus for the aquarium.

"We monitor about 50 otters," explains Marianne Riedman, director of the aquarium's five-year-old otter-research program.

"We know more about the intimate details of their lives than we do about most of our human friends.

"No two otters behave the same. One mother will wean her pup at four months, another at ten. They like different foods. Female 220 likes turban snails and octopus. I've watched her collect 20 octopus in an hour and a half. When I dive, I'm lucky to see even one.

"Female 517 likes clams. Number 184 eats kelp crabs, mussels, and snails. Porky—so named because every time we see her she's eating—likes mussels and abalones. She's usually carrying a cement slab that she holds against her belly as a tool. She either lies on her back and cracks mussels on it, or else she dives down and uses it to bash abalones open. Then there's Cola. We call her that because she uses a Coke bottle to break open rock oysters."

MONTEREY BAY BIOLOGISTS have a thousand stories to tell. Not all involve higher life-forms. At low tide off the Hopkins Marine Station I crunch over barnacle-encrusted rocks with Stanford ecologist John Roughgarden. For the past eight years he and his students have been counting barnacle larvae in the waters of the bay. They hope to understand the forces that control barnacle abundance on the rocks of the intertidal zone (ITZ), where waves and tides create ever changing cycles of wet and dry, peace and turmoil.

"People used to think," says Roughgarden, "that ITZ populations were controlled only by dynamics within the ITZ—starfish predation,

Surrogate mother to orphaned sea otter Pico, Julie Hymer helped him learn to dive and forage for food. The camera angle elongates the three-foot-long, five-month-old otter. A threatened species, sea otters number about 150 in the bay. "We try to duplicate everything moms do," says Hymer, supervisor of the aquarium's sea otter program. "But there's no manual. It's all pioneering information."

for example. We find that's wrong. The big influences come from outside. The kelp forest out there has a huge impact on larvae washing through it. A good year for fish means a bad year for barnacles. The larvae get eaten before they hit the rocks. Or consider upwelling. It's good news for most creatures. Not barnacles. When it occurs, it carries the larvae out to sea."

The kelp beds that bob just meters offshore also have tales to tell. And at least once a month aquarium researchers dive down to make detailed diaries on the lives of those spectacular seaweeds.

"We sit on the bottom with a clipboard and take notes on the growth rate and the impact of storms," says researcher Jim Watanabe. "It gets real chilly.

"Kelp is so fast growing," says Watanabe. "With terrestrial forests you have to wait a hundred years to watch the stages of recovery. When storms rip up a forest of kelp, it comes back in a couple of seasons."

Aquarium researchers also track drift kelp, the pieces that break off and wash into nearby waters. This detritus might be an important food source for the bay community, and biologists want to know who eats it.

"We are all working on the same question," he says. "How does Monterey Bay work?"

And so Ed Ricketts' quest continues. More sophisticated perhaps. But with the same awe and respect.

IT IS THE LAST NIGHT of my fieldwork, and I am invited by Bob Faul, a member of the club that owns and preserves Ricketts' Pacific Biological Laboratories, to have dinner in the old building. Bought by 20 local men shortly after Ricketts' death, "The Lab," as they call it, is used these days for occasional social events.

"There used to be lots of great parties here," recalls Faul's wife, Pat. "Until the guys got old."

Ricketts would not object. As Faul says, "He enjoyed life and raised a lot of hell. But he always remained dedicated to his science."

We go downstairs into the garage and storage area. Empty wine bottles now replace specimen jars on the shelves. We blow dust off a few copies of a 1937 journal of short stories. I can see my ghost again in the dim misty light. And I recall the words Steinbeck wrote about him. They apply just as well to this bay he loved.

"Everyone near him was influenced by him, deeply and permanently. Some he taught how to think, others how to see or hear. Children on the beach he taught how to look for and find beautiful animals in worlds they had not suspected were there at all. He taught everyone without seeming to." □

Athapaskans
Along the Yukon

One of the few women in her village able to perform the ancient Athapaskan songs, Karen Esmailka (right) hopes to pass them on to her daughter, Whitney. In remote villages like hers along Alaska's Yukon River, such traditions are in danger of being swept away forever by a flood of modern problems.

By BRAD REYNOLDS

Photographs by DON DOLL

IT'S EASY, they said. Nothing to it. Wearing snowshoes is just like walking, they said. But with my face two inches above the snow, my feet twisted over my head, and my body wedged between two willows in minus 20° weather on an island in the frozen Yukon River, it did not seem all that easy.

Ellen Peters, kneeling in front of me on snowshoes, looked up from her rabbit snare. "Are you OK?"

Ellen has been snaring rabbits most of her 70 years. Small, less than a hundred pounds, she agreed to take me, a man twice her size and half her age, along to help on this trip.

Athapaskan Indians like Ellen have trapped, fished, and hunted along the middle Yukon River in north-central Alaska for at least 2,500 years. It is called the Koyukon region, and the Athapaskans who live there refer to themselves as *Dena*, "the people."

In Ellen's village of Nulato, on the banks of the Yukon, we hooked a wooden sled behind the new Bravo snowmobile her son Mark had bought with money earned from fighting forest fires. I balanced on the runners of the sled while she drove the Bravo out of town, onto the frozen Yukon, and three miles upriver to her snares. Ellen has two stickers pasted onto her snowmobile's windshield: "Mothers Against Drunk Driving" and "Don't Drink and Drive."

She came to a stop at a small island, and we put on our snowshoes. I struggled. Ellen slipped hers on, dropped a hatchet into an Army pack, slung it over her back, and lit a cigarette while she patiently stood waiting for me. She wore quilted snow pants, a home-made parka, mittens, mooseskin mukluks. Sunglasses protected her eyes from the harsh snow glare.

We plunged into thick willow growth, following a snare line Ellen knows by heart. She pointed out willows that rabbits had gnawed and showed me broken branches where moose had brushed by with their huge racks of antlers. When she meets a moose on her trail, she stands quietly until the animal senses her presence, then she stamps her feet and whistles to scare it off. She also pointed out the tracks of fox, ptarmigan, and wolf.

As I pant and flounder in her wake, she moves steadily ahead, smoking cigarettes and whistling "Amazing Grace" as she peers through the willows at her snares. She ties a noose of wire onto a willow in a rabbit trail, setting out about 30 snares along a two-mile stretch. Today Ellen will find only two rabbits caught in her wire snares.

There used to be lots more rabbits, she tells

BRAD REYNOLDS and DON DOLL, both Jesuit priests, continue their study of Alaska's native cultures begun with "Eskimo Hunters of the Bering Sea" in the GEOGRAPHIC's June 1984 issue.

Fox tracks in the snow are the only signs of activity when the temperature falls to 35 below on a February night in Ruby, an Athapaskan village of 200 people.

Nicknamed "gem of the Yukon," Ruby was home to 10,000 at the turn of the century, when many Indian villages were overrun by white gold seekers.

Bath night turns the Pitka house into a madhouse—and tests the ability of Joann Pitka to juggle her three sons in and out of the tub. With a snowstorm raging outside their home in Kaltag, her husband, Randy, clears a path (right) to the family snowmobile, which he uses to take his older boys to school during heavy weather. Despite the high price tag, most Athapaskans find a snowmobile cheaper in the long run than keeping a dog team.

me. Her people used the fur to make socks, coats, and mitten liners, roasting the meat or cutting it up for stews and soups. Now she snares them just for the meat and for the pure enjoyment of being on the river.

"As long as my legs are good," Ellen says, "I'll keep doing this. I really like it."

INDIANS of the Athapaskan language family stretch from Alaska's interior across northern Canada to Hudson Bay. They have been traced as far south as northern Mexico. The Navajo and the Apache speak languages identified as Athapaskan. Whether their ancestors migrated from an original Athapaskan homeland across the Bering Strait or developed their culture in place in the Alaska-Yukon-British Columbia region is still a matter of debate. In either case the Athapaskans have occupied Alaska for a very long time, even longer than the Eskimos.

The Koyukon region, largest Athapaskan area in Alaska, is home to some 2,400 people. It stretches 375 miles along the Yukon River, from Beaver to Kaltag, and includes remote villages scattered up the Koyukuk River, which empties into the Yukon about 25 miles below Galena.

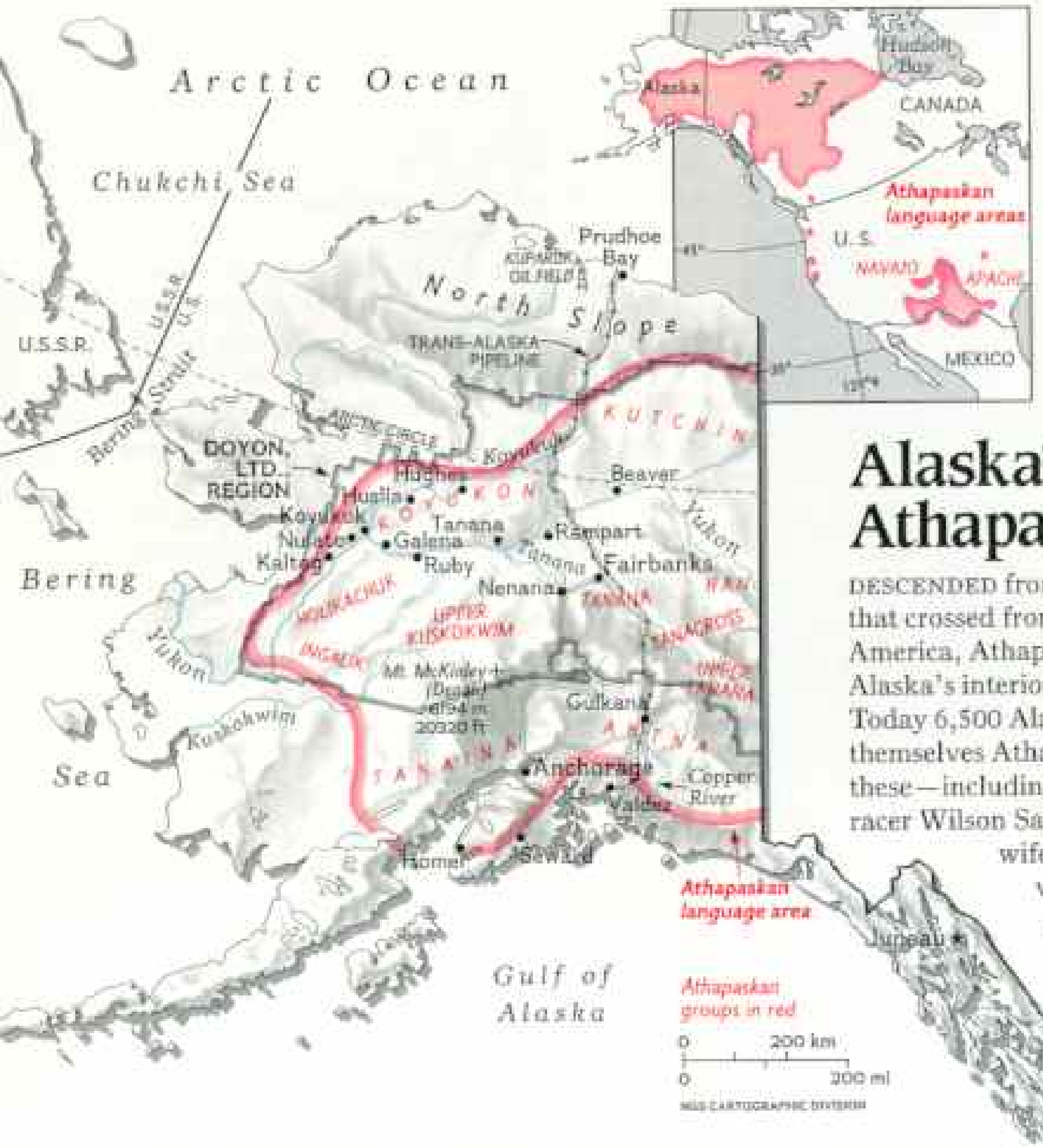
The population of these villages varies from under a hundred in Hughes to about a thousand in Galena, including the Air Force personnel stationed there. Two F-15 fighter jets scramble out of Galena as part of our frontline defense system guarding the border between the United States and the Soviet Union.

No roads connect these villages, so transportation is by air or on the river. In summer riverboats and barges ply the Yukon, which flows brown with suspended sediment. Over a mile wide in places, the Yukon in winter becomes a winding white highway traversed by snowmobiles and dogsleds. The river ice can grow more than four feet thick.

In the 19th century the Russians discovered that the Koyukon region was prime country for beaver furs, and they established trading posts along the river, including one in the village of Nulato. The Russian influence lives on in Athapaskan families with names like Demoski and Demientieff. It is not unheard of to see Indian children with bright red hair running through a village.

I FIRST CROSSED this country by plane, en route from Fairbanks to Yupik Eskimo villages on the Bering seacoast. The view below was mesmerizing. Snow-topped hills and mountains covered with spruce, birch, and aspen rolled down to the wide, white, frozen Yukon River dotted with islands thick with willow and spruce. Moose, chest high in snow, fed on the willows at river's edge.

On one of those trips to visit the Eskimos—the largest group of native Alaskans—I was informed, to my surprise, that the state is also home to nearly 23,000 Indians. Eager to explore the secrets of their survival in this



The Athapaskan language family

Linguists have traced the vocabulary and grammar of Athapaskan from Alaska to Hudson Bay and the American Southwest. Navajo and Apache are in the Athapaskan family, which spread as Indians fanned out after herds of game.

Alaska's Athapaskans

DESCENDED from wandering bands that crossed from Asia to North America, Athapaskans had settled Alaska's interior by 2,500 years ago. Today 6,500 Alaskans consider themselves Athapaskans; 2,400 of these—including champion dog racer Wilson Sam (below) and his wife, Eleanor—live in villages on the Yukon and Koyukuk Rivers, where the Koyukon Athapaskan language is spoken.

beautiful but harsh land, curious to learn how they are adjusting to 20th-century changes, I returned with my partner, photographer Don Doll, to meet the Dena.

Dena, over the centuries, have learned to survive by living in harmony with nature. They learned to live off what the land and river provide. In the Koyukon region you do not try to dominate nature, but work with it. Everything along the river has its own time and season: Salmon are taken in the summer, moose in the fall; caribou herds pass through during winter. The surrounding forests provide fuel for stoves and lumber for building cabins and fish wheels.

Now the Athapaskans must learn new lessons of survival, but in an environment much stranger and harsher than any they are used to. In less than a generation's time they have moved away from their subsistence life-style along the river into the high risks and corporate stress of the late 20th century.

The Alaska Native Claims Settlement Act of 1971 allocated 962.5 million dollars and 44 million acres of land for distribution among 13 corporations representing the native peoples of Alaska. Each native village was also incorporated, and a hundred shares of stock were issued to each qualifying native person.

The settlement terms were, at the time, foreign concepts to most Alaska natives. As a villager in Nulato remarked, "One day we were Indians standing on the bank, watching the river go by. The next day we were corporation members."

In the old days no one would have dreamed of laying claim to the land. It belonged not just to Dena but to the moose, caribou, bears, and the birds as well. The river was shared by the fish in it and the people on it. But today strips of orange tape, marking plots and subplots, flutter along the banks of the Yukon. Signs nailed to trees warn of private property and against cutting wood. Villagers find themselves buried in a blizzard of corporate papers. Even the hunting and fishing they have depended on for thousands of years are increasingly subject to licenses, permits, and regulations.

Bankruptcy, unemployment, and alcoholism are making survival problematic for many Athapaskans. Faced with frightening changes in their life-style and an uncertain future, many find they are drowning, figuratively and literally.

SUICIDE among Athapaskans has reached epidemic proportions. The rate for young native men is more than five times the rate for non-native men. Alcohol floods their villages. Father Bill Cardy, a priest serving several villages on the middle Yukon, testified about the effects of alcohol on village life to Alaska's Alcoholic Beverage Control Board. He recounted that testimony to me. "Eighty percent of our people who use alcohol use it destructively. In two years I have buried 16 young men and women. Alcohol was reportedly involved in all 16 deaths. In 22 months I have witnessed only four natural deaths."

Beer and whiskey can be ordered from Fairbanks liquor stores that cater to the villages. Getting alcohol out to the Yukon is not cheap, but it finds a ready market once it arrives there. I saw one man in Galena pay $24 for a case of beer and another $24 to fly it to a village downriver.

At the Native Hospital in Anchorage I talked with Vicki Hild, who coordinates the fetal alcohol syndrome (FAS) program for the Alaska Native Health Board. Among Alaska natives the number of babies born with FAS is more than double the national average. "Right now we have one of the highest rates among the populations studied," she noted. In one region she followed closely for a year, one out of every four babies was born with fetal alcohol syndrome.

Don Doll and I drove to that region. There in Gulkana, an Athapaskan village near the Copper River, we met Frank and Pauline George and their three children, Margaret, 15, Kelsey, 6, and Amy, 3.

Kelsey (page 61) was born with FAS, three weeks premature, weighing only five pounds, his lungs and eyes permanently damaged. He had to remain in the hospital a month before being taken home. Kelsey and his sister Amy, three years younger, are about the same size. Both are energetic. But Kelsey suffers bouts of bronchitis and catches colds easily.

"It's a miracle he lived," Pauline said. "The rest didn't make it. They were too small." Four other babies born to the Georges all had FAS. "Their blood was too much alcohol," she explained. "I never knew anything about this FAS, or that drinking could be that bad."

Both Frank and Pauline are recovering alcoholics. Pauline, born of alcoholic parents,

began drinking with them as a teenager. "It was my mom, my dad, and me," she said. At 19 she married Frank, who was 34. They moved into the little house at the bottom of the hollow and continued drinking together. "I used to go into the village every morning and get a bottle," Frank recalled.

Both went for treatment after Kelsey was born. They are still pulling their lives back together. "The kids are happy for us having stopped drinking," Frank said. Pauline nodded and looked at her son. "Every once in a while it makes me cry to see him suffer," she said. "He's got a lot of hyper in him. That's because of the alcohol. There is nothing the doctors can do."

ON MOTHER'S DAY I climbed the hill above Nulato to the cemetery overlooking the river. Ellen Peters and her granddaughter Carla were at the graves to offer food to the spirits of Ellen's four children buried there.

The old woman and the young girl cleared a patch of ground near the white crosses and gathered a pile of dry twigs and sticks. A strong, cold wind coming off the still frozen river made it difficult to start the fire. It took several tries before they had a blaze, burning most of the cardboard box in which they had carried the food.

As the flames grew, Ellen put food onto four paper plates. She served roast moose, dressing, gravy, and salad, speaking to her dead young as she set plates of food into the fire: "Here my children, I hope you like this food." She explained to the dead Stephen that at present she had no money for cigarettes, so he would have to settle for the chewing tobacco she sprinkled over the fire.

With her fingers Ellen dug four holes in the mud around the edge of the fire. Pulling a whiskey bottle from a sack, she poured some into each hole. "Stephen must be thirsty," she told her granddaughter, "look how that goes down so quick." And she poured a little more into that hole.

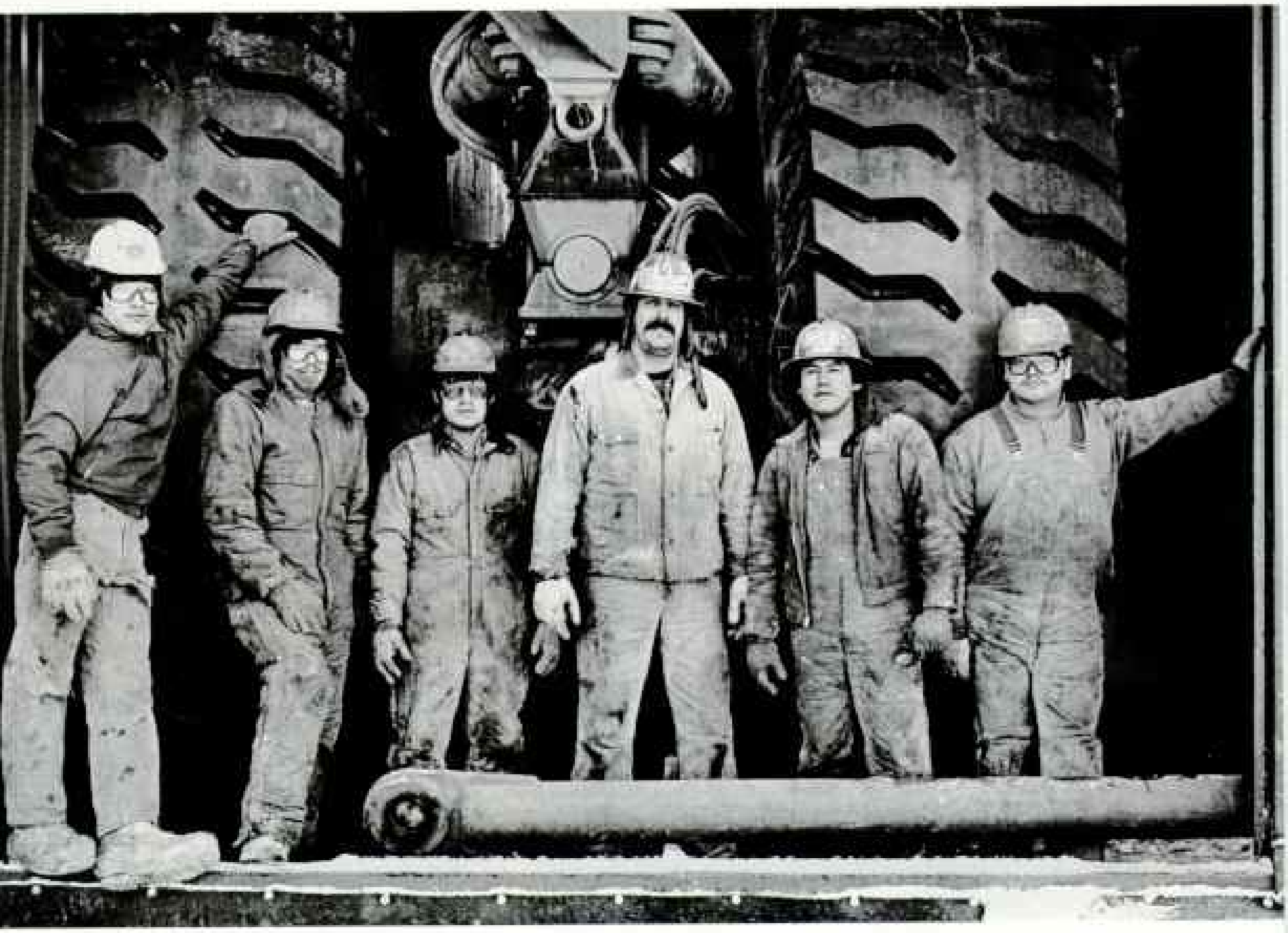
Photographs of her children line the walls of the small frame house she shares with two of her grandchildren. Of the 15 children Ellen bore, only six are living. Five died in infancy. "Alcohol," Ellen said, waving her hand toward photographs of the others, "these all died from alcohol.

"People used to die when they were old,

"I dig just enough gold to pay my bills," says Bill Carlo (above) as his granddaughter picks through a panful worth $10,000 from his mine near Rampart. "Anytime I run short of cash, I go dig up a little."

His measured approach is shared by Darlene Lord (left) and her mother, Anna, as they cut strips of king salmon—a dietary staple for Athapaskans during the winter. Chum salmon are now caught by commercial operators mainly for the roe (right)—a prize dish to Japanese buyers, who pay top dollar.

The dead come calling in spring during the Stickdance, an ancient grief ritual kept alive in the villages of Kaltag and Nulato. The community dances around a pole draped with furs (below). Then the family of each villager who is to be mourned in the Stickdance dresses a selected person in clothes symbolizing the deceased. He or she represents the dead person, visiting friends to say the good-byes so rarely exchanged in this land of quick and unexpected death. Thus Joseph Semakan, who died in a snowmobile accident, bids farewell to friends—through Albert Evans (left, at right), who built the fence around Joseph's grave.



Prime money-maker for Athapaskans is the North Slope oil-drilling operation run by a subsidiary of Doyon, Limited, the corporation created to manage 12.5 million acres covered by the 1971 Alaska Native Claims Settlement Act. Yet to Doyon president Morris Thompson (facing page), the jobs created are more valuable than profits—"Full-time jobs in the villages are virtually nonexistent." Native Alaskans (above) make up 45 percent of Doyon's oil-field work force.

and we would go to say good-bye and they would tell us stories about their lives. Those were good, happy deaths," she recalled. "But now they die so quick. We don't have time to say good-bye. It's all that dope and alcohol. It's no good."

THE RIVER IS QUIET and smooth and strong at nine o'clock on a summer evening. The sun remains high over the Yukon as Pat Madros and I head upriver to start his fish wheel. Pat points out five red foxes playing on the shore. Trees starting to change color splash bright red and orange on the hills above us. "I love this river," Pat tells me over the drone of the motor. "I could ride it for weeks."

Arriving at his fish wheel, Pat ties his boat to a log. When he pulls out a plank wedged beneath one of the wire baskets, the wheel slowly begins to turn.

He explained that a fish wheel runs on the same principle as a paddle wheel. Floating logs are lashed together into a rectangular frame. Two wooden uprights support an axle that revolves with two wire-mesh baskets and two wooden paddles. Each dips into the river, being pushed by the current: first a basket, then a paddle, then the other basket. Salmon swimming upriver are scooped up by the baskets and dropped into a wooden box at the side of the wheel.

The fish wheel, turning by itself, requires no tending. We found something hypnotic in watching the big wheel turn, splashing into the cold, muddy Yukon. When the fish are

lifted out of the water, they flop and thrash in the basket; the sound can be heard halfway across the wide river.

When Pat untied his boat, he did not start the engine, content to drift downriver toward home, enjoying the Yukon in the evening light. "In the fall when we're hunting moose," he said, "sometimes it's so dark when we come back, all you can see are the mountaintops."

The next morning, although it was cloudy and cold, we returned to the wheel with his wife, Mary. They tossed salmon into two plastic bins they had brought along. They had caught about three dozen, most about 20 inches long, a few closer to three feet.

Back home Mary flattened a cardboard box onto the table next to their smokehouse and began cleaning fish. She cut the head, tail, and fins with three deft slices, dumping them into a bucket to be boiled for dog food.

Pat watched for a while and offered to help. He picked up the curved fish knife and chopped at the tail, clearly not familiar with work usually reserved for women. Though his wife tried showing him how to do it, he soon cut his finger. Mary sent him inside, saying, "Men are not good for cutting fish."

IN 1973 limited-entry commercial fishing permits were introduced to regulate Alaska's fishing industry. Along the middle Yukon permits are granted for 74 gill nets and 159 fish wheels. With many more applications than permits, these have become a valuable commodity. The going price for a gill-net permit is about $9,800; for a fish-wheel permit, nearly $13,000. As the price escalates, fewer Athapaskan fishermen can afford permits, so outsiders buy them.

While most Athapaskan families in the Koyukon region still spend their summers drying fish for the winter, those with commercial permits spend their energy harvesting eggs from the fat bellies of female salmon ready to spawn. Processors from Japan have moved in to buy the roe. Salmon roe is as popular in Japan as sirloin steak in the U. S.

Jerry Felton is manager for Towa America, Inc., which operates out of Galena. "One hundred tons of roe go through this district each year," he told me, "and we get the majority of it." Each morning of the season he sends a boat up and down the river to buy roe from the commercial fishermen. Back in Galena it is cleaned, soaked in brine, sorted by size and quality, and crated to be flown first to Anchorage, then to Japan.

Competition for the roe has increased. Plants offer four to five dollars a pound. An average fish carries just under one pound.

Pat Madros has built his own roe plant near his father's traditional fish camp, 25 miles below Kaltag. A plywood cabin among the trees just above the Yukon serves as home for Pat and his family during the fishing season. Collaborating with the buyer for a Japanese company out of Anchorage, Pat pays cash for eggs delivered to his camp.

Felton admitted that harvesting the roe is sometimes looked upon with suspicion by Alaska natives, who are used to getting the most out of what they harvest. The temptation is to grab the roe and dump the fish, wasting good food.

In the village of Kaltag the commercial fishermen formed a cooperative. They sought a better price for gas and oil by buying in bulk and a better position to bargain with the

Life in a ready-made town takes some getting used to for residents of Nulato, who were relocated to high ground after Yukon River flooding threatened the old village (above, in background). Federal officials, who supplied the new houses shipped from Seattle, insisted on the hilltop location.

Since the new Nulato doesn't have plumbing, residents must bring water from the river to their homes—a chore that gives 13-year-old Patrick Madros, Jr. (right), a welcome excuse to drive the family snowmobile.

roe companies. Not that that helped in 1987 when they signed a contract with a company offering to buy both roe and fish. The buyer cemented the deal with an initial $10,000, and the Indians began delivering their roe and fish to him. But at the end of the season the dealer told them he was broke, and the 15 members of the Kaltag Fishermen's Association found themselves out $75,000 and with no stockpile of fish for the winter ahead.

THE CORPORATION for Alaska natives in the Koyukon region is Doyon, Limited, with acreage larger than Connecticut, Rhode Island, and Massachusetts combined; when title is conveyed, the corporation will be the largest private landholder in North America. "Doyon" is a Russian loanword meaning "chief."

Besides the corporate responsibilities to its shareholders, Doyon has the added responsibility of promoting their social, cultural, and personal interests in all its business ventures. For instance, any land deals must consider the subsistence needs of the villages included in the project.

Doyon has made major investments in oil exploration on Alaska's North Slope. Doyon Drilling Inc. Joint Venture owns four big oil-drilling rigs and leases them to companies like ARCO Alaska, which prefer the leasing arrangement to the expense of owning the rigs. Doyon Drilling's crews operate the rigs, and nearly half its employees are shareholders in the parent corporation.

In early spring Don Doll and I visited Doyon's Rig 14, drilling in the Kuparuk oil field. Daily flights shuttle ARCO and Doyon employees between Anchorage and the North Slope. A 90-minute jet flight took us to Prudhoe Bay, where we boarded a Twin Otter for a 20-minute hop to Kuparuk.

A Doyon truck took us the final 15 miles over gravel roads to the rig itself. Oil flows from the wells to a central processing facility that then pipes it to Prudhoe Bay. From there it is funneled into the trans-Alaska pipeline, which runs 800 miles to Valdez, in south-central Alaska.

Rig 14 rose up out of the flat, snow-covered tundra like a golden skyscraper. It stands 182 feet high, 100 feet long, 52 feet wide. Amazingly, this 2.4-million-pound structure moves from site to site on eight gigantic tires, each 12 feet tall and 3 feet wide.

Jim Spaulding, "tool pusher," or boss of the rig, took us to the "dog house," the rig's command central. The drill penetrates down 90 to 120 feet an hour, piercing as much as 10,000 feet of earth in a week. Its precise depth and location show up on the geolograph, which records the drill's depth at one-foot intervals. "It costs ARCO $100,000 a day to drill a well," Jim yelled over the drill's pounding, "so they want to know they're getting their money's worth."

The crew numbers 50, counting those on the rig and the support staff in the three-story modular living quarters, also on wheels. Everyone works a 12-hour shift, which means two employees for every job: cooks, maids, janitors, roughnecks, and roustabouts. When not working, they can relax in the recreation center, playing pool, watching

cable TV or a movie, or just unwinding in the sauna. Meals are served four times a day.

Athapaskans applying for work with Doyon Drilling far exceed the number hired. I met Lenny Lewis, a "roustabout pusher," or foreman, and a Doyon shareholder. Lewis commutes between the oil rig and his home in Quilcene, Washington, every two weeks. "Up here I work hard, and down there I play hard," he told me. "At home I like to kick back in my hot tub and drink beer.

"Oil rigs are rough on a marriage. My wife, she's glad to see me come home, but after two weeks she's glad to see me go."

Before signing on with Doyon, Lewis worked on oil rigs in Texas, where he earned $30,000 a year. With Doyon he has doubled his salary. "For guys coming out of villages, $60,000 is a lot of money," he said. No wonder young Athapaskans along the Yukon talk admiringly of their brothers and cousins working "on the slope" and dream of the day they can join them.

ONE COLD, GRAY DAY I went to the state-run Alaska Vocational-Technical Center in Seward. Here I met the students—15 young Alaskans from villages in the interior, Doyon shareholders being trained for the oil rigs.

A river of grief washes over family and friends during the funeral of National Guardsman Justin Patsy (left). He drowned in the Yukon trying to catch a falling boat motor.

Hauled downriver by the boatload (bottom), alcohol brings a different kind of grief to Athapaskans. Recovering alcoholic Pauline George (below) lost four babies to fetal alcohol syndrome (FAS). Her son, Kelsey, was born with FAS-damaged lungs. "We drank right along with his sickness," she recalls with a shudder.

Superhighway of Alaska's interior, the Yukon River is plied by speedboats during the June race to Fairbanks. Winter traffic is by snowmobile. More than linking

remote villages, "rivers are vital to our well-being," says an Athapaskan teacher. "If I can't get to the river once a year, I don't feel whole."

Robin Renfroe, from the Tanana Chiefs Conference, showed me around the campus. While the Doyon corporation can offer Athapaskans paying jobs, Tanana Chiefs (or TCC, as they call it) ensures that they gain the skills needed for those jobs.

Robin was TCC's director of training. She told me they had 120 applications for the 15 openings in the 11-week course and interviewed 45 young men and women. Once you are enrolled, TCC provides tuition, room and board, transportation, steel-toed boots, and a monthly stipend. Most of the $1,600 cost comes from federal grants.

While helping people learn specialized skills, TCC also promotes traditional native resources and crafts through its Alaskan Resources, Commodities, Trading and Investment Corporation (ARCTIC). One ARCTIC project was a candy company that provided jobs for village Athapaskans who gathered and shipped wild berries to their urban counterparts in Fairbanks and Anchorage to turn into delicious chocolate-covered candies.

ARCTIC's marketing and sales specialist, Kathy Mayo, showed me other company products, including potpourri, herbal teas, and spruce cones, all collected by villagers,

"I'm lucky to be alive," says Roger Huntington of Galena, who once spent weekends at his hunting cabin (top right) tending traps set for marten (above). Badly burned when his plane crashed in the bush, Huntington tore off his flaming clothes—then hiked seven miles in zero-degree weather for help. More than a year later Roger wears a plastic mask and body suit to help heal the skin grafts covering his body.

packaged in birchbark baskets and miniature dogsleds made by them, and distributed for sale to department stores and souvenir shops.

In Galena I attended an agricultural fair sponsored by TCC. As people brought their entries to the community hall, Amy Van-Hatten, who organizes this fair and others in Athapaskan villages, showed me through a vegetable exhibit. Radishes were as big as fists, turnips the size of pumpkins. Amy said TCC sells seeds and tools to the villagers at cost. The Alaska soil is rich, and though the season is short—from early June until late August—the sun shines almost constantly.

"We have only one livestock entry," Amy said, leading me to a wire cage. Inside sat the biggest, blackest rabbit I have ever seen. A hand-lettered sign explained that Shadow was the pet rabbit of the kindergarten and first-grade students at the Galena school. Laughing, Amy said it probably deserved a purple heart in addition to the blue ribbon on its cage.

Most Athapaskan villages have primary and secondary schools, usually housed in the same building. Teachers, many from outside the state, arrive in the fall for the nine months of school. Students take the usual academic subjects, plus electives like home economics, woodworking, and computer studies. During the long winter months basketball games in the school gymnasium are a popular pastime for the entire village. Competition is fierce. Teams travel up and down the river by snowmobile for weekend tournaments.

Maurice McGinty, from Nulato, has served as teacher, counselor, and principal in schools along the Yukon. He earned his master's degree in education administration from the University of Alaska in Fairbanks. McGinty said that while the schools are good at what they do, they are not designed for teaching the skills needed in village life. "A lot of boys would like to go out and trap if they had the skills, but there's no one instructing them.

"We're teaching them academics for moving on out," he explained. "In some cases we have kids who bloom and shine—and they go into the outside world. But if they bomb out, we've got nothing to offer them back here in the community. And that's a real letdown. Once you lose motivation, you lose self-esteem. And once you've lost that, there's nothing. That's when they go for the bottle."

I ATTENDED the Spring Festival in Fairbanks, sponsored by the Yukon-Koyukuk School District. About 200 students—most of them Athapaskans from villages scattered throughout the interior—compete in spelling, reading, mathematics, speech, and performing arts.

Each of the 11 schools in the district holds its own competitions, then sends its champions to Fairbanks. Although the school district provides food and housing, each school has to pay for transportation. Kaltag sent 24 participants; its plane bill came to $7,300.

I heard the Kaltag children's choir on stage in Fairbanks' Alaskaland Civic Center. They were performing a song that urged Indian youth to achieve great things in their lives. Then they sang "La Bamba" in Spanish, accompanied by maracas and drums.

City ways are required study for Joe Wright and Stephanie Alexander (left), whose backcountry school district sends students to Fairbanks each year to learn skills such as opening a bank account or applying for a job. A second taste of the city comes during Spring Festival, when students usually clad in blue jeans stage a fashion show (below). But moving to the city after graduation, says a school official, "is a transition a lot of our kids have trouble making."

On the last night of the festival the organizers mounted an awards banquet and a fashion show. A dozen girls and four boys had volunteered to model clothes they selected from the racks at J C Penney. Staring hard into the dressing-room mirrors, they combed their hair and fiddled nervously with their unaccustomed apparel. The music started, and, as they had carefully rehearsed, they sauntered one by one onto the stage. In front of a wall-size mural of spruce and birch trees they turned and posed for their appreciative audience before scampering back to the safety of the dressing rooms. Flashes from the cameras of fellow students, teachers, and parents gave the feel of an opening in Paris.

Bruce Kleven calls such experiences learning "urban survival skills." He helps run a program to teach them to Athapaskan youths. High school students from the villages spend two weeks living and working at the school district's headquarters in Nenana, about an hour's car ride west of Fairbanks.

They work with a journeyman printer and professional reporter, studying graphic arts and journalism while producing an issue of the school district's newsletter, *Han Zaadlit-l'ee*, "we live on the river." The students provide stories, poems, and reports about their own villages.

They also take field trips into Fairbanks to sharpen such urban survival skills as using a bus schedule, obtaining a driver's license, making hotel reservations, filling out job applications, opening a bank account, ordering food in a restaurant and then calculating the tip.

"The idea is not to make seasoned city dwellers out of these students," Kleven explained. "The thrust is to expose students to situations and conditions they will face whenever they leave the village. Remember, our students live in one of the most remote areas in the U. S. They are ill-equipped to function in Fairbanks."

DON AND I spend our final days with the Koyukon Athapaskans at the Stickdance—a traditional week-long memorial for their dead. It is said to have originated near the Yukon tributary of Bear Creek. There, according to legend, a man received a vision of the Stickdance in a dream after the rest of his family died, leaving him to mourn alone. Today the ceremony is observed in only two villages on the Yukon: Kaltag and Nulato.

It can take months and even years for a family honoring deceased members to prepare for a Stickdance—saving up gifts to distribute, choosing the people who will represent the dead they honor, making the clothes that will symbolize that identity.

Each evening of the week of the Stickdance we join the people who come to the community hall carrying traditional foods—moose, salmon, beaver, rabbit, ptarmigan—for the shared meal they call a potlatch. Afterward the women stand in a solemn circle, eyes downcast, swaying in place as they chant songs composed for the dead.

The hall becomes fuller each night as friends and relatives from other villages on the river arrive. Night by night the intensity of the mournful songs builds.

On Friday night, amid loud singing as the women dance in a circle around the hall, men carry a tall, thin spruce tree—stripped of branches and bark and wrapped in ribbons—to the center of the room. Wolf, fox, and wolverine furs are draped on it as the people surge around, chanting and dancing in a tight circle.

Their hypnotic chanting and dancing continues nonstop through the night. Laughter erupts and tears stream as the people remember and grieve for their dead during the long hours. Arguments and fights break out as some try to drown their grief and anger in alcohol.

By morning the exhaustion is tangible; some fall asleep despite the noise and constant movement around the stick. As part of the tradition, men force their way through the dancers to tear the skins and ribbons from the stick. Once it is stripped, they carry it out into the village, still chanting as they snake between the houses down to the Yukon. There they break the stick into pieces and hurl them onto the river ice.

Immediately the chanting stops. Eerie quiet descends over the village as people return to their homes to sleep.

On the final night—Saturday—those representing the dead are ritually dressed in their new clothes. With eyes downcast, they leave the village hall in a somber line to shake the spirits from their clothing at the river's edge.

I sit with Ellen Peters on the floor of the hall as we watch them leave. She tells me that

she plans to honor her own dead children at Nulato's next Stickdance, which will be held in two years.

"I'll start getting ready this spring before I put my garden in," she continues. "Because it will take me a long time. I'm not young. And I'm tired." But it is more the weariness of grief, I think, than loss of vigor.

The departed return from the river, file in silently, and sit in a row in the hall.

Suddenly the mood changes. The excitement of the traditional distribution of gifts sparks a night of celebration.

The next morning those who have assumed the identity of the dead move through the village, shaking hands with the villagers, sharing food and drink, and saying farewell.

Living in the twilight world between old ways and new, Athapaskans in Kaltag play night baseball under a midnight sun. Games in Athapaskan country often last deep into the night, played with the same gusto it takes to survive here.

ALTHOUGH THE VILLAGERS faithfully tried to adhere to the age-old rituals during the Stickdance, much of the meaning and symbolism behind the ceremonies appeared to have been lost. Originally there were 14 songs to honor the dead spirits. One has been forgotten, and today the other 13 are only vaguely remembered by a handful of elders. During the Stickdance these remaining songs were played on a cassette tape.

The Athapaskans we met along the mighty Yukon represent a culture that has struggled to survive for thousands of years. Their plaintive songs for the dead sound ever more poignant as parts of their heritage erode before their eyes. Amid calls for increased control over their own lives and welfare, Athapaskans recognize that, although as a people they are survivors, not all among them will weather the current cultural transitions. The unrecognized symbols and half-remembered chants of the Stickdance mourn not only those lost in the past but also those who will be lost to the future. □

LAST-DITCH attempt by desperate fishermen to hold on to the dying Aral Sea, a dried-up canal to the retreating shoreline is strewn with their abandoned boats. Drained of life, 11,000 square miles of former seabed, like this along the southern shore, have become deserts of sand and salt.

Still Asia's second largest body of landlocked water, after the Caspian Sea, the Aral has lost more than 40 percent of its surface area since 1960. Worse yet, what remains has become too saline to support any of the native species that once filled its waters.

A cause célèbre for the Soviet Union's newly vocal environmentalists, the sea is an ongoing environmental tragedy—at least on a par, say many, with the Chernobyl nuclear catastrophe of 1986.

THE ARAL

A Soviet Sea Lies Dying

By WILLIAM S. ELLIS
ASSISTANT EDITOR

Photographs by DAVID C. TURNLEY
BLACK STAR

From the rusting deck of the boat he captained for years, Dzhetpisbai Ibragimov surveys a sandy waste once part of the great Aral Sea.

THE MIGHTY INLAND SEA lies stricken now, caught in the grip of some evil chemistry as its waters dry to salt and blow away as noxious dust to strike the people with illness and death.

It has never happened before within the time frame of a single generation, the disappearance of such a large body of water; but the Soviet Union's Aral Sea, once larger in area than any of the Great Lakes save Superior, is vanishing from the face of the earth. As the waters continue to recede, final destruction of the Aral—26,000 square miles in 1960—could occur before another 30 years have passed.

The desiccation is taking place not only at a rapid pace but also with stealth, and in silence: the way a stallion plunges his muzzle into a bucket of water and drains it. Wide concern was late in

The receding shoreline of the Aral Sea is dramatically represented in a composite of 1973 and 1989 satellite images, coregistered with a 1960 map. During those years the Aral dropped from fourth to sixth among the world's largest lakes, having lost a volume of water equivalent to one and a half times that of Lake Erie.

The Amu Darya, known to Alexander the Great as the Oxus River, normally enters the lake through the great southern delta, at left. In recent years both the Amu and the Syr, which flows into the northeastern shore, bottom right, have had so much of their water diverted for agriculture that little remains to feed the lake and counteract evaporation. At present rates of inflow the Aral will continue to shrink; by the year 2000 it will have shrunk to two-thirds its present size, a new "dead sea," surrounded by huge salt marshes and flats.

SPACE MEDIA NETWORK, STOCKHOLM; DATA FROM DMSP AND NOAA 9 SATELLITES; MAP AND DATA COREGISTRATION BY MIKAEL STRÄM


NORTH
2000?
1989
1973
1960
Aralsk

coming and was delayed until now, when there is little that can be done to save the sea.

Before the emergence of Mikhail Gorbachev as the head of the Soviet government and his policy of *glasnost*, or openness, the calamity was not widely reported or even discussed in the Soviet Union. Rather, it was blurred to the public eye by the myopia of previous regimes. Ecology was not a primary concern. The well-being of a huge body of water sitting in the desert wastes of the Soviet Central Asian republics of Uzbekistan and Kazakhstan was subordinate to the good of the state, to the successful fulfillment of plans and quotas.

And so it was decreed in 1918 that waters of the two great rivers feeding the Aral would be drawn off to irrigate millions of acres for cotton production. There was a Soviet obsession to be self-sufficient in cotton. In 1937 the Soviet Union became a net exporter of what planners had come to refer to as "white gold."

But the cost of that self-sufficiency and of export profits would be nothing less than one of the most extraordinary violations of the environment in modern times.

"I doubt if there has ever been an environmental problem of this magnitude," said Philip P. Micklin, a leading authority on the Aral Sea and a professor of geography at Western Michigan University. "Certainly as a regional problem affecting 35 million people, it is unprecedented."

FOR TEN THOUSAND YEARS the Aral has drawn its life from those two rivers, the 1,578-mile-long Amu Darya and the 1,370-mile-long Syr Darya. In classical times they were called the Oxus and the Jaxartes, but by whatever name they are streams of strength and character, celebrated in verse and in the rich history of the times when Tatar horsemen rode the dry steppes.

The rivers come down from the mountain ranges to the southeast, flowing north to the Aral, and the routes they follow through deserts called the Kyzyl Kum and Kara Kum are like lifelines to which millions cling. The waters of the rivers are given to melon patches and fields of cereal, but most of all to 90 percent of all the cotton grown in the Soviet Union.

The great rivers serve too to wash some of the despair from the soul of a people, the mostly Muslim Uzbek, for whom equality in their own country is elusive. They are dying of throat cancer amid dust from the drying sea and birthing children plagued with a host of illnesses related to the sacrifice of the Aral to the growing of cotton. In northwest Uzbekistan the infant-mortality rate is the highest in the Soviet Union.

The plight of the Aral is widely mourned in the Soviet Union now, for it has been adopted as a cause célèbre by environmental activists. But it is in Uzbekistan that people care the most. They care enough to erect large signs in the streets, such as the one in the city of Nukus that reads, "The Aral Will Live Again." And the words chalked on the rusting hull of a large fishing boat sitting now on the dry bed of the sea: "Forgive us Aral. Please come back."

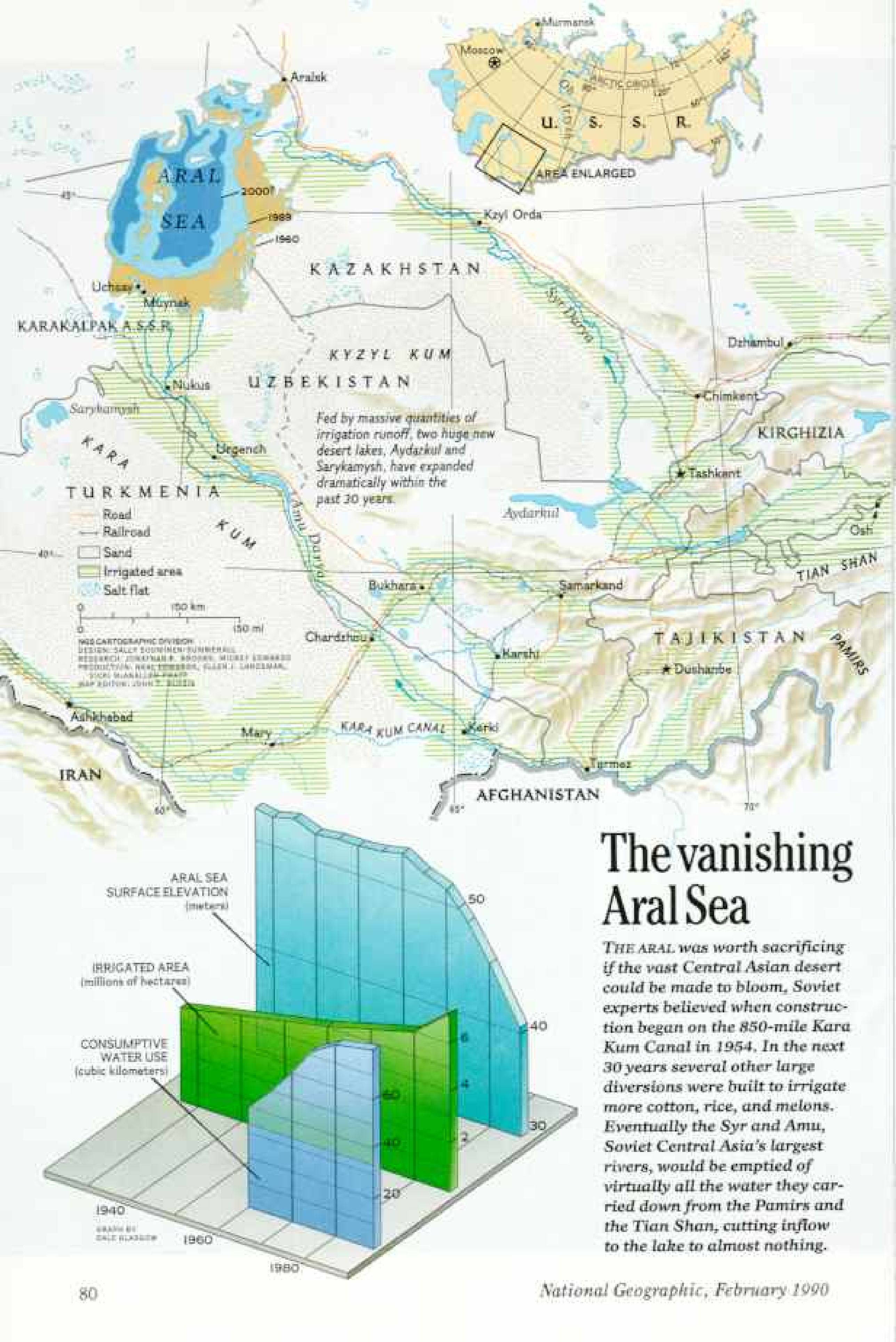
SUCH SENTIMENTS, however, are not enough for a person with the fires of social protest raging inside. "You cannot fill the Aral with tears," said Mukhammed Salikh, a young poet who lives in the Uzbek capital of Tashkent. "The measures taken by the government to correct the problem are insufficient. First of all the government should acknowledge that cotton is the reason for what has happened to the Aral Sea. Once they do that, they can start to develop concrete proposals for doing all that can possibly be done."

Salikh sits in an office in the Uzbek Writers Union building, under a portrait of an obscure Soviet poet who, he said, "suffered under the oppression of Stalin." As a member of a committee of scientists and writers organized to work for survival of the Aral, he devotes much of his time to speaking and writing about the tragedy.

"Even to be able to do that is something," he told me. "Before, it was almost impossible to publicize the problem, but everyone knew about it. Some say nothing was done because of discrimination, because this is happening in Muslim Uzbekistan. I can't say

As the level of the Aral Sea drops, so does the quality of water that inhabitants of the area tap for their wells. In the Amu Darya Delta a muddy pool from a broken pipeline provides much needed water for children to carry back to their families, as well as for local livestock, whose numbers have dramatically decreased.

Brimming with water and life, the Aral Sea seen in a 1960s photograph (below) no longer laps at the harbor at Muynak. Today the Aral Sea fishery, which once supported some 60,000 jobs, has been obliterated. In the former fishing village of Uchsay, now miles from shore, 66-year-old Dzhetpisbai Ibragimov (right, with his wife and stepdaughter) began retirement years early. The fish he once caught were processed and canned in the fish factory at Muynak. Today, in a heroic effort to keep the cannery (bottom) operational and preserve the town's primary livelihood, the Soviet government goes to great expense to ship frozen fish in from the ocean. While small numbers of Russians and Uzbek live in the Muynak district, most of the inhabitants—like Ibragimov—are Karakalpak, the Turkic-speaking people of northwest Uzbekistan.



The vanishing Aral Sea

THE ARAL was worth sacrificing if the vast Central Asian desert could be made to bloom, Soviet experts believed when construction began on the 850-mile Kara Kum Canal in 1954. In the next 30 years several other large diversions were built to irrigate more cotton, rice, and melons. Eventually the Syr and Amu, Soviet Central Asia's largest rivers, would be emptied of virtually all the water they carried down from the Pamirs and the Tian Shan, cutting inflow to the lake to almost nothing.

if that is true, but certainly there is a lack of official interest. For example, I can't understand why it is so difficult for foreign journalists to get permission to go to the sea."

Following months of waiting for permission, a NATIONAL GEOGRAPHIC team was allowed to travel to the Aral. We came upon it from the south, by way of the former fishing center of Muynak, now a landlocked, forlorn town more than 20 miles from the water. Less than 25 years ago Muynak sat at the edge of the sea.

Since the 1960s, when the first symptoms of the problem appeared, the Aral has lost about 40 percent of its surface area, or nearly 11,000 square miles of what are now largely dry, salt-encrusted wastelands. At times the sunlight plays on the salt until all that once was the sea appears to be wrapped in lamé. And it stretches to infinity, leaving only the mind's eye to see it as it was, wide and clear and heavy with fish.

There has been time enough for some growth to have occurred on the dry seabed, but the sodium chloride and sodium sulfate there are too toxic for almost everything other than a small bushy plant called *soliankа*. It has bright red flowers, and the contrast of the color with the setting is startling, like a blush on the gray cheeks of a corpse.

THE BED of the Amu Darya is dry where it reaches the sea; the water has been claimed for irrigation up the line. The greatest diversion is the Kara Kum irrigation canal, more than 500 miles away. It is a massive facility, stretching 850 miles, paralleling the boundaries of Afghanistan and Iran.

Waters of the Amu Darya began to flow into the canal, the world's longest, in 1956. But it wasn't until the 1960s that the delicate equilibrium between the inflow and evaporation of the sea (the Aral has no outlet other than through evaporation) fell apart. Since then production of cotton has doubled.

Eventually some party officials in Uzbekistan and Moscow became involved in a scam to inflate production figures and divert government payments for recorded, but nonexistent, cotton. Among those later indicted was Yuri M. Churbanov, first deputy interior minister and son-in-law of the late Soviet leader Leonid I. Brezhnev. He is now in prison, convicted of accepting the equivalent

Cotton is king in the Aral basin, but salt has become its nemesis as the naturally saline desert soil continues to degrade under irrigation. Near Nukus, where a woman helps gather the September crop (top), many fields have been poisoned by salts rising from waterlogged subsoil, encrusting young plants (above). The more salts that accumulate in soil, the more water is needed to produce the same yields.

A cotton field in the Amu Darya Delta is prepared for machine harvesting by clearing a strip by hand. Since its massive irrigation projects began in the 1950s,

the Soviet Union has more than achieved its goal of self-sufficiency in cotton: a fact that still justifies, for some, the sacrifice of the Aral Sea.

of more than a million dollars in bribes.

Between 1926 and 1960 the two rivers delivered an average of 55 cubic kilometers (13 cubic miles) of water to the sea each year, enough to fill *232 trillion* eight-ounce glasses. Now only a fraction of that reaches there. And sometimes there is not so much as the spit in a whistle.

There are few flights to Muynak now, and the faded sign on the terminal at the airport goes unread except by those who arrive by chartered plane, those who come shaken as much by the sight from the air of the dying sea as by the ride in the legendary relic of a biplane called the Antonov 2. The sign reads, "The City of Fishermen Welcomes You." Once there were 10,000 fishermen working out of Muynak, taking pike, perch, and bream as fat as piglets from the Aral. The town produced 3 percent of the Soviet Union's annual catch. There were 24 native species of fish in the Aral. Today there are none, and the commercial fishing industry is dead.

A living laboratory for the deleterious effect of a generation of misguided agricultural policy, the people of the Aral region are suffering from a host of maladies related to poor nutrition and environmental degradation. At the Muynak hospital Dr. Vladimir Maksimov (top) tends one of several babies suffering from severe anemia. Another anemic child nurses (facing page), despite repeated warnings that even mother's milk in the Karakalpak area is contaminated. At the hospital in Nukus, two patients suffer from another of the region's scourges: throat cancer.

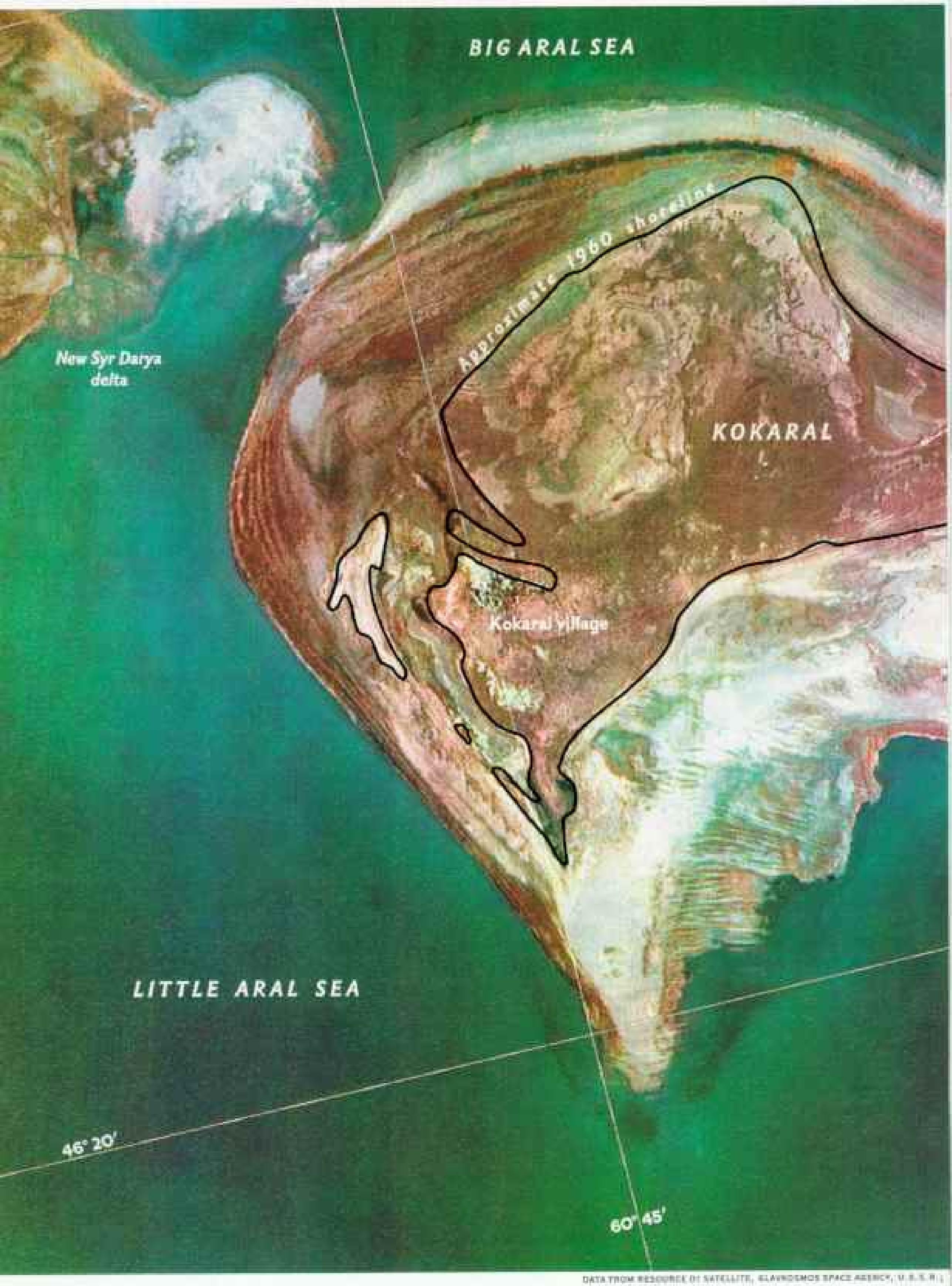
THE FISHING BOATS sit now on the dry bed that was the sea. They sit where they were abandoned when the Aral receded from Muynak, taking the spirit of the place with it. Some of the vessels have been cut up for scrap, but several dozen remain, some with anchor chains played out across the sand and some gutted of all but the wasp nests in the wheelhouses. Cast in heavy coats of rust, all smell of the death of the sea and of themselves.

"We tried to stop what was happening here, but no attention was paid to us," Koshkarbai Aitniiazov said. "The water continued to go away while the salinity increased. The weather changed for the worse with the summers getting hotter and the winters colder. The people feel salt on their lips and in their eyes all the time. It's getting hard to even open your eyes here."

Aitniiazov is the mayor of Muynak. He was also the last harbormaster. He explained that as the sea was shrinking, a canal was dug to link the harbor and the open water. "But we couldn't keep up," he said.

Dzhetpisbai Ibragimov, 66, remembers how it was. He spent his life as a fisherman on the Aral: "Until the sea left, when I was forced into early retirement."

He lives now in the village of Uchsay, not far from Muynak. A thousand families lived



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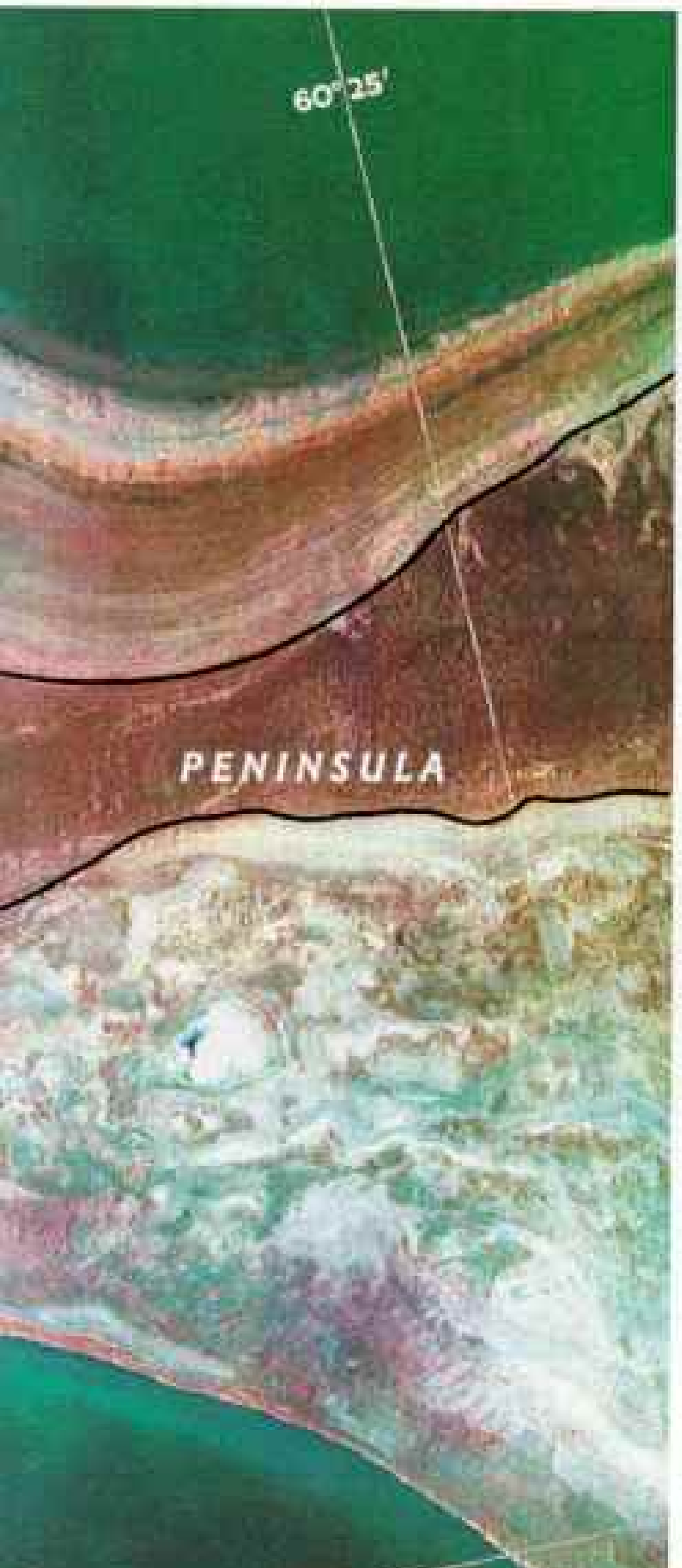

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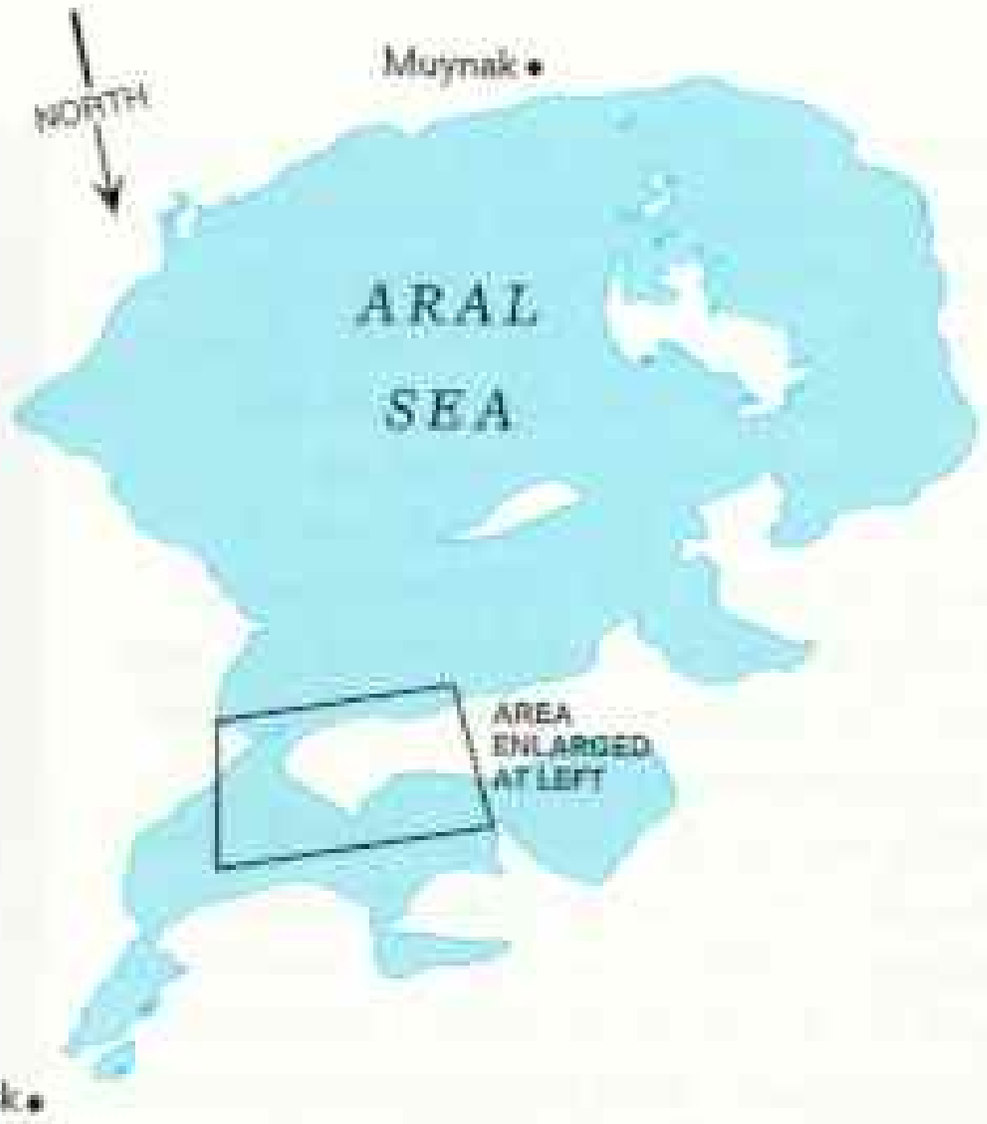


NASA, SPACE SHUTTLE STS, AUG. 8, 1985

Unforeseen by those who sanctioned the massive Aral basin water projects, huge salt storms spawned on the newly exposed shores of the shrinking lake are one of the most dire consequences, along with climatic changes that have made both summer and winter temperatures more extreme. One such storm is seen brewing in the upper left corner of a 1985 photograph (above) from the U. S. space shuttle Challenger. *A recent image from a Soviet satellite (left) shows great new deposits of salts, interspersed with sand, along the shores of the peninsula. Winds reportedly have carried these salts as far as the Arctic. Also visible is the Syr Darya Delta, formed in 1987-88 during two years of unusually heavy flows. For ten years before that, scarcely a drop reached the lake.*

there until the mid-1970s; now no more than 200. The sand has pushed in and up, ringing the village with dunes. Dzhetpisbai and I went to the fishing boats in the sand. It was the first time he had seen the vessels like that, and when I asked him what he thought, he replied, "I'm an old man. I can't speak of how I feel." Then he recognized a boat as one he had skippered. "I was *kap-i-tan*," he bellowed while hoisting himself up and over the side.

Standing on the deck with his World War II medal, the Order of the Great Patriotic War, taking a strike of sunlight, he was once again and for a brief time only in command of the 55-foot boat. And then he seemed glad to be done with it. He would sail no more; nor would he likely see the Aral Sea again.

ALTHOUGH THE ARAL has abandoned Muynak, the town remains dependent on fish. The processing plant remains open, giving work to 900 persons. To do that, Soviet planners have drawn on a scheme that excludes profit for the benefit of a community's survival.

The fish to be processed that day came from 1,750 miles away, from the Barents Sea port of Murmansk. They are sent frozen in refrigerator trains. "It is not clear if this operation will continue," said Daulbai Berdshev, general director of the plant. "However, there is the possibility that dikes can be built on the dry Aral Sea bottom, and areas can be flooded, creating a series of lakes for fish. In that way the plant would once again have its own fish supply."

Meanwhile, the people of Muynak continue to react with disbelief at what has happened. As much as anything, it is the wind and dust that stings them with the reality of the disaster. "Before this there were wind periods and calm periods," a government official in the town told me. "Now there's only the wind."

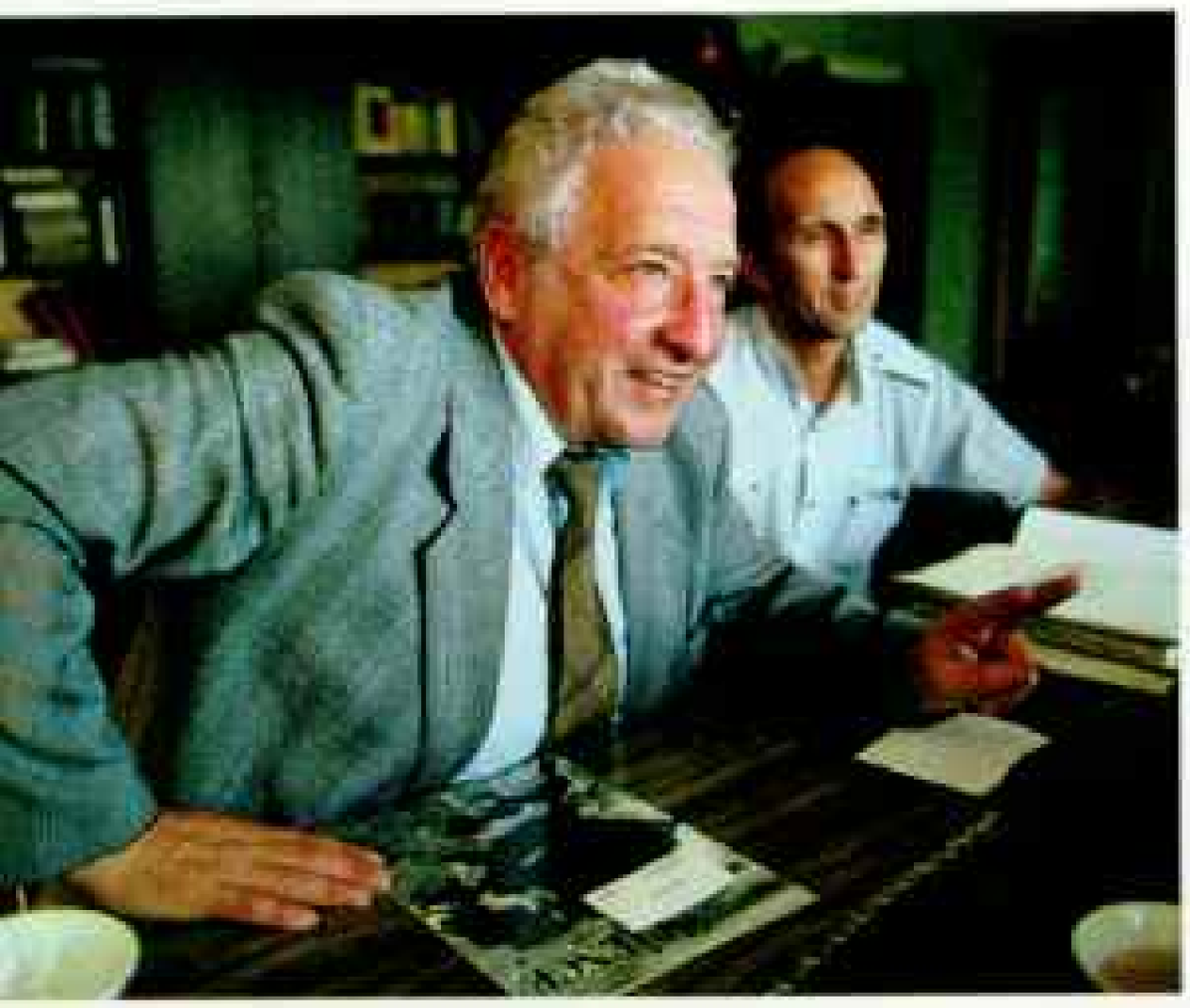
It has been calculated that 43 million tons of salty grit are whipped up from the dry seabed each year and carried away by the winds to harm the people and the land. Traces of salts have been reported as far away as the Soviet coast of the Arctic Ocean. In Muynak itself, the grit is raspy and thick, clogging the carburetors of cars.

Throughout Uzbekistan, and especially in the Karakalpak Autonomous Republic,

A plague on the land and on the throats and lungs of its people, airborne salts and poisons descend on Muynak (above) during one of the great dust storms that lash the Aral region with increasing frequency. Small wonder that respiratory diseases have risen so dramatically in recent years. Adding to the misery, Muynak temperatures now surpass 100°F for extended periods during the summer months. Meanwhile, all along the shores of the receding sea, the daily struggle for water (right) takes place amid scenes of desolation.

there have been sharp increases in certain types of illnesses. For example, the number of throat cancer cases has soared. "There have also been marked increases in respiratory and eye diseases," Khadisha Alimbetova, deputy director of the hospital in Muynak, told me. "Of those we can definitely say that the cause is the salt and the other

The Aral: A Soviet Sea Lies Dying



"Without water, the future is dim for Central Asia," says Viktor Dukhovnyi (top), director of the Central Asian Scientific Research Institute for Irrigation, in Tashkent. In charge of irrigation planning in the Aral basin, he has been under heavy attack from the media and scientific community. "The intellectuals realize the problem," he adds, "but not the farmers in the upper parts of the rivers." Meanwhile, on the lower reaches of the Amu Darya, the people of Muynak attend a Communist Party meeting (facing page) to learn how to deal with their rapidly deteriorating environment and the consequent health hazards.

Philip P. Micklin (above), an authority on Soviet water management and a geography professor at Western Michigan University, who accompanied the author to the Aral Sea, understands how some experts failed to foresee the consequences of the Aral projects: "Up to a point the environment could cope with irrigation, and the lake remained reasonably stable. But then a threshold was crossed, and suddenly the effects became enormous."

materials blowing off the dry seabed."

There are other villains here. For decades the cotton fields have been so laced with pesticides that much of the land is unfit to grow anything else. There are reports that DDT and other harmful pesticides continue to be used despite official bans and that a chemical called Butifos, also banned, is sometimes used to defoliate cotton plants, making them easier to pick.

Drinking-water supplies over a vast area have become polluted. At Nukus, 120 miles south of the Aral Sea, lack of drinking water has crippled life. Construction of a 125-mile-long pipeline to bring water in from a reservoir is now being rushed. But until the pipeline is completed, and until something is done to stop the saline dust from blowing off the seabed, it is not likely that there will be any change in the local infant-mortality rate for the Nukus area of 60 deaths for every 1,000 births.

"THE EFFECTS OF THE TRAGEDY of the Aral Sea are being felt by everyone, from infants to old people," said Mels Kabulov. He is associated with a medical-research institute in Nukus. "As an example, there were 74 cases of throat cancer treated here in our clinic in 1959. Last year we had 366 cases, an increase of five times. The population, though, has increased only two and a half times during that period."

Dr. Kabulov said that traces of pesticides were first found in the breast milk of some area women in 1975 and that the number of such instances has continued to rise. "We are approaching a medical emergency." The women picking cotton in the fields of Khalkabad state farm near Nukus know little of the causes of their ailments. They are among the poorest of the poor in Uzbekistan, a republic with an average annual income about half that of other parts of the Soviet Union.

About three-quarters of the 11,000 acres of the farm are given over to cotton. But the land is worn. In many places are large, bare areas crusted with salts and residues from the pesticides.

"Our assignment this year is to produce 6,130 tons of cotton," said Perdebai Kurbanazarov, chief party secretary for the farm. "Following new guidelines, we will reduce our cotton production so that it takes

up no more than 60 percent of the land."

It is not just that cotton is cherished in the Soviet Union because cotton clothes are comfortable. Exported cotton happens to be a major earner of hard currency.

Kurbanazarov led the way to a pleasant retreat on the farm, a shady glen by a stream where old men riding donkeys pass by. When he was ready to leave, I told him I'd stay awhile, and when he was gone, I sat beneath a linden tree and ate a melon swiped from a nearby patch. It was a gem of a melon with golden meat, and it was no less sweet for having failed to make it to market as part of the melon quota for 1989.

The decision to reduce cotton acreage meets guidelines adopted by the Communist Party Politburo in September 1988 aimed at stemming further depletion of the Aral. It was decided that irrigation systems would be made more efficient by lining with plastic and concrete the ditches that have stood for many years as mere slashes in the ground. Also, new collector canals are to be built to send some of the used irrigation waters directly back to the sea.

"With improvements to the irrigation system, we can give back to the Aral 21 cubic kilometers [5 cubic miles] of water a year by 2005. That is the best we can do," said Viktor Dukhovnyi (upper left), director of the Central Asian Scientific Research Institute for Irrigation. "We need water not only for the population and farms but also for industrial development. The intellectuals sitting at desks understand the ecological slogans, but they fail to understand the needs of the people working on the farms."

Leading voices in the matter of the Aral Sea have tended in recent years to be harshly conservative and very old line or angry and demanding of reform. If Viktor Dukhovnyi speaks for the former, then Raushan Tuliagakov, a novelist and member of the Committee to Save the Aral Sea, and Nikolai Aladin, of the Leningrad Zoological Institute, do the same for the latter.

Said Tuliagakov: "We knew the problem as far back as 1960, but we were not allowed to speak out. When we did, the bureaucrats crucified us." And Dr. Aladin, who is researching the reintroduction of crustaceans into the Aral, said: "As soon as we destroy the present complex of water management, we will make progress with the Aral Sea."

IF NOTHING ELSE, all agree that if the present level is to be stabilized, the Aral Sea will need half again the 21 cubic kilometers of water a year to be gained by the year 2005. The amount will not be obtained from the rivers unless a decision is made to reduce by half the nearly 18 million acres now under irrigation in the basin.

"We could do that today—cut it in half. But we have to think of the people who depend on the irrigation for work. What will they do then? What will they eat?"

Polad A. Polad-Zade sat in his Moscow office and made an accounting for all the river waters. As first deputy minister in the Ministry for Water Management Construction Projects, he is in a position of authority.

In talking with Polad-Zade and Dukhovnyi, it became clear that they intend to work for a solution giving priority to the people who depend on the irrigation. They know that the Aral is not likely to be, ever again, what it was before, and that the best that can be hoped for is some sort of stabilization of the sea and survival of the deltas of the two rivers.

Aral Sea expert Philip Micklin also feels that the price for restoring the sea may be too high. "Just to stabilize it would require an immediate injection of 30 to 35 cubic kilometers of water. I can understand the feeling that attention should focus on the deltas."

Saving delta lakes and restoring some of those now lost could lead to new commercial fishing activity and to the restoration of animals such as the muskrat. The watery mazes once supported large populations of boar and deer. But most of the animals are gone now, even the egrets that applauded the show with great claps of wings.

Quenching his thirst, this schoolchild and others of the Muynak district are happy for every drop of potable water. Victims of the great blight surrounding their beloved Aral Sea, they—more than most—can appreciate the Central Asia adage: "Water is life."

There is still some talk of a grand scheme to bring new water to the Aral by a diversion from the Ob and Irtysh Rivers in Siberia, 1,500 miles away. Environmentalists in the Soviet Union, for the most part, are opposed to altering the rivers, saying that this can only compound environmental problems.

So the Aral continues to give itself to the sun and take little in return. Dr. Micklin has looked beyond the year 2000 when, if nothing is done, the end for the sea will arrive.

"That does not mean there will be nothing left at all," he said. "The worst scenario would probably find the Aral shrunken to an area of 4,000 to 5,000 square kilometers, as compared with the present 40,000 [15,500 square miles]. Two lakes would remain in the south, both four or five times as saline as the open ocean. Both would be dead, like, well, the Dead Sea."

Who then, with the sea like that, will ever want to remember it in verse, as Matthew Arnold did in his epic work "Sohrab and Rustum":

The shorn and parcelled Oxus
[Amu Darya] strains along
Through beds of sand and matted
rushy isles—
Oxus, forgetting the bright speed
he had
In his high mountain cradle
in Pamere,
A foiled circuitous wanderer:
till at last
The longed-for dash of waves is
heard, and wide
His luminous home of waters opens,
bright
And tranquil, from whose floor
the new-bathed stars
Emerge, and shine upon the Aral Sea.

Ah, Matthew, if you could see it now. □

„БҮГІНГІ МЕКТЕП ПАРТА
СЫНА ОТЫРАТЫН ОҚУШЫ
ӘР КЕЗІРІ РАСЫРДЫҢ
АЛДЫҢҒЫДАЙ ЖӘНЕ
КЕЛЕСІ РАСЫРДЫҢ
БАСЫНДАҒЫ УАҚЫТ
МІНДЕТТЕРДІ ШЕШЕШІ

МЕКТЕП РЕФОРМАСЫНЫҢ

By PRIIT J. VESILIND NATIONAL GEOGRAPHIC SENIOR WRITER

Common Ground,

No barrier to a fond friendship, the U. S.-Canada border is straddled neighbors, George and Marguerite Horgus. Yet many Americans

Photographs by SARAH LEEN

Different Dreams

by Alberta farmers DeWayne and Doreen Ford, left, and their Montana and Canadians look across the line from divergent perspectives.

THE MOUNTAINS of British Columbia are the set for a new U. S.-Canadian television show called *Bordertown*, about a fictional 19th-century settlement on the 49th parallel, half in Canada, half in the United States. Each side has its law officer: The U. S. marshal is a scruffy, laid-back maverick in love with his six-gun; the Canadian is an uptight North-West Mounted Policeman dedicated to his spit and polish.

Periodically the prop girl tosses dirt on the marshal and dusts off the Mountie.

It's a family affair, full of inside jokes. On both sides of the border, viewers smile.

History has bred the caricatures. The United States was born of rebellion and the cult of independence. It spread west two hops ahead of the law. Canada was formed by consensus among public servants. On its way west the law went first. Canadians never had widespread slavery or suffered a civil war. They never had Indian wars, never had a Wild West. Canada was lumped together in 1867 from the residue of history: descendants of the original French settlers, British colonials, Loyalists who fled the American Revolution. Its union has been a shaky one.

So Canada frets and braces itself against the weight of the United States, with its seductive popular culture and sense of righteousness. As former Prime Minister Pierre Trudeau told the U. S. Congress, "Living next to you is in some ways like sleeping with an elephant: No matter how friendly and even-tempered the beast, one is affected by every twitch and grunt."

Now the beast is on the loose: In 1988 the two nations signed the U. S.-Canada Free Trade Agreement (FTA), which over the next decade tears down remaining tariffs and duties on goods and services between them and may eventually integrate the economies.

But Canadians are not sure about all this. They are worried that Prime Minister Brian

Rolling white ribbon in winter, a 20-foot-wide clear-cut called a vista, maintained by the International Boundary Commission, divides Maine, right, and Quebec. Self-assured Quebecois feel no threat from the American colossus, but English-speaking Canadians worry about losing their culture.

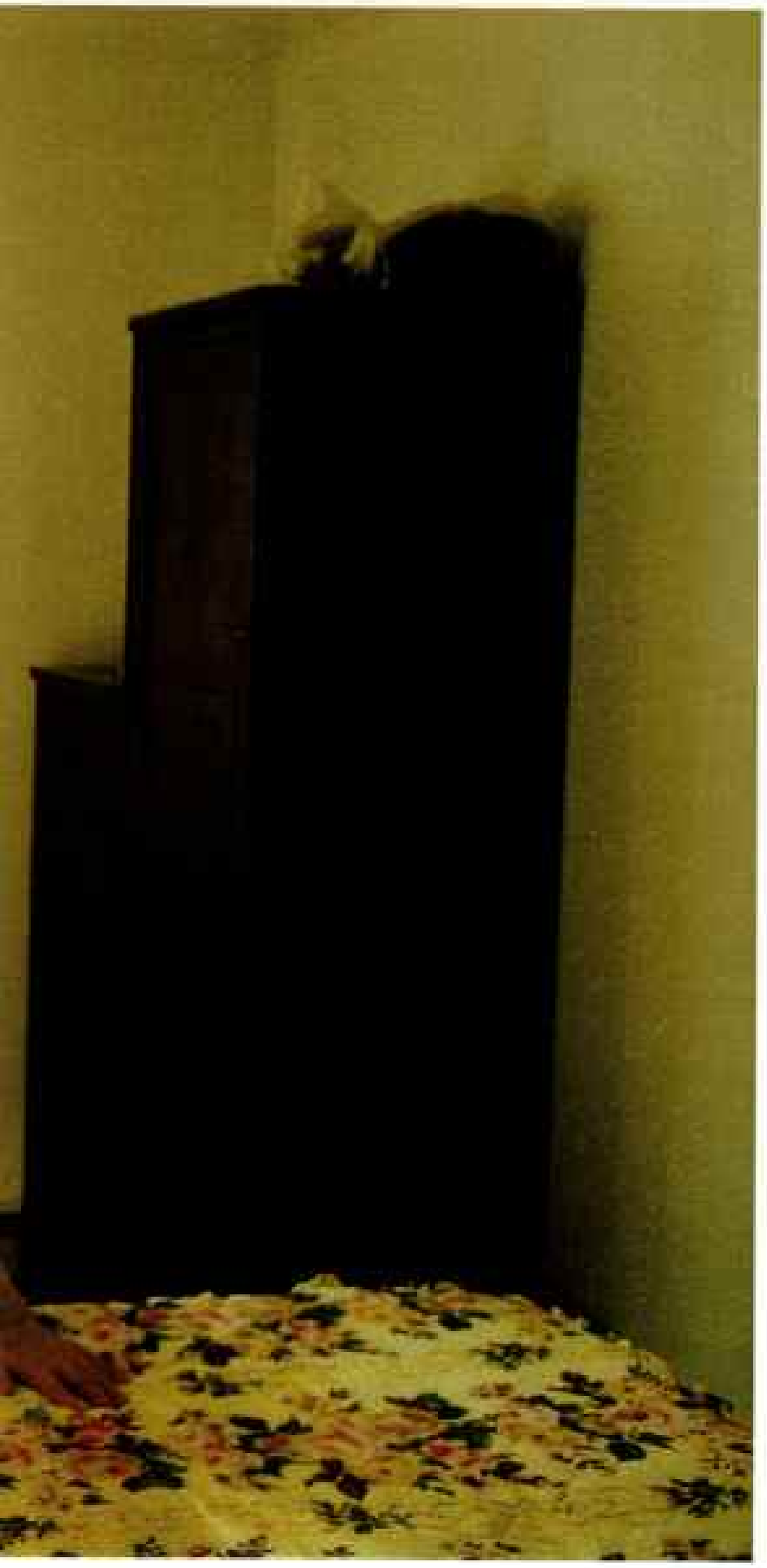
Mulroney has sold out the nation to the U. S. and multinational corporations, that Rambo and rap music are twisting young minds, that American handguns and crack cocaine will filter north and poison Canada's cities.

Already ice hockey great Wayne Gretzky has been traded to Los Angeles, and Canada frets that a nation unable to hold on to its heroes cannot hold on to its identity.

Only free-enterprise corporate Canada, now more free to plunge into a U. S. market ten times the size of its own, does not fret.

In the U. S. these emotional issues are met with the ho-hum that annoys Canada even more. Americans genuinely like Canadians. They are puzzled that the feeling is not always mutual, that the equation has changed. Americans still shout "We're number one!" but Canadians peer down somewhat sadly at what looks to them like a failed experiment. Canadians of 1990 think they have the better country; for Americans, that does not compute.

"Canadians are generally indistinguishable from the Americans," wrote American journalist Richard Starnes in 1965, "and the surest way of telling the two apart is to make the observation to a Canadian." I found that a good beginning as I journeyed 3,800 miles along the border last spring and summer, hoping that walls were not forming as fences fell.



A village divided: Redrawn here some 60 years after an 1843 survey, the border splits Estcourt Station, Maine—to the marker's left—and Estcourt, Quebec. The U. S. population includes one American wildlife warden and five French-speaking households such as Irene Morneau's (left); her bed, in fact, is bisected by the line. U. S. mail must pass through Canadian customs before delivery.

MAINE AND NEW BRUNSWICK share the border where the St. Croix River slips into the sea. Here I started on a morning when low tide had bared the shoreline rocks and the fog was laced by salt and seaweed pungent as a brewer's vat. To the west lay thick Maine forest, to the east the clapboard towns and apple orchards of the Maritime Provinces.

Canadians who live near the border live in their nation's banana belt, the most temperate climate Canada offers. Americans on the border live in the deep north. Popular perceptions are flip-flopped in the border zone, for here Canada has sophisticated urban centers like Vancouver and Toronto and a dense network of roads and agriculture. The U. S. has mostly hardscrabble farms and vacation sites.

To an eastern Canadian the state of Maine appears a bit regressive. On New Brunswick's Campobello Island, fisherman Donald Savage groused about his American neighbors as he mended nets. "I don't know what they *do* over there," he said. "Their main industries seem to be food stamps and yard sales."

And yet Campobello has no bridge to the Canadian mainland, only to the village of Lubec, Maine. Islanders depend almost totally on American groceries and goods. And if Savage and his friends have no use for Yankees, they resent even more the Acadians who dominate northern New Brunswick. "We're trapped by the French," he said. "When I hear that *bonjour* bull on the phone, I get mad. It's a lot easier and cheaper to go across the border to the U. S."

A winter wind clawed at the village of Estcourt Station, Maine, when I arrived, but Mme Irene Morneau slept warmly, with her feet in Canada and her head in the United States. The border, resurveyed here in 1906 after the settlement had grown, cuts through town like a cleaver. On the U. S. side, five French-speaking families and warden Phil

Dumond of Maine's Fish and Wildlife Department remain. From the only street, you can see the border climb the mountainside and head south—a 20-foot-wide swath of clear-cut, maintained by the International Boundary Commission, stretching from sea to sea.

Phil has seen enormous social change in his 32 years of experience. "When I first came up here, the Quebecois were a very 'moral' people," he told me. "They wouldn't dance. Men and women swam on opposite sides of the lake. Now the standard of living in Quebec Province is higher than ours, and they think they're a little country. They think Americans don't know how to dress, to eat, to enjoy themselves. They have jokes about us.

"What surprises me is that the U. S. flag is still flying here. Estcourt is lost. I'll be the last one to leave, like the captain of the ship. Ha!"

Canada's more divisive border may be the one between French and English speakers. Since the fire of the French Separatist movement in the 1970s, when English-speaking Canadians deserted by the thousands, Quebec has merely smoldered. Now a new generation of French-speaking entrepreneurs have inherited a province in their own image, but one even more isolated than before. Paradoxically Quebec supported the Free Trade Agreement because it felt no pressure from American culture. Ontario, the province most inundated by American pop, was the most reluctant.

The isolation of Quebec is often painful. When American Phil Norton married Brigitte Bruneau of Montreal, they first tried living in Pennsylvania, but Brigitte chafed under American indifference to the news from Quebec. They then moved to Montreal, where Phil was uncomfortable with the French-Canadian taste for drawn-out bouts of smoke-filled conversation. So they compromised and rented an old customs house near Franklin-Centre, Quebec, a mile from the border, surrounded by apple orchards and silence.

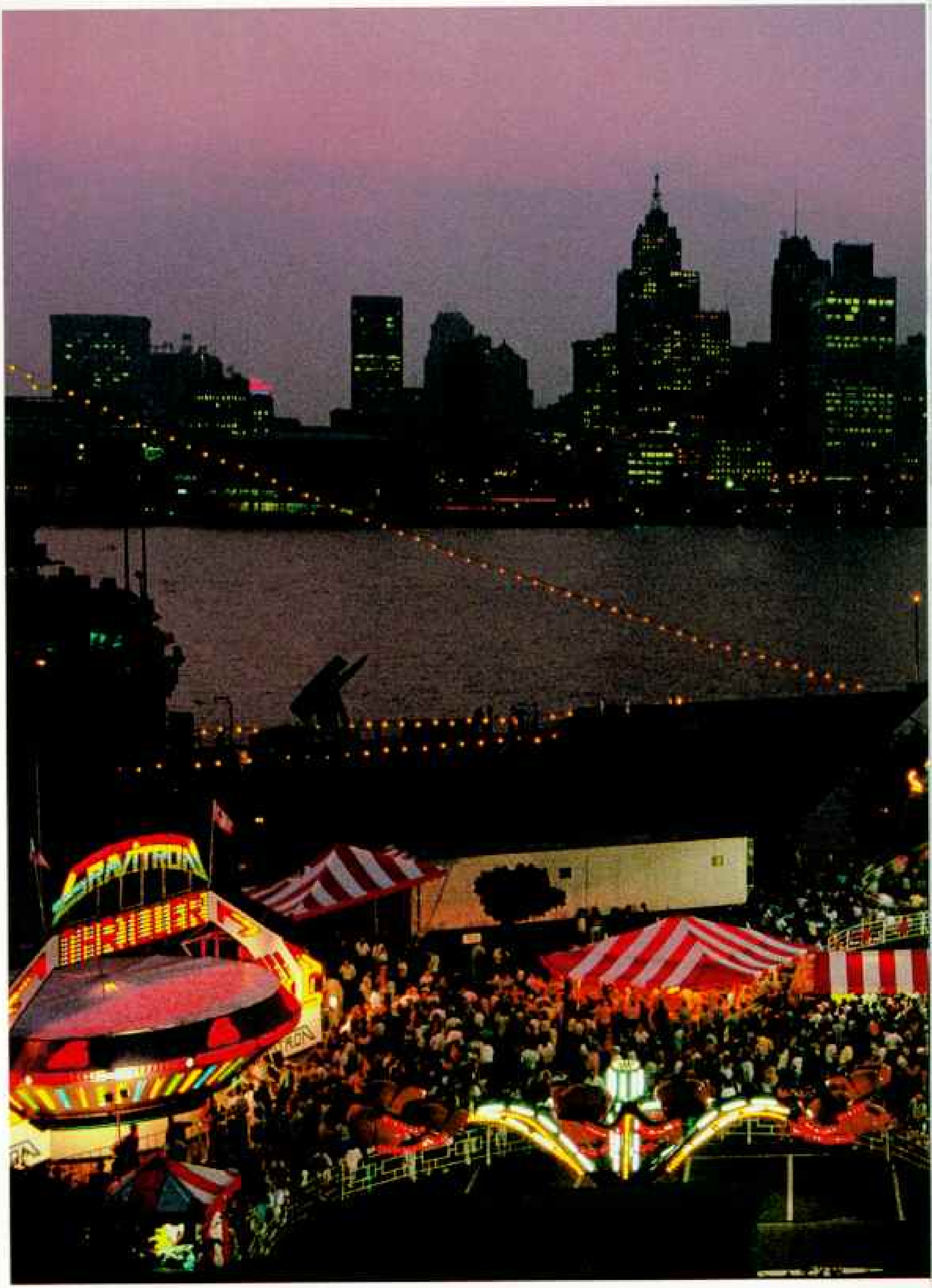
Brigitte speaks to Phil in French, he to her in English. Two-year-old Gabrielle says things like, "Papa, more *de l'eau* please." He edits a small English-language newspaper in Quebec; she commutes to work in Montreal.

Now even the compromise has foundered, and Brigitte has her own apartment, closer to her roots. "Although we each hold a fascination for the other's culture, there are real differences that are difficult to bridge," Phil wrote several months after I visited them.

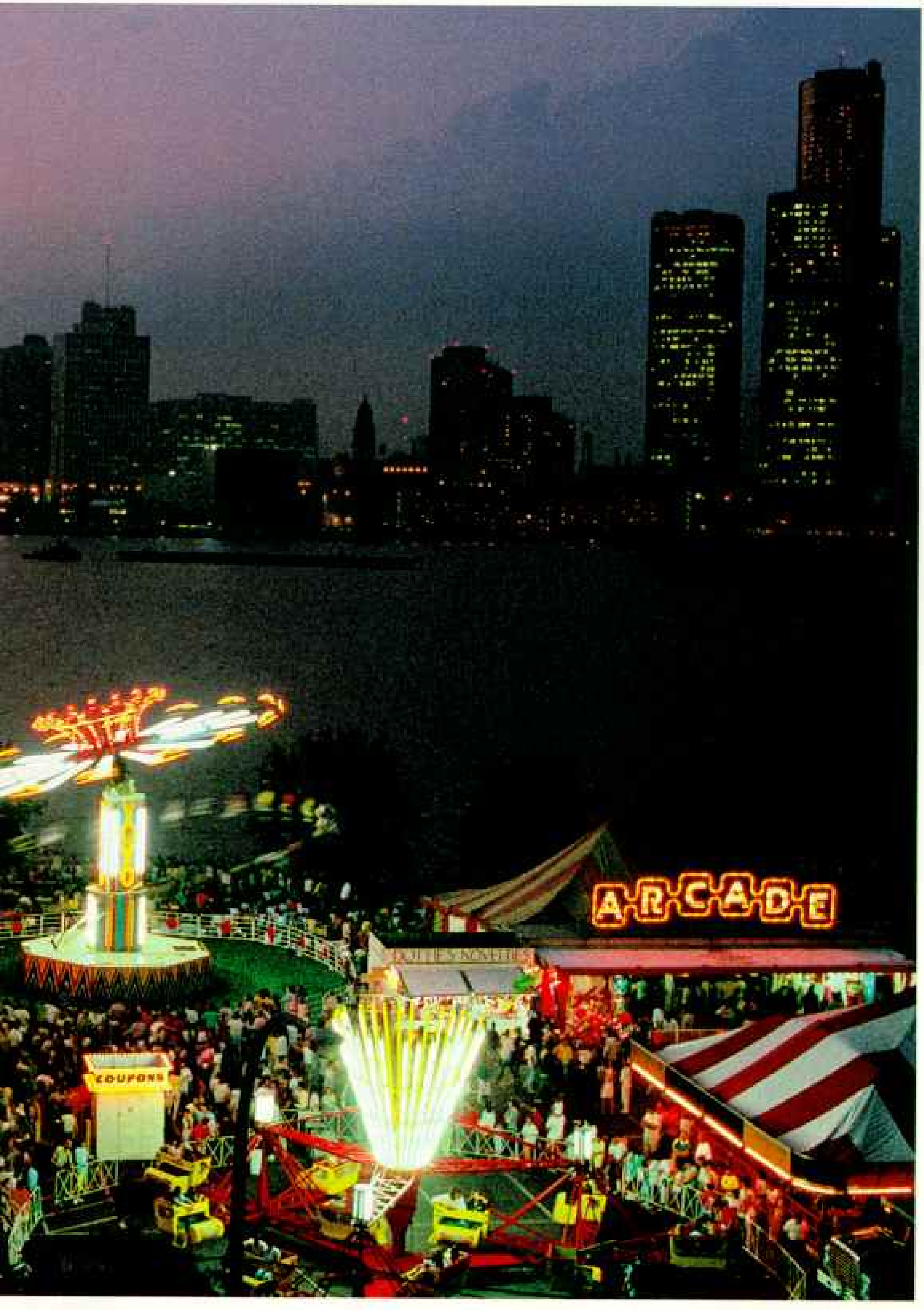
"I became a Canadian quickly. For others it took years." The Reverend Lance Weisser, ministering (above) at Quebec's Athelstan Presbyterian Church, fled the U. S. during the Vietnam War in 1968. He became one of some 20,000 antiwar Americans welcomed by Canadians. American firearms get a different reception: They are frequently seized at the border. An Ottawa technician renders handguns inoperable prior to their destruction.

THE UNITED STATES and Canada share the longest undefended border in the world. Each year more than a hundred million people approach 96 legal border crossings and thousands of informal ones. Hybrid communities have evolved where the border bisects farms and country roads, where the line is more nuisance than necessity. Dairy cattle sometimes wander back and forth, and business deals are made without paperwork. Guarding this frontier is the U. S. Border Patrol with its electronic sensors and television monitors that sometimes nab a pair of cold and frightened Guatemalans struggling from the Canadian woods into a U. S. snowbank.

The Rio Grande it isn't, pointed out the



Looking north into the U. S., a Windsor, Ontario, crowd faces the Detroit skyline during a combined celebration of Canada Day and the Fourth of July. Having crossed the Detroit River, a Saint Lawrence Seaway link, the crew of the guided-missile frigate



U.S.S. Oliver Hazard Perry joined in. While few large American cities mark the border as a popular place to live, four out of five Canadians dwell within a hundred miles of their southern boundary—and many wind up farther south than their U. S. neighbors.

Morning comes early for Canadian workers van-pooling to the Autoplex in Oshawa, where General Motors of Canada makes their hour-and-a-half commute worthwhile with salaries that start at $17.50 an hour ($15 U. S.). At the plant, one of the largest automotive complexes in North America, robots weld cars that travel not on an assembly line but on self-propelled platforms to groups of workers.

agents in Swanton, Vermont. Along the Mexico border 3,000 people a day might be intercepted, here fewer than 30. But recently, says supervisor Wayne Preston, traffic in illegal aliens and drugs has escalated. Smuggling rings in Montreal will simply pack a dozen Pakistanis into a pickup truck and send them to Vermont at night, through an unmanned crossing, at a price of $1,500 each.

Yet the idea of a barrier along the border offends most everyone. "You cannot do it—absolutely not," said Preston. "People here have half their farms on the other side, their aunts and uncles too. Some roads you can't shut down. These are not the criminals. The U. S.-Canada border is a living organism—a life and culture. We try not to disturb it."

One early April afternoon I went with agent Blaine Davis on patrol across the Lake Champlain islands. In the grudging spring Vermont was drawn in pen and ink, with every oak and maple etched against a neutral sky. In the dark blue early evening, during milking time, dairy barns still glowed like ocean liners with their rows of yellow windows.

"The land here is very swampy," said Blaine. "Few of the crossers run the risk of coming through these woods. They get lost, and one group froze to death. In the spring you can see where families have been lying on the ground. You'll find a Bible, a shirt."

For many refugees and emigrants the promised land is not America but Canada, because Canada needs people. But in the past four years the human flow from misery around the world has overwhelmed both countries.

The U. S. immigration act of 1986 gave amnesty to illegal aliens who had come to the States before 1982 and forbade businesses to employ those who have arrived since. Scared of deportation, many aliens in the U. S. turned to Canada. In reaction Ottawa began to weed out economic refugees from political ones. Those arriving at Canada's golden door were told to wait outside until a court hearing could determine their status.

The Adirondack Mountain town of Plattsburgh, on the corridor between New York City and Montreal, was a major point for refugees who had to wait, sometimes for half a year, to enter Canada. Many had no money and few possessions. Said Brian Smith of the Plattsburgh crisis center: "The hearing dates kept getting further and further apart. We had the city's low-cost motels loaded up till they were all full. The Salvation Army provided a shelter for 90 people, but we had to organize caravans to the YMCA for showers."

"Cosmopolitan Plattsburgh!" Smith marveled. "We had Somalians walking downtown among Sri Lankans, and Djiboutis, Lebanese, Nicaraguans, a fellow from Poland. It passed the 3,500 mark last year—a lot of people for a city of 28,000."

Things turned nasty with winter temperatures of 25 below. "Some of these people came wearing flip-flops, in sweatshirts and no outerwear," said Smith. "That's when everyone came in with donations. They were stacked so high that it filled the room."

Plattsburgh was America at its best, the people said. But others seemed confused to see

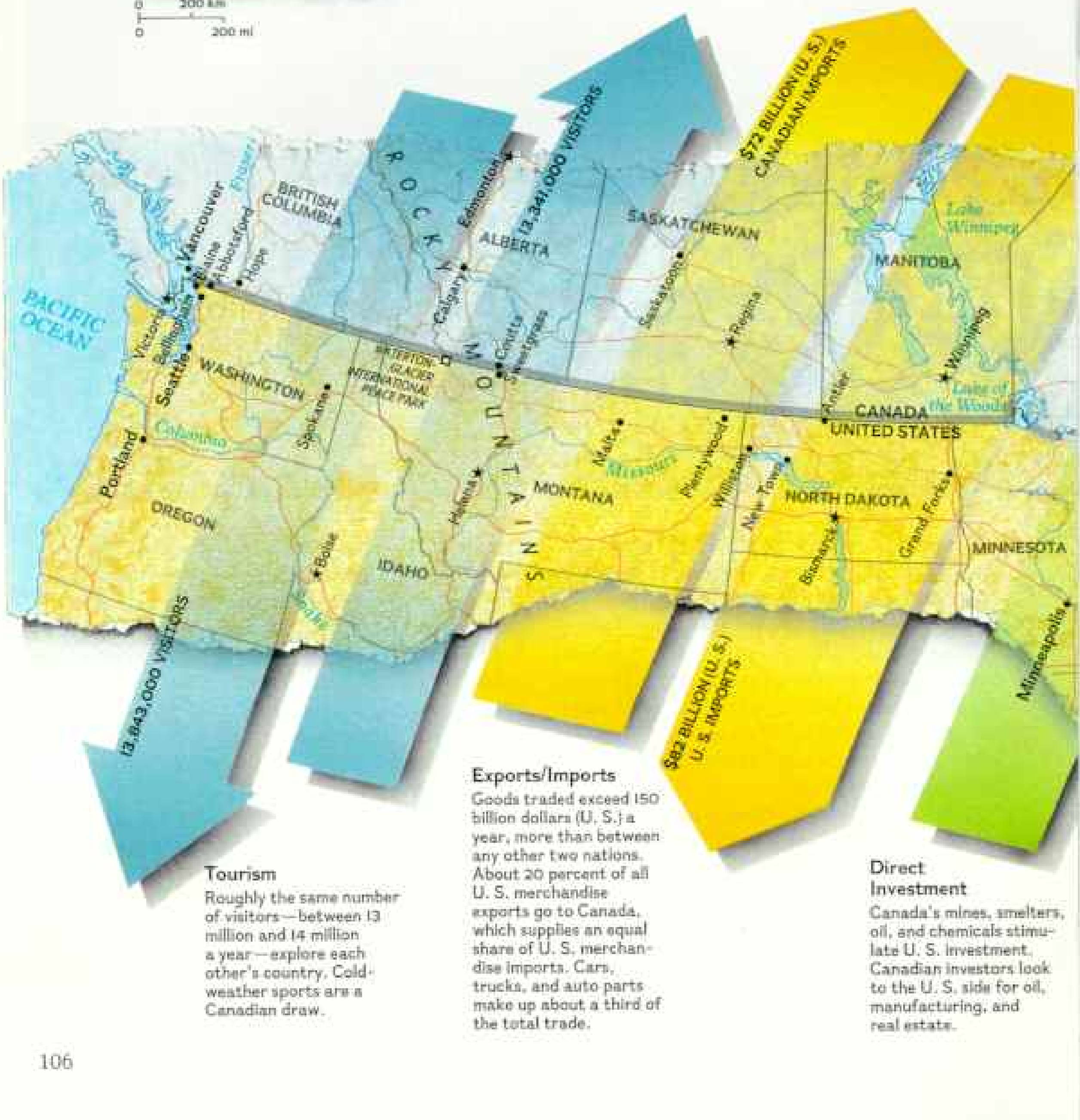
Caribou

Knowing no boundaries, the 185,000 caribou of the Porcupine herd roam between the Yukon and Alaska and could be affected by proposed oil and gas drilling in the region.

Give and take between neighbors

NO ARMIES DEFEND this frontier, 5,535 miles (8,900 kilometers) long. Yet its delineation has taken many acrimonious twists and turns, like the history of those who have drawn it.

American colonists launched their revolution with a futile attack on Québec City; a treaty



Tourism

Roughly the same number of visitors—between 13 million and 14 million a year—explore each other's country. Cold-weather sports are a Canadian draw.

Exports/Imports

Goods traded exceed 150 billion dollars (U. S.) a year, more than between any other two nations. About 20 percent of all U. S. merchandise exports go to Canada, which supplies an equal share of U. S. merchandise imports. Cars, trucks, and auto parts make up about a third of the total trade.

Direct Investment

Canada's mines, smelters, oil, and chemicals stimulate U. S. investment. Canadian investors look to the U. S. side for oil, manufacturing, and real estate.

with Britain in 1783 first defined a northern border. West from the Bay of Fundy, the line began at the St. Croix River's mouth and ran north to vague "highlands" between Maine and Quebec. Challenges arose to the location of the true St. Croix, decided in 1798, and to the highlands, finally agreed on in 1842. The U. S. won more than half the disputed area. From Maine the boundary intersected the 45th parallel, followed the St. Lawrence River, and traced the midpoints of the Great Lakes to Lake of the Woods. After the War of 1812 the border was extended along the 49th parallel to the Rocky Mountains, and to the Pacific in 1846, after a failed U. S. attempt to expand the Oregon Territory up the coast to Alaska.

In 1903 a tribunal agreed to an Alaska Panhandle boundary sought by the U. S., thus denying Canada free access to Yukon goldfields. Today, fishing rights remain an issue along that boundary, as they do off the Atlantic coast—part of the vital economic crosscurrents between these major trading partners.

Chronology of the U. S.-Canada border

1783 Treaty with Britain defines the boundary—soon disputed—from St. Croix River west to Lake of the Woods.

1814 Treaty of Ghent confirms most U. S. boundary claims.

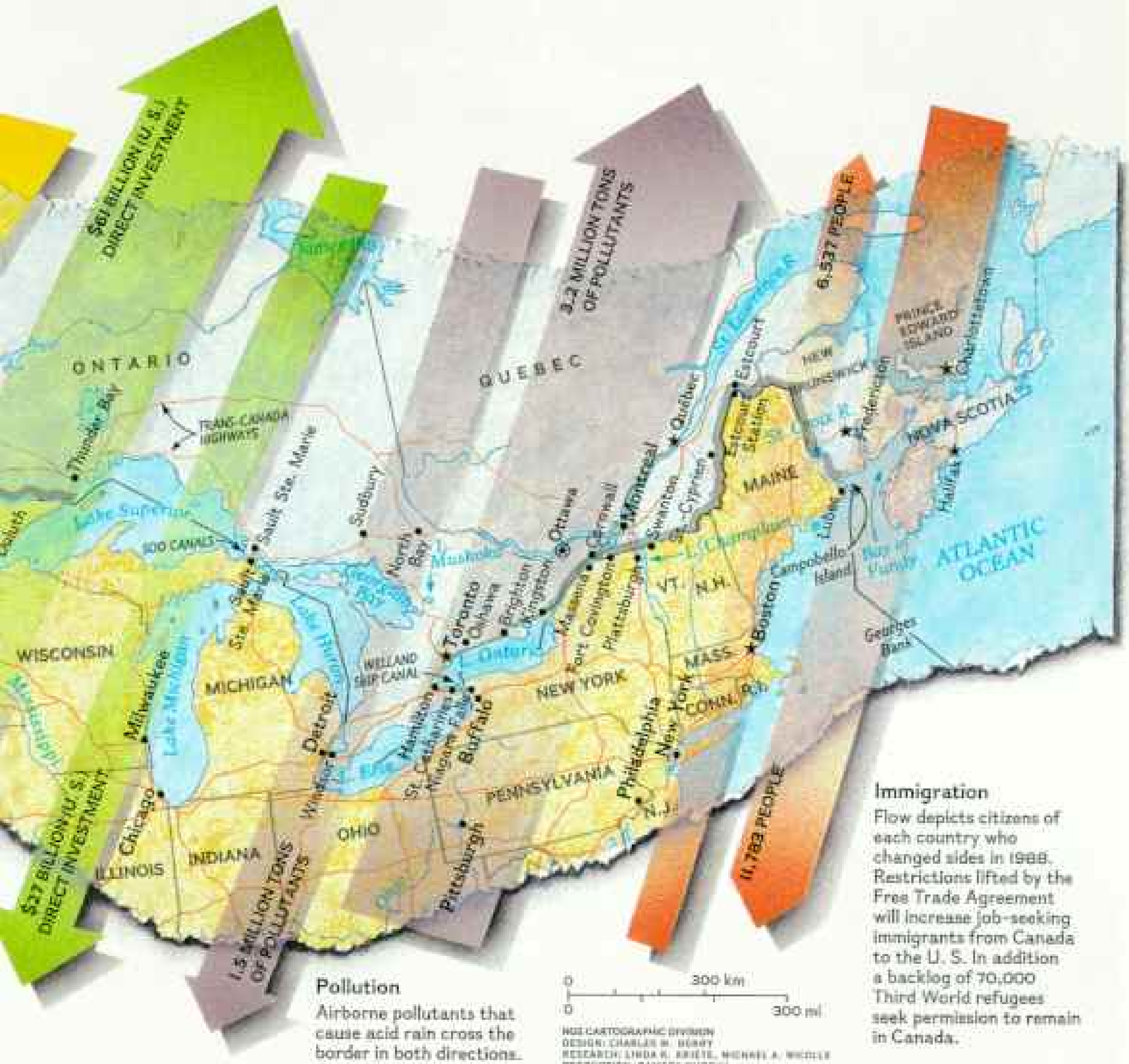
1818 Western border is extended along 49th parallel to the Rockies.

1842 Webster-Ashburton Treaty settles key Maine claims in U. S. favor.

1846 Northern limit of Oregon Territory is set at 49th parallel, rather than southern Alaska as the U. S. wanted.

1903 International tribunal accepts U. S. definition of Alaska Panhandle's boundary, now the site of a U. S.-Canada fishing dispute.

1984 International Court of Justice divides the Atlantic's Georges Bank, but fishermen's hard feelings continue.



Pollution

Airborne pollutants that cause acid rain cross the border in both directions. Canada receives more than twice the amount from the U. S. as the U. S. gets from Canada.

Immigration

Flow depicts citizens of each country who changed sides in 1988. Restrictions lifted by the Free Trade Agreement will increase job-seeking immigrants from Canada to the U. S. In addition a backlog of 70,000 Third World refugees seek permission to remain in Canada.

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America with thousands camped along its border hoping to get out.

Canada has always been an option for the refugees of war and conscience in America, starting with 100,000 Loyalists who fled the Revolutionary War because their attachment to the British king was stronger than their stomach for rebellion. Blacks escaping slavery rode the Underground Railroad to freedom in Canada before the Civil War. And in the 1960s more than 20,000 young Americans chose Canada over the war in Vietnam.

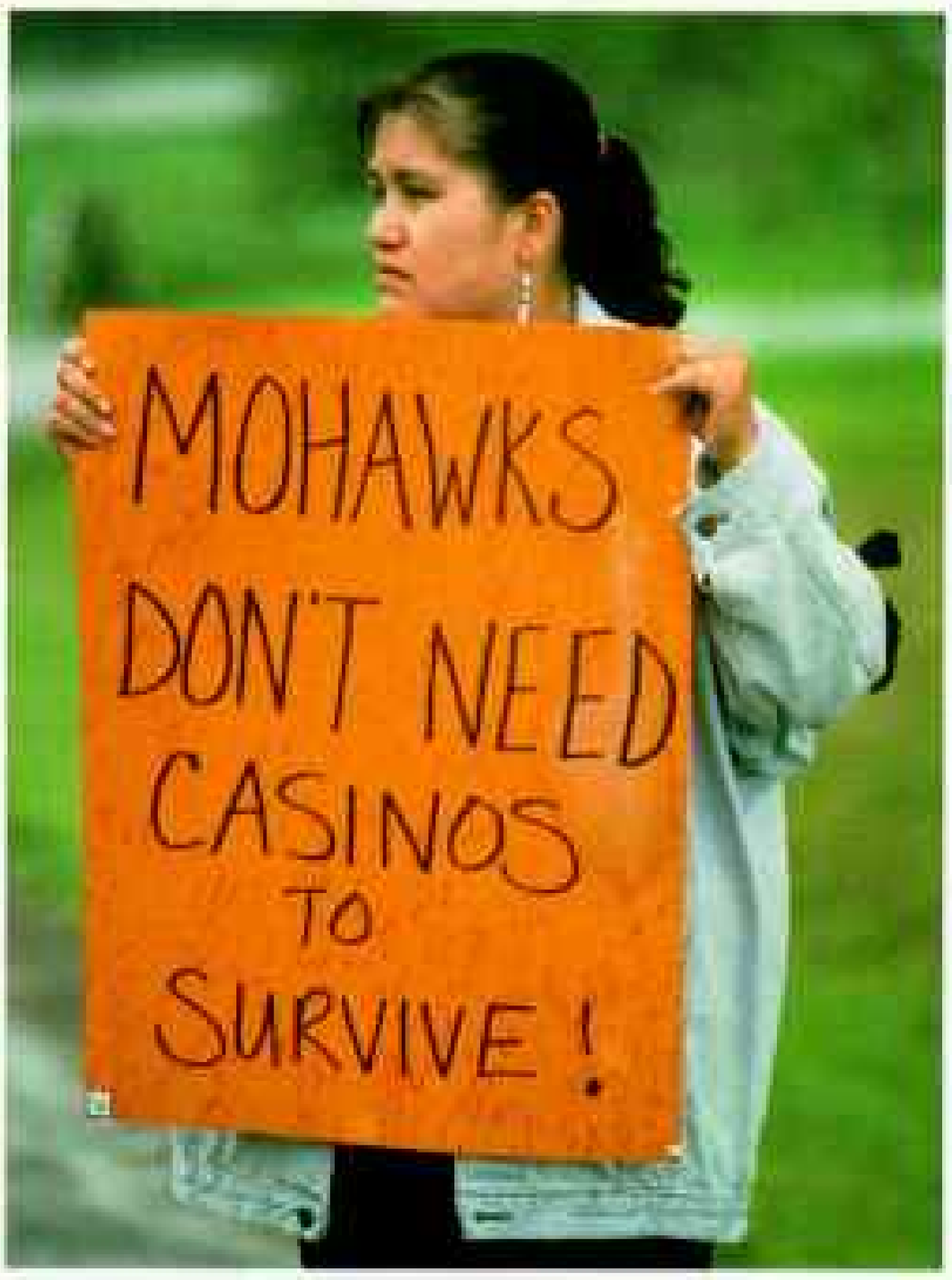
The Reverend Lance Weisser, a Presbyterian minister in the rural Quebec community of Huntingdon, was one of these (page 100). He left the United States for good in 1968. Mr. Weisser has an ache in his heart for home, but he has carefully considered his decision. He will stay a Canadian. He remembers returning to the United States for a football game some years ago, hearing "The Star-Spangled Banner," and seeing a big brass band marching, its drill immaculate.

"Their identity was so solid that it was almost oppressive," he said. "Americans are so sure of who they are . . . so anchored in their own 200 years of history. They set it out from the very beginning: This is who we are. And they just have filled it out ever since. They all know what to do on July 4. You pull out the sparklers. You put flags out and wave them. And do it up, like . . . like dinner.

"Here, people aren't quite sure what to do on Canada Day. Somebody puts up a flag. But, it's not the same. It's just not the same. They're not filling out a dream."

"Are you disappointed then?" I asked.

"No. No, I'm very happy here. If anything, Canada fits me. It's my country for that implicit reason. I'm not sure of where I'm going, and how I'm getting there. This country is always going through that kind of angst."



Cooperation and conflict: Awaiting permission to settle in Canada, Honduran refugee Francisca Pinto (facing page) finds shelter in Plattsburgh, New York. Tougher restrictions threaten immigrants already in the U. S. with deportation. Canada welcomes many, but the backlog marooms thousands in border towns like Plattsburgh, which has opened its arms to aid applicants.

A bitter dispute over gambling divides the Mohawk Nation straddling the border near Cornwall, Ontario, and Massena, New York. Canadian whites flock to the U. S. side where some Mohawks operate casinos, protested by others from Canada (top). Tension earlier spawned violence when antigambling forces seized slot machines and then destroyed them.

FROM QUEBEC to Kingston and the Thousand Islands, where the Great Lakes of North America begin their stately terrace up to the prairies, the border is the St. Lawrence River. On the river near Cornwall, Ontario, the St. Regis Reserve of the Mohawk Nation of the Iroquois Confederacy, which they call Akwesasne, or "Land Where the Partridge Drums," wrestles with itself.

Akwesasne is the only Indian reservation in North America that straddles an international border; 6,000 Mohawks live in Canada, 5,000

in the United States. Not long ago the major extralegal activity was smuggling cigarettes, drugs, and other contraband to avoid taxes and prohibitions. Some Mohawks moved almost anything across the border, for money. Others did so as acts of political defiance.

"This line—this imaginary line where the two white people couldn't get along—does not affect us," Canadian Mohawk Francis Boots told me at his home on Cornwall Island. "It goes above our heads."

Now gambling complicates all—big-time gambling on a strip of bingo halls and slot-machine casinos crowding New York State Route 37, thrown up since the U. S. Indian Gaming Act was passed in 1988. Millions of dollars have been made, hundreds of jobs created. The customers are mostly white Canadians—busloads weekly filled with players from Ottawa, Montreal, and Toronto. Backers, it is said, include the underworld.

The community has split bitterly into pro-gambling and antigambling factions. Those who have profited from gambling live mostly on the U. S. side, and emphasize their sovereignty—that on their own land they can do whatever they please. Those opposed, many of them Canadian, claim that profits promised to the reservation fund are siphoned out, and that easy money will corrupt and not enrich.

The battle lines are complex, but even here the conflict echoes North American history. It pits by-the-rules Canadian Mohawks against their free-wheeling American brothers.

Hard edge of American culture spreads into Yonge Street in Toronto. Canadians struggle to maintain their identity while their films and airwaves are dominated by the United States. A cardboard American icon, Johnny Cash, sells automatic teller service at Toronto's Canada Trust bank. Affirms popular Canadian historian Pierre Berton: "We know who we are not, even if we aren't quite sure who we are. We are not American."

The week before I drove through Akwesasne in early June, a barroom brawl had lurched into the street and spread. Anti-gambling Mohawks had raided Tony's Vegas International casino, ripping out more than 140 slot machines.

Violence escalated with the summer. In August a newly built casino was gutted by a mob tossing Molotov cocktails and armed with baseball bats and hunting knives.

Canadian band council chief Mike Mitchell, who works with outside governments to provide social services, speaks against the gamblers and the smugglers, while denying any part in violence. Mitchell lives alone for now, amid a tinderbox on Cornwall Island. Anger keeps him wired.

"Our traditions are breaking down," he told me. "Greed, money. It's hitting us like a disease. We need education, to be doctors, nurses, and lawyers. You don't need an education to pass out bingo cards. The gambling people tell me that it's about time we gave it back to the white man. We got slapped; let's slap them back. They tell me you can't eat honor. And I look back at them and say, 'But you can live it.' "

Militant Francis Boots is not convinced: "For us, Mike Mitchell has no voice. He doesn't even have a face. I no longer recognize him as a human being."

ROUTE 401 along the top of Lake Ontario quickly turned from farms to urban sprawl as I headed for Toronto. By Oshawa the highway picked up two more lanes and heavy traffic to match. We rushed numbly through tracts of industrial parks and blue-collar bedroom communities.

Toronto is the power broker of the nation, envied and despised, holding nearly 15 percent of all Canadians in its orbit and accounting for a sizeable portion of the nation's exports. Since 1981 incomes have soared, and

Fearing lost jobs, Canadian brewery workers protested the Free Trade Agreement (FTA) before its 1988 signing by Canada and the U. S. Such efforts successfully retained a duty on beer despite an eventual phaseout of protective tariffs on both nations' goods.

the Toronto Stock Exchange has thundered.

Opulent and nouveau chic, Toronto has been flattered for a decade as a city of the future, one that works, an example for the U. S. ones that don't. The skyline swells with banks, investment houses, publishers, designers. Smoking is forbidden in public buildings. Handguns must be registered.

America does not impress Toronto. Said Michael Adams, who conducts opinion polls in Canada: "We stand back from your culture, with a wonderful perspective. All these characters marching by, wearing different costumes, in all different directions. We pick out the stuff we want, reject the stuff we don't. Thirty years ago we had our noses pressed up against the American dream machine. But since the 1960s Canada has gained self-awareness. And here's the difference: We learn from your mistakes, and you don't learn from our successes."

The city's heroes tend toward financiers and writers. The Reichmann brothers head Olympia & York, the biggest commercial landlords in Manhattan. Developer E. P. Taylor built Lyford Cay in the Bahamas and owned the race horse Northern Dancer. Garth Drabinsky founded Cineplex Odeon, a theater chain with 1,300 screens in the U. S.

Beloved Margaret Atwood, novelist and cultural grande dame, has no counterpart in the United States. Writer Farley Mowat made a bundle writing of the time the U. S. wouldn't let him in because his name was on a subversive list.

Much of the city tunes to Peter Gzowski and his radio talk show, *Morningside*. "You must remember how recently we all lined up with whatever Great Britain did," he told me in his most affable and growling baritone. "People of my age grew up British—as part of the British Empire. And now we have to figure out whether we're part of the 'American Empire' or not. There hasn't been much time that we've just been ourselves.

"But what grates on us is that we know everything about American facts, and Americans know nothing about *our* facts. I can talk American politics, tell Dan Quayle jokes. You and I have the same vocabulary. But if we start talking Ottawa politics, there's no conversation. Because I have to explain everything to you. That's a nuisance."

Toronto plays down being compared with

New York City, but moviemakers use it as a New York look-alike: More than a hundred films and TV productions a year are rolling in the streets, their klieg lights vying for attention with the traffic signals.

Sometimes the streets are missing only dirt and squalor. City film commissioner Naish McHugh tells a tale of Sonny Grosso, producer of the cop-show television series *Night Heat* of a few years ago: "Sonny looked around the set here and said, 'Gee, this is supposed to be New York. This place looks too clean. You'd better get some garbage out here.' So plastic bags and cans were strewn about.

"They were shooting and then broke for lunch. It was a side street; they didn't leave anybody there. When they came back, public works had cleaned the entire street, taken everything. Sonny got on the phone to City Hall, screaming, 'We want our set back!' "

TORONTO AND ONTARIO fought against the Free Trade Agreement, in part because they saw the empty cans and plastic bags across the border. But the border seems too long, the links too strong for Canada to hide. America's biggest trading partner is Canada. Its trade with Ontario alone exceeds its trade with Japan. The nations have been moving toward an open market since the 1800s. Four-fifths of trade was free already.

Canada's acrimonious 1988 election hung on that remaining fifth. Prime Minister Mulroney's Conservatives sought reelection and a mandate for the FTA. Both opposition parties were bitterly opposed. Free Trade proponents took out newspaper ads to allay fears. For Americans the issue was of interest; for Canadians it was a crisis.

From his office on the 48th floor Brascan Limited President Trevor Eyton swept his hand across the Toronto skyline, past the gleaming copper towers and the yacht club slips on Lake Ontario, and declared that it was good.

With Labatt's Brewery and the Toronto Blue Jays under its umbrella, Brascan is one of the nation's largest companies. "The message of the business community was, 'You don't have the luxury to keep the status quo,' " Eyton reasoned. "The world is changing

Seeking a door to the U. S. market eased open by the FTA, Dominion Textile Inc. of Montreal—represented by Gary Wilson, center—celebrates a merger of its Caldwell towel division with New York City's C. S. Brooks Corporation, headed by C. S. Johnson, left.

swiftly, and we'd better change with it. There wasn't any promise that it would be easy. But the FTA didn't come out of thin air. It's a seamless, continuous process. The agreement was timely and right, and it was inevitable. And all of it leads to better living standards."

Critics said the FTA would mean the end of Canada's ability to control its own resources, and thus the end of nationhood. They saw the U. S. as a declining star not worth hanging on to. They feared that certain social welfare benefits would be seen as unfair subsidies to industries, and so be lost.

At election's end the opposition vote was split. Not enough to oust Mulroney, but the debate continues. In the Ontario farming town of Brighton, Canadians unified in pessimism met in the school gymnasium last June to hear Maude Barlow, chairman of the Council of Canadians, a coalition that campaigns to upend the agreement. Fifty angry people sang "O, Canada"; some called their prime minister "an American bootlicker."

Things are moving rapidly toward national disaster, said Maude. "Farmers are losing their fields, workers are losing thousands of jobs, factories are closing, moving to Mexico to exploit slave labor. . . ."

Later, over coffee, she continued: "During the election people would scream at each other. It was abusive, crazy. But passions were high. Virtually every popular segment in the country is against the FTA—teachers, labor, nurses, native people, senior citizens."

I said that in my travels it was hard to find this ground swell. "Look, maybe I'm dreaming," she answered. "Maybe it's done. But it is astounding for our country to have this level of dissent, our peaceful, quiet, little country, six months after the elections. Normally, we'd all be back asleep."

Next day I headed down the Queen Elizabeth Way past Hamilton, a factory town that smokes and hisses on the western tip of Lake Ontario. The grapes of eastern Canada grow here, not far from the smokestacks, near St. Catharines and Niagara Falls.

Farmers who grow Labrusca grapes for cheaper wines are losers in the Free Trade shakeout. Provincial governments had long protected homegrown wines by placing a stiff tariff on imports. Without the tariff, many Canadian wines could not compete, and vast tracts of Ontario grapes turned into instant surplus. To ease the blow, the government pays farmers to tear out their vineyards.

Howard Staff is a burly man with calluses for fingers. His family is losing 500 acres out of 700. "I'm fifth generation," he told me. "When my grandfather was 12, they planted

South of the border where the RVs circle, Vancouver-area residents camp in a Bellingham, Washington, shopping mall. By staying out of Canada for 48 hours, they can bring home $100 (Canadian) in duty-free goods. Their trips add nearly a million dollars a week to grocery sales in local Whatcom County.

the first grapes, and we've still got that vineyard. We keep it as a sort of living legacy.

"My parents have known nothing but hard work. And for them to stand there and see the whole thing being torn apart. . . . We bought them a motor home. They're getting in it . . . and out of here."

The machine that pulls up vines is powerful, for roots go deep. It squats between the rows. You can almost hear it groaning with the strain. "My Dad," said Howard as we drove past the machine, "this is what he doesn't want to see."

PAST THE STAFFS' old gristmill and a few miles down the dirt road, billions of gallons of water an hour hurl down mighty Niagara Falls. The border splits the river so that one branch cascades into Canada, the other into the U. S. Massive generators spin their power into electricity and send it singing over towers draped with wires.

I crossed the tightly packed, industrial nub of southern Ontario to Windsor and sat one fading afternoon on the waterfront, looking north into Detroit across the river. The cluster of the Renaissance Center buildings towered

The Florida colony: Quebec South

"THE SEA belongs to whoever sits by the shore," Canadian poet Louis Dudek observed. In Florida, where possession has long been at least nine-tenths of the law, Canadians, who have no south of which they can speak warmly, have established a firm beachhead. When the winter wind howls in Montreal, some 350,000 snowbirds fly to their favorite rookery in Hollywood, Florida, the Atlantic coast resort where the best of all things are savored in French.

Hollywood advertises not heated pools but *piscine chauffée*. Hockey games from home are televised in bars and hotels, and a French-language radio station broadcasts from the beach back to Quebec. "People spend six months here and never speak a word in English," says Jean Laurac Thomas, editor of *Le Soleil de la Floride*.

French Canada's affair with

Florida is said to have begun in 1924, when two dozen lumberjacks arrived to help a developer hack paradise out of a palmetto jungle. More than their English-speaking countrymen who favor the state's Gulf coast getaways, the French remain inseparable, breathing the warm heavenly air during morning exercises (above) or dancing to familiar tunes at Le Club Canadien. Some Canadians, such as Simon and Bella Sklarz of Toronto (top left), simply enjoy an environment that feels like home.

"Life-style is more important than language," one young woman told the author. "My parents own two golf courses in Montreal; they're rich. But they don't go to Martinique or Haiti or other French-speaking parts of the Caribbean. They come here. Here they can live like they do in Montreal. Here they have their McDonald's."

Visitors include farmers who bask in the fruits of their labors until fallow fields thaw for planting. They and fellow snowbirds spend 600 million dollars (U. S.) each season in the Sunshine State. About 50,000 French Canadians, including pharmacists, doctors, and lawyers, now make their home year-round in south Florida and dominate local real estate.

Long term or short, a good many Canadians have found their place in the sun.

A walk on the wild side in Maine, to the border's left, is a forbidden temptation during the October moose season for hunters in Quebec, which is mostly cleared farmland that holds little game. So Quebecois build blinds in the middle of the boundary, try to call Maine moose within range—and break the law if they pursue their quarry across the line. Maine wardens bag their share of poachers, such as one doleful Quebecois fined $300 (U. S.) for illegally snaring rabbits and trapping martin, fisher, and mink. Quebec has its own moose season, and in St.-Cyprien hunters display a diminutive hood ornament of unknown nationality.

bravely on the skyline. Between the cities slid the massive Great Lakes freighters hauling wheat from Thunder Bay, iron pellets from Duluth, coal from Buffalo.

For residents of Windsor the river is their buffer zone against Detroit, and crime, and who knows what. "You get a really unsettling feeling going over there," said Richard Miles. "I remember it from my childhood. When you came back to Canada, you always gave a big sigh of relief."

The Ambassador Bridge and the tunnel between Detroit and Windsor bear the heaviest cargo traffic of any U. S.-Canada crossing: trailer after tractor trailer loaded down with furniture, frozen food, and Oldsmobiles. For every new U. S.-made car shipped to Canada, a Canadian-made car comes back, as mandated by the Auto Pact of 1965.

In the spirit of supply and demand, conservative Windsor features nearly a dozen striptease clubs that cater mostly to businessmen from Detroit. The laws on nudity are less strict in Canada than in Michigan. One attraction was Hal Stone's Female Boxing Revue from Hollywood, with matches between "U. S. and Canadian" teams.

With more than 200 exotic dancers in town, it's hard to miss them while shopping in the tidy business section. One afternoon I met dancer-boxer Sindi Rome in a record shop and asked her about Canada.

"I feel I could roller-skate around here on the street and feel, like, safe," she said. "Windsor reminds me of Disneyland."

THE THUMB of Michigan's mitten points at cottage country—Lake Huron's Georgian Bay and Muskoka Lake. All that water, and much of it is sick from acid rain. More than 14,000 Canadian lakes are nearly fishless.

The United States accounts for half of this high-flying pollution. Washington has been sluggish in forcing higher standards on emissions from coal-fired power plants in the Ohio Valley. A promise of relief came last June, when President Bush vowed to nearly halve the harmful output by the year 2000.

I drove through North Bay to Lake Kipawa, a route etched in my mind from boyhood when we Boy Scouts headed north to Canada each summer to canoe these chilly lakes, always remembering to bring the citronella, against the bugs. Thirty years later acid rain had not

yet deadened the water at Kipawa, even though the fish were smaller. But loggers had destroyed the campsites where we panfried walleyed pike and stoked the coals as darkness fell, and shivered at the manic call of loons. Jim and John and Ted, the best friends I will ever have—they remember.

To the west, two towns named Sault Ste. Marie, one in each country, bracket the Soo Canals and locks that hoist 85 million tons of cargo every year. From here the Great Lakes radiate like iris petals, mini-oceans with their separate storms and fishing fleets. The border bisects four Great Lakes, but the basin is most often seen and studied as a region, a continental resource. Some 20 million Americans and a third of all Canadians rely on the lakes for drinking water.

Water-quality agreements over the past two decades have attacked pollution, and the downslide is being reversed. But with fear of chronic global warming, hydrologists warn that future water resources will be at risk. They gaze at all that water flowing north in Canada with longing; it simply disappears untapped into the ocean. Already two megaprojects in the James Bay basin have diverted water into Lake Superior.

Adding water from the north is one thing, say Canadians; sending water south is quite another. Critics charge that the wording of the FTA leaves openings for water exports to the U. S. Both Free Trade negotiating teams deny it, but that does not mollify emotions. When Illinois Governor James R. Thompson proposed tapping Lake Michigan through the Chicago Sanitary and Ship Canal in 1988, the year the Mississippi was so low that barges lay on sandbars, the outcry was swift.

"It set alarm bells off," said Don Gamble of the Rawson Academy of Aquatic Science in Ottawa. "It became a concrete example of the kind of issue that Canadians fear most. This is very difficult for some Americans to understand. They say, 'You Canadians have 20 percent of the world's fresh water, so what are you so uptight about? Why not sell some of the stuff? Make a buck?'

"But water is to Canadians as the Alps are to the Swiss—something that transcends the resource. It's so much a part of how Canadians see themselves. We're a land of rivers and lakes. Our history is built on it."

It was French-speaking explorers, plying the lakes and rivers from Quebec to Manitoba in quest of furs, who opened up Canada's west. Canadian heroes are not cowboys but voyageurs. And water is about the only thing they have more of than the Yankees.

"So when someone comes along and says, 'Look, we got a problem in the lower Mississippi, give us some water,' " said Gamble, "Canadians say, 'Not on your life!' "

Moving faster against acid rain, Canada decries efforts of the U. S.—responsible for half that form of pollution in Canada. Spearheading the attack in Ontario, scientists from the Dorset Research Center test for acidity beneath the ice in the Lake Muskoka region, vacation-cottage country. Near Sudbury at the Inco nickel smelter, one of the continent's worst sulfur dioxide polluters, a major cleanup is under way.

AROUND THE GIANT HUMP of Lake Superior, by the shores of Gitche Gumee, as Longfellow called it in *The Song of Hiawatha*, the Trans-Canada Highway wove through a spell of granite gorges carpeted in fir and cedar, and tiny beaches slippery with rounded stones the size of clams.

In Thunder Bay, major port for Canadian grain, streams of boxcars funneled wheat to giant storage silos on the lakefront. Conveyer belts with coal and limestone rattled back to

fill the boxcars up again. In the distant fog massive ships were anchored, waiting.

To the west, past the marshes and lakes of Minnesota, the border levels to the 49th parallel, an abstract line that defies geography. The grid of roads that chops the western states into little squares extends unchallenged into Canada. Both sides look much alike.

Ukrainians and Hutterites and others looking to breathe free have colonized these continental plains where summer burns and winter kills, but people are still wanting. In Antler, North Dakota, when his town was dying, Bud Kissner had an idea. He would give away his land in parcels and advertise for families with children who would stay five years and keep the Antler school from closing. That was 1981. Six families with nothing much to lose arrived to test utopia. The Antler school had more classes, though only one family stayed for the full five years. By last July the colony was finished, all but one house torn down.

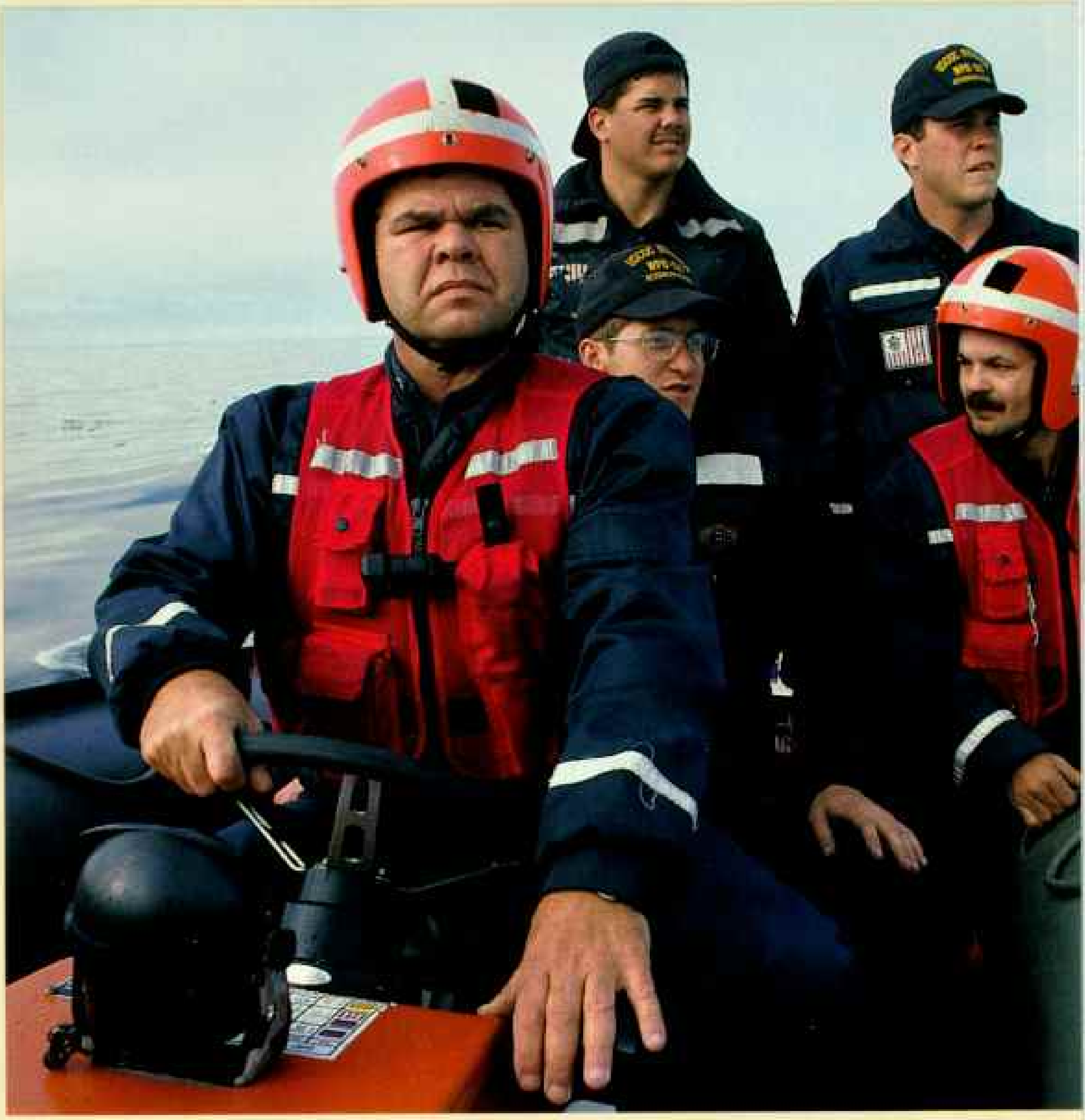
"Bud might have been all right," said his nephew Bucky Kissner, "if he'd only advertised around the area. But he went nationwide. . . . He had calls from California, Australia, Germany. They didn't know what this weather is like when it drops to 35 below."

"There wasn't any work here," added Bucky's wife, Shirley. "And some of them, they just gave up. It's hard in these northern states unless you're farming or in oil. You can't put a hamburger stand up and make it in North Dakota."

Near Williston my radio locked on to an Indian powwow, broadcast from the reservation in New Town, North Dakota, on FM 91.3. To the pounding of the drummers, I sped along the prairies to the town of Plentywood, Montana, on the Big Muddy Creek. Sioux Chief Sitting Bull led his band across the border to Canada near here, after Custer and the Battle of the Little Bighorn. "The meat of the buffalo," Sitting Bull noted, "tastes the same on both sides of the border." He returned to the U. S. along this route, to be humiliated and finally slain.

REGINA RISES from the prairies of Saskatchewan with a minimum of fuss. Between the city and the border, for a hundred miles, I could see no houses, towns, or service stations—only wheat fields, meadowlarks swooping with pointed wings that seemed metallic, and a storm that kept no secrets as it gathered on the western sky, swept the tumbleweed across the road like litter, and set the tall grass heaving.

These lonesome acres grow too much for Canada. The nation exports 80 percent of its grain, compared with 40 percent for the United States, and that *(Continued on page 126)*



Boundary dilemma gone to sea

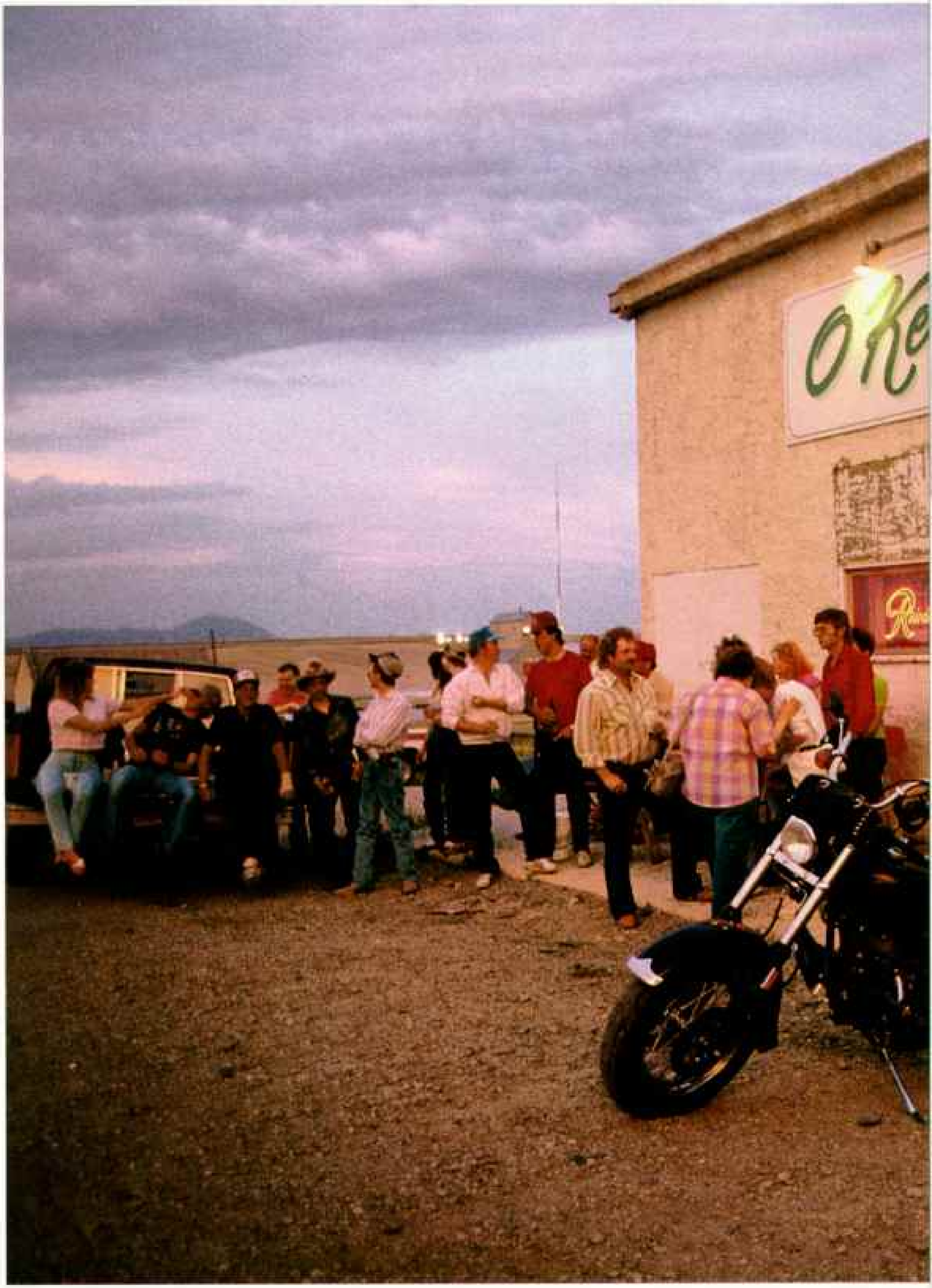
A SQUABBLE SIMMERS over the Pacific border that divides the annual bonanza of salmon—including one hefted by a Canadian fisherman (right)—that migrate through international waters.

Canada recognizes a 1903 boundary that crosses the southern tip of the Alaska Panhandle at latitude 54° 40' N (map), known as the AB (Alaska-British Columbia) Line. The U. S. contends that the border runs as much as 25 miles farther south, equidistant between both nations' offshore islands, thus giving Alaska fishermen legal access to rich fishing grounds in the Dixon Entrance, patrolled by the United States Coast Guard (above).

For about 20 years each nation sporadically has seized the other's vessels. Last July, for alleged illegal fishing, the U. S. impounded two Canadian trollers, including the *Viscount*

owned by Bruce Devereux (top right), standing behind his daughter, Christine, and his wife, Dianne Cheadle, at left, who serve as crew. Devereux had to post a $50,000 (U. S.) bond to get his boat back, which was returned minus about $7,000 worth of salmon.

Says Paddy Greene, head of Canada's Prince Rupert Fishermen's Co-operative Association, "We see this as a modern-day Manifest Destiny land grab."



Wide-open spaces are wetter in Sweetgrass, Montana, an oasis of saloons frequented by Canadians from Coutts across the Alberta border. Customers from the north seek to avoid the tax on alcohol that makes their own drinks stiff to buy, and many Canadian

bars are closed Sundays. The road west leads to Waterton-Glacier International Peace Park, created in 1932 when separate parks on each side of the border were joined. It is now the first biosphere reserve managed by two nations.

critical difference creates a gulf between Canadian and American farmers. By 1986, a bumper year for wheat, Third World nations like India and China were growing their own food. Exports shrank, and the European Community and the United States launched a price war. Prices plummeted, but Canada could not follow. Hundreds of small farmers were forced into bankruptcy.

"Canada's at the end of a bullwhip," said Harvey McEwen, president of the Western Canadian Wheat Growers Association in Regina. "Most nations can pursue their own national need and then just dump the rest of their wheat, and we're competing with all those guys who are just dumping."

McEwen took me to his farm, 50 miles east of Regina, where his three young children just can't wait for him to finish building the swimming pool. He's also facing the old farmhouse with local limestone. He's added solid brass hinges on the carved wooden doors. We trampled through his fields of durum wheat, used to make spaghetti, and his yellow meadows of canola, which provides a light cooking oil. A small red fox ran across the field in front of us, and McEwen wore a starry look.

"My wife keeps saying she'd like to retire someplace," he said, "but I think she knows I'm sort of stuck where I am."

DRIVING THROUGH MONTANA, I felt as if the continent embraced me. The grass hummed with sun and wind and insects till it seemed to vibrate. Black-eyed Susans crowded the macadam. The temperature: 104°. Nothing on the radio but wheat futures and Merle Haggard.

On July 2, perhaps out of enthusiasm for Canada Day on July 1, a newspaper columnist in Calgary, Alberta, published 85 things he disliked about the United States. I read his list on the 4th of July, at a hamburger stand in Malta, Montana, after a day of driving.

Among the offending things were Richard Nixon, evangelist Jimmy Swaggart, cruise missiles, the FBI, Frank Sinatra. He could have listed a full hundred, the columnist wrote, but he wanted to save room for 15 things he liked, such as hot dogs and New England farms. And I thought, as the hours droned on and the land wrinkled into hillocks, that most Americans don't know enough about Canada to list even ten things about it, good *or* bad.

By the time I reached Sweetgrass, across the border from Coutts, Alberta, the Rocky Mountains hovered in the distance, and I was too tired to defend myself against John Buckley, who propped his leg on the table in front of the Glocca Morra bar and opined, "Well, if you ask most people, like in Alberta, they feel about the same as Montanans . . . like you go down just this side of the Mississippi, and you run a fence from there all the way to the end, and you put about eight billion volts on the bastard, and you keep all the people from the East on their side, and we'll stay on our side."

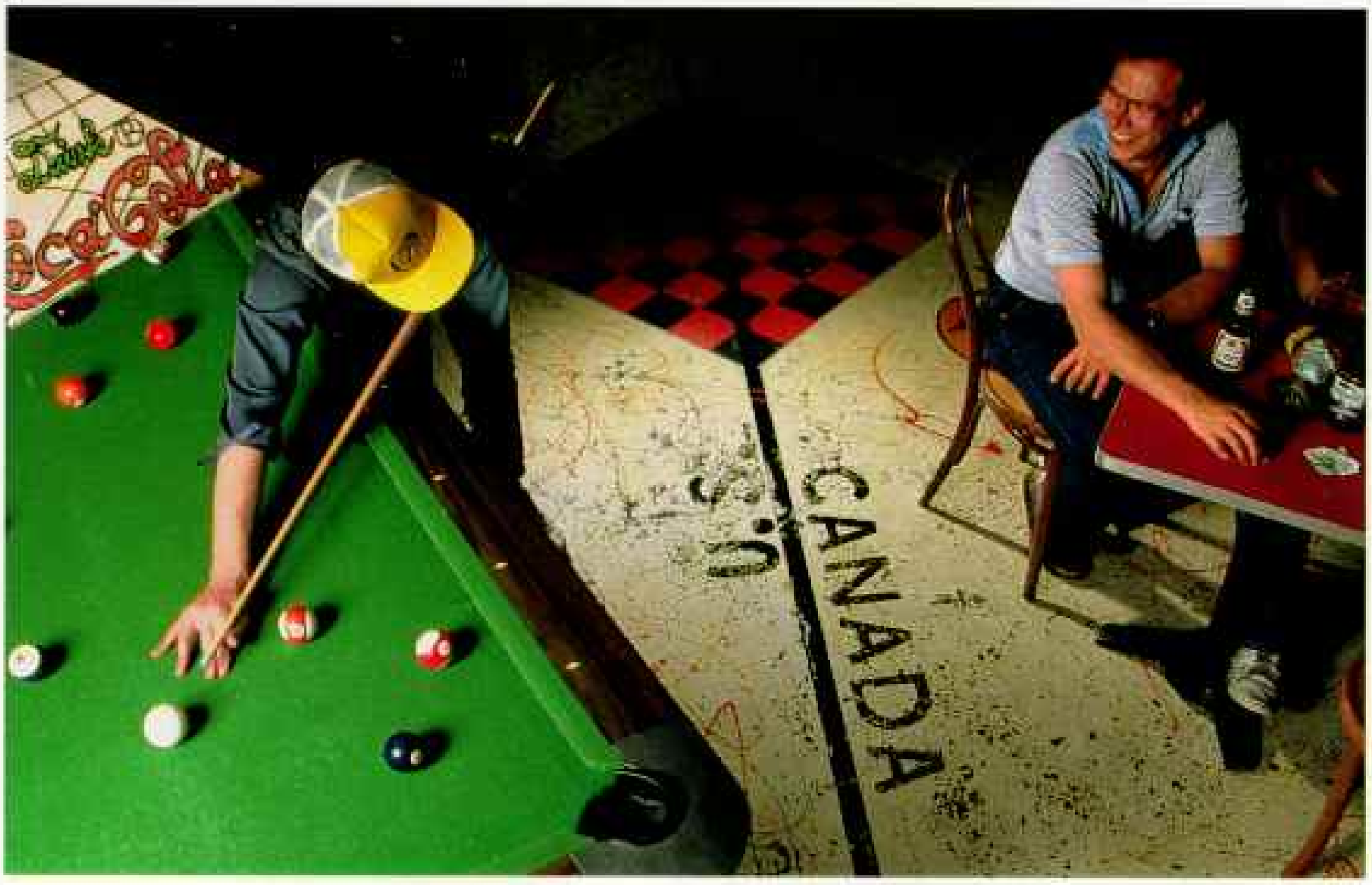
West of Sweetgrass and the prairies lies Waterton-Glacier International Peace Park, a garden of the massive and spectacular in Rocky Mountain scenery and a model of environmental cooperation between nations. Waterton-Glacier is the world's first international biosphere reserve.

Sagebrush turned to pine as I climbed the Cascade Mountains of Canada toward the Pacific. Two mule deer, their oversize ears twitching, stepped from the forest and regarded the highway with luminous eyes before bounding across. High on Allison Pass, the snow still lay in pads between ponderosa pine and Sitka spruce, and the breath of winter hung stale among the skeletons of branches.

Past the town of Hope the highway graded down to the Fraser River Valley, and the air was tinged by burning cedar. Then came the stink of fertilizers, dairy farms, and the raspberry fields outside Vancouver.

In the town of Bellingham, Washington, the paper ran a series called "Living in the Shadow," with accounts of how the population of Vancouver and its suburbs presses down on sparsely settled northern Washington. Land values are rapidly escalating in Vancouver, due in part to new money from Hong Kong immigrants. Canadian investors are buying up property in Washington, pushing prices past the budgets of the local people.

Border farmland that sells for $5,000 an acre in the States costs Canadians up to $25,000 on their side. Near the town of Abbotsford, B.C., where more than 200 East Indian farmers dominate the raspberry industry, Sher Braich, a Sikh, built an English Tudor mansion in the middle of his fields. I went there to see his son, 26-year-old Jivan "Jim" Braich, who had just graduated from college in business. There were skis and golf clubs in the garage and a Doberman pinscher



named Charlie. Jim greeted me in a baseball cap, not a turban.

The U. S. is 20 yards outside the kitchen window. "When we were kids," Jim laughed, "we'd go down in back of the house and pee. Then we'd come back and say, 'Well, we did it to the U. S. today.' "

The Braichs have depended on new immigrants from India for labor, but with stricter immigration quotas the pool has shrunk. "Most East Indians have been here now for ten years," Jim said, "and if you've lived in Canada for some time, there's no way you're going to pick raspberries for a living."

THIS WESTERN ATTITUDE has bound the area together, the conviction that the world is young and those with talent can go far, whether Sikh or Hutterite, American or Canadian. Out here the border seems a transitory thing. "My dream," confided insurance executive Paul Weeks of White Rock, B.C., "is taking British Columbia and Washington/Oregon, with Alaska and Alberta, and creating our own nation. A west-coast country."

Ottawa and Washington, D. C., never seemed so distant. Planners talk about an "evergreen triangle" from Seattle to Victoria to Vancouver, about the growth of shared high-tech development.

Duty-free conversation crosses the border at the Half Way House, a pub that straddles the line between Dundee, Quebec, and Fort Covington, New York. Owner Paul-Maurice Patenaude positions the pool table in the U. S., "where there's no entertainment tax."

In Blaine, Washington, a towering white Peace Arch marks the border. "Children of a Common Mother" is inscribed on it. Sam Holden of the U. S. Border Patrol showed me around. We went down Harvey Road, which dead-ends at a hedge just ten feet short of a two-lane highway. Step through that hedge and, splat, you arrive in a foreign country. No problem.

Wayne McGee, a commercial fisherman, ambled from his house to chat. "Neighbors. They're just neighbors," he said about the folks who live across that highway, in Canada. "They watch our home when we're gone, and we watch theirs."

"Most people are amazed that that's Canada right there," said Sam. "They want it to look different. Once a friend came up from Georgia, and he said, 'I want to see Canada.'

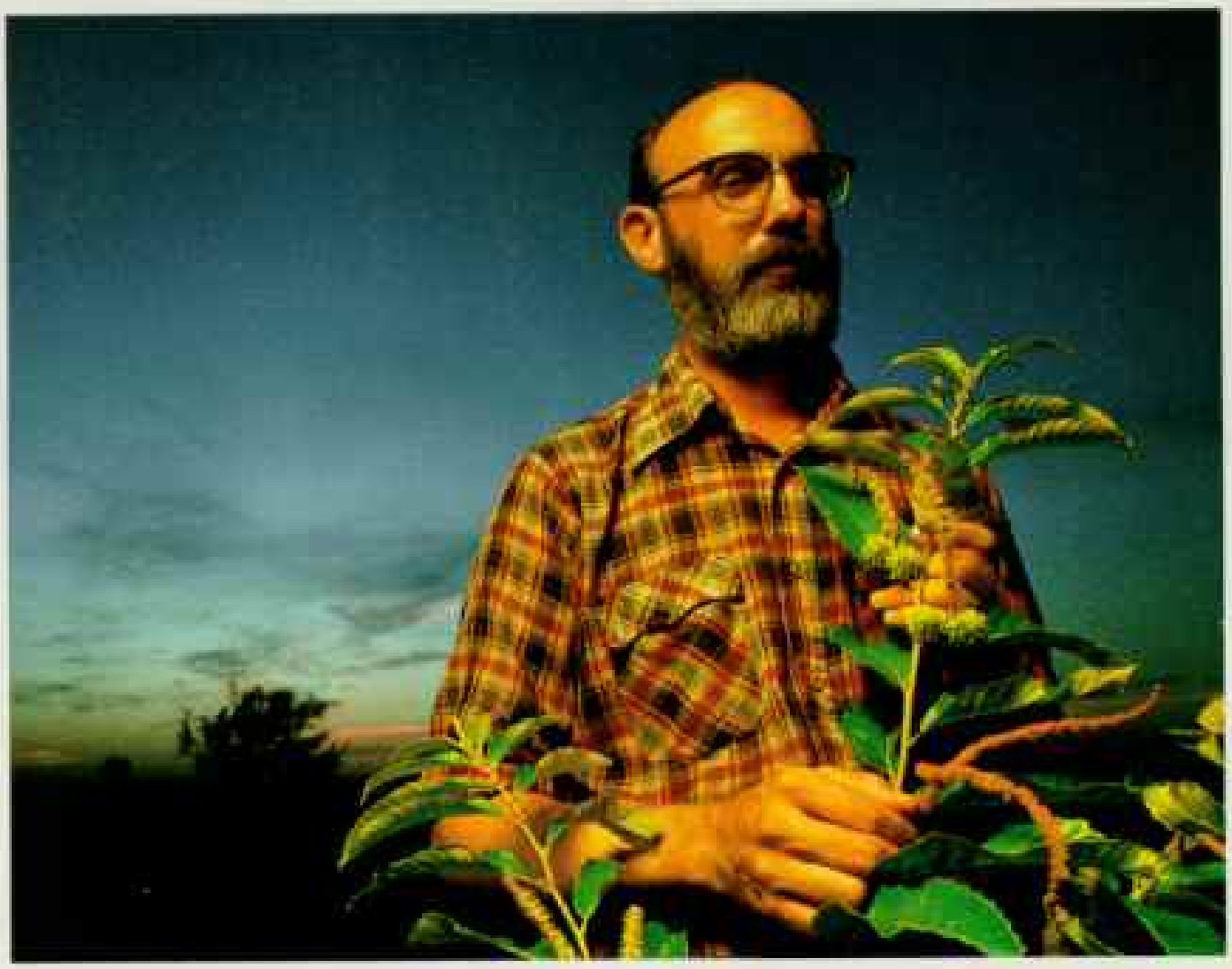
"OK, I said.

"And he said, 'Should I take a jacket?' "

That's the way it's been for years. The 1990s will not change it much. □

BACK FROM THE BRINK

CHESTNUTS



Stately boughs outspread, millions of American chestnuts once graced forests from Maine to Georgia and westward to the Mississippi River. Near the turn of the century an Asian fungus was accidentally introduced, and what is largely left are slender blight-infested trees and haunting gray specters such as a long-dead giant (right) in Great Smoky Mountains National Park. Today Philip Rutter (above), president of the American Chestnut Foundation, and others are working to resurrect the chestnut. Armed with new knowledge, researchers have but one goal: the tree's revival.

By M. FORD COCHRAN

Photographs by GARY BRAASCH

ROB BREDDAKAN (LEFT)

STRANGE BUSINESS: jets of thick white foam arching through the leaves, a yellow bulldozer ripping gashes in the Wisconsin earth, busy fire fighters. But there is no fire—at least none with flames. We are in one of the last known forests of American chestnut, and we're going to kill some trees.

They would soon die anyway, stricken with chestnut blight. Left alone, they would take the forest with them.

Their adversary, *Cryphonectria parasitica*, the Asian fungus causing the blight, arrived on this continent near the turn of the century. Within 40 years it had erased several billion chestnut trees from the eastern forests. Yet American chestnuts cling to life, as understory sprouts in their natural range and in remote stands like this one planted by westing settlers.

Generations fought and failed to avert the cataclysm, fought and have failed to restore the tree. But there are new, twin hopes. A breeding program promises to transfer blight resistance from Asian to American chestnuts. And a disease of the fungus—a "blight of the blight"—has begun to spread in the wild. It appears we are winning the chestnut back.

Not, perhaps, in time to save these in Wisconsin. Once this had been a common scene: tall, straight boles of American chestnut rising beneath a dense canopy of saw-toothed leaves. In 1885 a farmer named Hicks planted nine or ten nuts that his mother had carried from Pennsylvania. They took. The progeny of that first handful now cover the hill.

For years they escaped the blight. But spores travel on the wind, and it seemed inevitable that someday one would land here. In 1987 visitors found a dead tree and cankers on several others bearing the orange blush of the dread parasite. The Wisconsin Department of Natural Resources brought in fire fighters to spray the trees with foam (lest spores be scattered), then raze and bury them. That treatment failed: Cankers appeared on four nearby chestnuts.

So today the fire fighters are at it again. One tree they are cutting stands 60 feet tall, is more than a foot in diameter at shoulder height.

"The lumber would have been worth at least $500," says Philip Rutter, president of the American Chestnut Foundation, here to oversee the effort. He counts rings on the chestnut stump—just 25—and points to a white oak, no larger. "I'll guarantee that tree is 120 years old."

When the task is finished, fallen giants lie beneath fresh earthen mounds as live chestnuts sway overhead. I hope they will not die.

Mightiest of the survivors at 69 feet tall and 16 feet around, this chestnut was planted in 1885 in Sherwood, Oregon, where blight has yet to reach. The nut's spiny bur may serve as a deterrent to squirrels.

AN INDUSTRIOUS squirrel in 1900 could have traveled from Maine to Georgia rarely leaving the branches of chestnut trees. But it might have been a lean rodent by journey's end: Rutter describes the chestnut's spiny bur as "the most effective antisquirrel device nature has invented." Within, as many as three brown nuts nestle in downy fur, soft as sable.

Every fourth tree in America's central Appalachian forests was a chestnut. Wildlife relied on the tree for a steady meal: Oaks dropped plentiful nuts one year and few the next, but chestnuts produced bumper crops every year. People ate the nuts, and they ate what ate the nuts: wild turkey, squirrel, deer, bear. The wood split with a straight grain and worked easily. It resisted weather and rot and so became choice timber for fence posts, railroad ties, shingles, telegraph and telephone poles, cradles, and coffins. A cabin built of chestnut would last. Chestnut bark, rich in tannic acid, was ground to tan leather. And in modern terms, chestnut was a renewable resource: Cut a tree in the woods, and others would grow back from the roots.

I WALK TRAILS in Great Smoky Mountains National Park amid stumps six feet across and fallen trunks of huge chestnuts. The great boles littering the forest floor look as if they'd toppled a few years ago, not 50. Many lifeless gray ghosts would still be standing, but in the 1930s the Civilian Conservation Corps cut

Close inspection of a blight-resistant American chestnut by plant pathologist Gary Griffin finds a small number of spore-producing bodies on a swollen canker, signifying a nonlethal infection. Griffin's research is shared with chemist John Elkins of Concord College in Athens, West Virginia, who grafts resistant American chestnut scions to Chinese rootstock (below) in hopes of developing a tree with blight resistance.

M. FORD COCHRAN, a former member of the GEOGRAPHIC staff, is pursuing a doctoral program in geology at Yale University. Freelancer GARY BRAASCH of Nehalem, Oregon, specializes in nature and wilderness photography.

Battling the blight

INVADING the tree through cracks in its bark, the blight fungus Cryphonectria parasitica develops a sunken canker, indicating the presence of the virulent disease. A closer look at the canker surface reveals the orange blush of stromata with black structures containing sexual spores and tendrils of asexual spores (A). These spores are transported throughout the chestnut's natural range in North America, Europe, and Asia (map and inset) by birds, insects, and the wind.

As the fungus continues to penetrate the inner layers of the bark, it grows in threadlike filaments that fan out and girdle the tree (B). As water and nutrients to the rest of the plant are choked off, the tree begins to die.

In Europe in 1951 a number of healing cankers appeared that contained a less virulent (hypovirulent) form of the fungus. Researchers now know that the chestnut-killing fungus weakens if a hypovirulent agent fuses with the virulent strain (C). The result is a less significant infection that allows the chestnut to survive.

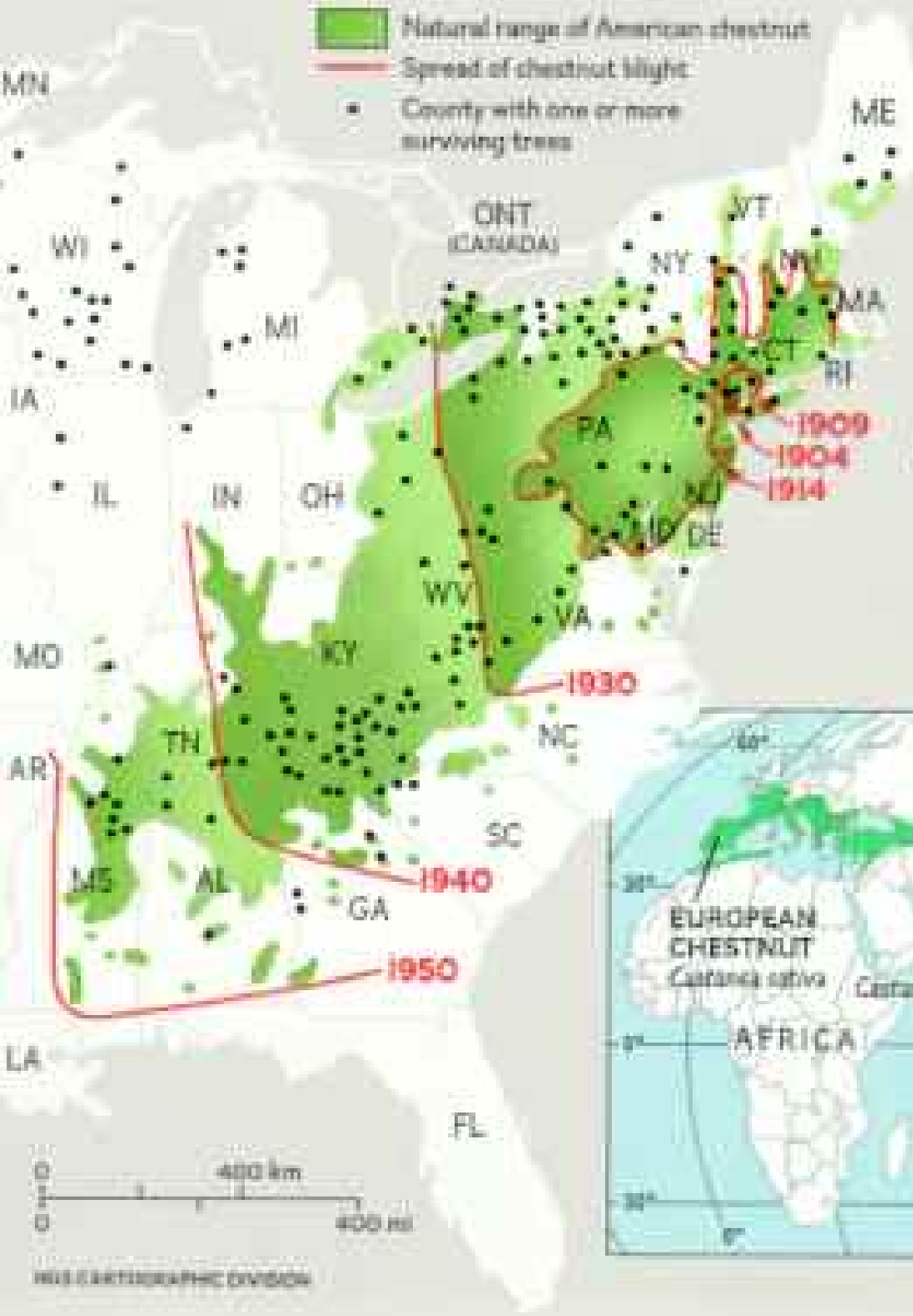
Evolving with the blight, Asian chestnuts bear a natural resistance. Although smaller than the American tree (below), they play a significant part in experiments to breed a resistant tree with American characteristics.

PAINTINGS BY JOHN D. DAWSON

A

B

C



the tall snags before they could become lightning rods.

Names on a map testify to the tree's onetime prominence in the Smokies: Chestnut Cove, Chestnut Branch, Big Chestnut Bald, Little Chestnut Ridge, Lower and Upper Chestnut Flats, Chestnut Top.

Glenn Cardwell was born in Greenbrier, within the present park borders, in 1930. Now he is a naturalist here. "It took the old-timers two days to get to Knoxville with a wagonload of chestnuts, a day to set up and sell them, two more days to come back home." A family would eat what it didn't sell and free its hogs each autumn to feed in the groves. With its hot, nearly smokeless flame, chestnut became the preferred firewood for moonshiners: no point sending a smoke signal to help revenuers find your still.

IT CAME FROM THE BRONX, most likely on nursery stock brought in from Asia. In 1904 forester Herman Merkel noticed that something was killing chestnut trees at the Bronx Zoo.

That something proved to be a lethal fungus that invaded through wounds and at the base of dead branches. It grew beneath the bark, extending fine tendrils in white mycelial fans. These fans blocked the passage of water and nutrients. A canker could girdle saplings in months, the base of a centuries-old mammoth in a few years.

Unlike the Asian chestnut, which had evolved to survive the blight, American trees lacked natural resistance. Blight swept the forests, unstoppable.

By February 1912, when the governor of Pennsylvania convened that state's Chestnut Blight Commission to "repel the

invader, using every means known to science and practical experience," the epidemic had destroyed wild chestnuts in New Jersey, southeastern New York, western Connecticut, and Massachusetts. The commission undertook a chestnut firebreak a mile wide. Blight easily leaped the break and raged on.

Some chestnut owners heeded self-serving advice from the American Forest Products Company, maker of telephone poles, to cut and sell their trees before the blight could kill them. The company's president argued: "Every time a chestnut tree is utilized, not only is it saved but a tree of some other species is also conserved for the future." What natural blight resistance lurked in the vast gene pool of American chestnuts may have gone to carry wires for AT&T.

"EVIL TENDENCIES cancel," wrote poet Robert Frost at a time when few fans of the chestnut had high hopes:

Will the blight end the
chestnut?
The farmers rather guess not.
It keeps smoldering
at the roots
And sending up new shoots
Till another parasite
Shall come to end the blight.

Indeed the roots often refused to die. Blight would destroy an entire stand. Then sprouts that had been long dormant would race skyward. Within a decade, blight would infect these new stems. Reproduction declined dramatically, and, with it, the chance to evolve.

Frost's vindication came in Europe. Despite quarantine efforts, blight appeared in Italy in 1938 and ravaged ancient orchards and forests.

RICHARD OLSENIUS

Attempting to isolate spores with fire-retarding foam, forest ranger Terryl Buchman sprays blighted trees before burying them (left). He hopes to protect blight-free trees in this stand in West Salem, Wisconsin. The blight does not harm roots. Fred Hebard, superintendent of the American Chestnut Foundation farm, examines the serrated leaves of sprouts growing from a mature stump.

Wading in thousands of marrons, workers tend the chestnuts in storage cellars of the Cimini Mountains in central Italy. The product of cultivated chestnuts that thrive throughout Italy, marrons are large nuts easily identified by light and dark striations on the shell. When candied, they become a delicacy called marrons glacés (right). Most of the exported nuts go to France, Switzerland, Austria, and West Germany—with lesser amounts going to the United States. Christmastime in New York City brings out vendors (left) who sell roasted Italian chestnuts by the bag.

The European chestnut, though another species, proved nearly as susceptible as the American. The tree appeared doomed on that continent too.

Then, in the 1950s, Italian plant pathologist Antonio Biraghi reported that some stricken chestnut trees were healing themselves. Few believed him, but he stood by his claim. Finally Jean Grente, a French mycologist, decided to find out for himself.

Grente made cultures from the healing cankers. In a petri dish they grew white instead of the standard orange. Put on a tree, they produced an infection that attacked the killing cankers and surrounded them with a healing callus. Grente called the new strains hypovirulent: literally, less potent, less deadly.

Hypovirulence has spread in Europe, and chestnut trees have made a comeback. Its source in the wild remains mysterious. But American scientists have isolated a blight-debilitating agent: double-stranded ribonucleic acid that floats in the cellular liquid of the lethal fungus, slowing its growth and giving the tree a chance to build healing walls of callus tissue.

MYCOLOGIST Sandra Anagnostakis performed some of the first American studies of hypovirulence. Her base of operations is the Connecticut Agricultural Experiment Station in New Haven. It has a long history of research on chestnut blight: Arthur Graves tried to breed resistant trees here from the 1930s to the 1960s, work furthered by Richard Jaynes and Hans Nienstaedt. When the scientists heard of Grente's discoveries in Europe, they decided to get the station involved.

Steady improvement of chestnuts in Europe promised rapid recovery for the tree in America. But the blight had tricks of its own. Hypovirulence is not always inherited. Spores blown or washed from a healing canker could produce lethal ones.

Another problem is known as vegetative incompatibility. "You can't just go out with one strain of hypovirulent fungus and treat many different cankers," explains Anagnostakis.

When closely kindred strains of blight grow together, their mycelia intertwine, and they sometimes exchange the molecules that cause hypovirulence. The process is called anastomosis. When distantly related strains of blight grow together, they often refuse to anastomose.

Scientists now believe that when hypovirulence first appeared in Europe, only a handful of blight strains had evolved there. Anastomosis occurred easily, and hypovirulence spread quickly. In America, blight had a longer head start, and strains number more than a hundred. The challenge, then, is to find the fungal equivalent of a skeleton key: one or a few strains of blight that will anastomose with many others.

We may have that key. At a conference on chestnuts, Anagnostakis describes the spread of hypovirulence from a test plot into the surrounding Connecticut woods. Dennis Fulbright relates similar results in Michigan. "I believe in hypovirulence now," he says.

I tour Michigan with Fulbright and graduate student Chris Durbahn. Our first stop: Grand Haven, home of George Unger and a small miracle. Unger has lived with his chestnuts since he was 14. The trees rise like phantoms, dead limbs reaching skyward like an outstretched hand. And between the gray limbs grow new ones, green ones, sagging with the weight of ripe burs.

Natural hypovirulence has saved the trees. Unger cut half his chestnuts years ago at the prompting of a county agent. "He said cut your trees and get your wood. Everybody agreed; they said they're going, gone."

We walk among the trees filling sacks with nuts. "This one I call my fighter, because he had so much canker on him," says Unger, indicating a particularly scruffy chestnut. "I wasn't giving him much of a chance, but he keeps on going. Chestnut is part of my life."

The next day we visit Jim Comp. While in his 80s Comp traveled Michigan with a college student, planting nuts and mapping trees. "We drove all over, wherever people said there were chestnuts. We'd drive a hundred miles to see a dumb old horse chestnut"—quite unrelated to the American chestnut.

Comp's hobby inspired workers with the Wexford Soil Conservation District. The district now grows seedlings and ships them, for a small fee, to anyone who wants to plant an American chestnut. Last year they had a record 5,000 requests. "People are crazy about the American chestnut," said one district worker. "It's a romance."

"DEARLY BELOVED, we are gathered here today, in the sight of the rain and the wind, the mountains and the trees, to join with one another and with this land in a bond of holy determination." The voice belongs not to a minister but to Phil Rutter of the American Chestnut Foundation.

"Today we place our feet firmly on the trail that will lead to the restoration of the American chestnut tree. Let us plant!" Two dozen shovels, including mine, break the wet, red earth.

The place is Meadowview, in Virginia. Rutter has come to dedicate a 20-acre farm as the first home of the foundation's breeding program. The effort aims to transfer blight resistance from Asian to American trees.

Why not simply plant other species? The Chinese chestnut, *Castanea mollissima*, and the Japanese, *C. crenata*, can withstand blight and bear nuts, but these are orchard trees, too short to compete with the native hardwoods of North America. The European chestnut, *C. crenata*, succumbs to blight and lacks ecological suitability. Only *C. dentata*, the American chestnut, could restore timber production to Appalachian forests.

Charles Burnham conceived the foundation's breeding program. Until his retirement he had studied corn genetics at the University of Minnesota. Then he looked to the chestnut.

Selective crosses had been tried before with little success. Breeders typically mated *C. dentata* with *C. mollissima*, then backcrossed the progeny with *mollissima*. The trouble came in this second generation: Seedlings grew short, with little resemblance to *dentata*, and succumbed to blight.

Highly rot-resistant, chestnut wood was prized for buildings like this turn-of-the-century cabin in the Blue Ridge Mountains near Montebello, Virginia (above right). The straight-splitting wood was also used for fence rails. Almost all 311 miles of fencing along the Blue Ridge Parkway is chestnut (right).

Mission House in Linville, North Carolina, is one of several structures in this resort town sheathed in rugged chestnut bark (middle right). The coarse grain of chestnut made it a favorite for rustic furniture; fine pieces such as this 18th-century slant-front desk in a home in Dover, Massachusetts (far right), are rare.

NATHAN BENN (BELOW)

Burnham concluded that with a few more generations of backcrossing, more persistence, and more trees, the backcross method should work.

It will require decades. The program will draw on surviving American chestnuts, which some researchers suspect have a modicum of blight resistance. It may also draw on seedlings irradiated in the 1950s in the hopes of producing a resistant mutation.

Burnham met Rutter through mutual friends. With others, they organized the foundation. Rutter has since traveled the country raising money and lecturing on the prodigious tree. On one of his trips he met Cheri Wagner, who persuaded her family to make their Meadowview Farm a chestnut plantation. Rutter has also lobbied in New York State to set up a national center for chestnut research.

Planting a future generation, Harold Hannah, at left, and Steve Shelley of the Virginia Department of Forestry will watch the performance of this Asian-American hybrid in Meadowview, Virginia. Researchers and volunteers across the country continue to help fight the demise of one of America's grandest trees.

AMID ALL THE ACTIVITY to bring back the American chestnut, some reasonable persons harbor strong doubts. "Organized campaigns to restore the species are trivial in comparison with nature," said Herman Forest, an ecologist who has reviewed the chestnut literature. "I am not optimistic about efforts to find resistant strains, introduce hypovirulence, or breed resistance."

"O chestnut-tree, great-rooted blossomer, / Are you the leaf, the blossom, or the bole?" asked Irish poet W. B. Yeats. The familiar "spreading chestnut tree" of Longfellow's village blacksmith grew in Massachusetts. It was a horse chestnut—*Aesculus hippocastanum*, unrelated to *Castanea dentata*. Another chestnut in name, the water chestnut, does not even grow on trees. But the chinquapin belongs to the same family and is a close cousin.

Despite the import of 20 million dollars' worth of chestnuts annually, the typical American eats less than an ounce in a year. Roasted chestnuts hawked by New York City vendors come from Italy. The ones you buy to stuff your Christmas bird may be European.

Mike Burnett, head of the Chestnut Growers Exchange in Portland, Oregon, believes fresh, domestically grown chestnuts will boom in the U. S. The nuts are a staple in Europe and in Asia, and so nutritious that Burnett calls them "a grain that grows on a tree. Chestnuts can be a snack, main course, or dessert: soups, pastas, breads, cakes, and even ice cream."

Summer in Yellowstone, the year of the fires. Ranger Tom Tankersley leads visitors up Specimen Ridge to see the renowned fossil forest. Trunks of silicified redwood, entombed by volcanic floods 40 million years ago, crown the heights. Among them lies microscopic pollen from the chestnut family.

I take an ancient redwood seat and look out across the valley, where smoke hangs like a faint mist. There is a fire in the woods, but botanists say the forests of Yellowstone will grow back stronger for the blaze.

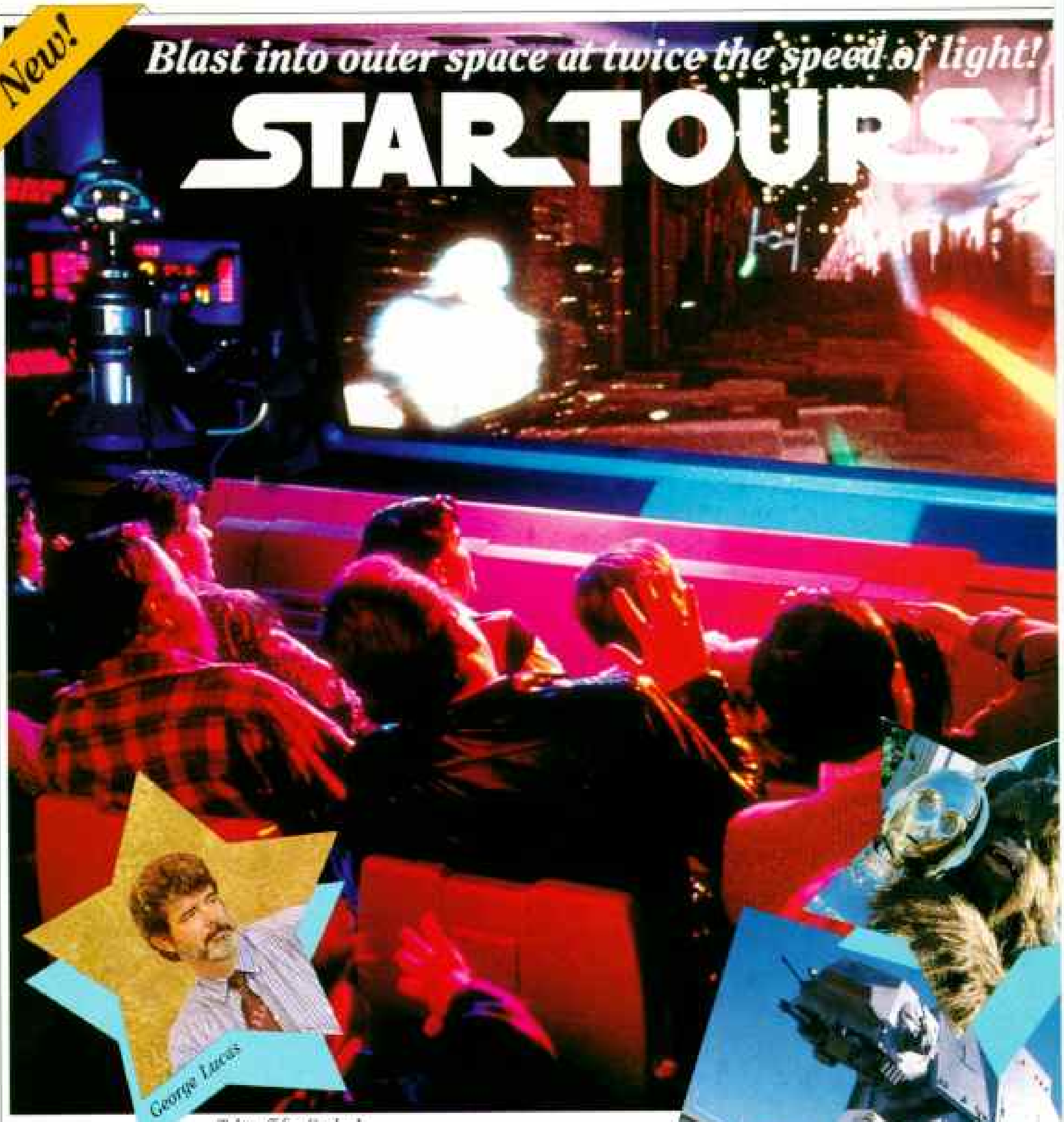
And the American chestnut? For at least 40 million years the chestnut has managed, without human help or hindrance. Its genes are rich in the stuff of survival, defenses we have only begun to understand.

We brought the blight here; now we are trying to stop it. I cannot believe we will fail. □

New!

Blast into outer space at twice the speed of light!

STAR TOURS



Take off for Endor!

Take a tour of the Ewok Village.

From the creative forces of Disney and George Lucas comes Star Tours, an attraction that's "light years" ahead of its time! Beginning in mid-January, C3P0 and R2D2 will welcome you aboard for a journey to the Moon of Endor and it looks like smooth "star sailing"—until your rookie robot pilot gets behind the controls. Then cosmic chaos breaks loose! You rip through the fabric of space at hyperspeed, dodge asteroids and alien craft and streak through the immense corridors of the dreaded "Death Star" before your terrifying trek ends. And when you land, you'll be glad to know you're among friends. Ewok friends, that is. Their charming village is situated among towering trees and the immense Imperial "Walker" they've captured. It's the perfect place to "unravel" after your intergalactic adventure.

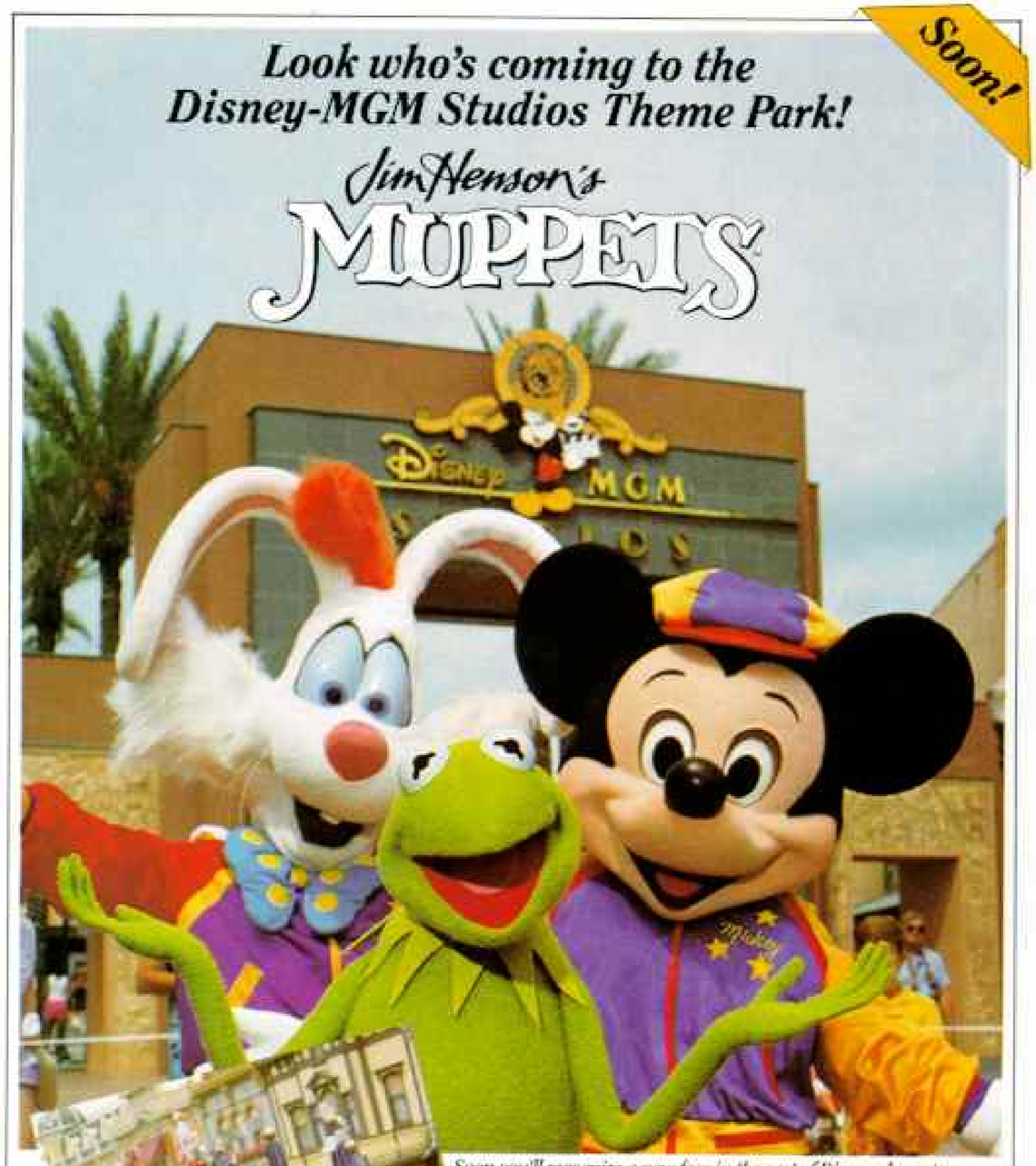
The new **Disney-MGM Studios Theme Park** is the ultimate movie park that's a full day of thrills! There's **Hollywood Boulevard** to explore with its famous Chinese Theatre and **The Great Movie Ride.** There's **Super-Star Television** and **The Monster Sound Show,** presented by SONY. Meet Hollywood hopefuls, gossip columnists (and maybe even a star or two) on your way to lunch at the **50s Prime Time Cafe!**

When you take the fabulous **Backstage Studio Tour,** you'll experience amazing "disasters" in the **Catastrophe Canyon** special effects adventure and get a firsthand look at **New York Street,** a giant backlot set used to film busy street scenes. You'll witness **The Magic of Disney Animation** and see actual movies and TV shows being produced.

Soon!

Look who's coming to the Disney-MGM Studios Theme Park!

Jim Henson's MUPPETS



Soon you'll recognize a new face in the cast of Disney characters.

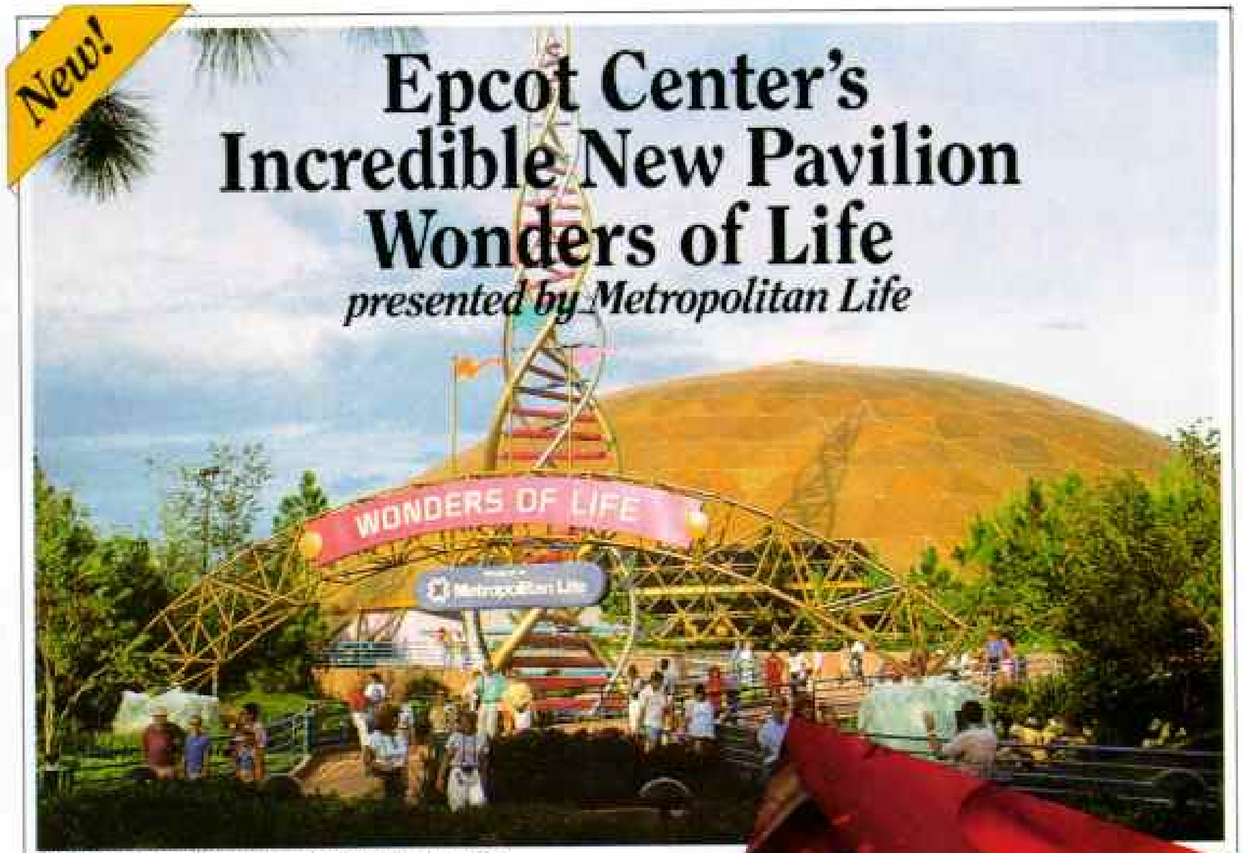
Kermit gets comfortable in his new Disney environment.

Kermit, Miss Piggy, Gonzo, Fozzie and the gang are on their way to the Disney-MGM Studios Theme Park. Starting in the summer of 1990, they'll be starting in one of the wildest song and dance routines you've ever seen, a magnificent Muppet musical review live and on stage every day. The troupe will also play a big part in the new Disney All-Star Parade down Hollywood Boulevard, along with a host of your favorite Disney characters. Plus, they'll be making personal appearances daily to greet the Disney-MGM Studios Theme Park guests.

New!

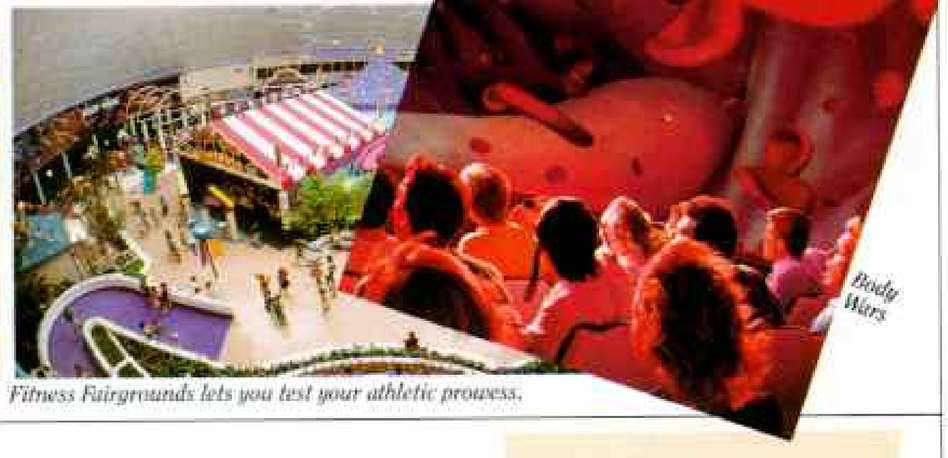
Epcot Center's Incredible New Pavilion Wonders of Life

presented by Metropolitan Life



Wonders of Life is the newest Future World pavilion.

Cranium Command.



Fitness Fairgrounds lets you test your athletic prowess.

Future World at Epcot Center is the site of Disney's newest pavilion: **Wonders of Life**, presented by Metropolitan Life Insurance. You'll test your stamina and skills on the **Fitness Fairgrounds**, celebrate wellness and health with incredible live and Audio-Animatronics shows, films and hands-on exhibits. Don't miss the hilarious **Cranium Command** show where you'll meet "Buzzy" and a "brainy" cast including Jon Lovitz, George Wendt, Charles Groudin, Bobcat Goldthwait, Dana Carvey and Kevin Nealon.

You'll love the antics of the Anacomical Players, a troupe of performers whose silly skits are all about what makes us healthy and happy. Sample some healthy fare then stroll through the colorful maze of the **Sensory Funhouse** or watch a rib-tickling video called "**Goofy about Health**," starring you-know-who!

Body Wars Plunge into inner space on the ride of your life!

In Wonders of Life's most thrilling attraction: "**Body Wars**," you'll get a totally new perspective on the human immune system as you dodge blood cells and antibodies at breakneck speed in a race against attacking organisms that threaten to destroy your craft and you!

New!

New!

What's NEW at the Walt Disney World Resort?

Sun-Filled Days Sizzling Nights

Typhoon Lagoon is Disney's newest water theme park.

Pleasure Island

The 56-acre **Typhoon Lagoon** is making big waves with sun-worshippers. After all, who can resist 4 to 6-foot waves, warm sandy beaches and eight hair-raising water slides like the "**Humunga Kowabunga!**" There's even a white-water raft ride the whole family can take together.

You can snorkel among the sea creatures at an abandoned "shipwreck" in **Shark Reef** if you're feeling brave or stay dry and watch the action from "below decks." You can spend the day just lazing along **Castaway Creek** in an innertube. There's even a pool and playground for the little fry called **Ketchakiddee Creek.**

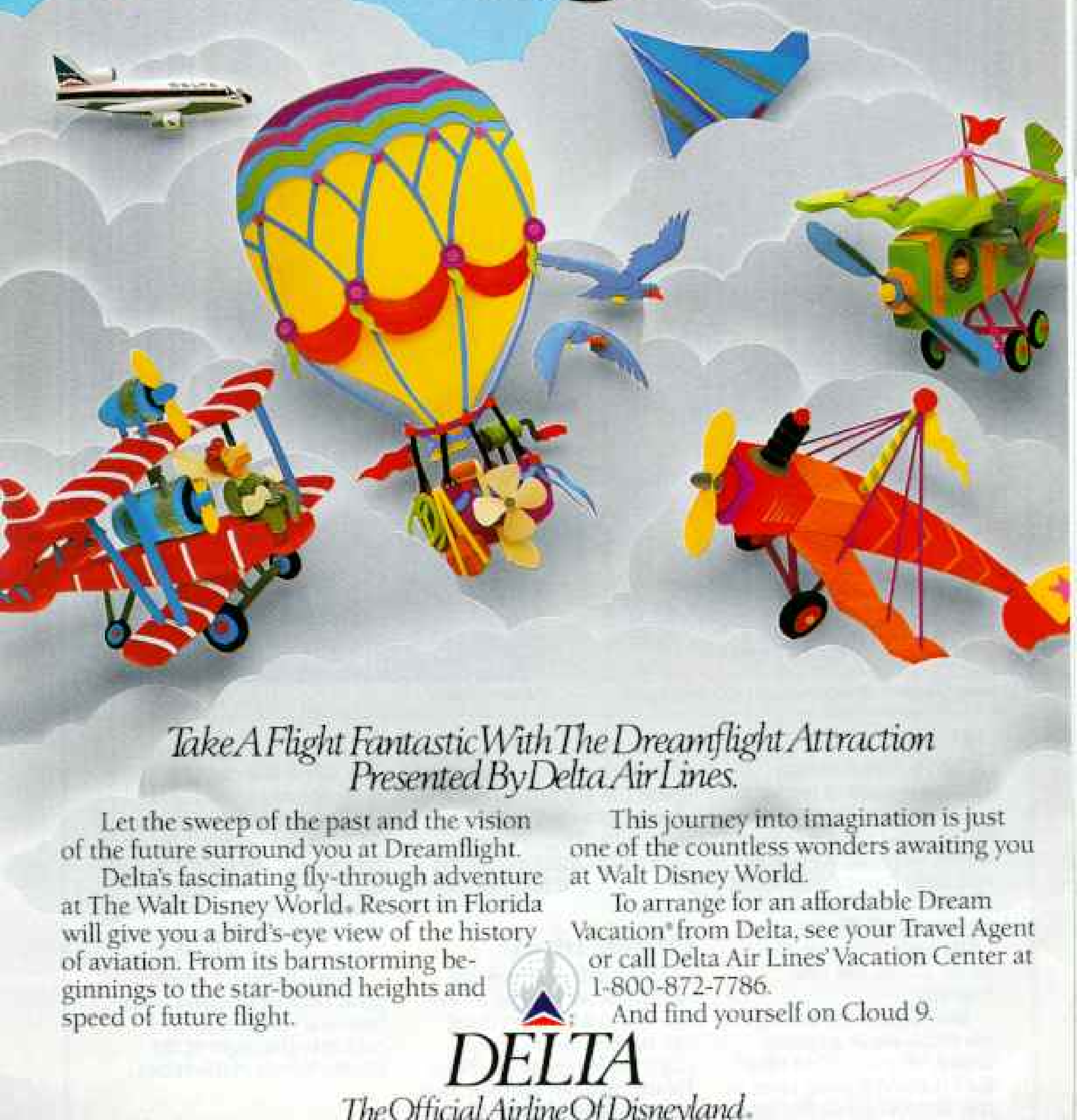
Pleasure Island

This is Disney's newest nighttime adventure! An entire island where anything can happen on any given night. At **Mannequins Dance Palace**, you can sharpen your moves to the latest sounds. The **XZFR Rockin' RollerDrome** blends great skating and terrific music. **Adventurers Club** is a haven for the odd, the eccentric and the unbelievable! And at **Videopolis East**, a no-alcohol club for the younger set, music videos take control.

In all, there are seven great clubs,shops, and some fabulous restaurants that rock into the night at the **Disney Village Marketplace!**

Delta Puts You On Cloud 9 At The Walt Disney World® Resort.

Introducing *Dreamflight.*™



Take A Flight Fantastic With The Dreamflight Attraction Presented By Delta Air Lines.

Let the sweep of the past and the vision of the future surround you at Dreamflight.

Delta's fascinating fly-through adventure at The Walt Disney World® Resort in Florida will give you a bird's-eye view of the history of aviation. From its barnstorming beginnings to the star-bound heights and speed of future flight.

This journey into imagination is just one of the countless wonders awaiting you at Walt Disney World.

To arrange for an affordable Dream Vacation® from Delta, see your Travel Agent or call Delta Air Lines' Vacation Center at 1-800-872-7786.

And find yourself on Cloud 9.

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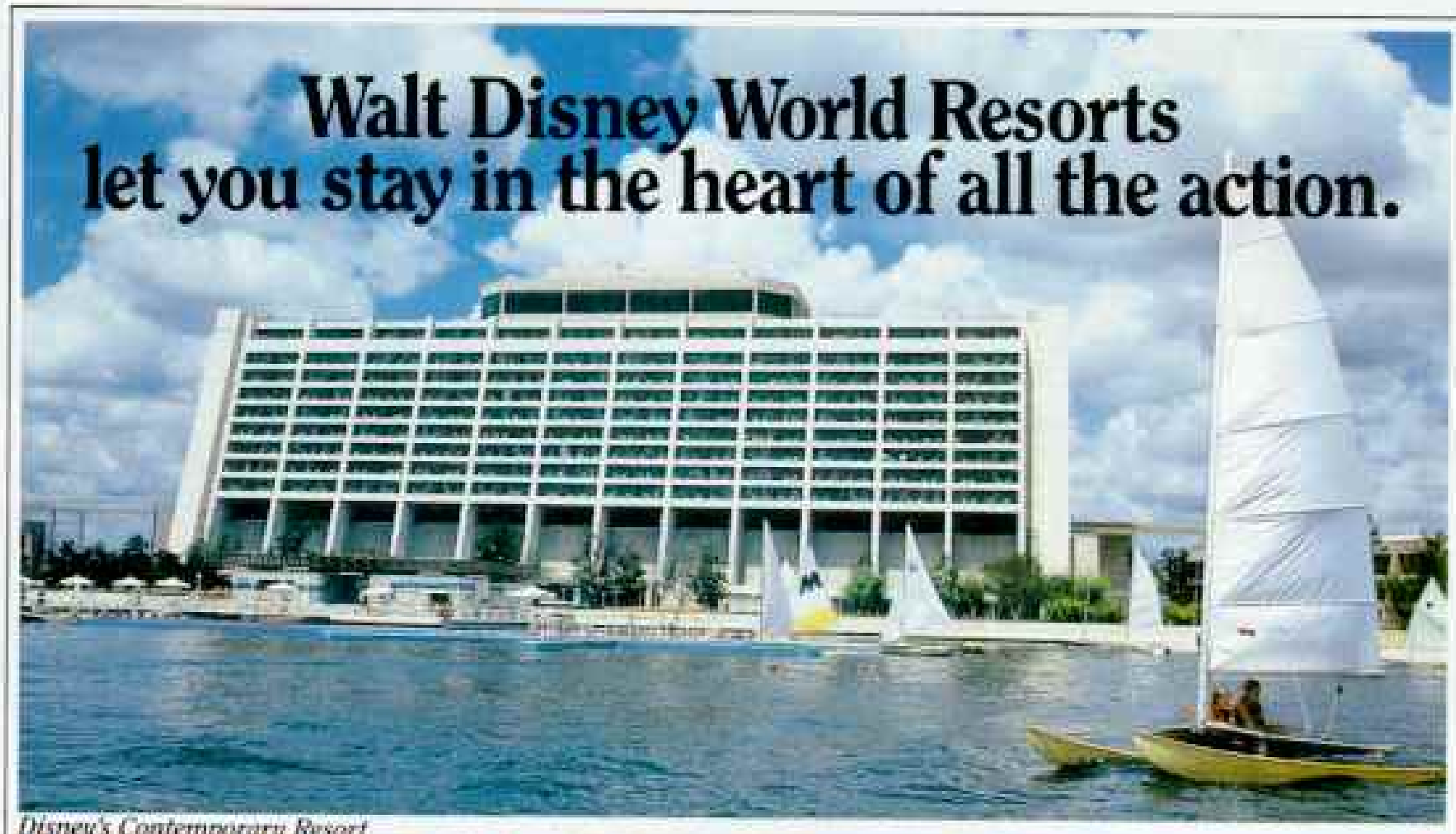
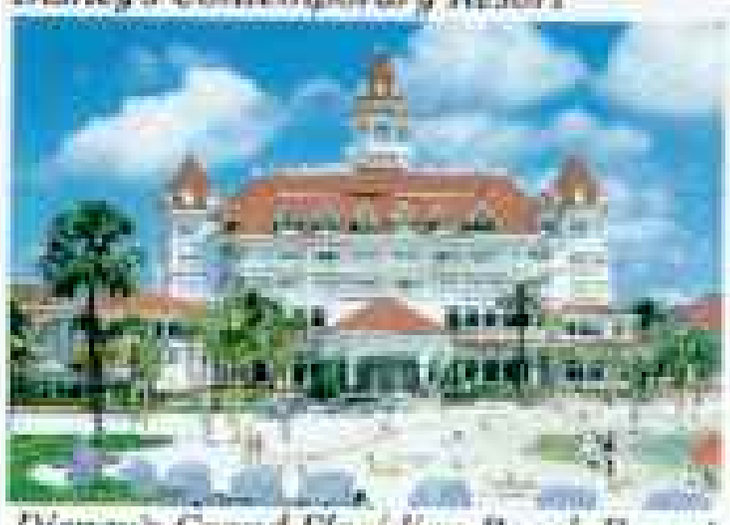


Disney's Contemporary Resort

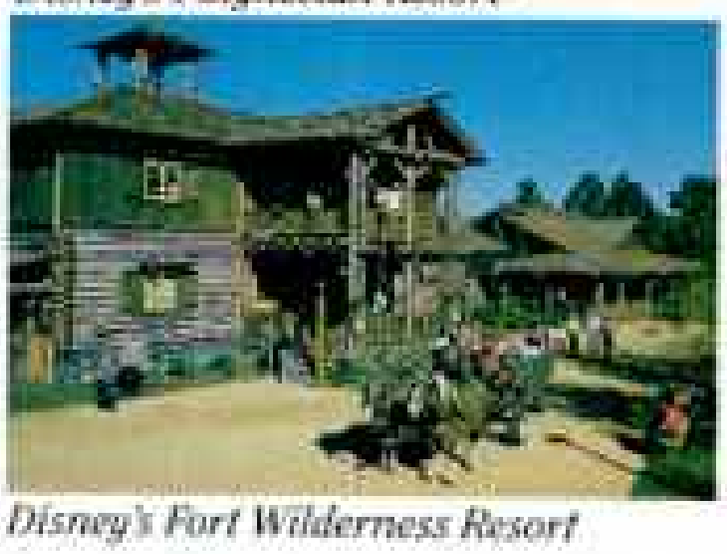


Disney's Grand Floridian Beach Resort

Disney's Polynesian Resort

Disney's Caribbean Beach Resort

Disney's Village Resort



Disney's Fort Wilderness Resort

The Disney Inn.

You'll want to plan on staying at least a week to take full advantage of Disney's three theme parks, two water parks and all of Pleasure Island's nighttime entertainment! Plus, there are all sorts of recreational activities, dinner shows, fabulous restaurants and an entire shopping village. And right now is the best time to visit! During the first few months of the year, the theme parks are less busy and the weather is superb.

Accommodations at Walt Disney World Resorts are readily available at this time, too, so you'll be able to stay right in the heart of it all. And whether you choose the rugged outdoors at Disney's Fort Wilderness Resort and Campground or the refined elegance of Disney's Grand Floridian Beach Resort ...there's a World of vacation magic waiting for you!

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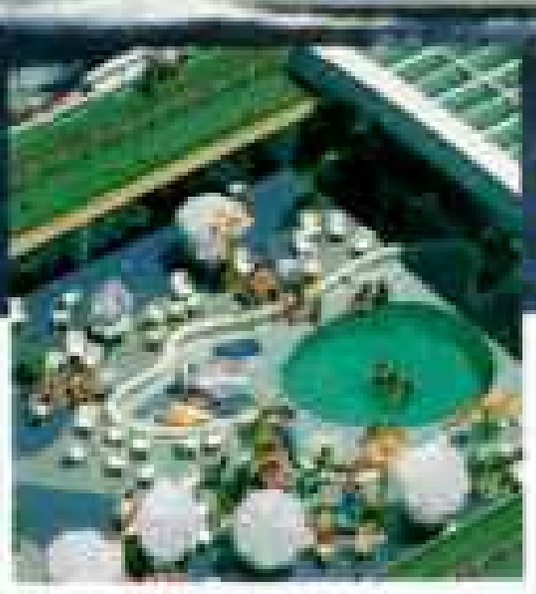
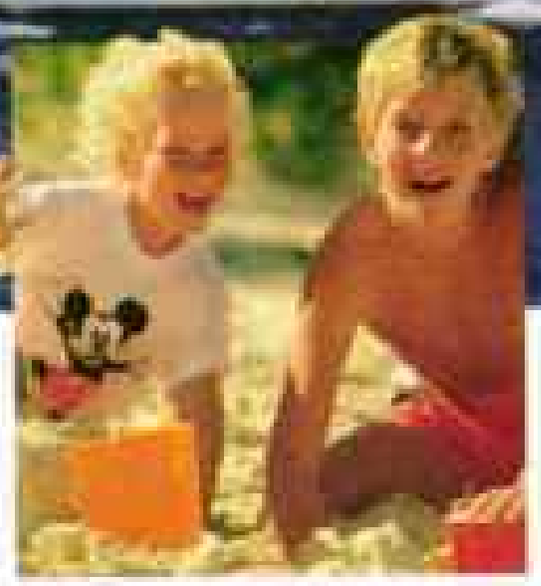


Rush hour at the pool: Premier presents the smart way to beat the traffic.



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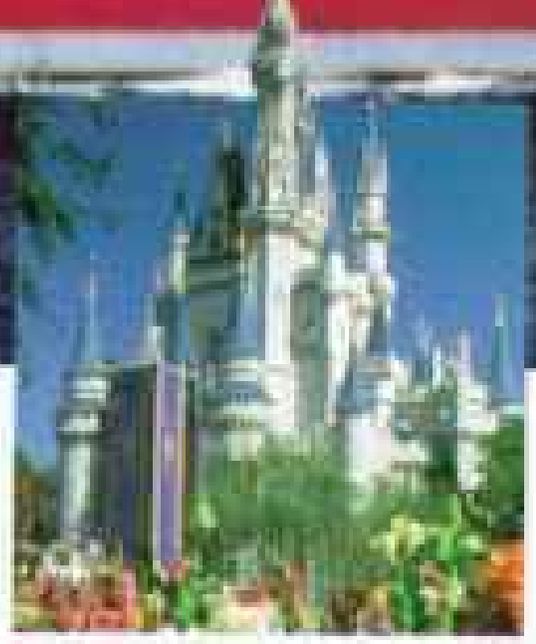
Free Disney!!! Free Vacation Kingdom resorts!* * free rental car, free admissions and more.



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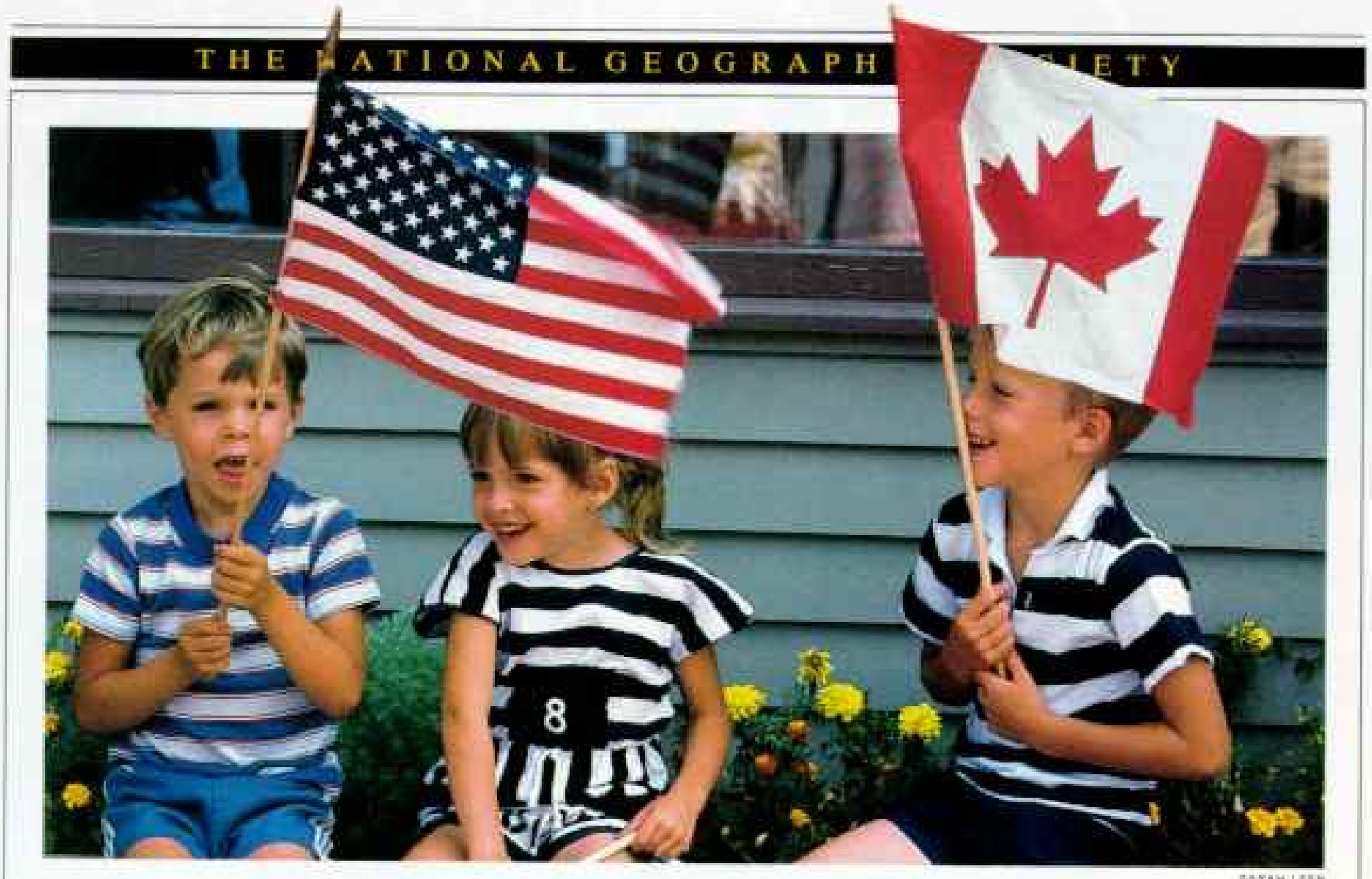
And to think it all started with a mouse.

THE MAGIC KINGDOM® PARK

Our Canadian Friends



SARAH LEEN

Showing the colors of close neighbors, Eric Binion, Darci Alcombrack, and Travis Alcombrack take delight in a parade through Sackets Harbor, New York.

THEY ARE YOUNGER and more likely to have children at home. They watch less television and read more books. They have a taste for geography, science, and photography, and they are slightly more critical of this magazine.

More than 850,000 strong, they are the Canadian members of our Society—the largest nationality outside the United States—and we learned such bits of information about them a few years ago from a survey comparing them with our American members.

As a member of a family that has summered in Nova Scotia for more than a century, I consider myself part Canadian. Thus I think I know the faces that go with these statistics: They are open and friendly, forthright, full of humor, gentle, and etched with a stubborn character.

And yet I am reminded of something a member from Quebec wrote on the back of his survey form.

"Sometimes I feel you don't know too much about us," he stated. "Or perhaps you are too indifferent about what we are."

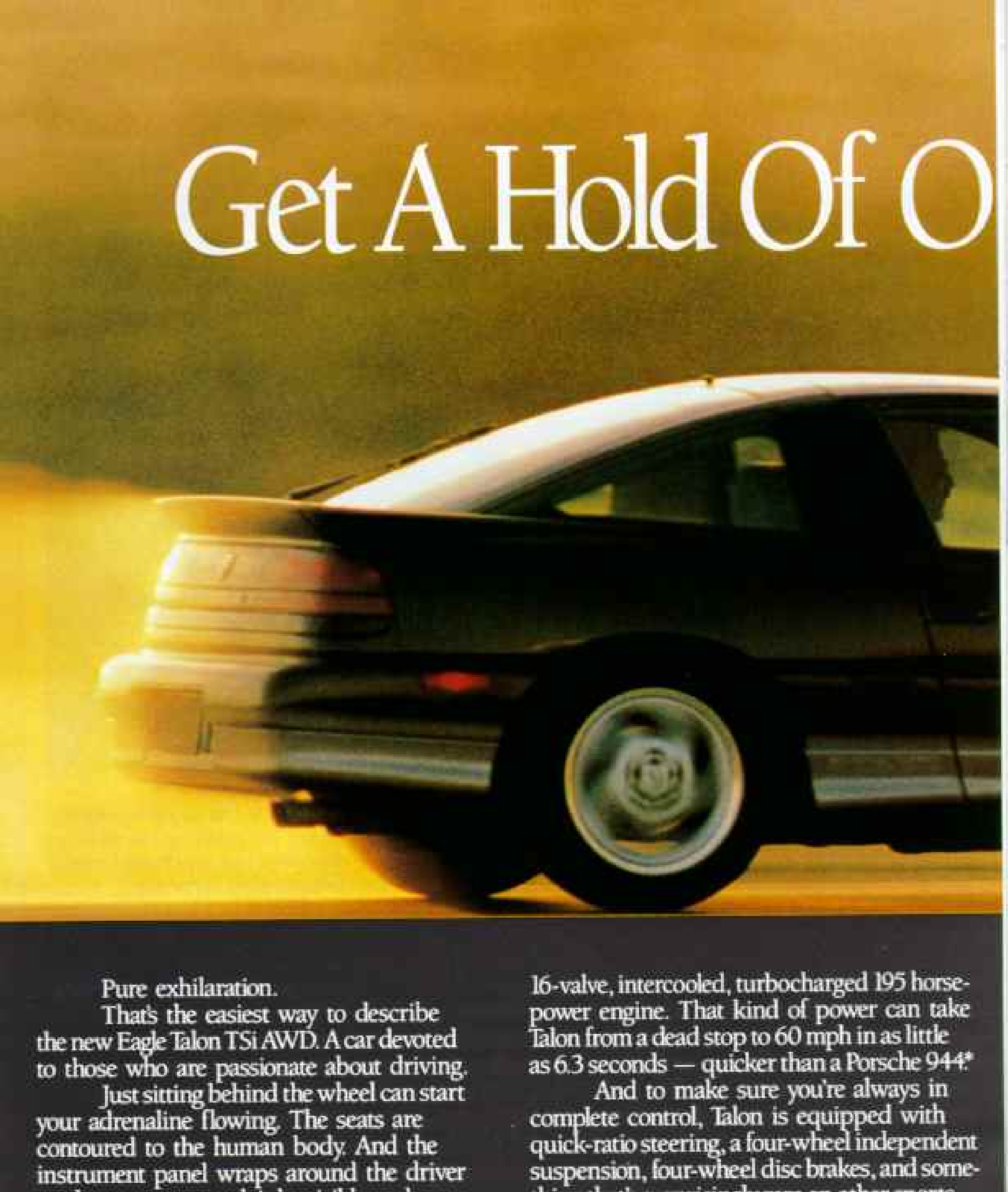
That same message—*you don't really know us*—has been voiced time and again during the past months as Canadians debate the merits of closer economic ties with the United States. A survey commissioned by *Maclean's* magazine seemed to bear out the claim: Only one in nine of the U. S. citizens polled correctly named Brian Mulroney as Canada's prime minister; 69 percent mistakenly said that Japan, not Canada, was our nation's largest trading partner.

Considering such lack of awareness, who could blame the Canadians for being annoyed with their neighbors?

"Part of me would like to talk to Americans and say, there's more up here than moose, mountains, and Mounties," Toronto pollster Michael Adams told Senior Writer Priit Vesilind, whose report on the U. S.-Canada border appears in this issue. "Canadians are feeling, in fact, that their own country has nothing to be inferior to, that we have created here a country that, in terms of quality of life, is one of the best in the world—if not the best."

I couldn't agree more. Canadian society, for me, has always held an appealing mixture of tradition and new ideas, of hard work and compassion and pride of place. And if the U. S. and Canada are destined to grow even closer in the years ahead—as the U. S. and Mexico may also—we would all benefit from a fresh effort to know one another better.

Gilbert M. Grosvenor



Pure exhilaration.

That's the easiest way to describe the new Eagle Talon TSi AWD. A car devoted to those who are passionate about driving.

Just sitting behind the wheel can start your adrenaline flowing. The seats are contoured to the human body. And the instrument panel wraps around the driver so that gauges are plainly visible and controls are within easy reach.

Under the hood is the power of a 16-valve, intercooled, turbocharged 195 horsepower engine. That kind of power can take Talon from a dead stop to 60 mph in as little as 6.3 seconds — quicker than a Porsche 944.*

And to make sure you're always in complete control, Talon is equipped with quick-ratio steering, a four-wheel independent suspension, four-wheel disc brakes, and something that's surprisingly rare on other sports coupes: full-time all-wheel drive.

Talon's advanced all-wheel drive

New Eagle Talon With All-Wheel Drive.

Jeep Eagle

*Based on Car and Driver test results.

Buckle up for safety.

ne. Then Let Go.

system distributes power to all four wheels as needed. On a curve, for example, if the inside wheels begin to lose traction, power to those wheels is automatically reduced and sent to the wheels with the most traction, resulting in improved performance.

For more information on the Eagle Talon TSi AWD, call 1-800-JEEP-EAGLE.

But to truly appreciate the concept of Talon, see your Eagle dealer.

And get a little hands-on experience.

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TPC Protects engine and powertrain for 7 years or 70,000 miles and against outer body rust-through for 7 years or 100,000 miles. See limited warranty at dealer. Restrictions apply.


WHITESIDES

Do we really want to return to those good, old-fashioned days before plastics?

America is coping with the problem of too much garbage—160 million tons a year. Ten years ago, we had 18,500 landfills. Today, it's 6,000, with 2,000 more due to close soon.

Some people believe that banning plastics will solve the problem. We don't.

First of all, if plastics were banned, we'd lose safety and convenience features such as closures for foods and medicines, shatter-resistant bottles, freezer-to-microwave packages, and wrappers that preserve food freshness.

A 1987 study showed that if paper and other packaging materials were to replace plastics, the energy to produce the packaging would double, the weight of packaging would increase four-fold, the packaging cost would double, and the volume of waste collected would increase 2½ times.

Myth vs. Reality.

The thinking behind a ban on plastics is based on myths. Myth #1 is that plastics make up a major part of our solid waste. Fact: according to a recent study, plastics make up about 18% of the volume of solid waste in our landfills. Paper and paperboard account for 38%; metals, 14%; glass, 2% and other wastes, 28%.

Myth #2 is that paper and other normally biodegradable products will solve the problem. Fact: recent landfill excavations have turned up newspapers buried 40 years ago—still perfectly readable.

Myth #3 is that plastics are not recyclable. Fact: plastics are among the easiest materials to recycle. 20% of all plastic soft drink bottles were recycled in 1987. Recycling takes plastic items destined for disposal and turns them into useful new products. It can turn plastics into a "natural resource."

Recycling is growing.

At Amoco Chemical, we believe that the solution will combine recycling, source reduction, landfilling and modern waste-to-energy plants. Everything recyclable should be recycled—yard waste, paper, glass, metal and plastics.

Today, almost 200 companies are recycling millions of used plastic containers into bathtubs, fiberfill for ski parkas, carpet yarn, trash cans, traffic cones, floor tiles, and "plastic lumber."

How Amoco Chemical is helping.

Amoco Chemical is sponsoring a program in New York demonstrating that used, polystyrene foam food-service containers can be recycled into insulation board for commercial construction, cafeteria trays and office products.

We're participating in a consortium with other major plastics manufacturers involved in the construction of regional polystyrene recycling plants.

We're encouraging the start up of new recycling efforts, helping to find better ways to collect and sort recyclables, and supporting efforts to create markets for recycled plastics products.

At Amoco Chemical, we believe that recycling can play a major role in helping America solve its solid waste problem. Before we decide to return to the past, let's remember that the good old days were sometimes the not-so-good old days.

For a free copy of "Recycling. Do It Today For Tomorrow," write Amoco Chemical, Recycling NG, 200 East Randolph Drive, Chicago, IL 60601.

Recycling. Do It Today For Tomorrow.

AMOCO

Amoco Chemical

Members Forum

La Ruta Maya

Someday your concept of invisible borders discussed in the October 1989 issue will apply to the remainder of the Americas and the world, not only for conservation and tourism but also for the betterment of all inhabitants of our biosphere.

It is appropriate to add that we at Calakmul would have accomplished nothing, including the biosphere reserve, without the dedicated people of Mexico's Secretariat of Public Education, the National Institute of Anthropology and History, the Secretariat of Urban Development and Ecology, and the state of Campeche.

We are happy to share with you a recent find from an Early Classic Maya tomb at Calakmul—this extraordinary jade portrait mask (below) of the ruler buried there about A.D. 500.

WILLIAM J. FOLAN
Universidad Autónoma del Sudeste
Campeche, Mexico

LINDA M. FLOREY FOLAN

The suggested development plan for Ruta Maya, while containing important considerations for environmental protection and economic development, proposes a tourist-oriented, theme-park concept that would endanger one of the most fascinating aspects of the Maya area: its authenticity. The isolation of the region has more or less preserved the zone's mysteries and unspoiled beauties. As in much of Latin America, it is still the tourist's duty and pleasure to discover the attractions. The cableway pictured on page 422 better suits Disneyland than Palenque.

SAUL BITRAN
Pittsburgh, Pennsylvania

The article continues a series of exceptionally well-documented reports on Mesoamerican archaeology in the GEOGRAPHIC. However, on page 451 two views of a pyramid at Tikal are wrongly identified as the Temple of the Giant Jaguar, or Temple I. You actually show Temple II on the west side of the Great Plaza. It stands only 125 feet high and is a squat version of Temple I, which rises to 145 feet. Your pictures were probably taken from the doorway of Temple I.

WALTER H. MASSION
Oklahoma City, Oklahoma

Correct. For an overview of Tikal see NATIONAL GEOGRAPHIC, *December 1975, pages 799-801.*

The feature on the Maya was superb. But while it vividly outlined the religious bigotry of the Spaniards, it muted the murderous religious practices of the ancient Maya. Do scholars tend to be less judgmental of the religious practices of their preferred subjects than those of their own culture? Can you suggest a recent publication that examines the ancient Maya religion?

RAY POINDEXTER
Sumner, Washington

Scholars try to analyze cultural data without passing judgment, and our article did describe Maya practices. Recent works covering the Maya religion include The Ancient Maya *by Morley, Brainerd, & Sharer (1983) and* The Blood of Kings *by Schele and Miller (1986).*

Your coverage has opened an entire new world of excitement for one whose cultural ideas have come almost entirely from Europe. Thank you, Wilbur and Kenneth Garrett, for a superb piece of work. I shall continue to read more about the Maya heritage.

HENRIETTA G. MCBEE
Center Sandwich, New Hampshire

We enjoyed the Maya wildlife photo section, but as acorn woodpecker biologists we must take issue with your description of storage trees as "insect traps baited with fermenting acorns." Alas, you have fallen victim to the infamous "grub theory." First proposed in 1866, it was discredited in 1895 but haunts us to this day. Acorn woodpeckers eat acorns, not grubs. In fact most grubs burrow out soon after the acorn is stored. The point of individual storage holes is

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to allow the acorns to dry without fermenting.

In addition to its storage habits, the acorn woodpecker has a highly unusual social system. It lives in what amounts to a commune; males share access to breeding females, who lay eggs in a communal nest. Offspring delay dispersal for several years and help at the group nest.

PHILIP HOOGE
MARK STANBACK
Hastings Natural History Reservation
Carmel Valley, California

A wonderful October issue, and what a great map! I wish we'd had it on our trip to Maya land with a group led by Mayanist Christopher Jones. At Izamal (pages 446-7), after climbing the visible pyramid and touring the church, Chris led us across the plaza at extreme left into a debris-filled courtyard behind a little hotel. There amid discarded soda cans he pointed out what is left of the base of the third pyramid, believed to be that of the 8,000 flints. Trees grow out of it, and the hotel proprietor seemed amused that we found so much of interest in his backyard.

EMILIE E. MULHOLLAND
Oaklyn, New Jersey

Copán

As I tried to imagine the immensity of the task of restoring the Hieroglyphic Stairway of Copán, I

recalled your January 1983 article on "Indonesia Rescues Ancient Borobudur," which referred to a 1975 IBM system developed to help in the restoration process. Would such a system be applicable to the Copán Mosaic Project?

MARCO POLO HERNÁNDEZ C.
Chester, Georgia

George Stuart replies, "Probably not. First the glyphs must be deciphered by epigraphists. An unknown number of stones are missing, and many are eroded beyond readability."

In his fascinating article George Stuart writes of a cache of items including bloodletting lancets of stingray and sea anemone spines. Sea anemones are soft-bodied coelenterates and have no spines. I would guess he meant to say sea urchin.

STEPHEN WALKER
Tulsa Zoo
Tulsa, Oklahoma

He did.

The razor-sharp edges of the "eccentric flints" on pages 492-3 are clearly serrations as on modern cutlery blades. The alternation of two to three small serrations with one or two larger, deeper ones resembles in form and function the teeth on a crosscut saw. The blades also are "ventilated," reducing weight and wind resistance. The Maya blade cutter has made use of the

blade's ventilation to provide additional cutting edges on the inner shaft and barbs, suggesting a most terrifying aspect of the Maya blade—the cut and then the kill. I suggest the sophistication of these blades evidences an "arms race" in Maya stoneworking technology, rather than an art dedicated to mere emblematic authority.

WILLIAM T. LIVINGSTON III
New York, New York

Photography at 150

As a photographic historian, I was extremely impressed with the in-depth research and clarity expressed by Erla Zwingle in "Seizing the Light." Her work presents a historical yet philosophical perspective to the first 50 years of photographic art. Although photographic technology has advanced tremendously, the beauty, simplicity, and artistic creativity of the early masters remain unsurpassed.

C. E. LINDGREN
Courtland, Mississippi

I did not think "Stone Wall" was attributed to A. J. Russell (pages 542-3). Other sources credit Mathew Brady. Should I conclude that many photographs credited to Brady were actually taken by Russell or by Alexander Gardner, another employee?

EDWARD NEMETH
Lincoln, Nebraska

Yes, Brady was credited with most photographs taken by his associates, a common practice then. This photograph, taken by a camera the size that Russell often used, came originally from an album of Gen. Herman Haupt that Russell, his staff photographer, assembled.

Horse Ferry

We still have a man-powered ferry in the U. S. It crosses the Rio Grande, 15 miles west of McAllen, Texas, at Los Ebanos. This three-car ferry is pulled by six men and is operated by Mexico.

LOWELL FISHER
Troy, Ohio

The illustration of the boat propelled by oxen in Roman times may not be so far from the truth as it seems (page 549). James Thomas Flexner writes in *Steamboats Come True:* "It is said that the legions of Claudius Caudex were taken to Sicily in boats propelled by paddle wheels driven by oxen."

JOHN A. PERRY
Rockland, Maine

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

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GEOGRAPHICA

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Mono Lake to Get Some Water Back

Since 1941 Los Angeles has been obtaining about 15 percent of its water supply by diverting streams that feed California's Mono Lake. Now the city has been told to stop taking so much water.

The lake—just east of Yosemite National Park—is an important habitat for millions of migratory birds and the brine shrimp on which they feed. Since the diversion began, the level of the lake has dropped more than 40 feet, creating land bridges that make birds on island nesting sites vulnerable to predators, notably the coyote (NATIONAL GEOGRAPHIC, October 1981).

An El Dorado County judge has ordered Los Angeles to limit diversion of Mono basin water until the lake can rise to an acceptable level. Meanwhile the state has authorized as much as 60 million dollars to help Los Angeles pay for new water sources. To get it, the city and environmentalists must agree on ways to preserve the lake.

"We're laying the groundwork for solving the problem," said Martha Davis of the Mono Lake Committee, an environmental group. But city officials contend that the funds will pay only a fraction of the costs of alternate water supplies—most likely purchased from farmers in the San Joaquin Valley.

A state agency has begun hearings on what changes to make in how Los Angeles gets its water. It will rule on Mono basin water rights by 1993.

DAVID CARRIERE, AITER IMAGE INC.

Good News Hatching for Whooping Cranes

Wildlife officials are not yet whooping for joy. But they are smiling with relief at a steady growth in the number of whooping cranes, a bird that had teetered on the edge of extinction (GEOGRAPHIC, May 1979, April 1984). The crane population, which dipped as low as 21 in the mid-1940s, has topped 200, including more than 150 in the wild, and is climbing. By the mid-1990s officials hope to release 15 to 20 captive birds annually into the wild. A flock of cranes at the U. S. Fish and Wildlife Service's Patuxent Wildlife Research Center at Laurel, Maryland, increased enough for 22 of its 54 birds to be transferred to the International Crane Foundation facility in Baraboo, Wisconsin, last fall. Splitting the flock will protect it from catastrophe if disease strikes, according to Scott Hereford, crane flock manager at Patuxent. "You don't want to put all your eggs in one basket," he says.

The last remnant wild flock—which breeds in Canada and winters at the Aransas National Wildlife Refuge in Texas—now numbers about 140 and produces 10 to 15 chicks a year. But a flock that summers in the Rocky Mountains, introduced under a U. S.-Canada agreement, dropped last year to 13, mostly male. A female born at Patuxent was shipped out last spring in hopes that she would become half of a breeding pair. She "took up" with a male, Hereford says, "but when the flock flew south, she remained."

ANNIE GRIFFITHS BELT

1990 Census to Take a TIGER by the Tail

"NATIONAL GEOGRAPHIC has to produce 11 million copies of one map," says Robert W. Marx. "We have to produce one or two copies of a million maps."

That is how Marx, chief of the Geography Division of the Census Bureau, explains why 325 million dollars—and more than a decade—are being spent to compile a gigantic data base file called TIGER for this year's decennial census. TIGER stands for topologically integrated geographic encoding and referencing, and never mind what *that* means. The system is designed to make sure that every census taker knows the area he or she is responsible for, that every census supervisor can be certain that an area has been covered, that census information can be disseminated accurately about areas as large as any of the nation's nearly 3,300 counties or as small as a city block.

Working in cooperation with the U. S. Geological Survey, Marx and his Census Bureau colleagues are assembling a computer file that contains—by name and in digitized map form—the range of address numbers for every street and road in the nation's 345 largest urban areas, every creek, lake, river, and railroad. They have devised a way to produce the individualized maps that enumerators will use when they collect census data beginning April 1 and that analysts will use when they study the results.

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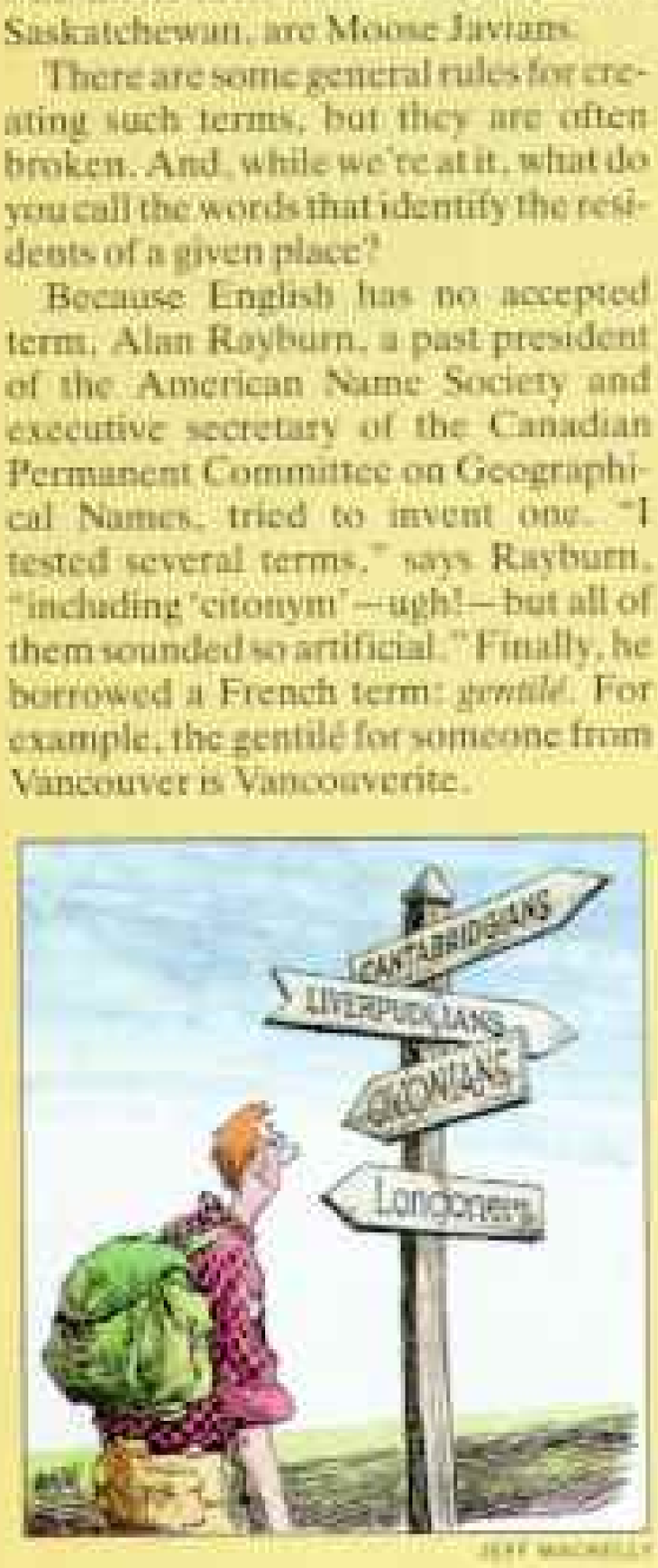
Gentilés, Demonyms: What's in a Name?

Residents of New York are New Yorkers, and people who live in Rome are Romans. But Oxford dons are Oxonians, residents of Liverpool are Liverpudlians, folks from Moscow are Muscovites, and those who make their home in Moose Jaw, Saskatchewan, are Moose Javians.

There are some general rules for creating such terms, but they are often broken. And, while we're at it, what do you call the words that identify the residents of a given place?

Because English has no accepted term, Alan Rayburn, a past president of the American Name Society and executive secretary of the Canadian Permanent Committee on Geographical Names, tried to invent one. "I tested several terms," says Rayburn, "including 'citonym'—ugh!—but all of them sounded so artificial." Finally, he borrowed a French term: *gentilé*. For example, the gentilé for someone from Vancouver is Vancouverite.



JEFF MACNELLY

Writer Paul Dickson, author of a newly published book entitled *What Do You Call a Person From . . . ?*, has coined another term: "demonym," from the Greek *demos*, the people, and *nym*, name. Dickson says this denotes the fact that people choose what to call themselves rather than relying on some arbitrary authority to decide for them. He decided to choose demonym after rejecting several other far-ranging possibilities, including "locunym," "urbanym," and "hailfrom." The latter, he says, is used as in, "Where do you hail from?"

An Ecological Probe of Brazil's Jaguars

The Pantanal region of Brazil has been called the Serengeti of South America because of its abundant wildlife. But as tropical forests are cleared for pasture, the amount of wildlife on South America's largest wetland has decreased.

FRANCOISE SAUZE, BRUCE COLEMAN INC.

To most effectively save an animal, however, government officials, scientists, and ranchers must know the basics: how much land an animal needs to roam, what it eats, its social organization. Supported by the government of Brazil, with the National Geographic Society and the New York Zoological Society providing additional funds, George Schaller, Howard Quigley, and Peter Crawshaw have made the first such intensive study of the ecology of Pantanal jaguars. They found that jaguars often share territory with one another, prefer dense forest close to rivers—and sometimes kill cattle.

Habitat destruction and hunting may have reduced the number of jaguars to a thousand, in an area the size of Virginia, Quigley says. As their prey is wiped out when forests are cleared, jaguars prey instead on cattle, inciting stock managers to hunt jaguars in return. Quigley says ranchers could try keeping calves away from the forests jaguars prefer—to "keep cattle from becoming box lunches for jaguars."

JIM RUDOR

Seeking the Residents of 97 Orchard Street

It was an ordinary six-story building, typical of New York City's Lower East Side: The five upper floors each had four tiny apartments. There were minimal amenities, and residents crowded in, as many as 11 to an apartment. But to millions of immigrants who poured into New York City between the Civil War and the 1930s, buildings like 97 Orchard Street became stepping-stones to the American dream. Germans, Italians, Irish, Chinese, free blacks, eastern European Jews—all sought a better life and lived, at least temporarily, in tenements.

Built in 1863 and inhabited until 1935, 97 Orchard Street is now home to the Lower East Side Tenement Museum. The museum is seeking former residents of 97 Orchard, those who were what founder Ruth J. Abram calls "a piece of the jigsaw puzzle that dotted this small corner of the United States."

The museum would like former residents, or their descendants, to send a stamped, self-addressed envelope to the museum, 97 Orchard Street, New York, NY 10002. They will be asked to tell their stories to help re-create an accurate picture of tenement life. So far, six have been found, including Josephine Baldizzi Esposito and Max Mason (left). Mason moved into 97 Orchard at the age of eight on his first full day in the United States in 1921.

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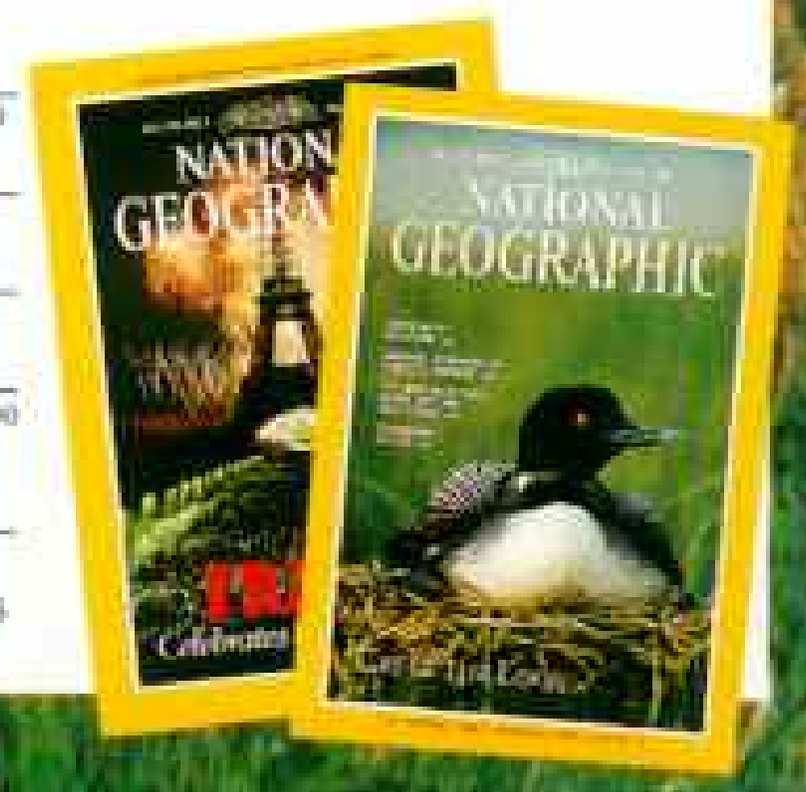

BILL CROWN

Playing Board Games in the Stone Age

They didn't play chess or bridge, but people who lived 7,900 years ago had ways to spend their leisure time. Scientists excavating a Neolithic

BILL CROWN

site in Jordan have found what may be the oldest game board yet known.

Gary O. Rollefson of San Diego State University and his colleagues, working with National Geographic Society support, have been uncovering the remains of Ain Ghazal, one of the largest population centers in the Middle East between 7000 and 5000 B.C. (GEOGRAPHIC, February 1984). Last summer, while excavating a house, they found a limestone slab with two parallel rows of circular depressions, six in each row, cut into it. "It didn't suggest anything utilitarian or ritualistic," Rollefson recalls. "This is probably the oldest indication we have that people then took time out for leisure."

Rollefson thinks that the game played on the board (above) used pebbles or seeds as counters. To a Jordanian member of Rollefson's crew (top), the board wasn't unusual. He had played a modern version, called mancala, on a wooden board before working at Ain Ghazal.

Bird Population Crash on a Shetland Island

The scene is Foula, one of the Shetland Islands (GEOGRAPHIC, April 1977). In 1989 arctic terns fared badly: There were no fledglings for the fifth year in a row. Puffins produced few surviving young for the third straight year. And while 6,000 kittiwake pairs produced about a thousand fledglings in 1989, up from a lone chick in 1988, that was a far cry from the earlier norm of about 8,000.

Robert Furness of Glasgow University has been studying seabirds on Foula for nearly two decades. The vast colonies of nesting birds did a little better in 1989 than in 1988, "the worst year ever recorded," Furness says, but the situation remains grim.

The seabirds feed on sand eels, small fish that had once been present in enormous quantities in the North Atlantic Ocean around Foula. But in recent years sand eel stocks have declined dramatically, making it difficult for birds that feed on or near the surface—like terns, kittiwakes, puffins, and northern fulmars (bottom)—to find enough food for their chicks. Most of the eggs hatch normally. "There's nothing intrinsically wrong with the chicks," Furness says.

Some experts have blamed the sand eel decline on fishing; in response, the British government imposed a partial ban on the sand eel fishery before the 1989 fishing season closed. But Furness says scientists really aren't sure why sand eel numbers dropped around Foula; fishing has continued off other Shetland islands without a significant effect on the size of bird populations. He will be back this summer to see how Foula's seabirds are faring.

KEVIN SCHAFER, EARTHWATCH

PAUL A. SELDEN

Unraveling the Secret of a Spider's Web

Many animals have a single feature we associate with them: a camel's hump, an elephant's trunk, a turtle's shell. When we think of a spider, we think of the distinctive web in which it traps its prey.

But when did the spider first acquire the ability to weave webs? No one knows yet, but Paul Selden, a researcher at the University of Manchester in England, has evidence that spiders could weave orb, or radial, webs as long ago as 140 million years.

Selden studied four tiny fossil spiders found in two Spanish quarries—"Each piece of spider looks like a little brown flake just under the surface of the translucent rock," he says—and found that they had "accessory claws" that modern spiders use to weave a web. The age of the orb-web weavers turns out to be many million years earlier than any previously known.

Scientists have discovered fossils of spiders that could spin silk threads almost 400 million years ago. But such spiders probably used the silk to line their burrows or as aids in sensory perception, Selden says. The Spanish spiders are the earliest known that could weave the common orb web; one that hangs in the air and traps the flying insects that are the spider's prey.

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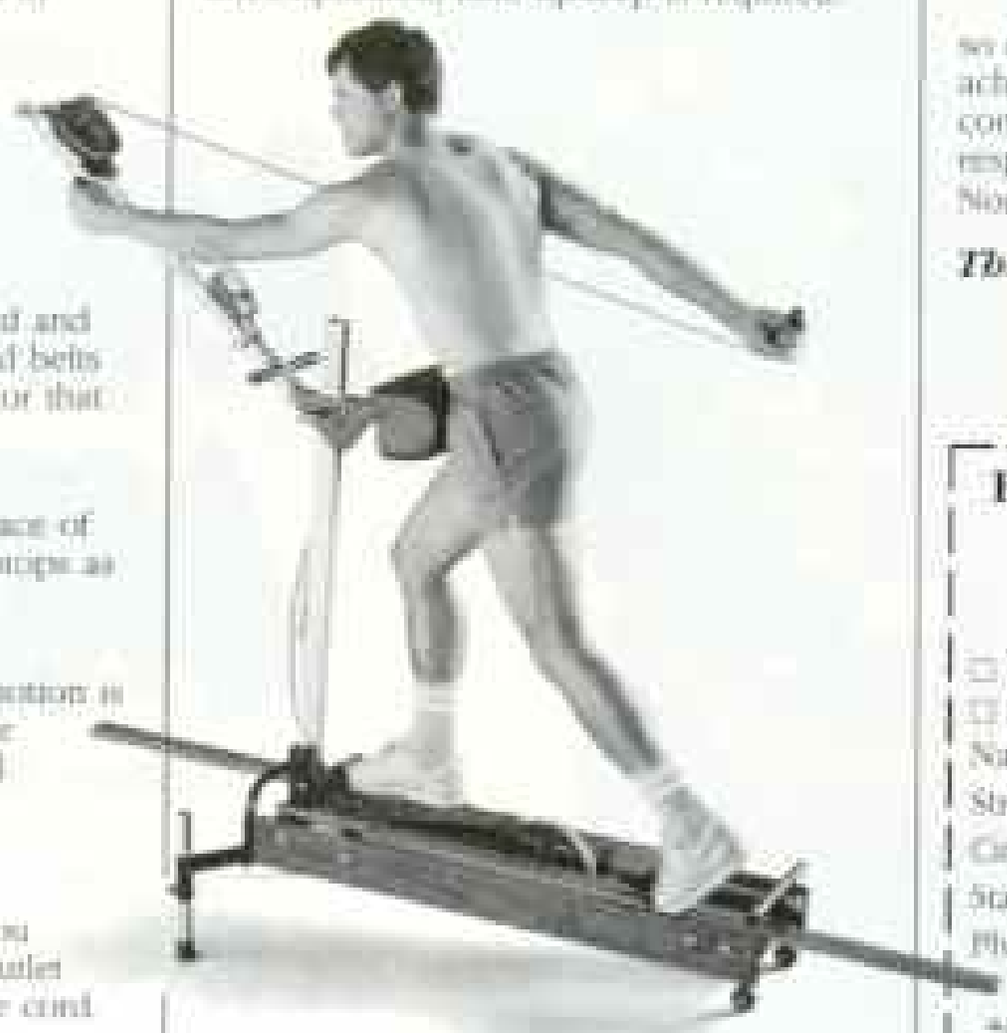

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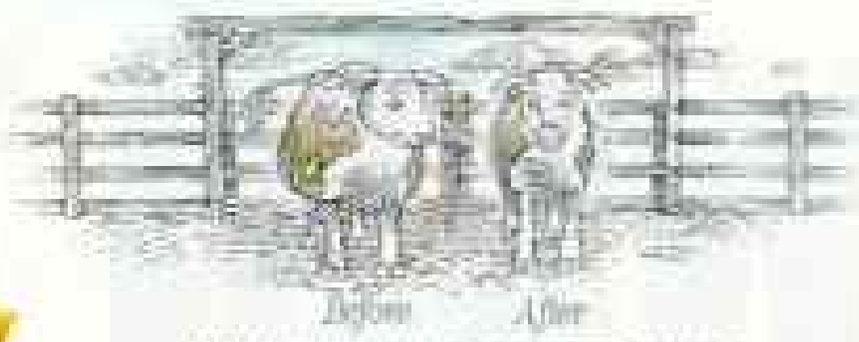

Before After

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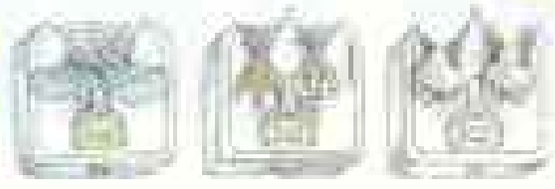

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SKINNY BEEF SALAD

For a salad you won't wish was something else, toss in a few strips of tender sirloin along with the green stuff. P.S. It also works with leftovers.

Figures are for 3-ounce servings, cooked and trimmed of fat. © 1988 Beef Industry Council and Beef Board.

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NATIONAL GEOGRAPHIC MAGAZINE

LAST MONTH when we ran a story on the *Exxon Valdez* oil spill, Alaska's tourism industry braced for another damaging information spill. Masses of worldwide publicity after the spill last spring had caused Alaska tourist reservations for 1989 to tumble.

Thousands of Alaskans who depend on tourism were going to be hurt, and the natural reaction for many was to lash out at the press. None of the tour-operator complaints to the Alaska Tourism Marketing Council blamed a basic problem—an appalling international geographic ignorance.

Despite Germany's high ranking in our Gallup Poll on geographic literacy, within a few weeks of the spill tour agencies there reported cancellations of 50 percent of their Alaska bookings and had no new requests for trips. A group handling Japanese tourists reported 1,300 cancellations, with a revenue loss of four million dollars.

Alaska has twice the land area of East and West Germany and Japan put together, and more miles of coastline than our other 49 states combined. Relatively little was affected. Yet even U. S. citizens who should have known better also panicked. One caller canceling a trip asked how far the oil had gone up Mount McKinley. Another wanted to know how badly hit was Fairbanks—300 miles inland. A fishing resort in southeastern Alaska, 700 miles from the spill, reports losing two hundred expected bookings. That's like canceling a vacation to Yellowstone National Park because of the San Francisco earthquake.

Governor Steve Cowper had a letter from a lady in Georgia who canceled a long-awaited first trip to Alaska because she couldn't bear to have her lifelong view of a beautiful place destroyed.

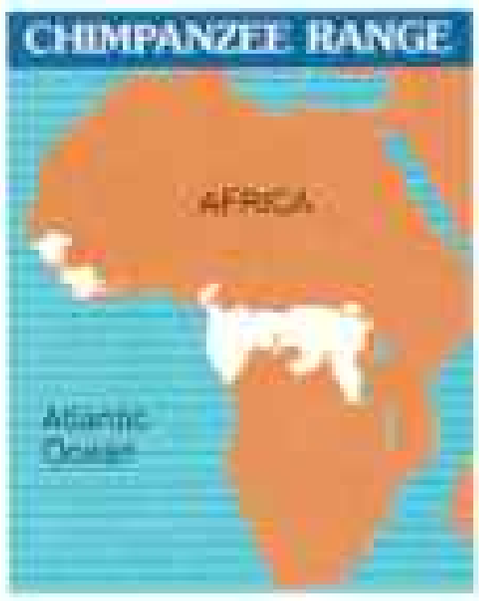
An advertising campaign largely funded by a four-million-dollar grant from Exxon reversed the losses. Except for Prince William Sound, Alaska enjoyed a record tourist season.

Potential visitors this summer need not worry. As bad as the spill was, the damage has been less than many predicted, and natural healing has been faster than expected. Like a lady who has been jilted, Alaska is as beautiful as ever but a lot wiser, and more than ever determined to protect one of her greatest assets—her natural beauty.

Milbur E. Garrett

EDITOR

WILDLIFE AS CANON SEES IT



Chimpanzee
Genus: *Pan*
Species: *troglodytes*
Adult size: Height, 70-90cm
Adult weight: 30-50kg
Habitat: Tropical forests and woodlands of equatorial Africa
Surviving number: Estimated at 150,000-235,000 in the wild
Photographed by Geza Teleki

In the wild animal kingdom, it is the chimpanzee that can readily evoke our emotions. Through decades of study, we have learned much about chimpanzees' social behavior, intelligence, and even their sensitivity. Only 50 years ago, there were several million chimps in Africa. Today, as few as 150,000 remain in scattered populations, mainly a result of habitat loss. To save endangered species, it is essential to protect their habitats and understand the vital role of each species within the earth's ecosystems. Photography, both as a scientific research tool and as a means of communication, can help promote a greater awareness and understanding of the chimpanzee and our entire wildlife heritage.

"BY 1945, AMERICA'S FORESTS WILL BE HISTORY."

In 1920, authorities predicted that we'd run out of forest land in 25 years. But today we have nearly *730 million acres* of lush forest land in the U.S. — and more trees than we had 70 years ago.

Thanks, in part, to private landowners and America's forest products companies, who plant over 6,000,000 trees a day, reseed entire forests, and use other forest management techniques to promote natural regrowth.

We're determined to keep up with the growing demand for wood and paper products. And to make sure our forests will continue to make history.

To learn more about the future of America's forests, write: American Forest Council, 1250 Connecticut Avenue, N.W., Washington, DC 20036. Or call **1-800-648-6699.**

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On Assignment

PHILIP P. WICKLIN (ABOVE); MIGUEL GUIE FAIRBANKS (RIGHT)

IN THE BROKEN HEART of Soviet Central Asia, GEOGRAPHIC Assistant Editor WILLIAM S. ELLIS (above, at left) and *Detroit Free Press* photographer DAVID TURNLEY look out on the desiccated remains of the Aral Sea. With them on his abandoned boat is Dzhetpisbai Ibragimov, one of thousands of Soviet fishermen thrown out of work after the once bountiful lake began to shrink. Though one of the century's worst environmental disasters, the crisis had been kept under wraps by authorities who permitted virtually no journalists in the area. Then debate about the catastrophe intensified among Soviet journalists and environmentalists. After months of negotiation the GEOGRAPHIC was granted access last September. In the spirit of *glasnost* the Soviets also shared their satellite images (pages 86-7).

For Bill the subject fits a growing interest in large-scale environmental calamities, such as the destruction of Brazil's rain forest (December 1988) and the desertification of Africa's Sahel (August 1987), just a few of his 36 articles for the magazine.

AN AUTHORITY on seafloor mapping, marine geologist H. GARY GREENE helped design the Monterey Bay map for this issue. Then he continued to consult with our staff even after the October 17 Loma Prieta earthquake left his surroundings in shambles.

At his home in the Santa Cruz Mountains, three miles from the epicenter of the 7.1 Richter-scale quake, he felt "as if a plane had hit the house." Though they were wildly tossed, Gary and his wife escaped injury. At his office in Moss Landing Marine Laboratories (below), a 40-foot-long crack in the floor exposed the underlying beach; the entire building must be demolished. Yet between rebuilding his house and assessing earthquake damage as a Branciforte fire department volunteer, Gary managed to locate working phones and stayed in touch with us.

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Discovery of hollow tree yields few clues to age of elves, but rich insights into cookie making.

Sequoia gigantheum
2,200 years old

Koebleram incognitus
Anybody's guess

Exactly how long elves have been baking uncommonly good cookies and crackers in magic ovens has been difficult to pinpoint. Hopes that the discovery of their hollow tree would help date the elves vanished when elfologists pointed out that the tree's very hollowness makes determining its age impossible.

But it is not hollowness, rather what *fills* hollowness, that helps us better understand elves and their ways. Consider Keebler® Magic Middles® cookies.

Ordinary cookie

Magic Middles®

Just as they rush to fill their tree with the industry of cookie baking, so do elves rush to fill crispy cookies with fudge. To bite into a Magic Middles® is to instantly understand the elfin mentality. Elves believe that a cookie's middle should do more than hold its outsides together. Each Magic Middles® brims with rich, creamy fudge that sends shivers of delight through the most indulgent cookie lover. As one luxuriates in the fudginess of this cookie, comforted by the assurance that it is low in cholesterol and saturated fat, thoughts of hollowness are replaced by waves of satisfaction.

A tree is filled with elves. A cookie is filled with fudge. A stomach is filled with cookie. Such is the rhythm of life when all seems well with the world.