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French POLYNESIA

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NATIONAL GEOGRAPHIC

From the Editor

THE MAN in the pearl gray topper, Luis Marden, often seems to me like a character out of fiction.

He speaks five languages, flies ultralight airplanes, and cultivates a rare Chinese bamboo on the banks of the Potomac River, where he lives in a house designed by Frank Lloyd Wright. He introduced 35-millimeter cameras to NATIONAL GEOGRAPHIC when he joined the staff in 1934 and, two years later, Kodachrome film; at the time, such cameras and film were considered amateur playthings.

He pioneered underwater color photography, sailing on Jacques-Yves Cousteau's early *Calypso* voyages. He discovered the wreck of Captain William Bligh's *Bounty* in the South Pacific and produced a National Geographic film on the find that became the inspiration for the Society's television division. He discovered a new species of orchid, *Epistephium mardenii*, and a new species of sea flea, *Dolobrotus mardeni*, named in his honor. He twice sailed his own ketch across the Atlantic in the wake of Christopher Columbus's first voyage. He introduced a young Polynesian prince named Tungi to the joys of scuba diving and returned in 1967 in the company of National Geographic's then Chairman and Editor-in-Chief, Melville Bell Grosvenor (dark topper), to see the prince (plumed hat and fur-trimmed cape) crowned King of Tonga.

With this issue Marden, rumored to have retired some years ago, returns to his native Boston to report on a venerable friend, Old Ironsides, which was sailing for glory not long after *Bounty* was ghosting into oblivion, sunk off an obscure Pacific island named Pitcairn. This marks Marden's 59th article for NATIONAL GEOGRAPHIC, which is proud to run the byline of an esteemed colleague.

Bill Allen

Charting a New Course

FRENCH

By PETER BENCHLEY

Photographs by JODI COBB
NATIONAL GEOGRAPHIC PHOTOGRAPHER

POLYNESIA

With strong arms and obliging souls, Tahitians usher ashore French vacationers after a lagoon cruise on an outrigger canoe. But hospitality has turned to hostility among many islanders for whom the burdens of French rule outweigh the blessings.

Fueled by a Polynesian passion for dance, torch-twirling Tahitians stage a sizzling show at a beachfront resort. Nearly extinguished during the 19th century by

disapproving missionaries, Tahitian dancing has been rekindled by a renaissance of native culture—and by tourists' appetite for spectacle.

Lacy breakers lap the coral reef that rings Bora-Bora, an ancient sunken volcano 165 miles northwest of Tahiti. With sugar white beaches edging its electric-blue

lagoon, the island fits everyone's image of a South Seas paradise—but not every-one's pocketbook: Waterfront thatch huts go for up to $700 a night.

"YOU CAN'T SEE THE SCARS," Oscar Temaru said, "but the wounds are deep." For a man with a reputation as a firebrand politician, Oscar seemed remarkably gentle and soft-spoken. He leaned back in his chair and parked his bare feet on the coffee table in his office in Tahiti's working-class district of Faaa. With a sad-eyed smile, he touched his breast. "They are here."

It had been nearly nine months since the riots sparked by France's unilateral decision to resume testing nuclear bombs at Mururoa Atoll, a tiny speck in the Tuamotu Archipelago, 750 miles southeast of Tahiti. By now—May 1996—most of the signs of riots had been erased. Tahiti and her sister islands of French Polynesia had buffed their tarnished image and resumed their mythic role as romantic idyll in the South Pacific.

As had happened dozens of times over hundreds of years, paradise had been threatened but not lost. And despite the wounds that festered beneath the cosmetic calm, I felt certain that these legendary islands would survive this latest time of tumult and transition.

The question of independence from France—could it happen? might it happen? should it happen?—seeped into nearly every conversation. Among Polynesians, animosity toward what was perceived as French hegemony was, if not universal, at least pervasive. The French, meanwhile, struggled to maintain a facade of serenity: Let Hong Kong slip away from Great Britain, let the world ride a wave of decolonization; Tahiti would remain not merely French but *France*.

Some of the wounds were obvious, visible, tangible. Tourism, for example, one of the mainstays of the economy, had sagged drastically—in some cases to the point of collapse. Australians, New Zealanders, and Japanese were staying away out of protest against the nuclear tests. One hotel I visited had a staff of 140 serving 17 guests. The day after I departed, 80 staff members were laid off.

The malaise was personified by Oscar Temaru himself. Mayor of Faaa, crusader for Polynesian independence, Oscar had led his Tavini Huiraatira (Serving the People) party to stunning success in recent elections, winning 11 seats in the 41-member Territorial Assembly—not enough to snatch the reins of power from the French-backed establishment, certainly, but more than enough to make its voice heard throughout the country's five disparate and far-flung island chains.

On all the islands, from the Marquesas in the north to the Gambiers and the Australs in the south, from Mangareva in the east to Maupiti and Bora-Bora in the west, the blue-and-white flag of independence flew on rooftops and hillsides. Such brazen defiance was a far cry from the time, only 25 years ago, when the very idea of independence was illegal, and children had their knuckles rapped for daring to speak Tahitian in school.

Why wasn't Oscar celebrating? I wondered.

He shook his head. "I will celebrate," he said, "when we win freedom for our people. Yes, they are beginning to learn their history; yes, they are at last permitted to speak their language. But we still have a very, very long way to go. The French have no intention of letting us go."

And why not? Where was the treasure in these 118 islands and atolls, most uninhabited, sheltering a grand total of 220,000 people?

"Look at the map," Oscar said.

At first glance a map of the world reveals nothing significant about French Polynesia, which resembles a few grains of rice on a

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PETER BENCHLEY, author of novels and television documentaries about the sea, has written seven other stories for NATIONAL GEOGRAPHIC. The first was Nantucket in 1970.

Fed up with France, Oscar Temaru, at left, and his Polynesian independence party made big gains at the polls last year after French President Jacques Chirac outraged Tahitian voters (and dismayed Japanese visitors) by refusing to halt hotly protested nuclear weapons tests. "Chirac dreams of France becoming a superpower," says Temaru. "We dream of freedom, freedom, freedom."

field of blue. But soon you realize that the impression is an illusion, created by the overwhelming size of the Pacific Ocean. French Polynesia's paltry 1,359 square miles of landmass are scattered over one million square miles of ocean, an area as large as Western Europe. France exercises sovereignty over this entire region of the Pacific—to use, develop, and exploit as it will.

Thanks to its claim on French Polynesia and two other Pacific territories—New Caledonia, Wallis and Futuna—France is the second largest presence (after the United States) in the Pacific. Clearly, the nation that has always prided itself on its past glories and has striven to maintain its present power was not about to lop off its most far-reaching arm in the name of some lofty principle like self-determination.

As Paul Roncière, the debonair French high commissioner (and expert in the art of diplomatic euphemism), told me in his palatial office in Papeete, "Naturally, Francophonism is important to us in this crucial crossroads of the Pacific, and we have always been much more paternalistic than the British."

OVER THE PAST 150 YEARS French paternalism has created in Polynesia a country of wild contradictions: a semiautonomous, semidependent, semimodern, semiprimitive, semiprogressive, semireactionary land that has little regard for its past and little confidence in its future.

Relative to its neighbors, French Polynesia is rich. The annual per capita income is about $15,500, almost three times that of Fiji. But its riches come largely from the French nuclear program. In 1995 France pumped 1.25 billion dollars into the economy, more than a third of the entire gross national product. Now that

Churchgoers in Sunday finery sweat out a sermon with the help of handheld fans in Papeete, Tahiti, French Polynesia's steamy capital. Worshipers sit in

same-sex groups, blending their voices in rousing himenes*—Tahitian-style hymns. So transporting is the sound, vows one hearer, "it lifts you right out of your seat."*

the tests are over and the facilities at Mururoa are being dismantled, jobs are evaporating. Unemployment is at least 16 percent and rising, and though the French have pledged to subsidize the economy until 2006 to compensate for the loss of income, no one knows where replacement funds will be found.

Unemployment's handmaiden, of course, is crime, which is increasing every month. "We call it Tahitian socialism," a policeman on Papeete's waterfront Boulevard Pomare said with a wry smile. "You have it; I want it; I take it. Simple as that."

Because nearly everything must be imported, the cost of living is very high. Gasoline costs $4.50 a gallon, whiskey is $35 a bottle, coffee at a café on the Boulevard Pomare is $3 a cup, and an automobile that costs $25,000 on the mainland may retail in Papeete for nine million Polynesian francs, more than $90,000.

Like other imperial powers of the 19th century, France realized that the key to loyalty lay in dependency, and it established a huge, entrenched, self-perpetuating bureaucracy that endures to this day. Of the total workforce of 79,000, half are employed in government-related jobs.

"India has 950 million people and 24 ministers," Oscar Temaru said archly. "We have 200,000 people and 14 ministers."

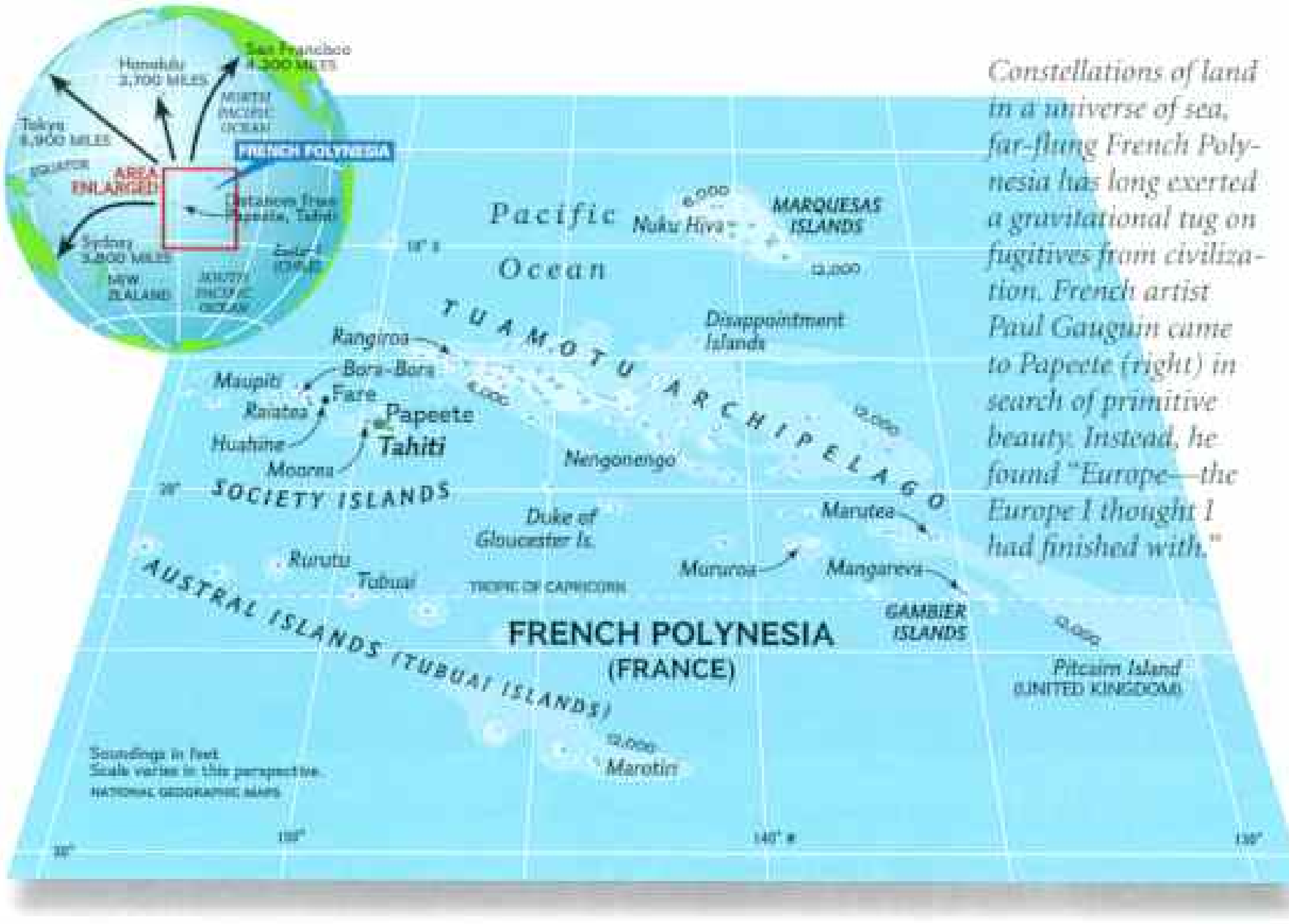
And they make a lot of money. A government minister takes home nearly $10,000 a month, a teacher more than $4,000 a month.

Clearly, this 50 percent of all working Polynesians is not rife with rabble-rousers ready to pitch the French out, and so whenever election time rolls around . . . voila! . . . Tahiti votes to remain a French colony.

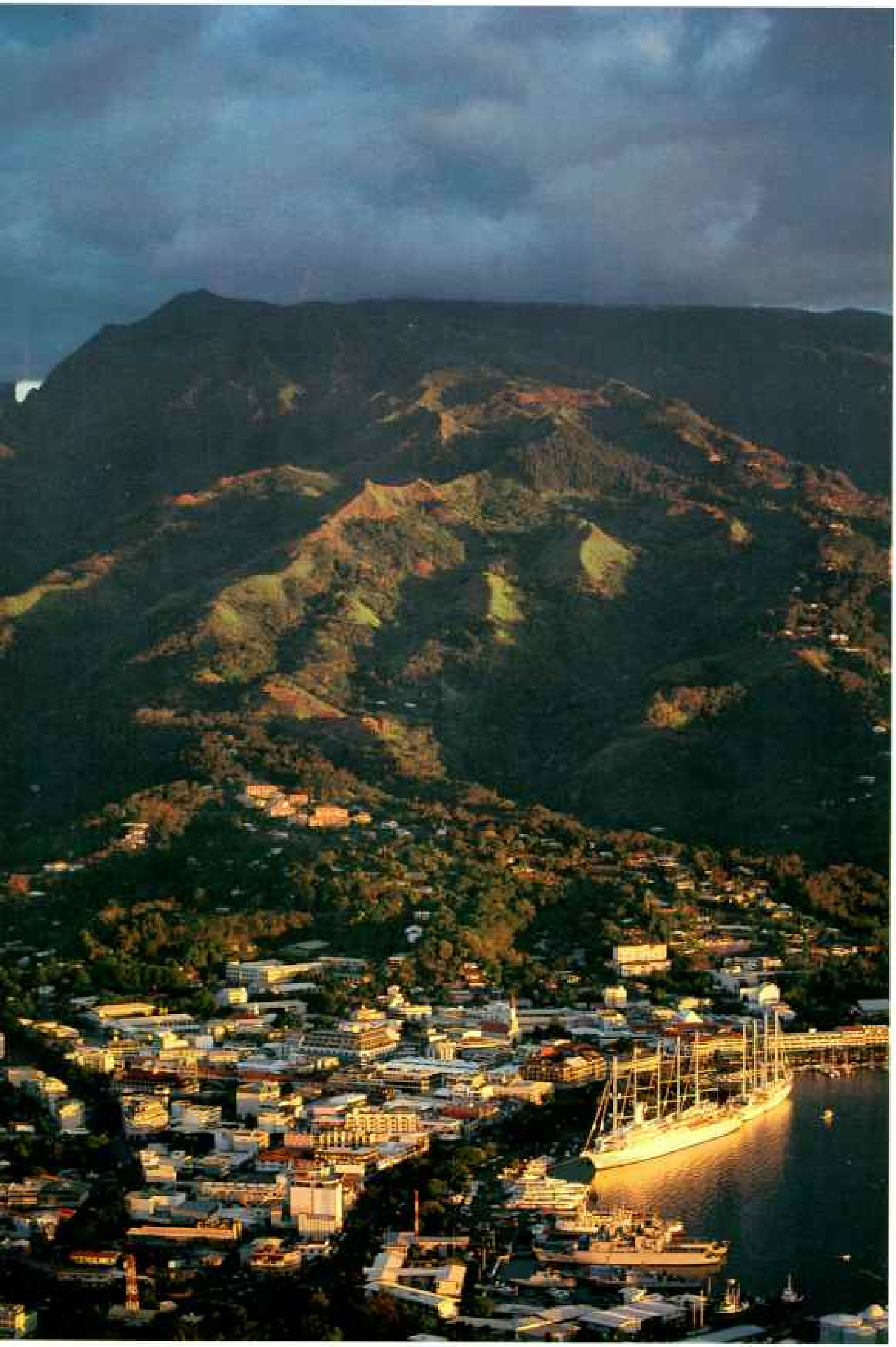
But among the rest of the population—people of every temperament and ancestry known to man, motley products of thousands of years of Pacific trade and hundreds of years of colonization—there is a contagious yearning to be free. In more than a month in the islands, I had trouble finding any working-class Polynesians not employed by the government who opposed independence.

One fine May day I docked my chartered sailboat at Huahine, 105 miles northwest of Tahiti, and wandered through the town of Fare. It was a village like most small Polynesian villages: a main street, a mom-and-pop general store run by a Chinese couple, chickens running free through every yard, scabietic dogs napping in the dust.

Sitting in the storefront office of the local branch of the independence party was a gray-haired woman who radiated serene dignity: Yvette Oopa, a descendant (by marriage) of one of Polynesia's heroes, Pouvanaa a Oopa,



Constellations of land in a universe of sea, far-flung French Polynesia has long exerted a gravitational tug on fugitives from civilization. French artist Paul Gauguin came to Papeete (right) in search of primitive beauty. Instead, he found "Europe—the Europe I thought I had finished with."



who in the 1950s opposed France's dominion over the islands and was sentenced to eight years in jail. Like most Polynesians, Yvette has a family tree that reads like an atlas. She is part English, part Swiss, part German, Swedish, and Danish, and part Tahitian.

Her heart, however, is pure Polynesian, and she is deeply worried about the future of her people. "We are becoming foreigners in our own country," she said. "We're taught in school that our ancestors were les Gaulois. Many young people are growing up speaking no language—a bit of Tahitian, a bit of French, a bit of English, and a lot of slang."

But would Polynesia be able to survive without annual infusions of French money?

"Absolutely," she said flatly. "Some say we would suffer under independence. I say we are suffering now under the domination of a country 20,000 kilometers away. We are just a postbox for France, a vehicle for taxes. And look at immigration. If we stay French and if European unity goes through, any European will be able to come here, live here, work here, take our jobs. We would never survive that."

Yvette lit a cigarette and watched the smoke drift toward the ceiling. "I'm not suggesting that we become isolationist, but we must be allowed to preserve our traditions and our culture, and that will be hard even without the French. Television is ruining us. The evenings used to be times when parents would pass along the stories, the wisdom, the lore. Not anymore." She paused. "All we ask is to be permitted to be ourselves, live our lives, determine our own fate."

Similar demands have fallen on deaf ears since 1842, when France snatched Tahiti and its islands from the careless British and arbitrarily declared them a French protectorate.

Showing his colors, French Polynesia's President Gaston Flosse wears the French tricolor while reviewing troops parading through downtown Papeete on Bastille Day. While French military spending has floated Tahiti's economy for the past 30 years, French influence has swamped Tahitian culture. "We are losing our language," laments one native. "That's our soul."

After a three-year war of independence Queen Pomare IV reluctantly accepted the protectorate. In 1880 the queen's son and heir, the preposterous sot Pomare V, "sold" the islands for a pension of a mere 5,000 francs a month, and France's hegemony was complete. (Pomare V is buried in the Arue district of Tahiti, in a tomb topped by what looks suspiciously like a bottle of his beverage of choice, Benedictine.)

Polynesia's relations with France have never been placid, and the islands have always had vocal champions ready to castigate the French as greedy oppressors. In February 1903 Paul Gauguin, who had retreated from civilization to a sanctuary in the Marquesas, wrote bitterly to the colonial inspectors: "This hypocritical consideration of liberty, equality, fraternity under a French flag becomes a remarkable irony when applied to this disgusting spectacle of humanity who are no more than the flesh from which all kinds of contributions are extracted by the arbitrary gendarme."

A few months later the great painter was dead, unaware (and probably uncaring) that his work would endure as a representation of all that is wondrous and beautiful and magical about the islands of the South Seas.

By mid-20th century Tahiti had become embedded in the human consciousness as a synonym for romance and remoteness, and writers were scouring the language for adjectives that would do the islands justice.

"There it is!" James Michener wrote in 1951. "Vast, insignificant Polynesia, ruled badly by many different nations, victimized by all kinds of robbers. It is not rich. Its people seem to have few causes to be happy. It is a backwash in the world's eddies, yet these trivial islands have imposed on history the most lasting vision of the earthly paradise. Why?"

Simplicity is one answer. Quandaries seem to lose their urgency in Polynesia, as if blown away by the sweet Pacific breezes.

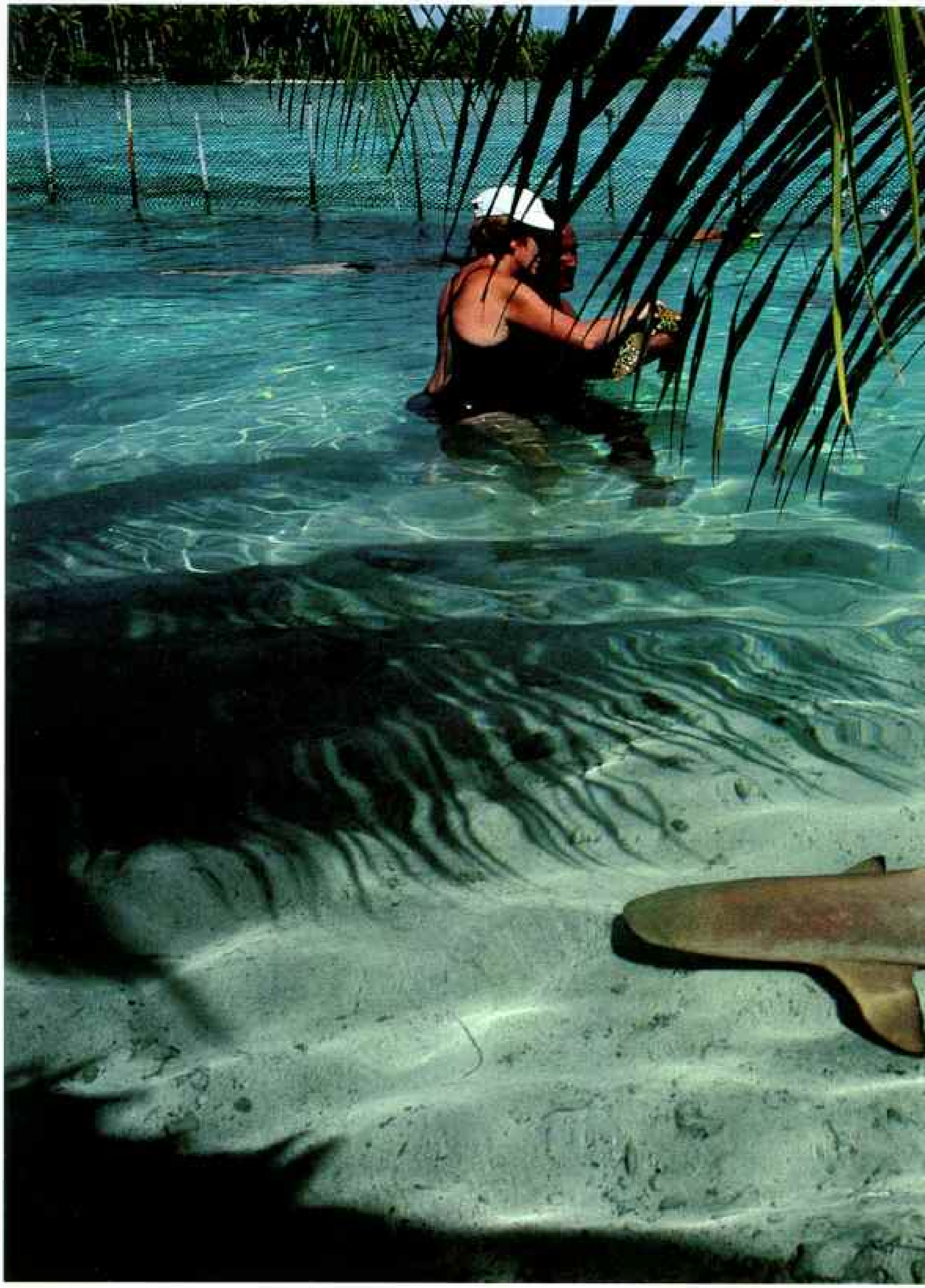
Fecundity is another. Food grows on trees and swims in the sea. Particularly in the out islands a person can live by his wits.

Beauty is a third. Nowhere on earth can one so quickly overdose on breathtaking gorgeousness.

And then there are the people. Answering his own question, Michener continued: "Without these remarkable people, the island [Tahiti] would be nothing. With them, it is a carnival. They are generous, courageous and comic. They wake each morning to a fresh day that has forgiven the previous day's outrages."

They are also hospitable, affectionate, and frank. On a plane headed southeast to the remote Gambier Islands, I found myself seated beside a stunning young woman—blondish brown hair, honey-colored skin, flawless features—who greeted me in fluent Parisian French. Her name was Heiata Roomataroa, and as we talked, I discovered that she was living testimony to the generosity (and biological good sense) of Polynesians.

Her father was from the Austral Islands, far to the southwest of Tahiti, where an age-old Polynesian custom was followed with particular diligence. As far back as the 18th century, she told me, there was fear of inbreeding, and



Close encounters: Visitors at the Lagoonarium on Bora-Bora share a fenced pool with turtles, rays, and more than a dozen blacktip sharks. Fed amply and often by

caretakers, the nonchalant sharks help dispel irrational fears. "It's a great way to demythologize these animals," says one swimmer.

so whenever a foreigner would arrive, he was offered a woman—usually a chief's wife or daughter—in hopes of adding new blood to the community.

Heiata knew her parents, of course, and her grandparents, but beyond that generation she had no idea of her ancestry. She had French blood, she thought, and possibly German, and her dark eyes may have come from a Jewish forebear who was seduced sometime in the 19th century.

It is generally held that fewer than 20 percent of the people throughout the islands have pure Polynesian ancestry, and that number drops every year. Often within families, siblings bear no resemblance to one another, as different genes dominate from child to child. My guide, Joel Hart—an affable bear of a man wont to weigh himself on airport luggage scales in search of a sympathetic reading of less than 265 pounds—was the product of parents who were English, Polynesian, and German. He married a Chinese woman, and their four children look as if each came from a different continent.

A delightful consequence of this ethnic olio is that French Polynesia is almost completely free of racism. There are island rivalries, naturally, because human beings are compelled to feel superior to somebody. Society Islanders purvey jokes about dummies from the Tuamotus; residents of Maupiti are derided as drunks, Rurutuans from the Australs as yokels, Marquesans as pugnacious thugs. But bloodlines and skin color are never an issue.

What is an issue, however, is the Tahitians' unanimously held perception—nay, conviction—that they are treated as second-class citizens in their own land, that in everything from jobs to permits to opportunity and

Chanted harmonies and scented coconut oil prepare a guest for a Tahitian-style marriage rite at Tiki Village, on Moorea, where native culture is packaged for tourist consumption. With tourism now its main hope for economic self-reliance, French Polynesia must nearly triple its 170,000 visitors a year. One tactic: Attract some of the seven million vacationers Hawaii hosts annually.

income, French people are given preference over Polynesians, that the government in Paris has imposed not only its will but also its culture upon a people whose sophisticated civilization was flourishing in these islands long before there was a France.

A FEW MILES OUTSIDE PAPEETE is a complex of low buildings that houses the country's only comprehensive collection of cultural artifacts: the Museum of Tahiti and Its Islands. I had heard that its archaeologist, Raymond Teriieroo Graffe, was a dedicated guardian of Polynesia's past, and I drove out to see him.

Bearded and densely tattooed, Raymond has an advanced degree in archaeology from the Sorbonne. He spent his early years working as an interpreter. Then, as he saw new generations arising in utter ignorance of their culture, he became a crusader for its preservation and its renaissance.

"The Europeans claim they discovered Polynesia," he said, sitting in his simple office, clad only in a wraparound skirt. "But by the time the English arrived in 1767, we had been here for 2,000 years." He laughed. "I think a good question is, who discovered whom?"

The museum, Raymond said, had another name, which he preferred. "*Our* name for it is the 'cave with many mouths talking' because it tells the tales of Polynesia and its people."

Those tales include feats of open-ocean navigation never since duplicated and still not fully understood by modern man. The earliest settlers, who arrived at about the time of Christ, are generally thought to have come from Southeast Asia, and somehow they made their way across thousands of miles of trackless sea, guided by stars and currents and clouds and birds. From Raiatea, seven fabled canoes set out to colonize what became known as the Polynesian triangle, marked by Hawaii in the north, New Zealand in the south, and Easter Island in the east, a realm said to belong to the great god Oro.

Because in Raymond's childhood it was forbidden to speak Tahitian, he learned the language on the sly. Now he is a member of a commission charged with revising the language to keep pace with the modern world. Tahitian has only 13 letters and relies heavily on tone and inflection, so the task involves combining existing words in ways that create new concepts. The Tahitian word for "computer," for instance, translates literally as "the machine with the electronic brain."

Raymond struggles to keep Tahitian culture alive in other ways too. For the past 15 years he has studied Polynesian tattoos, and the ones that adorn his body tell two stories: the history of Polynesia and his own journey as a man. "These triangles," he said, pointing to his torso, "represent the triangle of all Polynesia. The designs on my ears signify royal descent. I am of the Pomares."

I noticed that the fingers on his left hand were tattooed while his right hand was bare.

"I lost my wife in 1991," he explained. "These are the tikis of mourning. In the old days, through a man's tattoos you could read his life, where he came from, what he had

been through. They are not just decorations."

Nowadays, more and more young people are visiting traditional tattoo artists and having themselves adorned with symbols of their culture, which pleases Raymond. "The more people take pride in their culture," he said, "the more they will want independence."

If INDEPENDENCE seemed to dominate most conversations in Tahiti, the farther afield I roamed the more it faded into the background. On some islands other issues were more pressing.

Ten miles northwest of Tahiti, a 20-minute hovercraft-ferry ride across the Sea of the Moon, lies Moorea, the island Michener described as too beautiful to describe. One of the high islands, like Tahiti, with verdant mountains soaring steeply from the sea, Moorea is suffering from rampant development. Land prices had soared to 20,000 francs per square meter (roughly $800,000 an acre) as Tahitians fled the congestion, crime, and pollution of Papeete for what was fast becoming the capital's primary suburb. Locals were fighting a developer's plans to build yet another huge tourist hotel.

Scientists at a Moorea research station were deeply concerned about the increase in coral bleaching throughout the region. Caused by a rise in water temperature, bleaching is a stress reaction that can presage the death of coral reefs. Without the protection of the surrounding reefs, many of the islands of Polynesia would disappear.

In Bora-Bora, the picture-postcard tropical paradise with its crystalline lagoon surrounding cloud-covered volcanic peaks, overdevelopment was causing severe economic angst. Too many hotels with too many rooms were squabbling over too few tourists. Prices were dropping, employees were being laid off, unemployment was rising, and municipal services were vanishing. The public wharf, built to be the gateway to Bora-Bora's earthly delights, had been vandalized into a shambles; visitors were greeted not by strolling musicians but by broken glass and graffiti.

On other islands technology was threatening traditions and altering people's relationship with the sea. Fishing, which for millennia had been a prime source of jobs, food, and revenue, was under severe stress. As is the case in much of the world, skyrocketing demand and new, efficient locating and harvesting gear have damaged fish stocks, inshore and off. The high cost of boats and fuel has forced many independent fishermen out of business.

Metal roofs have replaced palm thatch, but Laundromats have yet to appear in the Marquesas, French Polynesia's most remote and disadvantaged archipelago. Material expectations will rise, however, now that islanders have a new window on the world: satellite television. "Now our young people want the same things as young people everywhere," complains a local official. "So they leave."

But, as if in confirmation of the myth of Eden, as one resource has diminished, another has sprung up. Over the past decade a small private industry has grown to a point where it is now the third largest money machine in the colony, behind only French largesse and tourism: the seeding, growing, harvesting, polishing, mounting, exporting, and retailing of black pearls. Also known as South Sea pearls, in 1996 these exquisite fruits of the sea provided the islands with 5,000 jobs and 140 million dollars in revenue (see following article).

There are 500 pearl farms in all of Polynesia; some are tiny one-man operations tucked into remote lagoons. But fully half

of all the pearls produced come from eight farms in three lagoons owned by one man, Robert Wan, the founder, chief, and presiding genius of Tahiti Perles.

Two of Mr. Wan's lagoons are in the Tuamotus—Nengonengo and Marutea—and the third is on Mangareva in the Gambiers. He invited photographer David Doubilet and me to Marutea to see how pearls are born.

We flew in one of the three large planes Mr. Wan maintains to ferry his pearls and his 400 workers back and forth between Tahiti and his atolls. After a three-hour flight we arrived at Marutea. From the air it looked barren and barely inhabited. Like most of the low islands of Polynesia, it is 95 percent water, 5 percent land—a ring of sand and coral enclosing a lagoon. A few white buildings stood amid sheltering palms in two small communities on opposite sides of the tranquil lagoon.

Mr. Wan greeted us at the airstrip. Fit and amiable, he shepherded us toward the dock and explained that the image of tranquillity was somewhat illusory. Beneath the placid blue waters of the lagoon, man and nature were busy collaborating to create beauty. Millions of black-lipped oysters hung in mesh panels, nourished by tidal flow, the pearls within growing microscopically every day.

While David prepared his camera gear for a dive, Mr. Wan took me into the sorting room, where scores of trays held countless pearls—so many that they looked like mammoth servings of Brobdingnagian caviar. I had heard that "black pearl" was a misnomer, and now I saw why. Not one of them was truly black. Some were gray, some purplish; some tended toward green, some toward a champagne yellow. And some, when Mr. Wan held them to the light, gave off a rainbow luster.

Parisians escape to Tahiti. Tahitians escape to neighboring Moorea, whose shark-toothed volcanic skyline and quieter living beckon just across the Sea

of the Moon. Yet like other suburbs where serenity forever moves one more exit from town, Moorea is suffering growing pains.

"Now look," Mr. Wan said with a smile. He reached for a small plastic bag and poured into my palm a single pearl—perfectly round, richly, lustrously hued, and the size of a cherry. "You're holding in your hand the largest round black pearl in the world."

It had just come from one of his lagoons and was a total surprise. No one, he explained, had ever cultured a black pearl that large. "So many things have to go right: the nucleus, the grafting of the nucleus into the oyster, the growing. And then, month after month, to have layer after layer be perfect!"

The pearl weighed almost half an ounce and measured 21 millimeters—nearly an inch—in diameter. So rare was the pearl that it had been given a name: the Robert Wan.

Before I left Marutea, I told Mr. Wan that I had heard his business was so successful that his three islands could survive on their own as an independent country. Since many people on other islands had been lobbying to secede from France, I wondered if he harbored any such ambitions.

"Never," he insisted. "I'm Tahitian. We're Tahitian. And as for independence for Tahiti, it would be a disaster. How would we survive? Who would pay to educate our children, care for our sick, pave our roads?"

But France, I reminded him, had declared its intention to withdraw its financing. What would save Tahiti when the well of French wealth ran dry?

"Tourism can save us," he said. "It's the only thing. If we got 500,000 tourists a year, we could make it on our own."

I had heard the same promise from High Commissioner Paul Roncière, but I was skeptical. Half a million visitors a year, an average of 10,000 a week, would nearly triple current

Whetting knives and appetites, Marquesan fishermen indulge their taste for fresh tuna. Unlike many Tahitians who yearn to break with France, most Marquesans feel greater loyalty to Paris than to Papeete. "France is a solid partner, a strong ally," says one loyalist. "We don't have the resources to stand on our own."

figures. True, that would still be only about 7 percent of the number of tourists who inundate Hawaii, but wouldn't their presence alter the very nature of the place they had traveled so far to enjoy?

ONE ATOLL in the northern Tuamotus beckons scuba divers from around the world: Rangiroa, whose lagoon, 48 miles long by 15 wide, is the second largest on earth (only Kwajalein in the Marshall Islands is bigger). All Tahiti could fit within it, and it is its own world, fed by the ocean but distinct from it, with its own ecosystem and its own rhythms.

The atoll is a necklace of 240 motus—islets more or less connected around the lagoon. Only two passes are open to the ocean, and the rush of water in and out of the immense lagoon can give a diver the ride of his life.

Tiputa Pass, the steeper of the two, cuts the low landmass in a slice about 440 yards wide, and as David Doubilet, diving instructor Yves Lefèvre, and I approached in our inflatable boat, the rushing water tossed seas that towered over us. When we were a few hundred feet outside the pass, the boatman put the motor in neutral. David hefted two cameras; I carried a third; Yves took a fourth. In his other hand Yves carried a covered bucket of stinking fish.

"Follow me," Yves said, "as fast as you can. Ready? Go!"

At once we flung ourselves backward off the sides of the inflatable. Before we could clear our masks, gray reef sharks were on us—quick, curious, unafraid, darting around us like a pack of wild dogs.

Yves held the bucket of fish to his chest and kicked as hard as he could for the bottom—a dim gray mountainside that loomed below. As we followed him down into the gloom, I glimpsed schools of jacks and barracuda. In the deepening darkness the sharks that cruised beside us became ghostly outriders.

At 115 feet Yves ducked under an overhang—a small cave barely big enough for the three of us but fine protection on three sides. Here we could not be blindsided by any shark whose inquisitiveness crossed the line to aggression. By now, leakage from the bucket had released a spoor, and sharks in numbers beyond counting circled before the cave, waiting.

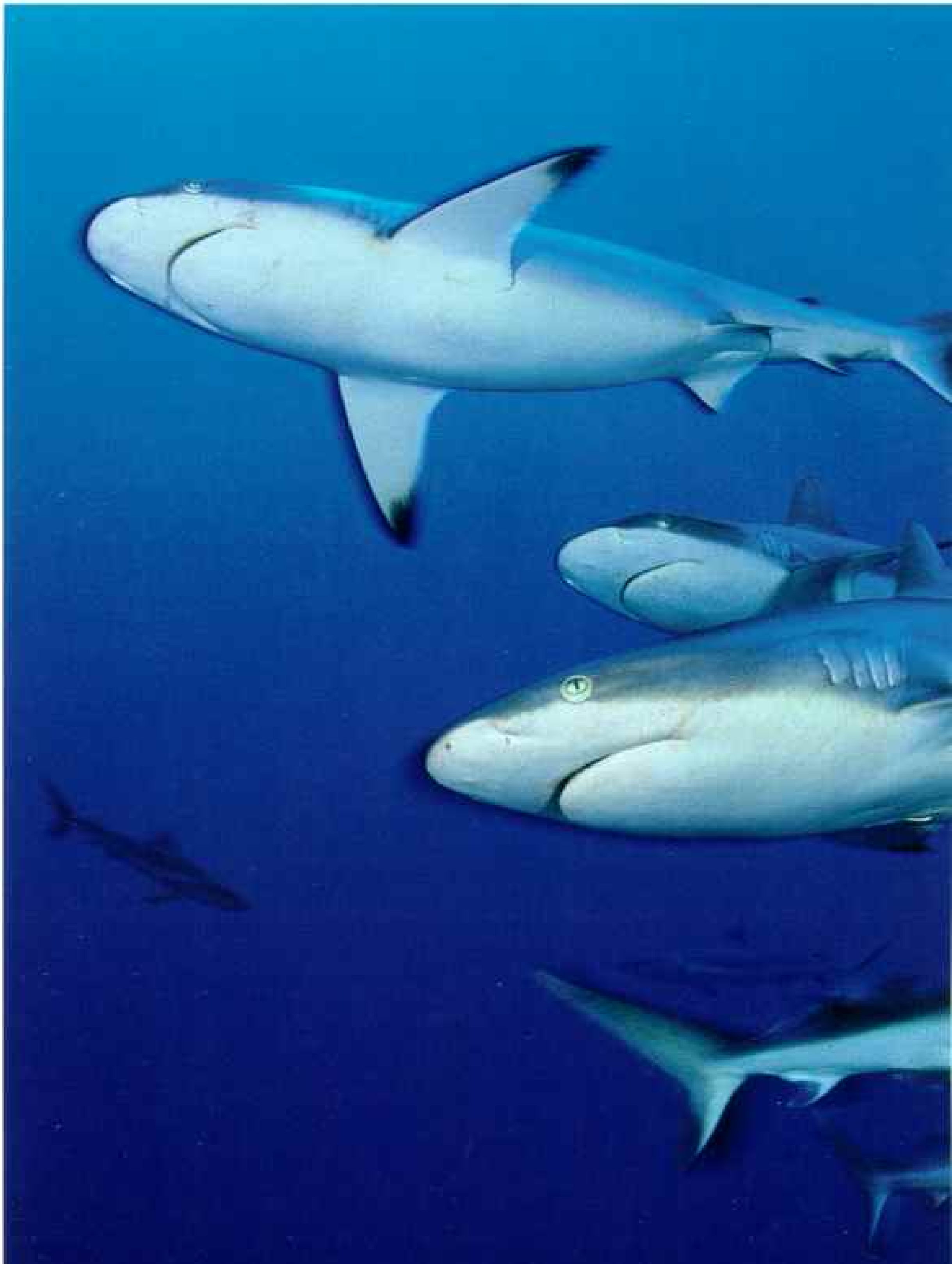
When David's cameras were ready, he signaled Yves. Yves pushed the bucket of fish a few feet out of the cave, checked behind him to make sure no sharks were waiting in ambush, and yanked the top off the bucket.

The ocean exploded.

Sharks swarmed like enraged bees—dozens of them, scores perhaps—snapping and biting and twisting and tearing, their bodies torqued in impossible contortions, their motile jaws extended, their eyes partly covered by nictitating membranes that gave them the look of murderous cats. They were a tightly wrapped ball of frenzy.

The bucket rose up in the water and spun, throwing off a cloud of blood. Sharks charged it, and it disappeared in a flurry of bodies.

A shark grabbed one of David's strobes and worried it, as a dog worries a bone. Another shark opened its mouth, turned toward me,



Lured heart-stoppingly close by the scent of bait, gray reef sharks—as well as tiger, mako, blacktip, and others—are themselves the lures that draw divers to the

sapphire lagoon of Rangiroa in the Tuamotus. Sharks by the hundreds gather along a narrow gap in the reef for twice-daily banquets delivered by the tides.

and lunged, trying to force its way between David and me. I struck it with the heel of my hand, and it sped away.

And then it was over. In an instant they were gone. A few lingered in the distance, calmly resuming their routine patrol.

The bucket, scratched and torn, rolled lazily on a bed of coral. Yves fetched it, and on his signal we pushed off. The current grabbed us and shoved us along like a hurricane wind. We were helpless, creatures of the current, unable to stop, change direction, or go back.

I checked my dive computer and saw it flashing at me: "Decompress!" it fairly shouted. "Decompress! Decompress!"

We had stayed too long, too deep.

I waved to get Yves's attention and pointed at my computer. He made the OK sign.

Swell, I thought, it's OK with him.

What was OK with him? That we were all doomed to die? That the best we could hope for was to survive as gnarled as a pretzel from the dreaded bends?

But Yves had been here before. As we rode the current into the pass, he knew to rise gradually . . . first to 80 feet, then to 60, 40, 20. Now the messages flashed on my computer were less frantic, merely urging me to spend some quality time at 10 feet if I ever wanted to see my children again.

Polynesian dancer John Taha embodies the romance of Tahiti for American writer Kate Hall, whose grandfather James Norman Hall co-authored the 1932 South Seas classic, Mutiny on the Bounty. *As French Polynesia explores a new chapter in its history, the question now becomes: Will its native people win back the freedom to write their own story?*

WHEN AT LAST WE were safely in the boat—alive, unbitten, and unbent—I looked back at the boisterous sea churning in the pass and thought of a sailor who had taken a similar trip more than two centuries ago.

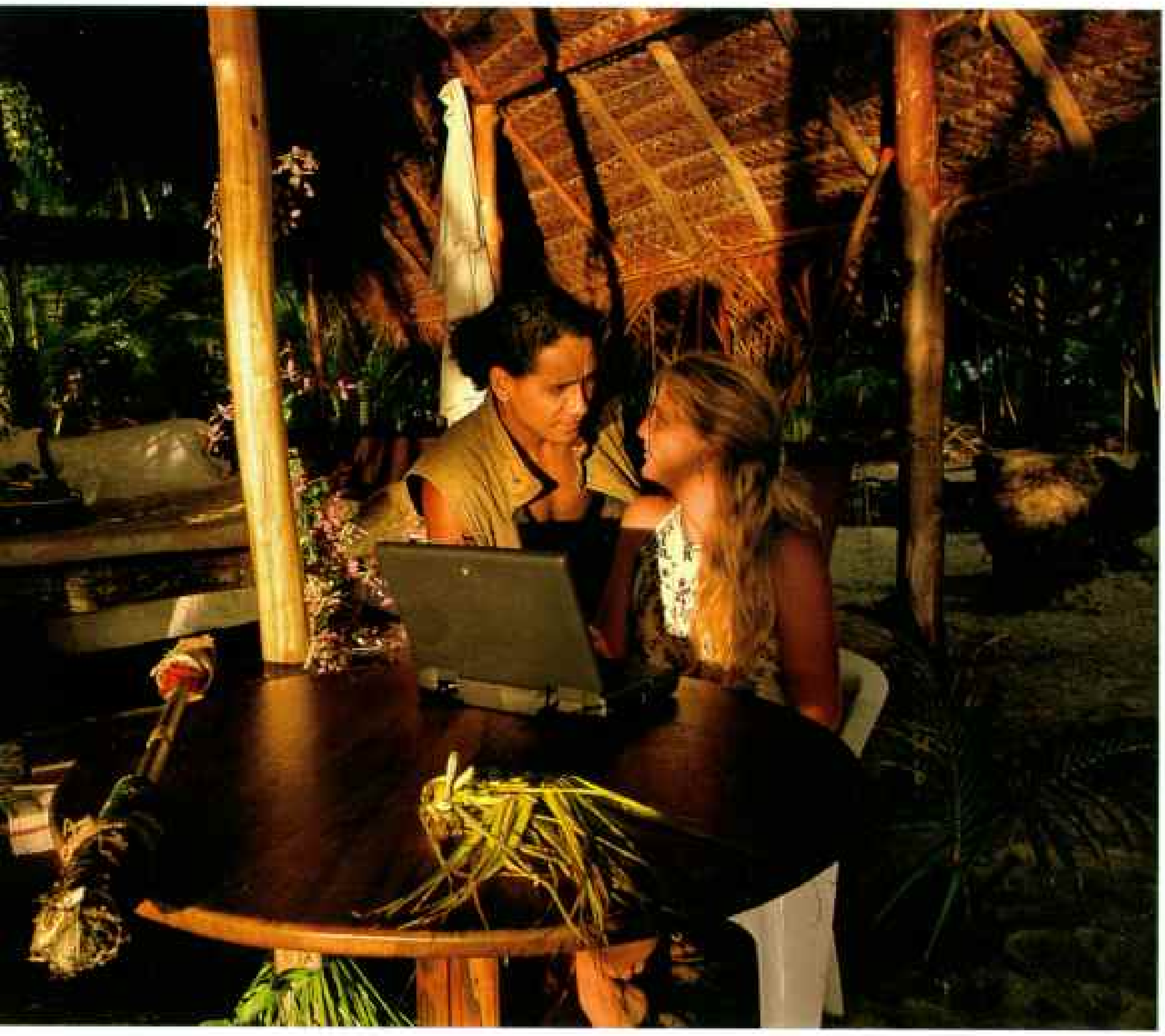
On Captain James Cook's third voyage to the South Seas in 1777, one of Cook's midshipmen, James Trevenen, had been ordered to navigate a pass into a lagoon. The pass was narrow, the sea was rough, the water was shallow, the bottom was rocky. But what really bothered Trevenen was . . . well, let him tell it.

"On every side of us," he wrote in his journal, "swam sharks innumerable, and so voracious that they bit our oars and rudder, and I actually stuck my hanger [saber] into the back of one while he had the rudder in his teeth."

Although the voyages of Captain Cook and his predecessor, Samuel Wallis, had effects on Polynesia more cataclysmic and long lasting than any event before or since, few artifacts are left to remind you that the explorers ever set foot on the islands. On Tahiti's Point Venus, named for Cook's observation of the transit of the planet in June of 1769, there is a stone memorial . . . unimpressive, ill cared for, and inaccurately placed. Otherwise, the only echoes of Cook's momentous visits are the names of bays and points of land that he and his crew bestowed on these exotic shores.

"There's no history left," Nancy Hall Rutgers told me one day as we stood on her patio overlooking Matavai Bay in Tahiti, where Cook first landed and the *Bounty* later anchored. "It's all gone. There's the Gauguin Museum and a statue of [French novelist] Pierre Loti somewhere, but that's it. No history!"

More than most, Nancy knows the shame of the obliteration of Polynesia's history, for she is a living legacy of Tahiti's past. She is the



daughter of a half-Tahitian mother and an American father who spent his most productive years—and died and is buried—in Tahiti: James Norman Hall, co-author of the *Bounty* trilogy (*Mutiny on the Bounty*, *Men Against the Sea*, and *Pitcairn's Island*) and other novels.

For a decade Nancy and her husband, Nick, encouraged— implored— the government in Papeete to fulfill a legislative mandate and restore her father's classic colonial house on the waterfront in Arue as a museum. The government has finally agreed, but for years the house sat vandalized, trashed, painted with obscene and satanic graffiti—a sad relic of gentler times.

"It makes my heart sick," Nancy said, "to know that Tahiti . . . *my* Tahiti . . . is gone."

But is it gone? Or is it, as many people believe (and I am one), merely in transition? It has endured, after all, for more than two millennia, through wars, conquest, disease, and the onslaught of modern civilization.

On my last day in the hills over Matavai Bay, I awoke, as always, to raucous cockcrow and watched the sunrise tint the sky pink over Point Venus. Then I turned, as always, to the west, to the gray-green silhouette of Moorea. As the first rays of the dawn sun struck the spume of Moorea's reef, a rainbow formed in halo over the Sea of the Moon. As always.

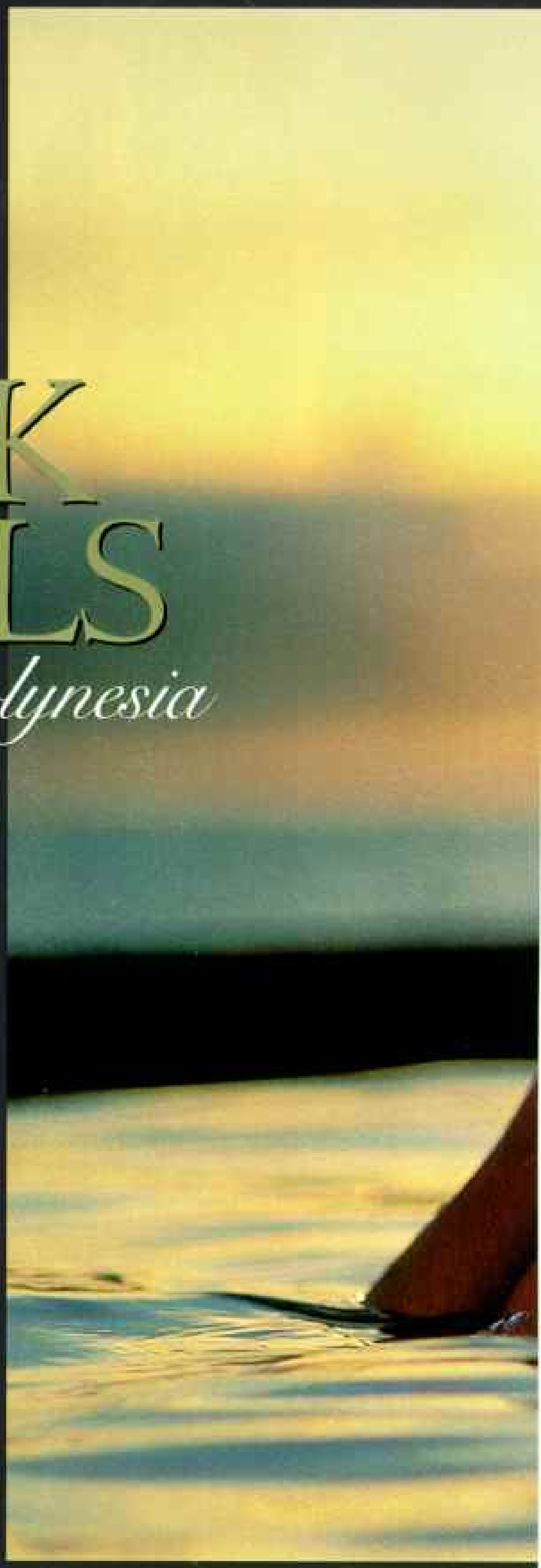
It lasted only a moment, an evanescent thing, but reliable.

I recalled something written by Charles Clerke, Captain Cook's favorite lieutenant, on his departure from Polynesia, and decided to adopt it as my own: " 'Tis with some reluctance I bid adieu to these happy isles, where I've spent very many happy days. . . . In short, in my opinion, they are as pleasant and happy spots as the world contains." □

BLACK PEARLS
of French Polynesia

Awash in a Tahitian evening, Heiata Roomataroa seems lost in a trance of pearls and golden light. Luminous against her skin, her necklace—two strands of black pearls worth two hundred thousand dollars—holds and reflects the magic of the Polynesian seas. Such pearls are not accidental gifts from the sea. They are the product of a complicated partnership between humans and oysters, spawned in azure lagoons amid the distant atolls of the South Pacific.

ARTICLE AND
PHOTOGRAPHS BY
DAVID DOUBILET



Roused by the whine of aircraft engines, I awake to a dream beneath my wing: The Tuamotu Archipelago is strewn across the empty sea like a string of bright pearls. They are atolls, coral crowns on the rims of ancient volcanoes outlined in breaking surf (opposite).

The Tuamotus are made up of two mountainous islands and 76 atolls. Each atoll traps and holds a piece of ocean, a lagoon that acts like a giant soup tureen for plankton. The lagoons also protect and nourish *Pinctada margaritifera*, the black-lipped pearl oyster.

I'm flying to meet a man known in this part of the world as the King of Pearls, Robert Wan. His company, Tahiti Perles, is by far the largest producer of pearls in French Polynesia. Scattered across the Tuamotus, his pearl farms are perhaps the best place on earth to see the intricate process of culturing pearls.

We land on the island of Marutea after a three-hour, 950-mile flight from Tahiti. It is noon, and the light is painfully white. There to meet me is the King of Pearls himself, a quiet, courteous man in a T-shirt, khaki shorts, and rubber thong sandals.

"End of the world," he laughs. "Everything from generators to soy sauce has to be brought in." Later, as he guides me through his farms, we talk of pearls.

"This black pearl oyster of ours," he says, "is four times the size of the Japanese *akoya* pearl oyster, which produces most of the pearls in the world."

Black pearls are rarer, thicker, and bigger, he tells me. They are also richer in orient, the reflection of light beneath the surface of the pearl. And then there are the colors (above)—silver gray, obsidian—sometimes even white. "The green ones," he beams, "peacocks I call them—we raised in the cooler waters of the Gambier Islands south of here."

In his lagoons the oysters act as barometers, registering the health of their environment. When the lagoon declines, so do the oysters; they require temperatures of about 75°F and clear, unpolluted water.

Most Japanese oysters are maricultured, Wan tells me, born in a hatchery where egg and sperm are artificially combined. But here in the Tuamotus, the lagoon is the true parent of the oysters, which spawn naturally.

The egg and sperm drift as the lagoon rises and falls with the tide, then combine to produce a larva. This is *French* Polynesia, after all, where even oysters begin life with a touch of romance.

At the turn of the century the pearl fisheries of Polynesia harvested oysters just for the iridescent inner shell, mother-of-pearl for the world's buttons. Back then a pearl was an exotic windfall. Today nearly every pearl on the world market is cultured, grown by man.

At another of Wan's farms, I marveled at the pearl farmers' ingenuity. They use plastic garlands suspended in the lagoon to provide an anchorage for the drifting pinhead-size larvae. In a few months each garland is choked with little oysters (bottom far left), which soon grow to the size of silver dollars. At six months the oysters are placed in hanging baskets (left), where they grow for another year and a half.

Then the oysters are removed and wedged open, one by one. With surgical precision, grafting operator Tsunoda Kunitoshi (bottom center) makes a slit with a scalpel near the oyster's gonad and inserts a snippet of mantle tissue, followed by a nucleus (bottom right) —a bead carved from the shell of an American freshwater mussel.

The mantle tissue forms a sac where nacre—the pearlescent substance that coats the nucleus to form a pearl—is generated.

After surgery the oysters are returned to the lagoon. In three years the pearls will be ready to harvest.

The May harvest is over, and Robert Wan appraises the results—thousands of gleaming black pearls in his sorting room on Marutea, each plucked from the maw of an oyster (left).

They will be graded for

quality, then sold in the United States, Europe, and Japan. In 1996 French Polynesia exported a million pearls, worth 140 million dollars. More than half came from Wan's operation. The rest came from 500 other farms throughout Polynesia. Some farms are large, but many are little more than a boat, a few lines of oysters, a scuba tank, a shed, maybe a dog.

"Look at this," says the King of Pearls, setting one next to his glasses (above). "Our biggest round pearl, 21 millimeters. From our farm on Nengonengo." He smiles, and I see the dream reflected in his eyes: atolls of pearls, shining in the bright Pacific. □

DAVID DOUBILET made his first underwater photographs off the New Jersey shore at age 12. In his 42 GEOGRAPHIC stories he has covered the world's major seas.

to her own element, with
her bottom, who forked up
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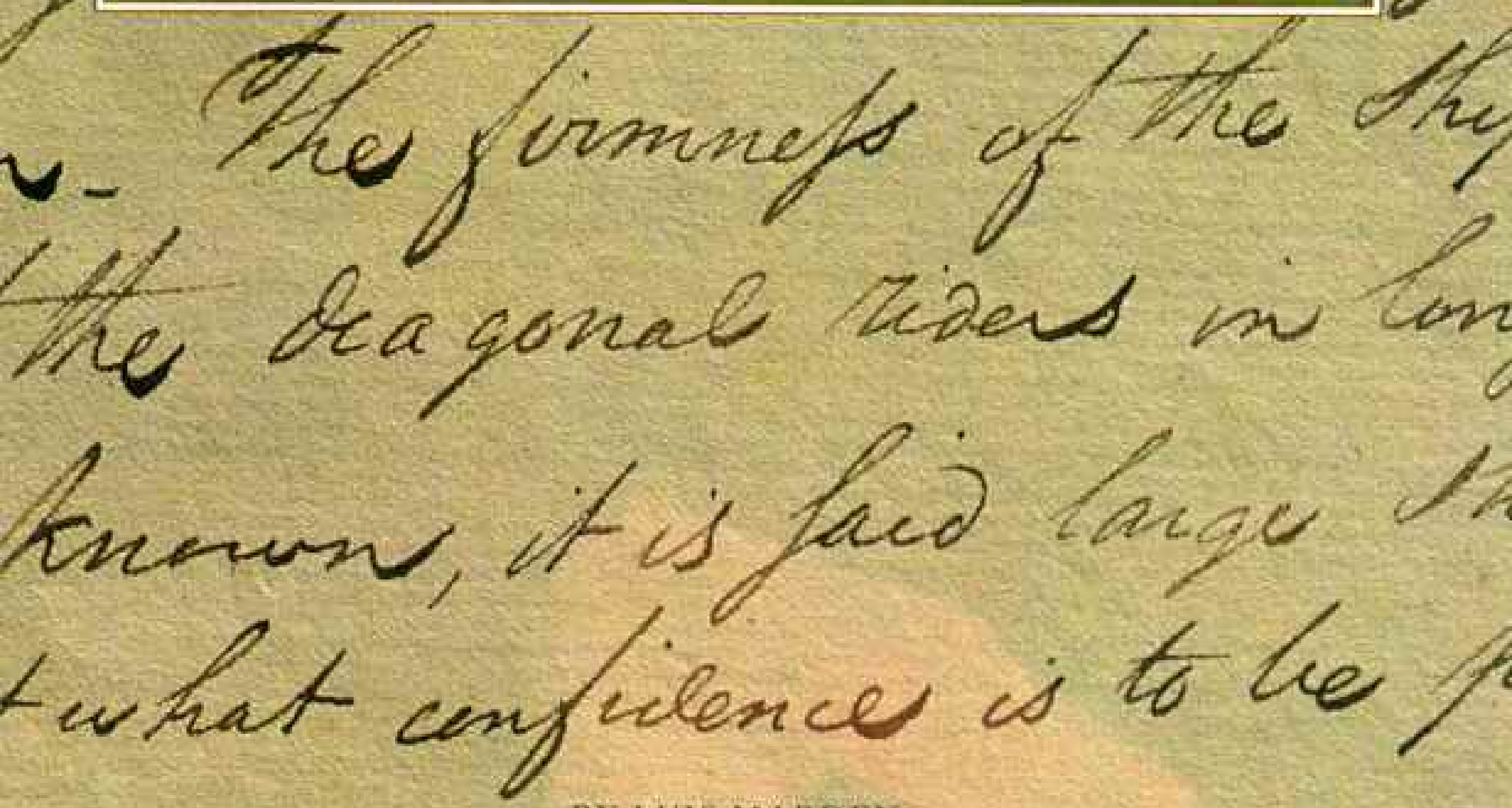
Restoring OLD IRONSIDES



BY LUIS MARDEN

PHOTOGRAPHS BY MARIA STENZEL

She was the pride of the nation's young Navy, and what she could not outgun, she could outrun. In the War of 1812 her captain kedged her away from becalmed British warships (left) to make an escape. When the U.S.S. Constitution *entered a four-year restoration in 1992, her designer's journal (background) provided clues to original construction details, such as structural members called diagonal riders.*

THE TIMES OF LONDON was annoyed.

"It is not merely that an English frigate has been taken . . . but that it has been taken by a new enemy, an enemy unaccustomed to such triumphs, and likely to be rendered insolent and confident by them. . . . Never before in the history of the world did an English frigate strike to an American."

The Royal Navy was unused to striking its colors to anyone or, since Trafalgar, sharing its insolence and confidence. It was the summer of 1812, and the upstarts across the Atlantic, with an infant navy one-fortieth the size of Britain's, had done the unthinkable, vanquished and sunk the *Guerrière*, a warship of the Mistress of the Seas. *The Times* had dismissed the young nation's few ships as a "Bastard Navy." But one British sailor, though he did not live to see his foreboding come true, had thought otherwise. Years earlier he had said: "I see trouble for Britain in those big frigates from across the sea." The sailor's name: Horatio Nelson.

The vessel that had done the impossible, U.S.S. *Constitution*, was a technical triumph far ahead of her time. Today the gallant frigate, the world's oldest commissioned warship remaining afloat, is preserved in a national historical park at the old Boston Navy Yard, just 700 yards from where she first slid into the sea in 1797. I know her well, as I was born almost within sight of her berth, and some of my earliest memories recall her masts and rigging rising above the gray granite walls of the navy yard. Together with other children across the country, I had contributed hoarded pennies to her restoration.

About once a generation *Constitution* undergoes an overhaul, and in the autumn of 1992 she entered dry dock for inspection and repairs. There she remained until September 1995, when, restored more closely than ever before to her original state, she once again took her pierside berth to receive the admiration and affection of all Americans.

At sundown Old Glory is lowered aboard ship by the active duty Navy crew assigned to Constitution. *True to the ship's restoration to her 1812 form, the flag bears 15 stars and 15 stripes. During the War of 1812 a dozen enemy vessels lowered their own ensign in surrender to her.*

The War of 1812 has been called the most unpopular war—including Vietnam—that the United States has ever fought. Britain had been fighting or containing Napoleon for 20 years, and her 850-ship navy was spread thin and consumed able-bodied men. The Royal Navy had provoked Yankee anger by boarding American vessels at sea and pressing into its own service British deserters, but they frequently also seized seamanly-looking Americans. The United States, for its part, had imposed repeated embargoes on trade with the French and British belligerents, arousing the ire of New England shipmasters and merchants. The American battle cry became: "Free trade and sailors' rights."

In 1794 President George Washington had given his assent to Congress's "laying the foundation of our infant navy" by building six frigates, principally to protect American shipping from the depredations of the Barbary corsairs. Experienced naval captains specified that those

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During his 42-year career as a NATIONAL GEOGRAPHIC writer and photographer, LUIS MARDEN found the remains of the *Bounty* off Pitcairn Island, discovered a new species of orchid, and pioneered underwater color photography. MARIA STENZEL, a native of Plymouth, Massachusetts, has covered subjects ranging from Walt Whitman to Antarctic ice for the magazine.

first six frigates were to be built of "the most durable wood in the world (the live oak of Georgia)." Two hundred years later much of that live oak is still soundly in place.

If America's timber was extraordinary, so were her frigates. Like the great ships of the line, frigates were rigged with square sails on all three masts, but they were smaller, lighter, and faster. In the age of fighting sail, ships of the line with three tiers of guns engaged the foe by sailing parallel to the enemy line, firing broadside after broadside at each other. These unwieldy gun platforms, carrying 74, 90, or more than 100 guns, were slow to turn and maneuver but were nearly invincible to smaller ships.

Frigates, on the other hand, had only one gun deck. They served as fast cruisers, operating alone or in pairs on search-and-destroy missions. If they encountered big ships of the line, their only hope was to take to their heels.

The design of the frigates had been entrusted to a Philadelphian, Joshua Humphreys, who, though a Quaker, had no qualms about designing ships of war for his country. He knew his newly fledged nation could not afford to build battleships. He and the planners reasoned: Why not make a frigate as big and as strong but with finer underwater lines to give her speed. Her large size, bigger than any other frigates in the world, would enable her to carry heavier armament to overpower standard frigates, yet she would be fleet enough to escape from adversaries with superior firepower.

A frigate normally carried a single tier of guns on its one gun deck, with a few pieces mounted on the open upper deck, for a total of 24 to 40 guns firing a 12- or 18-pound ball. Humphreys's superfrigates shot a 24- or 32-pound ball. Though designed as a 44, *Constitution* usually mounted more than 50 guns, some on an upper deck made flush so that, in effect, she had two gun decks, both high enough so that they could be used in all weathers. In heavy seas, ships of the line with three tiers of

Taking over from tugs (above right), dockhands haul lines to maneuver Constitution *into the John Quincy Adams Dry Dock at the Charlestown Navy Yard in Boston. As water drains away (above), the frigate's underbody is revealed. Sleekness below the waterline gave the ship legendary speed and advantage over her*

guns had to close the gunports on the lowest deck so the ship would not take on water.

Constitution is 204 feet long and just under 175 feet on the water. In ships, length at the waterline determines speed. A long ship will cut through the hills and straddle the valleys of the waves, while a small vessel slides down into the troughs and labors up the crests.

Late one Friday in September 1992, as the last water drained from the granite basin of No. 1 dry dock, Comdr. Richard B. Amirault, USN, 63rd commanding officer of U.S.S. *Constitution*, was the first to walk under the full length of the ship as she rested high on her keel blocks. "Ever since I took command," he told me later, "I have wanted to touch the original wood of the keel. How sleek she looked! When I saw the true shape of the ship's slender underbody, I thought: No wonder she was so fast."

Eighteenth-century and earlier shipbuilders designed vessels that were full and rounded in the bows and ran aft to a tapering stern—cod's head and mackerel's tail, the saying went. Joshua Humphreys, working from a half model, a hull sliced lengthwise, fined his bows and ran all lines aft in smoothly sweeping curves, fairing and blending until all was eyesweet.

Constitution spread nearly an acre of sail, which—it seems incredible today—her crew of some 450 could set in minutes. This cloud of canvas could drive the superfrigate at 14 knots, 16 miles an hour, a remarkable speed for a sailing warship.

Such a hull and such sails enabled Consti, as her crew called her, to outsail the enemy.

CRAIG MAPP

enemies. "Our challenge is to bring this ship back to life," says commanding officer Michael Beck. "She's more than a museum. She's a symbol of the nation." Constitution, *the world's oldest commissioned warship still afloat, was the first vessel to undergo repairs and refit when the dry dock opened in 1833.*

Once, when closely chased for 60 hours by five British ships, one a fast battleship, she eluded them all and sailed away to safety.

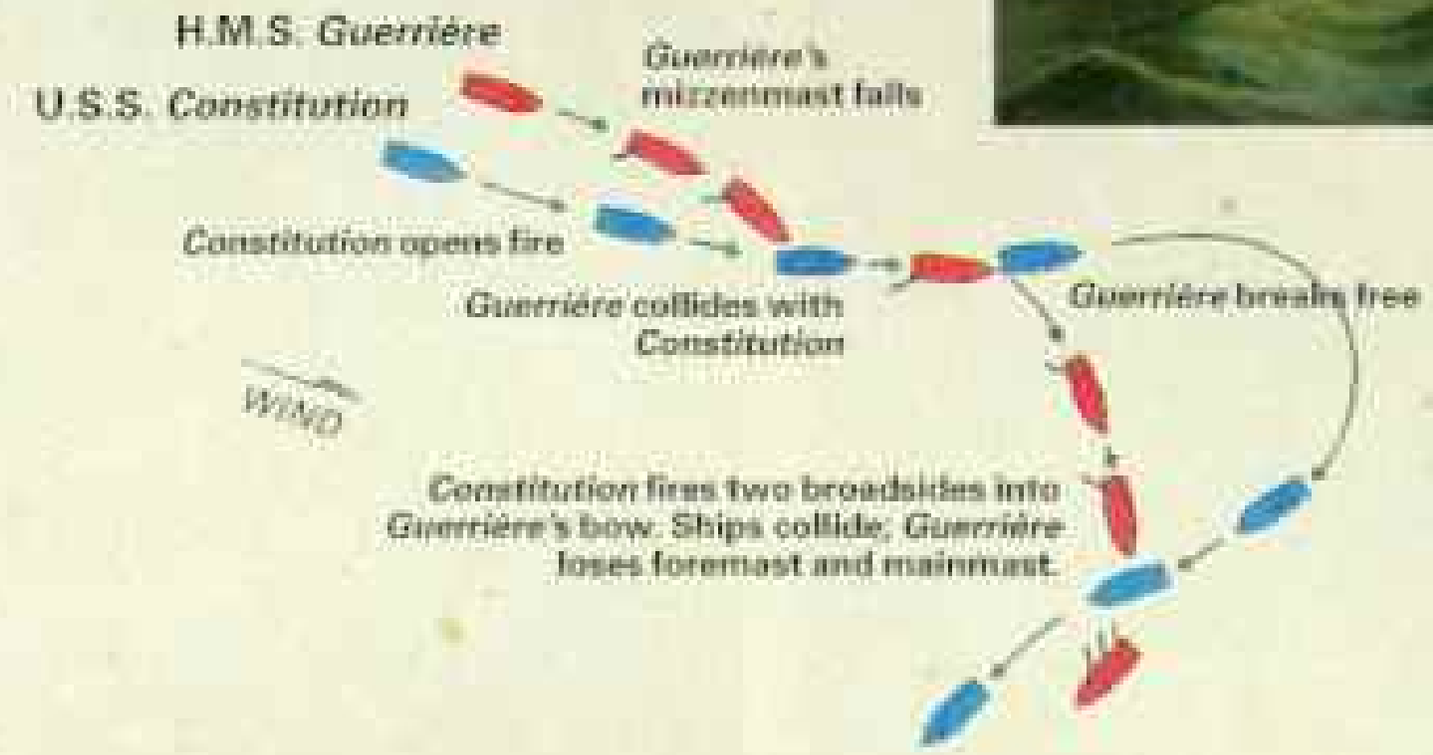
A wooden ship, like a living vertebrate, is built around a backbone and ribs. The backbone is the keel, the long scarfed timber running from stem to stern, and the ribs are the frames, like upturned curled fingers, rising from each side of the keel. Planking outside the ribs forms the shell of the ship, and a second layer of planking lines the inside of the frames. In ships of war the thickness of these wooden members would be particularly robust to resist shot, and Joshua Humphreys spaced the heavy frames of his superfrigates so close together that they seemed almost solid. In *Constitution* and her sister ships the wide and thick ribs were about an inch apart. Living on a continent with an east coast still virtually one unbroken forest, American shipwrights could afford to be lavish with timber.

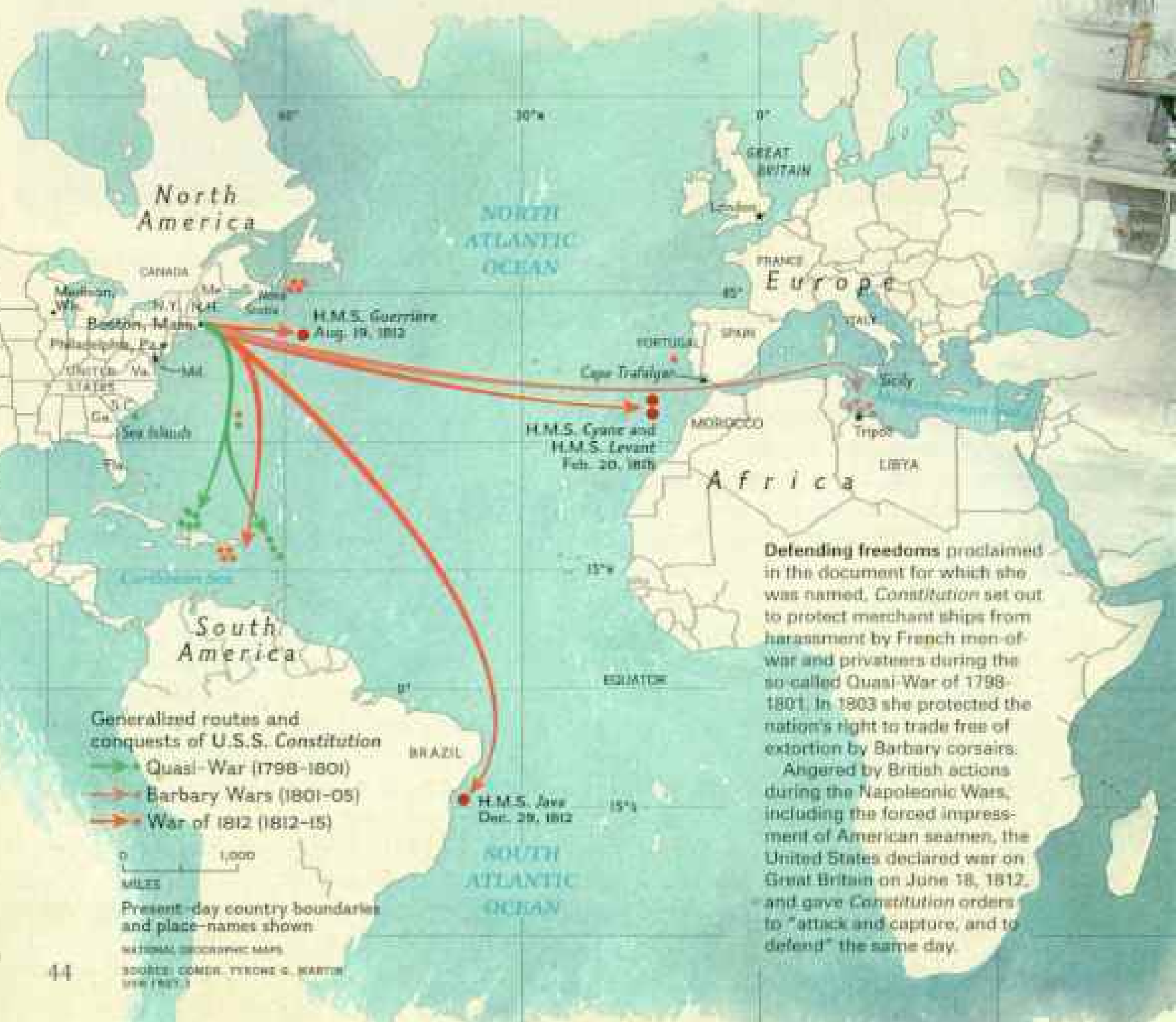
WHEN PATRICK O'BRIAN, the eminent novelist and authority on fighting sail, visited *Constitution* in November of 1993, I heard her executive officer point out the thickness of her sides, two to three feet of oaken sandwich. He mentioned that her sailors, seeing cannonballs rebound from her hull during the engagement with the British frigate *Guerrière*, cried "Huzzah! Her sides are made of iron!" "Discouraging," said Mr. O'Brian, who writes from the British point of view.

I asked the *(Continued on page 48)*

PAINTINGS BY MICHELE FELICE CORNE, 1812. © NEW HAVEN COLONY HISTORICAL SOCIETY

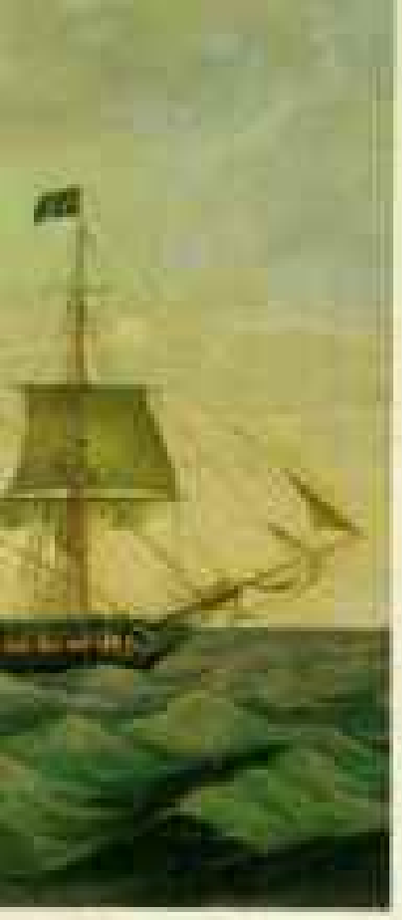
Battered from fighting in the western Atlantic, the British frigate *Guerrière* was on her way to Halifax, Nova Scotia, to repair a damaged mast when she met *Constitution* on August 19, 1812. In the ensuing battle, which lasted less than three hours, *Constitution* fired more than 950 rounds into the enemy ship. When it was all over, she set the ruined hulk on fire. The victory marked the first defeat of a British vessel by a U.S. warship. Wrote one sailor: "It was a grand and awful scene."





Defending freedoms proclaimed in the document for which she was named, *Constitution* set out to protect merchant ships from harassment by French men-of-war and privateers during the so-called Quasi-War of 1798-1801. In 1803 she protected the nation's right to trade free of extortion by Barbary corsairs.

Angered by British actions during the Napoleonic Wars, including the forced impressment of American seamen, the United States declared war on Great Britain on June 18, 1812, and gave *Constitution* orders to "attack and capture, and to defend" the same day.



War at Sea

Officers of U.S.S. *Constitution* could not have asked for a scrappier or more disciplined crew: some 450 sailors and marines—volunteers to the man. Officers and enlisted men were well trained and adequately paid. To keep them armed, boys called powder monkeys ran canisters of gunpowder from the magazine on the orlop deck to the gun and spar decks.

One of six heavy frigates authorized in 1794 to form the U.S. Navy, *Constitution* launched her 57-year fighting career in 1798. She fired her last shot in battle in 1815. After retiring from battle duty in 1855, she served as a naval training ship.

Sharpshooting marines perched on fighting tops—platforms mounted on masts—could pick off enemy officers at close range, but they made prime targets as adversaries trained their guns toward spars and sails.

1. Spar deck. Facing death by enemy fire and falling spars and rigging, crewmen kept to battle stations behind 24 carronades loaded with 32-pound cannonballs. **2. Gun deck.** *Constitution*'s 30 other guns fired 24-pound round shot. Bags of fist-size grapeshot blasted sails and rigging. Canister shot—lead cylinders filled with musket balls and metal scraps—was designed for maiming and killing crew.

3. Berth deck. Sailors ate simple meals of such foods as hardtack, cheese, salted meat, and pickled cabbage. They slept in hammocks hung in rows. When battles raged, rolled hammocks stacked topside served as barriers from shrapnel and musket balls.

4. Orlop deck. Seven hundred feet of anchor cable filled the deck amidships. Injured men were taken aft to the surgeon's cockpit, where wounds were stitched and limbs amputated.

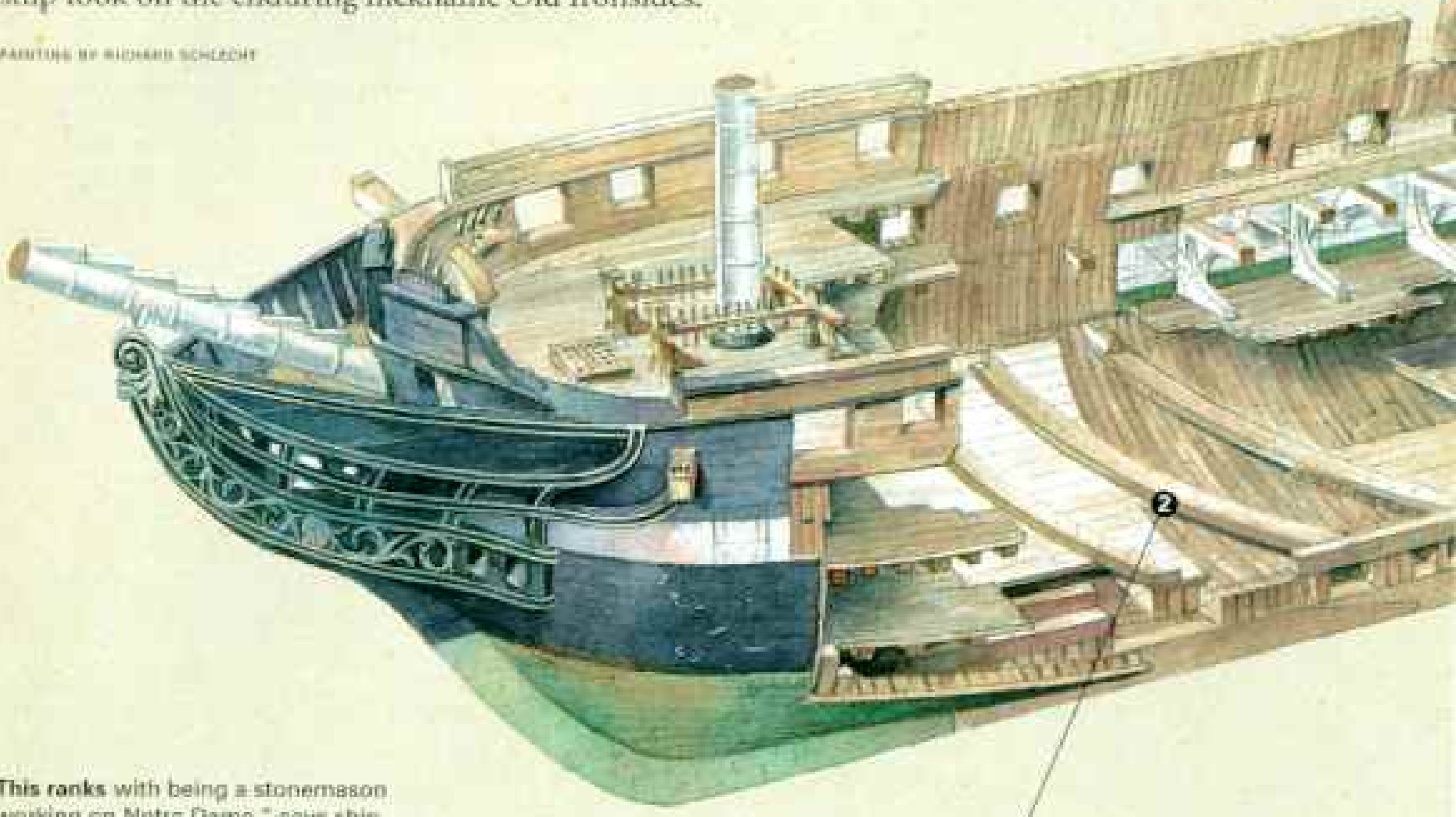
PAINTING BY RICHARD SCHLECHT

Building Tough Ships

As one of the nation's largest seaports, Boston in 1794 teemed with ship chandleries, ropewalks, and craftsmen skilled in maritime trades. The city was an ideal location for building the U.S.S. *Constitution*, designed by Philadelphian Joshua Humphreys. Three requirements dictated the ship's design: She had to be powerful enough to attack sizable enemy warships, fast enough to give chase, and tough enough to take a pounding. *Constitution* was larger than other frigates of the time, and her narrow underbody gave her speed. Dense live oak framing and white oak planking formed her hull, which ranged from two to three feet thick. When an enemy cannonball in the 1812 battle with *Guerrière* bounced off *Constitution's* side and fell into the sea, sailors declared, "Huzzah! Her sides are made of iron!" And so the ship took on the enduring nickname Old Ironsides.

Abundant stands of white oak and live oak supplied wood for Humphreys's new ships. Ninety New England woodcutters and carpenters went to Georgia, where local slaves helped them bow rot-resistant live oak timber into shape.

PAINTING BY RICHARD SCHLECHT

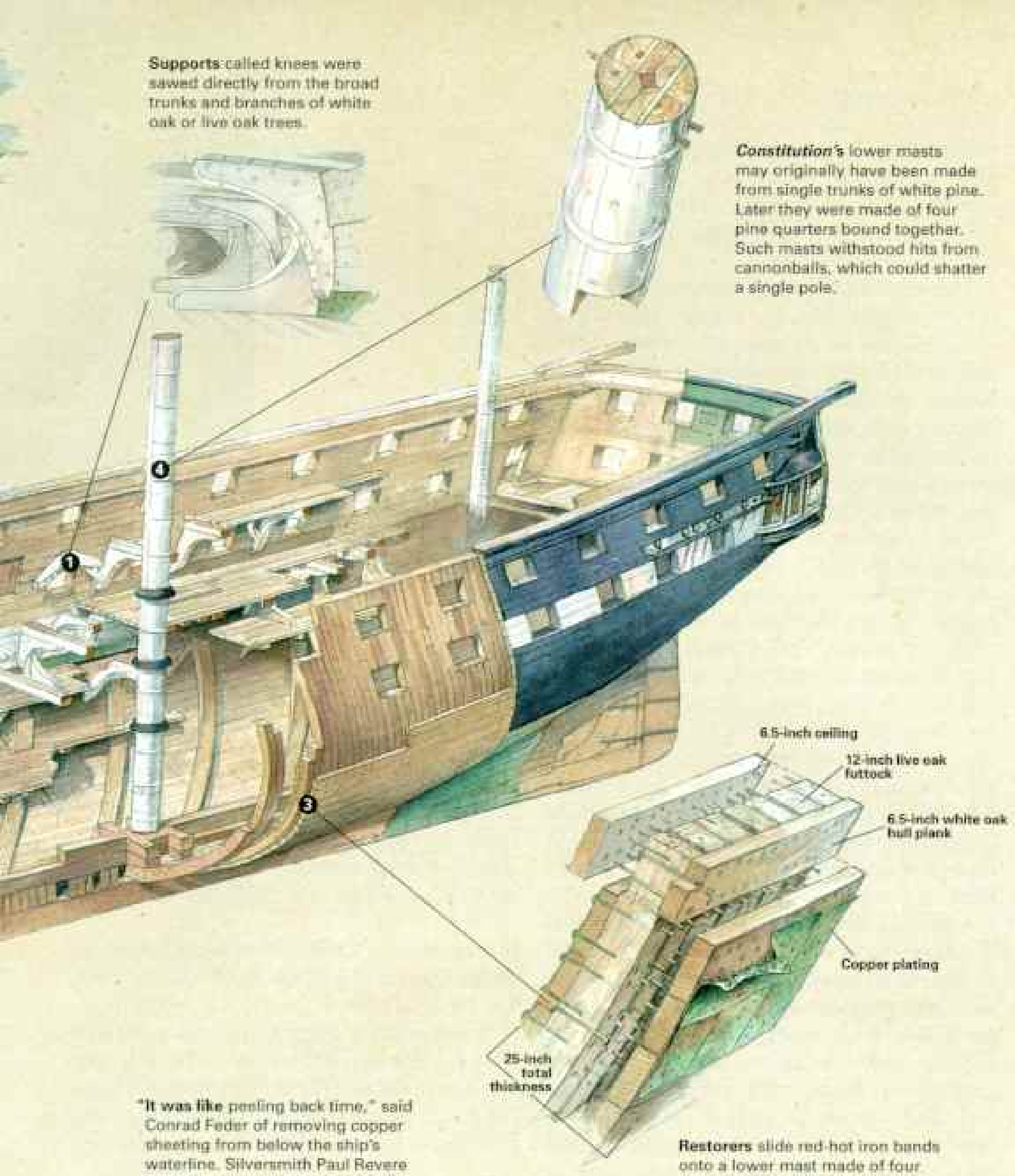


"This ranks with being a stonemason working on Notre Dame," says ship restorer Mike McBride. As if moving a massive stone, he levers an 1,100-pound standard knee into place. Made of laminated white oak, it supports overhead beams and cannon on the upper deck.

Restorer John Shabo checks the fit of a diagonal rider. The originals, removed during earlier overhauls, stiffened the ship's hull and reduced hogging, or bending, of the keel.

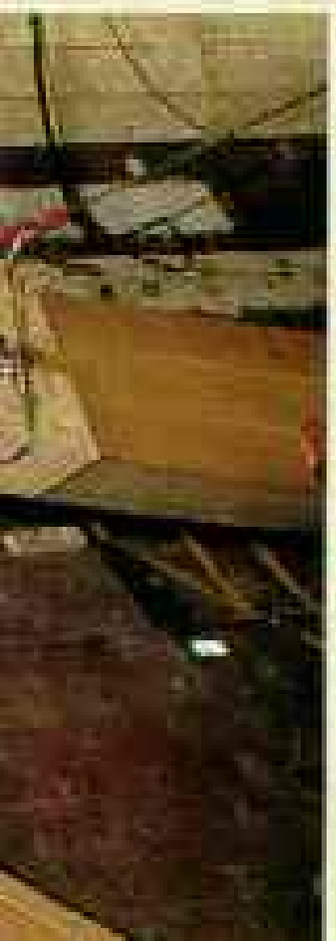
Supports called knees were sawed directly from the broad trunks and branches of white oak or live oak trees.

Constitution's lower masts may originally have been made from single trunks of white pine. Later they were made of four pine quarters bound together. Such masts withstood hits from cannonballs, which could shatter a single pole.



"It was like peeling back time," said Conrad Feder of removing copper sheeting from below the ship's waterline. Silversmith Paul Revere supplied copper for the ship's first overhaul in 1801-03. And who got the job this time? Revere Copper.

Restorers slide red-hot iron bands onto a lower mast made of four quarters of Douglas fir laminate. Water chills the bands, shrinking them into place.



celebrated master of the sea fight if he thought *Constitution* had been something new in naval warfare. "Lord yes, this big frigate was an admirable innovation; it gave your Navy an immense sense that they could take on anybody, and they did. The Royal Navy did not have such seamen as you had."

The captain of *Constitution* agreed. "Yes, she has pretty thick sides, but I say the iron in Old Ironsides was in the men who manned her. They were highly trained and motivated volunteers." At that stage of the Napoleonic Wars Britain's navy contained many inexperienced landsmen, the resentful harvest of the press-gangs who seized able-bodied men from pierside, tavern, or farm.

The American naval historian Alfred Thayer Mahan wrote that good sailors in poor ships are better than poor sailors in good ships. It follows that good sailors in good ships must be nearly invincible, and *Constitution*, a lucky ship that was never defeated, had superb crews and some brilliant commanders. In 1815 *Constitution* took on two British vessels at the same time. When one attempted to cross Old Ironsides's stern in order to rake her—fire a broadside the length of her deck—the American commander *backed* his ship out of danger, no mean feat under scant fighting sail alone, and went on to capture both ships.

A wooden ship, like a man, is made of organic matter, and as with a man its fabric is subject to decay. The vessel is suspended between two wetnesses, the rains above and the cradle of the sea below. Fresh water rots wood while salt water prevents decay, and if a wooden ship could always be kept dry above the waterline and constantly immersed in the sea below, she should last indefinitely. But rain must fall, and the sea is home to wood-hungry organisms. To protect her against marine borers, *Constitution*'s builders sheathed the underwater hull with copper, a successful method first tried by the Royal Navy in 1761.

The danger to a wooden ship begins when rainwater collects in dark, warm crannies and compartments. Then airborne fungi can infect the wood and grow, consuming the wood by what is inexplicably called dry rot though it can only happen in the presence of moisture. "Salt water is a good preservative," says Charles Deans, director of the Naval Historical Center Detachment Boston and the man in charge of the restoration. "I believe that about 20 percent of the ship's timber dates from when she was laid down in 1794.

"Fresh water is our major problem when it runs down into confined places. For example: When we removed the decking from the powder magazine, there were actually mushrooms growing in there, big ones, feeding on wood."

Old copper plates affixed to Constitution's *hull to prevent marine infestations are hand-stripped. Elevated on numbered concrete piers, the ship is cushioned by blocks of pine resting atop iron sandboxes. As the sand is gradually emptied, her backbone will settle level, thereby correcting a 13⅜-inch hog.*

IN OLD IRONSIDES's celebrated victory against *Guerrière*, the cause of *The Times*'s irritation, she shot away the enemy's mizzenmast in the first 20 minutes of fire. During the close engagement that followed, the ships collided twice, snagging their rigging. When the vessels pulled apart, *Guerrière*'s whipping bowsprit brought down first her foremast and then her mainmast, forcing the British commander to strike his colors.

Four months later *Constitution*, cruising off Brazil, fell in with the British frigate *Java*. In the

fight that followed, Old Ironsides repeated the scenario. Maneuvering with consummate seamanship, she raked the Englishman four times, reducing the vessel, in the words of *Constitution*'s commander, to a mastless hull "laying like a log . . . perfectly unmanageable."

Firs and pines were the only trees that grew tall, straight, and large enough for big ships' masts. New England had vast supplies of giant white pines *(Pinus strobus)* up to three feet in diameter, enabling masts of even first-rate ships of the line to be fashioned of one piece.

Constitution's original lower masts may well have been single sticks of New Hampshire or Maine white pine, but by the time of the War of 1812 replacements were made of four pieces bound together. The big white pines are now long gone, and restorers must turn to Douglas fir from the Pacific Northwest, fastening together four laminated pieces secured by iron bands driven on red-hot, then chilled with water to shrink them tightly in place.

Unstepping Old Ironsides's masts in 1992 revealed a clutch of coins under the heel of each mast. This custom goes back to Greek and Roman times, when a coin was placed under a new vessel's mast so that a shipwrecked crew would be able to pay Charon to ferry them across the river Styx. Since the old frigate became a national icon, the coins have been carefully replaced after each refit, with a few new ones added.

Every restoration of Old Ironsides down the years has encountered a classic problem, one known to the ancient Egyptians. All wooden ships will eventually hog, that is, sag at the ends and arch upward in the midsection. Buoyancy pushes the full-bodied midships section upward, while the tapered bow and stern, having less flotation, hang downward. In 1992 Old Ironsides had a 13⅜-inch hog amidships, measured by divers stretching a line from stem to stern.

When *Constitution* went into dry dock, a

contoured line of wooden blocks ran down the center of the dock for the keel to rest upon. The blocks stood on iron frames filled with sand. As the water was pumped out of the dock and the ship settled on the blocks, her weight flattened some of the hog. To remove the rest without straining her venerable timbers, the sand was gradually driven out of the frames, allowing the keel to straighten completely. The remaining question was how to stiffen the ship in order to prevent hogging when she floated again.

Restorers had noted during previous overhauls that Humphreys's plans for building a 44-gun frigate listed structural members called diagonal riders. The object of the riders was to stiffen the ship lengthwise. But the present ship had no such timbers.

To find some record of *Constitution*'s diagonal riders, Patrick Otton of the ship's restoration team searched the Humphreys papers preserved in Philadelphia. He found nothing for Old Ironsides, but he did unearth a letter from Humphreys to the secretary of war concerning the launching of a sister ship, the *United States*. Humphreys wrote that she slid down the ways "without straining or hogging more than one & a quarter Inch. . . . The firmness of the ship is a convincing proof to me of the utility of the diagonal riders in long ships, in Europe where they are not known, it is said large ships hogg in launching nearly two feet."

Definite proof that diagonal riders had indeed been originally built into Old Ironsides turned up in a letter of June 16, 1797, from the War Office to the Congress: "*Constitution* . . . diagonal riders . . . are all in and secured."

Donald A. Turner, production manager of the restoration team, told me: "When we finally had definite proof that the diagonal riders had been originally fitted, we decided to do some testing. We had a wooden frame model of *Constitution* 13 feet long; we loaded this with 800 pounds and the keel deflected three-quarters of an inch. We then installed diagonals and found that we had to place a load of 2,280 pounds on it before the keel deflected only half an inch.

"Navy engineers confirmed our tests, and we got the go-ahead to rebuild the original design. If Humphreys's diagonals had still been in the ship, 70 percent of our difficulties would have been eliminated."

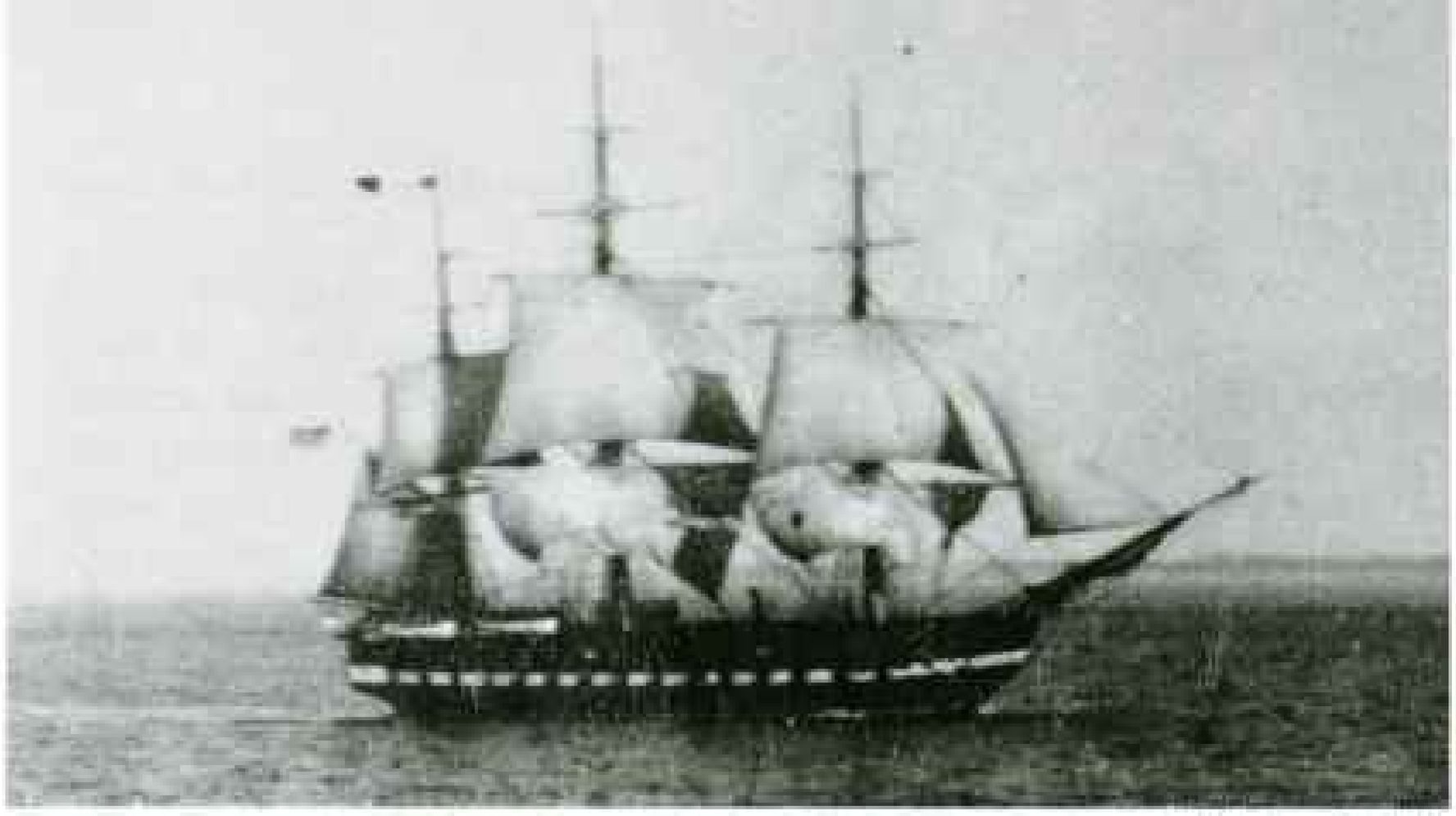
Replacing the diagonal riders and some other members has so strengthened Old Ironsides longitudinally that the Navy has authorized something that, for fear of straining and damaging a national treasure, had long made the admirals blanch. On July 21, 1997, to celebrate the 200th anniversary of her commissioning and the birth of the United States Navy, the grand old frigate will set sail for the first time in 116 years. Tugs push *Constitution* out to sea for her annual turnaround, but for this sortie, if the sea is smooth and the winds 15 knots (17 mph) or less, the tugs will cast off, and she will move downwind for one hour under six of her possible 36 sails.

When you look at *Constitution*, you are seeing white oak, her exterior planking, but her structural members, like frames and some knees, were fashioned of live oak *(Quercus virginiana)*. This evergreen oak, which grows along the American southeastern coast from Virginia downward, is half again as dense as white oak.

The live oak hung with Spanish moss is a majestic tree, with a massive trunk that may reach nearly 12 feet in diameter. Besides the hardness and resistance to rot of live oak, which give it a life expectancy much longer than that of white oak, the extraordinary tree is indispensable for what shipwrights call "compass timber," naturally curved pieces of wood that can be used for knees, the massive L-shaped members that support deck beams, and other curving parts of a ship's structure. These are cut where the great branches spread arms as thick as the trunks of ordinary trees. Naturally curved pieces of wood are much stronger, because they avoid the need to saw across the grain when shaping straight timber into curved pieces.

To build each of the big American frigates required some thousand pieces of live oak, the product of perhaps 500 trees, and live oak did not grow in forests. Even at the end of the 18th century there was concern for the future supply of this matchless shipbuilding timber.

Down the hatch goes a diagonal rider, a laminated white oak version of the live oak original. Old strength renewed, Constitution *is scheduled to sail again this summer, the first time under canvas in 116 years.*



U.S. NAVAL HISTORICAL CENTER

The only known photograph of Constitution *under sail (top) shows her in 1881, a training ship at the end of her wind-driven days. Today a team of 52 riggers, restorers, artisans, and support staff give Old Ironsides new life. As a rigger parcels rope with tarred canvas and sailors practice furling a new sail—purchased with pennies from the nation's schoolchildren—U.S.S.* Constitution *is made ready to take to the sea once more.*

Some of the best live oak stands occurred on the Sea Islands of Georgia, and in 1799, two years after Old Ironsides was launched, Congress authorized the purchase of two islands, Grover and Blackbeard, the first nationally owned timber reserves.

One thing the low, branching live oak cannot give a ship is long pieces of straight wood for making plank. *Constitution*'s planking skin is of white oak *(Quercus alba)* four to seven inches thick, the shipbuilder's "thickstuff." (Shipwrights call shorter pieces of wood "promiscuous timber," as it can be put to any use.)

Wood still lives—and dies—in the hull of *Constitution*. What her restorers needed were nondestructive methods of testing the ship's structure. Classically, shipwrights bore out wood cores and remove fasteners for testing. This is time-consuming, costly, and may weaken the structure, so the restorers, who were already using x-rays, turned for further help to what is probably the world's foremost repository of timber knowledge, the famed Forest Products Laboratory in Madison, Wisconsin, run by the U.S. Forest Service. There a group of engineers, chemists, microbiologists, and wood scientists formed a *Constitution* team under the direction of Lawrence Soltis, a structural engineer.

"To test the soundness of the timber without destroying it, we use a stress-wave test," says Dr. Soltis. "To do that, you strike a pin driven into one end of a specimen of wood and time how long it takes the stress wave

DAVID L. RYAN, BOSTON GLOBE

to travel through the wood to the other end.

"We accelerate decay in test specimens by placing them in a dish with cultured dry rot fungus and storing it in a hot, humid chamber. In ten weeks Douglas fir will crumble to the touch. But we haven't been able to get live oak to rot. We have had specimens in the chamber for 42 weeks with no change at all. There is something in live oak that is toxic to dry rot.

"We did find chemical degradation around the metal fasteners—nail sickness. That softens the wood, allowing movement."

There are some 158,000 pins and bolts in *Constitution*, and even slight play around so many, added together, would increase the hull's flexibility and so contribute to hogging.

"I have a disparate team," says Dr. Soltis, "but we work well together, because we want to preserve Old Ironsides. She's American history, a piece of all of us."

The successes at sea of a few American frigates did not affect the inconclusive outcome of the War of 1812, but they earned the respect of the world's most powerful navy, and they gave pride, confidence, and a sense of identity to a new nation. In the end *Constitution* and her sister frigates received the ultimate accolade; the British Admiralty forbade its frigates to engage an American in single combat.

Comdr. Michael C. Beck, the present commanding officer of Old Ironsides, says: "The mission today of the U.S.S. *Constitution* is to represent the values and ideals of the naval service and the nation, recalling to citizens what we must do to keep this country free.

"The ship has been restored to close to her original strength. Setting her under sail once again will reveal that strength and symbolize the living nature of the document for which she is named."

One observer, impressed by the devotion of Old Ironsides's restoration team, commented: "They have the ship in their heart." So does every American. □

Nature's Masterwork

Cats

Between lion and lapcat the feline family resemblance is unmistakable. Cloaked in elegant camouflage and lethally armed, cats reveal what British veterinarian David Taylor calls the "essence of the perfect, polished warrior."

By CATHY NEWMAN
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by KAREN KUEHN

I HAVE ALWAYS been wary of cats, and now, walking alongside a 500-pound African black-maned lion, I know why. They remind me there is something higher on the food chain.

Josef, the lion beside me, is trained. "The best lion in the business," his owner, Charlie Sammut, says, beaming. Josef has starred as the MGM lion and posed for Disney animators for *The Lion King*. Josef is a big-time Hollywood cat.

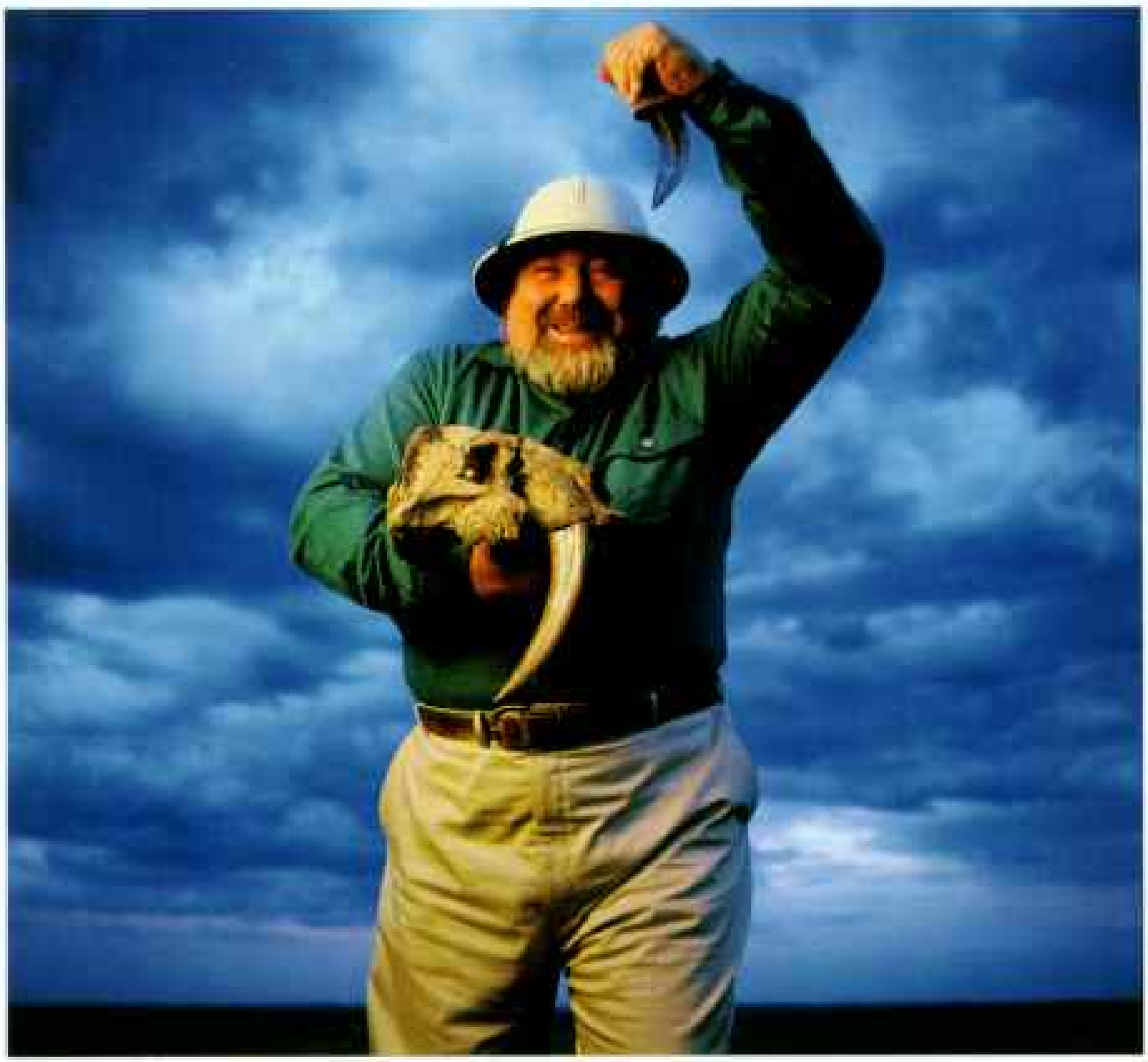
But Josef is not tame. No big cat ever is, a difficult fact to ignore as we climb the hills of the Salinas Valley ranch Josef calls home. He strides with the fluidity of unfurling silk. Deliberately—not an ounce of tentative in each footfall. "Cats don't rent; they own," it is said. Lions own everything in sight.

As we walk, I hear a low rumble of growl. Does Josef grumble? Perhaps he knows he is not working for union scale today. This stroll is a favor to an inquisitive journalist.

We stop at the crest of a hill, and Josef pushes his face in my lap. I've had house cats greet me that way. At Charlie's behest he rolls on his side and lets me stroke a cloud of mane as fragrant as dried grass.

Then Charlie flicks a piece of meat in front of Josef. Snap, swallow, gone. Another grumble. Clearly it is time to head home. As I stand in front of Josef's cage, chatting with Charlie, the big cat turns his back on me, lifts his tail, and sprays me smack in the face. "You might want to wash up," Charlie says, adding that I'm not the first visitor to get such a soaking from Josef. "It's his way of getting attention."

Amazed to meet a prehistoric predator on the Walk of Fame, a Hollywood resident gets a close-up look at Smilodon fatalis, *the sabertooth that dominated the California landscape 10,000 years before movie moguls arrived. Modeled on La Brea tar pits fossils, the skeleton is life-size.*



In a gripping explanation of a sabertooth kill, University of Kansas paleontologist Larry Martin raises an antique dagger for a lethal plunge. Slicing through the throat, Martin believes, dispatched a victim without a prolonged struggle that could injure the attacker.

Later I ask researcher Craig Packer, who has studied lions in the wild for two decades, what Josef meant. Sexual overture? Territorial gesture? Insult? "Never heard of such a thing in the wild. Bizarre," shrugs Packer. Maybe Josef has worked too long in Hollywood, he says.

I feel less vulnerable handling the skull of Josef's 34-million-year-old ancestor, *Proailurus*. A cast of the skull, in the collection of the American Museum of Natural History in New York City, fits comfortably in my hand. *Proailurus*, the earliest known cat, an Old World native, weighed about 20 pounds to Josef's 500. Despite the difference in size and age, *Proailurus* and Josef unmistakably belong to the same clan—Felidae: cats. In 34 million years their basic structure hasn't changed.

Other animals would never recognize their ancient ancestors. The 34-million-year-old *Mesohippus*, an archaic horse about the size of a Dalmatian, three-toed with a short skull, looks nothing like today's nag. Nor would you ever connect the 34-million-year-old *Poebrotherium* and its deerlike limbs with today's camel. And us? Trace the lineage of man back 34 million years, and you might be looking at an eight-pound, fruit-eating creature with monkeylike limbs and apelike teeth. Camels, horses, and humans—among others—had far to go before settling into their current form.

But the cat is one animal nature pretty much got right the first time around. Other mammals came and went as they tried to adapt to changing climates and vegetation. Cats sharpened their claws, fine-tuned their bodies, and snapped up whatever prey the next epoch offered.

Fang to fang with its distant kin, an Abyssinian kitten paws Smilodon fatalis *remains at the George C. Page Museum in Los Angeles. Sabertooths dined on large herbivores; more adaptable domestic cats flourish on fare ranging from self-serve mice to kibble in a dish.*

The story of cats is ultimately a story about design. Richard Tedford, curator of vertebrate paleontology at the Museum of Natural History, says: "The cat is the perfect hunting machine."

NO OTHER ANIMAL rivets the human imagination as vividly as cats. The fascination with cats mixes primitive fear and profound respect. Until the invention of weapons, our ancestors were easy prey for cats. In the wild, even in a zoo, we still regard a cat's presence with caution, sometimes even panic.

"Just knowing a big cat is around sharpens perceptions," points out John Seidensticker, curator of mammals at the National Zoo in Washington, D.C. "You look at shadows differently. You're no longer dominant. You're no longer in control."

The cult of the cat spans human history and geography. Roman soldier Marc Antony drove a chariot pulled by lions. The Hindu god Siva, the destroyer, rides a tiger. The tomb of Egyptian king Tutankhamun held a leopard-skin mantle adorned with gold stars. South American Indians tell stories of the earth sailing through space on the back of a winged jaguar, of shamans turning into jaguars and back again. We are awestruck in the

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NATIONAL GEOGRAPHIC regularly features documentary images of animals in the wild. Departing from custom, these photographs enlist experienced animal handlers and their diverse feline partners to create scenes illustrating the powerful bonds that can form between people and cats and the family traits that link the wild and the tame. The photographer, KAREN KUEHN, lives in New York City in a family that includes two dogs, two turtles, and a Persian named Fraidy Cat.

presence of the perfect predator—the emblem of power and death. In the jungle—and everywhere else—the lion and his tribe are king.

Then there is the feline you and I are most likely to meet: the house cat, "an independent, wild little panther," one writer called it. Beloved if standoffish companion to millions of humans the world over, the domestic cat came late in the evolutionary cycle but is now the aloof emperor of the cat world, far outnumbering its larger cousins, accepting with cool grace—sometimes even disdain—the pampering of owners.

Cats also spin a story about how creatures adapt to the world they live in. Most landscapes hold wild cats, indigenous to every continent except Australia and Antarctica. They live in forests, plains, mountains, deserts, snowy steppes. The margay, a small spotted cat of Central and South America, has gymnast-like limbs suited to a life of tree climbing in the rain forest. The gray-white coat of the snow leopard melts perfectly into rocky highlands from Siberia through the Himalaya. The slightly webbed front toes of the fishing cat help it dive for prey in the rivers of tropical Asia. The clouded leopard, once found only in Asia's pristine forests, has turned up in habitat damaged by overgrazing and logging. It has adapted to the careless hand of man.

So too the leopard's spots enable it to vanish into the dappled light and shade of heavy forest. To the biologist the leopard's spots embody the principle of natural selection—that process of genetic winnowing through millennia. To Rudyard Kipling the leopard of his *Just So Stories* "goes into spots" with the help of the Ethiopian, who presses his fingers on the leopard's skin and leaves "five little black marks, all close together."

What you believe depends on your preference for poetry or science. Happily, with cats, there is room for both.

Let's see how a cat works. Just what

Nearly as loud as a rock band, the roaring male lion needs neither microphone nor amplifier to proclaim his dominance to the borders of his kingdom. The subtle rumble of a house cat's purr can comfort kittens even before their ears are developed enough to hear it.


Marshall
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Jumbo pupils and light-reflecting cells within its eyes help give this black leopard an advantage over soldiers in night-vision goggles. Many cat species, nocturnal hunters adapted to life in dense forest, operate easily in what humans perceive as complete darkness.

has 34 million years' worth of evolutionary refinement produced? The merest hint of collarbones or none at all: Front limbs are flexible as a free-swinging door. That and a loosely connected spine account for a cat's slinky walk. Exquisitely agile, a domestic cat can tumble out of a 46-story high-rise, as one did three years ago, and break only a tooth.

A broad face and short jaw. Result: a more powerful bite than long jaws (the difference between bolt cutters and needle-nosed pliers).

Retractable claws that whip out like a switchblade when needed but stay sheathed to prevent wear when not.

A keen sense of sight, their most critical sense, and night vision six times as sensitive as ours. Large, close-set eyes allow binocular vision, important in judging distances and picking out prey from a background.

Large back teeth called carnassials that slice like shears. Cats are carnivores. They live on meat.

I AM HOLDING in my hand a ten-inch-long canine tooth of *Smilodon fatalis*, the saber-toothed cat that roamed North America as recently as 10,000 years ago. Cats originated in the Old World and didn't arrive in North America until about 18 million years ago, when they took advantage of the Bering land bridge to increase their range. So New World cats like *Smilodon* are recent in the lineup.

Smilodon was a big, barrel-chested guy with powerful forelegs, the 325-pound linebacker of carnivores. The tooth, elegant in form, horrible in function, belongs to the fossil collection in the George C. Page Museum at the La Brea tar pits, seven miles west of

Lured by a milk treat, a wary lynx flashes its tongue. Multipurpose tools, cats' tongues curl to lap liquids and flatten to rasp meat off bones with hooked spines called papillae. Thorough licks also clean fur and renew a cat's signature scent.

downtown Los Angeles. Long before Valley girls and surfer boys, this realm belonged to *Smilodon fatalis*.

Strip the mansions from Beverly Hills. Peel back the asphalt from the Los Angeles freeways. Dismantle the Century Tower. Erase the sky-smudging smog. Go back 10,000 years or more to the Pleistocene, when a mix of scrubby coastal sage and pine and oak woodland covered much of today's Los Angeles County.

They're called the tar pits, but the black liquid that seeps from oil pockets 1,500 feet or so below the surface is technically asphalt. It bubbles up through sand to the surface and collects in shallow depressions, forming pools of a superglue-like guck that caught the unfortunate animal that stepped in it.

Think of La Brea as a carnivore cafeteria. A mastodon wanders into the tar and gets irreversibly stuck. This rings a dinner bell for *Smilodon*, which leaps to get its prey and then, struggling to free its huge paws, discovers there's no such thing as a free lunch, even for a sabertooth.

"Would you like to see our small collection?" Christopher Shaw, the collections manager at the Page Museum, asks wryly.

He precedes me down a long, dark corridor. It is 260 feet from front to back of the wing where the collection is housed, a veritable fossil warehouse with more than 166,000 *Smilodon* bones representing 2,200 individual cats. Not to mention two and a half million other fossils plucked from the paleontological flypaper of La Brea.

"Asphalt is a wonderful preservative," Shaw says, handing me a skull. "It saturates the bone and is easy to work with. You peel the matrix back, instead of chipping away."

There's always something new to discover. In 1975, when breaking ground for a museum building, workers unearthed a new fossil deposit. Among the finds were two sabertooth skeletons preserved in the position in which the cats died. Previous skeletons had been cobbled together from pick-up-stick-scattered assemblages of bones. The first intact skeleton examined revealed that the paleontologists had configured the toes all wrong. The largest digit went in the thumb position, not in the middle as previously thought.

All the skeletons in the collection underwent toe rearrangement. A volunteer spent Fridays patiently resorting boxes of toe bones. She only had 10,000 to do.

ATTENTION PLEASE. Larry Martin will demonstrate how a sabertooth killed its prey. From beneath a jumble of papers and bones in his basement office at the Natural History Museum in Lawrence, Kansas, where he is curator of paleontology, Martin pulls out a *jambiyya*, a 19th-century silver-handled knife from the Middle East. Its shape mimics the deadly curve of a sabertooth's serrated canine.

"Most people think that you cut across the neck to kill," he says, slicing the air. "But that would probably only produce a tracheotomy. Disturbing but not necessarily fatal. What you really want to do is stab the neck from the side and slice the carotid artery. That way your prey bleeds to death. It's a lot quicker."

So Martin believes the sabertooth aimed for the jugular. Others think the cat aimed for the belly or pounced on its victim's back and went for the neck. How the sabertooth killed is one of the great debates in cat paleontology. Without a living sabertooth around to observe, it's hard to know who's right.

Smilodon fatalis is not the only sabertooth, merely the best known and most recent

A fast flip in free fall shows off the "righting reflex" that helps cats survive tumbles. With thick foam pads waiting below, a practiced Siamese swiftly assumes an impact-resistant posture—toes spread, legs stretched, and back arched—for a textbook feline touchdown.

"Don't be fooled," says educator and wildlife rehabilitator Melissa Margetts. "Ruby is a dangerous predator." She and Ruby teach people what to do if they encounter a mountain lion. At Melissa's home in Colorado, Ruby roams a 1.5-acre enclosure.

version. Nature keeps reinventing itself; the sabertooth type has appeared a dozen times in the cat chronology. Our own era is practically the only time in the past 11 million years without a sabertooth lurking about.

Why any of the extinct cats vanished depends on whom you ask. Theory 1 for *Smilodon*'s exit: Climate and vegetation changes; big herbivores like the mastodon go belly-up, and so do the sabertooths that eat them. Theory 2: Man arrives on the scene, wipes out the mastodons and their ilk. Same result.

The moral of the story: Change can be bad, especially if events overtake your ability to adapt. It's called overspecialization, evolution's great pitfall. If you're a big cat feeding on big prey like mastodons and the mastodons vanish, you do too. "Evolutionary downsizing," Larry Martin calls it.

Even so . . . "Extinction is not forever," says Martin, who revels in the outrageous. "Give me about seven million years, and if everything worked right, you could probably develop another sabertooth. Assuming, of course, you do away with man."

Do away with man . . . .

Today most of the 37 species of wild cats are in decline. I call Peter Jackson, chairman of the cat specialist group of the World Conservation Union in Bougy, Switzerland, for a census. Cheetahs at around 10,000 (down from an estimated 15,000 in the early 1970s). Tigers down to 6,000 (from about 11,000 in the mid-1960s). One of the most fragile is the Iberian lynx, a native of Spain and Portugal. Perhaps only 1,200 remain of a population that possibly numbered in the tens of thousands.

"The acute threat is poaching in Asia for use in traditional medicines and hunting for

In the Lorton, Virginia, prison, Warren Anderson and Lady help each other find gentler ways to survive. Aided by a local vet, inmates adopt strays, learning to offer care and to value simple affection. Hardscrabble cats gleam with health, and both lives benefit.

fur," Jackson says. "The chronic threat is habitat degradation. Still, thanks to the collapse of the spotted-cat fur trade and because cats are so adaptable, even to man's damaging impact, I'm hopeful. Though the future of the tiger looks grim—poaching and too few sanctuaries of adequate size—the other cats should survive, though in reduced numbers, over the next half century."

And beyond that? I ask.

"Who knows?"

IF THERE'S A GOLDEN AGE of cat evolution, it's the late Miocene—ten or so million years ago, when the modern-day lineages began to evolve—the panoply of lions, tigers, cheetahs, leopards, and assorted small cats. The late Miocene was prime time for the diversification of all mammals: Forests gave way to broad plains, allowing animals room to move in large herds. Cats played a game of predatory catch-up and honed their bodies and behavior to expedite capture of prey.

These days the classification of cats is a complex, ongoing process, aided by high-tech methods like DNA analysis. Recently, for example, geneticist Stephen O'Brien and others suggested that the Nepal leopard be reclassified as part of the Indian leopard subspecies. (See "The Human-Cat Connection," page 77.)

"It drives our sign people crazy," says John Seidensticker at the National Zoo in Washington, D.C. From his office you could see a male African lion pacing on rocks in the big-cat display.

"The story keeps changing. But that's the excitement. In the past quarter of a century we've seen a magnificent leap in our

understanding of the biology of wild cats."

Domestic cats harbor their own mysteries, of course, but sometimes the enigma lies more within owner than pet. Hadn't Mark Twain observed that if a man could be crossed with a cat, it would improve the man but deteriorate the cat?

"Come with me to the cat show at Madison Square Garden," I ask Richard Tedford, the Museum of Natural History's curator of vertebrate paleontology. He customarily spends his time with cats in fossil form, but he politely indulges me. We arrive at a press preview, where a dozen owners cluck over a like number of extravagantly pampered cats, as flashes pop and cameras whir.

There are dainty Abyssinians, a big lunker of a Maine coon with a feather-duster tail, and several bored-looking Persians, among others. Amid the flurry of fur the breeders share beauty tips:

"I give mine bean sprouts," says one.

"Eyedrops to make their eyes sparkle."

"Three to five baths, then white grooming powder."

A snow-white Persian, its coat trimmed in a poodle cut, lounges on a miniature fainting couch upholstered in oyster white silk.

"Not a poodle cut, a *coupe de lion*," corrects owner Lise Girard, who, in contrast to her white cat, looks shrink-wrapped in black toreador pants, a black long-sleeve shirt with gold sequins, and needle-sharp black heels.

"It's the cut for the cat with the busy lifestyle," she explains.

What does it cost to keep her nine Persians, who live in Fort Lauderdale, Florida, in the busy lifestyle to which they've become accustomed?

"A Mercedes payment. My boyfriend says I am their slave. He's right. I cannot live without their love."

Meanwhile, owners coo to their cats and size up the competition like stage mothers at a talent show.

"Land like a pussycat," directed choreographer George Balanchine. Wrapped in creamy satin or Russian blue fur, dancer and kitten exemplify grace. Ballerinas coat their toe shoes with rosin to avoid onstage slips. A cat's paw pads provide similar traction and muffle each footfall.

"What man has done to poor old *Felis catus*." Tedford shakes his head.

"Even so," he sighs, "under the skin, they're all alike."

Be it 600-pound Siberian tiger, 4-pound Central American oncilla, 10-pound Persian, or even the long-extinct *Proailurus* in the Museum of Natural History's collection, the template remains the same.

Just how did *Proailurus* end up as the purring Persian in Lise's lap? Among other things, it took time and changes in environment. Think of the cat family as a river system with *Proailurus*, the prototype, the headwaters. Millions of years unfold. Climate turns colder, drier. Forest changes to grassland. Cats move from trees to plains. With room to roam and grass to eat, herbivores increase in size. So do their predators, the cats.

Cats cloak themselves to blend into their surroundings. Mottled coats meld into forest shadow. Solid coats blend into open country. Stripes are perfect camouflage for the vertical shadows cast by tall grass. Cats are stalkers, lying in ambush. Natural selection refined the predatory habits of some, making them capable of great bursts of speed.

As the climatic cooldown continues and the Miocene proceeds, the flow of feline evolution divides into two branches. One branch becomes the big-toothed cats like *Smilodon*—seemingly evolutionary dead ends. The other becomes the success-story cats—those that evolve into Lise's Persian, Josef the lion, and the Bengal tiger stalking an elephant calf in the suddenly silent Himalayan forest.

A CONFESSION. I do not, and never have, owned a cat. I can't stand the rejection, that "Can I get back to you?" attitude. Give me the wet, licking love of a dog. I don't care for cats, but I admire their grace.

One day Jaromir Malek, an Egyptologist at the Ashmolean Museum at Oxford University

If it shopped instead of hunted, a big cat would run up quite a grocery bill. Lone tigers have been observed consuming 60 to 80 pounds of meat in a night. Unlike other carnivores—bears, for example—that can survive on plants when meat is scarce, wild cats must capture prey or go hungry.

in England, put his hand on the back of a 2,500-year-old bronze Egyptian statue and realized, with a start, that it evoked the feel of the cat beneath his hand at home. It was one of those revelations that spans centuries and provides an almost shocking sense of immediacy, Malek said, as we sat in his office.

Such a distinctive curve, the back of a cat—the protruding, knobby shoulder bones, the smooth sweep of spine, ending in a long tapered curl of tail.

Felis catus turned up relatively recently in the evolutionary process, 7,000 or so years ago. It's probably a relative of the African wild cat, and it struck a bargain with humans, most likely in that corner of the world where the Middle East brushes up against North Africa.

Domestication coincided with the shift from nomadic life to permanent settlement around 5000 B.C. Mud-brick houses appeared along the Nile. Plant gathering yielded to agriculture. And rats attracted by granaries attracted cats. In exchange for hanging around and controlling rodents, cats got a steady supply of food.

Cats are known to have been domesticated in Egypt by 2000 B.C., and in today's Cairo suq, cats with the striped markings of their wild ancestors dart in and out of narrow, crowded lanes, scrounging for scraps. (Some, of course, fare better. In a fashionable Cairo suburb, a young woman explained how she hand-feeds tidbits to her five pets. "My maid doesn't like them, and I can't blame her. I spend $12 on litter, and she comes twice a week to make that.")

The most telling relic is the old Egyptian word for cat: *miw*. For the ancients the cat became associated with the Egyptian goddess Bastet, a sort of local saint to the city of Bubastis, today's Zagazig. The Greek historian Herodotus ("We must take him with a grain of salt," cautions Malek, the Egyptologist) reports that killing a cat is punished by death, and that if a cat dies in a house, the entire household must shave their eyebrows.

Cats were mummified as offerings and buried in tombs. "Mummified in the millions," says Malek. "In the 19th century so many were exhumed by archaeologists that they were shipped to Britain as ballast, then ground into fertilizer."

Surely Egypt's most spectacular cat is the Sphinx, and one morning I stood on the Giza plateau on the outskirts of Cairo watching the sun slowly light the monumental statement of a pharaoh who wanted to transform himself into the most magnificent cat of all—a lion.

The Sphinx faces east, toward the Nile, an eternity of desert at its back. To watch the first light of day pick its way through the haze of Cairo and illuminate that face is to understand the longing for a merger with a powerful force and to feel a kinship with the Maya shamans who draped themselves in jaguar skin so they might be filled with the spirit of the most sovereign animal in the jungle.

CATS OUTNUMBER DOGS as pets in the United States, 66 million to 55 million. Cats—the turnkey pet—are less needy than dogs and better suit the modern, mobile lifestyle. Cats also outnumber dogs in Switzerland and England. But dogs prevail in France. When I asked Juliet Clutton-Brock, a British archaeozoologist, why, she cited cultural differences, one of them being, perhaps, that the French are less squeamish than the English about dog turds lying about in public places.

Can you ever really domesticate a cat? "You probably never can curb a cat's interest in going out and doing stuff on its own," James Serpell, associate professor at the University of Pennsylvania School of Veterinary Medicine, told me. Pinned to a bulletin board above his desk was a snapshot of a black cat, his pet, Tallulah, and he spoke of the pleasure of watching her track birds and creep through underbrush. "A cat leads a double life," he said. "It likes to enjoy the fruits of domesticity. It likes to lead its own wild life too."

It's an old story. Cats will be cats, and they readily turn feral.

Two years ago, as I bounced by four-wheel drive through the middle of nowhere in Australia's Cape York Peninsula, a gray-and-white tabby darted furtively across the road, looked back, and bared its teeth. My guide cursed, sorry he hadn't hit it. Australia reportedly has three million to four million feral cats. According to David Paton in the department of zoology at Adelaide University, ferals may kill four billion native creatures a year.

Feral cats are the greatest threat to wildlife on many islands. In 1894 the lighthouse keeper's cat on a small island off New Zealand dispatched 15 Stephens Island wrens, thereby

A cat's whiskers guide it through tight spaces and help it pinpoint prey for the killing bite, according to University of Pennsylvania zoologist James Serpell. "Blind cats," he adds, "find their way around familiar places using their whiskers and ears alone."

rendering that species extinct. In the Turks and Caicos Islands, cats and dogs killed some 15,000 iguanas between 1976 and 1978. On some islands of Fiji, cats have wiped out the *Emoia* skink, a five-inch long lizard.

It's not just feral cats. It's your own "Here kitty kitty" on the loose. A bird here, a bird there—it adds up. In 1981 Peter Churcher, a biology teacher, kept tabs on 77 cats in his Bedfordshire, England, village. He asked owners to collect their pets' bring-home kills in baggies and toted up a body count of nearly 1,100 birds, voles, mice, and other small mammals killed in the course of a year. Extrapolating the bird numbers means that pet cats kill at least 20 million birds a year in Britain, though James Serpell of the University of Pennsylvania considers the figure "ridiculous" and insists a reliable study has never been done.

WHICH IS SMARTER: DOG OR CAT? "The answer is we'll never know, until someone comes up with an intelligence test fair to both," says Bruce Masterton, professor of psychobiology and neuroscience at Florida State University. "Suppose," he continues, "you had a test that required the animal to respond to hand signals. The dog would win. On the other hand, a cat would win a test that required stalking a mouse in tall grass. The problem is the same: We don't know if we're asking the question in their language."

Do cats, perchance, dream? "They have rapid eye movements during sleep, so they may," says James Serpell.

Dream of what?

"I don't think I want to know."

Perhaps, considering the urban angst we subject them to, they don't so much dream

as have nightmares. In New York I make a house call with Carole Wilbourn, cat therapist. The patient, P____ (professional confidentiality, you understand), an eight-year-old black-and-white shorthair, has been diagnosed with aggressive cat syndrome. He has chewed the stereo, phone, and VCR wires. He will not use the litter box. He attacks his owner. Valium has been prescribed. Look at it from P____'s point of view, Carole says empathically. A traumatic kittenhood. Inadequate nurturing. Little wonder P____ suffers from low self-esteem and anxiety. Cats have feelings too, she says.

As she talks, Carole sprinkles catnip from a tiny velvet pouch and makes soothing sounds. This is P____'s seventh session (at $95 a visit). "When someone suggested a cat therapist, I wondered if I needed one instead," P____'s owner confesses. "But it works."

Carole clicks on a tape with New Age music. P____ rolls over on his back, thrusts his paws up in the air, and promptly closes his eyes. I am tempted to curl up myself.

What is it about cats? I ask Carole, who majored in psychology, then worked with a veterinarian before starting her practice as a cat shrink 24 years ago. In reply she reminisces about the cats she has owned. The pets who provided companionship through difficult times and two failed marriages.

What is it about cats? "They're always there for you," Carole answers. We stare at each other for a moment. She looks as if she may cry.

THE THINGS WE LEARN from cats . . . *To nurture:* "The cats help me care. In taking care of them I feel that I care more about other living things," says Eric Weaver, a convicted felon. He and six other prisoners—in for crimes ranging from murder to robbery to rape—sat around in a circle in a room at Lorton, a penitentiary south of Washington, D.C., and spoke about the cats they care for as part of a

For owners perplexed by furry misbehavior, cat therapist Carole Wilbourn, with calico patient Millie, offers dual-species "family therapy." Wilbourn believes pet cats act on emotions as complex as the tangle of feline fears and desires pictured in this dreamlike setting.

prison project known as People-Animals-Love (PAL). Talk turned to Six Pack, the cat with six toes; Refugee, the cat everyone steps around; Big Red, the toughest cat in the compound; and Tom, who loves to chase bugs.

"The men learn what it means to be needed," says Earl Strimple, the Washington veterinarian who started PAL and also provides medical care to the Lorton cats. "They learn a nurturing sense that enables them to connect with other people. They learn that if they don't take care of the cat, it won't make it." They learn something about love.

"So how do you know which cat belongs to who?" Strimple once asked an inmate.

"If you whistle and it comes to you, it's your cat," he replied.

To know nature: "I like the fact that my cat goes out and participates in the natural world," says the University of Pennsylvania's James Serpell. "She is a link between two worlds: important for those of us raised in cities. Some pets just become part of our world. But if we are fortunate, we have an animal whose world we become part of."

To bear death: "Especially for children," says Michael Fox, vice president of the Humane Society of the United States. "The death of a pet is a hideous wrench, but it teaches children to go through that process. When one of our cats, a female Siamese, died, my son cried and cried. 'I miss Lily,' he said. 'Do animals go to God's heaven?' Heaven is a place where all beings are, including Lily, I told him."

To bear life: A friend reveals that her cat kept her from suicide. The thought of someone else caring for her pet after her death was more than she could bear. And so each painful day for a year, she opened cans and fed her cat, her responsibility for its life the slim, solitary tie to her own.

"I don't doubt that," Ellen Noonan, a consulting psychologist in London, told me. We sat in her living room, separated by a pot of tea and plate of cookies. On the bookshelves sat china cats; on the walls, etchings of amused cats and dignified, regal cats; needlepoint cats on pillows; and somewhere in the house (or perhaps the garden) there was a real cat, a kitten named Melrose, tortoiseshell successor to Pekoe, who had died three years earlier, purring by her owner's side, "contrary to the end."

"I mourned her as I have never mourned anything or anyone else before or since," Ellen Noonan said. She is a thin, angular woman, cool and elegant, and her formality belied the passion of the statement.

The human-cat relationship is a mix of complicated and uncomplicated, she suggested. We mother them and they us. We hold conversations about sensitive family matters with them, conversations meant to be overheard, to ease the difficulty of saying such things directly. We signal what we want from others by saying what we get from a pet. "We wear ourselves at the end of our leads," was how she put it.

Cats may exasperate. They may not come when called. They may not eat when fed. They may shred the couch. Ruin the rug. Tear the drapes. But, unlike humans, they do not wound. Instead, they awe.

The wonder of cats: large and small, tame and wild. There is, in the unfolding of 34 million years of grace and power, a sublime, if terrible magic—a moment when the heart stands still, when to breathe would be to make the spell vanish.

For Blaire Van Valkenburgh, professor of biology at UCLA, it was the sight of an uplifted tail moving through grass—a leopard in Kenya that suddenly charged up an acacia to snatch a vervet monkey in its jaws. For Mauricio Antón, the Madrid-based artist whose paintings illustrate the following story, it was the gaze of a lion in Botswana. "A high-voltage stare. You can't help feeling like prey for a moment." For John Seidensticker it was the mountain lion he'd been tracking all summer in Idaho, which turned round and started tracking *him*.

For Andrew Kitchener, curator at the Royal Museum in Edinburgh, Scotland, it was as a child of six, building a sand castle on a beach on the Isle of Wight, when a puma hurtled toward him.

"Though it was attached to a lead held by a man, and despite the fact that I had read in my *How and Why Wonder Book on Wild Animals* that pumas do not usually harm people, I ran away as fast as I could, my bewildered sister in tow." Thirty years later, and his voice is still burnished by wonder. "The horror of that moment has never left me, but I have come to terms with cats." □

Learn more about the ways of cats in mid-June at www.nationalgeographic.com.

The Family Line

The Human-Cat Connection

KAREN KUEHN

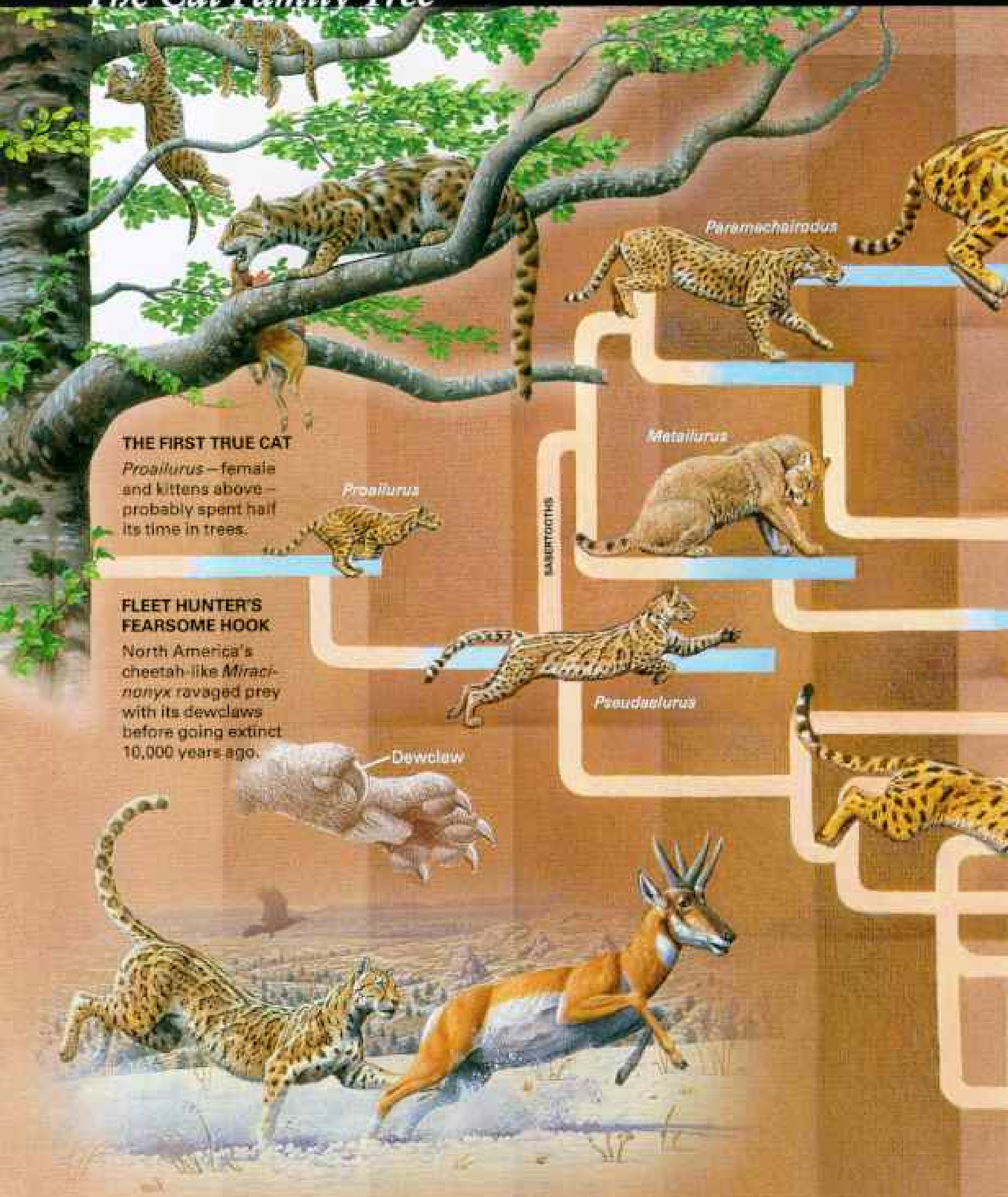
WHEN DID YOU LAST SEE someone dressed up as a dog? Maybe never. A cat? Well, yes. Catwoman—Batman's nemesis—the Cats in Andrew Lloyd Webber's musical, and trick-or-treaters with cat mask and tail all somehow ring true. I like to think that science explains our occasional urge to morph into cats: If you consider cats and humans in terms of life's underlying structure, the genetic code, we are in fact astonishingly alike.

In the early 1980s my research group, the National Cancer Institute's Laboratory of Genomic Diversity in Frederick, Maryland, began identifying the genes that make a cat a cat—its genome. Our spark was the Human Genome Project, an international effort that has also spawned genome projects for dogs, mice, flies, and worms.

In effect we're explorers of a new interior world—biological mapmakers

By STEPHEN J. O'BRIEN
Art by MAURICIO ANTÓN

The Cat Family Tree



THE FIRST TRUE CAT

Prosilurus—female and kittens above—probably spent half its time in trees.

FLEET HUNTER'S FEARSOME HOOK

North America's cheetah-like *Miracinonyx* ravaged prey with its dewclaws before going extinct 10,000 years ago.

OLIGOCENE
35.5-23.5 MILLION YEARS AGO

MIOCENE
23.5-5.3 MILLION YEARS AGO

From the time of their earliest known existence—more than 30 million years ago—cats possessed familiar feline traits. Between 10 and 15 million years ago sabertooths developed. With burly bodies, an ambush hunting style, and dramatic teeth they attacked even the largest prey successfully. Recent analysis of DNA from Smilodon *bones by author Stephen O'Brien suggests that the New World sabertooth is part of the modern big-cat family, contrary to traditional fossil studies.*

The fossil record of the modern cats is generally less than two million years old. (Blue shading on the family tree indicates extent of fossil record.)

MARSUPIAL
Thylacosmilus
LATE MIOCENE TO EARLY PLIOCENE

NIMRAVID
Barbourofelis
LATE MIOCENE

SABER-TOOTHED CAT
Megantereon
LATE MIOCENE TO MID-PLEISTOCENE

Elongated fangs and wide-gaping jaws evolved independently in cats, marsupials, and extinct carnivores called nimravids. No saber-toothed predators exist today.

GENETICALLY RELATED CATS

Ocelot lineage
7 species

Domestic cat lineage
7 species

Puma lineage
3 species

Pantherines

Panther lineage
6 species

Lynx lineage
5 species

Rusty-spotted cat lineage 1 species

Serval lineage
1 species

Caracal lineage
2 species

Bay cat lineage
2 species

Asian leopard cat lineage 4 species

PLIOCENE
5.3–1.8 MILLION YEARS AGO

PLEISTOCENE
1.8 MILLION–10,000 YEARS AGO

Here, too, genetics is changing our picture of family relations. The supersprinter adaptations of the cheetah seem to set it apart from all other cats. But DNA studies show that modern cheetahs are closely related to pumas. However the cat family tree is classified, British veterinarian David Taylor declares that it "boasts the most cunning, subtle, dangerous, handsome, and valiant mammals on this planet."

THE ROOT OF DNA TREES

Genetic studies of cats reveal new relationships. DNA-based family trees derive from the "molecular clock" principle. Genetic mutations are thought to accumulate at a steady rate, so the amount of genetic difference between species indicates when they split from a common ancestor.

plotting the exact location and sequence of DNA in each gene. If you imagine the genome as an encyclopedia, molecules of DNA are the letters in the sentences, and the sentences are the genes themselves. Chromosomes, the tiny cellular structures that carry the genes, correspond to the different volumes of the encyclopedia. Only by knowing the sequences of the letters—the DNA—can we hope to read the whole encyclopedia.

About 7,000 of the estimated 100,000 human genes have been mapped so far; we have pinpointed about 100 genes in the cat genome, which has about the same number of genes as that of humans. Virtually every cat gene has a human counterpart, and the sequence of the DNA in the two species is so similar that it's possible to determine which gene is which just by comparing their DNA sequences.

Our immediate aim is to establish the genetic basis of the many hereditary defects in cats, described over the years by veterinarians, that appear identical to such human afflictions as hemophilia. Cats also suffer from some of the same cancers as people and from similar devastating viral infections, including a version of the one that causes AIDS.

It's really not surprising that we have so many diseases in common with cats. Over millions of years of evolution, members of the cat family, the Felidae, have stayed closer—genetically speaking—to humans than our best friend, the dog, and all the other mammals except apes and monkeys.

Because cats and humans are such a close genetic fit and because cats, both wild and domestic, have evolved genetic solutions to various diseases, understanding these strategies can provide important clues about our own responses to those diseases. By unlocking the secrets in genes, we are hoping to find better treatments, and even cures, for fatal maladies in humans and cats as well.

Last fall my team and other scientists jointly announced an important discovery about the AIDS epidemic: One in five Americans of European descent carries a mutation in a gene called *CCR5*. When inherited from both parents, this mutation provides resistance to infection by human immunodeficiency virus (HIV), even in people who have had heavy exposure.

Before this finding many AIDS researchers had pooh-poohed the notion that gene differences among people had any role in HIV infection. But what we'd learned a decade earlier from lions, cheetahs, and leopards gave us the resolve to search for genetic resistance in humans.

MICHAEL NICHOLS (OPPOSITE)

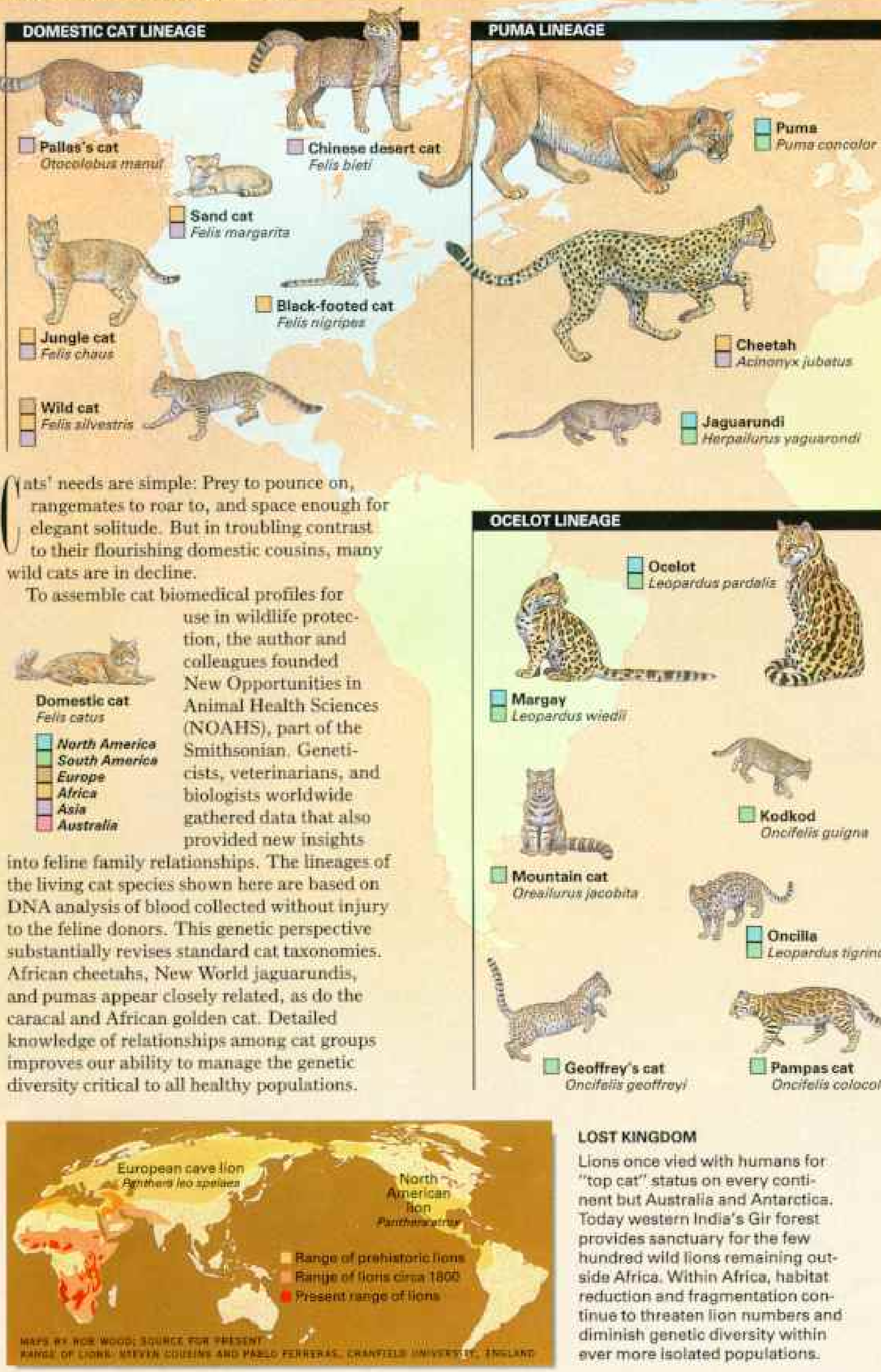
Using DNA, biologist Sriyanie Miththapala and the author reduced 30 leopard subspecies to eight (map, above). Veterinarian Melody Roelke-Parker (opposite) collected genetic data on severely inbred Florida panthers, concluding that their survival hinged on breeding with a genetically diverse related subspecies. Translating research into conservation, Texas cougars were introduced in 1995 to diversify the panthers' dangerously small gene pool.

Now, with *CCR5*, we've opened up many new possibilities for fighting HIV, which has infected 22 million people and killed more than 6 million worldwide.

MAN, WOMAN, cat, or mouse—it's the assemblage of genes, encrypted as a string of DNA molecules, that dictates how we look and even affects how we behave. Recent advances in the field of molecular genetics make it possible to locate individual genes on chromosomes, which may hold as many as 10,000 genes, organized in a long line not unlike the rolling cars of a railroad train.

STEPHEN J. O'BRIEN received a National Geographic Society research grant in 1985 for his groundbreaking work in cheetah genetics. A principal contributor to the Human Genome Project, he holds adjunct faculty appointments at seven universities. Paleontological artist MAURICIO ANTÓN specializes in reconstructing extinct cats.

The World of Cats



Cats' needs are simple: Prey to pounce on, rangemates to roar to, and space enough for elegant solitude. But in troubling contrast to their flourishing domestic cousins, many wild cats are in decline.

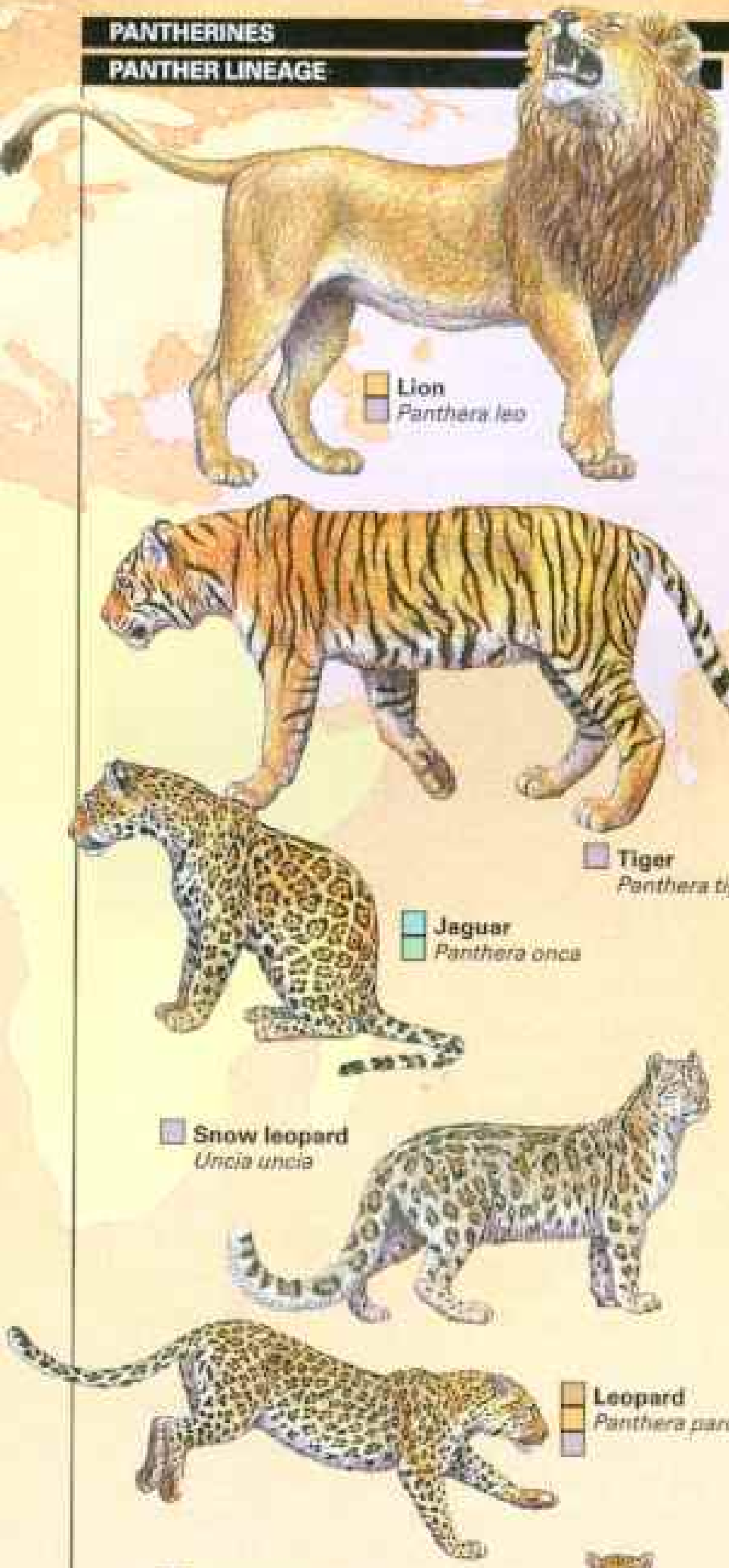
To assemble cat biomedical profiles for use in wildlife protection, the author and colleagues founded New Opportunities in Animal Health Sciences (NOAHS), part of the Smithsonian. Geneticists, veterinarians, and biologists worldwide gathered data that also provided new insights into feline family relationships. The lineages of the living cat species shown here are based on DNA analysis of blood collected without injury to the feline donors. This genetic perspective substantially revises standard cat taxonomies. African cheetahs, New World jaguarundis, and pumas appear closely related, as do the caracal and African golden cat. Detailed knowledge of relationships among cat groups improves our ability to manage the genetic diversity critical to all healthy populations.

LOST KINGDOM

Lions once vied with humans for "top cat" status on every continent but Australia and Antarctica. Today western India's Gir forest provides sanctuary for the few hundred wild lions remaining outside Africa. Within Africa, habitat reduction and fragmentation continue to threaten lion numbers and diminish genetic diversity within ever more isolated populations.

PANTHERINES

PANTHER LINEAGE



Lion
Panthera leo

Tiger
Panthera tigris

Jaguar
Panthera onca

Snow leopard
Uncia uncia

Leopard
Panthera pardus

Clouded leopard
Neofelis nebulosa

SERVAL LINEAGE

Serval
Leptailurus serval

RUSTY-SPOTTED CAT LINEAGE

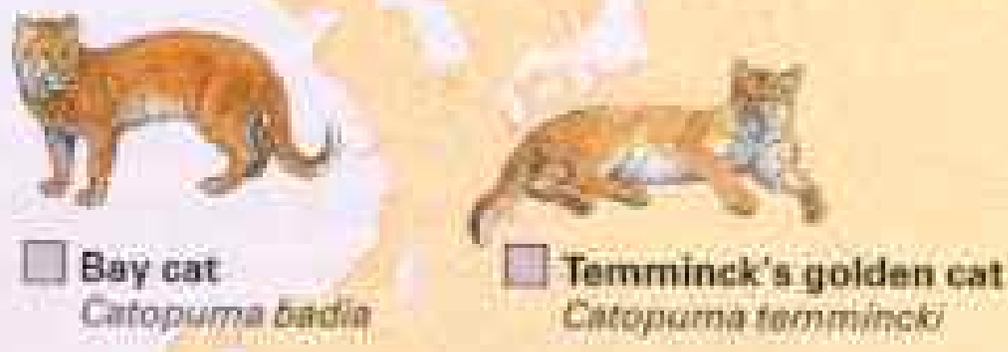
Rusty-spotted cat
Prionailurus rubiginosus

CARACAL LINEAGE

Caracal
Caracal caracal

African golden cat
Profelis aurata

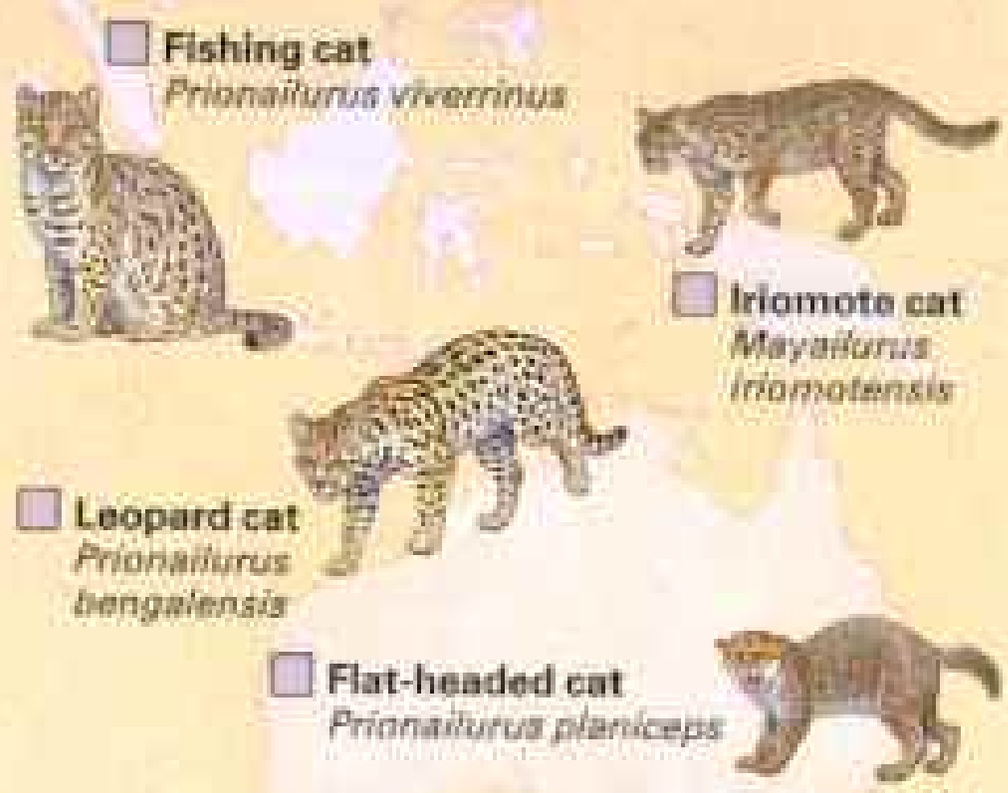
BAY CAT LINEAGE



Bay cat
Catopuma badia

Temminck's golden cat
Catopuma temminckii

ASIAN LEOPARD CAT LINEAGE



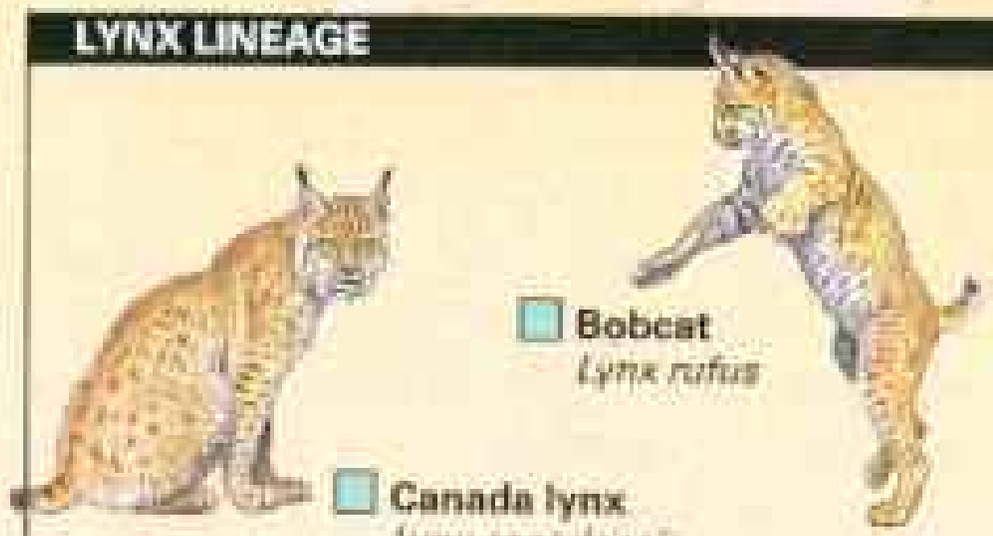
Fishing cat
Prionailurus viverrinus

Iriomote cat
Mayailurus iriomotensis

Leopard cat
Prionailurus bengalensis

Flat-headed cat
Prionailurus planiceps

LYNX LINEAGE



Bobcat
Lynx rufus

Canada lynx
Lynx canadensis

Marbled cat
Pardofelis marmorata

Eurasian lynx
Lynx lynx

Iberian lynx
Lynx pardinus

In sleuthing genes we enlist the help of numerous cats: domestic cats in labs and veterinary schools, show cats representative of fancy breeds, zoo animals, and wild cats. First a veterinarian checks the cat's basic health; then, causing minimal discomfort, we draw a blood sample. It's that simple.

We use two main approaches to build the gene map. The first involves examining blood samples from a family group of cats to determine the inheritance patterns of different traits, such as coat color and genetic diseases. Through statistical analysis, we find the general location on a chromosome of the DNA sequence containing the gene responsible for coat color. Once we've determined the right neighborhood for the gene, we use techniques of molecular biology to establish its exact DNA address.

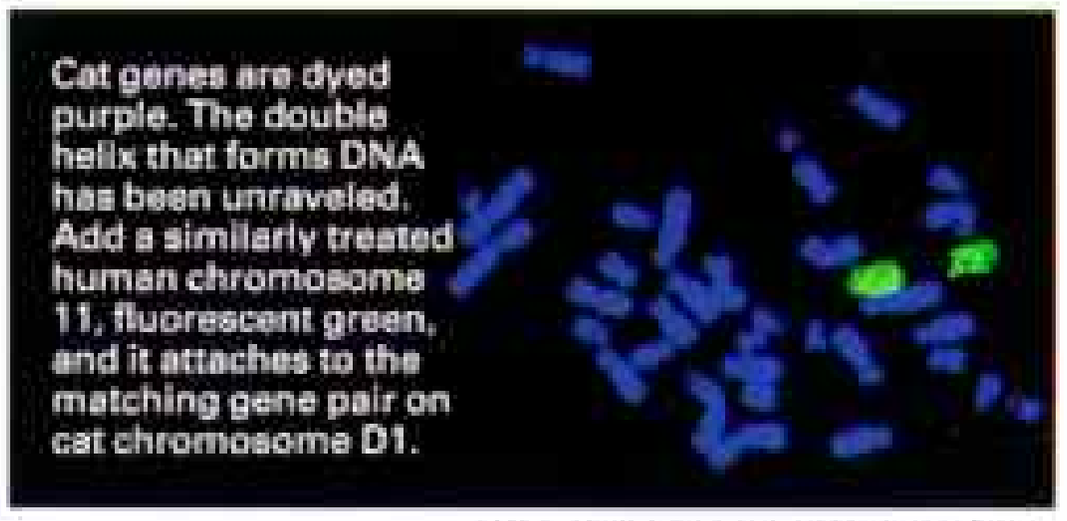
We've come far enough with this work to see just how close the genome match is between cats and humans (illustration at right). Long strings of human genes, sometimes extending over an entire chromosome, are repeated when the same genes are mapped in cats. (Humans have 23 pairs of chromosomes in each cell; cats, 19.) In chromosome after chromosome, the same genes are hooked together, so that if you were to rearrange just a few cat chromosomes, you would convert its gene order into the human pattern. To do that for a dog or a mouse would require about a hundred chromosome flips.

GENOME MAPPING gives us new perspectives on incurable diseases, as *CCR5* shows. As recently as the 1970s we knew little about how cancers begin, why tumors grow so uncontrollably, or how to stop them. Cats are interesting to cancer researchers because they have been found to transmit leukemia through an infectious agent: feline leukemia virus (FeLV). How FeLV turns white blood cells into self-replicating leukemic cells has clarified and broadened our view of cancers.

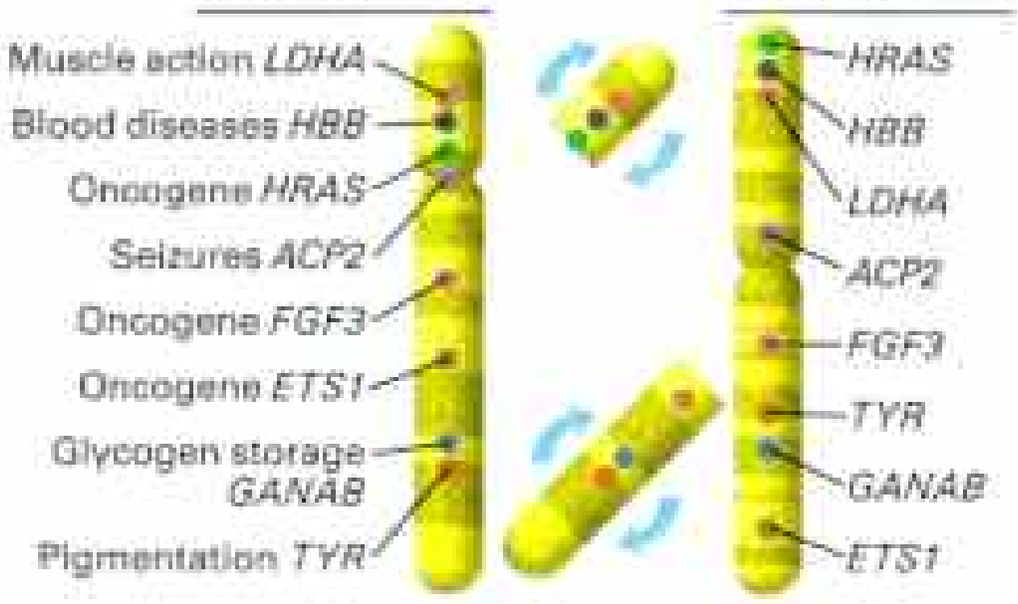
In infected cats the leukemia virus seeks out the white blood cells in the lymph nodes, spleen, thymus, and bone marrow, where it integrates its own genome into chromosomes adjacent to a special kind of gene called an oncogene (Greek for "cancer gene"). Oncogenes have been found in humans, monkeys, mice, and chickens, for example, as well as in cats, and we now know of more than 150 such genes in nature. Some oncogenes switch on just once, during the fetal stage, to stimulate the genes responsible for the differentiation of organs and tissue. By the time a kitten—or baby—is born, they are turned off. But when FeLV integrates itself next to an oncogene in an infected cell, it can switch the gene back on, triggering uncontrolled cell division—the hallmark of cancer.

Today human oncogenes are the object of designer drugs, revolutionary treatments whose purpose is to search and destroy tumor cells. Thanks in no small measure to cats, we're beginning to figure out how cancer, a disease of the genes, actually works.

We're also sharpening our ability to fight



JOAN C. MERRINGER AND STEPHEN J. O'BRIEN



the group of scourges known as emerging viruses, which affect animals and humans alike. These viruses are aggressively opportunistic germs that can jump from one species to another, wreaking havoc as they go. AIDS and Ebola, which appeared recently in humans and kill most of those infected, are notorious examples. There are many other diseases—from influenza, hantavirus, and Rift Valley fever to rabies and dengue fever—that incubate in animal or insect species. Often quiescent in their hosts, the viruses cause debilitating symptoms and even death when transmitted to humans.

The effect of one such virus in cats has taught us an unexpected—and promising—lesson in genetics. In 1990 at a conference

of medical researchers, Bob Olmsted, a senior fellow with the National Institutes of Health, announced his determination of the DNA sequence of the feline immunodeficiency virus (FIV), which causes the immune system of domestic cats to collapse.

Over coffee Bob and I wondered aloud what would happen if FIV jumped to wild cats. Would it ravage their populations? The prospect horrified me because most species of wild cats are already considered threatened or endangered.

We immediately began screening more than 2,000 blood samples collected over the years from 27 species of wild cats. A number of individuals from 18 of those species—among them lions, pumas, leopards, ocelots, and jaguars—had antibodies to FIV, meaning that they had been exposed to FIV. The same was true for cheetahs, Ngorongoro Crater lions, and Florida panthers, which may be in even greater danger. Squeezed by human activity into ever smaller areas, these big cats have become inbred, with severely reduced genomic diversity. Their immune systems are genetically uniform and, as a result, are easy targets for viruses like FIV.

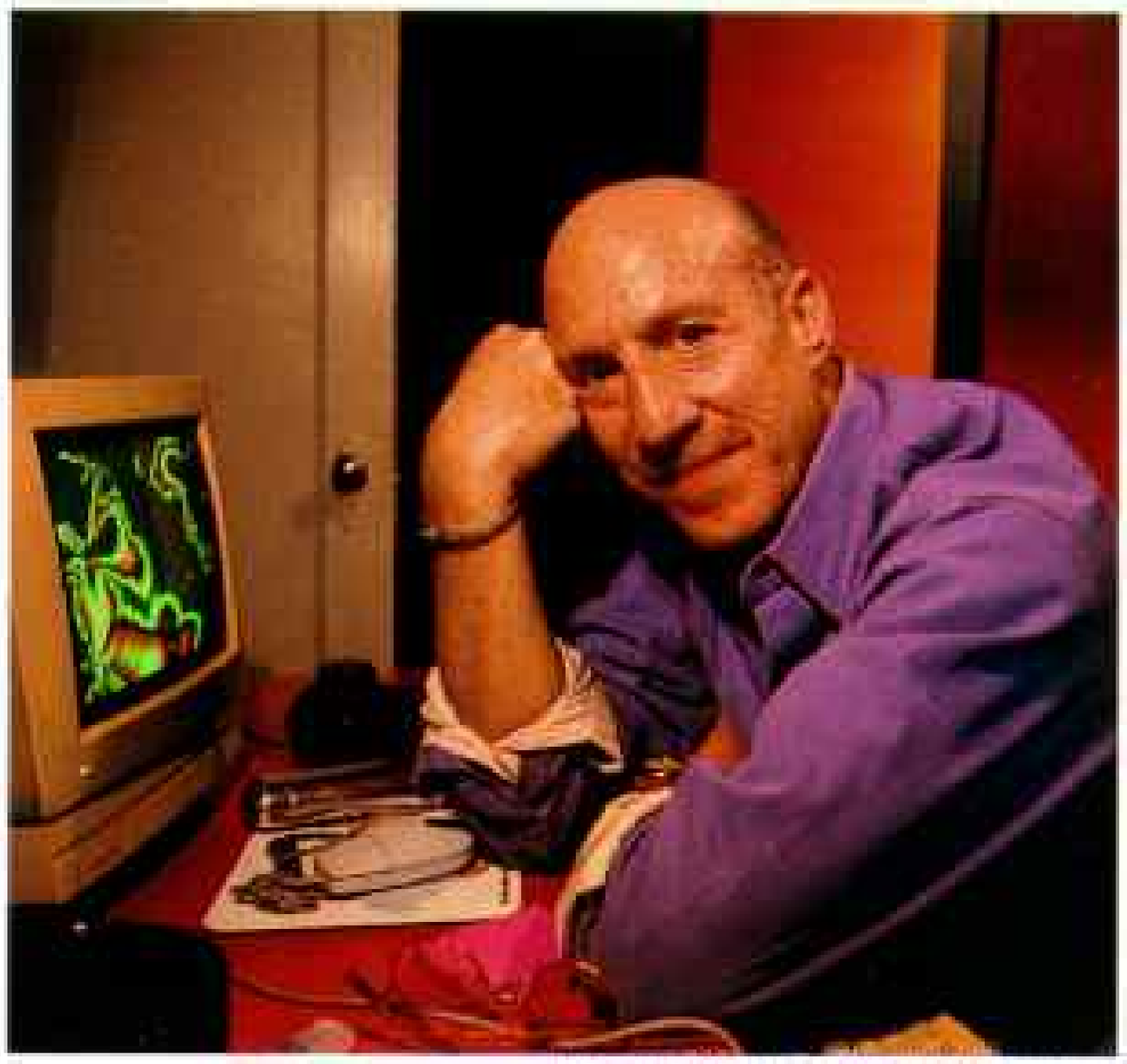
I feared the worst—a massive outbreak of the disease in all these cats. Certain disaster.

It took several field seasons of observations of Florida panthers and lions in the Serengeti to assuage my fears. As best we could tell, the virus was not killing or harming the animals we watched. They were in fact living to ripe old ages.

HOW DO WILD CATS avoid the death sentence FIV confers on domestic cats? In the wild the disease-inducing virus was somehow neutralized in the descendants of cats that survived the original outbreak. One explanation is that the virus itself may have changed, becoming less deadly. Another is that immune-defense genes protect some but not all cats from the virus by tempering its furor. Viruses like FIV and HIV mutate rapidly, so this genetic defense may also be an effective prevention against secondary infection by a new "hot" strain of the disease. Quite possibly gene adaptations in both virus and cat take place at the same time.

We're searching now for the cat genes that provide innate resistance and for the virus genes that might have changed in response to the host. Uncovering such evolutionary strategies will enable us not only to further improve our lives through medical progress but also to figure out better ways to protect the endangered cats themselves.

If you think about it, the cat may really be man's best friend. But whatever your opinion about that, there's no denying the benefits arising from a genetic bond that has linked cats and humans for millions of years. □



Genes linked on a human chromosome also appear on a cat chromosome, and each can be used to identify the other (micrograph, left at top). Chromosome maps (left at bottom) show the scientific designation for each gene and illustrate genetic parallels so close that simply inverting two segments of the cat chromosome makes its gene arrangement mimic the human one. Another parallel holds special promise: Some humans, like New Yorker Steve Crohn (right), seem to be genetically protected against the effects of HIV. Some wild cats also seem to resist the feline immunodeficiency virus, FIV. Understanding these DNA-coded defenses may lead to more effective treatments.

NATIONAL GEOGRAPHIC PHOTOGRAPHER JODI COBB

Okinawa

Claiming its birthright

By ARTHUR ZICH
Photographs by KAREN KASMAUSKI

Striving to assert its island heritage, Okinawa chafes at dominance by Japanese influence and the American military presence. Accidents and noise pollution from aircraft such as a Marine helicopter above Shioya stir up rancor against the U.S. bases that cover a fifth of Okinawa's main island. Tourism boosts a struggling local economy that long banked on civilian jobs at the bases, which many islanders now want removed. The Okinawans' target: full recognition of their distinctive culture.

SAFFRON AND SCARLET brighten a performance in Ginowan of *Yotsudake,* an elegant indigenous dance that reveals contributions from China and Southeast Asia as well as from Japan. Interest in the Okinawan language and performing arts flowered after World War II, helping to renew a people weary of war—and of efforts by Japan to suppress their cultural identity.

WARTIME SORROWS run deep at the Himeyuri Peace Museum near Itoman. There 203 teenage nurse's aides died in caves during 1945's horrendous Battle of Okinawa. Some killed themselves, following exhortations by Japanese commanders who insisted that advancing U.S. troops would savagely rape and kill them.

OKINAWA CITY had grown up so it was barely recognizable. But a small plaque on a doorframe brought the past rushing back. *Kimura*, the Japanese characters read. An old lady in a kimono answered the door.

"Hello, I'm Art," I said in rusty Japanese. "I lived here 38 years ago."

She eyed me suspiciously. Then a light of recognition crept across her face. *"Akto-san!"* Mrs. Kimura cried.

Mrs. Kimura had been my landlady when I was stationed on Okinawa as an airman in the late fifties and first fell under the island's spell. She welcomed me inside like an old friend. Mr. Kimura hopped to fetch me a frosty Orion beer, and I settled down on the tatami mats to catch up on their lives.

Kimura-san, now 75, retired 15 years ago, after three decades of service as a security guard at a United States Army base. He pointed proudly to the framed commendation letters that crowded the walls. I recalled the beaming young Kimura of old, on his rickety bicycle, earnestly saluting me as he pedaled off to work. America could hardly have had a more loyal friend back then.

Kimura and I were first brought together by the Cold War. In the closing months of World War II, U.S. armed forces wrested Okinawa from Japan. It was the largest land, sea, and air battle of the Pacific, and the Okinawans suffered terribly. In its aftermath the U.S. stayed on, helped rehabilitate Okinawa's hapless people, and turned the island into the keystone of American military defense in the Pacific.

Four hundred miles off the China coast, Okinawa continues to serve as a jumping-off point for the defense of U.S. interests in Taiwan, Korea, and the rest of the Asian mainland, and as the linchpin of the U.S.'s mutual security treaty with Japan. As a senior U.S. official told me, "North Korea is unstable and dangerous. China's military power is growing; its future leadership—who knows? Peace in this region depends on American military presence. And there is no better place for that than Okinawa."

In September 1996 Okinawans mounted a nonbinding referendum on the future of that presence, which included calling for the reduction of U.S. forces. When I asked Kimura how he had voted, his answer reflected the sentiment of almost 90 percent of the voters. "Out," Kimura-san said firmly. "Better no more bases here."

Driving the island's jungled northern mountains, its twisting coral seafront, and its more built-up southern reaches, I could clearly see why Okinawans feel the way they do. Mile after mile of chain-link fence topped with barbed wire encloses the bases. U.S. Marines bar the gates. Inside, broad thoroughfares, spacious officers' homes, and banyan-shaded golf links roll on for miles. Screaming jet aircraft crease the island's skies. The thud of Marine artillery echoes off its verdant slopes. Even at sea, under sail at night, I was reminded by

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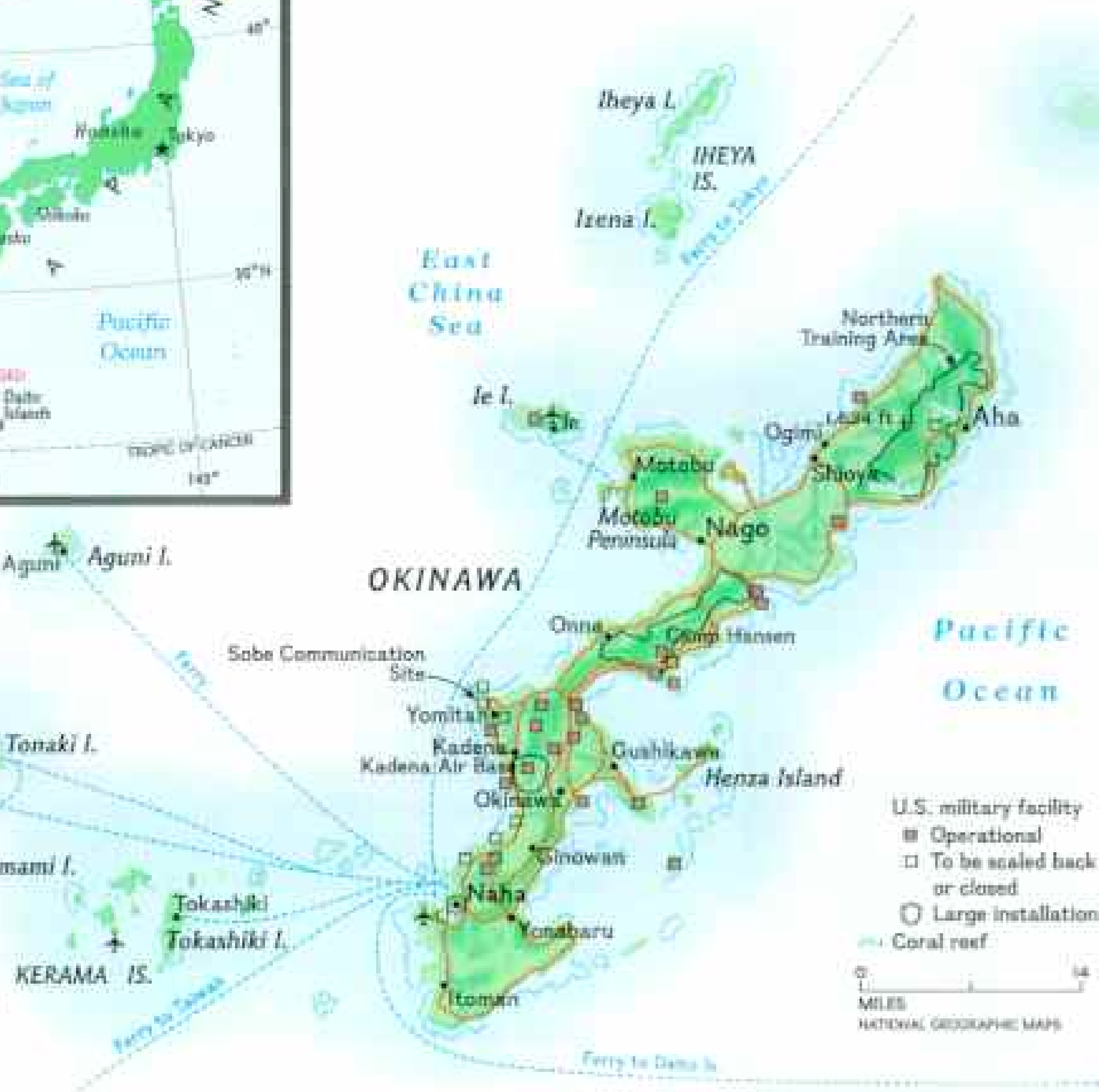
ARTHUR ZICH has reported on Asia for more than 30 years. This is his seventh story for the GEOGRAPHIC. KAREN KASMAUSKI has photographed three previous articles on Japan for the magazine, most recently "Kobe Wakes to a Nightmare" (July 1995).



OKINAWANS FIRST, Japanese second, Islanders occupy the southern part of the Ryukyu archipelago, once a kingdom in its own right. Centuries of trade with China under a string of dynasties dating from the 14th century have flavored the culture. Japanese warriors invaded in 1609; Okinawa was made a prefecture in 1879. Japan's World War II defeat led to U.S. occupation until the islands reverted to Japan in 1972. The 1.27 million Okinawans share their land with 28,000 Americans stationed at 38 sites, 30 of them on the main island alone.

the red landing lights of Kadena Air Base that the threat of war remains a fact of life.

Accidents have inevitably happened. Plane crashes, errant bombs and artillery shells, gas leaks, and fuel and chemical spills have taken a toll on islanders' lives and patience. Two years ago Americans and Okinawans alike were shocked when three U.S. servicemen abducted and raped a 12-year-old Okinawan schoolgirl.

As I returned to Okinawa, I had to wonder if the military presence, together with a frantic rush toward modernization, has wrested something essential from the warm, easygoing people I remember—whether anything of the island I once knew and loved remained.

JAPAN'S 47TH PREFECTURE includes Okinawa and some 160 of the islands that hang like beads beneath the country's four main islands. When the U.S. occupation ended in 1972, Japan began providing Okinawan land to the U.S. for its military bases. Today there are 30 different U.S.-run facilities—in all, a fifth of the island's landmass, much of it the most valuable land on the island. The Japanese government pays most of the operating costs for the bases.

Okinawans have grown increasingly restive over both the size of the U.S. presence—Okinawa contains 75 percent of the U.S. military

facilities in Japan—and what they see as Tokyo's halfhearted efforts to redistribute it more equitably throughout the country. "The issue behind the bases is our feeling toward Japan and the government," said Yukikazu Kokuba, head of Kokuba Gumi, a giant Okinawan conglomerate with interests ranging from construction to American fast-food chains and movie distribution. "We're tired of being treated like country cousins."

This alienation dates from the 15th century, when Okinawa became united as the Kingdom of Ryukyu. The kingdom enjoyed a flourishing trade and cultural exchange with Korea, Japan, Southeast Asia, and especially China. Confucianism guided the rituals of the court, and Chinese Buddhism mingled with the Okinawans' indigenous ancestor worship.

In 1609 feudal barons from southern Kyushu swept down on the kingdom and conquered its people. Yet the Ryukyu kingdom lived on for another 270 years, though the people were vassals to Japanese masters. Okinawans were reduced to penury and prohibited from speaking Japanese, wearing Japanese clothing, or adopting Japanese names. When the feudal lords journeyed to the Japanese court, they brought a complement of Okinawans, to be shown off for the court's amusement along with exotic animals from distant lands.

In 1854 Japan opened its doors to the world. It annexed Okinawa and set about trying to assimilate its people. "We tried to be good Japanese, but it didn't quite sink in," said Nariyuki Agarie, a professor of social psychology at Meio University, in the west coast city of Nago. He chuckled. "When the Japanese crown prince visited Okinawa in the early 1920s, we lined the way to get a look at him. In the rest of Japan, casting one's eyes upon the crown prince was unthinkable."

CLAMOROUS property owners demand removal of a U.S. listening post in Sobe called the "elephant cage" for its size and appearance. Japan rents the land from 450 individuals, then provides it to the U.S. Compliance is mandatory. The protest "was sort of symbolic," said Shoichi Chibana, "but some of this land was owned by my grandfather." Many Okinawans feel Japan's main islands don't house their share of U.S. bases. Long-term pressure paid off; the facility should be relocated by the year 2001.

But by the 1930s Okinawan schoolchildren were worshiping the emperor, bowing to the Rising Sun, and singing "Kimigayo," Japan's haunting anthem.

Then came the war. As American forces swept up the Pacific, Okinawa stood as the last bastion between Japan's lost empire and its sacred home islands. The Okinawans were deceived. Japanese commanders told the people that the American fleet was being lured into a trap that would result in victory for Japan.

Instead American guns laid down what Okinawans call a "typhoon of steel." The battle raged from March to June 1945. U.S. casualties totaled nearly 50,000, including 12,500 killed or missing. But Japanese forces lost roughly ten times that number, and 150,000 Okinawans—nearly a third of the population—died with them. "Everyone here lost someone," said Okifumi Komesu, a professor of English literature at the University of the Ryukyus, who lost two members of his family. "Not many people anywhere can say that."

STORIES OF LOSS are as common as the traditional turtleback-shaped tombs that dot the island. Shoichi Chibana, a modest 48-year-old storekeeper from the west coast village of Yomitan, lost his grandfather, killed by American troops on the very first day of the invasion. He also lost the small plot of land his grandfather had left him. Chibana has been trying to get back the land, now part of a U.S. Navy communications installation, through the courts.

But Chibana blames Japan, not the U.S., for the loss of his land. Ten years ago, at the national softball games in his hometown, Chibana tore down and burned a Japanese flag. The crowd cheered. "Eight thousand Yomitan residents had petitioned against the flag," Chibana explained. "We saw it as a symbol of a war that destroyed Okinawa—a war that Japan started.

"I'm against all war," Chibana told me quietly over tea in his tiny flower shop. "If you're Okinawan, I think you have to be. For me it stems from Chibichiri Gama—the 'endless cave.' " He led me to this place down a limestone stairway, into a grotto framed in ferns and palms. A group of Japanese tourists stood about, snapping pictures of each other. Atop a memorial at the mouth of the cave sat the carved figure of a man playing a *sanshin*, the Okinawan three-string lute, his face a shadow of agony in the lowering sun. The only sound was the drip of unseen water. As we entered the cave, I felt a chill.

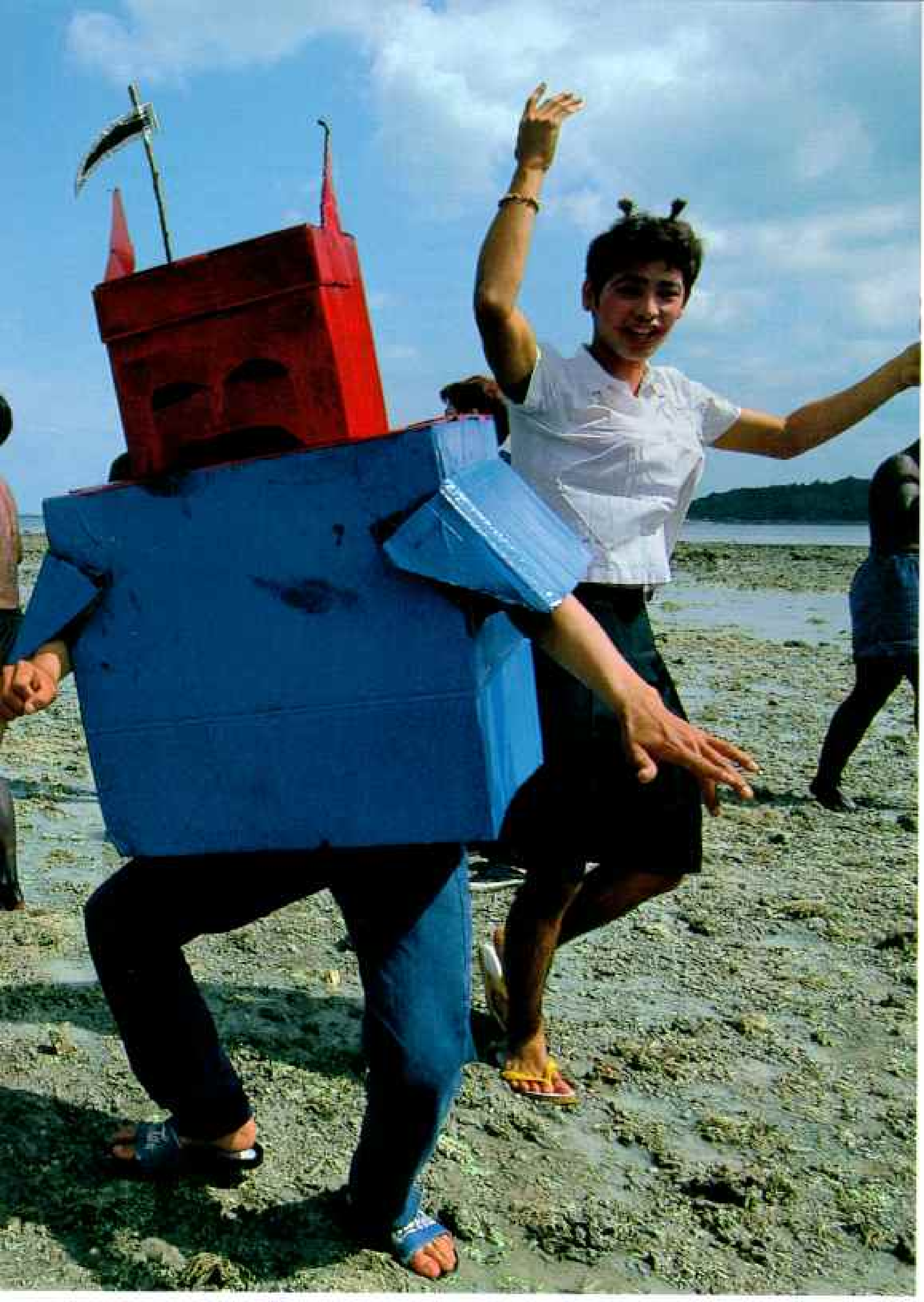
"Eighty-five people died here. Forty-seven were children," Chibana said quietly. The tourists stopped to listen. "Japanese militarism had imbued these people with the idea that suicide was better than capture and torture by American 'devils.' So mothers slaughtered their children with knives, sickles, flaming oil from their oil lamps. The large bones are buried here near the mouth of the cave." He gestured to a burial site strewn with flowers and unlit candles. "But the interior is closed off. Because the smaller bones—the fingers, toes, and teeth—are still there, and people walking on them will disturb the spirits of the dead."

As Chibana spoke, an old Okinawan woman, wrinkled, stooped, and well past 80, hobbled down the stairway and into the cave to tidy up the burial site and take away dead flowers. As she started to leave, one of the Japanese visitors asked her her name. The woman turned and pointed to the cave's hollow darkness. "Ask my

PUNCHING THE SKY, an F-15 jet fighter heads for Kadena Air Base. American icons welcome military personnel to hotels and apartment houses. But public opinion took a nosedive in 1995 when three U.S. servicemen were accused of kidnapping and raping a 12-year-old Okinawan girl. They were later convicted.

Cleared of military housing ten years ago, a prime tract in Naha is poised for development.

YOUTHFUL SPIRITS cavort during a spring festival on Henza Island. Dressed as a woman just for fun, a boy joins in a dance with two robotic figures as other merrymakers with fake harpoons and body paint impersonate Polynesians. The festival originated as an invocation for bountiful fishing, a trade now largely eclipsed on the island by oil refining.



mother!" she said. "Ask my father! My two sisters and brother! They're all in there!"

OKINAWA HAS RISEN from the ashes of war, but peace has brought a new set of troubles. "We have serious problems here," Governor Masahide Ota, the driving force behind the recent referendum, told me. "Per capita income is the lowest in Japan. Unemployment is twice the national average. In the fifties money from the U.S. military was about 40 percent of Okinawa's total income. It's now around 5 percent. Base employment is barely a fifth of what it once was. Tourism is taking its place. But that's not enough. We cannot develop our industries without regaining some of those lands."

The village where I lived in the fifties, outside Kadena, typifies Governor Ota's concerns. It had grown up catering to the air base's personnel, its economy built upon on-base jobs like Kimura's, and off-base bars, brothels, and tailor shops. That income had withered with the reduction of forces. Every other shop had a "For Rent" sign posted out front.

Traffic around the military bases has become hellacious. One stretch of the two-lane road that meandered north along the East China Sea is now a multilane freeway suffering from gridlock. Its flanks are chockablock with garish pachinko parlors (a Japanese pinball gambling game), used-car lots festooned with flags, and fast-food joints. Construction has laid bare large tracts of Okinawa's loose red dirt, which washes to sea in annual rains and is killing the coral reefs.

Tourism is an economic mainstay now, and I could see the effects everywhere. Once pristine beaches were clogged with visitors from the main islands staying at pricey hotels owned by Japan Airlines and All Nippon Airways. On Saturday nights Naha's main street, Kokusai Dori, which I recalled as GI Nightclub Row, was a neon midway of Japanese tourists, Okinawan girls in leathery hot pants, and guys wearing earrings and baseball caps turned backward.

But as I traveled out beyond Naha, I realized that the Okinawa I knew was not all gone. Shuri Castle, seat of the Ryukyu kingdom, had been rebuilt with Japanese government funds after its destruction in the war, and the sun still rises over its curved, red-tile roofs. Afternoon thunderheads still stack up over the island's northeast shoulder. The tides roll in over the long reef ledges. And its people still harken to the land's timeless rhythms, its rust red earth and fecund sea—still cling to their ancient values and vibrant culture.

GOOD TIMES ROLL on Miyako Island as a *moai,* or investment club, conducts a well-lubricated monthly gathering. Donations provide low-interest loans for business ventures. "It's easier than a bank and less paperwork," says a member. "But we must trust each other."

In a moment of trust and tenderness, Yukio Arakaki and his daughter Yui compose a tableau of family closeness, a hallmark of the Okinawan character.

ON THE ISLAND'S rugged northeast coast, in the village of Aha, 70-year-old Takeo Miyagi works his pineapple fields, unmindful of development and tourism, as he has for more than 40 years. He showed me an old black-and-white photograph of his village as it was long ago. A cluster of wood-frame, thatch-roof houses nestled against a wild mountain jungle. Now the houses are concrete with flat roofs. The old dirt road through the village is paved, and above it a thicket of electric wires signals the advent of progress. Miyagi-san invited me into his new home and told me how his life had changed, yet remained the same.

Miyagi and his wife, Haruko, have been growing pineapples for as long as there have been roads to get them to their crops. When they married 47 years ago, they lived in one of the old houses, where *habu,* Okinawa's venomous pit vipers, would sometimes wander in. "We built the house ourselves, with trees from the forest and a community spirit we call *yuimaru,*" Miyagi told me. "Everyone pitched in. The land, a modest lot, cost 300 dollars."

The Miyagis raised eight kids, drew their water from a well, and sipped sake by the light of oil lamps at night. If they didn't get enough rain, they went down to the sea and prayed. Their children have grown and moved away. The habu are gone too. The Miyagis now have running water. They sip iced Nescafé and watch the Yomiuri Giants on a color television. Their new house and land, only marginally bigger than the original, cost them $318,000.

"But it's still the wife and me," Miyagi said. His deep-set eyes looked off to some private horizon. "We're not going to sell the land—our kids may yet come home. And the spirit of yuimaru is still with us."

The ancient arts that spring from Okinawa's deep-red earth are alive as well. Three centuries ago Okinawan potters in a quarter of Naha known as Tsuboya, or "pot shops," fashioned giant jars for *awamori,* a local liquor distilled from Siamese rice. As post-war Naha became congested, neighbors complained about pollution from the old-fashioned, wood-burning kilns. A potter named Shinman Yamada followed his colleagues out to the forested hills near Yomitan, where they had created a community of their own, a new Tsuboya, to keep the tradition alive.

Yamada, a large, gentle man with thick babylike fingers stained red with clay, is one of the few Okinawan potters whose work is exhibited in the Mingeikan, the Folk Crafts Museum in Tokyo. His house is cluttered with a lifetime of his work—cups, plates, and urns painted in earthy reds, leafy greens, and deep-sea blues. Their designs are as simple and cheerful as traditional island life. He handed me a small blue bowl. My fingers traced its satisfying roundness. "My very first pot," he said. "Thirty-two years ago."

We went out to his studio, a shed open to the breeze, lined with racks of pots waiting to be fired. Yamada got behind his potter's wheel. He flipped a switch, and the wheel began to spin. His fingers caressed a mound of soft, wet clay, shaping it into a graceful, narrow-necked vase. "We used to do this with pedal power," he said. "But that doesn't mean we've forgotten tradition."

Nor has Okinawan tradition been lost in the vital art of living. Several miles north of the potters' colony, Motobu Peninsula juts out like a thumb into the East China Sea, and on the very tip sits a tiny pension called Bise Zaki, a quiet, banyan-shaded inn with seven

GENTLY ACCENTING its placid realm, a boat wafts above the coral reefs of the Keramas, a twenty-isle group among the prefecture's 160 islands.

Covering only 454 square miles, Okinawa, the biggest island, is noted for fine beaches. The deeply indented coast gives way to a rugged semitropical interior rising 1,600 feet. "Like a luscious pear," one observer wrote, "laid on soft, crinkly blue paper."

simple rooms, a communal dining room, and a sushi bar with six stools. Its grounds dappled with crimson hibiscus, it is an idyllic retreat favored by one of the princes of the Japanese royal family. And its diminutive, passionately Okinawan proprietor, 36-year-old Yasumi Kumamoto, is the reason why.

Kuma, as he likes to be called, has elevated the preparation of sushi to the level of fine art. He allows no one but himself behind the sushi bar. He has used the same slicing knife for 18 years. And if he should cut himself? "I squirt the cut with Krazy Glue, blow on it, and keep on slicing," he said.

Each day Kuma puts on fins and face mask and sets out from the beach with a spear to bag the seafood he needs for lunch or dinner: octopus, sea urchin, squid, giant clam, grouper, or *semi ebi*, a local lobster. "It must be fresh!" he said. "Fresh!"

"It takes ten years to learn sushi," Kuma said. He gave it 12, as an apprentice in the sushi shops of Tokyo. "I worked like hell," he said. "Up at 5:30, to Tsukiji fish market to buy fish, then slice and serve till midnight. On my day off I roamed the city tasting the competition. When I found the best, I went to work for them—and started back at square one."

EARTHLY ALIENS take slow-motion undersea excursions at a resort hotel in Onna. Headgear pumps oxygen and counteracts buoyancy. Such attractions have helped Okinawans increase tourism, although the prefecture remains the poorest in Japan. Nearly all of the more than three million visitors each year come from the country's four main islands.

But Tokyo wasn't Okinawa. "Eventually it got so I couldn't stand it," Kuma said. "The counter was full of Japanese businessmen on cellular phones! Buying property all over the world! Money, money, money! Everything was money!"

Kuma's wife, Kazuyo, brought out a tray of pineapple, guava, mango, and kiwi garlanded in orchids and hibiscus. It was something to be framed, not eaten, and it moved me to ask this master sushi carver what the difference was between Okinawans and Japanese. "The heart," he answered immediately. "*Ninjo*—human feelings. Up there it's cold." He threw up a hand to the cloudless sky. "In Okinawa it's warm! Like our sun!"

Okinawans are among the longest-lived people on earth, and I wondered if these same qualities of heart and human feelings, so evident among the islanders, might have something to do with their longevity. Shoshin Nagamine, a 90-year-old grand master of the traditional Okinawan form of karate, provided an answer. Nagamine's nickname, Chippai Matsu, means "tenacious pine tree," and he is all of that. He works out three times a day, performing all 18 exercise routines in the karate syllabus. He boasts about his 25 teeth, eats what he likes, and lectures his students on the evils of aggressiveness.

CHEERLEADERS of a certain age—and beyond—urge on men competing in a dragon-boat race at Shioya, part of a summer festival. Straw garlands proclaim their farming heritage. Women participate into their 80s; Okinawans are among the longest-lived people on earth. Credit diet, active lifestyles, and community involvement—a zest for life that many islanders feel would increase if they could just be left in peace.

"The Japanese believe that he who attacks first will be the winner—like Pearl Harbor." Nagamine snorted. "Not in Okinawa. The philosophy of karate involves *shin, gi,* and *tai*—heart, technique, and body. Karate's true value lies within the heart. Here, through meditation, we train our hearts—in concentration, endurance, self-control, and, most important, modesty of mind. *'Nuchidu takara*—Life is the most precious thing.' It's something we often say in daily life."

THE ISLANDERS have the same reverence for the dead as they do for the living. Their most solemn and sacred festival is Obon, when, it's believed, the spirits of the departed return to their ancestral homes to dwell for three days among their kin. On the last of those days I saw the strength of Okinawan faith on the tiny island of Tokashiki, some 20 miles west of Okinawa.

I was the guest of Shizu Arikaki, a 71-year-old widow and the mother-in-law of Yoko, my interpreter. Shizu-san had laid out bowls of soup, fish, rice, and other amenities on the family altar for the spirits of her husband, a son, and other relatives.

"We believe our ancestral spirits really do come back to visit," she said. "We worship them." She gave me a wry smile. "But nobody has ever died and come back to tell us what it's like, so we don't know for sure."

At midnight the family knelt before the altar. Keibun, the elder son, murmured the ritual prayers and held a sheaf of paper money over a metal bowl. His mother lit it with a match, and the ashes of the offering fell into the bowl as Keibun prayed. Yoko's husband took two stout stalks of sugarcane from the altar and placed them outside the house. "They're sending the spirits back to the spirit world," Yoko explained. "The cane is for shoulder poles to help them carry their gifts."

Keibun rose with a sigh. "Obon is over," he said. "It must be a relief," I said. "The spirits of father and brother are always welcome here," he replied. "But all those other spirits that I don't know—frankly, it's time for them to go."

My last night on Okinawa was filled with the same Okinawan warmth and gentleness I'd known as a youth living with the Kimuras. It was dark and overcast outside, with spitting rain and gusting winds that signaled an approaching typhoon. I went with friends to a tavern called Urizun, meaning "that time in spring when buds first appear." It was a tiny place of rough-hewed logs, with clusters of aromatic mountain tangerines drying on the walls. The happy crowd insisted that we press in family style at their tables and ordered up some *champuru,* Okinawa's signature stir-fry of tofu, bean sprouts, local greens, and bitter melon, and a jug of awamori for us all.

Toasts of *kanpai!* (dry glass!) rang out. Someone produced a sanshin. A local real estate broker began picking out a poignant folk song evoking Okinawa's lovely hills and turquoise waters. We all joined in. Eyes brimmed as sentiment mingled with good fellowship. A bank manager from Naha raised one more toast to this stranger from America who had lived here so many years ago. "*Ichariba chode,*" he shouted, voicing an old adage in the native dialect. "Once we have met, you are as our family!" □

SPECIAL PLACES

Hemingway's Many

Hearted Fox River

By NICK LYONS

Photographs by JAY DICKMAN

Nearly 80 years ago young Ernest Hemingway
went trout fishing on a remote Michigan river.
The fishing was good, the inspiration priceless:
From that trip flowed a classic short story
titled "Big Two-Hearted River." His story
actually describes the Fox, which remains,
as Hemingway called it, "the good place."

FALL SETS MAPLE AND BIRCH AFLAME ALONG THE FOX RIVER'S EAST BRANCH.

"Gad that is great country."

—Ernest Hemingway, of the Upper Peninsula

LATE SEPTEMBER in Michigan's Upper Peninsula can be a time of gray mists and steady rain. The deciduous trees—maple, aspen, crab apple, birch—have begun to turn; but in a wet year their colors are less brilliant, more muted: umber, ocher, russet, mustard rather than gold, gaudy orange, and vermilion. The trees were only beginning to turn when I came. It rained all week and the rivers ran high, some as much as several feet.

The Fox River near the town of Seney was swollen too, the fishing slow. In a week of driving every day from Seney to the black-stump fields of the Kingston Plains, to Stanley Lake at the head of the Little Fox River, I have watched the maples and birch along the Fox River Road turn slowly, the sweet fern grow from faded green to a tawny red. I have seen Canada geese silhouetted against the gray sky, two bald eagles, a couple of ruffed grouse, a dozen white-tailed deer—always at dusk, one fording the river. No fly fishermen. Only a handful of men who use spinning rod and bait, like Howard and Dean. They have been taking brook trout on worms; the brothers come up from downstate every year. It is a happy ritual for them, and they tell me that they can take their limits anytime they choose; they are forthright, workingmen, not the kind to brag.

Over the years I know of a dozen young writers who made the pilgrimage to fish the river Ernest Hemingway fished and used for his remarkable story "Big Two-Hearted River"—taking the resonant name of a nearby river, to suggest life and death, perhaps, and also, I think, a generosity of spirit. A few pilgrims, including Hemingway's eldest son, Jack, fished the Two Hearted River, some 30 miles northeast of Seney, in error—for the river in the story is surely the Fox. Those who came out of curiosity or homage, as I did in the late 1950s, have been less impressed by the Fox's trout than by the prodigious blackflies and mosquitoes. Even in September the few mosquitoes by the river verify that reports of their size and ferociousness were not far-fetched.

COURTESY OF ERNEST H. WAYCLAND

A YOUNG HEMINGWAY

In a week of hard fishing I caught more nostalgia than trout. One look at the tangled river above Seney, choked with tag alder trees, and I glumly put my fly rod back into its aluminum case and set up a spinning outfit. I tied on a favorite lure from my teens, the silver C. P. Swing, size #3. With it, I cast into the deeper pools at the few pull-outs, where the state has built fences and paths to stabilize the soft

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NICK LYONS, a dedicated fly fisherman and author of nine books on the subject, lives in Manhattan, where he is president of Lyons & Burford, Publishers. This is his first article for NATIONAL GEOGRAPHIC. JAY DICKMAN, a Pulitzer Prize-winning photographer who lives in Colorado, documented the wild beauty of Canada's Tatshenshini-Alsek Wilderness Park for the February 1994 issue.

TOO SMALL TO BE A KEEPER, A BROOK TROUT IS STUDIED BY A BIOLOGIST.

sandy banks, and into the flat below the old railroad bridge, as close, always, to the many deadfalls as I dared. I lost a scant 17 lures and caught a handful of wild brookies—all bright as jewels and not much larger. Then I found a place where a grassy bank left room for casting a fly and began to fish with my long rod and a Dave's Hopper. I'd cast up and across, against the omnipresent tag alder branches on the opposite bank. I'd try to find slight indentations into which I could pitch my fly, allowing me to float the hopper into the trouty shade, out of sight, and keep it free floating until it dragged in the slick glides. I liked having the fly rod in my hand again, and I cast well and fished the water well but took only one eight-inch brookie.

As the week wore on, I learned more about this difficult, even inhospitable river, of a kind I had not fished in many years. And I tried—in the steady, cold rain—to scrape the patina of time away to find the underpainting, a river and a young man, more than three-quarters of a century ago.

Seney, the town through which the Fox flows, and the place-name that positively identifies the river the fictional Nick Adams fished, has 185 residents these days. There are a couple of gas stations, motels, a bar, two family restaurants, stores only sparsely stocked in September. Seney is a brief stop on arrow-straight M-28 that bisects the Upper Peninsula. It is hard to imagine that a hundred years ago it was a notoriously lawless town, founded in 1881, growing like "an ugly and poisonous toadstool," according to one observer, the fulcrum for at least 15 lumber camps that cut the great white pine forests. In the 1890s the town had 20-odd saloons, two huge brothels, and it catered to lumbermen with names like Snag Jaw, Pig Foot, and Pump Handle Joe. It was a raw, violent place, where an ear sometimes got chewed off in a fight. While the lumbermen were decimating the forests, the town burned in 1891 and again in 1895. Only in the graveyard south of town is there a hint of the town that was. It is an inscription on a white wooden grave marker:

CHAS DEWEY
Killed Age 33 Fighten

Seney and its history of violence are important to Hemingway's story; he

starts there, and the burned-over country reflects Nick's nearly bankrupt emotions. But the river is the heart of the story, and I went directly to the railroad bridge, even as Nick Adams did, as soon as I reached the town. I knew the river would not be the same long before I stood where Nick stood more than 75 years earlier and looked down into the "clear, brown water." This river was smooth and quick, still tea colored from the tannic acid it picks up in the bogs and from the decomposition of pine needles and cedar scales, and it brushes up against the same black bridge pilings. I stood for a long time but could see no trout holding on the sand-ridged bottom. Surely the water—even in this month of high water—was not deep enough to hold the head of trout Nick describes, no doubt because sand and silt had filled it in when timbering sent the soft banks crumbling into the river. I doubt if the boulders and pebbles Nick saw were ever in this river; Hemingway plucked them, as he did much else he needed, from other rivers he had fished. From the bridge, I was looking at several rivers—the one Hemingway fished, the one fished by Nick in the story, and the one below me.

I took one of the five grasshoppers I had caught by hand and dropped it into the river. The hopper kicked and twisted on the flat surface, floated without movement, kicked a bit more, and then drifted the length of the pool, undisturbed. The others followed it and went downstream equally undisturbed. Another dozen went into the Fox at various points upstream, and not one was taken. For those first few hours I thought I was fishing a halfhearted little river.

Sometime before mid-September 1919 Hemingway fished the Fox with two friends, Jock Pentecost and Al Walker, for a week. Though there are a dozen theories about where they camped, their base was probably no more than a mile or so upriver, and from there they ranged above the confluence with the Little Fox, seven miles northwest. In a letter Hemingway wrote soon after their trip, he says the three of them caught some 200 trout, mostly on live grasshoppers, and that he wantonly shot at deer with a .22 and lost a fish big enough to break his hook at the shank. And then, late in 1923, in Paris, he started a story he called "Black River," then "Big Two-Hearted River."

Just ten miles wide and 26 miles long, the Fox River drainage system is short in length but long on lore. The brook trout that Hemingway cast for still reach up to three pounds, largely due to a steady supply of groundwater that rarely tops 68°F.

HEMINGWAY FOUND HIS "GOOD CAMP" UNDER THE FOX RIVER'S PINE CANOPY.

In brief the story is a vivid, detailed drama in which a young man, quite alone, gets off the train at a burned-out town called Seney, takes a daylong walk upriver, camps, and the next day, with ritual care, fishes with live grasshoppers. He catches a small trout that he releases, two decent fish that he kills, and loses a big one—the "thrill" of the loss too much for him.

By his deliberate movements we realize that the young man has come to the woods, as many fishermen do, for some form of rejuvenation; we realize he is carrying some unidentified mental baggage. By slowly setting up his camp, preparing his own beans and spaghetti, and the next day rigging his fly rod and fishing, he is regaining some measure of control over himself, imputing order to his life. He brings certain skills: how to read a river, the techniques of fishing. He loves to fish. The story starts late, after traumatic events have happened to Seney and Nick, and ends abruptly when he decides he will not fish the swamp, where he has less control. "There were plenty of days coming when he could fish the swamp." He knows his limits.

It is a remarkable story—fresh, understated, crisp, earthy, full of love of country, an attempt to regain innocence, and oddly as suspenseful as a good detective story.

Though Hemingway changed the Fox, and the country around it, to fit the precise needs of the story, a river called the Fox very much remains, and it has the mysterious spirit of the river Nick Adams fished. The whole Upper Peninsula still contains pockets of barely compromised country.

The Fox today is still crowded with old logjams, with velvet moss and grasses growing from them, plastered with maple leaves. There are pine deadfalls everywhere, their spiked branches like a Maginot Line to protect the river from canoeists and fishermen. Often the bottom and mid-water of pools are booby-trapped with branches and snags, or too soft with silt to dare wade. The quick river plays against the tangle of trees and creates riffles and eddies, and so do the pilings from old dams, bridges, and stream deflectors the river has mostly reclaimed. In the distance you can see stands of yellowing birch and aspen, the brighter red of a few maples, and random clusters

"THE COUNTRY WAS BURNED OVER AND CHANGED," HEMINGWAY REPORTED IN "BIG TWO-HEARTED RIVER." TWICE DESTROYED, THIS FOREST NEAR STANLEY LAKE WAS FELLED FOR LUMBER IN THE LATE 1800S, THEN ITS REMAINS WERE BAKED BY INTENSE BRUSHFIRES.

of conifers defoliated by insects or fire, skeletal, ghostly, still straight. There is not one swamp, as in the story, but a hundred of them, each dangerous, each—for Hemingway's purposes—a moveable swamp, each as threatening to me, a 64-year-old writer, as to the young, skittish Nick Adams. And everywhere there are the tag alders, the low-growing, weedlike tree that proliferated after the cuttings and burnings brought sun to the moist plains near the river; often they extend three or four feet into the river, making wading and casting impossible. The river runs under the branches and then, as it bends, the river appears to vanish into a maze of browning alder leaves and angled pines. It is a difficult, overhung, and very trouty river.

Eventually I fished hardest well below the town, where the river is wilder, shallower, as it flows through cattail bogs and tamarack swamps. There I found several worn spots in the marsh and thicket where bait fishermen had set up shop. There was barely room to lean out for a quick underhand cast, a single thrust directly across and slightly upstream. It was an old skill for me, and I could soon send the lure to the opposite bank with some ease, flutter it back a foot, reel backward a turn or two so it dropped lower in the water, flutter it again. I had switched, on local advice, to a Panther Martin; on the same local advice I soon affixed a small worm I found by lifting a log. On my seventh cast a fish flashed at it in the deep water downstream. I could see little more than that the fish was large. I cast again, to the same spot across the river, and negotiated the lure so it went back into the same eddy. There was no response this time, so I lifted the lure with a swift movement for another cast. And then, a foot below the surface, coming quickly, I saw a head emerge from the undercut bank and one of the largest wild brookies I have ever seen, 19 or 20 inches' worth, lunged at the lure and nicked the worm. I saw the whole of the fish—its solid girth, dark flanks, huge head. And then it was gone and, on repeated casts, would not come to the lure again.

I sat on the wet bank, shaking a little, smiling, and listened to the susurrant hum of water as the smooth river bent and went out of sight.

THERE ARE TALES at the Seney general store of secret pools and trout measured by hands spread half a yard apart. Local young men, rugged and evasive, walk far back into the tag alder swamps, camp for several nights, and come out with their limit of brook trout—plump brookies, their flanks a smooth dark silver gray, with mottled back and bright red markings. Clearly the river can provide excellent fishing but only to the best fishermen, who take faintly marked trails or make their own, often through high grasses, marshland, and bog. They are rightly covetous of their hard-won knowledge, and they rightly resent those who blaze trails, cut the tag alders and fallen hardwoods that make penetration by foot or canoe difficult. It is not a river to be fished quickly.

But the fish are there, thanks to friends like Seney Town Supervisor Dick St. Martin, who pressed the state to make the Fox a wild-scenic river recently, and thanks to sensible, well-educated men like Steve Scott, a biologist and the district fisheries program manager. Scott has seen photographs from early in the century of tables loaded with 16-to-20-inch brook trout, and he knows that a few of the better fishermen today can still take a limit of outsize trout. He broods about the river, about whether the limit of ten fish is too great (he and I think it is), whether boats ought to be allowed on the river, how to prevent more sand from collecting on the bottom, how many fish to stock. It all costs money, and there are limits to that. Scott is pleased that since 1988 the Fox has been part of the Michigan Natural Rivers Program. He is pleased that there is enough gravel for natural reproduction, enough sculpins,

A CANOE STIRS THE SILENCE AND STILL WATERS OF THE EAST BRANCH.

minnows, crayfish, caddis flies, mayflies, and stone flies for food, that there is no winterkill. The river has a lot going for it—the groundwater that feeds it, that keeps the temperature under 68°F, the deadfalls that provide cover, even the tag alders that provide shade and limit access. He is pleased that the Fox, especially the East Branch, is a river capable of providing quality fishing for wild brookies, decent numbers of big fish like the three-pounder recently caught there. He worries about use and overuse, crowds and publicity, and the mandate to provide quality fishing against the conflicting demands made on it. He says, puckishly, that "the best fishing is in May and June, when the mosquitoes and blackflies are worst."

EACH DAY there was a bit more gold and crimson in the birch and maple along the Fox River Road. On my last day, looking out across the burned-over Kingston Plains littered with black stumps a hundred years old, preserved when fire struck green pine and the pitch preserved them, I thought about the old railroad bridge, the logjams and deadfalls, the stands of second-growth pine, the grasshoppers. It was not hard, beneath the patina of the years, to imagine Hemingway up there with Jock and Al, finding the Little Fox "lousy" with trout, camping out, ranging over country just as wild now as it was then—and Hemingway being brawny young Hemingway with youth to burn, which he did, and Nick Adams being skittish of swamps. Nor was it hard to imagine the young man in Paris who had not yet begun to trade on his talent, writing about what he knew and loved best, trout fishing in wild country.

In front of me, next to a stand of blueberries, there is a black stump, stark against the failing vermilion sun in the west. It looks solid as oak. I touch it gently. The crust is firm, the century-old cinders soft beneath my fingers. I touch it again, and the stump, like an old memory or stale cake, crumbles in my hand into black dust. But inside is a core of fresh pine, preserved all these years by the pitch.

Now the water deepened up his thighs

sharply and coldly. Ahead was the

smooth dammed-back flood of water

above the logs. The water was smooth

and dark; on the left, the lower edge of

the meadow; on the right the swamp.

"Big Two-Hearted River"
ERNEST HEMINGWAY

KNEE-DEEP IN THE FOX, A FLY FISHERMAN CASTS AT DAWN.

At the edge of the meadow flowed the river. Nick was glad to get to the river. He walked upstream through the meadow. His trousers were soaked

HABITAT FOR INSECTS THAT FEED THE RIVER'S FISH.

with the dew as he walked. After the

hot day, the dew had come quickly

and heavily. . . . Nick looked down

the river at the trout rising.

"Big Two-Hearted River"
ERNEST HEMINGWAY

FOG SHROUDS SNYDER LAKE; A DEER FORDS THE MAIN BRANCH.

The river was clear and smoothly fast in the early morning. . . . a mink crossed the river on the logs. . . . Nick was excited. He was excited by the early morning and the river. □

"Big Two-Hearted River"
ERNEST HEMINGWAY

Central Africa's Cycle

HUTU VERSUS TUTSI: hatred, flight, death. For almost 40 years these peoples of the African nations of Rwanda and Burundi have been killing and driving out one another in spasms of violence that grew to genocidal proportions. Perhaps a million people, or even a million and a half, have died. A great swath of central Africa has been destabilized, including Zaire, the continent's third largest nation, more than three times the size of Texas (maps, pages 126-7).

Last year nearly two million refugees were living in huge United Nations-sponsored camps. Now, ousted by their weary hosts in Tanzania or to escape the conflict in Zaire, most of the Rwandans have gone home—rivers of people walking with belongings on their heads, trailed by knots of orphaned children. After returning, thousands were arrested as suspected killers, and hordes slept in the open because their houses were occupied by others. Because civil war still wracks Burundi, some 270,000 Burundians have been allowed to stay in Tanzania.

Rwanda and Burundi, each about the size of Maryland, are part of the Great Lakes region, which extends west from Lake Turkana and across Lakes Kivu and Tanganyika in the Great Rift Valley. Composed mainly of temperate uplands, 3,000 to 6,500 feet high, the region is intensively farmed.

Even after so much slaughter Rwanda and Burundi are the most crowded nations on the African mainland; most families have no more than a few acres of land. Rwanda's population, doubling every 20 years, exceeded 7.1 million in 1991, with a density of 745 people per square mile. (By comparison the density in Maryland, which is heavily urban, is only 516.) Tensions *(Continued on page 130)*

# of Violence

DAVE KINSEL, HOUSTON CHRONICLE

In nearly four decades of killing, more than a million people in Rwanda and Burundi have died and millions more have been driven from their homes. To help stop the violence, Rwanda is putting 90,000 suspected killers on trial, including these men waiting in a crowded prison.

ZAIRE

For 31 years President Mobutu Sese Seko diverted Zaire's mineral wealth and hundreds of millions of dollars in aid into his own pockets, quelling rebellions with foreign troops. By 1996, when Zairean rebels launched an uprising, the government barely functioned. Mobutu's poorly paid, poorly trained soldiers retreated in disorder. Within five months the rebels took the eastern fifth of Zaire. Mobutu recruited Serb mercenaries and Angolan allies, but the rebels, welcomed as liberators, enlisted a growing number of Zaireans, including exiles returned from decades in western Angola.

RWANDA

Rwanda's Tutsi-led army skirmished with Zaire's soldiers early in the Zairean uprising. Rwanda backed the rebels, whose advances drove exiled Rwandan Hutu militias away from the Rwanda-Zaire border. The fighting also forced about 800,000 Hutu refugees to return to Rwanda. To make room for them, the Rwandan government evicted squatters and built houses. But in the northwest, where many Hutu settled, unidentified attackers killed returning Hutu, international relief workers, and witnesses to genocide.

BURUNDI

Pierre Buyoya, a Tutsi who once promoted democracy, seized control in July 1996 from an increasingly powerless Hutu president. Although neighboring countries responded with economic sanctions, Buyoya refused to negotiate with Hutu guerrillas. In the countryside, guerrillas and government troops waged war on each other and on civilians, killing thousands.

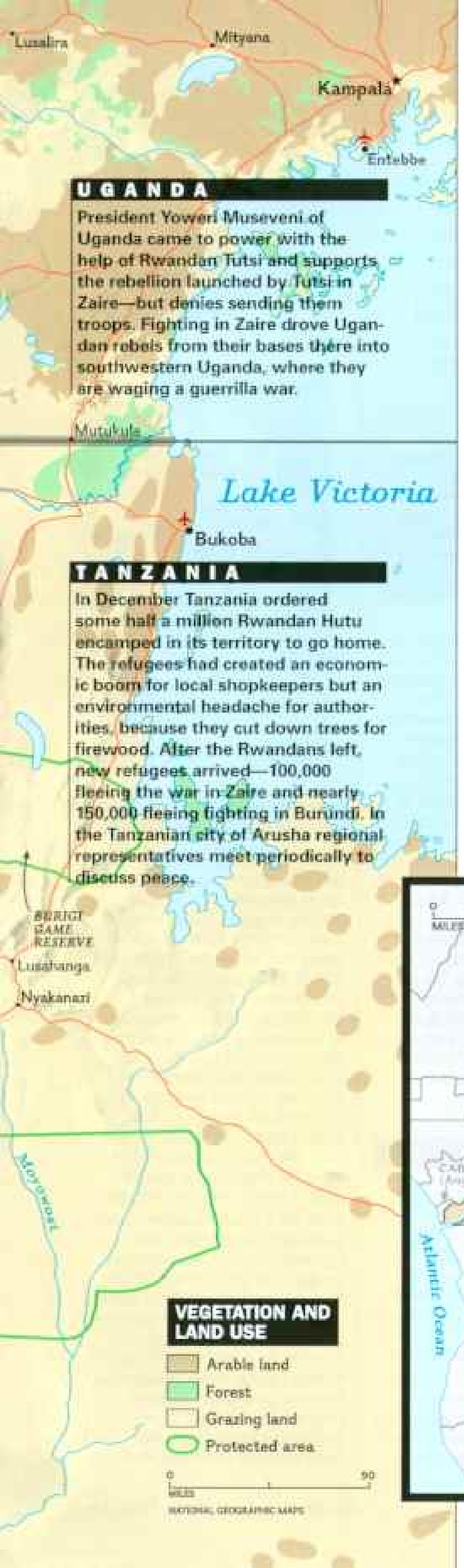
ZAIRE
UGANDA
RWANDA
BURUNDI
TANZANIA
Lake Edward
Lake Kivu
Lake Tanganyika
Lake George
RIFT VALLEY
RUWENZORI MOUNTAINS
VIRUNGA MTS.
MITUMBA MOUNTAINS
Beni
Butembo
Lubero
Kasese
Mt. Speke 16,795 ft
KIBALE FOREST RESERVE
KATONGA GAME RESERVE
QUEEN ELIZABETH NATIONAL PARK
Bushenyi
Mbarara
LAKE MBURO NATIONAL PARK
Rukungiri
Ntungamo
VIRUNGA NATIONAL PARK
IMPENETRABLE NATIONAL PARK
Kisoro
Kabale
MGAHINGA GORILLA N.P.
Rutshuru
Mt. Muhavura 13,540 ft
Mt. Gahinga 14,787 ft
Mt. Sabinyo 11,960 ft
Mt. Karisimbi 14,787 ft
Ruhengeri
Kinigi
Byumba
Gabiro
AKAGERA NATIONAL PARK
Kigali
Nasenga
Kibungo
Ngara
Kirundo
Muyinga
Ngozi
Karuzi
Cankuzo
RUVUBU NATIONAL PARK
Muramvya
Bujumbura
Uvira
Citega
Rusengo
Ruyigi
Kibondo
Mwaro
8,760 ft
Rutana
Kisogwa
MOYOWOSI GAME RESERVE
Bururi
Source of the Nile
Makamba
Nyanza-Lac
Kasulu
GOMBE N.P.
Kigoma
Ujiji
Rumonge
Baraka
Fizi
Kabambare
Kalehe
Kituye
Gitarama
Kibungo
Gako
Ngara
Goma
Gisenyi
Cyangugu
Bukavu
Kigoma
Butare
Gikongoro
Kibuye
Kayanza
Cibitoke
Bubanza
KIBIRA N.P.
RUVIZI N.P.
Mwenga
Shabunda
Walikale
250 miles to Kisangani
Source of the Nile

Crowded countries lead a region into war

In a narrow corridor of central Africa, people crowd together to till the rich volcanic soil. Reflecting the land's fertility, the number of people per square mile peaks along a line from southern Burundi to northern Rwanda, where population growth rates and densities are among the highest on the continent. Since the 1970s the population has increased so much that large families are confined to tiny plots. The governments of both countries discourage people from leaving the countryside for the cities. They work harder and harder but reap only hunger.

Using fertilizers and erosion control, farmers could grow enough to feed themselves, but they remain poor, powerless, and uneducated. The elite have profited from foreign aid while urging the rural masses to kill one another over ethnic differences.

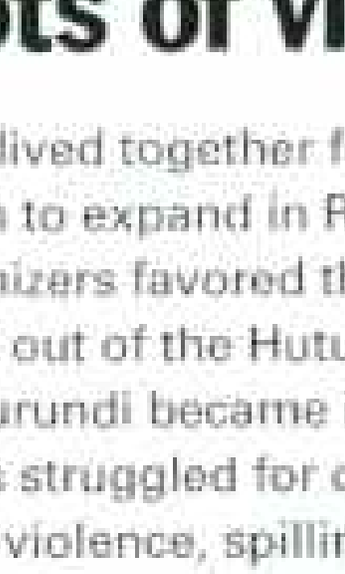
In 1994 a defeated Hutu army and militias retreated from Rwanda into eastern Zaire, where Hutu and Tutsi had lived for generations. There Hutu, sometimes helped by Zairean soldiers, attacked Tutsi farmers. In 1996 Zairean Tutsi, ordered out of the country by the government, joined with local allies to launch a rebellion that drove out Hutu refugees and divided Zaire, threatening regional war.



A deepening divide: the roots of violence

Hutu and Tutsi lived together for centuries before a Tutsi kingdom began to expand in Rwanda in the 1700s. Later, European colonizers favored the Tutsi while squeezing taxes and work out of the Hutu. In the 1950s and '60s, as Rwanda and Burundi became independent, Hutu and Tutsi political groups struggled for control of the two countries. Violence led to violence, spilling across decades and the borders of Zaire, Tanzania, and Uganda.

Precolonial



As early as 800 B.C. the common ancestors of the Hutu and Tutsi lived in what is now Rwanda and Burundi. By A.D. 1500 in Rwanda a social hierarchy distinguished between Hutu subordinates and their Tutsi superiors.

18th and 19th centuries: In Rwanda an expanding kingdom ruled by a Tutsi dynasty elevated its members over Hutu, laying the foundations for a Tutsi ruling class. In Burundi another expanding kingdom ruled by the Ganwa elite, which was neither Hutu nor Tutsi, appointed members of both groups to the royal court.

Colonial

1884-85: At the Berlin Conference European powers divided Africa, giving Rwanda and Burundi to Germany and the Congo (Zaire) to Belgium.

1899-1916: Germany established a system of indirect rule, governing Rwanda and Burundi through the existing rulers and extending its control by helping ruling Tutsi conquer Hutu kingdoms in northern Rwanda. During World War I, Belgian troops took Rwanda and Burundi.

1926-1952: Belgium increased the local authority of governing Tutsi in Rwanda and Ganwa royalty in Burundi in order to extract more taxes and labor from small farmers, mostly Hutu. It granted Tutsi and Ganwa royalty government jobs and positions in schools, arguing that they were racially superior to Hutu. Local Tutsi chiefs in Rwanda took advantage of their authority by seizing cattle and land from rivals and small farmers, punishing all who opposed them.

1950s: On the eve of self-rule in Rwanda, various political parties formed. Some called for cooperation between Hutu and Tutsi, while others advocated violence. Belgium withdrew its support from minority Tutsi, who were pressing for independence.

1959-1961: The killing began in 1959 with a Hutu uprising in Rwanda that started a Tutsi exodus. Two years later, backed by Belgium, Hutu deposed the Tutsi king and held elections. An extremist Hutu party's victory created what a UN report called a "racial dictatorship" of Hutu over Tutsi. In Burundi, Prince Louis Rwagasore, popular among both Hutu and Tutsi, was shot dead a month after his party won an election, aggravating divisions already created by events in neighboring Rwanda.

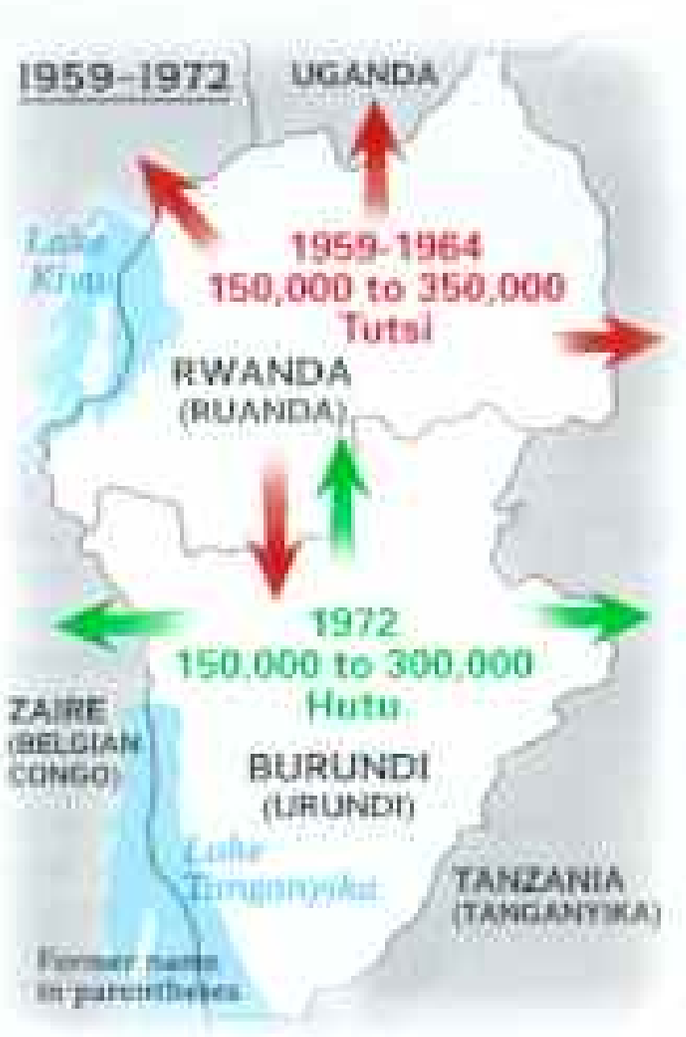
Independence

1962: Rwanda and Burundi became independent.

1963-64: More and more Tutsi fled from Rwanda. By 1964, refugees numbered in the tens of thousands in neighboring countries, from which Tutsi guerrillas attacked Rwanda, drawing Hutu reprisals that left at least 10,000 Tutsi civilians dead.

1965-66: After putting down a Hutu coup attempt and executing Hutu leaders, Tutsi army officers in Burundi took over the ruling party, the government, and the army. They responded to attacks from Hutu peasants by killing as many as 5,000 Hutu civilians. A year later, they deposed the remaining neutral force—the Ganwa king. Burundi split into Hutu and Tutsi factions.

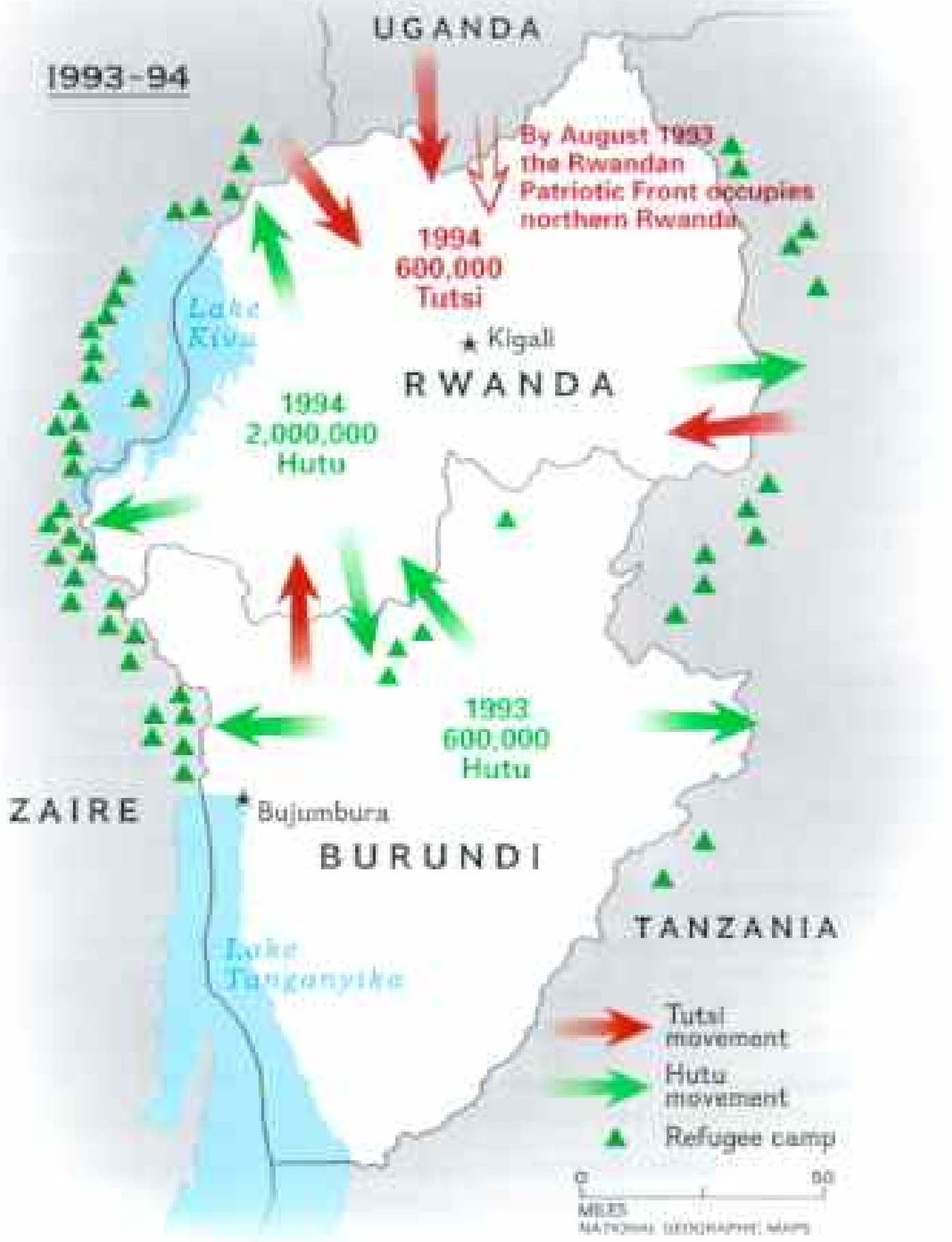
In both Rwanda and Burundi ruling groups split along regional lines. In Burundi southern Tutsi killed northern Tutsi to stay in power.



Violence Escalates

1972-74: In response to attacks by Hutu guerrillas based in Tanzania, Burundi's army and Tutsi militias hunted down Hutu, exterminating most of the educated. Between 80,000 and 200,000 Hutu civilians were slaughtered, and at least 150,000 others fled, mainly to Tanzania, from where they launched raids into Burundi. In Rwanda, Hutu peasants attacked Tutsi in revenge then turned their anger on Hutu authorities. During the unrest, Maj. Gen. Juvenal Habyarimana, a northern Hutu, seized power from a rival southerner.

1982-89: Exiled Rwandan Tutsi learned to wage war from Ugandan rebels. Persecution by the Ugandan government had driven thousands of Tutsi refugees into the rebel army of Yoweri Museveni, a Ugandan fighting to overthrow President Milton Obote. After Museveni became president, popular resentment against their influence as foreigners rose, and Tutsi quit the Ugandan Army to



form their own—the Rwandan Patriotic Front (RPF).

A new ruler in Burundi promised change, but the violence continued. When Maj. Pierre Buyoya seized control, he ended repressions against Hutu and other government opponents and pledged to consider giving Hutu more power. But local Tutsi authorities threatened Hutu activists with death. Hutu rose up, slaughtering hundreds of Tutsi. The army restored order by massacring as many as 20,000 Hutu.

Genocide

1990-93: In the face of international condemnation for the 1988 killings, Burundi's President Buyoya began to work toward democracy. At the same time, under similar pressure, the Rwandan government started a transition to multiparty rule. However, these moves were undercut by power struggles between Hutu factions in Rwanda and by the actions of extremists in both countries.

A civil war broke out in Rwanda when the Tutsi-led RPF invaded from Uganda. The government army, supported by France, fought to evict the guerrillas. Both sides killed civilians, and the government launched an anti-Tutsi propaganda campaign. President Juvenal Habyarimana and the RPF signed a power-sharing agreement under which the ruling party, opposition parties, and the RPF would all receive positions in the government. Hutu extremists prepared to kill all of Rwanda's Tutsi.

1993: Another conflict erupted in Burundi when the nation's first Hutu president was assassinated four months after his election. Enraged Hutu killed Tutsi local officials; as before, the army responded by killing Hutu. Between 30,000 and 50,000 Hutu and Tutsi died, and some 600,000, mainly Hutu, left the country.

April-July 1994: When a plane carrying Rwanda's President Habyarimana and Burundi's President Cyprien Ntaryamira, both Hutu, was shot down over Kigali, the Rwandan capital, Rwandan Army units and Hutu militias began systematic massacres of Tutsi and moderate Hutu, murdering at least half a million people. During the chaos the RPF took Kigali. As the RPF advanced, about two million Hutu fled into Zaire, Tanzania, and Burundi.

Aftermath

The retreating Hutu fighters carried the war from Rwanda into eastern Zaire, where local groups were already fighting over land. Soldiers of the former Rwandan Army and members of the Hutu militias attacked Tutsi and local ethnic groups. In turn, the local groups attacked Zairean Hutu, Tutsi, and one another. Driven off their land and robbed of their cattle, many Tutsi fled to Rwanda.

In Burundi in 1994-95 Tutsi extremists took control of the government and annihilated Hutu neighborhoods in the capital. Fighting between the government army and Hutu guerrillas killed 150,000 by the end of 1996.

Full-scale war in Rwanda ended, but there was no peace. In 1994-95 the government established by the RPF jailed more than 80,000 suspected war criminals and clashed with Hutu soldiers and militias staging raids from Zaire. Tutsi who had fled Rwanda came back, but most Hutu refugees refused to return out of fear of the RPF and of Hutu soldiers and militias, who threatened to kill them if they tried.

By early 1997, forced from Zaire by Tutsi-led rebels and from Tanzania by government edict, nearly 1.5 million Hutu had returned, 7,000 to face arrest. War crimes trials began, the first in the history of Rwanda and Burundi.

between Hutu and Tutsi are further exacerbated by sheer poverty; the per capita income in Rwanda and Burundi is around $200 a year.

THE CONFLICT is not tribal; Hutu and Tutsi are socioeconomic castes. They speak the same languages—Kinyarwanda in Rwanda and Kirundi in Burundi—and scholars believe that most descend from the same ancestral stock. Before the recent violence Hutu made up an estimated 85 percent of Rwanda and Burundi, Tutsi 14 percent, and Twa Pygmies the rest.

Many who have watched the hatred intensify see it as the legacy of colonial rule, which began with the division of Africa among European nations in the 1880s. Rwanda and Burundi were part of the territory allotted to Germany, but Belgium was awarded those lands in 1919, after Germany's defeat in World War I. Historians say that there is little evidence in the precolonial era of ethnic violence, much less ethnic cleansing, even though the Tutsi minority held most of the positions of power in Rwanda. (Burundi was ruled by a princely elite, the Ganwa, which was not identified with either group.)

Both the Germans and Belgians ruled through the Tutsi and Ganwa chieftains. Among them were tall individuals who appeared less "African." The Europeans concluded that their ancestors were Caucasoid, thus creating a myth that still hangs on: that Tutsi are a superior people who migrated from Ethiopia, Sudan, or Egypt.

As one expert summarizes colonial attitudes, the Tutsi were "white Africans," cleverer than the "dumb" Hutu. Hence Tutsi were preferred as civil servants, businessmen, and landlords. In Rwanda nearly all the school spaces were allotted to them. Most Hutu were exploited peasants. Identity cards that specified ethnicity confirmed everyone's place in the pecking order.

Tensions escalated as political parties organized. In 1959, after a Hutu leader in Rwanda was brutally beaten by Tutsi, Hutu attacked Tutsi with clubs and machetes. Hundreds died. At about the same time, Belgian policy flip-flopped, with the colonial rulers endorsing the Hutu majority. Rwanda achieved independence in 1962 with a Hutu government in power. A violent government massacre in 1963-64 sent tens of thousands of Tutsi fleeing, mainly to Uganda and Burundi.

These events terrified the Tutsi of Burundi, also independent but still ruled by a Ganwa king. When a mutiny of Hutu soldiers erupted in 1965, Tutsi officers not only crushed it but executed many Hutu political leaders. Afterward they seized the government. Another Hutu uprising, in 1972, was put down with a genocidal slaughter; estimates of Hutu dead range from 80,000 to 200,000.

Rwanda and Burundi became partners in a terrible dance. "They fed off each other," says Jane Rasmussen, a U.S. human rights lawyer who has worked in the region. "When Tutsi were killed in Rwanda, it intensified the fear of Tutsi in Burundi, and when Hutu were killed in Burundi, it played on the fear of Hutu in Rwanda. Hatreds built and built."

Killers went unpunished. Both Rwanda and Burundi, meanwhile, endured guerrilla attacks staged by some of the more than 600,000 refugees in adjoining nations.

At the end of the 1980s Rwanda was in crisis. The price of coffee, the main export, had collapsed. Unemployment was widespread. And many Rwandan Hutu now opposed their longtime dictator-president, Juvenal Habyarimana, who was Hutu but reserved favors for a small elite from his home district—the *akazu*, or little house, as the clique was called.

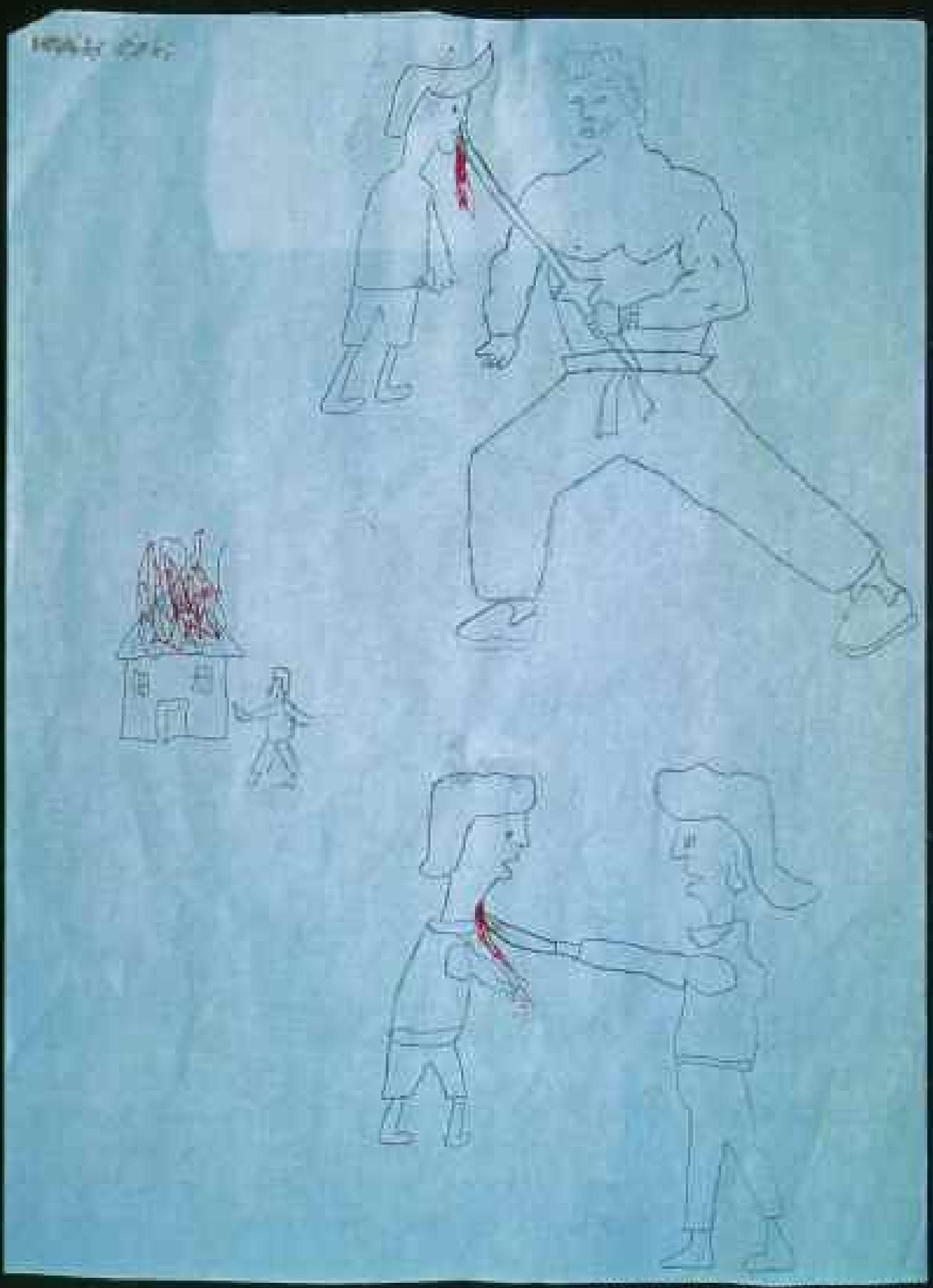
Worse, Tutsi refugees in Uganda had created a potent fighting force, the Rwandan Patriotic Front (RPF). Invading in 1990, it was beaten back but continued to raid.

Evidently hoping to buy time to shore up his tottering regime, Habyarimana radically changed course. Heeding the urgings of the international community, especially France, which backed him with arms, he allowed political reforms. His one-party state was opened to opposition parties, deeply disturbing the privileged akazu.

In 1992 he agreed to a cease-fire with the RPF and entered peace negotiations, further angering leaders in both the akazu and the army. They began to demonize the Tutsi as exploiting foreigners, harking back to the colonial-era myth of Tutsi as a people who had originated in Ethiopia or some other place. "Wipe them all out!" one political leader screamed at rallies. Hundreds of Tutsi were

Scarred survivors

The recent genocide in Rwanda wasn't about ancient tribal hatreds but about power. To keep it, Hutu extremists struck both at Tutsi and at Hutu moderates. They mutilated a Hutu who opposed the killings (above right) and targeted even the young. "Children received machete blows to their heads, children were shot, children were stoned, children were executed after listening to long speeches about why they must be killed . . ." wrote the director of a Rwanda orphanage that was attacked. Two years later a child eyewitness to murder, whose name has been obscured to protect his identity, drew horrific memories in therapy.



JAMES NACHTWEY, MAGNUM (TOP); REZA

RIZA

Foundations for peace

"The evil comes from the top," said a Hutu in Burundi shortly before he died in a wave of army killings. Now Rwandans hope that good will come from the bottom. Supported by grassroots organizations, women who lost husbands and children work together to rebuild homes and communities.

killed, prompting the RPF to renew the war.

Still, in August 1993 Habyarimana and the RPF signed far-reaching accords. The Tutsi were promised cabinet posts and even half the officer slots in the army—meaning that many Hutu officers would be ousted. Determined to derail the peace agreement, extremists began to advocate genocide—the killing of *all* the nearly one million Tutsi still in Rwanda.

In October 1993 Tutsi soldiers in Burundi assassinated the first democratically elected president of that country, a Hutu moderate, playing into the Rwandan hard-liners' hands.

ASSASSINS STRUCK in Rwanda on April 6, 1994. At least one missile hit the president's jet as it approached Kigali, the capital. Killed with Habyarimana was Burundi's new president, Cyprien Ntaryamira.

It isn't known who fired the missile, but members of Habyarimana's inner circle are high on the list of suspects. As if this was a signal, the presidential guard and the militia, or Interahamwe ("those who attack together"), began to kill. The first victims were moderate Hutu and opposition politicians—persons who would oppose a "final solution," reminiscent of Nazi Germany's assault on Jews. Then they went after Tutsi. Mayors ordered largely illiterate peasants to "clean the fields"—to kill Tutsi. A radio station egged them on: "The graves are not yet full." Businessmen, priests, students, whole families—Hutu gangs shot them, clubbed them, hacked them with machetes, raped the women. In a hundred days the *génocidaires*, as they are called, slew at least half a million people.

Lightly armed UN peacekeepers stationed in Rwanda took no action. In fact, the international community never seriously tried to stop the slaughter. The United States, which had sent troops on an abortive mission to Somalia in 1993, wanted no part of another African intervention. As the genocide began, RPF troops attacked, seizing the government a hundred days later. Two million Hutu fled to Tanzania, Burundi, and Zaire.

And in crumbling Zaire, one of the world's worst governed nations, the war continued. Rwandan Hutu soldiers and the Interahamwe operated freely, raiding Rwanda from the refugee camps. Trying to establish a new Hutu homeland in eastern Zaire, they also besieged Tutsi who had lived in the region for generations. In 1996 Zairean government harassment of the Tutsi remaining within its borders culminated in an order to leave the country under penalty of death. The Tutsi fought back, scattering the Interahamwe as well as Zairean troops. Diplomats say Rwanda and Uganda aided the Tutsi so as to secure their borders; not only Hutu guerrillas but also Ugandan revolutionaries had used Zaire as a haven.

The Zairean Tutsi merged with a Zairean rebel movement, creating the Alliance of Democratic Forces for the Liberation of Congo-Zaire, which vowed to bring down ailing President Mobutu Sese Seko. Zaire's ruler for 31 years—and a client of the United States in the Cold War—he had amassed a vast fortune while sucking the country dry. Against Mobutu's undisciplined troops the rebels swept easily westward across Zaire. Today the future of this potentially rich nation—endowed with gold, diamonds, and copper—remains unclear; most Africa experts believe that Zaire will break up.

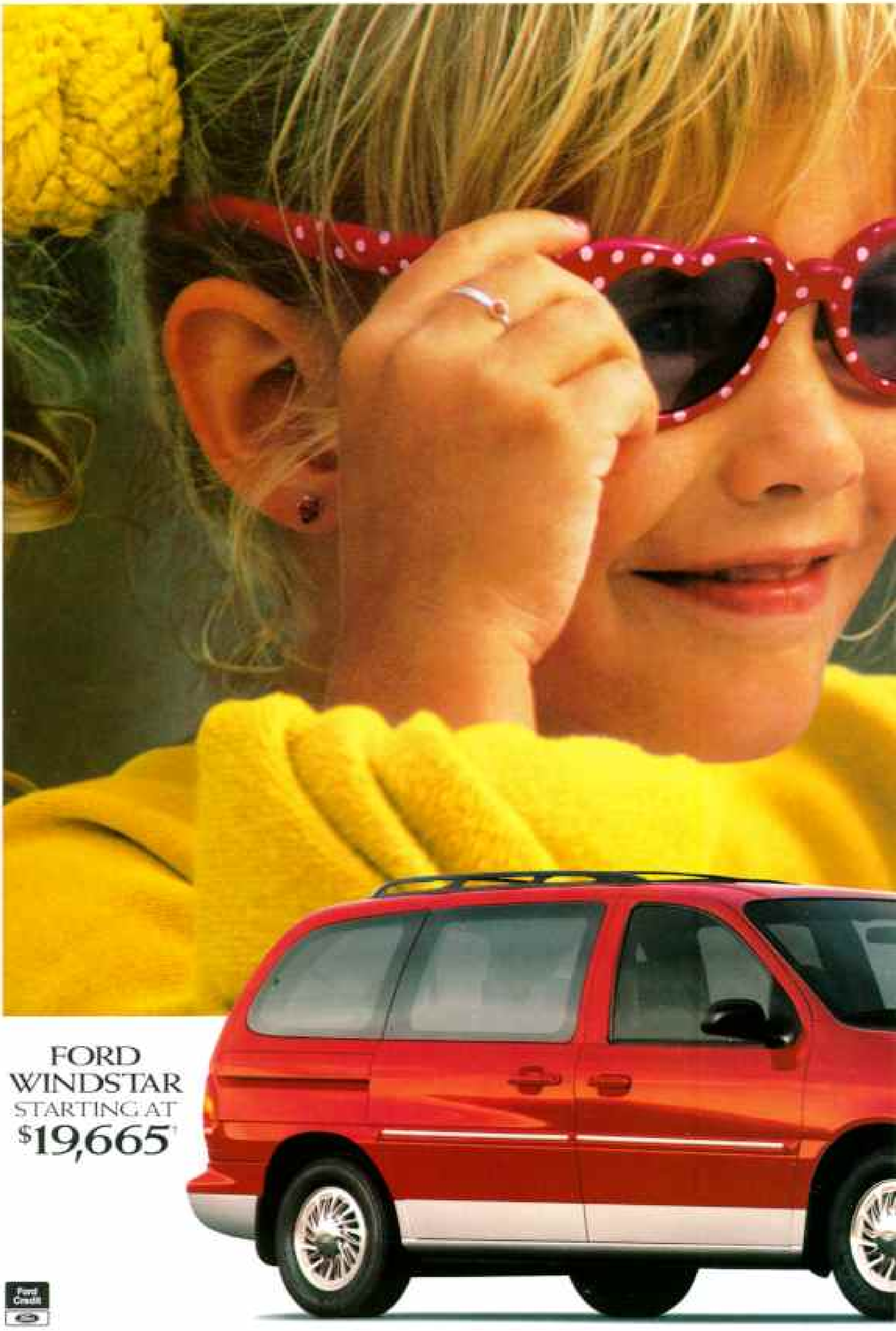
As for Burundi, no end seems in sight to the patchwork of small battles that continually erupt in all parts of the country, in which both Hutu and Tutsi are being killed.

Rwanda, meanwhile, has begun to deal with the 90,000 suspected killers who overflow its jails. "Of course everyone who murdered should be punished, but are you going to execute 90,000 people?" asks Rasmussen, the human rights lawyer. Rwandan officials estimate that some 2,000 people—leaders, wholesale killers, and torturers—will be shot. Many others presumably will receive prison terms. Some of the accused planners of the genocide are being tried by a UN tribunal in Tanzania.

None of this goes easily. Rwanda lacks experienced judges and prosecutors, and the UN tribunal has been plagued by bureaucratic mismanagement. Some murder witnesses have been killed before they could testify.

Nevertheless, as Rasmussen says, "Before the region can be stable, there must be justice." It will not solve all the many problems: poverty, crowding, displaced masses, political instability. But it would be a start; it might even deter more massacres. And for now, justice is about the most that can be hoped for.

TEXT BY MIKE EDWARDS
ASSISTANT EDITOR



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Steller Sea Lion (*Eumetopias jubatus*) **Size:** Average length of male, 280 cm; female, 230 cm **Weight:** Average male, 560 kg; female, 260 kg **Habitat:** Coastal waters and offshore islands in the North Pacific **Surviving number:** Estimated at 68,000

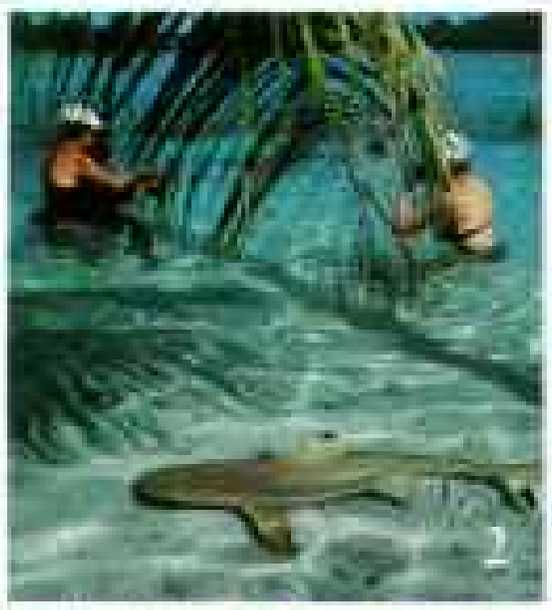
Photographed by Kennan Ward

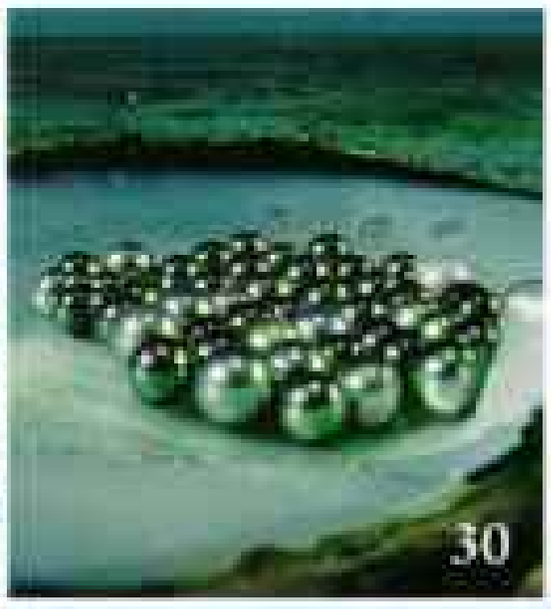
WILDLIFE AS CANON SEES IT

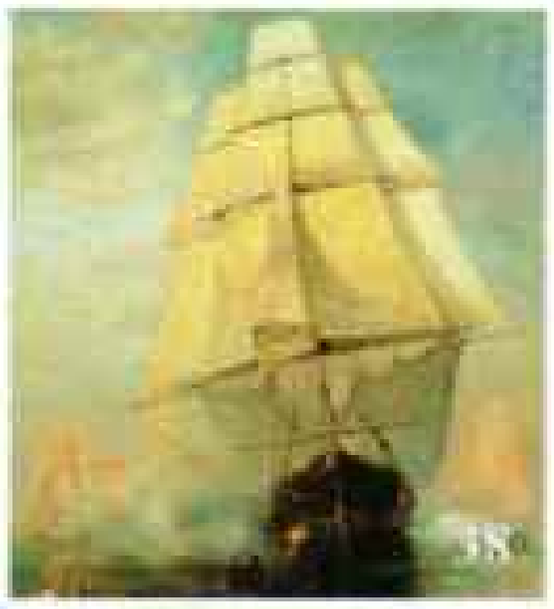
A group of Steller sea lions gather on an island off Alaska. Largest of the eared seals, bulls can reach over three meters in length and weigh 1,000 kg. During the breeding season, bellowing roars echo in the rookeries as dominant bulls wield their formidable presence against intruders. While vigilantly guarding their territories, they even forego eating and rely solely on fat reserves. In recent years, Steller sea lion populations have decreased by over half. Depleted fish stock of the sea lion's favored food could be a main factor. But long-term studies are still under way to determine the exact causes of this severe decline. As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.

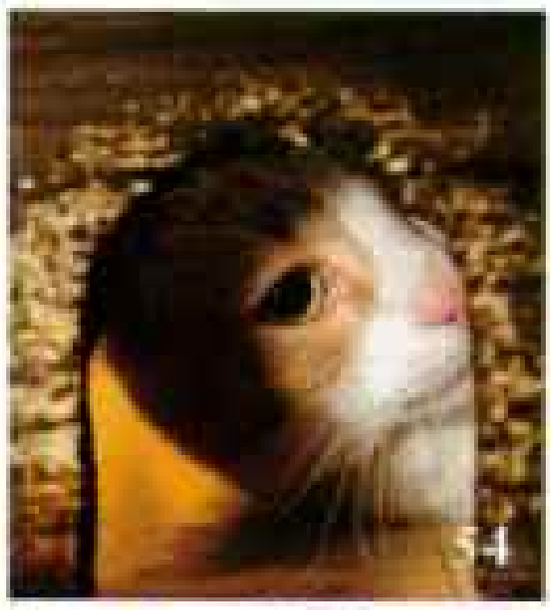
NATIONAL GEOGRAPHIC

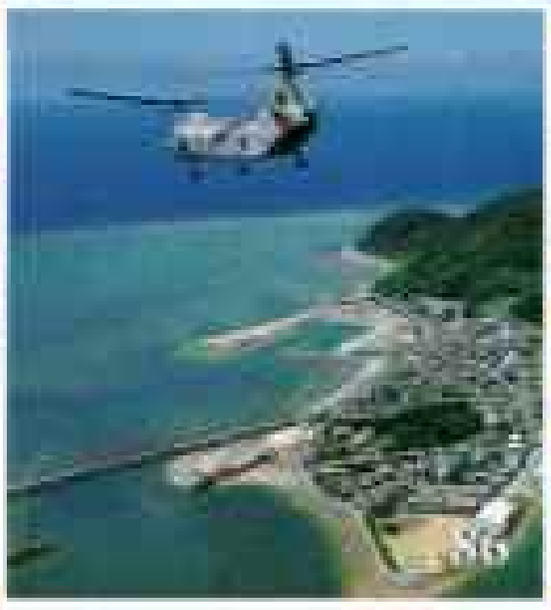
JUNE 1997

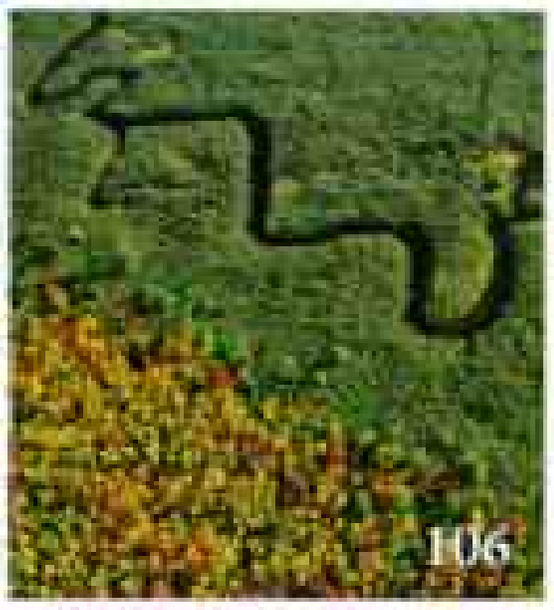


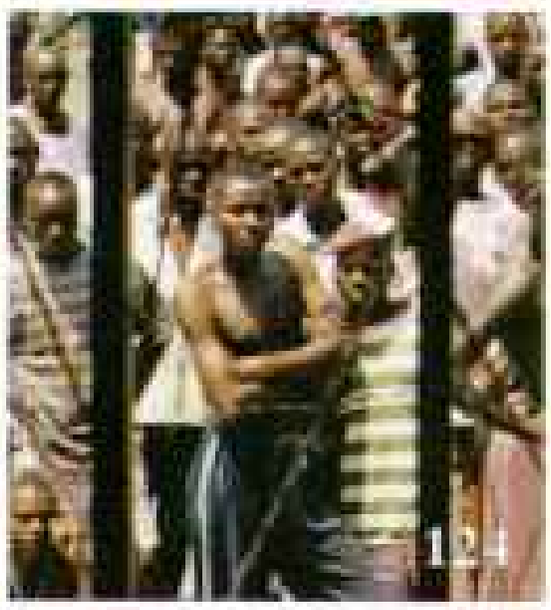












The Cover

Black pearls, the luminous product of oysters and human ingenuity, adorn a Tahitian woman. Photograph by David Doubilet

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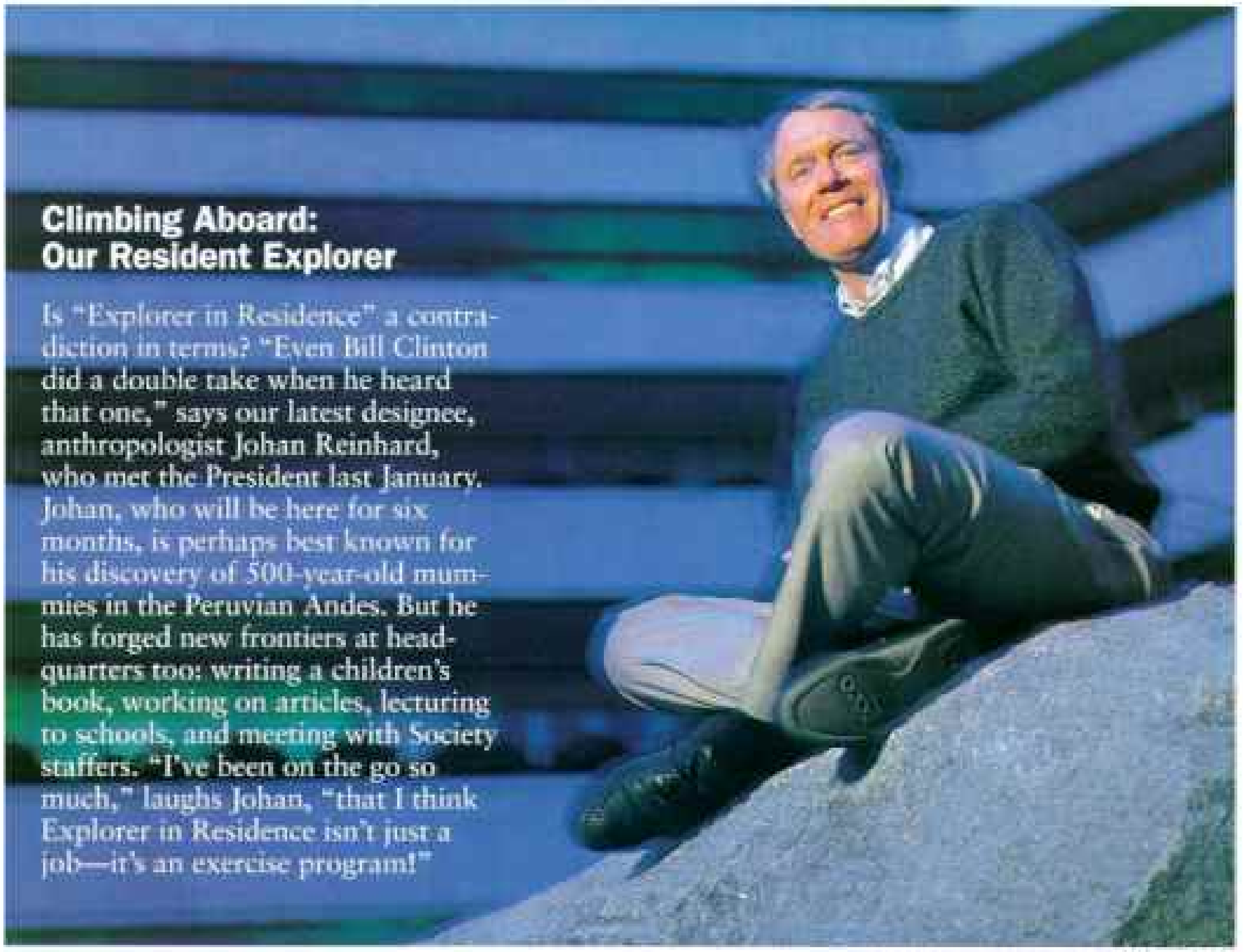

Climbing Aboard: Our Resident Explorer

Is "Explorer in Residence" a contradiction in terms? "Even Bill Clinton did a double take when he heard that one," says our latest designee, anthropologist Johan Reinhard, who met the President last January. Johan, who will be here for six months, is perhaps best known for his discovery of 500-year-old mummies in the Peruvian Andes. But he has forged new frontiers at headquarters too: writing a children's book, working on articles, lecturing to schools, and meeting with Society staffers. "I've been on the go so much," laughs Johan, "that I think Explorer in Residence isn't just a job—it's an exercise program!"

MARK THIESSEN

DAVID CLARK

The Eagle Has Mended in Lebanon

Abboud Nasrala had a problem. Walking in the forest near his home in Lebanon, he discovered an injured eagle, felled by a gunshot. He took the ailing bird home and, seeking help, logged on to National Geographic's website to find Joe Blanton's "Glad You Asked" column. Joe quickly put Abboud in touch with the Wildlife Center of Virginia, a state-of-the-art animal hospital that was displaying live birds of prey at our Explorers Hall. Experts there explained how to care for the eagle. Abboud reports that the bird was soon well enough to release.

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Eli Underwater: A Whale of a Shark Story

It was Eli Weiss's first time snorkeling, and the first time he'd used an underwater camera. But the Florida five-year-old, whose mother and grandmother had taken him along on a research expedition off the Mexican coast, performed like a pro—even when several 12- to 28-foot whale sharks cruised by. "I just focused on the white spots," explains Eli of his two-frame shot of the rarely seen, harmless shark. No one is prouder of Eli than his grandma. She's the Shark Lady—scientist and NGS grantee Dr. Eugenie Clark, who was studying whale sharks (GEOGRAPHIC, December 1992).

■ FOR INFORMATION

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Going to the Dogs

Spending countless hours with felines big and small for her cats article left Cathy Newman impressed but not converted. So what pet did she choose for her family? Cathy and son Jeb, 11, picked up Skitch, a Minnesota-bred Labrador retriever, at a Washington airport in January.

—MAGGIE ZACKOWITZ

FREQUENT HEARTBURN SUFFERERS:

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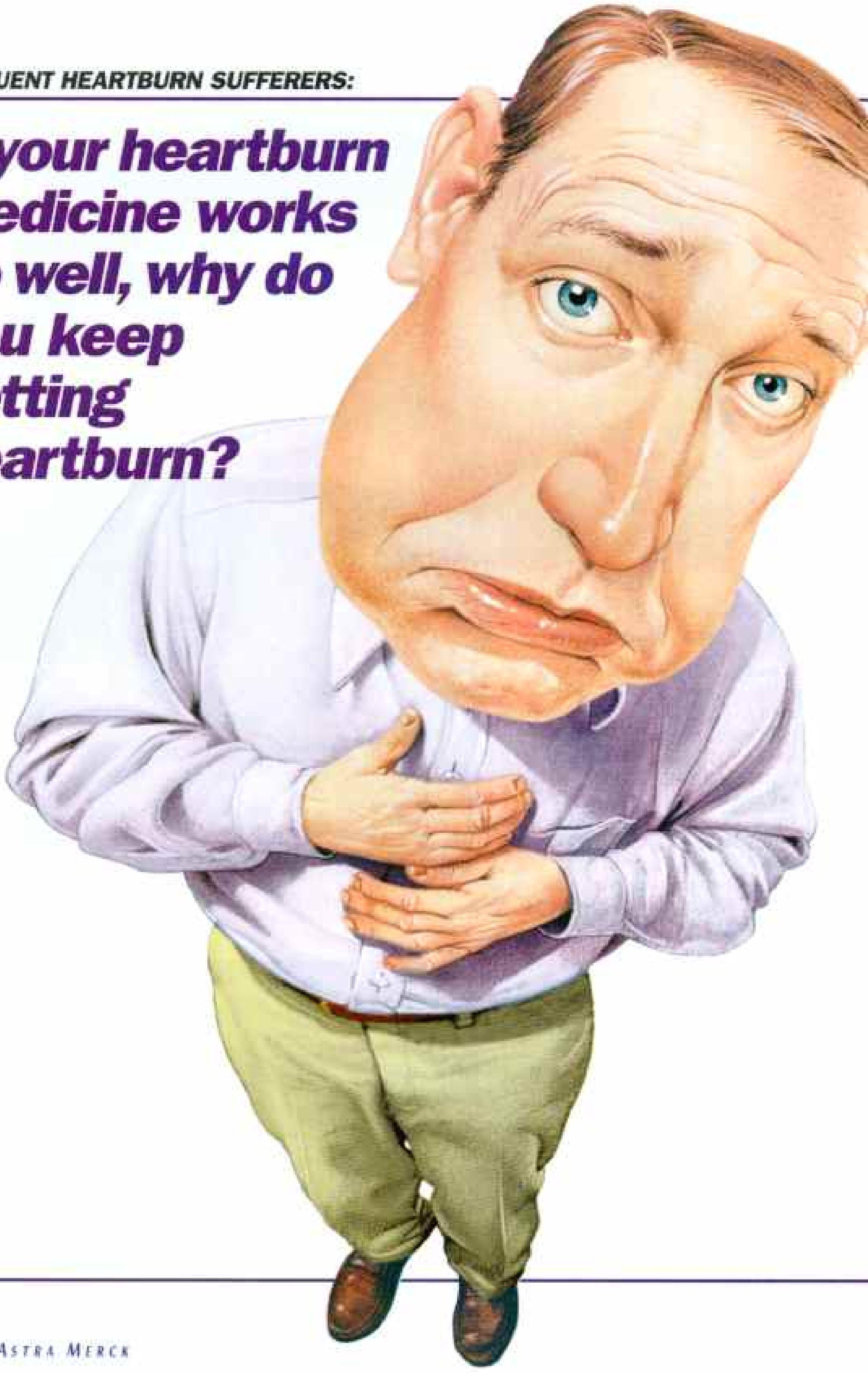

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PRILOSEC®* (OMEPRAZOLE)

Delayed-Release Capsules

BRIEF SUMMARY

CLINICAL PHARMACOLOGY ***Pharmacokinetics and Metabolism:*** **Omeprazole –** In pharmacokinetic studies of single 20 mg omeprazole doses, an increase in AUC of approximately four-fold was noted in Asian subjects compared to Caucasians. Dose adjustment, particularly where maintenance of healing of erosive esophagitis is indicated, for the hepatically impaired and Asian subjects should be considered.

INDICATIONS AND USAGE ***Duodenal Ulcer:*** PRILOSEC is indicated for short-term treatment of active duodenal ulcer. Most patients heal within 4 weeks. Some patients may require an additional 4 weeks of therapy. PRILOSEC, in combination with clarithromycin, is also indicated for treatment of patients with *H. pylori* infection and active duodenal ulcer to eradicate *H. pylori*. Eradication of *H. pylori* has been shown to reduce the risk of duodenal ulcer recurrence. In patients who fail therapy, susceptibility testing should be done. If resistance to clarithromycin is demonstrated or susceptibility testing is not possible, alternative antimicrobial therapy should be instituted. [See the clarithromycin package insert, MICROBIOLOGY section.] **Gastric Ulcer:** PRILOSEC is indicated for short-term treatment (4-8 weeks) of active benign gastric ulcer. **Treatment of Gastroesophageal Reflux Disease (GERD): Symptomatic GERD –** PRILOSEC is indicated for the treatment of heartburn and other symptoms associated with GERD. **Erosive Esophagitis –** PRILOSEC is indicated for the short-term treatment (4-8 weeks) of erosive esophagitis which has been diagnosed by endoscopy. The efficacy of PRILOSEC used for longer than 8 weeks in these patients has not been established. In the rare instance of a patient not responding to 8 weeks of treatment, it may be helpful to give up to an additional 4 weeks of treatment. If there is recurrence of erosive esophagitis or GERD symptoms (e.g. heartburn), additional 4-8 week courses of omeprazole may be considered. **Maintenance of Healing of Erosive Esophagitis:** PRILOSEC is indicated to maintain healing of erosive esophagitis. Controlled studies do not extend beyond 12 months. **Pathological Hypersecretory Conditions:** PRILOSEC is indicated for the long-term treatment of pathological hypersecretory conditions (e.g., Zollinger-Ellison syndrome, multiple endocrine adenomas and systemic mastocytosis).

CONTRAINDICATIONS ***Omeprazole:*** PRILOSEC Delayed-Release Capsules are contraindicated in patients with known hypersensitivity to any component of the formulation. ***Clarithromycin:*** Clarithromycin is contraindicated in patients with a known hypersensitivity to any macrolide antibiotic, and in patients receiving terfenadine therapy who have pre-existing cardiac abnormalities or electrolyte disturbances. [Please refer to full prescribing information for clarithromycin before prescribing.]

WARNING: ***Clarithromycin:*** **CLARITHROMYCIN SHOULD NOT BE USED IN PREGNANT WOMEN EXCEPT IN CLINICAL CIRCUMSTANCES WHERE NO ALTERNATIVE THERAPY IS APPROPRIATE. IF PREGNANCY OCCURS WHILE TAKING CLARITHROMYCIN, THE PATIENT SHOULD BE APPRISED OF THE POTENTIAL HAZARD TO THE FETUS. [See WARNINGS in prescribing information for clarithromycin.]**

PRECAUTIONS ***General:*** Symptomatic response to therapy with omeprazole does not preclude the presence of gastric malignancy. Atrophic gastritis has been noted occasionally in gastric corpus biopsies from patients treated long-term with omeprazole. ***Information for Patients:*** PRILOSEC Delayed-Release Capsules should be taken before eating. Patients should be cautioned that the PRILOSEC Delayed-Release Capsule should not be opened, chewed or crushed, and should be swallowed whole. ***Drug Interactions:*** ***Other –*** Omeprazole can prolong the elimination of diazepam, warfarin and phenytoin, drugs that are metabolized by oxidation in the liver. Although in normal subjects no interaction with theophylline or propranolol was found, there have been clinical reports of interaction with other drugs metabolized via the cytochrome P-450 system (e.g., cyclosporine, disulfiram, benzodiazepines). Patients should be monitored to determine if it is necessary to adjust the dosage of these drugs when taken concomitantly with PRILOSEC. Because of its profound and long lasting inhibition of gastric acid secretion, it is theoretically possible that omeprazole may interfere with absorption of drugs where gastric pH is an important determinant of their bioavailability (e.g., ketoconazole, ampicillin esters, and iron salts). In the clinical trials, antacids were used concomitantly with the administration of PRILOSEC. ***Combination Therapy with Clarithromycin –*** Co-administration of omeprazole and clarithromycin may result in increases in plasma levels of omeprazole, clarithromycin, and 14-hydroxy clarithromycin. [See CLINICAL PHARMACOLOGY, Pharmacokinetics, Combination Therapy with Clarithromycin in full Prescribing Information.] ***Carcinogenesis, Mutagenesis, Impairment of Fertility:*** In two 24 month carcinogenicity studies in rats, omeprazole at daily doses of 1.7, 3.4, 13.8, 44.0 and 140.8 mg/kg/day (approximately 4 to 352 times the human dose, based on a patient weight of 50 kg and a human dose of 20 mg) produced gastric ECL cell carcinoids in a dose-related manner in both male and female rats; the incidence of this effect was markedly higher in female rats, which had higher blood levels of omeprazole. Gastric carcinoids seldom occur in the untreated rat; in addition, ECL cell hyperplasia was present in all treated groups of both sexes. In one of these studies, female rats were treated with 13.8 mg/kg/day omeprazole (approximately 35 times the human dose) for 1 year, then followed for an additional year without the drug. No carcinoids were seen in these rats. An increased incidence of treatment-related ECL cell hyperplasia was observed at the end of 1 year (94% treated vs. 10% controls). By the second year the difference between treated and control rats was much smaller (46% vs. 25%) but still showed more hyperplasia in the treated group. An individual primary malignant tumor in the stomach was seen in one rat (2%). No similar tumor was seen in male or female rats treated for 2 years. For this strain of rat no similar tumor has been noted historically, but a finding involving only one tumor is difficult to interpret. A 78-week mouse carcinogenicity study of omeprazole did not show increased tumor occurrence, but the study was not conclusive. Omeprazole was not mutagenic in an *in vitro* Ames Salmonella typhimurium assay, an *in vitro* mouse lymphoma cell assay and an *in vivo* rat liver DNA damage assay. A mouse micronucleus test at 625 and 1250 times the human dose gave a borderline result, as did an *in vivo* bone marrow chromosome aberration test. A second mouse micronucleus study at 2000 times the human dose, but with different (succedinal) sampling times, was negative. ***Pregnancy:*** ***Omeprazole: Pregnancy Category C –*** In rabbits, omeprazole in a dose range of 6.9 to 69.1 mg/kg/day (approximately 17 to 172 times the human dose) produced dose-related increases in embryo-lethality, fetal resorptions and pregnancy disruptions. In rats, dose-related embryo/fetal toxicity and postnatal developmental toxicity were observed in offspring resulting from parents treated with omeprazole 13.8 to 138.0 mg/kg/day (approximately 35 to 345 times the human dose). There are no adequate or well-controlled studies in pregnant women. Sporadic reports have been received of congenital abnormalities occurring in infants born to women who have received omeprazole during pregnancy. Omeprazole should be used during pregnancy only if the potential benefit justifies the potential risk to the fetus. ***Clarithromycin: Pregnancy Category C –*** [See WARNING (above) and full prescribing information for clarithromycin before using in pregnant women.] ***Nursing Mothers:*** It is not known whether omeprazole is excreted in human milk. In rats, omeprazole administration during late gestation and lactation at doses of 13.8 to 138 mg/kg/day (35 to 345 times the human dose) resulted in decreased weight gain in pups. Because many drugs are excreted in human milk, because of the potential for serious adverse reactions in nursing infants from omeprazole, and because of the potential for tumorigenicity shown for omeprazole in rat carcinogenicity studies, a decision should be made whether to discontinue nursing or discontinue the drug, taking into account the importance of the drug to the mother. ***Pediatric Use:*** Safety and effectiveness in children have not been established.

ADVERSE REACTIONS: In the U.S. clinical trial population of 465 patients (including duodenal ulcer, Zollinger-Ellison syndrome and resistant ulcer patients), the following adverse experiences were reported to occur in 1% or more of patients on therapy with PRILOSEC. Numbers in parentheses indicate percentages of the adverse experiences considered by investigators as possibly, probably, or definitely related to the drug.

	Omeprazole (n=465)	Placebo (n=54)	Ranitidine (n=139)
Headache	6.9 (2.4)	9.3	7.7 (2.9)
Diarrhea	3.0 (1.9)	3.1 (1.8)	2.1 (0.7)
Abdominal Pain	2.4 (0.4)	3.1	2.1
Nausea	2.2 (0.9)	3.1	4.1 (0.7)
URI	1.9	1.8	2.8
Dizziness	1.5 (0.9)	0.0	2.8 (1.0)
Vomiting	1.5 (0.4)	4.7	1.5 (0.7)
Pain	1.5 (1.1)	0.0	0.0
Constipation	1.1 (0.9)	0.0	0.0
Cough	1.1	0.0	1.9
Asthenia	1.1 (0.2)	1.8 (1.8)	1.5 (1.0)
Back Pain	1.1	0.0	0.7

The following adverse reactions which occurred in 1% or more of omeprazole-treated patients have been reported in international double-blind, and open-label, clinical trials in which 2,621 patients and subjects received omeprazole.

Incidence of Adverse Experiences ≥ 1% Causal Relationship not Assessed

		Omeprazole (n=2621)	Placebo (n=170)
Body as a Whole	Abdominal pain	5.2	3.5
	Asthenia	1.9	1.8
Digestive System	Constipation	1.5	0.6
	Diarrhea	3.7	2.9
	Flatulence	2.7	3.8
	Nausea	4.0	6.7
	Vomiting	3.2	10.0
	Acid regurgitation	1.9	1.2
Nervous System Psychiatric	Headache	2.9	2.9

Additional adverse experiences occurring in < 1% of patients or subjects in domestic and/or international trials, or occurring since the drug was marketed, are shown below within each body system. In many instances, the relationship to PRILOSEC® (omeprazole) was unclear. Body As a Whole: Fever, pain, fatigue, malaise, abdominal swelling. Cardiovascular: Chest pain or angina, tachycardia, bradycardia, palpitation, elevated blood pressure, peripheral edema. Gastrointestinal: Pancreatitis (some fatal), anorexia, irritable colon, flatulence, fecal discoloration, esophageal candidiasis, mucosal atrophy of the tongue, dry mouth. During treatment with omeprazole, gastric fundic gland polyps have been noted rarely. These polyps are benign and appear to be reversible when treatment is discontinued. Gastro-duodenal carcinoids have been reported in patients with ZE syndrome on long-term treatment with PRILOSEC. This finding is believed to be a manifestation of the underlying condition, which is known to be associated with such tumors. Hepatic: Mild and rarely marked elevations of liver function tests [ALT (SGPT), AST (SGOT), γ-glutamyl transpeptidase, alkaline phosphatase, and bilirubin (jaundice)]. In rare instances, overt liver disease has occurred, including hepatocellular, cholestatic, or mixed hepatitis, liver necrosis (some fatal), hepatic failure (some fatal), and hepatic encephalopathy. Metabolic/Nutritional: Hyponatremia, hypoglycemia, weight gain. Musculoskeletal: Muscle cramps, myalgia, muscle weakness, joint pain, leg pain. Nervous System/Psychiatric: Psychic disturbances including depression, aggression, hallucinations, confusion, insomnia, nervousness, tremors, apathy, somnolence, sweating, dream abnormalities, vertigo, paresthesia, hemifacial dysesthesia. Respiratory: Epistaxis, pharyngeal pain. Skin: Rash and, very rarely, cases of severe generalized skin reactions including toxic epidermal necrolysis (TEN; some fatal), Stevens-Johnson syndrome, and erythema multiforme (some severe), skin inflammation, urticaria, angioedema, pruritus, alopecia, dry skin, hyperhidrosis. Special Senses: Tinnitus, taste perversion. Urogenital: interstitial nephritis (some with positive rechallenge), urinary tract infection, microscopic pyuria, urinary frequency, elevated serum creatinine, proteinuria, hematuria, glycosuria, testicular pain, gynecomastia. Hematologic: Rare instances of pancytopenia, agranulocytosis (some fatal), thrombocytopenia, neutropenia, anemia, leukocytosis, and hemolytic anemia have been reported. **Combination Therapy with Clarithromycin:** In clinical trials using combination therapy with PRILOSEC and clarithromycin, no adverse experiences peculiar to this drug combination have been observed. Adverse experiences that have occurred have been limited to those that have been previously reported with omeprazole or clarithromycin. Adverse experiences observed in controlled clinical trials using combination therapy with PRILOSEC and clarithromycin (n=346) which differed from those previously described for omeprazole alone were: Taste perversion (1.5%), tongue discoloration (2%), rhinitis (2%), pharyngitis (1%), and flu syndrome (1%). For more information on clarithromycin, refer to the clarithromycin package insert, ADVERSE REACTIONS section.

OVERDOSAGE: Rare reports have been received of overdosage with omeprazole. Doses ranged from 321 mg to 900 mg (16 - 45 times the usual recommended clinical dose). Manifestations were variable, but included confusion, drowsiness, blurred vision, tachycardia, nausea, diaphoresis, flushing, headache, and dry mouth. Symptoms were transient, and no serious clinical outcome has been reported. No specific antidote for omeprazole overdosage is known. Omeprazole is extensively protein bound and is, therefore, not readily dialyzable. In the event of overdosage, treatment should be symptomatic and supportive.

DOSAGE AND ADMINISTRATION ***Duodenal Ulcer:*** Short-Term Treatment of Active Duodenal Ulcer: The recommended adult oral dose of PRILOSEC is 20 mg once daily. Most patients heal within 4 weeks. Some patients may require an additional 4 weeks of therapy. [See INDICATIONS AND USAGE.]

Reduction of the Risk of Duodenal Ulcer Recurrence: Combination Therapy with Clarithromycin

Days 1-14:	Days 15-28:
PRILOSEC 40 mg q.d. (in the morning) plus clarithromycin 500 mg t.i.d.	PRILOSEC 20 mg q.d.

Please refer to clarithromycin full prescribing information for CONTRAINDICATIONS and WARNING, and for information regarding dosing in adults and pediatric patients, DIRECTIONS, Geriatric Use and PRECAUTIONS, Drug Interactions. ***Gastric Ulcer:*** The recommended adult oral dose is 40 mg once a day for 4 to 8 weeks. [See INDICATIONS AND USAGE, Gastric Ulcer.] ***Gastroesophageal Reflux Disease (GERD):*** The recommended adult oral dose for the treatment of patients with symptomatic GERD and no esophageal lesions is 20 mg daily for up to 4 weeks. The recommended adult oral dose for the treatment of patients with erosive esophagitis and accompanying symptoms due to GERD is 20 mg daily for 4 to 8 weeks. [See INDICATIONS AND USAGE.] ***Maintenance of Healing of Erosive Esophagitis:*** The recommended adult oral dose is 20 mg daily. ***Pathological Hypersecretory Conditions:*** The dosage of PRILOSEC in patients with pathological hypersecretory conditions varies with the individual patient. The recommended adult oral starting dose is 60 mg once a day. Doses should be adjusted to individual patient needs and should continue for as long as clinically indicated. Doses up to 120 mg t.i.d. have been administered. Daily dosages of greater than 80 mg should be administered in divided doses. No dosage adjustment is necessary for patients with renal impairment, hepatic dysfunction or for the elderly.

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December 1996 PRI25

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NOTE: This summary provides important information about PRILOSEC. If you would like more information, ask your doctor or pharmacist to let you read the professional labeling and then discuss it with them.

May 28, he'll pick on people half his size.

Watch the **National Geography Bee** on your PBS station, moderated by Alex Trebek, host of "Jeopardy!"

Check local listings or http://geobee.nationalgeographic.com for exact day and time.

Millions of America's best and brightest kids have already competed in local school geography bees. On Wednesday, May 28, the state-level winners will meet to determine this year's national champion. A $25,000 college scholarship is the grand prize.

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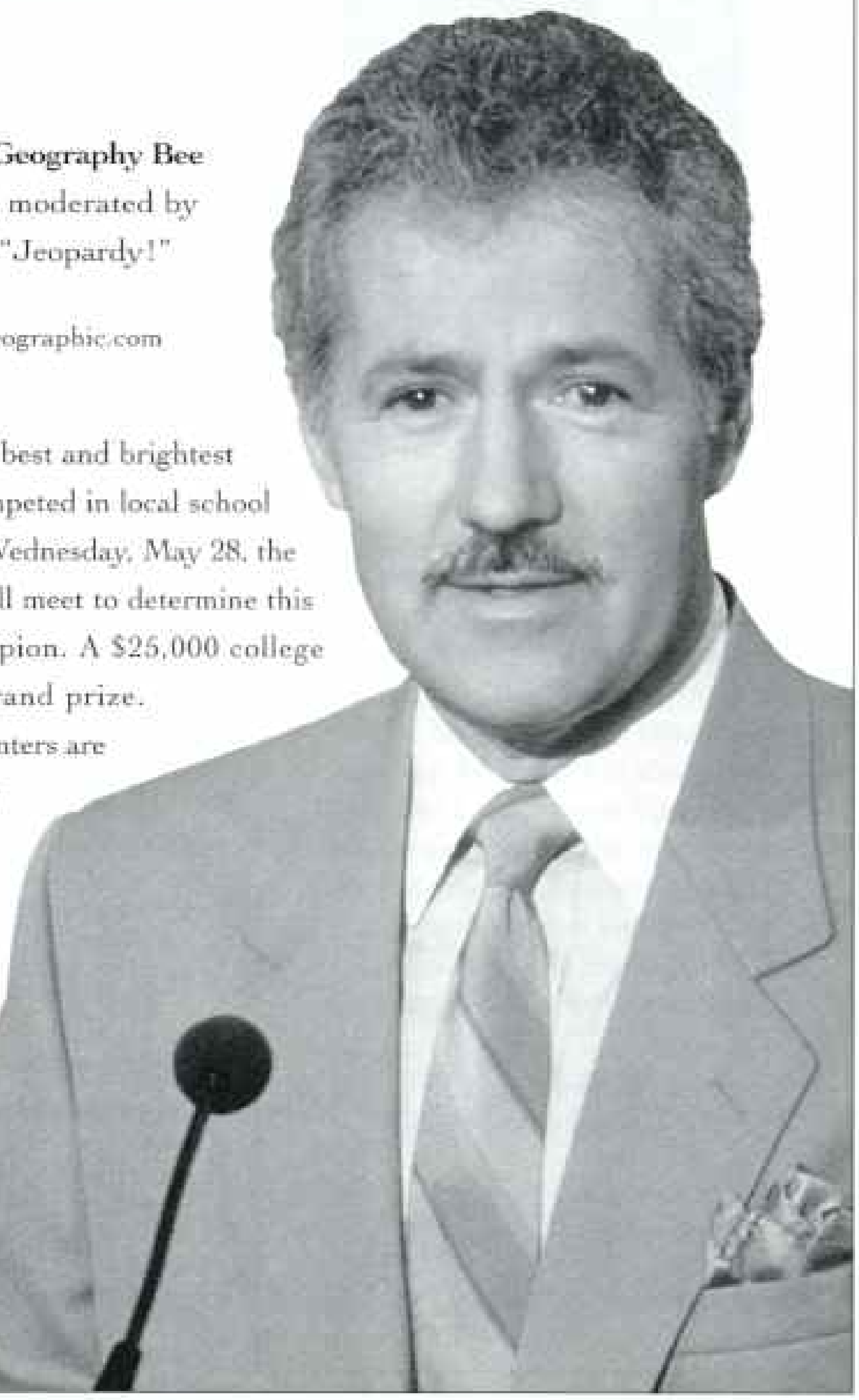

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Forum

A number of readers took issue with "The First Steps," our February 1997 article on the dawn of humans. Some offered alternative ideas about how evolution has proceeded, while others took us to task for accepting evolution as fact. Several readers thought we devoted too little space to Siberian tigers, especially since one appeared on the cover.

The Great Khans

As a history teacher from Romania, I was disappointed that you omitted my homeland in writing about the Mongols. The invasion was a terrible time for Romania too.

SILVIA BIRSAN
North York, Ontario

The article does not mention that the Mongol invaders were defeated twice in the late 13th century by the Vietnamese fighting for their independence.

PHILIP D. NGUYEN
Winter Park, Florida

Kyyivan Rus is referred to as Russia. But Russia did not exist at that time. Kyyivan Rus was in fact the first Ukrainian state, of which Kyyiv [Kiev] was the capital as it is to this day. Americans of Ukrainian descent consider it an insult when a publication attributes their ancestral history to another country.

OLENA C. BOYKO
Urbanna, Virginia

The caption on page 32 calls Pagan the city of four million temples. The Burmese more modestly refer to it as the city of 4,000 pagodas, although a 1954 archaeological survey report said that traces of some 5,000 pagodas had been uncovered.

RICHARD H. HOWARTH
Reston, Virginia

The photograph on page 11 shows a trumpeter sounding his clarion call, the *hejnał*, from the tower of St. Mary's Church in Kraków. Polish Radio has adopted the hejnał as the country's noontime signal, a constant reminder of the ritual.

SUSAN CACHEL
New Brunswick, New Jersey

An Arctic Breakthrough

The thriller *Ice Station Zebra* dramatized a nuclear submarine crew's adventure under the Arctic ice pack. Ever since, I have been fascinated by the existence of drift stations and their pursuit of scientific data, but not much has been published about them. It never occurred to me that the reason was that most of the work was classified.

ROBERT STEPHENS
Little Rock, Arkansas

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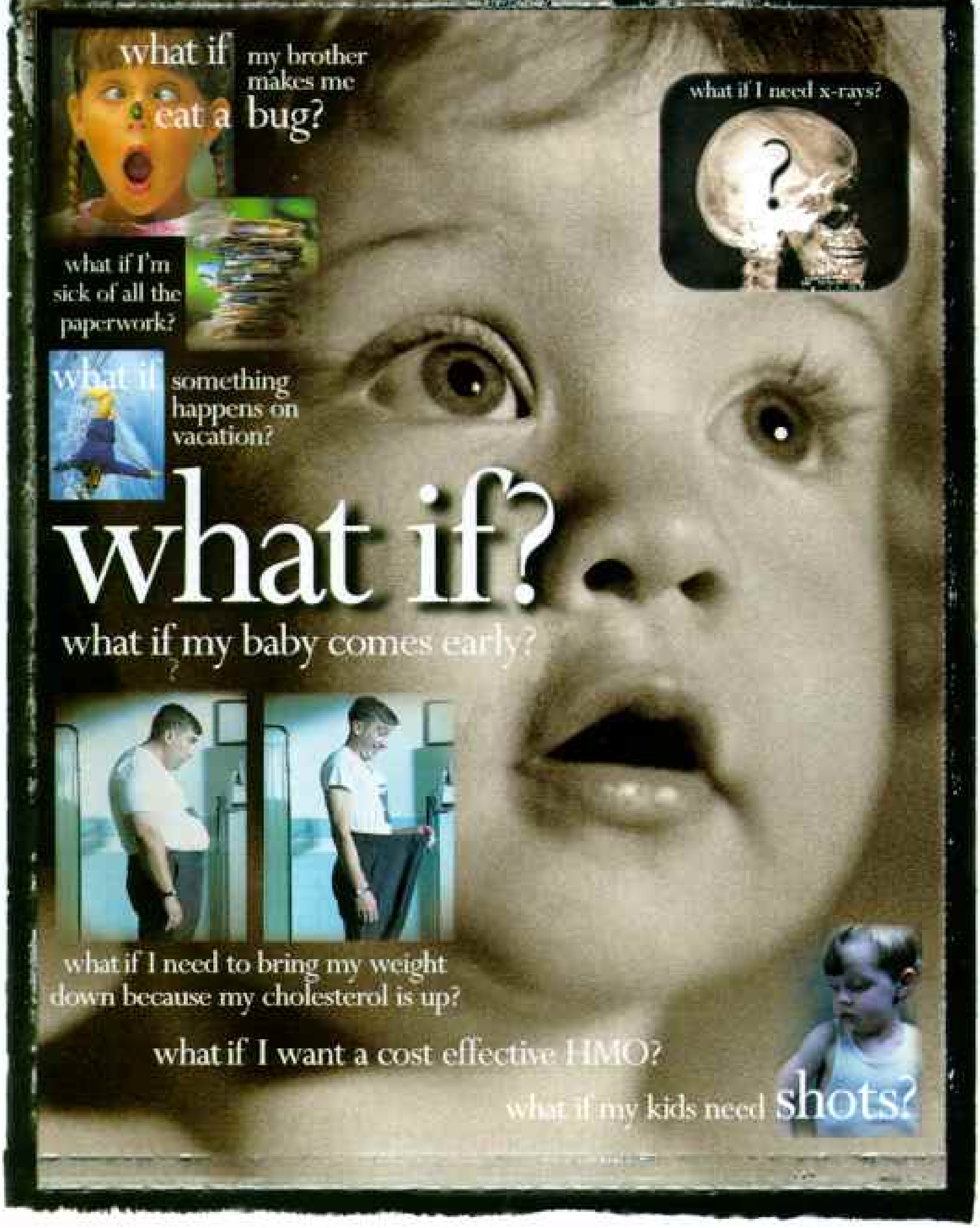

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The sail of the *Pargo* is referred to as a conning tower. Conning towers are structures limited to diesel-powered submarines. The *Pargo* and her sister ships have specially reinforced "under-ice sails" for punching through the ice.

MERVIN MILLER
Comanche, Iowa

The First Steps

It is always a humbling thought to remember that DNA comparisons show that our genes are more than 98 percent identical to those of today's chimpanzees. We should recognize that the great apes are entitled to much better protection. Perhaps they should be given species rights similar to our human rights.

MICHAEL IRWIN
London, England

As an educator I have found that it is difficult to teach human evolution and that the subject is often crudely explained in textbooks. Your article was a brilliant eye-opener for my students. They spent countless sessions debating the scientific evidence of evolution, religious beliefs and doubts on the matter, and the problems within the scientific community. The minds of dozens of children were critically thinking about the subject.

JARED W. STAGNER
Plainfield, Indiana

You make the statement that termites are eaten by chimpanzees and some hunter-gatherers today. I have worked as a biologist for over 20 years in southern Africa, and I can assure you that termites are eaten by most people from Lesotho through Malawi. Most eat only the winged reproductives, which emerge with the onset of rain and are considered a delicacy. In northern Malawi I was shown elaborate traps to catch them. Personally, I insist on cooking them, since there is evidence that they may be involved in the spread of a worm related to hookworm.

BRUCE J. HARGREAVES
Bakersfield, California

There is agreement that man evolved from animals, but the explanation for the jump from animals to man is missing until you consider the possibility of a spirit.

C. GARSTANG
Taunton, England

Map Supplement: Dawn of Humans

Your magazine is never devoid of visual stimulation. My favorite feature was the back of the map supplement. The early humans are portrayed in an objective and dignified manner. I especially enjoyed the pan-racial portrayal of a modern human. He resembles one of the pharaohs, at least popular reconstructions of Ramses.

ROGER B. SNOW
Ledyard, Connecticut

It seems insensitive to have chosen to represent modern man as a light-skinned person and our most remote predecessors as dark skinned. How

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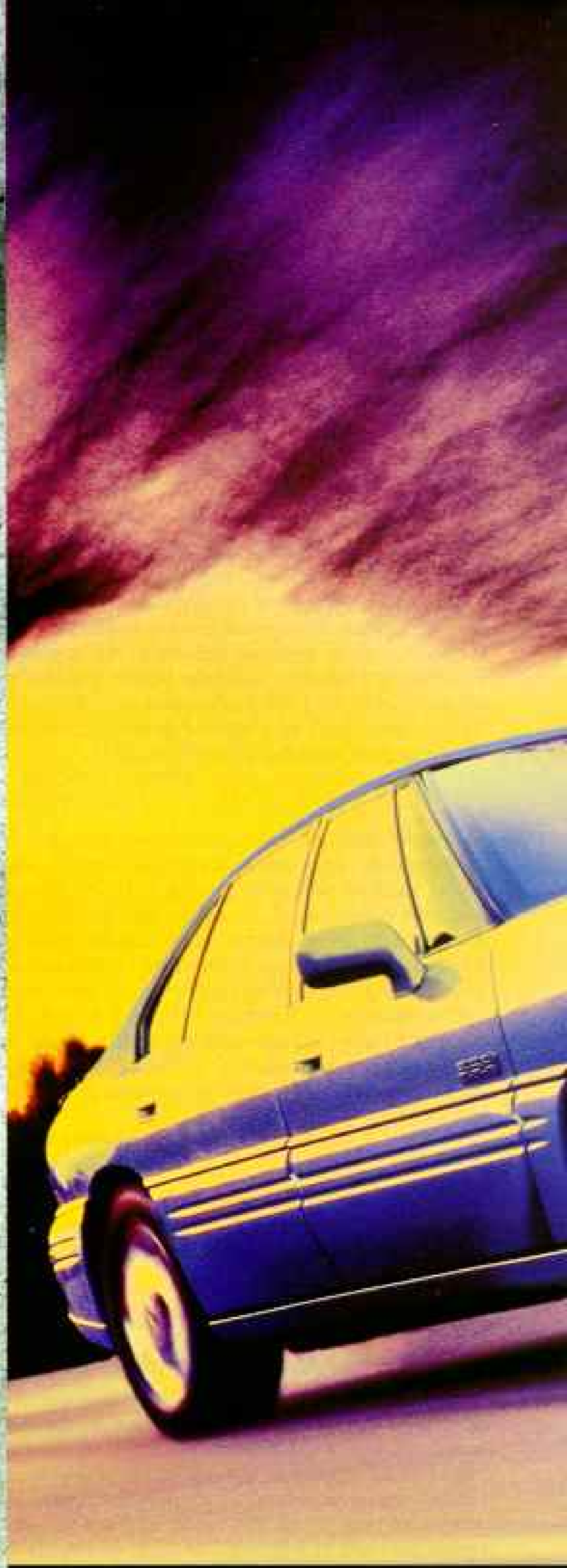

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logical it would have been for the evolutionary pyramid to have been surmounted by a face reminiscent of Nelson Mandela or Frederick Douglass.

ARTHUR BINDER
Brooklyn, New York

The illustration is a composite modern human. Rather than representing one race or sex, artist John Gurche blended features of nine individuals from various groups, from African Americans to Japanese. Since early humans originated in Africa, it is speculated that they displayed a dark-skin adaptation to tropical climate.

I was delighted to find two of Croatia's best known archaeological sites, Krapina and Vindija, on the supplement. Fossil remains of early humans were found at Krapina in Hushnjak Cave during an excavation led by Dragutin Gorjanović-Kramberger from 1899 until 1905. For the most part the bones were violently smashed; some anthropologists conclude that this suggests cannibalism.

TOMISLAV MIROSAVLJEVIC
Slavonski Brod, Croatia

Lichens

On a pilgrimage to the Glenlivet distillery in Scotland, I was disappointed to see glorious Scotch whisky stored in warehouses covered with what looked like tar paper. We learned that these bonded warehouses were really covered by a black lichen that thrives on vapors escaping from the barrels. I snitched a piece of that happy lichen; it smelled just like the Glenlivet!

RICK ISAACS
Newburyport, Massachusetts

Siberian Tigers

If you plan to publish another sampling of memorable photographs from your magazine, I suggest you include the man cuddling the tiger cub (page 108). The expressions on the faces of both man and animal are sublime.

PETER YOUNG
Southampton, Ontario

Under New York

Kudos to artist Don Foley for the computer-aided drawing that gave a visual assist in figuring out where new tunnels are being added. The cutaway on page 125 provided an astounding view of the immensity of bedrock layers. I appreciated seeing the contrast between the East River, here a mere 83 feet deep, and the new water tunnel at 400-plus feet below the surface. Graphic art at its finest.

TANYA L. BUTTON
Woodinville, Washington

As president of Amtrak's Northeast Corridor, I must object to your characterization of Amtrak's handling of the homeless population in one of our rail tunnels. Amtrak helped find federally subsidized housing, provided social service outreach, and relocated many of the homeless to apartments.

GEORGE D. WARRINGTON
Philadelphia, Pennsylvania

National Geographic, June 1997

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My granduncle claimed that a network of pneumatic tubes below the streets of New York once linked the main post office to local post offices, allowing letters and small parcels to be distributed quickly. He could not recall the reason for the system's shutdown.

JOE KANOWITZ
Ridgefield, Connecticut

Your granduncle was correct. Pneumatic tubes once sped mail at 30 miles an hour below the streets. The system was abandoned as uneconomical in 1952. The U.S. Treasury Department also once transferred currency and securities by a pneumatic tube network.

Joel Swerdlow's bleak testimonial to the apathy and "aloneness" on the New York subway was disappointing, especially the comparison with "some lower ring of Dante's inferno." As one of 3.5 million riders, I can assuredly say: Cheer up, it's not that bad.

JOE NAPOLITANO
Setauket, New York

When I first rode the subway, I was fascinated by New Yorkers' blank, vacant expressions. But as I was to learn, and as Mr. Swerdlow observed, it is a shield against the unknown forces in Dante's indifferent, subterranean world.

ASHFORD W. MEIKLE
Kingston, Jamaica

On my first subway ride I saw a man in his mid-30s offer his seat to an elderly woman. I will always remember that even in the darkest of dark, one small candle can spread a lot of light.

JANNAH MORGAN BAILEY
Montgomery, Alabama

Forum

May I expand upon your correction of "fish parts" for "shark's lung" as an ingredient in glue? Chinese have used glue made from air bladders of fish, especially carp, for centuries. The tough, white bladders are made of mainly elastic collagen fibers. After simmering to a desired consistency, the glue can be used in carpentry and bookbinding. Ordinary fish parts wouldn't do.

LEON WANG
Suffern, New York

Letters for FORUM should be sent to National Geographic Magazine, Box 98198, Washington, D.C. 20090-8198, or by fax to 202-828-5460, or via the Internet to ngsforum@nationalgeographic.com. Include name, address, and daytime telephone. Letters may be edited for clarity and space.

We wrote a n
Then we bou

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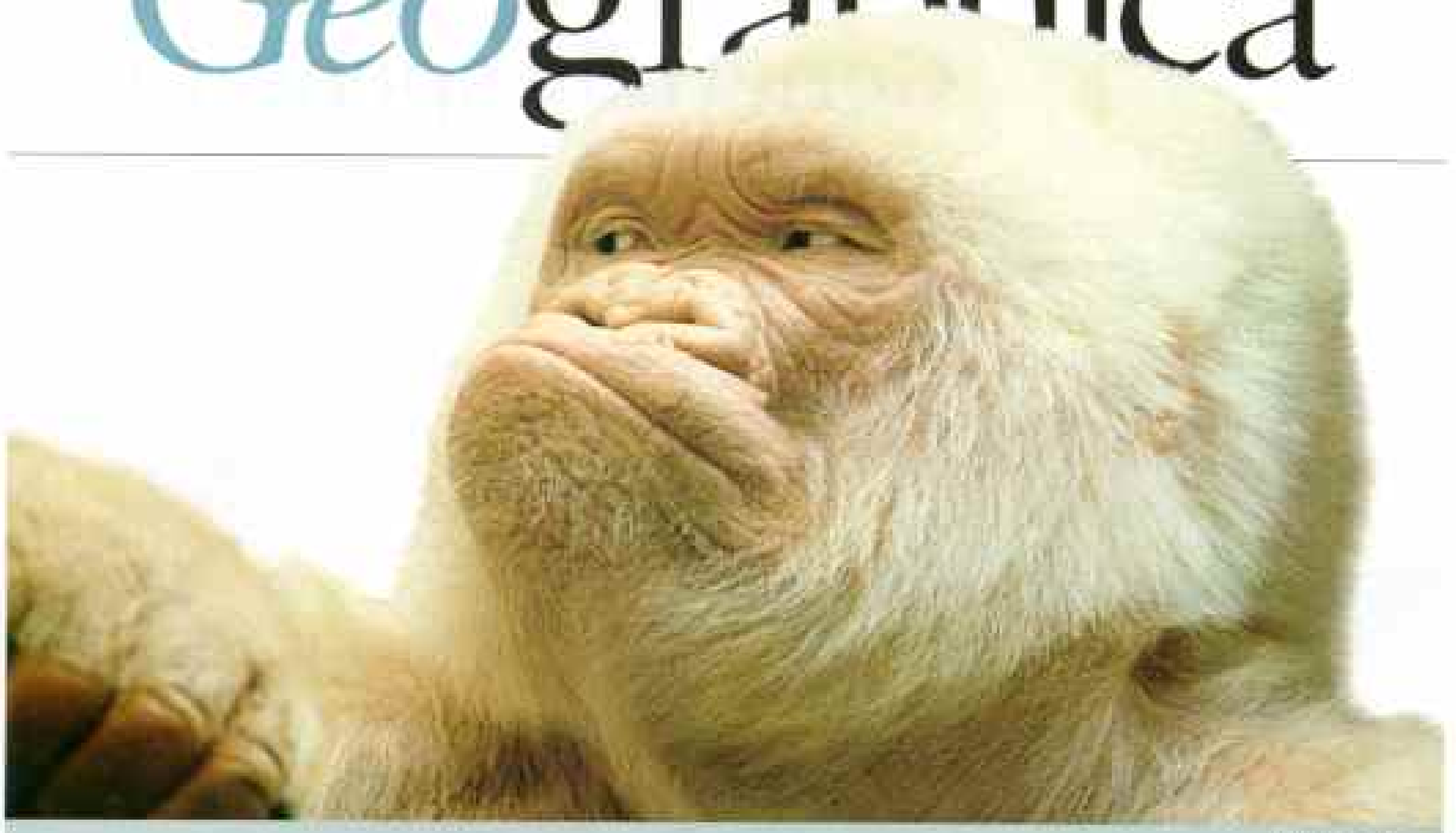
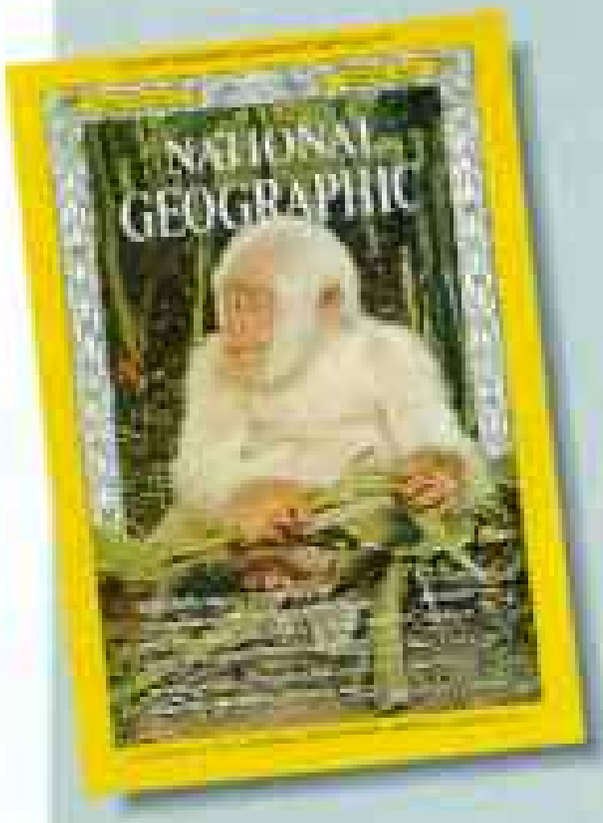


MICHELE ZOMEL

Anniversary Bash Hails a Special Gorilla



The Catalan-language signs gracing Barcelona's streets last year said it all: "*Ets ionic, Xato*—You're unique, Sweetheart."

Snowflake, the world's only known albino gorilla, was celebrating a milestone: He had arrived at Spain's Barcelona Zoo 30 years earlier, after his capture in what is now Equatorial Guinea (GEOGRAPHIC, March 1967, left, and October 1970). During a three-day celebration at the zoo last November, musicians performed, a huge cake was served, and visitors filled an album with their photographs of the much beloved great ape. Snowflake watched impassively from the cage he shares with a female named Ndeugue.

Healthy except for weak eyesight attributed to his albinism, Snowflake is about 32 years old; some gorillas in captivity live into their fifth decade. He has sired 21 offspring, all of them with the normal black gorilla coloring. Only six are still living—five in the Barcelona Zoo, the other in a zoo in Tokyo.

New Elms Fight Off a Killer Disease

Most tree lovers try to avoid Dutch elm disease. But since 1970 Alden Townsend of the USDA Agricultural Research Service has been injecting American elms with heavy doses of the disease-causing fungus, seeking trees that will tolerate the scourge. The disease wiped out millions of elms that once gave American streets "the architectural perfection of an Old World cathedral," according to a November 1955 GEOGRAPHIC article.

By cloning promising trees, injecting the clones with the fungus, and then repeating the process over and over, Townsend has succeeded: Two new elms—dubbed Valley Forge and New Harmony—survive the fungus. Wholesale nurseries are now selling the cultivars. "These two may not be perfect urban elms, but they're better than anything out there," Townsend says.

AGRICULTURAL RESEARCH SERVICE, USDA

Things we've noticed

Generally speaking, the

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Orlando, Florida

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Home of Canada's English Pioneers

They sailed to Newfoundland from Bristol in 1610. The 39 men, sent by investors, cleared the land, planted crops, raised livestock, tried to make glass. For a while Cupers Cove thrived. More settlers, including women, came; Canada's first English baby was born there in 1613.

Now archaeologists, using a settler's diary, letters, and an early 17th-century map (background), have pinpointed the site of the first English colony in Canada, in the town of Cupids on the Avalon Peninsula. They have unearthed ceramics such as this partly reconstructed English-made thumbprint pot, clay pipes, and bottle glass. A stone-and-brick fireplace may have been part of a colonist's home.

The colony never turned a profit; most investors pulled out by 1625. But artifacts found there hint that settlers stayed into the late 17th century, says William Gilbert, who led the excavation.

JOHN BOURNE, BACCALIEU TRAIL HERITAGE CORPORATION

M. R. BRANCH

At Home in the Rocks, a New Gecko Emerges

Barely an inch and a half long, this newly described gecko is having a big effect on how scientists view the little lizards.

Found in Richtersveld, South Africa's only national park owned by local residents (GEOGRAPHIC, July 1996), *Phyllodactylus gemmulus* lives in cracks in rocks, not amid vegetation as many geckos do. That discovery, says Aaron Bauer of Villanova University, who headed a Society-funded research team, led him to look at the region's other leaf-toed geckos. He turned up more species of rock dwellers. "For them, rocks are not just rocks," he says. "Each species selects particular kinds of rocks and cracks for the right camouflage, temperature, and egg-laying sites."

Fixing a Last Boundary, Better Late Than Never

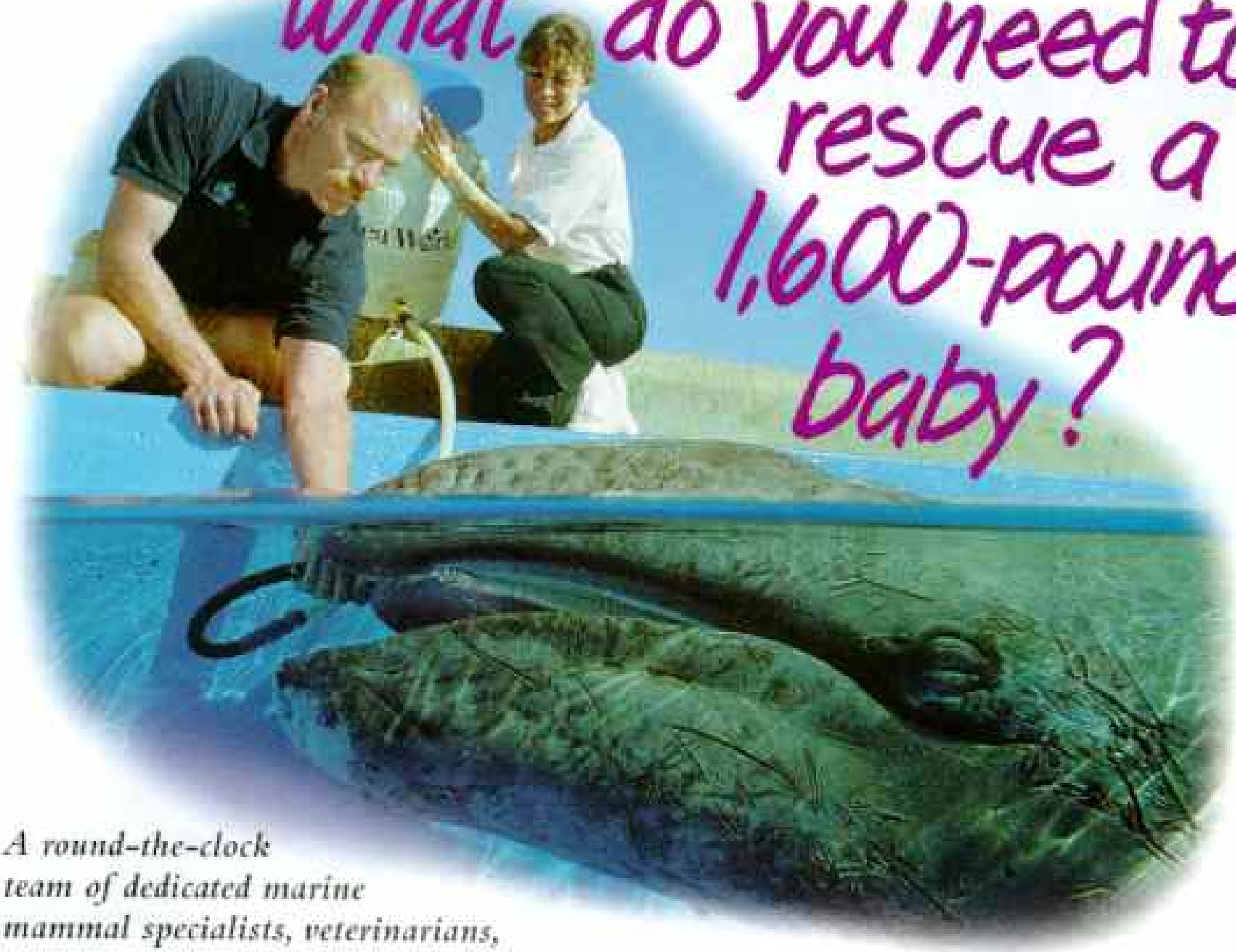
Ever since Virginia's Loudoun County was created in 1757 and neighboring Jefferson County in 1801, "everyone" knew that the boundary separating them was "the crest of the Blue Ridge." But just where, exactly, was that?

No one bothered to survey the line, not even after West Virginia split from Virginia in 1862 and Jefferson County joined the new state four years later. But now people are moving into the area, sending their children to school, and expecting fire and police protection from "their" state. So this year a two-state commission finally fixed the boundary, putting in markers along a 16-mile stretch of the ridge.

The long delay had its advantages in improved technology: Surveyors used global positioning satellites, aerial photography, and computers. But they still had to lug conventional surveying gear up the ridge (below) for on-the-ground work. Experts can't recall any other state boundaries yet unresolved.

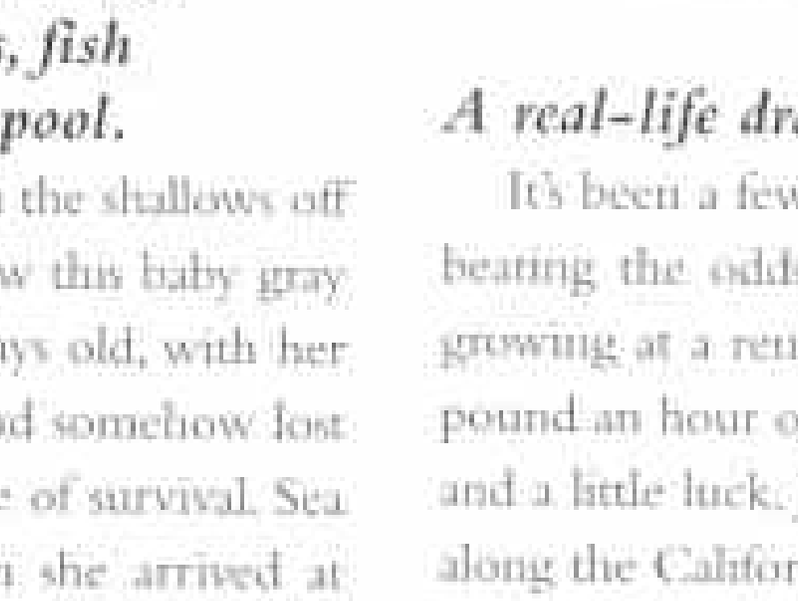
MARK THIESSEN

What do you need to rescue a 1,600-pound baby?



A round-the-clock team of dedicated marine mammal specialists, veterinarians, ***hundreds of gallons of clams, fish and cream, and a really big pool.***

When they saw her thrashing in the shallows off the California coast, everyone knew this baby gray whale was in trouble. Just a few days old, with her umbilical cord still attached, she had somehow lost her mother, and almost any chance of survival. Sea World volunteered to help. When she arrived at Sea World in San Diego, she was nearly comatose, dehydrated, yet still clinging to life. Rescue team members lowered the baby gray whale into a 120,000-gallon pool and gave the whale just what she needed...antibiotics, special fluids, and lots of tender loving care. For hours, she barely moved. Then, at long last, she opened her eyes and began to breathe normally.



A real-life drama.

It's been a few months now, and this big baby is beating the odds. They call her J.J. She has been growing at a remarkable rate, gaining more than a pound an hour on average. With lots of special care and a little luck, J.J. will be swimming on her own along the California coast next winter.

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JOE STEFANCHIK, DALLAS MORNING NEWS

Bath Time for Some City Steers

Steer roping, yes, but steer soaping? These Dallas teens (above) know what they're doing as they scrub down one of sculptor Robert Summers' 40 beef-in-bronze creations in Pioneer Plaza: They're saving works of art for the future.

The Dallas project is one of many grassroots efforts around the nation inspired and fostered by Save Outdoor Sculpture! (SOS!), a Washington, D.C.-based group. Its volunteers have found, cataloged, and assessed the condition of some 30,000 outdoor sculptures. Now SOS! is working to ensure that 10,000 or more survive well into the next century through maintenance and conservation.

"Sculptures are incredibly vulnerable to acid rain, weather, neglect, graffiti, vandalism, a whole realm of dangers," says Susan Nichols, director of SOS! "Preserving them can mean anything from treatment by professional conservators to washing and waxing. That's very basic, but it's like cleaning your teeth or waxing your car or painting your house: You do it to have them around longer."

Now You See This Lake, Now You Don't

Water gushes out of Marzbacher Lake in eastern Kyrgyzstan once or twice a year, leaving the lake's lower end dry and strewn with great blocks of ice (below). The lake's upper portion, separated by an ice wall, always remains full. Marzbacher sits between two glaciers. Periodically the pent-up water of the lower lake either crashes over one of the glaciers or drains through subglacial tunnels, says Colin Lewis of South Africa's Rhodes University. Such glacial floods, like last year's in Iceland (GEOGRAPHIC, May 1997), are common in alpine environments.

MICHAEL CROCKETT

French Flamingos Get New Chance to Soar

Flamingos in the Camargue region of southern France were in desperate straits in the 1960s. Their nesting island was eroding, low-flying airplanes buzzed their favorite haunts, and herring gulls from a nearby garbage dump preyed on eggs and chicks. From 1964 to 1968 the once numerous flamingos failed to breed at all.

ALAN JOHNSON, TOUR DU VALAT

At the Tour du Valat Biological Station, English ornithologist Alan Johnson took on their plight. He persuaded pilots to detour. He convinced local officials to control the gulls. And once flamingos began to return, he built an artificial nesting island and maintains it to prevent erosion. Johnson's staff has banded more than 13,000 chicks. "Now we have 10,000 to 20,000 breeding pairs a year—quite a successful result," he says. A third of the western Mediterranean's flamingos live in France year-round.

It Took A Month Of Saturdays To Find The Perfect Chair. But Only One To Find The Perfect Kitchen.

She enjoyed the hunt as much as anything else. But when she saw that chair, peeking out from under a pile of red velvet curtains, she knew it was over.

As for her husband, he'd already done his part: hooked them up with a fabulous new range and refrigerator. Wasn't his fault it only took one day. But since Jenn-Air's known for making top quality appliances, there really wasn't much point looking anyplace else. Even she could see that.

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For Minor-League Stars, One Hit, a Few Strikes

They were the boys of spring, those eager young baseball players portrayed in "A Season in the Minors" (GEOGRAPHIC, April 1991). All dreamed of making it to "the show," the major leagues. Only one, John Jaha, number 43 of the Stockton Ports, beat the one-in-fourteen odds. Last year's most valuable player for the Milwaukee Brewers (above) batted .300, clubbed 34 homers, and drove in 118 runs. His reward: a one-year contract for nearly 3.4 million dollars.

The lives of the others took different turns. Many never made it past the rookie leagues; some advanced before leaving the professional ranks. El Paso Diablos pitcher Steve Monson, glaring from our pages in the locker room after an injury forced him out of a game, pitched in Mexico before hanging up his spikes in 1993. Now living in Maryland with his wife and three children, including five-year-old Amanda (above right), he runs a forklift for a supermarket chain. "I loved the game. I don't regret anything I've done," he says, "but there's always the thing in the back of your mind that says, 'What if?'"

Shon Ashley, an El Paso outfielder, reached Triple-A, top rung of the minor-league ladder; a separated shoulder ended his 1992 season with the Indianapolis Indians. Now he hoists windows (below) at his father's glass company in Boise, Idaho, where he lives with his wife and two children. He may take over the business when his dad retires. "I have no regrets, but I miss baseball a lot," he says. "You turn on the TV, and friends you played with, roomed with—seeing them on TV, it's tough."

Greg Edge, who appeared on the cover standing in silence for "The Star-Spangled Banner," played for Buffalo, a Triple-A team, in 1992. He became a free agent but didn't catch on. He now lives in Reading, Pennsylvania. "I've been struggling," he admits. "You get accustomed to playing ball; it took me a while to get over that." He plays softball "so I can hear people cheer."

—BORIS WEINTRAUB

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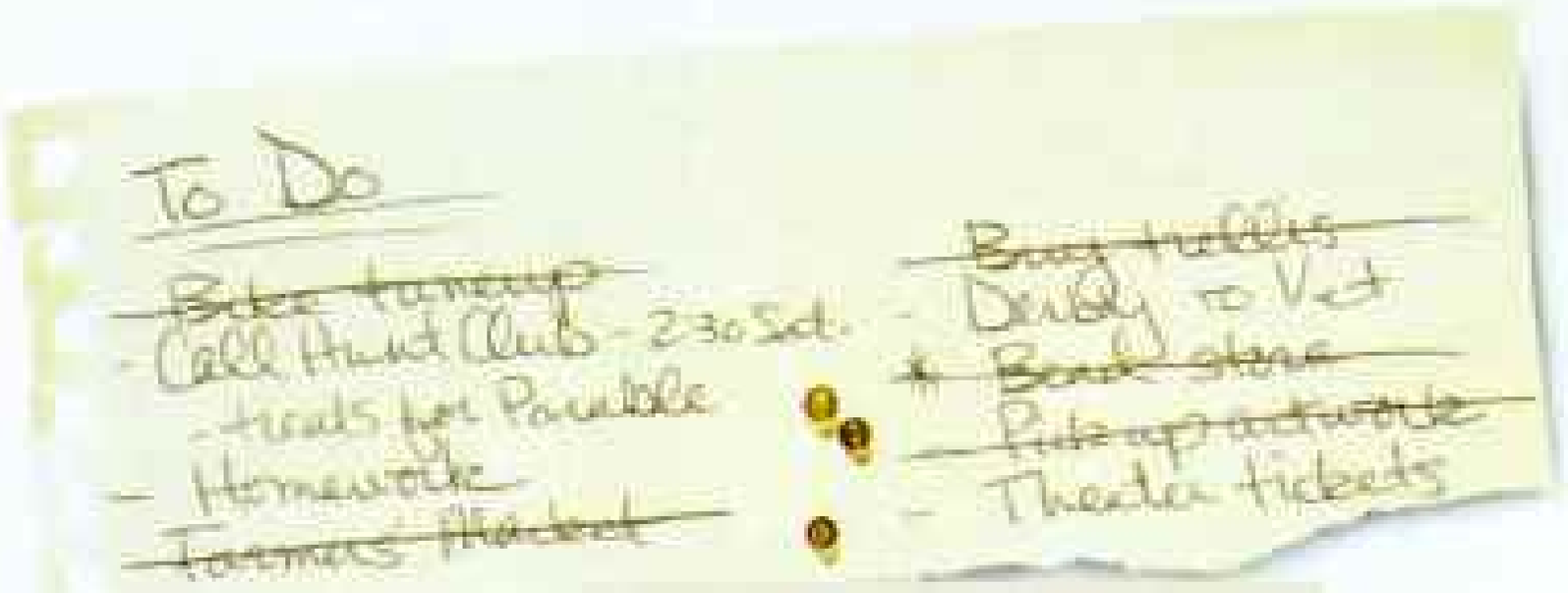

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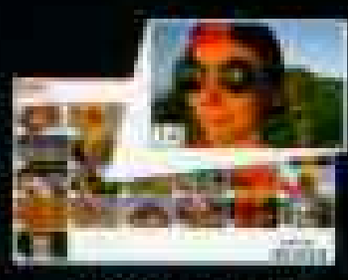

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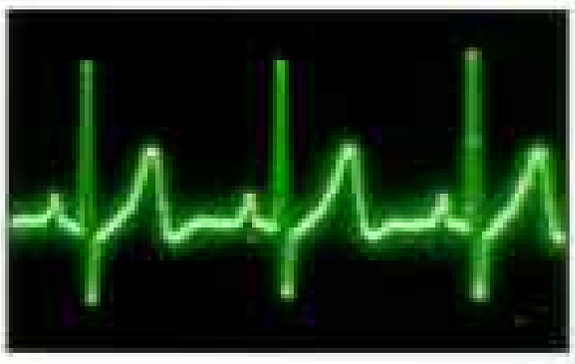

If You're Taking Aspirin For Your Heart, What Should You Take For Your Aches And Pains?

You may have heard about the use of aspirin to help prevent second heart attacks. You might even know somebody whose doctor has prescribed this aspirin heart therapy. Clearly, for those patients with a high risk of second heart attacks, this is important news.

See Your Doctor First

A responsible heart healthcare program starts with a careful study of your needs by a qualified medical professional. Your doctor will probably consider diet, exercise and lifestyle as part of a total heart healthcare regimen, and aspirin heart therapy might be considered. Only your doctor can tell you how, when and if you should use this aspirin therapy.

The Importance of Following Your Doctor's Recommended Dosage

Always follow your doctor's recommended dosage for aspirin therapy exactly...don't take less aspirin, don't take more. In fact, taking too much aspirin, especially over a long period of time, may put you at a greater risk of stomach side effects (irritation, an ulcer) and those side effects could affect your ability to continue the regimen your doctor has prescribed. Sometimes these side effects can occur without obvious symptoms so that you may not even be aware of the problem.

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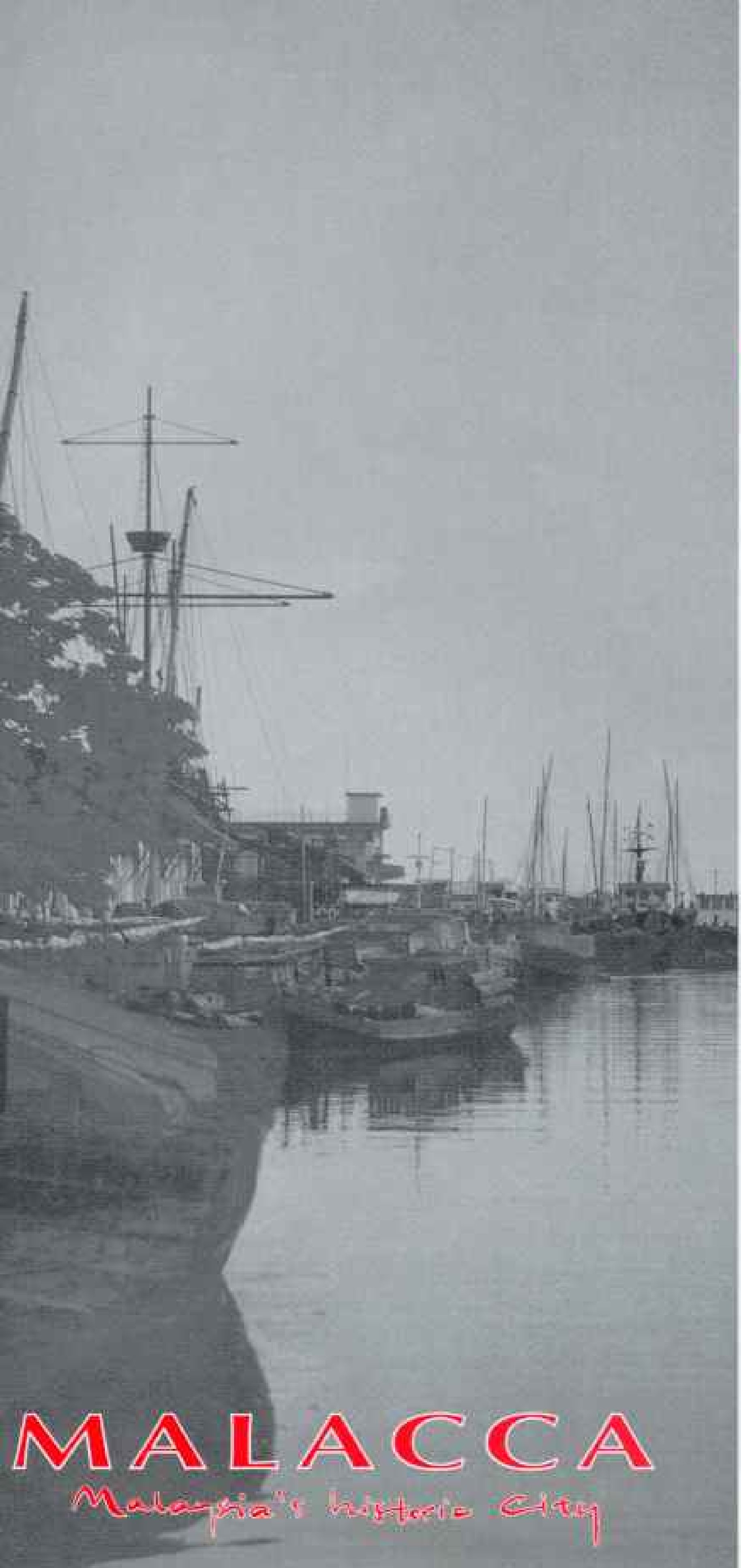

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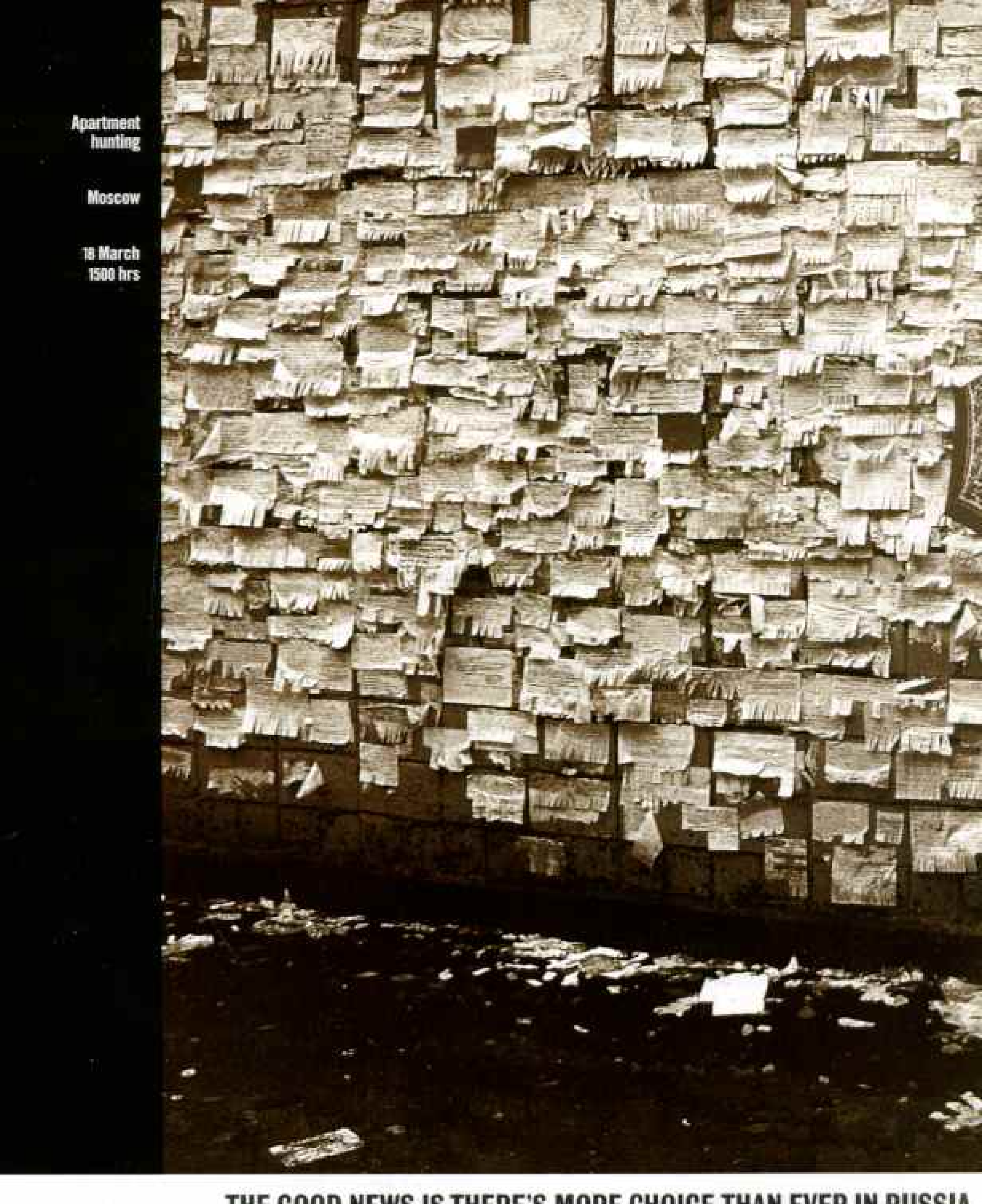

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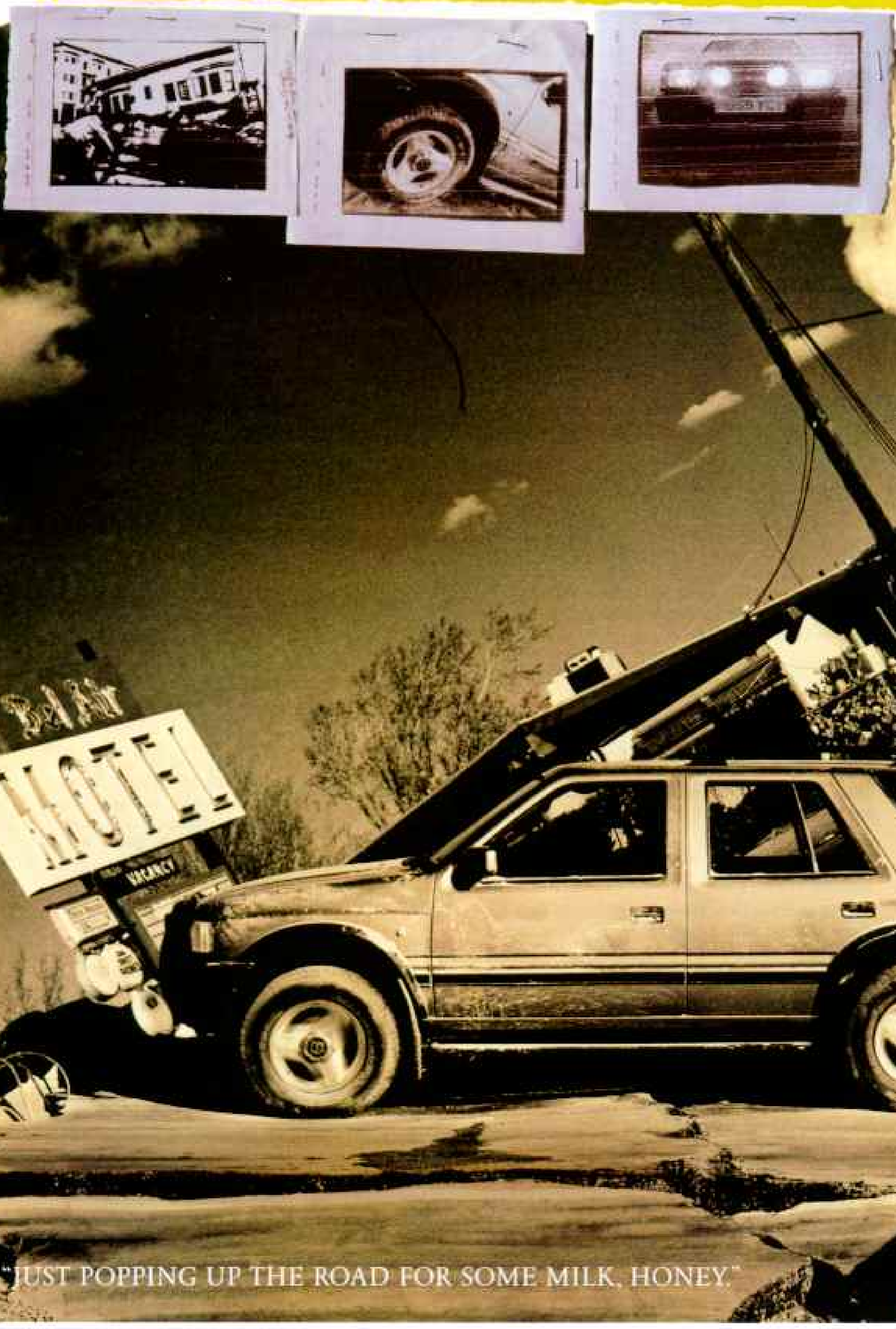

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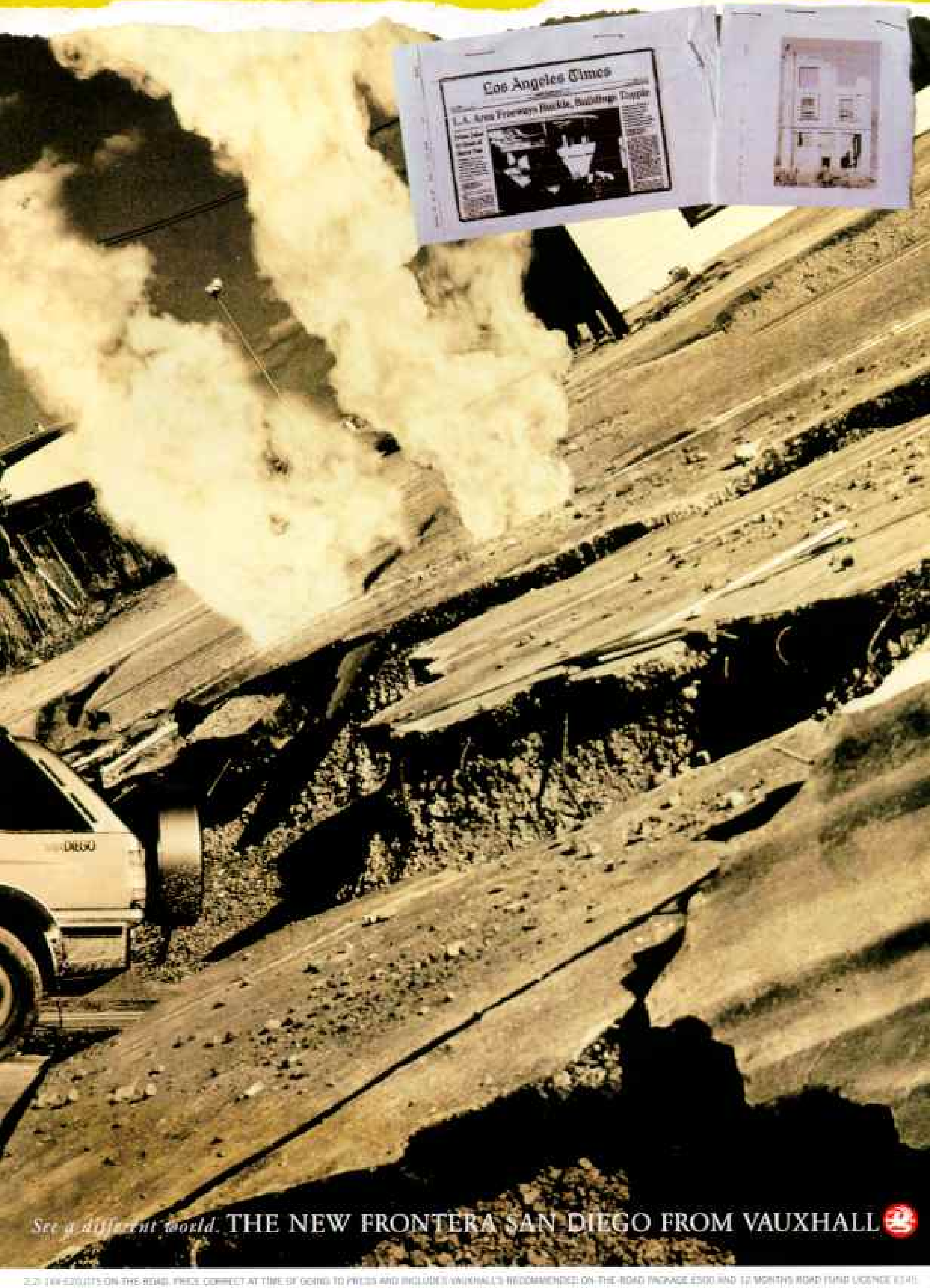

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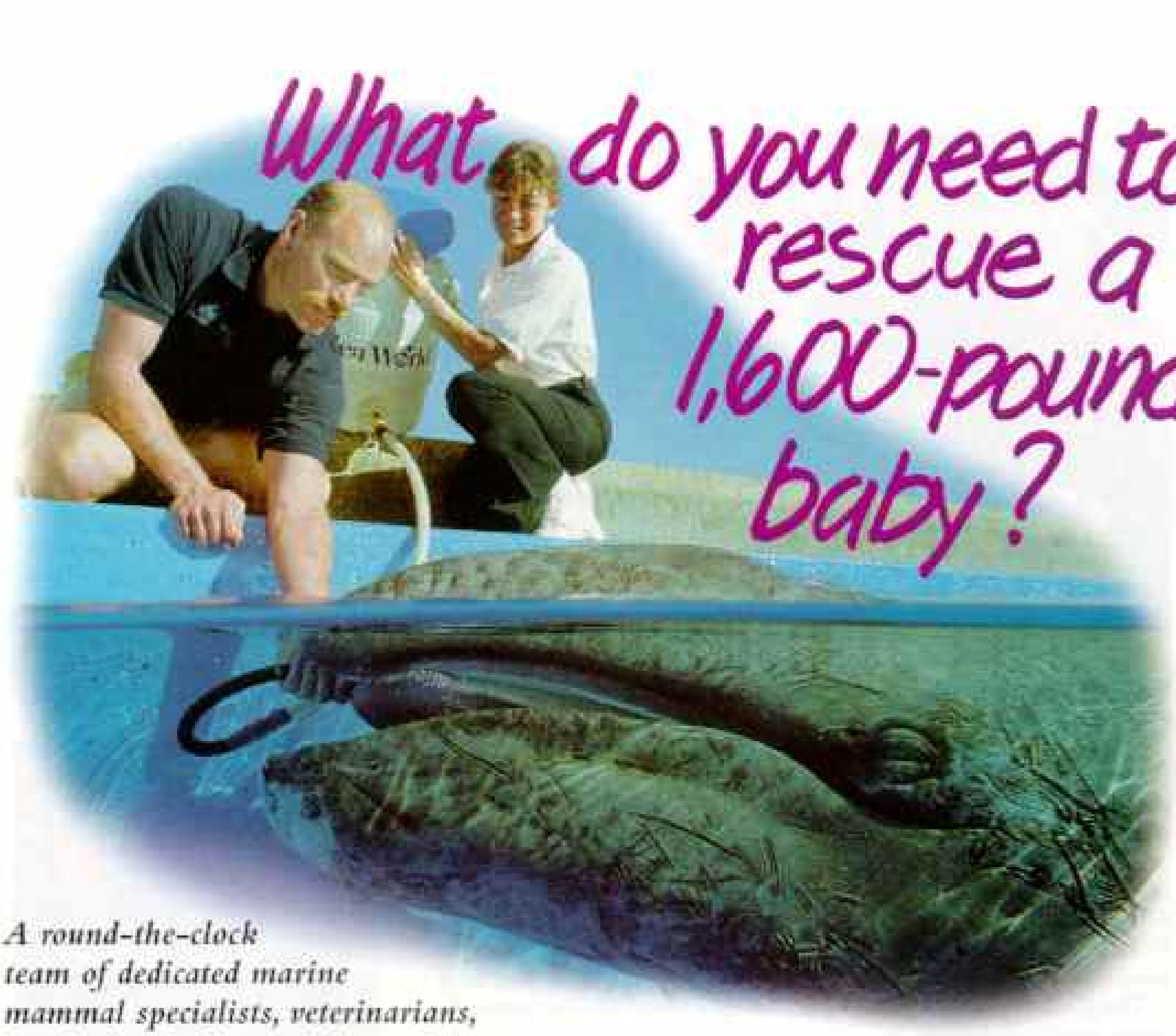

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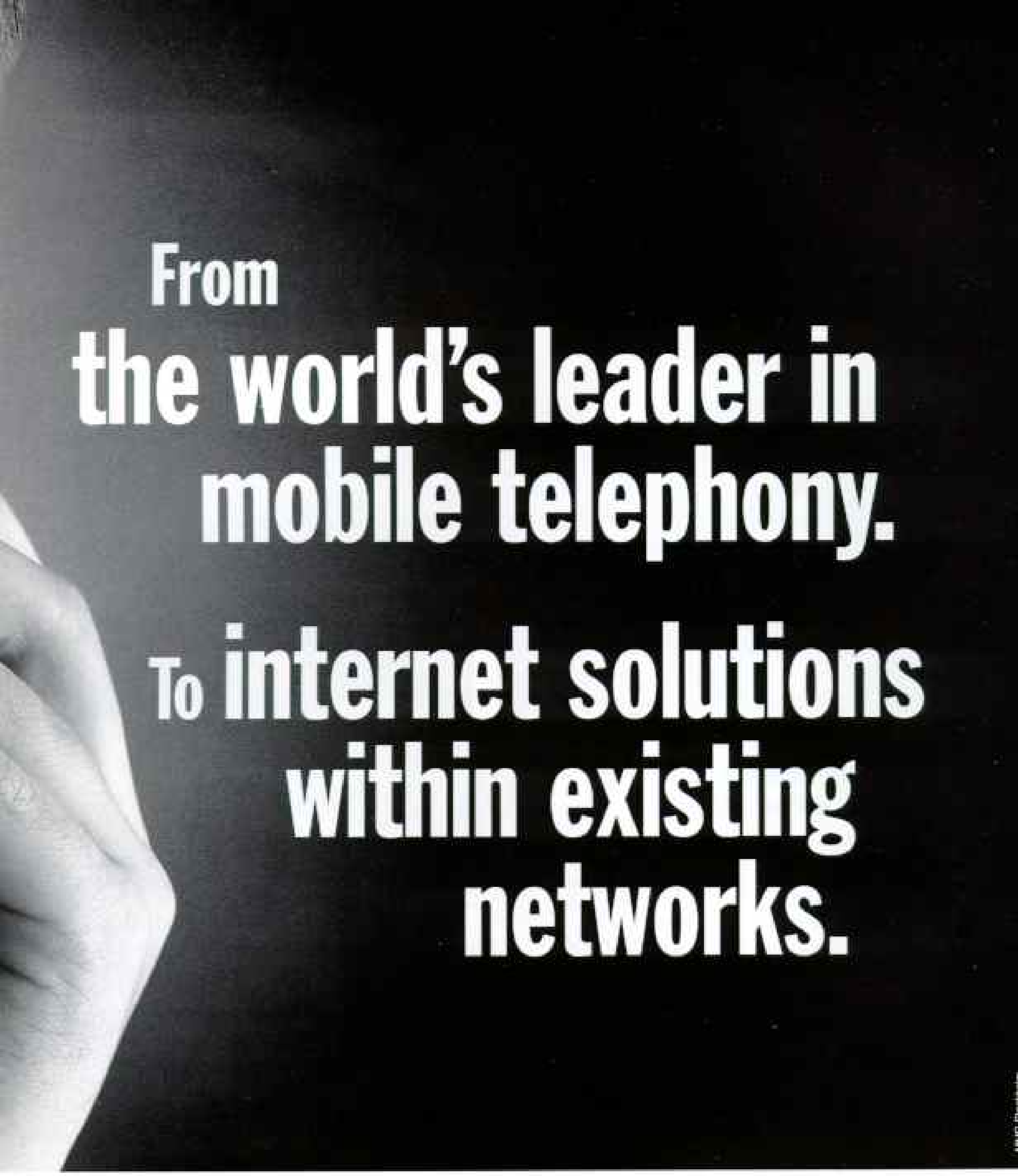

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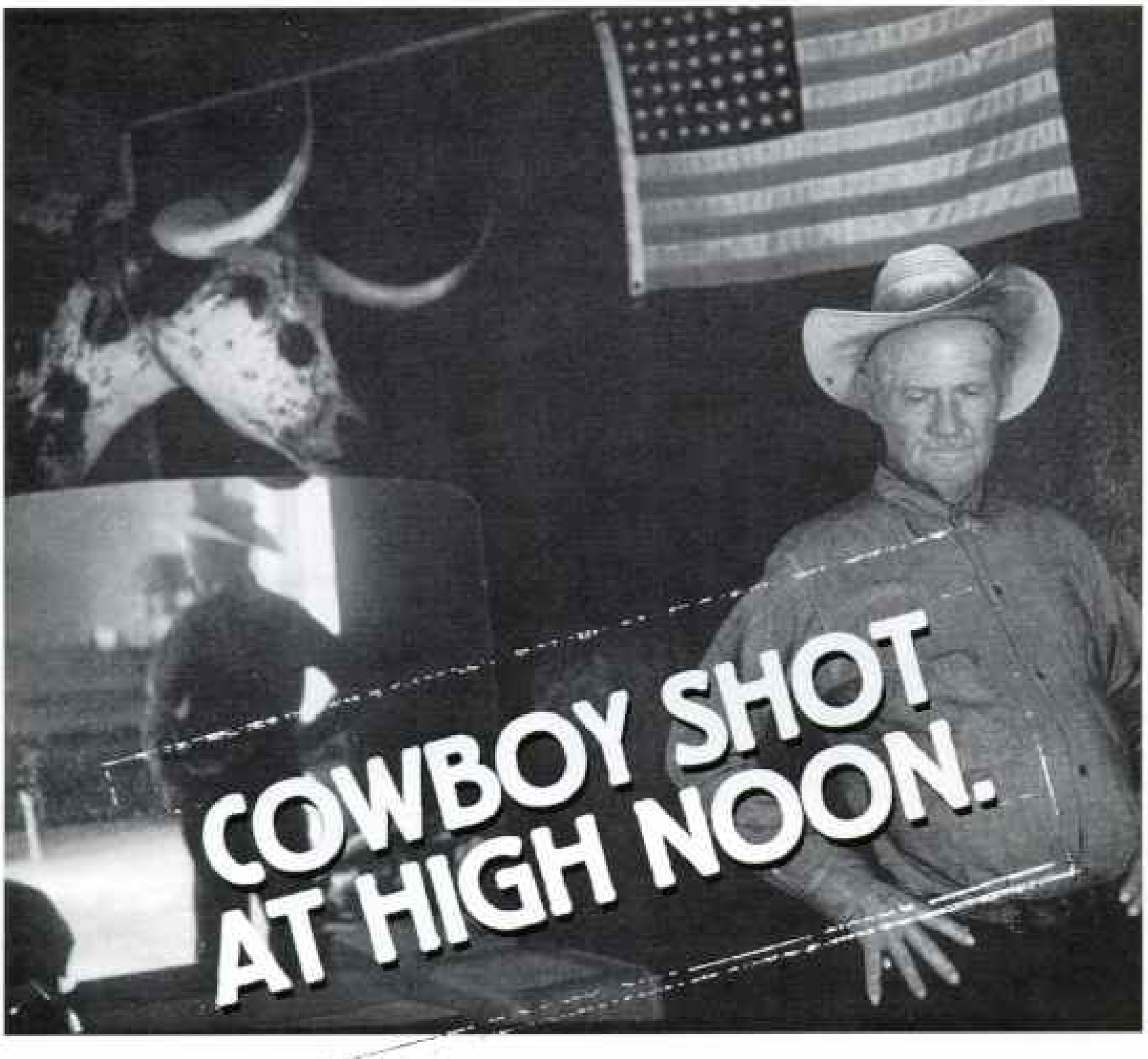

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William Albert Allard. High Noon Journey with National Geographic on exotic photo shoots to see and hear the world through the eyes of award-winning photographers. Share firsthand findings from explorers in search of dinosaur eggs, pirates' treasure and rare species. National Geographic Online is an interactive adventure with stunning images, detailed maps and exciting discoveries. Every day is new. And anything is possible.

NATIONAL GEOGRAPHIC ONLINE

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Maggie is one of thousands of Toyota people around the world whom customers rarely meet. But her efforts ensure car buyers can easily find the facts they need to make a wise purchase decision.

On the weekend, Maggie's efforts go into her local Scout group. There she encourages the children in a range of different activities, giving them a better sense of trust and teamwork and using the challenge of rock climbing to improve their skills and confidence.

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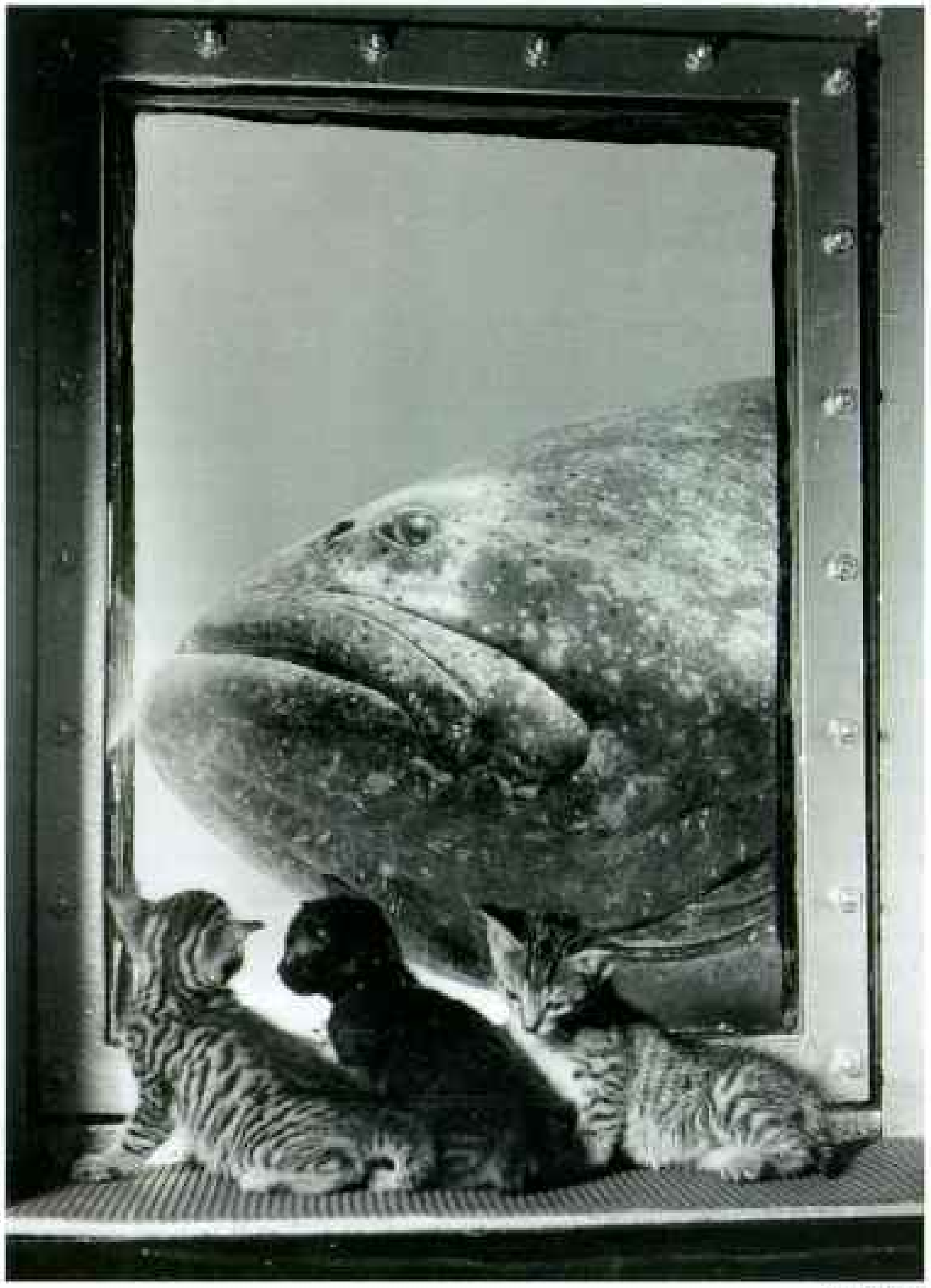
swissair world's most refreshing airline.



LUIS MARDEN

■ FROM THE GEOGRAPHIC ARCHIVES

Dream On

A giant grouper may have looked like lunch to three resident kittens at Marineland, the world's first "oceanarium," opened in 1938 near St. Augustine, Florida, with the help of millionaire Cornelius Vanderbilt Whitney. Cats still roam the popular park and adjacent campground, living off the largesse of picnicking tourists. The photograph was made by Luis Marden for "Marineland, Florida's Giant Fish Bowl" (November 1952) but was never published.

Park and 47th. Attraction.

Park and 61st. Flirtation.

Park and 59th. Conversation.

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NATIONAL GEOGRAPHIC

On Television

GEORGE AND KATHY DODGE, NGT

SAM RITTNER, NGT

■ EXPLORER, JUNE 22, 7 P.M. ET

Charge of the Garden Brigade

Captured in macrocinematography, a pugnacious tiger beetle prepares to clamp down on a daddy longlegs (above).

Have you ever really observed what goes on in your garden? Are you laboring under the delusion that your garden is a place of peace and harmony? Do you, like actor Leslie Nielsen of *Naked Gun* fame, think that you orchestrate nature in your garden? Macrocinematographers George and Kathy Dodge reveal the naked truth in EXPLORER's natural history comedy *Savage Garden*.

Nielsen strikes a sour note as he notices a tobacco hornworm on his luscious tomato (left). Playing the role of the Gardener, Nielsen can never have too many catalogs or enough gear. His leaves are raked; his weeds are whacked. He's in control.

Wrong!

Extraordinary close-ups, some of which took two years of excruciating patience to capture, show common garden creatures as combatants and domestic natural settings as a battlefield.

The shrew, North America's only venomous mammal, is a fiercely solitary animal ("one of nature's crankiest creatures," the Gardener warns). In its life-or-death struggle with the tiger beetle ("an orthodontist's nightmare") the daddy longlegs escapes by shedding its own limb, which continues to twitch to divert its attacker.

Savage Garden is not your typical natural history film. Its spectacular footage and insights come with a twist—and a smile.

■ PROGRAM GUIDE

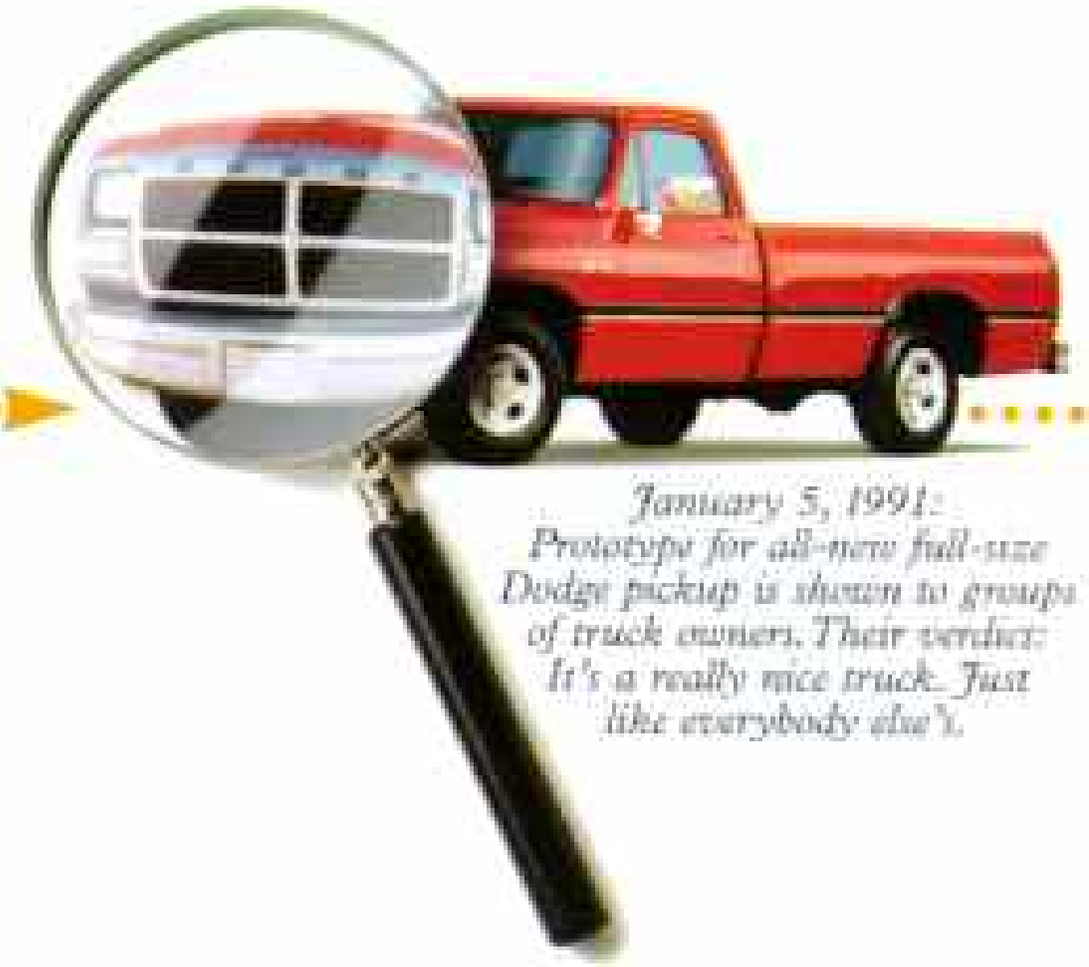
National Geographic Specials
NBC. See local listings.

National Geographic EXPLORER
TBS. Sundays, 7 p.m. ET.

Children's Programming:
Really Wild Animals
The Disney Channel. Weekends.

National Geographic Videos and Kids Videos Call 1-800-627-5162.

WHEN PEOPLE STARTED TELLING US THEY HATED IT, WE KNEW WE HAD A WINNER.



January 5, 1991:
Prototype for all-new full-size Dodge pickup is shown to groups of truck owners. Their verdict: It's a really nice truck. Just like everybody else's.

April 23, 1996:
*Strategic Vision confers its 1996 Total Quality Award™ for "Best Ownership Experience" for full-size pickups on Dodge Ram.**

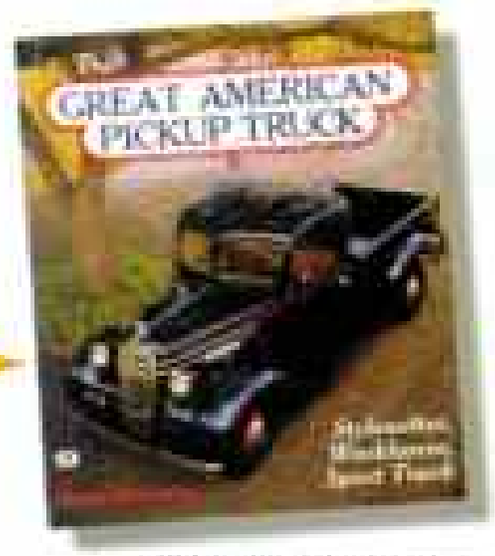
September 1, 1993:
New Dodge Ram Pickup named Motor Trend's Truck of the Year. Not to be outdone, Texas Auto Writers Association dubs Ram "Truck of Texas."

January 6, 1993:
New Dodge Ram Pickup is introduced. Quote from Motor Trend: "Behind its aggressive appearance is a solid, powerful pickup that's all business where it counts..."

Everybody in the car business talks about eliminating problems: squelching squeaks and rattles, raising the bar on reliability. At Chrysler Corporation, we've been winning major accolades for product excellence for the past several years. But to us, success is a lot more than just avoiding mistakes: It's a truck design that gets your blood pumping. The sound of a V10 engine clearing its throat. Giving people the freedom to create products that aren't for

Visit our World Wide Web site at http://www.chryslercorp.com, or call toll-free 1-888-GREATCARS. ***We calculated resale using average N.A.D.A. Official Used Car Guide® monthly editions. Always wear your seat belt. *Strategic Vision's 1996 Vehicle Experience Study™ surveyed 35,652 October-*

February 6, 1991:
With launch just 25 months away, design team starts over.



March 14, 1991:
Designer discovers a book on the history of American pickups. Meanwhile in the United Arab Emirates, Sheik Hamad Bin Hamdan Al-Nahyan is building a 60-foot replica of a 1942 Dodge Power Wagon.

April 20-24, 1991:
Design team visits construction site, observes how workers really use their trucks. Collision with dozer narrowly avoided.

June 6, 1991:
Merging onto I-75 with 20-ton semi on their bumper, designers have instincts for revised design confirmed.

March 12, 1992:
Interior design team dons thick work gloves to test operation of knobs and switches in the cab under real-world conditions.

November 4, 1991:
Aggressive new truck design is shown to consumers. The verdict: They either love it or hate it. (Luckily, they mostly love it.) Chrysler honchos say, "Build it."

April 10, 1992:
Power train team adds Magnum V10, cast-iron cousin to the 400 hp Viper V10 and the most powerful engine ever in a pickup, as power plant option.

everybody. Considering that our Ram Pickup has a higher resale value than Ford, Chevy, or GMC**–not to mention a bed full of "Best of" awards–it seems we're on to something. Besides, it's the only way we know to build great cars and trucks.

trade-in values for '94-'96 full-size models vs. MSRPs published in Jan.'95-Feb.'97
November new vehicle buyers of 200-plus models after the first 90 days of ownership.

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CHRYSLER CORPORATION

NATIONAL GEOGRAPHIC

EarthAlmanac

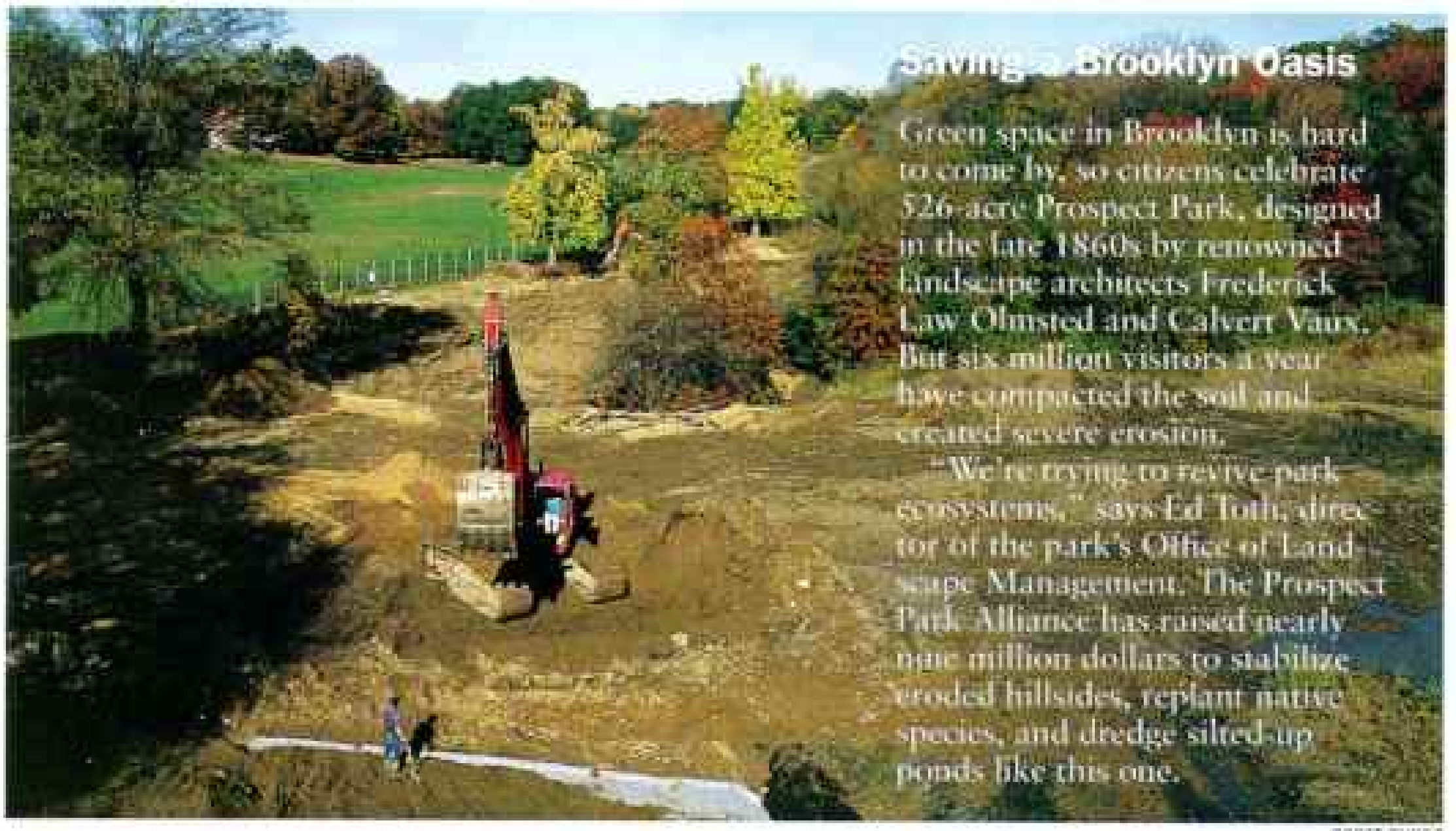
DONALD BREMNER (BOTH)

Condors Have Their Day in Arizona

Six celebrities took wing last December as captive-bred California condors were released from Arizona's Vermilion Cliffs north of the Grand Canyon. A rapt audience watched from a viewing area in the valley (above right). Bearing radio transmitters and wing tags, the fledglings landed to feed on a calf carcass (above) provided by biologists; the birds will be given food until they can forage for themselves. One of the condors was later killed by a golden eagle apparently competing for a meal.

"Overall, we're very pleased. These are the first condors seen in Arizona since the early 1900s," says William A. Burnham, president of the Peregrine Fund, which released the birds. Their addition makes a total of 27 condors in western skies.

Condors were shot or inadvertently poisoned for years; the last wild bird was captured in 1987. About 100 have been hatched in captivity. Since 1992 several groups have been freed in California; additional Arizona releases are planned.



SCOTT THODE

Saving a Brooklyn Oasis

Green space in Brooklyn is hard to come by, so citizens celebrate 526-acre Prospect Park, designed in the late 1860s by renowned landscape architects Frederick Law Olmsted and Calvert Vaux. But six million visitors a year have compacted the soil and created severe erosion.

"We're trying to revive park ecosystems," says Ed Toth, director of the park's Office of Landscape Management. The Prospect Park Alliance has raised nearly nine million dollars to stabilize eroded hillsides, replant native species, and dredge silted-up ponds like this one.

As I See It, #27 in a series
Mimi Haines
"The Real Me"
Black & White Photography

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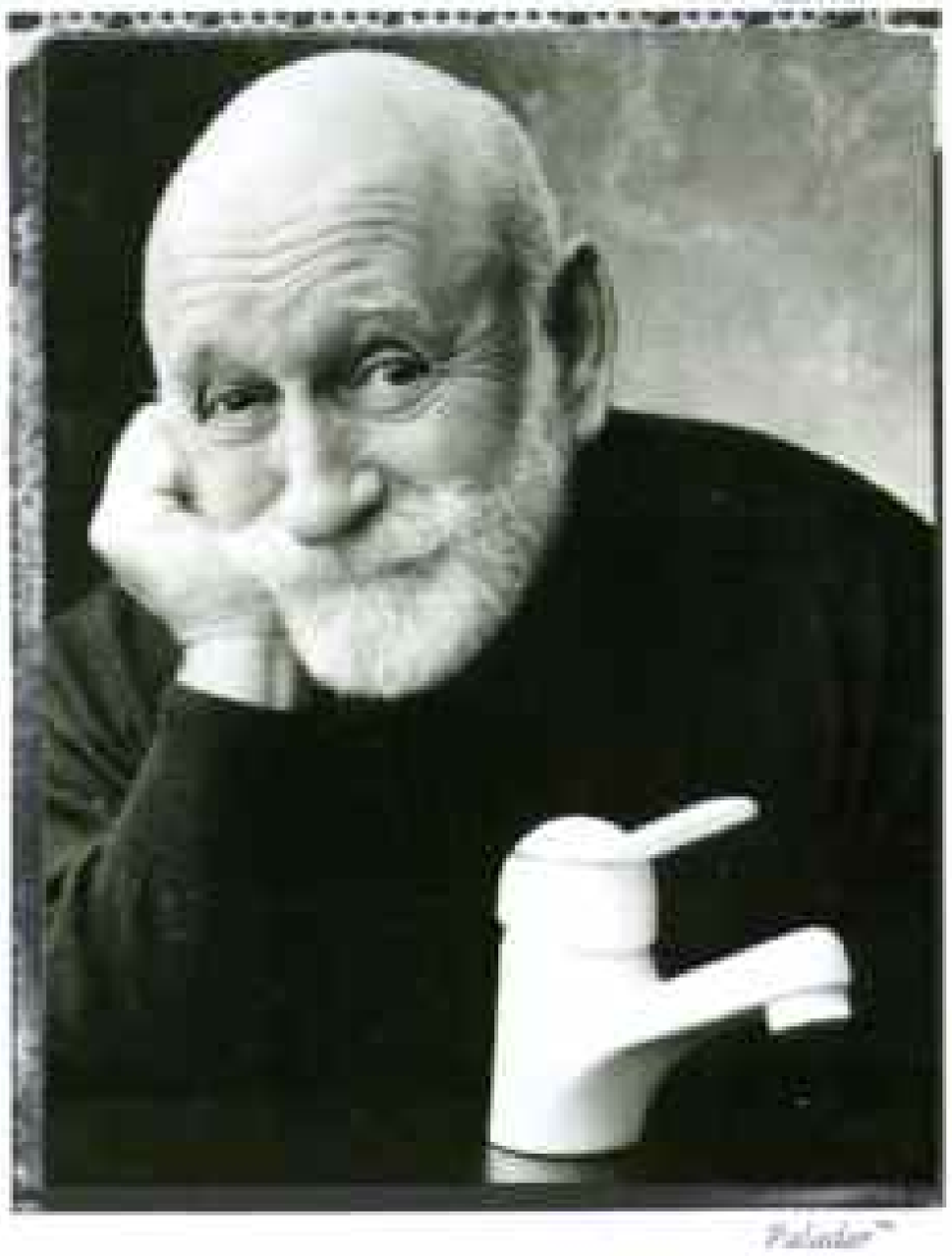

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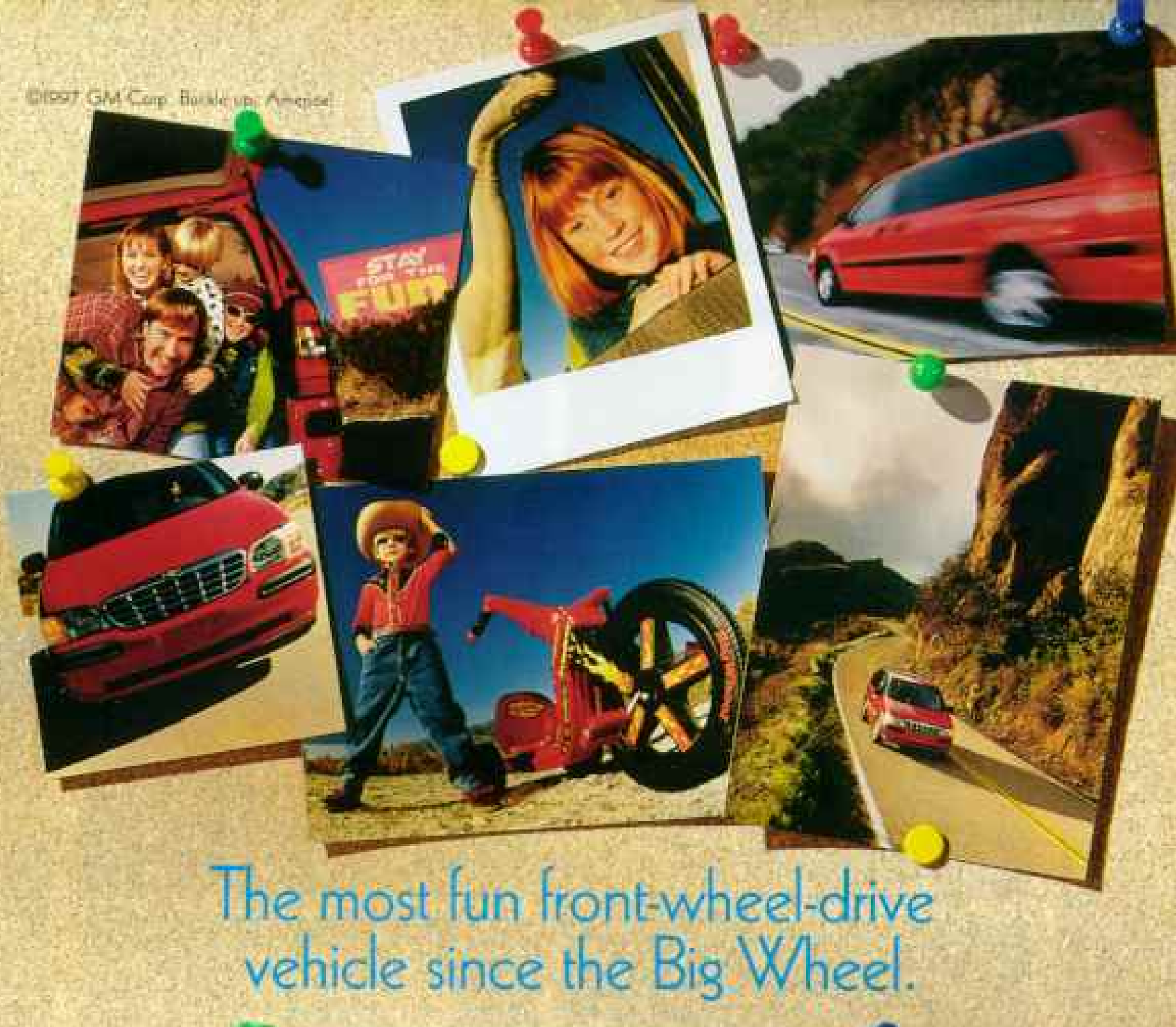

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Now that you're a grown-up, you can't be confined to the driveway anymore. The all-new Chevy "Venture" is ready to conquer a whole country full of Key Lime Pies, funny accents and one-of-a-kind scenery. So even though it offers a surprisingly smooth car-like ride and is available with traction control, it's still been known to get stuck in a tourist trap.

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Jawfish Guard the Next Generation by Mouth

The sea brims with billions of eggs, representing the future to some species—and a free, nutritious meal to others. Some fish take no chances and brood their eggs in their mouths, like this four-inch-long yellowhead jawfish in the Caribbean. Living communally in burrows in the sandy seafloor, the males carry the eggs in a sticky ball for about a week until they hatch. The egg protection gained by mouth brooding has a catch: Such fish are usually forced to fast while incubating the eggs. Yellowhead jawfish, however, will stash their eggs in a safe place and sneak out for a snack.

FRANKLIN J. VIOLA

Breeding Tortoises Helps Offset Devastating Theft in Madagascar

Among the world's rarest reptiles, plowshare tortoises were decimated by the theft of 73 young and two adults on May 6, 1996, from a breeding station in Madagascar; the island is their only home. The station lost nearly half its tortoise stock. Only 400 to 1,000 remain in the wild; much of their habitat has been cleared by brushfires to create grassland for cattle grazing.

Plowshares' numbers had long been in decline because in past centuries neighboring islanders prized them as food.

The stolen tortoises were destined for the pet trade. "Ten were offered for $1,000 each in the Czech Republic," says Lee Durrell of Britain's Jersey Wildlife Preservation Trust, which manages the station. Late last year 40 tortoises hatched, bringing the total to some 130 juveniles.

DON REID, JERSEY WILDLIFE PRESERVATION TRUST

Cheetah Cannibalism Shows That Intruders Will Not Be Tolerated

Fights to the finish sometimes result when a male cheetah enters territory already staked out by other cheetahs. Yet twice in South Africa's Phinda Resource Reserve a pair of males has not only killed interlopers but eaten them—the first time such cannibalistic behavior has been photographed by scientists.

Why do the cats do it? "It's still something of a mystery," says Luke Hunter, who has been studying these cheetahs since 1992. "Both males had fed less than 48 hours earlier." The aggressors killed the victim with a suffocating bite to the throat and then, with unusual ferocity, mauled the carcass for almost an hour after the animal was dead. The same two males killed and ate another intruder the following year. Although male cheetahs often travel together, both victims were loners.

LUKE HUNTER, MAMMAL RESEARCH INSTITUTE

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As with all prescription medications, side effects may occur. Always talk to your healthcare provider about any medication you may take. When ZYRTEC tablets were studied, most side effects were mild to moderate. Dose- or treatment-related events included drowsiness (13.7% vs 6.3% for placebo), fatigue (5.9% vs 2.6%), and dry mouth (5.0% vs 2.3%). Only one out of one hundred patients stopped taking ZYRTEC due to drowsiness.

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BRIEF SUMMARY

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(FOR FULL PRESCRIBING INFORMATION, CONSULT PACKAGE INSERT)

CONTRAINDICATIONS ZYRTEC is contraindicated in those patients with a known hypersensitivity to it or any of its ingredients or hydroxyzine. **PRECAUTIONS** Activities Requiring Mental Alertness: In clinical trials, the occurrence of somnolence has been reported in some patients taking ZYRTEC; due caution should therefore be exercised when driving a car or operating potentially dangerous machinery. Concurrent use of ZYRTEC with alcohol or other CNS depressants should be avoided because additional reductions in alertness and additional impairment of CNS performance may occur. **Drug-drug Interactions:** No clinically significant drug interactions have been found with theophylline at a low dose, azithromycin, pseudoephedrine, ketoconazole, or erythromycin. There was a small decrease in the clearance of cetirizine caused by a 400 mg dose of theophylline. It is possible that larger theophylline doses could have a greater effect. **Carcinogenesis, Mutagenesis and Impairment of Fertility:** No evidence of carcinogenicity was observed in a 2-year carcinogenicity study in rats at dietary doses up to 20 mg/kg/day (approximately 10 times the maximum recommended human daily oral dose on a mg/m² basis). An increased incidence of benign liver tumors was found in a 2-year carcinogenicity study in male mice at a dietary dose of 16 mg/kg/day (approximately 4 times the maximum recommended human daily oral dose on a mg/m² basis). The clinical significance of these findings during long-term use of ZYRTEC is not known. Cetirizine was not mutagenic in the Ames test, and not clastogenic in the human lymphocyte assay, the mouse lymphoma assay, and an in vivo micronucleus test in rats. No impairment of fertility was found in a fertility and general reproductive performance study in mice at an oral dose of 64 mg/kg/day (approximately 26 times the maximum recommended adult human daily oral dose on a mg/m² basis). **Pregnancy Category B:** Cetirizine was not teratogenic in mice, rats and rabbits at oral doses up to 96, 225, and 135 mg/kg/day (or approximately 40, 190, and 215 times the maximum recommended adult human daily oral dose on a mg/m² basis), respectively. There are no adequate and well-controlled studies in pregnant women. Because animal studies are not always predictive of human response, ZYRTEC should be used in pregnancy only if clearly needed. **Nursing Mothers:** Retarded pup weight gain was found in mice during lactation when dams were given cetirizine at 96 mg/kg/day (approximately 40 times the maximum recommended adult human daily oral dose on a mg/m² basis). Studies in beagle dogs indicate that approximately 3% of the dose is excreted in milk. Cetirizine has been reported to be excreted in human breast milk. Because many drugs are excreted in human milk, use of ZYRTEC in nursing mothers is not recommended. **Geriatric Use:** In placebo-controlled trials, 146 patients aged 65 to 94 years received doses of 5 to 20 mg of ZYRTEC per day. Adverse events were similar in this group to patients under age 65. Subset analysis of efficacy in this group was not done. **Pediatric Use:** The safety of ZYRTEC, at daily doses of 5 or 10 mg, has been demonstrated in 378 pediatric patients 6-11 years of age in placebo-controlled trials lasting up to four weeks and in 254 patients in a non-placebo controlled 12 week trial. The effectiveness of ZYRTEC for the treatment of seasonal and perennial allergic rhinitis and chronic idiopathic urticaria in this pediatric age group is based on an extrapolation of the demonstrated efficacy of ZYRTEC in adults in these conditions and the likelihood that the disease course, pathophysiology and the drug's effect are substantially similar between these two populations. The recommended doses for the pediatric population are based on a cross-study comparison of the pharmacokinetics and pharmacodynamics of cetirizine in adults and pediatric subjects and on the safety profile of cetirizine in both adults and pediatric patients at doses equal to or higher than the recommended doses. The cetirizine AUC and C_{max} in pediatric subjects 6-11 years of age who received a single dose of 10 mg of cetirizine syrup was estimated to be intermediate between that observed in adults who received a single dose of 10 mg of cetirizine tablets and those who received a single dose of 20 mg of cetirizine tablets. **ADVERSE REACTIONS** Controlled and uncontrolled clinical trials conducted in the United States and Canada included more than 6000 patients aged 12 years and older, with more than 3900 receiving ZYRTEC at doses of 5 to 20 mg per day. The duration of treatment ranged from 1 week to 6 months, with a mean exposure of 36 days. Most adverse reactions reported during therapy with ZYRTEC were mild or moderate. In placebo-controlled trials, the incidence of discontinuations due to adverse reactions in patients receiving ZYRTEC 5 mg or 10 mg was not significantly different from placebo (2.9% vs. 2.4%, respectively). The most common adverse reaction in patients aged 12 years and older that occurred more frequently on ZYRTEC than placebo was somnolence. The incidence of somnolence associated with ZYRTEC was dose related, 6% on placebo, 11% at 5 mg and 14% at 10 mg. Discontinuations due to somnolence for ZYRTEC were uncommon (1.0% on ZYRTEC vs. 0.6% on placebo). Fatigue and dry mouth also appeared to be treatment-related adverse reactions. There was no difference by age, race, gender or by body weight with regard to the incidence of adverse reactions. Table 1 lists adverse experiences in patients aged 12 years and older which were reported for ZYRTEC 5 and 10 mg in controlled clinical trials in the United States and that were more common with ZYRTEC than placebo. **Table 1. Adverse Experiences Reported in Patients aged 12 years and older in Placebo-Controlled United States ZYRTEC Trials (Maximum Dose of 10 mg) at Rates of 2% or Greater (Percent Incidence), ZYRTEC (N=2934) vs Placebo (N=1812) respectively:** Somnolence (13.7% vs 6.2%); Fatigue (5.8% vs 2.6%); Dry Mouth (5.0% vs 2.3%); Pharyngitis (2.0% vs 1.9%); Dizziness (2.0% vs 1.2%). In addition, headache and nausea occurred in more than 2% of the patients, but were more common in placebo patients. Pediatric studies were also conducted with ZYRTEC. More than 1300 pediatric patients (6 to 11 years) with more than 900 treated with ZYRTEC at doses of 1.25 to 10 mg per day were included in controlled and uncontrolled clinical trials conducted in the United States. The duration of treatment ranged from 2 to 12 weeks. The majority of reported adverse reactions reported in pediatric patients (6 to 11 years) with ZYRTEC were mild or moderate. In placebo-controlled trials, the incidence of discontinuations due to adverse reactions in pediatric patients receiving up to ZYRTEC 10 mg was uncommon (0.4% on ZYRTEC vs 1.0% on placebo). Table 2 lists adverse experiences which were reported for ZYRTEC 5 and 10 mg in pediatric patients (6 to 11 years) in placebo-controlled clinical trials in the United States and were more common with ZYRTEC than placebo. Of these, abdominal pain was considered treatment-related and somnolence appeared to be dose related: 1.3% in placebo, 1.9% at 5 mg and 4.2% at 10 mg. **Table 2. Adverse Experiences Reported in Pediatric Patients (6 to 11 years) in Placebo-Controlled United States ZYRTEC Trials (5 or 10 mg dose) Which Occurred at a Frequency of ≥ 2% in Either the 5 mg or the 10 mg ZYRTEC Group, and More Frequently Than in the Placebo Group. ZYRTEC 5 mg (N=161), 10 mg (N=215) vs Placebo (N=309):** Headache (11.0%, 5 mg: 14.0%, 10 mg: 10.2%, placebo); Pharyngitis (6.2%, 5 mg: 2.8%, 10 mg: 2.3%, placebo); Abdominal pain (4.4%, 5 mg: 5.6%, 10 mg: 1.9%, placebo); Coughing (4.4% 5 mg: 2.8% 10 mg: 3.9%, placebo); Somnolence (1.9% 5 mg: 4.2%, 10 mg: 1.9%, placebo); Diarrhea (3.1%, 5 mg: 1.9%, 10 mg: 1.9%, placebo); Epistaxis (3.7%, 5 mg: 1.9%, 10 mg: 2.9%, placebo); Bronchospasm (3.1%, 5 mg: 1.9%, 10 mg: 1.9%, placebo); Nausea (1.9%, 5 mg: 2.8%, 10 mg: 1.9%, placebo); Vomiting (2.5%, 5 mg: 2.8%, 10 mg: 1.9%, placebo). The following events were observed infrequently (less than 2%), in other 3660 adults and children 12 years and older or in 850 pediatric (6 to 11 years) patients who received ZYRTEC in U.S. trials, including an open adult study of six months duration; a causal relationship with ZYRTEC administration has not been established. **Autonomic Nervous System:** anorexia, urinary retention, flushing, increased salivation, dry mouth. **Cardiovascular:** palpitation, tachycardia, hypertension, cardiac failure. **Central and Peripheral Nervous Systems:** paresthesia, confusion, hypokinesia, hypertonia, migraine, tremor, vertigo, leg cramps, ataxia, dysphonia, abnormal coordination, hyperesthesia, hypoesthesia, myelitis, paralysis, ptosis, twitching, visual field defect, syncope, dizziness. **Gastrointestinal:** increased appetite, dyspepsia, abdominal pain, diarrhea, flatulence, constipation, vomiting, ulcerative stomatitis, aggravated tooth caries, stomatitis, tongue discoloration, tongue edema, gastritis, rectal hemorrhage, hemorrhoids, melena, abnormal hepatic function, jaundice. **Genitourinary:** polyuria, urinary tract infection, cystitis, dysuria, hematuria, micturition frequency, urinary incontinence. **Hearing and Vestibular:** earache, tinnitus, deafness, otalgia. **Metabolic/Nutritional:** thirst, dehydration, diabetes mellitus. **Musculoskeletal:** myalgia, arthralgia, arthrosis, arthritis, muscle weakness. **Psychiatric:** insomnia, sleep disorder, nervousness, depression, emotional lability, impaired concentration, anxiety, depersonalization, paranoia, abnormal thinking, agitation, amnesia, decreased libido, euphoria. **Respiratory System:** epistaxis, rhinitis, coughing, bronchospasm, dyspnea, upper respiratory tract infection, hyperventilation, sinusitis, increased sputum, bronchitis, pneumonia, respiratory disorder. **Reproductive:** dysmenorrhea, female breast pain, intermenstrual bleeding, leukorrhea, menorrhagia, vaginitis. **Reticuloendothelial:** lymphadenopathy. **Skin:** pruritus, rash, dry skin, urticaria, acne, dermatitis, erythematous rash, increased sweating, alopecia, angioedema, furunculosis, bullous eruption, eczema, hyperkeratosis, hyperchromia, photosensitivity reaction, photosensitivity toxic reaction, maculopapular rash, seborrhea, purpura, skin disorder, skin nodule. **Special Senses:** taste perversion, taste loss, parosmia. **Vision:** blindness, loss of accommodation, eye pain, conjunctivitis, xerophthalmia, glaucoma, ocular hemorrhage. **Body as a Whole:** increased weight, back pain, malaise, fever, asthenia, generalized edema, periorbital edema, peripheral edema, rigors, leg edema, face edema, hot flashes, enlarged abdomen, nasal polyp, pain, pallor, chest pain, accidental injury. Occasional instances of transient, reversible hepatic transaminase elevations have occurred during cetirizine therapy. A single case of possible drug-induced hepatitis with significant transaminase elevation (500 to 1000 IU/L) and elevated bilirubin has been reported. In foreign marketing experience the following additional rare, but potentially severe adverse events have been reported: hemolytic anemia, thrombocytopenia, orofacial dyskinesia, severe hypotension, anaphylaxis, hepatitis, glomerulonephritis, stillbirth, and cholestasis. **DRUG ABUSE AND DEPENDENCE** There is no information to indicate that abuse or dependency occurs with ZYRTEC. **OVERDOSAGE** Overdosage has been reported with ZYRTEC. In one adult patient who took 150 mg of ZYRTEC, the patient was somnolent but did not display any other clinical signs or abnormal blood chemistry or hematology results. In an 18-month-old pediatric patient who took an overdose of ZYRTEC (approximately 180 mg), restlessness and irritability were observed initially; this was followed by drowsiness. Should overdose occur, treatment should be symptomatic or supportive, taking into account any concomitantly ingested medications. There is no known specific antidote to ZYRTEC. ZYRTEC is not effectively removed by dialysis, and dialysis will be ineffective unless a dialyzable agent has been concomitantly ingested. The acute minimal lethal oral doses in mice and rats were 237 and 562 mg/kg, respectively (approximately 55 and 255 times the maximum recommended human daily oral dose on a mg/m² basis). In rodents, the target of acute toxicity was the central nervous system, and the target of multiple-dose toxicity was the liver. **DOSAGE AND ADMINISTRATION Adults and Children 12 years and older:** The recommended initial dose of ZYRTEC is 5 or 10 mg per day in adults and children 12 years and older, depending on symptom severity. Most patients in clinical trials started at 10 mg. ZYRTEC is given as a single daily dose, with or without food. The time of administration may be varied to suit individual patient needs. In patients with decreased renal function (creatinine clearance 11-31 mL/min), patients on hemodialysis (creatinine clearance less than 7 mL/min), and in hepatically impaired patients, a dose of 5 mg once daily is recommended. **Children 6 to 11 years:** The recommended initial dose of ZYRTEC in children aged 6 to 11 years is 5 or 10 mg (1 or 2 teaspoons) once daily depending on symptom severity. The time of administration may be varied to suit individual patient needs. Cetirizine is licensed from UCB Pharma, Inc.

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CAROL A. WILSON, U.S. FISH AND WILDLIFE SERVICE

Alaska Cliffs Prove Deadly to Walruses

They climb. They fall. And they die. Why do walruses—only males—make fatal climbs at Cape Peirce in Alaska's Togiak National Wildlife Refuge? Biologists are searching for answers. In 1994 walruses ascended a low eroded slope just to the left of this scene. They were apparently seeking shelter from a storm. One, at center, slides backward on the wet grass and falls off the cliff onto dead and dying victims below—some 45 perished. In 1995 about 20 died; last August, 60. "Walruses are herd animals. If one goes up, others are likely to follow," explains biologist Carol Wilson. "But I've asked local Yupik Eskimos, and they've never heard of walruses falling to their death."

Do Beetles Go for Blooming Heat?

Turning on the heat, an aquatic plant called the sacred lotus may regulate its temperature to benefit insects that it needs to reproduce. When the plant flowers, it heats its blossoms to above 86°F for as long as four days, even when the air is as cool as 50°. The heat releases an aroma that attracts beetles and other insects, which fly into the flower to feed on nectar and pollen. But the heat does more, speculate Roger Seymour and Paul Schultze-Motel of Australia's University of Adelaide: It rewards insects with a stable environment that enhances their ability to eat, mate, and prepare for flight. To fly, beetles must warm their muscles by vibrating them—a draining ordeal—or, as the scientists suggest, by staying within the flower's cozy chamber. —JOHN L. ELIOT

ROGER S. SEYMOUR

Avian Flashers

Why do sunbitterns, ranging from Mexico to South America, have large wing patches resembling giant eyes? Bruce Lyon of the University of Calgary has studied the birds in Costa Rica and believes the false eyes form part of a scary "face" that sunbitterns flash to ward off predators—"including eagles and us," he reports.

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■ ONLINE

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■ Celebrate the first anniversary of the launch of National Geographic Online by visiting some of our most innovative features. At Society headquarters Vice President Al Gore (above) announced a jointly produced U.S.-Russian atlas of the Arctic Ocean in CD-ROM format. Users at their computers could aim our on-site webcam—a digital camera with a robotic head—to areas of individual interest *(www.nationalgeographic.com/modules/gore/index.html)*. Check our site regularly for live webcasts.

■ Archaeologist Johan Reinhard re-created his dangerous high-altitude climb and discovery of frozen mummies in "Ice Treasures of the Inca" *(. . ./modules/mummy/index.html)*.

■ "Dinosaur Eggs" reveals the embryos and shows worldwide locations of the fossils *(. . ./modules/dino_eggs/index.html)*.

■ Our first real-time expedition visited an isolated Amazon tribe in "Korubo Expedition Contact" *(. . ./modules/contact2/contact_splash.html)*.

■ CD-ROMs

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Rembrandt Was Good, But He Couldn't Do This.

Too bad the great masters never had 3D graphics software or internet access to the entire art world. If so, they could have created images as mind-blowing as those designed by the kids in Lorelei Jones' art class.

Ms. Jones teaches *Electronic Art*, a class she developed to expose high schoolers to cutting-edge technologies, and prepare them for careers in computers or graphic design. She also conducts regular meetings with educators outside her district to spread the word about this new teaching tool. Her efforts have convinced dozens of teachers that the use of electronic media can make for some amazing artwork. "Plus," she reminds them, "compared to most art classes, cleanup is a breeze."

For helping students create with keystrokes instead of brushstrokes, State Farm is pleased to present the Good Neighbor Award to Lorelei Jones, along with $5,000 in her name to Homewood-Flossmoor High School of Flossmoor, Illinois.

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The Good Neighbor Award was developed in cooperation with the National Art Education Association.

NATIONAL GEOGRAPHIC

On Assignment

■ FRENCH POLYNESIA

Our Pair in Paradise

"Beautiful people, beautiful places. Too much beauty altogether—if there can be such a thing!" says photographer Jodi Cobb of French Polynesia. "I cried at the airport when it was time to go." Shooting a wedding at Moorea's Tiki Village, Jodi (left, in a leaf tiara) met with traditional dancers including, to her right, a fire dancer—before the flames started.

Writer Peter Benchley has a longtime interest in underwater subjects. The author of novels such as *Jaws* and *The Deep* accompanied photographer David Doubilet for much of the issue's undersea coverage. Wreathed by snapper and black triggerfish in Rangiroa Atoll's Tiputa Pass, Peter (left, at left) and diving companion Sabrina Lefevre bumped heads with a 150-pound hump-headed wrasse. Peter learned to dive in Antibes, France, in 1961, "when nobody really knew what they were doing. For my first lesson I was given a tank and an air regulator and told, 'Don't hold your breath on the way up.'"

Peter now has plans to return to French Polynesia: He wants to teach his ten-year-old son to dive. "If you're going to write," he says, "you might as well do it somewhere wonderful."

JODI COBB (TOP); DAVID DOUBILET

■ FOX RIVER

Angling for a Story

Hip deep in Hemingway's Fox River, writer Nick Lyons claims, "I've been fishing since before memory. My grandfather owned a hotel in the Catskills, and I could usually be found fishing in a nearby creek." As a boy he even found a dozen places to fish in his native Brooklyn. Nick was in the Army in his 20s and already had a degree in economics when he first fell in love with words. Since earning a doctorate in English from the University of Michigan, he's written 18 books and some 400 articles, taught college English, worked as an editor, and founded Lyons & Burford, Publishers, which specializes in books about outdoor adventure. He also finds some time to fish.

JAY DICKMAN

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KUNIO KADOWAKI

■ OKINAWA

Warm Welcome on Miyako Island

"They may be investment club members, but they know how to have fun," says Karen Kasmauski (above, at right) of an Okinawan *moai* gathering. "As each guest arrives, everyone downs a cold shot of *awamori*, a local liquor. I'd take a sip, then hand my cup to the guy behind me. Somehow he was still standing when I left."

Though she'd been to Japan many times before—she was born on a U.S. naval base there—this was only Karen's second visit to Okinawa. The day didn't begin well: She spent the morning on a storm-tossed ferry, where driving rain and hundreds of seasick tourists made picture taking almost impossible. "I was exhausted," admits Karen. "That evening I was welcomed by these wonderful people," she says of the Maedomaris, at left. Her hosts gave her a gift when she left that night. "More awamori," Karen laughs. "I shared it with everyone I photographed after that!"

DAVID GRIFFIN, NGS

■ EVOLUTION OF CATS

Sharing Her Felines

"I ought to be able to write off their cat food," says illustrations editor Kathy Moran of pets Emerson, on her shoulder, and his brother Whitman, who inspired her to propose the special approach to cats in this issue. Kathy, who studied journalism in college, came to the Society 16 years ago as a staff assistant. Now animal stories are among her favorite assignments. She was fascinated to see behaviors in wild cats that she had read about for this article re-created by "the boys" at home. Domestication is in the eye of the beholder. "Whit and Emmy aren't all that far from lions," she insists. Nor are they ever far from her heart.

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