NATIONAL GEOGRAPHIC

From the Editor

SEEING IS BELIEVING, they say. Trouble is, they started saying that before the advent of computerized photo enhancement.

Trouble appeared on the horizon early. No sooner had photography been invented than charlatans began using the new medium to stage fake double-exposure "ghost" images. Hot on those heels came misleading editing (Stalin erased Trotsky from a picture in which he had appeared with Lenin).

Digital manipulation came into its own in the 1980s. A room-size computer system for making subtle color corrections was, in a 1982 burst of technological enthusiasm, used to shift one of Giza's pyramids slightly to the right on a GEOGRAPHIC cover. That was a mistake that still haunts us.

After a bumpy beginning, I believe that the magazine has the ethics of digital manipulation down right. Computer enhancement made possible the re-creation of faded murals at Bonampak (right), featured in our February 1995 issue. A celebrated image of a roomful of chimpanzees pecking at word processors—used to illustrate our October 1995 story on the information age—was accomplished on a desktop computer. Our policy, which applied in those cases and will be rigorously followed in all others: Do not alter reality on the finished image, except when it is done for some instructional purpose. And then make certain we tell our readers what was done, and why.

PHOTOGRAPH BY ENRICO FERORELLI; COMPUTER RECONSTRUCTION BY DOUG STERN

Clearly, the artistic capabilities of digital enhancement are endless and useful, so long as they are tempered with a healthy dose of honesty and integrity.

Bill Allen

Labored wingbeats lift scarlet ibises from the *llanos*, the vast grasslands of Venezuela's interior. During the May-through-November wet season the flooding Orinoco and its tributaries turn the llanos into an inland sea, attracting tens of thousands of waterbirds—and a growing number of watchers. A few *hatos*—huge ranches that double as wildlife reserves—now accommodate birders as well as cattle, giving rise to a fledgling ecotourism industry.

THE ORINOCO

Into the heart of Venezuela

Much has changed along this river since Columbus first sighted its delta (right) in 1498. But much remains the same. Near its remote rain forest source, a Yanomami girl looks out on a world little altered for hundreds of generations.

By DONOVAN WEBSTER
Photographs by ROBERT CAPUTO

A MOONLESS MIDNIGHT in July, and the stars show themselves with the clarity of chipped diamonds. In the darkness our dugout pulls quietly from a broad channel into a backwater creek, three miles from where the waters of Venezuela's monstrous Orinoco River empty into the Atlantic. Alongside, mottled silver-and-pink freshwater dolphins puff and roll on the surface, giving me and my boat mate, Rogeli García, a curious once-over.

The creek narrows. Rogeli, a Warao Indian, paddles into the forest's depths, inaccessible by boat except now—during the floods of Venezuela's rainy season. Ahead, the red glowing eyes of an Orinoco crocodile, an animal that can exceed 20 feet in length, are set wide at the waterline. As the dugout approaches, the creek's black flatness flashes to white water and makes a percussive *whoosh* as the croc submerges. As it moves beneath us, dozens of shrimp, flailing to escape the predator below, land in the boat.

Rogeli scoops up the shrimp, which are all a good four inches long, tossing them into a pile in the stern. He grins. "For breakfast," he says.

A jaguar explodes through the trees, just 15 feet above the creek. *"¡Tigre!"* Rogeli whispers, breath hissing fast. Directly above, the cat bounds away on tree limbs, its fur a flash of yellow-orange. It rumbles into the blackness and sends sleeping parrots and monkeys into squawking rage, converting the formerly serene night into a threatening burst of noise.

Rogeli stops rowing. The dugout glides. In another few minutes the air is quiet.

Eruptions from peace are how things have always happened along the Orinoco. Undiscovered riches lie on its banks and beneath its surface; they are found—and life changes with dizzying speed. Animals of every imaginable shape and species coexist until the amity is shattered for a brief, sometimes bloody moment; then life calms as if nothing has happened. Unhalted by a dam anywhere on its 1,300-mile course, the Orinoco floods annually and prodigiously. When the rainy Venezuelan "winter" arrives, lasting from May through November, the river rises more than 40 feet, drowning grazing lands miles from its low-water line. Then comes arid "summer," December through April, when the Orinoco's level falls so low that people cross it on foot at some places—watching for freshwater stingrays and electric eels. Along the river's course are a handful of different native peoples, from the Warao in the delta to the Yanomami at the headwaters. The Yanomami have been dubbed

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DONOVAN WEBSTER's book, *Aftermath: The Remnants of War*, won the Lionel Gelber Prize for the best book on international relations in 1997. ROBERT CAPUTO wrote and photographed "Nepal's Forgotten Corner" for the November 1997 GEOGRAPHIC.

ROBERT CAPUTO, AURORA

Living up to their reputation as the Fierce People, Yanomami warriors parade before their admiring neighbors and hosts during a feast. On such occasions allied villages come together to talk politics, conduct trade, and air grievances. Disputes are sometimes settled by chest-pounding duels.

the Fierce People for all-too-real periods of murderous and ritualized violence, yet they allowed me to stay with them for the most peaceful week I've ever experienced.

From source to mouth the Orinoco is many things, all of which seem juxtaposed by their opposites. A river of contrasts, a waterway eternally on the brink of change.

IT BEGINS PLACIDLY, where the Fierce People live. In Venezuela's southernmost state, Amazonas—a dense rain forest the size of Oklahoma and home to roughly 16,000 Yanomami—the headwaters of the Orinoco braid into a slender stream at the base of the Parima highlands, a mountain range so remote it has been little explored.

On an early March afternoon nearing the end of the dry season, Jesús Cardozo, a Venezuelan anthropologist, and I are chest deep in the river's tea-colored water and surrounded by a friendly group of Yanomami. After a sweaty, six-hour hike through the rain forest, we are at Hasupiwei-teri, Village of the Bullfrogs, where roughly 40 Yanomami from six families

On its 1,300-mile run from the Parima highlands (above) to the Atlantic, the Orinoco slices Venezuela into two realms: the settled north and the wild south. A renewed push to tap the basin's mineral wealth may doom efforts by local environmentalists to save its ecological riches.

live communally in a *shabono*, a circular, 25-foot-high lean-to of woven palm fronds and logs. Filthy from our trek, we have made only a short stop in the village before leaving for a dip in the river. Our bath has inspired the locals, who follow us to the slick mudbank, then climb in after us to rinse off the day's grime.

Despite their off-putting reputation, my visit with the Fierce People has been nothing but neighborly. When we arrived in Hasupiwei-teri, for example, they greeted us with hoots and screams, their headman slapping us repeatedly on our chests and backs as a sign of welcome.

Our Yanomami guides from other villages didn't receive the same friendly displays. Instead, they had to hang their hammocks inside the shabono and lie there until they were approached and menaced by a village member. As the threats came—often at the point of a spear or knife—our guides could not flinch or blink. Stoic ferocity is one of their cultural trademarks, as the Yanomami believe that men descended from drops of blood spilled on the dirt in a struggle between mythical beings after Earth's formation. Because of this legend, violent confrontation between individuals and neighboring villages is a part of Yanomami life and heritage.

"It is the traditional style," Cardozo says. "The visitors know they can be killed. The village also learns that the visitor is fierce, so they respect him. Maybe once every two or three years someone is killed. If he is a member of an enemy village, his body may be left outside the shabono, so his village can come collect his remains. More often, the ritual ends when they bring the visitor a sort of milk shake of crushed plantains mixed with water. Then the visitor is welcome to partake in the life of the shabono."

Cardozo and I are free of such rigid manners. We are called *nape* (NAH-peh), which means "outsiders," less than human. Like all the Yanomami I meet, those of Hasupiwei-teri are curious. They see perhaps a dozen nape a year and want to know me, though none will tell me their given names—as they believe speaking them shows disrespect for the bearer and could cause spiritual harm. They call me *shori*, a term of endearment meaning "brother-in-law." I call them shori too—except for one particularly carefree young man of about 18 who loves to laugh, dance, and mimic others. He has earned the name Wacky-shori.

Wacky-shori regularly grabs at my thick black wristwatch. While the Yanomami don't understand the concept of clocks, they love my watch's hourly chime and anticipate its arrival. "*Ting, ting*?" he and the others ask every few minutes, grasping the watch and twisting my wrist their way.

During our bath they climb on my shoulders and splash. They borrow my soap, whose foamy pleasures fascinate them. Before Cardozo and I left the village, the Yanomami also took an instant shine to my lime green nylon hammock, which I'd hastily strung to reserve my sleeping spot in the shabono. Now many of them suggest I trade my hammock for their intricately woven and dyed baskets.

As we exit the river, two scarlet macaws fly overhead, their wings pounding against the jungle twilight's electric blue sky. I sit on a log near the smooth, swirling river and eat a tiny banana that Wacky-shori has given me. It tastes deeply sweet, as if a regular banana has been pressed down to a purer form. This place, beyond the negative propaganda of the outside world, feels like paradise.

"THERE ARE SO MANY misconceptions about this part of the world," Cardozo says. Thickset and bearded, he is seated in his hammock, plantain milk shake in his cup, with night falling fast. He is talking about the Yanomami. But he is also talking about the Orinoco, anywhere along its length. Around us life as it has probably been lived for thousands of years goes on in the shabono's open interior. Children chase each other with toy bows and arrows, honing hunting techniques. In the shadows families are cooking and eating plantains and the day's collection of game—a few turkey-size birds called guans. Along the top of the structure, green parrots roost for the night, their rounded shapes like a dozen bedpost finials.

To protect the people and the broad, intact ecosystems, the Yanomami lands have been set aside by the United Nations as an international biosphere reserve, and tourists need written permission to visit. But isolation from the rest of the world is nothing new for the Orinoco's tribes. They are estimated to have been in Venezuela for at least 3,000 years, but it wasn't until

1498 that any history of the area or its people was recorded. That was when Christopher Columbus sailed past the Orinoco Delta, proclaiming that the river must find its source at the Garden of Eden.

Soon after Columbus, the Old World began charging upriver in a quest for the land of El Dorado, a mythic king so rich that he was regularly showered with a new layer of gold dust. Not until the late 18th century, however, did a European explorer encounter a Yanomami. After his epic journey in 1800 Alexander von Humboldt reported that the Yanomami were a dangerous, war-making people, despite having no close contact with them. He based his account on the stories of earlier explorers. During the next hundred years, as dozens of others pushed toward the Orinoco's source, said to be a mountain lake, little was done to amend the Yanomami's hostile reputation.

In 1920 an expedition led by American explorer A. Hamilton Rice showed the Fierce People the outside world's ferocity. During a riverbank exchange of gunfire and arrows, Rice's team killed some Yanomami, paradoxically cementing the tribe's reputation as belligerent. By the early 1950s a French-Venezuelan expedition had crossed the final rapids and pressed upriver, pinpointing the river's beginnings in the Parima highlands and disproving a pair of myths: that the Orinoco spilled from a mountain lake and that the indigenous people were always hostile.

A dying fire fends off the dawn chill in a Yanomami village near Venezuela's border with Brazil. Harder to repel are sporadic assaults by Brazilian gold miners, who in the summer of 1993 killed at least 16 Yanomami. Many more die each year from malaria and other diseases brought by outsiders.

EVEN TODAY confusion surrounds the Yanomami. Since 1968, when Napoleon Chagnon, an American anthropologist, published his controversial study, *Yanomamo: The Fierce People*, the tribe's overstated reputation for violence has been debated. Many subsequent scholars have claimed that the Yanomami are far less violent than Chagnon reported, and he eventually dropped "The Fierce People" from the book's title. Although Chagnon says it wasn't due to pressure from colleagues, others claim the contrary.

What I see is peace. Families doze in hammocks and huddle around fires. While the Yanomami have adopted some modern technologies from visitors, they live as they always have, a source of some impatience in shabonos that now catch glimpses of what they're missing. Though they may fish with steel hooks given to them by missionaries and the few anthropologists who are allowed into these forests, the tribe is thirsting for more from the outside world.

Most Yanomami remain in the jungle, but some have left for the half dozen missions in the Orinoco's upper reaches. There they are taught to read and speak Spanish. They also learn trades and Western work habits, which are seen as necessary for surviving outside the jungle. Patronizing as this may sound, without such acculturation many Yanomami would be as vulnerable in a modern city as an urban American tourist would be alone in the Yanomami rain forest. Discussions about the fate of the Yanomami occupy the conversations of many Venezuelans from Caracas to Amazonas.

"What will the future hold for the Yanomami?" Cardozo asks one night in Hasupiwei-teri. "They desire so many things that we take for granted. Who can blame them? We can't keep them like a human museum."

I look over at Wacky-shori, who rocks in a hammock. He smiles and waves. I ask the village headman, who is cooking nearby: What does he want for the people of Hasupiwei-teri?

The headman's face is painted an oily crimson from a healing ceremony performed this afternoon. He thinks about my question. Finally he says, "The nape and the Yanomami were once the same tribe—all Yanomami. Then a great flood came, and it washed some of the people down the river, where they learned new things. They became subhuman, nape. But some of what they learned I would like to know. Their medicine. The material from which they make hammocks. Their steel. But I would have to give up my life here. And why? To have what the nape have? *Ting, ting!*"

He stirs his fire with a stick. Sparks fly. "I am like all men," the headman says. "I want to know my future—then I want to control it. It is not possible." *(Continued on page 18)*

The rhythms of flood and drought regulate the pulse of life on the llanos. Coiled on a termite mound, an anaconda claims one of the few pieces of high ground left during the wet season, when an Orinoco tributary jumped its banks and flooded the grasslands for miles.

Abandoned by the river that once fed it, a pond-become-pavement affords a caiman—a cousin to the alligator—no refuge from the desiccating heat of the dry season. On this sunbaked plain, which sits only 8° north of the Equator, the soil temperature can hit 130°F.

Emerging at dusk to hunt, a burrowing owl is no threat to a capybara, the world's largest rodent. Resembling a cross between a guinea pig and a hippopotamus, the web-footed "water hog" may grow to 140 pounds and stand knee-high to a man. Its mortal enemies include jaguars, caimans, and cowboys.

FROM HASUPIWEI-TERI the Orinoco flows smoothly northwest. I ride downstream in a motorized dugout, every hour parsed into scorching, sunburned minutes. Beyond the river's tall banks the jungle looks impenetrable: a thick, green tapestry rising a hundred feet into the sky. Occasionally, around a bend, two or three dugouts will be beached on a mudbank near a trail to a shabono deeper inside the rain forest. We stop at a few settlements, ferrying villagers downriver to visit family or return home. They share their fruit and fish roasted in banana leaves.

The river meanders past steep green mountains and foams across rapids created by gardens of boulders the size of houses. It will be another 200 miles before the first mud road is carved into this jungle. Slowly the lands of the Yanomami recede, replaced by jungles that are home to the more westernized Yekwana and Piaroa.

At the western edge of Yanomami lands the Orinoco flows into the 220-mile-long Casiquiare. A wide channel that connects the upper Orinoco and the Río Negro (a tributary of the Amazon), the Casiquiare links the two waterways like no other river on Earth. At times the Casiquiare slurps 20 percent of the Orinoco's flow into the Amazon.

Exiting the mountains of Amazonas, the Orinoco winds along the empty cattle lands of the *llanos*, which make up nearly a third of Venezuela. Snaking over these plains, taking tributaries as it goes, the river swells, and during the wet season everything floods, sometimes turning towns and their few stores into islands accessible only by boat. Good news for nature-watchers.

On a drizzly morning in July, on a ranch called El Cedral, Archie Araujo is showing me around in a tall truck. We are 170 miles from where the Orinoco flows in the dry season, but now—given the basin the llanos sit in and the backing up of a wet-season Orinoco and its branches—the ranch is almost completely underwater, and plants grow lushly with the rain. Animals are gorging themselves everywhere.

We drive for miles along a dike that separates a deep inland sea from a pasture for some of the 20,000 cattle that live on Cedral's 131,000 acres. On one side of the road, storks, ospreys, anacondas, and piranhas own the landscape. On the other, where floodgates help control the water levels, cattle stand chest deep in water and tall green grass. On top of this dike, chocolate brown and pig-size rodents called capybaras nap.

Headed for a pasture to meet some of the ranch's rough cowboys, called *llaneros*, Archie is telling stories. During Venezuela's colonial period, he says, a Spaniard killed a capybara.

Because the season was Lent and the colonists were starving and the capybara lived most of its life in water, the rodent was declared a fish. "The colonists," he says, "were obviously very hungry."

Archie says that an estimated 13,000 capybaras and 12,000 *babas*—four-to-five-foot caimans—live at Cedral, as well as several hundred anacondas, which can reportedly grow to 37 feet long. He's also pointing out several of the ranch's 294 species of birds: Orinoco geese, green swallows, straight-billed creepers, crested bobwhites, aplomado falcons, yellow-headed parrots, Amazon kingfishers, southern lapwings, crested caracaras, black skimmers, roseate spoonbills. . . . Until the late 1980s Cedral was a holding of the enormous King Ranch of Texas, which had a policy of peacefully coexisting with the wildlife. Consequently many animals have little fear of humans, bringing bird-watchers by the hundreds every year.

Ahead, some llaneros are driving cattle across the dike to higher, drier ground for inoculations. Ramón Albujas, a short, stocky ranch worker, rides up. He is 70 years old. "I can't imagine another life," he tells me. "I can't even go to the nearest town without feeling lonely for this."

Like Archie, Ramón is a born raconteur. He has fathered 24 children. He has mixed it up with caimans and has been bitten by piranhas. As he rolls up a pant leg to show the circular depressions from the bites, he smiles. "These happened when I was in my 20s," he says,

"when I was naive enough not to be afraid. Now I am smarter."

He shows scars from snakebites and a long slash on his leg where a freshwater stingray impaled him. "This happened in my 20s too," he says. He adds that a stingray's poison is painful enough to make even a llanero cry.

We watch the llaneros for a long moment. Ramón says he must get back to work. This evening, he offers, he will take me fishing. He will show me the other side of life in the llanos: the land, seen from the water.

Following an afternoon thunderstorm I meet Ramón at a dike crossroads near his bunkhouse. He is loading some fishhooks and a sack of gristly beef into a motorized skiff. "Let's catch some piranhas for dinner," he says.

We push off, crossing flooded pastures toward a forest on the horizon. Scores of four-foot-long green iguanas take refuge in the partly submerged trees along a dike. Ramón swings the boat toward the bank, then cuts its engine. He motions ahead. On the dike's high ground an 18-foot anaconda lies coiled like a pile of black-and-brown tires.

"A pregnant female," Ramón says. "Go ahead. Get out and grab her. Just remember: If she bites you, don't pull your arm out quickly, since her teeth angle inward. Instead, push your arm *deeper in*. The anaconda is strong but slow. She will try to get a better grip. When she lets go, *then* pull your arm out."

The boat grinds ashore. I step onto the dike. The shiny pile of anaconda is taller than my knees; her triangular head, with black beady eyes, lies in the center of the coil. I grab one of the thicker loops of snake, perhaps a foot in diameter, and she responds. Slowly she shifts her head. She slides it between two loops of her body and toward the carpet of water hyacinths that laps against the shore. Muscular pulse by pulse, she slides into the water. Her dark brown scales are larger than my thumbnail. Her body has a line of blackish circles running along it. She is smooth and dry. In another minute I hold only her thick tail, which pulls through my fingers and into the flood.

"Some are almost twice as long as that one," Ramón says, smiling. "Monsters."

We boat south for 25 minutes. Ramón cuts the motor and moors to a tree branch. He pulls out the handlines and beef we will use as bait. "Piranhas love flesh," he says. "But it has to be bleeding, or they do not care. You can swim across this river if you are not bleeding. If you are bleeding, you will not last 30 feet."

Sprinting to safety, wildlife researchers release an Orinoco crocodile bred in captivity to boost wild populations. A yank on the rope will free its jaws. Tropical cowboys called *llaneros* (left) avoid foot rot from soggy boots by riding barefoot—despite piranhas, stingrays, and electric eels.

Wrestling a chunk of meaty tendon onto the sharp hook, Ramón shows me how to fish llanos style. He lets some line off a spindle, twirls the hook and line above his head like a lasso, then sends the bait flying. It hits the water and sinks. The surface boils. Ramón jolts the line with a snap of his wrist and retrieves a fighting ten-inch piranha, round and silver, with a bright red belly. He unhooks the fish, using his pocketknife's blade to push back its lips, and exposes triangular, razor-sharp teeth. He hands the hook and line to me.

Fishing for piranhas is difficult. The meat is a struggle to pierce onto the hook, yet once my offering hits the water—unless quick reflexes are at play—the flesh is stripped away in a heartbeat. As I catch a few, Ramón is telling piranha stories. Two weeks ago, he says, a steer that didn't want an injection ran away from the llaneros into a semi-submerged thicket that slashed his hide. The llaneros chased after the animal to dress his wounds, but piranhas got to him first. "Minutes later," Ramón says, "the llaneros had one less cow to work with. And they had a new skeleton."

In an hour we have caught a few dozen piranhas for dinner. Satisfied with our take, Ramón fires up the motor and runs us home. Back at the dike crossroads we look over the flooded land at twilight. "This is the world I love. It has changed a little, but it is still a place of men and land and cattle and horses," he says. "It is hard, though. You must always be accommodating the water. It is either too flooded or too dry. But for the man who owns a ranch and cattle, it gives great riches. For the rest of us, we take other pleasures."

One of those pleasures is to feast on piranhas. As darkness falls, we fry our catch, first dipping them in a batter laced with cayenne pepper. Served with white rice and black beans, the fried piranhas are meaty and flaky, a mix of fried chicken and flounder. Ramón eats more than his share, smiling as he savors revenge for a few hard lessons taught to him in his youth by the Orinoco.

SOMEWHERE toward the middle of the empty llanos, 350 miles east of El Cedral, the riches of the Orinoco are found underground, and the river divides them like a cleaver. Flowing more east than north from here to its delta, the Orinoco courses alongside the ancient stone of the Guayana Shield to the south, home to a lost world of flat-topped mountains called *tepuis*.

A capybara nears the end of its rope during the pre-Easter round-up at a spread called El Cedral. What turkey is to Thanksgiving in the U.S., capybara is to Easter in Venezuela. Tradition holds that the semiaquatic capy is a fish and so offers guiltless dining during Lent, when faithful Catholics shun meat.

Leaving a wasteland in their wake, independent miners called *garimpeiros* use high-pressure hoses to prospect for gold (right). After a day in the mud pits, diamond miners return home to Salvación (above), where banners trumpet the "Best Beer in Venezuela."

Tucked beneath the tepui foothills* is enough gold to make even El Dorado crazy—an estimated 11,000 tons, or 11 percent of the world's supply. The river's south bank also has huge deposits of iron ore, diamonds, and bauxite. On the northern shore is the Orinoco Belt, a deposit of extra-heavy crude oil estimated at more than 270 billion barrels.

On a hillside along the river's southern shore rests Ciudad Bolívar. Formerly the colonial city of Angostura, it was renamed for Venezuela's liberator from Spain, Simón Bolívar. Today, in honor of the old name and the Angostura narrows—where the river slims to less than a mile across—the Angostura suspension bridge looms above the city, the only span along the river's length.

Despite the city's population of 250,000, it retains the feel of a small town, with steep cobbled streets and fountained interior courtyards. On a sunny morning in the wet season, walking along Paseo Orinoco, Ciudad Bolívar's parklike street fronting the river, I'm admiring the town and all it has to offer. Trees shade the railed sidewalk, which towers 15 feet above the concrete wall that keeps the Orinoco from eroding the town. Craftsmen hammer and tap gold into jewelry at tables. The artisans occasionally sell their work in exchange for raw gold. Some merchants keep a scale next to their cashbox just in case a miner coming to town wants to pay in gold.

PAST THE BOTTLENECK at the Angostura narrows the river slows and broadens to almost three miles. Here it becomes host to ship traffic as container boats—like skyscrapers laid sideways—churn upriver to load up with the area's bursting stores of iron ore, bauxite, and aluminum.

Most of these ships visit Venezuela's fastest growing commercial center, Ciudad Guayana, a planned city 60 miles east of Ciudad Bolívar. Founded in 1961 by a government development agency, it is unlike its upriver neighbor, where shop and card-table commerce makes up the bulk of daily transactions. The way to do business here is big. *Very big.*

Using the available bauxite and ten million kilowatts of electricity created by a string of hydroelectric dams along the Caroní River, which enters the Orinoco near the heart of the city, Ciudad Guayana has become a world leader in aluminum production, bringing tens

*See "Venezuela's Islands in Time," by Uwe George, NATIONAL GEOGRAPHIC, May 1989.

of thousands of jobs to town. It is also Venezuela's fastest growing urban area, populated by more than 600,000, up from fewer than 10,000 when the city was founded. Town boosters claim that more than a million people will live there by the turn of the millennium.

It's a dry-season afternoon in February, and a boat driver named Alberto Aguilera and I are in an 18-foot runabout, powering around the Caroní off Ciudad Guayana. It's a far different view from that along the Orinoco; we zip between large ships, past the city's shoreline, which is dotted with tall apartment buildings and yacht clubs.

Alberto runs us out to the confluence of the Caroní and the Orinoco, said to be one of the river's most beautiful phenomena. Where the rivers meet is like coffee mixing with cream. The Caroní, nearly black with soil washed down from the highlands, swirls into the pale brown Orinoco in a line that stretches downstream for miles.

We head toward Ciudad Guayana's wharves, where visiting containerships take on cargo. More than a thousand miles from its source, the Orinoco is fouled by floating garbage, downed trees, and technicolor spills that shimmy, amoeba-like, with oil. Back with the Yanomami I drank from this waterway with no side effects. Now, after pulling my hand from the water, I make a mental note to wash later.

Along the shore a string of yellow railcars, carrying 90 tons of iron ore apiece, rolls downriver from Cerro Bolívar, the iron-rich mountain 75 miles away. At the wharves the ore is dumped through a series of close-set bars that sort it into crushers or direct it right onto ships. As I watch this titanic work—the dumper spewing black diesel smoke into the sky, the separators clanging with a new drop of 180,000 pounds of iron every few minutes—a pair of dirty, tired-looking sailors step to the rail of a rusted red containership.

"Where are you bound?" I call.

"Belgrade," one of them shouts over the din of falling ore.

The Orinoco, once chest deep and home to a few Yanomami, has grown into a global main street.

ALMOST 50 MILES northeast of Ciudad Guayana, near the town of Barrancas, the river widens and shallows, achieving its greatest breadth—13 miles—having taken on the waters of a vast network of tributaries. Then it shatters into its delta.

In the tumbledown delta town of Tucupita, it's easy to see that not all riches along the Orinoco are legitimate. Inside a walled estate outside town, sentries with guns keep everyone at a distance. The man who lives here is rich. He was made this way, I have been told, by arranging the movement of cocaine through the delta and into the Caribbean.

Because of a crackdown on Colombia's airports and drug lords, plus a clamping shut of the overland drug routes, the Orinoco provides an increasingly trouble-free track for moving cocaine. After arriving in the delta, the drugs—often hidden beneath bags of rice or dried fish—are sent downstream in motorized dugouts. They disappear into a maze of creeks, where 220 miles of ragged, tree-shrouded tidal inlets give ample solitude to floatplanes and jet boats. According to a U.S. State Department study, up to 220 tons of cocaine—about 30 percent of Colombia's annual harvest—moves through the delta each year.

"This is a drug trafficker's paradise," says Johan Obdola, a dark and intense gentleman who, until the end of 1996, was the head of Venezuela's drug enforcement in the delta. "Once the drugs get here, there is almost no way to stop them flowing out. This is a mangrove jungle hundreds of miles across—and 60 percent water. Even if there was money to combat the trafficking, it would take constant surveillance and effort."

Lack of money, Obdola says, is why he quit. "I was working alone. I can tell you who is

Steeped in history, Ciudad Bolívar—renamed in 1846 to honor Venezuela's liberator, Simón Bolívar—was known in colonial times as Angostura, or "narrows." Here the Orinoco tapers to less than a mile across. The city's earlier name now applies to the river's only bridge—and to bitters once bottled here.

directing the flow of drugs. But if I were to do anything, I would be dead. Last year I had $21,000 for everything: my salary, equipment, deputies, and expenses. How can you stop 200 tons of cocaine with $21,000?"

Obdola's resignation helped to awaken the government. In early 1997 the Venezuelan antidrug office became a commission with cabinet-post power, if not a lot more money. "It will take a deep commitment to stop this problem, which is growing," Obdola says. "It is infecting every part of life here."

Last year, for instance, when a jettisoned bale of cocaine washed ashore near a Warao village, a villager opened it. When the drug runners discovered what had happened, they beat the man nearly to death. "This is a rotting of the culture," Obdola says, "and it will not stop. That is the greatest problem I see associated with drugs: They harm anything they come in contact with."

DRUGS AREN'T ALL that's flowing into the delta. As it's been since Columbus sailed by the Orinoco 500 years ago in search of riches for Spain and souls for the Roman Catholic Church, a sometimes pestering quest for new congregations continues, occasionally yielding beneficial results.

On a Sunday dawn in the wet season, Father Ismael Laguna—piloting a red fiberglass speedboat—pulls up at a Warao stilt house. This structure is the center of a community of 700 called Muraco, a jumble of longhouses standing perhaps 15 feet above the river.

Laguna, a Venezuelan missionary, is from nearby Misión San Francisco de Guayo, inaccessible except by boat. Today, as he does every Sunday, he will visit 28 different villages across the delta. He will play the same songs on his guitar and will tell of the Scriptures, gathering an audience of Warao as each service hurtles on. Inside the village's great house he leads a hymn that's got the locals singing, "Alleluia, alleluia, the Lord Jesus has risen."

Outside the great house Raimundo Medina, a short and wrinkled man in his 60s, watches with benign skepticism. "I have seen this for more than 50 years," he says. "And still every day I go down to the river, wash myself, catch my fish, and see little change. It is always the same. We pray for everlasting life. We pray for new outboard motors. We have not seen either one. Father Laguna says we must be patient."

Medina leads me across the stilt village toward his house, crossing a raised platform of tall manaca palm stems laid sideways. I step carefully. It's like walking on row after row of long baseball bats. Occasionally one of the trunks rolls or snaps under my weight, dropping my foot into open air below the platform.

A spiky iguana looks positively punk in the company of tuxedoed stilts. As the dry season wrings ever more moisture from the llanos, creatures congregate at shrinking pools that concentrate fish and freshwater shrimp and set a banquet for waterbirds.

"A place to paddle"—so Orinoco is translated from the tongue of the Warao Indians, who escaped 18th-century slave traders by dissolving into the delta's labyrinth of creeks and channels. Today they also play ball, fish, bathe, build their homes in—and draw life from—its blood-warm waters.

Medina laughs as my feet crash through. "We will have to fix parts of the floor," he says. "It has gotten old. Or you are too heavy."

We are close enough to the Atlantic—maybe three-quarters of a mile—that tidal swings affect the river's level. Below the platform, low tide has left behind a brackish mire of black swamp. In some places the village pigs have emerged from a mangrove thicket. They root for garbage in the mud.

"This is my house," Medina says as we enter a hut. "Three families live in here."

My eyes grow accustomed to the low light. Hammocks hang everywhere from the rafters. Near them are low disks of dried mud: hearths that hold smoldering fires off the wood floor. "The smoke keeps bugs away," Medina says as we settle into a pair of hammocks.

"This is how life has always been," Medina says. "Some parts of life here will never change. The river. The bugs. The mission helps. It has good health care. We have a schoolteacher now for the children. There has been talk of electric lights and a generator. So I think God and the mission are a good thing. But slow. I think the oil companies will help faster. They are starting to hire some of the Warao to help with the drilling. That means money."

I say good-bye to Medina and catch up with Laguna, who is already putting his guitar into its scarred black case. Tall and lean, with thinning black hair, he seems as committed to his task as an arrow in mid-flight.

"How long have you been doing this?" I ask.

"Two years," he says, hurrying toward his boat. "It keeps me busy."

"What is planned, long-term, for the Warao?"

"We help represent them to the government. We tend to them. We try to bring the Lord to them. There is much to do."

"Are you succeeding?"

The priest smiles. "As always," he says, "success is a difficult thing to define."

WHICH IS ALSO A TRUTH about the Orinoco. Thanks to its endless variability, the river and its people elude all who try to impose a steady definition upon them. It floods and dries up. It is home to Yanomami who've yet to discover how to turn iron ore into tools and to iron-processing plants that belch smoke and 90 tons of ore every few minutes. Along its shores are grinding poverty and drug-created riches, dugout canoes and high-tech containerships. In some places you can drink from it; in others a well-placed spark could set the water to flame.

Near the Isla de Pájaros, Bird Island, I take a boat downriver and look out over the Atlantic for the first time. It's my last morning, and I see the metallic blue wings of morpho

butterflies—each one the size of a pie plate—as they flutter in the jungle to my left. It is the wet season, but the day is as perfect as any spent in my months along the river. I glance north, along the delta's shoreline. Somewhere up there, British Petroleum has a new billion-dollar drilling rig. Boring into the earth at low angles, it will be able to draw oil from beneath Warao homelands without disturbing the natives—a far preferable version of the old, bloody chase for El Dorado.

Against the wooden stilt villages and the simple fishing life of the Warao, the platform's acres of steel—footed to the river bottom on long legs—seem to have landed from outer space. Fortunately the rig is friendly. The oil company is hiring the Warao for unskilled work, and some of its profits may go into programs to help improve local living conditions.

Ironically the rig is located near where Christopher Columbus sailed past the Orinoco in 1498, setting into motion five centuries of civilizing change, a settling that has now blanketed most of Venezuela with religion and relative prosperity. Most, that is, except for the lands along this river's banks, which—with the exception of the mining towns—are still considered Venezuela's outback, too big and difficult to tame.

After 500 years El Dorado may have exchanged his cloak of gold dust for one of slick crude oil—but he's still out there, as surely as men continue chasing his legendary riches up the Orinoco. □

JOHN EARLE, ODYSSEY (ABOVE); INSTITUTE FOR EXPLORATION/
WOODS HOLE OCEANOGRAPHIC INSTITUTION

HIGH-TECH SEARCH FOR ROMAN SHIPWRECKS

Diving to the bottom of the Mediterranean in the U.S. Navy nuclear submarine NR-1, the author (above) and his team locate the largest concentration of ancient shipwrecks found in deep water. The cargo (right) testifies to the open-sea trade that flourished between Carthage and Rome.

By Robert D. Ballard

Photographs by Priit J. Vesilind

NATIONAL GEOGRAPHIC SENIOR WRITER

THE SKIES GLOWERED for days as our support ship, *Carolyn Chouest*, heaved 70 miles west of Sicily. The sea roiled, and one huge wave thundered over the starboard deck to rip *Jason*, a 1.5-ton remotely operated vehicle (ROV), off its platform. Slipping in the wave wash, I struggled along with the crew to relash the delicate and irreplaceable ROV to its cleats. Damage was minimal; we were lucky.

Only days before, I had watched in fascination as video cameras on *Jason*, provided by Woods Hole Oceanographic Institution, had swept over the bottom of the Mediterranean Sea, revealing the remains of ships that had foundered in such squalls over the past 2,000 years. Some were wooden trading vessels of the Roman world—square-rigged and deep bellied. Their skippers had been entrepreneurs, risktakers. While some mariners hugged coastlines, they had shaken off fear and blazed straight across the Mediterranean between Rome and Carthage, near today's Tunis, hoping to turn a profit from their cargoes of wine, olive oil, or fish sauce. But many paid dearly for their courage. When storms caught ships, those that didn't sink immediately jettisoned their cargo, hoping to keep afloat. We found their debris lines strewn like crumbs in the stygian darkness.

During four explorations beginning in 1988, our Skerki Bank Deep Sea Project documented eight ships: five Roman wrecks dating from about 100 B.C. to A.D. 400, one 17th- or 18th-century wreck of North African origin, and two from the 19th or 20th centuries. All were within a 55-square-mile area.

Until now the study of shipwrecks has been largely restricted to sites no deeper than 200 feet, the limit for scuba divers. This means that 97 percent of the world's oceans have never been examined—and these depths may

Carefully packed stone blocks from a first-century A.D. Roman wreck (below) may have been part of a prefabricated structure, according to the author. On deck archaeologist John Oleson (right) from the University of Victoria examines a terra-cotta amphora used to transport wine.

A WRECK DISCOVERED

Stormy violence turned to abiding peace for a 100-foot Roman trading vessel from the first century B.C. In this mosaic of images taken from *Jason*, the ship's two cargo holds have gently settled into silt, undisturbed by treasure hunters. The team took only sample artifacts from six wrecks, leaving virtual museums intact for further archaeological investigation.

INSTITUTE FOR EXPLORATION/WOODS HOLE OCEANOGRAPHIC INSTITUTION (ABOVE AND TOP LEFT)

hold more history than all the museums of the world combined.

Diving as deep as 2,800 feet, we moved marine archaeology from the fringes of the oceans to the deep sea. The project was supported in part by the National Geographic Society, the Office of Naval Research, and the J. M. Kaplan Fund. Our technical arsenal included the U.S. Navy nuclear research submarine NR-1, with powerful, long-range sonar that can find even small objects in wide swaths of the bottom.

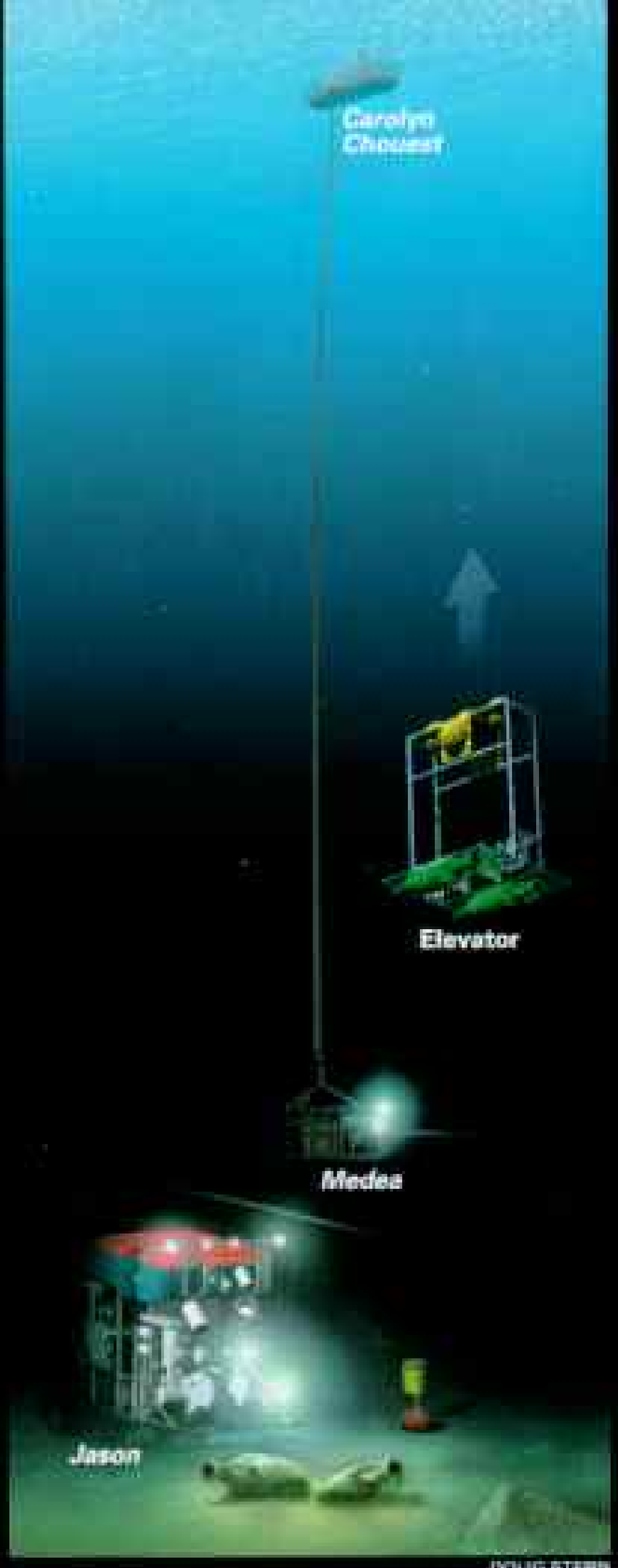
After locating a target, we deployed *Jason* to map the site and retrieve artifacts. Under the supervision of Anna Marguerite McCann of Boston University, our director of archaeology and conservation, we recovered more than 150 artifacts—amphorae, glassware, anchors—from sites untouched by looters, fishermen, or storms because of their depth.

Where no diver dares go, *Jason* (right) uses its manipulator arm to lift an iron anchor from the 2,600-foot-deep Roman shipwreck nicknamed *Isis*.

With still and video cameras, sonar, and precision mapping abilities, *Jason* performed analytical work on each wreck.

LAUNCHING JASON

Loaded with advanced hardware and able to scoop up delicate glass objects with its netted hand, *Jason* is launched from our support ship, *Carolyn Chouest* (above). In the control room (right) the author confers with technical wizard Dana Yoerger, at left, the project's head of engineering.



DOUG STERN

Precisely positioned by dynamic thrusters, *Carolyn Chouest* lowers *Medea*, a metal platform fitted with lights and monitor cameras. Hanging like a bob on a plumb line, *Medea* provides a steady base from which *Jason* maneuvers on its tether. After delivering to the seafloor the cylindrical yellow sonar transponders used to control *Jason*, an elevator raises artifacts in mesh nets, saving valuable dive time for the ROV.

USING THE NR-1 SUBMARINE

A nuclear reactor as small as a garbage can allows NR-1 to prowl indefinitely without surfacing. The sub's deep-sea capability and equipment enable scientists to locate sites for further exploration with *Jason*. At one stretch they were finding a wreck every other day. "We had to tell them to stop," says the elated author.

1. Nuclear reactor compartment
2. Steel pressure hull, 1.3 inches thick
3. Bunks
4. Living quarters
5. Control station
6. Forward-aiming sonar
7. Green thallium iodide lights penetrate farther than white lights in water
8. TV and still cameras
9. Work module fitted with storage basket and tools
10. White incandescent lights used for color photography
11. View ports
12. Manipulator arm
13. Retractable wheels
14. Side-scanning sonar

ART BY DALE GUSTAFSON

Jason's advanced capability allowed us to compile a photomosaic and a sonar map of a shipwreck within hours of arriving at a site, in contrast to the weeks or months such mapping can take using divers in shallow water.

Although our project was only a beginning for deep-water archaeology, a new chapter can already be written on the economic history of the Roman world. Next we plan a deep-sea survey in the Black Sea, where wooden wrecks may be well-preserved in the oxygen-depleted depths. There we might find even older ships, hidden like time capsules of history. A new era of discovery awaits.

Robert D. Ballard, who received the Society's highest award, the Hubbard Medal, in 1996, directs the Institute for Exploration in Mystic, Connecticut. Watch his Mediterranean expedition in "Treasures of the Deep" on National Geographic EXPLORER, Sunday, April 26, at 7 p.m. ET on TBS. For more on Roman shipwrecks join our online forum at www.nationalgeographic.com.

FINDING AN ANCHOR

Pale images of a 2,000-year-old anchor glow from video monitors in NR-1's control station as Lt. Comdr. Scott Swehla guides a camera to oversee the anchor's recovery. Below him the manipulator-arm operator remotely threads a rope through the anchor's eye for hoisting.

The lead artifact (left) weighed more than 300 pounds, too heavy for *Jason* to lift. As Lt. Comdr. Charles Richard, the NR-1's captain, directed from the bridge (far left), scuba divers attached the ancient anchor to an inflatable boat and hauled it back to *Carolyn Chouest*. □

AUSTRALIA BY BIKE

Part Three

Closing the Circle

By ROFF MARTIN SMITH
Photographs by R. IAN LLOYD

Wednesday, January 29, 1997
Margaret River, Western Australia

The gouges in my helmet tell a story of a day I'd like to forget: Wednesday, January 8, about 6,500 miles on the wrong side of Sydney. I'd finished the second leg of my journey, over the Top End and down the hard, dry western side of Australia, and was preparing myself for the next big challenge: the Nullarbor Plain. I should have sensed the bad conjunction of the stars when I was served up a hamburger crawling with maggots at Eats Diner in Margaret River and didn't notice until I'd eaten half of it. A cleansing Coke didn't help much, and I headed out of town full of grubs and misgivings, which began fading on Rosa Glen Road, a leafy, narrow country lane freckled with afternoon sunlight. No cars, the air fresh and cool, fields and forests a lively summery green—sheer bliss after four grueling months in the outback.

Rolling along south of Perth through a forest of giant karri trees, I realized I was about to turn back east toward Sydney and a big decision. After 15 years in Australia, should I stay or pack up and return to my native New England? Six months earlier I had begun this 10,000-mile trek around Australia in the hope it would give me a clearer sense of direction.

I remember cresting a hill, fast, about ten miles out of Margaret River, then coasting down a steep grade toward a curve at the bottom obscured in shade. What happened next is a blur. There was a flash of premonition when I saw some potholes, then my bike started bucking like a bull out of a gate. When the world righted itself, I was sprawled beneath the bike, my T-shirt drenched in blood, my right arm hanging limp. It felt as if the entire Australian cricket team had had a go at my ribs with two bats each.

If the gods had been shirking for a moment, they gave me their fullest attention afterward. A Good Samaritan named Andrea Lindsay drove up out of nowhere and whisked me to the hospital back in town.

I remember sailing down a hill at 30 mph . . . then suddenly finding myself sprawled on the pavement in a bloody heap. But luck turns quickly on the road, and a passing stranger gave me a lift to Margaret River District Hospital. It took a dozen stitches on my elbow and several weeks of convalescing before I was fit enough to ride again.

I had a couple of broken ribs, a badly yanked tendon in my right shoulder, which meant I couldn't move my arm, and a wound on my elbow that required scalpel work and stitching. "You could see the bone," Andrea said when she came by later, bringing chocolate and soft drinks to cheer me up. "Sorry if the look on my face scared you, but the sight of that arm made me feel faint." She laughed. "Don't know whether I should tell you this, but my little boy says there's a lot of crows pecking at the pavement where you fell."

That was three weeks ago. For recovery I've loitered at a youth hostel at Prevelly, getting to know the surfers; watched the Super Bowl with a couple of fellow Yanks (surfers from California); sampled local wines and cheeses (very nice); taken long walks under the green karri, a type of gum that's one of the tallest trees in the world. For adventure I've been rereading letters from Cheryl, an English friend I met in Perth. She wrote last from the roof of a bus stranded in a flash flood in Queensland. We'd hoped to meet up again in Tasmania, but at this rate perhaps neither of us will make it.

Physically I'm ready to ride. Stitches are out, the ribs are pretty much healed, and I can raise my arm well enough to grip the handlebars. Mentally I'm not sure. For the first time I'm weary of life on the road. Sydney seems light-years away.

Sunday, February 16
Eyre Highway, Nullarbor Plain

There he sat, lord of the wheels, high in the cab of his crimson-and-chrome Kenworth, hands clasped behind his head, steering his 90-ton rig with his bare feet as he highballed down the centerline of the Eyre Highway at about 80 miles

an hour. I skittered off the bitumen, straight into the weeds, praying the luck on my St. Christopher medal hadn't worn smooth and wondering who was crazier—him for playing the Eyre like a crapshooter or me for trying to cross the Nullarbor Plain on a bicycle. Dust slapped my cheek as he roared past, grinning, toes wiggling, a stinging rebuke for my having the impudence to mix it with the road trains "crossing the paddock," as transcontinental truck drivers refer to this stretch of desert.

As its name (null arbor) implies, this place is treeless—a waterless void that divides southern Australia east from west. Even the Aborigines left it alone. Going east on the Eyre Highway, once you pass Norseman, a last-chance mining town in the goldfields of Western Australia, there's nothing but 800 miles of saltbush (which reminds me of sagebrush on the American plains) and a scattered archipelago of roadhouses until you reach Ceduna, a lonely fishing port in South Australia, on the other side. The Eyre Highway is Australia's lawless road, the getaway route of choice for lowlifes and misfits wanted by the authorities back east.

Dawn on the Eyre: Sunlight sparkling on broken glass, refracting through discarded plastic Coke bottles, shimmering on the disemboweled cassette tape festooning a saltbush; loaded diapers; plastic bags fluttering in the breeze; crumpled cans of Emu Bitter. Every sign has bullet holes in it. A homophobic sticker on one sign reads, "Register Poofters, Not Guns! Before They Kill Us All!"

For hundreds of miles the only law is a police outpost at Eucla—and the law of the truck-driving man. Sunday, I've discovered, is the big day for westbound hauling, with drivers aiming for Perth first thing Monday morning. Every quarter of an hour or so another speck appears on the gray-blue eastern horizon, grows into a road train, and blasts by. Here comes *Stray Dog*, *The Bitch*, and *Pist-'n-Broke*, their handles

emblazoned on the plastic trim above their bull bars. A month ago one late-night cannonballer took out a herd of 16 wild camels near Norseman. The police had to come out to finish off seven crippled animals.

Monday, February 17
Caiguna Roadhouse

After a fortnight riding against stiff head winds, my shoulder's better than expected, but I've no doubt I'll hear from it on long winter nights. It was 112°F in the shade when I reached Caiguna, just on 11 a.m., Perth time. (The roadhouse hasn't troubled itself to adjust its clocks to central western standard time—an unofficial 45-minute time zone.) As J. Alfred Prufrock measured his life in coffee spoons, life on the Nullarbor is meted out in roadhouses, 11 tiny dollops of humanity a day or two apart by bicycle. They all look much the same: a cinder-block diner with gasoline pumps in front and a few motel rooms down the side. I drew satisfaction from ticking each one off on my map.

At Caiguna a sign greets thirsty folk: "Please don't ask for water as refusal often offends." The usual take-it-or-leave-it aggression hangs in the diner along with bumper stickers that read "I've been to Caiguna, the hub of the Universe" and tea towels with off-color jokes about Aussie blokes, beer, and bush flies. A T-shirt tacked on a bulletin board establishes the pecking order: "On the first day the Lord maketh Caiguna; on the second day He maketh the first truck; on the third day he maketh the first truckie; and for the rest He didn't give a $%#&*."

Tuesday, February 18
Camped near Cocklebiddy

A skittish southerly blew in off the Great Australian Bight late yesterday afternoon, and, after nursing overpriced sodas chez Caiguna, I started out for Cocklebiddy, about 40 miles away, prodded along by the wind. The land opened up to an empty immensity of yellowish knee-high grass; clouds scudded in, smothering the sun and throwing an eerie bluish cast on the landscape. The air felt unnaturally cool, so much so that kangaroos crowded onto the road, gray shapes basking in the warmth radiating up from the bitumen, and I had to stop riding for fear of colliding with them as they bounded in from the verge.

I made camp on a scabby piece of earth a few hundred yards off the road. Woke up twice in the night, first to cold rain splashing through my mosquito net onto my face, and next to the yapping of dingoes. I was just beginning to doze off again when there was a snarl close by—about an arm's length away. I lay awake for a long time, assuring myself that no wild dingo had ever attacked an adult human. The next thing I knew a feeble dawn light was filtering into my Gore-Tex cocoon. Another morning on the Nullarbor.

Surfing and body boarding are practically sacred rites at River Mouth Beach, where David Hohnen (below) and a clutch of others make their morning pilgrimage. When he's not catching a wave, Hohnen runs a winery, where I joined him and some friends one day for a barbecue (opposite). After too many roadside meals of meat pies and rubbery cheese, I'd almost forgotten there were such things as grilled shellfish, fresh fruit, and Chardonnay.

Saturday, February 22
Eucla, Western Australia

Southern Australia is in the grip of its worst hot spell in decades. Adelaide has just endured its longest heat wave since 1939, and there have been scores of heatstroke victims (and several deaths) in Melbourne and Sydney. Out here on the Nullarbor, birds are dropping dead, the highway is melting in places, and roadhouses have stopped pumping gasoline, which vaporizes in the heat. The past three days I've been marking time in Eucla. I can only guess at how lucky I am to be here at all.

The omens were there, if I'd been paying attention. Millions upon millions of flies swarmed down from the north, clearly desperate for moisture from any source. When I shook my head to clear them from my eyes, a rain of sweat sprayed out from beneath my helmet—which should have been the second clue: It was too early to be that hot. But I'd made a hundred miles the day before, and all I could think about was taking advantage of the still air to make another quick hundred.

I'd stopped for a drink 13 miles from Mundrabilla Roadhouse when

A camel, a wombat, and a kangaroo cross the road: It sounds like the setup for a joke, but there was nothing funny about the Eyre Highway. The main link between Western and South Australia, the route stretches for 800 miles across the Nullarbor

Plain but has only 11 roadhouses along the way. While I reveled at times in the solitude and the company of brightly winged parrots and other wild creatures, the place is so empty it can be truly unsettling. Out here, no one could hear a cry for help.

it hit, sounding like a runaway road train. A savage gust of heat tumbling down from the hills to the north rocked me back on my heels and left me rubbing my eyes in disbelief. I'd never felt air this hot. I stood a moment wondering what was happening to me, then realized with an oddly detached sense of amazement that this could actually be life threatening.

It took more than two hours to reach Mundrabilla, wobbling along, pausing every couple of miles to gulp a quart of water, trying not to think of a news item I'd heard on the radio weeks before: Motorcyclist drops dead in 113-degree heat in Simpson Desert. My legs ached, my temples throbbed. Like a dentist's pick, the withering gusts dug under the enamel, probing the stuff of character.

As I struggled, I grew angry, then irrational. This was a stupid country, full of stupid people. I began recasting my entire journey in this grotesque crucible, recalling and magnifying every slight, every rip-off, every driver who'd cut me off during the past 7,500 miles. Motorists who now tooted and waved encouragement as they zoomed by became smug air-conditioned bastards who deserved to be stranded out here with a boiled-over radiator. See how they like that. Toot toot.

The manager of the roadhouse was watching through the window as I staggered the last few hundred yards through a hot swirl of wind-driven dust. "God, you must be glad to get here," he said, when I came through the door. "This blew up out of nowhere. It'll go 120 today. Easy." I nodded and slumped in a chair. As the pressure in my temples eased, so did the anger.

The temperature reached 124 in the shade of the roadhouse veranda. "The heat's bad enough," grumbled one truck driver, who said his rig's

thermometer was registering an air temperature of 133, "but Jesus, that wind! I was making good time this morning and then—wham! Knocked off 20 kilometers an hour."

At dusk (temperature down to 98) I left Mundrabilla for Eucla. If you have to get stuck on the Nullarbor, Eucla's the place to be. It's the last of the family-owned roadhouses, a friendly joint built 30-odd years ago by Gedeminas and Pajauta Patupis, who emigrated from Lithuania after the war. It's clean, friendly, and you can get a fresh salad and homemade lasagna in the diner. Even so, there's not much to do in a truck-stop motel room except watch TV, play solitaire, and read. In three days I've worked my way through Agatha Christie's *Murder on the Orient Express*, 700 pages of James Clavell's *Tai-Pan*, and made a good attempt on the Gideon Bible.

My idle hours have given me time to think about this country and my place in it. In the past months on the road I've found an Australia I'd always hoped existed—spirited, funny, openhanded, often breathtaking. Oddly, though, the place I've felt happiest was up in the Kimberley among the drifters, the rootless, people who are just passing through. I suppose that's the feeling I've always had in Australia—that I'm just passing through.

This morning Rasa Patupis, who manages the roadhouse her parents built, heard about my plight and brought me several paperbacks and a satellite weather map faxed in from Perth. "Good news!" she said. "A southerly change is coming in tonight. Temperature in the low 80s for Eucla tomorrow." At last the massive high-pressure system that's been pumping hot air down from the Great Victoria Desert is weakening.

Maintenance man Derek Morgan lives and works at a roadhouse that straddles the border between Western and South Australia, hundreds of miles from the nearest hint of civilization. So do roughly ten other folks. The place was usually tranquil, despite UFO abductions, hapless creatures, nymphs on the Nullarbor, and other colorful bits of local lore.

Sunday, February 23
On the South Australia border

The billboard beside the caravan park reads: "Beware UFOs next 111 kilometres. We border on the unbelievable." There does seem to be some strange *X-Files* affinity between the terrestrial void of the Nullarbor and outer space. Just east of Eucla the highway makes a dogleg around a bomb-size meteorite crater, and the desert floor is littered with blackened gravel-size meteorites called tektites. In 1979 NASA's Skylab slammed to Earth west of here, and in 1988 a family driving across the Nullarbor claimed a flying saucer picked up their car and tossed it to the side of the road. I could use the help of some friendly aliens this morning. The cool southerly blew in all right, bringing with it a line of squalls, chilly winds, and a spiteful, stinging rain. The next town, Ceduna, is 300 miles away.

Saturday, March 1
Iron Knob, South Australia

Finished the Nullarbor. Celebrated with a dinner of a pound of sausages, half a pound of rice, a plate of steamed vegetables, a cantaloupe, a pound of cherry yogurt, half a gallon of fruit juice, and two packets of gingersnap cookies. Slept for 14 hours and woke up hungry. After breakfast—a box

of muesli, two pounds of cherry yogurt, half a gallon of orange juice, another cantaloupe, three cups of black coffee, and a toothpick—I left Ceduna, riding vigorously across the hardscrabble wheat country of the Eyre Peninsula. Covered 270 miles in two days. Late in the afternoon of the second day I decided to reward myself with the comfort of a night in a motel bed in Iron Knob, which I reached at dusk.

Waylaid by the flu, I spent a week recuperating at the home and workshop of Steve Gilchrist, a virtuoso craftsman of mandolins and guitars who lives in Warrnambool. Propped beside his woodstove, I sipped coffee while wind and rain rattled the windows. The stone spires off Victoria's coast are called the Twelve Apostles (opposite), but that week Steve Gilchrist was my savior.

Iron Knob is a low-slung jumble of fiberboard shacks and trailers with corrugated-iron roofs huddled in the weeds at the base of a gouged-out crag where workers mine iron ore. I walked my bike up the main street in the gathering gloom, looking for life. There were no lights on at the Shell Roadhouse, and the motel looked just as deserted. Although there were cars in the driveways, no lights glimmered, no Saturday night laughter drifted out of a doorway. Only the low, menacing growls of unseen guard dogs. I was about to turn back when I spotted a faded electric sign advertising West End beer. My heart lifted. A pub. Aussie pubs almost always have lodging for travelers.

I leaned the bike against a fence and stepped inside a cramped room cluttered with brewery company memorabilia, where a dozen or so locals on the downhill side of middle age were lounging against chest-high tables drinking and watching a British serial called *Heartbeat* on the television above the bar. A veil of cigarette smoke hung in the air. The buzz of conversation ceased abruptly. Nobody turned to look at me, but I had an impression that anybody in the room could, if asked, have described me down to the hole in the toe of my left sock. I made my way to the bar, where a lynx-eyed matron stood with arms crossed. She said:

"Yeah?"

"Do you have accommodation?"

She regarded me without speaking for about 30 seconds. I was about to repeat the question when I noticed her eyes flick past my left shoulder to field a signal from somebody behind me. She said: "*Yeah.*"

"What's the rate?"

Another flick of the eyes, another signal. "Twenty-five dollars." She threw it out as a challenge. It was a very steep price for a room in such a pokey pub, but I was in no position to dicker. I placed three tens on the counter. "Done. Is there anyplace I can park my bike?"

The woman looked at my money, then pushed the bills back at me. "I think you'd be better off at the motel. Why don't you go there?"

"Because it's closed."

"Folks that own it live just across the street. I'm sure they'd open up and give you a room. Why don't you do that?"

Road weary but determined to ride all the way around Australia, I hopped a ferry to Tasmania. At an open market in Hobart, where you could buy everything from used books to Elvis wall rugs (opposite), I was reminded how much cultural flotsam from the U.S. has washed up on Australia's shores. In fact Aussies joke that their country has become the 51st state. What a far cry from 15 years ago, when Oreo cookies were available only at gourmet food stores.

A heavyset, putty-faced man sidled up to me, very close, pointedly trespassing on the personal space we all like around us. He leaned farther into my face and said: "I think that'd be your best bet. Go to the motel."

A few seconds passed on tiptoe. Then I gathered up my money. "Sure. Why not?"

I'd met the odd bit of nastiness before (the Wooramel diner on the way to Perth, for one thing), but this was a really unnerving xenophobia. Iron Knob is dying, and I suppose the appearance of an American breezing into town must have thrown grim reality into intolerably sharp relief.

Back into the night, pushing my bike up the same darkened street with its sullen shacks, weedy lots, and snarling dogs. I found the motel owner's house, a beige transportable, as mobile homes are called in Australia; inside a radio crackled, but there were no live voices. I was tired, lonely, and more than a little worried by this time, wondering where to sleep on a windy night in the world's meanest town. Then, out of the corner of my eye, I saw a blue light I'd not noticed before. The police station. A sergeant named Trevor was just closing up for the night. He told me the police department had a children's camp on the edge of town. Clean beds, showers, a stove to cook on, a television to watch. "Oh, don't worry about paying anything," Trevor told me. "Get a good night's sleep and lock up when you go."

Now I'm stretched out on a sofa, cup of Lapsang souchong steaming beside me, listening to the wind rattle the branches outside. I'm beginning to think I know the answer to Einstein's great question: Is it a friendly universe?

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Monday, March 3
Camped near Gladstone, South Australia

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Six months of outback riding ended at a wall of purplish mountains rising above Port Augusta. I set out this morning to cross those mountains, the southern tail of the Flinders Ranges, over Horrocks Pass. Just below the pass I pulled over to look back on the flat drabness of miles of silvery gray saltbush, realizing with a sudden pang that this would be my last glimpse of true outback. On the other side is the gentled farm country of South Australia's "mid-north," bronzed in the late summer sun, with old towns such as Melrose and Murray Town every ten miles or so. I stood for quite a spell, playing back in my mind a fading cavalcade of people and places, then pushed up the hill feeling a vague sense of loss.

Half an hour later I was coasting past rippling wheat and shady gum

trees with a glow of anticipation. Laura and Ethan, my young ones, are less than a hundred miles from here.

Monday, March 17
Barossa Valley, South Australia

The grapes were ripe for harvest when I rode into the valley past acres of Chardonnay and Shiraz vines heavy with fruit, past stout Lutheran churches built by German settlers about 150 vintages ago. This is familiar turf. I used to live not 25 miles from here. But that house was sold almost a year ago. A different lifetime. The place I was looking for was a stone settler's cottage in the big-gum country south of the valley, where Laura and Ethan's mother chose to make her fresh start. I arrived a little before noon. Laura ran down to the gate when she recognized the rider coming up the road; Ethan was hesitant, walking with his Big Bird doll clutched close, a slow grin spreading across his face.

Being with my boisterous, playful kids again, I'm pleased their mother has brought them to this wholesome place, with its horse farms and two-room schoolhouse. I'm also saddened because even though I now have a deeper appreciation of what it means to be an Aussie, I know I can't live with them here. I also know that Australia will always have a claim on me through Laura and Ethan—as America will on them, even if they never have my accent. One day they'll see my New Hampshire in its full autumn colors, carve a Halloween pumpkin on the porch, and take in a Red Sox game with me, just as they now watch

the Adelaide Crows playing Aussie-rules football and go riding through the big Murray gums with their mother.

Wednesday, April 2
Warrnambool, Victoria

For months I'd enjoyed a rude good health, so when I woke up one morning with my head thumping and my throat on fire, I thought there must be some mistake. Along with cuddles and hugs, Laura and Ethan had passed along a wicked little virus. When I felt able to leave, I hadn't gone 60 miles before I knew the bug was still alive and well. I pressed on, my brain writing checks my body couldn't cash. Each day ended with shakes and chills, each morning brought a thumping headache and a sore throat.

Near the old whaling port of Warrnambool, on Victoria's shipwreck coast, a freezing rain blew in off the Indian Ocean. With no shelter on this exposed stretch, I fought hypothermia for three hours, talking to myself to stay conscious. I had an address in my pocket for Steve Gilchrist and the offer of a bed for the night. Steve is a mandolin maker, and I'd met his brother-in-law the night before at a hotel in Coleraine. I got to the Gilchrists in a state of collapse, shivering uncontrollably, my hands and feet numb. The next evening, Good Friday, Steve took me to the emergency room at Warrnambool Base Hospital with a fever of 104.

Steve, his wife, Christine, and their four kids treated me like family. I'll never forget waking up Easter morning to find that the Easter Bunny—or Easter Bilby as they say here—had left chocolates outside my door, a kindness that healed me in ways no antibiotic could.

In Steve's workshop, my recovery room, I looked through his library of books on rare and vintage mandolins, savoring the

scent of raw maple and spruce, listening to bluegrass music and the loving rush of sandpaper on wood as he labored over the final touches on a mandolin, while outside rain rattled on the windowpanes. In one book I found a passage about Steve himself, noting that he's considered one of the finest living makers of mandolins, with top bluegrass recording artists paying thousands of dollars for a Gilchrist. When I drew Steve's attention to this praise, he shrugged in that dry, ironic manner Aussies have when they're at the pinnacle of their profession: "Well, mandolin making's not a very big field, really." He also makes guitars. One former owner: Jerry Garcia.

Tomorrow I move on. My fever's broken, and the wracking cough is subsiding, but I still feel fragile as blown glass. A thousand miles to go.

Sunday, April 13
Melbourne, Victoria

Bass Strait was like a millpond (an unusual calm for what are reputedly some of the roughest waters in the world) as I pedaled along the Melbourne foreshore on a brilliant Sunday morning feeling almost well again after a ragged excursion into Tasmania. I used to ride this path to work at the *Sunday Age* newspaper from our 1920s-era bungalow in the bayside suburb of Elsternwick. I slid down memory lane: Pushing Laura in her pram down cracked, leafy sidewalks; the rattle of commuter trains; that nice Italian couple, the Mollucas, who lived next door; going down to a Jewish bakery called Aviv's on a Sunday morning to pick up warm poppy-seed cakes just out of the oven. The closest I'd come to feeling at home in Australia was here in Melbourne, maybe because Melbourne is the closest thing Australia has to a Boston, with its Old World shadows and old money patricians.

I had an inspiration. Up at the "Paris end" of town, on Spring Street and across from Parliament House, is a gracious 19th-century landmark called the Windsor Hotel. It's the epitome of the Victorian-era establishment, where green-liveried doormen wait by brass plaques to help you with your luggage. Like most locals I'd never stayed there. So I rolled up this morning and handed my bicycle to Neil, the doorman. "Would you park this for me? I'd like to check in."

Making history: I am the first person in the 115-year history of the Windsor Hotel in Melbourne to request valet parking for a bicycle. A haunt of the rich and famous—the nation's constitution was drafted in one of its suites—the Windsor gave me a badly needed chance to shut a brass-handled door on the world for a night and stretch out on a king-size bed.

Friday, April 25
Gundagai, New South Wales

To look at all the bronze doughboys, cenotaphs, and commemorative artillery in town squares around Australia, you could think this far-flung continent has been the crossroads for every invading army since the Peloponnesian Wars. At the bottom of each town's monument to Australian courage are the words: "Lest We Forget." Every April 25—the anniversary of the day in 1915 when the first Aussie troops waded into history (and a hail of bullets) on a Turkish beach near Gallipoli—the nation stops to mourn its dead and give thanks to its veterans. Anzac (Australian and New Zealand Army Corp) Day is a very big day, with well-attended

Waiting for a green light just outside Melbourne, I felt on friendly turf despite the crush of traffic. I used to live around here, and I cycled these streets to work every day. Yet Melbourne's urban riptide reminded me of too many years of

getting swept along with the crowd rather than finding my own way. This bike trip was a blessing because I finally had the freedom to let my days take shape around the weather, the terrain, my mood. I had time to dream.

dawn services, wreath layings, and parades in every town. These are not showy parades but solemn rows of silver-haired veterans in Sunday suits and regimental ties cheered on by thousands of compatriots.

It was still dark, with a hint of gray in the east, when I set off for the cricket oval where Gundagai was gathering before its dawn memorial service. The diggers, as Australians call their soldiers, mostly in their 70s and 80s, were clustered near the clubhouse. It was cold, the moon just off full. Conversation came in spurts of steam. "Ow ya goin', Jack?" a voice asked. "Aw, not bad, mate," the man named Jack replied, the words escaping from around the stub of a dead roll-your-own cigarette pasted to his lower lip. A row of campaign medals tugged at his lapel. I found myself making small talk with Stan Deal, who'd earned his chestful of medals flying Catalinas in the Pacific theater. "Stuff so secret they wouldn't even tell us what we were doing!" he recalled.

They held the memorial service in a copse of 80-year-old kurrajong trees planted in the shape of a cross to honor Gundagai's World War I dead. A sergeant nearly as old as the trees barked at his men to fall in, and they marched, stiff and proud, into position. A chaplain read the service. A bugler sounded the last post. There was a two-minute silence, broken only by the hoots of kookaburras.

Kicking back in Sydney, I finally closed the great circle of the island continent. What now? Get back on the bike and start all over again? That impulse grabbed me for a second, then let me go. As much as I had grown to love Australia, my mind was made up: I would go back to New England.

Sunday, April 27
Sydney, New South Wales

I'd wondered at the beginning of this adventure whether immersing myself in Australia, which I'd always kept just beyond arm's reach, might change the course of my life. I'm not sure yet. What I can say is that the journey has been a lot like growing up all over again, but this time as an Australian. I've absorbed so much from the people I've met, and from the land itself, and with the same sort of intensity I'd felt growing up in New Hampshire. If nothing else, 10,000 miles on the bike has shown me what a hold your childhood place can have. It helps make you the person you are, and when life gets rough, it's what draws you back. Perhaps if from the start of my time here I'd known the Australia I've come to know over the past months, things might have turned out differently.

I rode impatiently through the rich farmlands of New South Wales, covering 140 miles my last full day. Yet as I cycled along George Street toward Circular Quay, where my ride had begun more than nine months before, I found myself slowing down, not wanting to let go. Hardships faded, memories came unbidden: Booming along the Capricorn Highway with a glorious tailwind and three emus trotting down the yellow line in front of me; playing cards with Mick, Thommo, and Paul in the back room of Ash Colahan's motel along the croc-filled waters of the Gulf of Carpentaria; riding back to the homestead on Fairfield Station in Queensland, with three-year-old Mary Macintosh sitting on her daddy's lap singing as the dying rays of an outback sunset lit up her face. For a daft moment I thought about starting over.

I was about to call up an old friend to tell him I was back in town when a stranger stopped me with a familiar question, asked one last time: "Geez, mate, you're all loaded up! Where you off to?" I shook my head. "Nowhere, I've finished. I'm going home." □

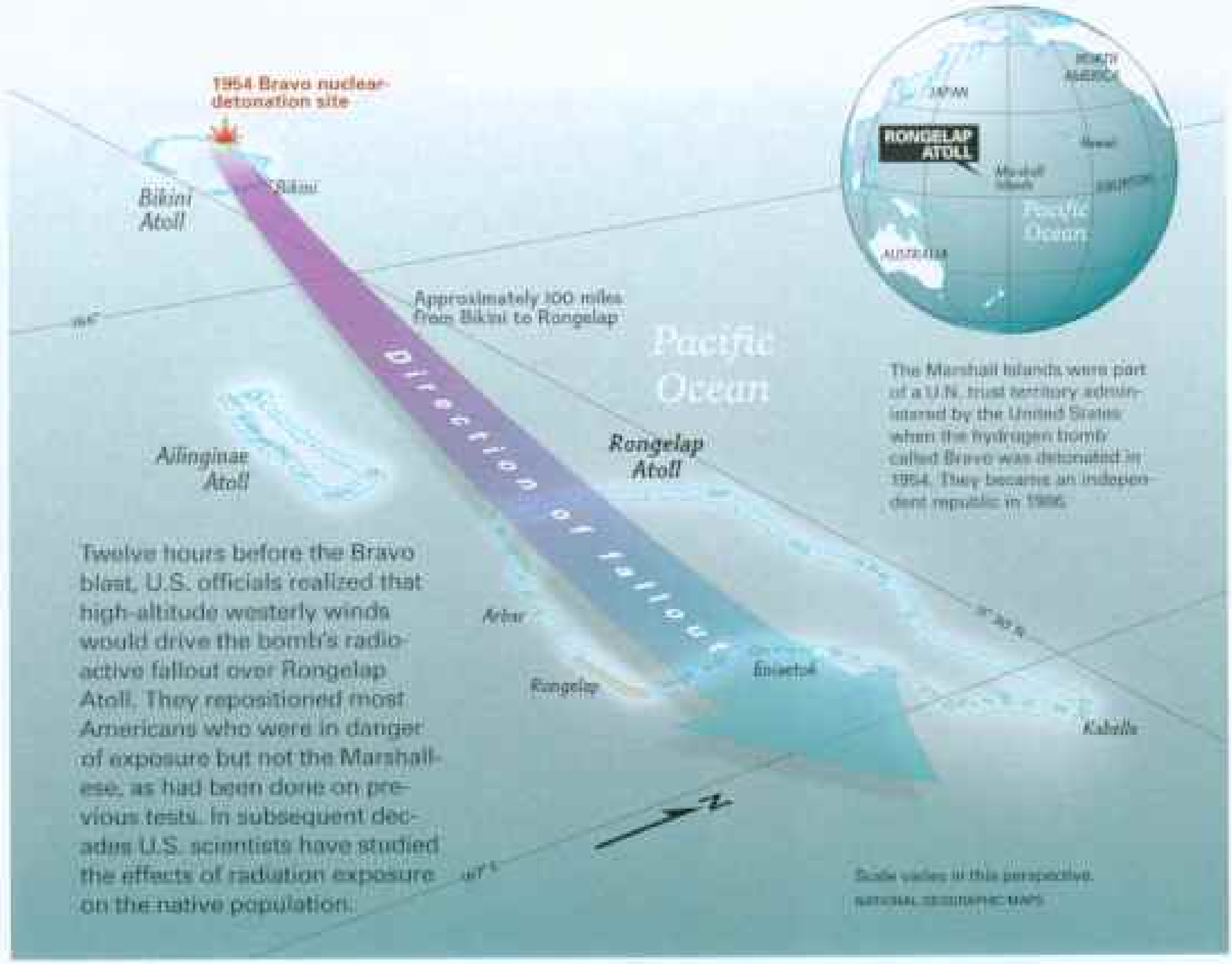
TESTING

THE WATERS OF RONGELAP

BY BILL CURTSINGER
AND EMORY KRISTOF

Missing its mark at 2,500 feet, a sixgill shark chomps the chain instead of the bait off Rongelap Atoll in the western Pacific. A nuclear weapons test contaminated these islands in the 1950s; Rongelapese who returned fled again in 1985, fearing continuing risks. How has the atoll's marine life fared? A GEOGRAPHIC team goes deep to find out.

EMORY KRISTOF WITH R. MICHAEL COLE, NGS STAFF


1954 Bravo nuclear-detonation site
Bikini Atoll
Bikini
Approximately 100 miles from Bikini to Rongelap
Pacific Ocean
Rongelap Atoll
Ailinginae Atoll
direction of fallout
Ailuk
Rongelap
Kwajalein
Kwajalein
Kwajalein

March 1, 1954: On a small ring of Pacific islands known as Bikini Atoll, the United States detonated a nuclear bomb a thousand times more powerful than the one that incinerated Hiroshima. This megabomb, code-named

Bravo (above), was one in a series of nuclear weapons tests conducted by the U.S. on Bikini in the 1940s and '50s. Radioactive fallout from the bomb landed on neighboring islands, including Rongelap Atoll, a hundred miles to the east.

Two days later, with radioactive "snow" blanketing Rongelap, the U.S. government evacuated 82 people. After three years residents returned, told that the islands were safe. But in 1985, faced with a disturbing number of abnormal births, thyroid problems, and other radiogenic illnesses, the Rongelapese left again. Assisted by the environmental group Greenpeace (below), they settled elsewhere in the Marshall Islands. Rongelap Island is now a ghost town (opposite).

The atoll's primary problem remains radioactive contamination. Cesium 137 permeates the soil and gets absorbed by plants and by the people who eat them. One proposed plan calls for the removal of the top layer of Rongelap's soil. Another possible strategy is to apply potassium to the soil, thereby inhibiting plants from soaking up cesium.

Accepting responsibility for the damages, the U.S. government established a 45-million-dollar trust fund in 1995 to help the Rongelapese restore their island and resettle it.

U.S. AIR FORCE/DEFENSE SPECIAL WEAPONS AGENCY (TOP); FERNANDO PEREIRA, GREENPEACE

Bill Curtsinger and Emory Kristof have photographed oceans worldwide for the magazine.

Flushed twice daily by Pacific tides, coral reefs and other aquatic life around Rongelap Atoll wear no visible scars from nuclear radiation. Yet there are reminders of the war that ushered in the nuclear age. Fifty feet down, an antiship mine bears a brass plate with Japanese characters. "To see it, we had to rub away encrusted algae and coral," reports photographer Bill Curtsinger. "I rubbed it once, very carefully."

BY BILL CURTSINGER

ALL BY BILL CURTSINGER

No fishermen have worked these waters since the last evacuation of Rongelap in 1985, and with fewer human predators fish have flourished. Huge schools of trevallies appear in a flash (above), then vanish into the blue. Remoras, lithe scavengers that feed on a wide variety of aquatic life, appear healthy too, exhibiting no ill effects from what little radioactivity remains in the food chain. "I've been floating around in the ocean for 50 years, and I've never seen so many remoras in one place before," says Teddy Tucker, a deep-sea fishing expert

(above). "I'd shake some bait out of my bag and they'd be all over me—my back, my arms, my legs."

Fortunately remoras rarely bite. Sharks, on the other hand, require a less intimate approach (right).

EMORY KRISTOF WITH R. MICHAEL COLE (ABOVE); BILL CURTSINGER

Safely behind bars, photographer Bill Curtsinger and his assistant, Eric Hiner, get photographed themselves by a remote control camera as gray reef sharks close in.

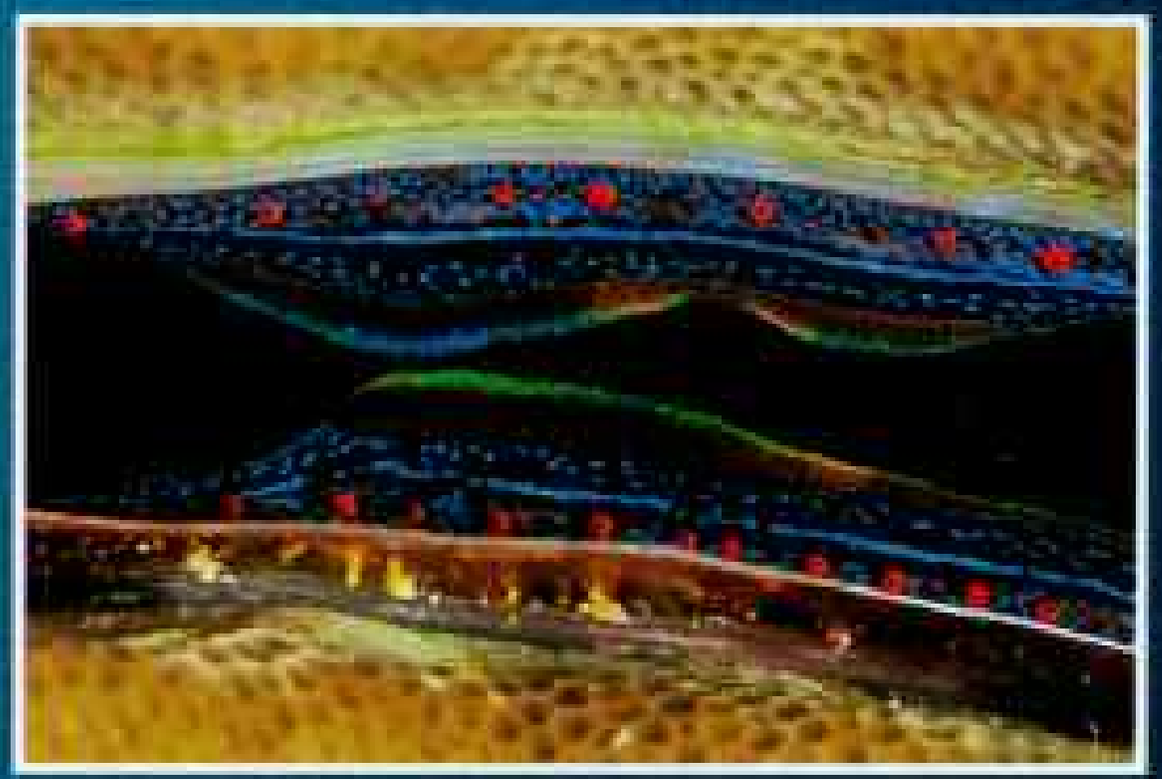
"They were so aggressive," says Curtsinger, "that I used my camera as a shield to keep them from sticking their heads in the cage." And they appeared in great numbers too, often cruising around the boat as soon as the team dropped anchor. "They're at the top of the food chain, and they looked healthy," says Curtsinger. "That's good."

BOTH BY EMORY KRISTOF WITH R. MICHAEL COLE

More than a mile deep, a four-foot slab of barracuda draws a crowd, including (left, clockwise from top left) a chimaera, a prawn, an eel, and a small shark. They disappeared when a Pacific sleeper shark showed up (above). "Superb!" beamed Emory Kristof when he realized he'd snared these images using a video "rope cam." Loaded in a cylinder and then dropped deep, the camera ran at programmed intervals, no matter what passed before the lens. "I'm like a fisherman," says Kristof. "I dangle bait and hope for a catch."

Lazy loops of wire coral swing with the tide on Rongelap's crowded reefs. Close inspection reveals the speckled eyes of a coral scallop (top inset) and tiny crown-of-thorns cardinalfish living among the spines of their namesake starfish. "What astounds me," says Curtsinger, "is that the nuclear blasts that rocked this region seem to have had no long-term impact on the marine life. The waters teem. Nature has prevailed." □

This expedition to Rongelap will be featured on National Geographic EXPLORER, Sunday, April 26, at 7 p.m. ET on TBS.



ALL BY BILL CURTSINGER

By LISA MOORE LaROE
NATIONAL GEOGRAPHIC SENIOR STAFF

Photographs by RANDY OLSON

HARMONY

The clatter of pickups and braying of hounds still sound through many an Ozarks town. Yet new chords are being struck by swarms of transplants who have "discovered" the natural beauty and hands-off freedoms of this heartland plateau. "We're facing the most profound change since the Civil War," says a local historian. That has some folks cheering—and others singing the blues.

EYES INTENT, Johnny Morris faced the gaping mouth of a cave newly discovered in the Missouri Ozarks. A roaring backhoe tore roots and rock away from the entrance as we approached with the caving experts who would guide us through. Morris, a native of the Ozarks who made his fortune founding Bass Pro Shops, owned this hole in the ground—and was about to become among the first ever known to enter it.

Earth thick as potter's clay sucked at our boots as we scaled a wall of mud at the entrance. We then descended a swinging wire ladder into the darkness. Our helmet lights revealed the first formations—gnarled stalagmites rising from clear pools. We crawled on our bellies to avoid snapping delicate soda-straw stalactites that dangled by the hundreds from low shelves overhead. Standing again we gazed in silence. Graceful calcite draperies, sculptures of striated flowstone, and nuggets of cave coral filled the underground chapel.

"Guys, I had no idea," Morris said.

This moment culminated five years of costly excavations and several dead ends for Morris, who had been obsessed with finding a cave on his land. "This is like catching a magnificent fish," he said. "I guess some treasures are meant to be found."

Once discovered, treasures often become tarnished. Inside that cavern, with one clumsy tilt of my head, I broke a thin stalactite that had been growing undisturbed for thousands of years. The cave was altered—however minutely—forever.

The Ozarks, a 60,000-square-mile wooded plateau that straddles the Missouri-Arkansas border and spills into Oklahoma and Kansas, has itself become an X on the map for treasure hunters of all types (map, page 83). They seek opportunity, escape, easy living, cheap land, natural beauty, fat fish, and few rules. So many are coming that the population is growing at a rate nearly twice the national average—an influx that is changing the cultural landscape.

Change is about as welcome as tick season in the Ozarks. Though kindness is quick, acceptance comes slowly. One longtime native summed it up: "You're only a stranger for five minutes, but you're a newcomer for 50 years."

Ironically, newcomers gave the Ozarks its name. Eighteenth-century French trappers and miners moving inland from the Missouri and Mississippi Rivers—the Ozarks' northern and eastern boundaries—used the shorthand "aux Arcs," or "to the Arkansas," as they headed for a settlement on the Arkansas River at the region's southern edge. Original inhabitants—Osage, Quapaw, and other Indians—lost ground as

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RANDY OLSON's previous assignments for the magazine include "County Fairs" (October 1997) and "Earth Day" (April 1995).

farmers and loggers came from the burgeoning East. These and other immigrant forebears brought the Scotch-Irish, German, and French traditions that still faintly flavor the hollows.

Little of that immigrant past remains in Branson, Missouri. Not much more than a bait stop 25 years ago, Branson got a boost in 1983 when Roy Clark became the first country music star to open a theater there. Other stars soon followed, and this little town of 3,900 has become the heartland's music-show capital. With more seats than Broadway, Branson is now the nation's number one tour-bus destination, host to nearly six million visitors a year. Like every boomtown, this one draws its share of dreamers.

"We had nothing to lose." Marie Haygood stood in the living room of her modest rambler on a Saturday morning, seven of her eight children in different rooms practicing music. A pretty woman with long blond hair, Marie recalled her family's hard days in Boerne,

Heartfelt patriotism shines in Branson, Missouri, during a weeklong celebration honoring veterans. The town's booming music industry has capitalized on love of God and country, held dear in the hardscrabble Ozarks hills.

Texas, living in a cramped trailer, playing gigs all weekend. A *60 Minutes* show about Branson in 1992 prompted the Haygoods to apply for work at Silver Dollar City, a popular area theme park. They were hired, and their lives went from hard to unrelentingly hectic.

The children—seven boys and one girl ranging in age from 4 to 20—sing, dance, and fiddle through four shows a day, five days a week. They tout their act as one of "faith, family, and freedom" (chords struck with varying degrees of sincerity in virtually all Branson shows). Between performances the kids fit in home schooling, music lessons, lunch, and autograph signings for fans, some of whom toss paper airplanes on stage with phone numbers scribbled

LIFEBLOOD OF A WILD LAND

To float the Buffalo's crystal currents is to feel embraced by a wilderness as unspoiled as dawn. Flowing free for 150 miles through some of

Arkansas's poorest counties, America's first national river carves sand-soft curves from banks fragrant with cedar. Sections rimmed by towering limestone bluffs echo the call of eagles. Says one local, "This is my church."

NEON AND SEQUINS ON THE MAIN DRAG

"Building a theater in Branson was the best gift I've ever given myself," says Andy Williams (right), who good-naturedly spoofs his elegant image by donning a Carmen Miranda gown to croon "Copacabana" to appreciative crowds. Branson's throngs—which helped Williams gross ten million dollars last year—jam "the Strip" (below) and seem to relish its overbuilt jumble of motels, music shows, and blazing marquees.

inside. Playtime is rare and bedtime comes early, part of the price of their dream.

"I want to see these children succeed," said Marie, who doubles as manager. We talked backstage as she gave four-year-old Aaron a violin lesson. Despite the hectic pace, there was still time for tenderness. Aaron stroked his mother's hair before she gently placed his hand on the bow. "My hair is long for him," she said. "It's his security blanket." As Aaron's cue approached, Marie led him toward the stage with a final instruction: "Let me see you smile."

BRANSON WORKS OVERTIME to prompt smiles from the graying hordes that brave its mind-numbing traffic. Prices are low, people are friendly, and entertainers work the crowds like politicians. At first I was won over by Branson's unabashed excesses, such as the ladies' room in the theater of Japanese violinist Shoji Tabuchi—a confection of purple chandeliers and potpourri that proved nearly as big a draw as the show itself.

But the dazzle soon becomes disquieting. Marquees blaze with names well past their prime: Bobby Vinton, Anita Bryant, the Osmonds. ("What's the difference between Branson and Jurassic Park?" quipped a local. "One's a theme park for dinosaurs, the other's a movie.") Eyes mist and flags unfurl during perfunctory patriotic finales. Motels flash "Vacancy" signs beside go-cart tracks and mini-golfs. New outlet malls, highways, and tract mansions eat through the hills. And billboards sprout like voracious weeds.

Repercussions from this explosive growth reach far past the edge of town. Compton Ridge is a sinuous wooded spine west of Branson where Lester Vining, born nearby in 1912, has lived for nearly 60 years.

"I used to drive the school bus up here," he said with a wink, showing me a picture of six children on a mule, young Lester at the head.

Kansas City
Kansas City
Independence
Topeka
KANSAS
Missouri
St. Louis
ILLINOIS
Jefferson City
Harry S Truman Reservoir
Lake of the Ozarks
MISSOURI
Lebanon
ST. JOE STATE PARK
1,772 ft.
St. Francois Mountains
OZARK NAT. SCENIC RIVERWAYS
Springfield
Joplin
Eminence
Winona
Poplar Bluff
KENTUCKY
McDowell
McClurg
Peace Valley
Branson
Bentonville
Eureka Springs
Clifty
Rogers
BUFFALO NATIONAL RIVER
Tulsa
Fayetteville
Berryville
Harrison
Hasty
Cave City
TENNESSEE
OKLAHOMA
Boston Mts.
ARKANSAS
Little Rock
UNITED STATES

A billowing American flag draped the kids' bare legs "so the girls' bloomers wouldn't show."

Outside his tidy white house Lester pointed to where cows once grazed and tomatoes grew in the days before Branson's glaring lights filled the valley. "We had homesteaders over there. They had coal-oil lamps. We knew when they went to bed, and they knew when we went to bed. And if a lamp was lit all night, we knew someone was sick."

Walking slowly in blue overalls and his summer straw hat, Lester—who calls himself "the last of the old hillbillies"—was like many Ozarks natives I came to know. Funny, hospitable, hardworking, plainspoken, and protective of his family, Lester clearly valued land above money. In the past few years he has turned down several lucrative offers for his hundred acres, half of which now lie condemned for a planned Branson bypass.

"We've had quite a fight on our hands," said Lester, whose family is battling the highway in court. "But you got to have a place to live and to pass on to your children."

One scorching summer day Lester and I walked to Evergreen Cemetery, founded in 1894. He has four generations buried there. "Here's where I'll go," he said, pointing beside the grave of his wife of 62 years. Nearby were two smaller stones—Jimmie Dale, Lester's only son, and Vera Elizabeth, a daughter. Each died of illness at age 11. As Lester stooped to straighten some silk flowers, I began to understand the tug of deep roots, why he won't sell at any price.

THE OZARKS' RUGGED LAND was born of an ancient sea, its uplifted floor untouched by scouring glaciers that stopped to the north. Eons of erosion carved deep valleys into this crusty limestone and dolomite plateau, transforming its flat surface into an unlikely roll of hills. They march nearly level into the distance and peak

HEAVEN FOR RISING AND AGING STARS

Handling chaos like seasoned pros, five of the eight musical Haygood children prepare to perform at a Branson theme park. "We get a lot of cheek pinchers" in the crowd, says Pat (seated), who uses self-discipline and humor to handle stage life. His goal: "to make it to the top and stay there." Tony Orlando (below) made it in the 1970s and today draws crowds in Branson. "Stars aren't untouchable here," he says. "It's very homespun."

at 2,578 feet in Arkansas's Boston Mountains.

This scrappy landscape is riddled with caves, springs, and sinkholes. Streams vanish suddenly into pebbled creek beds and groundwater lies deep within porous bedrock. Pollutants can travel miles a day through this spongy karst (versus a few feet a year in non-karst aquifers). That speed puts wells and rivers at risk from the harmful by-products of the Ozarks' main industries—poultry, logging, tourism, cattle, and lead mining.

The nation's largest lead belt snakes through the Missouri Ozarks. Called the Viburnum Trend, its richest ore could be spent in 15 to 30 years. Seeking new deposits, the Doe Run Company, which has mined here for decades, has requested permits to do exploratory drilling in the Mark Twain National Forest near Winona—a karst area whose watershed feeds some of the nation's purest springs and rivers.

State environmentalists are concerned about new lead mining there. "If they dump tailings in these karst valleys, lead and other heavy metals will leach out, and that could expose springs and wells to harmful concentrations," says Missouri hydrogeologist Tom Aley.

Doe Run president Jeffrey Zelms—whose company employs 1,200 people in the state—says that if Doe Run did open a new mine, "we'd have to pass muster for tailings disposal and assure that there's no groundwater contamination."

Water ripples across the Ozark Plateau like laugh lines on an aging face. Each year millions of people fish, float, and camp along the area's plentiful shores. Strung across the Missouri-Arkansas border is a glittering strand of five lakes—Beaver, Table Rock, Taneycomo, Bull Shoals, and Norfork—formed as dams dissected the White River beginning in 1913. Their placid coves are an angler's haven. But it's the untamed Buffalo River to the south that most captures the Ozarks' raw beauty.

Named America's first national river in

LIQUID REFRESHMENT

Caressed by the current and summer's warmth, friends end a day on the Jacks Fork river—a 34-mile stretch of Missouri's spring-fed Ozark

National Scenic Riverways. "It's wild and free," says Julene Willman (in sunglasses). So were those who once survived off this rugged karst land—from trappers and loggers to farmers coaxing crops from rocky soil.

1972, the Buffalo flows free for 150 miles through northern Arkansas, changing from torrent to trickle with the seasons.

On an April day its tug was strong as I put in at Steel Creek near Ponca. My guide was Mike Mills, an outdoorsman whose cap shaded mischievous eyes. Like the river, he was full of surprises. "Screamin' eddy!" Mills roared as we bobbled down a rapid toward a rock. We plunged our paddles into the current on opposite sides of the canoe and pulled hard toward the boat, a draw stroke that instantly spun us 180 degrees into the calm of the rock's eddy. "Not bad for a beginner," he said.

Along a gentler stretch I gazed at the limestone bluffs that rose more than 200 feet straight up from the river's edge. Painted gray and gold by algae and minerals, the rock wore a cap of cedar trees. Ledges dripped with moss and wild pink azaleas. Turtles and water snakes sunned on logs, and rock bass darted through currents clear as air.

Four miles downstream we beached the canoe and walked to an abandoned cabin overtaken by weeds and cobwebs. Hand-hewn beams still showed ax scars. Curling yellowed newspaper dating from the 1950s covered the walls. As we ate lunch on the rotting porch, Mills recalled the days when private land along the Buffalo was bought out as the federal government converted most of the river to a national park. Restrictions were placed on land use within park boundaries, and many owners left their homes. "There's hostility and bitterness still ingrained in some people," Mills said.

Farther downriver we stopped again for a trek to Hemmed-in Hollow, site of the tallest waterfall between the Rockies and the Appalachians. The 200-foot rope of water whipped like a lariat in the rising wind of a thunderstorm. We ducked under a ledge as hail pelted the hollow. A frog started to croak, tricked by the night-dark sky. "Oh, he likes this," said Mills, clearly enjoying the show himself.

TOE TAPPING AND TOURIST TRAPPING

"It's like a family reunion," says young Levi Roden (left), who jams with friends at the biweekly hootenanny in McDowell, Missouri. Levi plays by ear a hundred old-time fiddle tunes native to the Ozarks hills. For him, mountain music heals the soul: "It sounds happy, like you want to dance." Visitors are more likely to hear Mozart in Eureka Springs, Arkansas (below), an artsy town made famous in the 1880s by its healing waters.

LEAVING PONCA, I drove east along Route 74. Like most roads in the Ozarks it was a steep twister with subtle beauty around every bend—a weathered barn, a running foal, a pond catching the blush of twilight. It led to the town of Jasper in Newton County, Arkansas, which gets my vote for America's quirkiest county seat. Within a few hours of my arrival I had been offered a bootleg beer (it's a dry county), had fed peppermints to a 500-pound cinnamon bear (pet of a local innkeeper), and had eaten berry cobbler with a California recording executive turned astrologer, whose hand-built home was an elfin fantasy of wood and wildflowers.

I felt at home in Jasper. Nearly everyone I met was from somewhere else. Most had come seeking the middle of nowhere. They found it.

"This strikes me as the most primitive place left in America," said John O'Keefe, who with his wife, Nancy, moved here six years ago from Austin, Texas, to run their employment business by phone. Their rambling porch overlooks a silent valley. "Oh, there's plenty of noise during full moons," said Nancy. "Whippoorwills, coyotes, lots of howling."

Unlike much of the rest of the Ozarks, Newton County, Arkansas, is barely growing. National forest and parkland cover more than half its 822 square miles. There are no stoplights. Thirty percent of the people live below the poverty level, some of them by choice.

Herb Culver and Karyn Zaremba-Culver made that choice. A quiet couple with a passion for trees, they live in a three-room cabin on private land within the Ozark National Forest. Their home has the haphazard look of a child's fort, cobbled together from scrap lumber and old stones taken from the root cellar of an abandoned homestead. A woodstove supplies heat. Rain and a well provide water. Sunlight fuels the batteries they use for power.

Afternoon shadows dappled the ground as we walked toward their grocery—a carefully

tended garden sprouting sage, onions, lettuce, peas. Herb, who moved from Indiana in 1988, paused to admire a favorite umbrella magnolia, then guided me past the delicate showy orchids that grow here in abundance.

"This is my place," he said, to explain the allure of the woods. It's a place that he feels is threatened. "I believe there should be no logging on public land," said Herb, who, with Karyn, lobbies against clear-cutting and the spread of chip mills, which are moving into the state. "But you can't just cut it off," he added. "A lot of people here depend on it."

John Phillips is one of those people. Owner of one of the 25 sawmills in Newton County, Phillips worries about what he calls the "environment problem"—attempts by environmentalists to find and use endangered plants to prevent logging in the Buffalo River watershed. "Well, maybe those plants need to survive, but us folks need to survive too," said Phillips. "Without the timber industry, there wouldn't be much to do here. There's a happy medium, but we're not coming to it yet."

I SAW FAITH, contentment, grit, and humor in many who had found their dream in the Ozarks. The wizened farmer who constructed a brush arbor for revivals because "the Lord told me to build it." The former college professor who extolled the "fine piece of oak" on his outhouse seat. The urbane herb grower who strolled with a cellular phone and sold "dream pillows"—pouches stuffed with herbs to induce sweet dreams. "It's OK to be in business and enjoy yourself," he said.

It's OK to quit business and enjoy it here too, as growing numbers of retirees attest. Lured by low costs, low crime, gentle weather, and abundant beauty, retirees from around the nation are buying lots newly carved from the Ozarks hills. "Our buyers are from states that have a lot of problems, from mud slides to earthquakes to gangs," said Bay Biossat, a real estate

SOMEBODY'S GOTTA DO IT

"It's dusty, dirty, stinky, and you get a lot of scratches," says William Patrick (left), whose crew clears an Arkansas chicken house in two hours, tossing 18,000 birds into hoppers to be forklifted onto trucks. More broilers come from Arkansas than any other state in the nation—and more lead comes from Missouri. At St. Joe State Park tailings piles from abandoned mines challenge riders unconcerned about possible health risks from lead dust.

agent in northwest Arkansas, where a three-bedroom lakefront home sells for $150,000—a fraction of its California counterpart.

It didn't surprise me to learn that this corner of Arkansas is one of the fastest growing regions in the country. Driving along Route 71 from Fayetteville to Bentonville, I passed a bumper crop of new roads, malls, and houses. Trucks roared past bearing the names of area blockbuster companies—Wal-Mart, J. B. Hunt trucking, and poultry king Tyson Foods.

Poultry powers the economy here. More than 13 million chickens are produced in Arkansas each week by several firms. The resulting manure and processing wastes have tainted area waterways, in some cases making well water unsafe to drink. But the industry accounts for one of every 12 jobs in the state, and long metal chicken houses lie across the land like toppled silver dominoes.

"Come on babies. Mama's comin'." Karen Robertson coos to her chickens during her daily rounds. One of roughly 2,400 Tyson contract farmers in Arkansas, this exuberant woman allowed me to join her early one morning on her farm near the town of Clifty.

Wearing white paper face masks to screen out swirling dust and feathers, we entered the first of her four chicken houses. Some 25,000 six-week-old birds skittered and clucked. Our task: To pick up the birds that had died in the night of heart attacks from overeating.

We walked slowly so scattering birds wouldn't pile up and smother. I grabbed the cold fleshy feet of a splayed-out bird. Then another. Four per hand. We threw them in a green cart and went back for more. The birds we collected would be frozen and ground for feed. Others were "culls"—barely living runts that wouldn't make it. Karen picked these up by the head and, with a few rapid twirls, wrung their necks. After 32 years of raising chickens, the task still makes her wince.

Outside, soaked with sweat, we peeled off

FULL-SERVICE FILLING STATION

Sure, they pump gas and fix flats at Perkey's gas station in Cave City, Arkansas. They also supply a makeshift meeting place. "On cold or rainy

days it's all you can do to get in the door, there are so many people talking and telling hunting stories," says attendant John McSpadden (above). Art Ozarker, he says, is "a person willing to help you any way he can."

DOWN HOME AND DOWN UNDER

Married 57 years, retired dairy farmers Earl and Versie Henry (right) enjoy selling homemade molasses from their home in Hasty, Arkansas. "It doesn't make a lot of money, but it makes a lot of people happy," says Versie. Seeking more novel joys, wealthy Coloradans bought a nearby cave and turned it into a million-dollar home. Say caretakers Jim and Diana Setters (below), "If you get bored, you can go spelunking."

our masks and sucked in the fresh air. "Do you enjoy this, Karen?" I asked. "I love it or I wouldn't be a-raisin' 'em," she said, walking briskly to the next house.

NOT FAR FROM THE HEART of poultry country lies the Ozarks' eccentric soul. Eureka Springs became famous in the 1880s for its mineral waters, said to cure all ills. Today's arrivals seek not cures for chancres and boils but escape from convention and boredom. A combustible mix of religious fundamentalists and gays, artists and entrepreneurs, New Agers and old agers all stake a boisterous claim.

"There's very little mainstream anything here," said Beau Zar Satori, who runs a gallery in town. Wearing black clothes and a long braid, he talked of his controversial vision of a historically pure Eureka Springs and railed about the commercial schlock that now lines the highway above the city's core. Despite this feud with local developers, Beau loves his home. "There has always been magic here."

Many a disappearing act has enlivened the Ozarks hills. The region was a hideout for Jesse James, Bonnie and Clyde, and other outlaws drawn to deep hollows where the law rarely treads. Even peaceful citizens have a tradition of bending the rules. Many older natives recall how the profits from moonshine stills helped feed families during the Depression.

"Back in those days it was quite a bit of help," said Joe, who still brews his own supply just because "it's interesting." I joined him one afternoon in his cramped basement, where sweet, heavy air rose from a stone crock of corn mash. At the still, clear liquid dripped from copper tubing through a charcoal pouch into a jar. I took a sip. It was surprisingly smooth. Joe poured the day's labor into a glass jug and confessed, "I still like peach the best."

Today's moonshine is more likely illegal drugs produced for personal use and extra

cash. Methamphetamine labs have popped up throughout the region. And folks of all ages readily admit that they smoke or grow marijuana. One man talked of "guerrilla patches"—plots small enough to escape the notice of federal helicopters that search for pot to burn.

Curious about the region's history of bucking authority, I spoke with Robert Flanders, former director of the Center for Ozarks Studies at Southwest Missouri State University. "The Ozarks is a semi-arrested frontier, where people have resisted the transition to full government regulation," he said. "It's not that they're antimodern. It's just that they want to take modernity on their own terms."

Nowhere was this I'll-do-it-my-way attitude more potent than in Shannon County, Missouri. And nowhere was it more unsettling. Natives expressed fierce pride in being born and raised there and fierce resentment of bureaucratic regulations. Building permits on private land are virtually unheard of. "If you own it, you do what you want," said one local. Such freedom appeals. But while this is a fine place to be from, it's no easy place to come to.

Bill and Michelle Bryson learned that the hard way. Anxious to escape the crime and congestion of Anchorage, Alaska, they bought (sight unseen) a 280-acre spread in the town of Eminence, packed their two kids and their belongings into a blue school bus, and drove into town. "It was like moving back in time 40 years," said Bill, a big man with a ruddy beard and bright eyes who I met on a visit a few years ago. Clattering down the road in his pickup, Bill bemoaned the long drives to a movie, the lack of leash laws for ubiquitous dogs, the open sewage lagoons used for water treatment. But he said he loved the beauty of Eminence, the low taxes, the challenge.

"I wanted to do some trappin' on my land," he said. "That got all the huntin' dog owners upset. The buzz goin' around town was that I was gonna trap dogs, and they'd have to take

SIMPLE PLEASURES

Family and rural freedoms—to pull a hay cart into the shade, to rest, to dream—drew Jim and Judy Protiva to Peace Valley, Missouri, where

they manage a hundred-acre farm. The couple and their three children dress and live simply, fed by their land and their faith. "If we don't complicate life," says Judy, "we have quiet time to listen to the Lord."

care of me. My mailbox was bashed in. That's how they settled things around there. To them I was just a damn foreigner who wouldn't get along." The Brysons eventually sold their farm and moved out of state.

THROUGHOUT THE OZARKS I sensed a mix of tolerance and intimidation. Most startling was the widespread prejudice, particularly against African Americans. "We're free of 'em" was a common sentiment I heard in the region, which is 98 percent white—a draw to some newcomers fleeing racially mixed areas. Some Ozarkers expressed concern about the influx of Hispanics who are coming to work in poultry and other industries. "It's putting a strain on society, and it's not fair to the taxpayer," says Dan Morris of Rogers, Arkansas, who in 1997 founded AIM—Americans for an Immigration Moratorium.

Yet Nelson Lara gave me hope that the Ozarks will adjust to its changing face. Raised in El Salvador, Lara worked in Los Angeles before moving to Rogers in 1993. "I've never experienced any kind of discrimination here," said Lara of his newly adopted town, which is now 12 percent Hispanic and offers radio, television, and church services in Spanish. In less than three years he saved enough to buy a home for his family. "That wouldn't even have been a dream in California," he said.

Overall I found far more harmony than

BEAR-KNUCKLE BRAWL

Dodging a playful swipe, Larry Visnosky tangles with his pet bear, Coco, in Arkansas's Little Buffalo River. "His natural instincts come out when he gets exhilarated," says Visnosky. The Ozarks, too, faces a challenge: to harmonize with newcomers while keeping its regional voice.

discord in the Ozarks. Some of the sweetest notes sprang from the Notch Community Church in Missouri. Strumming a guitar, a preacher welcomed two dozen of us to a nondenominational service. "Does anyone have a special occasion to share with us today?" he asked. I told the group that I had just celebrated my first wedding anniversary. The preacher struck a chord, and everyone sang "Sweeter As the Years Go By," a gift to me, a stranger.

Music is as fundamental to the people of the Ozarks as water and earth. In many homes a cherished fiddle or guitar lies ready for the playing. At Bill and Doris Graves's home near Lebanon, Missouri, that honor went to an old dulcimer made of cherry and apple wood, which Bill struck with a turkey quill. ("A quill from a left wing feather is best," he said.) As he played, Bill and Doris sang a duet: "All the good times are past and gone. . . ."

Such dulcet sounds—like much of the old mountain culture in the Ozarks—are fading. "Traditional music is very fragile," said Gordon McCann, an amateur folklorist who has recorded and played with Ozarks musicians for 30 years. He worries that the region is being "mainstreamed"—homogenized by an influx of newcomers and mass-media culture. "You may be seeing the last of the old ways."

McCann took me to McClurg, Missouri, population six. The town has dropped off the map. But here, every Monday night, Ailene Adams welcomes friends to a "music party," which she holds in the country store that she and her late husband ran for nearly 50 years.

Evening shadows painted the fields as neighbors arrived with corn bread, slaw, and tattered fiddle cases. By nightfall some 30 musicians and friends were tapping their feet on the worn wooden floor. They played "Tennessee Wagoner," "Soldier's Joy," and other ageless melodies as treasured as family heirlooms. I asked Ailene why she has hosted this for 12 years. "These people are my family," she said. "I don't go to Branson. That's a show. This is from the heart."

I walked outside. The moon and stars shone undimmed by city lights. Through open windows an old fiddle tune beckoned. I danced barefoot in the damp grass, which shimmered in the glow of the porch light. My arms opened wide for an imaginary partner—and were filled with the Ozarks night. It was a fine but fleeting embrace. No young musicians played inside, to learn and keep alive this music. Just 25 miles to the west, Branson quaked with countrified pop that blared from monstrous speakers. Suddenly this simple McClurg gathering, which so defined traditional Ozarks culture, seemed as fragile as a thin stalactite—soon to be snapped. □

THE RISE OF LIFE ON EARTH

Life grows up

By RICHARD MONASTERSKY
Photographs by O. LOUIS MAZZATENTA

Racing the morning light, Guy Narbonne scrambles up a canyon wall in the Flinders Ranges of South Australia. Glare from the rising sun spills into this narrow mountain valley, called Bathtub Gorge.

Our footsteps startle a rock wallaby—a pint-size relative of the kangaroo—which hops up the rough slope and out of view. I skirt clumps of porcupine grass, whose needle-sharp leaves puncture my clothes and break off in my skin. Yacca shrubs send up spear-like flowers seven feet high; their fuzzy tops glisten with nectar. I collect a dead stalk and use it as a walking stick in the style of the Aborigines.

Narbonne runs past the Australian wildlife, angling instead toward the red sandstone layers above. Our guide, a tall Australian named Jim Gehling, calls out

A frond-shaped organism swayed beneath the waves 550 million years ago, anchored to the seafloor by its circular holdfast. Paleontologists like Ken McNamara of the Western Australian Museum, above, believe fossils from this period, known informally as the Ediacaran (pronounced Ee-dee-AK-aran), provide the first evidence of the existence of large, multicellular life on Earth.

CHARNIODISCUS ARBOREUS, 18 IN LONG

Fossil stromatolite mounds—built up on an ancient seafloor from sediments trapped in mats of bacteria and algae—dot Namibia in southwestern Africa. University of California paleontologist Mary Droser hunts among them for fossils of tiny *Cloudina*, the earliest organism known to have built itself a mineralized shell.

MAMMOMITES SPRIGGI, 8 IN WIDE

KIMBERELLA QUADRATA, .55 IN LONG

POSSIBLE "PROTOSTROBOS," .46 IN LONG

PARVANCORINA MINCHAMI, 1.1 IN LONG

Scientists debate whether *Mawsonites* (facing page) was an ancestor of familiar beasts or a strange, fluid-inflated organism unlike anything alive today. They generally agree, though, that other fossils (above) and a burrow (below) were made by equally old creatures related to living starfish, crustaceans, and worms.

directions from the valley floor. "Hurry up. You're just about to lose the proper light," he warns. "Keep climbing until you hit your head on that big rock. Then look up. You have only a few minutes left before the fossils disappear in the shadows."

For paleontologists like Gehling and Narbonne, Bathtub Gorge is hallowed ground: It holds stunning samples of Ediacaran fossils—the first large multicelled organisms to populate Earth. Reaching as much as three feet across, these pivotal species lived between 600 million and 540 million years ago, at the close

WORM BURROW, 3 IN LONG

of the Precambrian. Their appearance, which ended three billion years of domination by bacteria and other organisms too small to see, set the stage for the evolution of large animals, including humans.

Ediacaran fossils range in shape from spoked wheels and miniature anchors to corrugated ribbons and lettuce-like fronds. The first few examples turned up in England in the mid-1800s but went ignored until Australian geologists unearthed an arkful of fossils at a site called Ediacara (pronounced Ee-dee-AK-ara) in the late 1940s. Scientists proclaimed them jellyfish, soft corals, and worms—the long-sought ancestors of the creatures that slither, scuttle, and soar across the globe today. But new finds and alternative ideas are toppling those old assumptions. "A short time ago we thought we knew

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RICHARD MONASTERSKY, a writer at *Science News* magazine, reported on "The Rise of Life on Earth" for the March 1998 NATIONAL GEOGRAPHIC. Photographs by O. LOUIS MAZZATENTA, a former senior assistant editor, also illustrated that story.

how these organisms related to modern animals. Now we're not so sure," says Narbonne, of Queen's University in Kingston, Ontario.

Some of the Ediacaran fossils were undoubtedly small, mobile animals—the oldest known representatives of our own kingdom. Others, though, belonged to a bizarre array of flat-bodied species that flourished briefly and then disappeared, leaving so few clues that paleontologists don't know how to classify them. Both dwelled in an age of ecological innocence, before predators started cruising the oceans, before animals acquired defensive shells and hard skeletons, before the world had sorted itself into hunters and hunted.

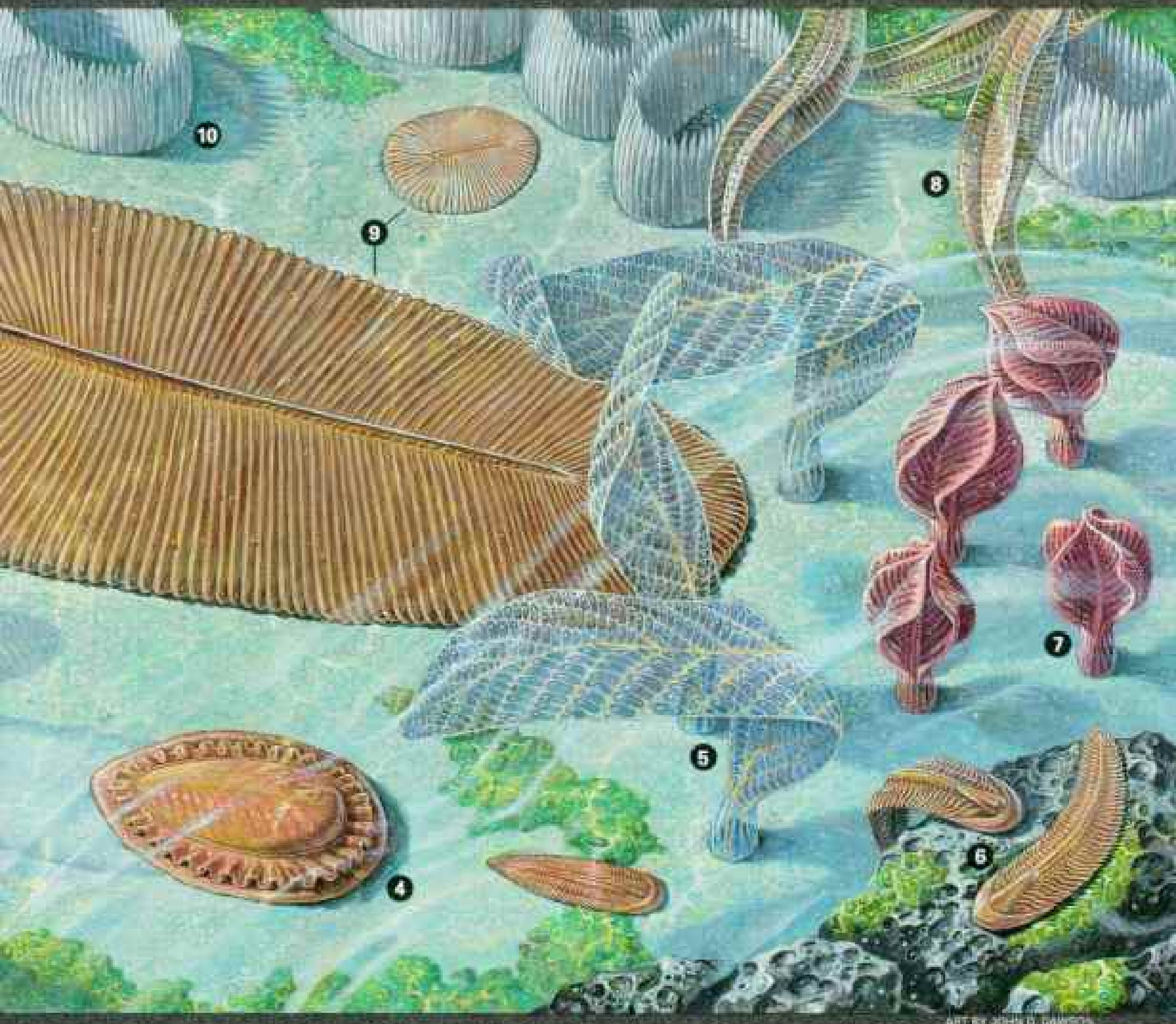
Ediacaran fossils hold the key to understanding the origins of animal life. "This is one of the hottest topics in paleontology today," says Narbonne. In recognition of the importance of the Ediacaran creatures, a committee of experts will soon carve out a space for this period on the official international geologic time scale. For geologists this is more important than adding a new state to the union. The last time they established a geologic period was back in the 1870s.

IT IS THE QUEST to decipher these fossils that propels Narbonne and me up the wall at Bathtub Gorge. We arrive just as the sun grazes the surface of the rock. Only during these brief moments, in early morning and late afternoon, do the subtle fossils come out of hiding. Narbonne, a compact, balding Canadian, reaches the fossils first, huffing from his climb. He motions me alongside him and points at the sandstone, eager for me to see. But the surface looks blank. I stare hard, my brain searching for a pattern. Slowly, faint imprints materialize in the grainy rock.

The first fossil I discern is an oval about the size of a half-dollar, with ridges radiating from a central line. Called *Dickinsonia*, it resembles a miniature version of the footprints that Apollo astronauts left on the moon.

Narbonne doesn't bother with this small specimen. He is gawking at a granddaddy *Dickinsonia* as big as a welcome mat.

"When this was alive, it would have lain like a flat sheet on the sea bottom. It might have absorbed nutrients directly from the water. Algae may have lived within it, helping harness the sun's energy," says Narbonne. "It couldn't



ART BY JOHN D. GARRISON

A peaceable kingdom

Between 600 million and 540 million years ago, no predators hunted with claws and teeth; softer lifestyles prevailed. Russian paleontologist Mikhail Fedonkin calls organisms attached to the bottom like *Tribrachidium*, 3, and *Rangea*, 7, "economical." They may simply have feasted on plankton that drifted by in abundance. The large body surfaces of others may have served as greenhouses for colonies of photosynthetic bacteria that functioned as internal food factories. Small, mobile *Kimberella*, 4, probably grazed on bacterial carpets growing on the seafloor.

This illustration shows representatives of some of the world's widely scattered Ediacaran species. No one site preserves all the organisms shown, and though *Ernietta*, 10, for example, occurs in clusters, other species are found more widely dispersed. Did *Pteridinium*, 8, rise up from the seafloor? We're not certain. Specimens as long as two feet are known, but none has both ends intact. Did *Phyllozoon*, 2, undulate freely through the water, or was it anchored? Again, the evidence leaves room for debate.

"So much rock, so little time," sighs Australian paleontologist Jim Gehling (below, at right). Scanning the rough mosaic of 550-million-year-old sandstone that paves southern Namibia, Gehling noticed promising traces on a cracked slab. A gentle nudge with a pry bar (right) revealed a tangle of the bizarre three-bladed organisms called *Pteridinium* (below). Many Namibian fossils are preserved in three dimensions, unlike the flattened impressions found elsewhere. "To understand these enigmatic creatures," Gehling says, "we have to study them in as many geological settings as possible."

swim. It probably couldn't even crawl. It was a strange and beautiful creature that apparently disappeared 540 million years ago without leaving any modern relatives."

I reach up and run my finger along the rippled fossil, trying to imagine the creature that left this imprint in the shallow seabed—a grand but ultimately unsuccessful experiment in evolution. Suddenly the rising sun plunges the overhang into shadow. The fossil, now too faint to see, fades back into the rock.

BEFORE THE EDIACARAN SPECIES took over 600 million years ago, evolution worked mostly on the microscopic scale. Bacteria and other microorganisms appeared between 4 billion and 3.5 billion years ago. Algae emerged more than 1.5 billion years ago, followed sometime in the next billion years by the single-celled forerunners of animals. Throughout this vast stretch of time, life remained small and simple, kept in check by a lack of oxygen. The oceans and atmosphere held such scant quantities of this vital gas that they couldn't support the evolution of larger organisms.

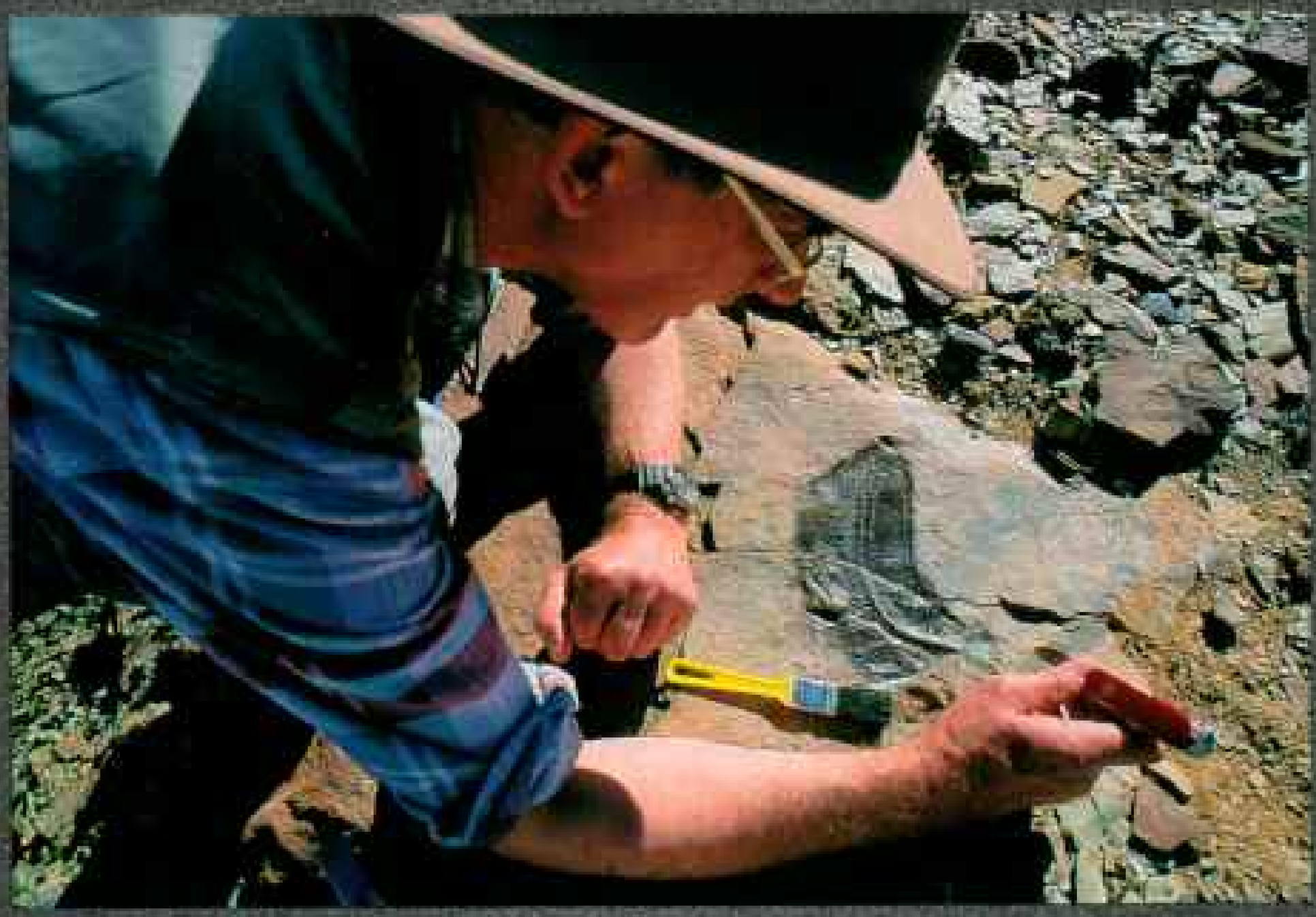
A billion years ago all the continents were glued together into a single enormous realm called Rodinia, a landscape with no trees, shrubs, grasses, or even mosses. It was a drab world of rock and sand. The most vibrant color came from the green scum growing in lakes and ponds.

About 750 million years ago Rodinia started tearing apart at the seams, breaking into smaller continental chunks. Over tens of millions of years some of these slammed back together, shoving up Himalaya-size mountain ranges, rerouting ocean currents, and rewiring Earth's climate. These convulsions triggered as many as five ice ages, coating much of Earth with ice.

The shattering of Rodinia had profound effects on the evolution of life. It eventually infused the seas with oxygen, allowing organisms to break through the size barrier. "As oxygen levels rose, there was the potential for the proliferation of animal life," explains Richard Jenkins, a paleontologist from the University of Adelaide, who takes me to see where the Ediacaran fossils first captured global attention.

Jenkins has a gray beard, unruly hair, and a penchant for storytelling—a man who has never heard a tale he couldn't embellish. He fills the long hours of our drive with accounts of bad luck involving car crashes and cliffs toppling around him. They seem hard to believe—until fate chimes in. As we cross parched ranchland west of the Flinders Ranges, a tire catches two thorns and goes flat. We put on the only spare and creep ahead through the roadless brush. "Cross your fingers and hope we don't get another puncture, because we're lost if we do," says Jenkins.

Eventually we reach an abandoned turn-of-the-century silver mine called Ediacara. Hordes of bush flies greet us, sucking moisture from our eyes and nostrils. The sky is cloudless. Overhead, a brilliant sun bakes the stones on the ground until they are too hot to touch. A mother kangaroo and joey, alarmed by our voices, bound to the top of the hill, then turn to stare back.



Tumbled into a gritty grave

Storm waves surging into shallow waters ripped up soft-bodied bottom dwellers and smothered them in sand, "like old pieces of plastic you find buried on the beach," explains Jim Gehling. Unable to dig themselves out, slender *Pteridinium* and spiked *Ernietta* (illustrated below) perished, often in jumbled heaps. In Namibia, Gehling examines the youngest *Pteridinium* known (above); it died in quieter waters 544 million years ago.

ART BY JOHN D. SIMMONS

Jenkins leads me up a gentle slope where an Australian geologist named Reg Sprigg wandered in 1946. "Here's the spot where Sprigg found the first fossils. He stopped here for lunch and was turning over slabs like this," says Jenkins as he upends sandstone blocks and checks their undersides. I join him, using a geologist's hammer to turn over the searing rocks. The first few show nothing. Then Jenkins lifts a rust-colored flagstone. "Look at this. Here's a big rock crawling with life."

The slab is dimpled with five circular fossils resembling pineapple slices. Jenkins identifies them as the anchors of ancient soft corals, some of the earliest animals. "We're standing here at an initial point in the diversification of animal life," says Jenkins. "It's exciting to be at the beginning, when many kinds of multicellular creatures first appeared on Earth."

IN HIS ADELAIDE LABORATORY Jenkins introduces me to some of the other residents of the Ediacaran seas. He switches on a lamp and turns it horizontally so the light skims the fossils on his desk and shoots into my eyes.

The low-angle light reveals details that remain almost invisible when the rock is illuminated from above. Many fossils from later eras are easier to see because their mineral-rich shells and bones stand out as a different color from the surrounding rock. The Ediacaran species, though, had no hard parts that could be preserved in the rock. Their fossils are more like footprints—impressions made in the sandy seafloor before their bodies decayed away.

Jenkins takes a small rock and tilts it slowly until the light catches a two-inch-long depression curved like a comma. Named *Spriggina* in honor of Sprigg, this creature has a boomerang-shaped head and a body divided into dozens of thin parallel segments. Because of its shape, Australian paleontologists identified *Spriggina* as a segmented worm, a relative of the common earthworm.

Jenkins's mentor, a renowned Australian paleontologist named Martin Glaessner, was the first to study many of the Ediacaran fossils. In the 1950s he classified them as representatives of modern phyla—the fundamental categories of animals based on body design. Glaessner proposed that the circular shapes were impressions left by jellyfish. He categorized oval fossils reminiscent of trilobites as the ancestors of insects and crustaceans. *Dickinsonia*, with its segmented body, joined *Spriggina* as a worm, an interpretation that Jenkins still favors.

For Glaessner and other paleontologists of his day, the discovery of these fossils in Precambrian rocks solved a problem that had bothered scientists since Charles Darwin. In Darwin's time, rocks from the Precambrian were considered barren of fossilized life, yet slightly younger rocks from the Cambrian period contained an abundance of animal fossils. If natural selection happened gradually, as Darwin believed, then the lack of Precambrian life undermined his theory.

The burst of animal life 540 million years ago was so sudden that paleontologists came to call it the Cambrian explosion.* In just a few million years, a hiccup in geologic time, the oceans filled with representatives of almost all modern phyla—the forebears of clams and crabs, starfish and snails, and even animals with the hint of a backbone. Going from the lifeless Precambrian rocks to the fossil-rich layers of the Cambrian was like walking past an empty lot on Tuesday and finding a fully furnished house in the same place on Wednesday.

Sprigg's discovery of Ediacaran fossils was hailed as the long-sought solution to Darwin's problem. Scientists felt that they had finally found the simple ancestors of modern animals—an initial budding of the groups that would blossom in the Cambrian explosion.

It was a tidy story, but it didn't last. In 1983 an influential German paleontologist named Dolf Seilacher attacked the idea that the Ediacaran organisms gave rise to modern animals. They were too simple and too strange to have anything to do with animals, he thought.

Even the most basic animal, the sponge, is divided into parts, with a mouthlike opening leading to a compartment for digesting food. More complicated animals have specialized organs and appendages. The Ediacaran fossils, though, show none of these features. "We don't see any indications of organs," Seilacher says. "We see no legs, no mouths, no anuses, no digestive tracts, nothing to suggest they were animals. We have to stop shoehorning them into categories of modern animals." He described them as immobile, jelly-filled organisms and made up the term Vendobionts to

*See "The Cambrian Period: Explosion of Life," by Rick Gore, NATIONAL GEOGRAPHIC, October 1993.

label them. Unable to eat, the Vendobionts absorbed sunlight or nutrients from seawater.

Seilacher, whose spiky silver hair stands upright, delights in challenging conventional ideas, both scientific and cultural. I meet with him at an exhibit he has organized of patterns in ancient rock. The show forces people to consider whether mud cracks and worm burrows are art.

One exhibit displays a cast of an Ediacaran fossil called *Charniodiscus*, which looks like a foot-long feather attached to a ball. When Jim Gehling found this fossil 25 years ago, he classified it as a soft coral, a modern animal with sievelike arms that filter food particles from the water. But Seilacher contends that *Charniodiscus*'s body couldn't have filtered food because it was a continuous sheet. "A filter must have holes, like a net or a feather, but this organism didn't," he says. *Charniodiscus* and other Vendobionts resembled thin, fluid-filled air mattresses divided into many compartments—a pattern unknown in the animal or plant kingdoms, says Seilacher. "We have nothing like this today."

Seilacher classified the Vendobionts as an extinct kingdom of life—as different from modern animals as creatures from Mars might be. "These strange fossils show us, better than any spacecraft, what life on another planet might be like."

RADICAL YET WIDELY RESPECTED, Seilacher originally regarded virtually all Ediacaran fossils as Vendobionts unrelated to modern animals—an extreme idea rejected by other paleontologists. Since then, researchers have mined rich Precambrian sites in northern

Russia, Namibia, Newfoundland, northwestern Canada, and Australia. Just last year important specimens turned up in Nevada.

Studies of these new finds have brought Seilacher and other paleontologists closer together. A consensus is emerging that the Ediacaran organisms fall into two main categories. "Some were certainly animals," says Jim Gehling. "Others were truly bizarre."

In his neat office at the University of South Australia, Gehling pulls out samples of both groups. A slab of orange sandstone is covered with short parallel scratches that look like rows of quotation marks. Seilacher and Gehling recently studied them and recognized them as lines made by an early mollusk, a predecessor of snails and clams. In Russia scientists recently reported finding the organism that may have made these marks—an oval

Evolution's experiments etched themselves into the sandstone and quartzite layers that stripe South Australia's Wilpena Pound formation. Similar fossil deposits from southern Africa to the Arctic Circle reveal traces of the same sea life that flourished here at the end of the Precambrian.

Ediacaran fossil named *Kimberella*. Together, these discoveries offer proof that complex, mobile animals evolved before the Cambrian explosion.

Gehling's second example is an oddball fossil called *Phyllozoon*, a foot-long, beltlike creature divided into zigzagging segments. "*Phyllozoon* is the archetypal Vendobiont. We have no modern equivalents. I think

Grappling with the "prince of worms," Australian paleontologist Richard Jenkins sees kinship between doormat- and silver-dollar-size *Dickinsonia* (below and facing page) and a wriggling bloodworm. Other scientists say the jury is still out on ties between such ancient oddities and living animals.

Phyllozoon was a quilted organism that lived by colonizing bacteria and algae in its chambered body, which might account for its bizarre shape. It may have needed a large surface area to absorb sunlight or chemicals from the water."

Paleontologists don't know where to place the Vendobionts on the tree of life. Seilacher envisions them on their own branch, separate from animals and plants. Narbonne, who has found a new species in Namibia, wonders whether they were an extinct animal phylum. Gehling suggests that some could have been unusual algae. All agree, though, that the Vendobionts left no heirs.

The late Precambrian was a singular time in Earth's history when big, immobile, defenseless species flourished because there was nothing around to eat them. Then the Cambrian explosion gave rise to large predators, and the peaceful lifestyle of Ediacaran times suddenly became as outmoded as a carrier pigeon in the age of e-mail.

No one knows what caused this frenzied evolution of animal life. Some scientists think a change in seawater chemistry sparked the Cambrian explosion. Others believe a genetic innovation set it off.

Before the Cambrian, though, animals held no advantage. The curious fact about the Ediacaran is that large, bizarre organisms outnumbered small, mobile animals. Mollusks, worms, anemones, and other animals dwelled in the shadows of *Phyllozoon*, *Charniodiscus*, and other quilted species. There was no hint that animals would survive and Vendobionts die out. "We're looking at evolution sitting on a knife-edge. It could have gone in many different ways," says Gehling. "This was a time of experimentation."

IN THE MOUNTAINS of the Flinders Ranges, Gehling and Narbonne take me to see the end of the Ediacaran story. We hike along a dry creek and around gum trees until Gehling comes to a halt where orange sandstone meets mottled gray-and-white rock. "You're standing on a revolution here. Your right foot is on Precambrian rock, your left on Cambrian rock," he says.

Worm burrows preserved in these rocks illuminate the transformation. In the Precambrian, when the Ediacaran species thrived, worms were relatively simple and weak. They couldn't penetrate deep into the seafloor sediments to mine the rich source of food there. The Cambrian rocks, however, are full of vertical burrows made by mobile worms with sophisticated nervous systems.

"This is part of the explosion in animal life," says Narbonne, pointing out the myriad traces of Cambrian worms. "The whole world is starting to change." Not long afterward, the pace of life escalated. Creatures developed shells and skeletons, teeth and claws, legs and tails. Animals began chasing one another. The strong ate the weak. Aggression was born.

I look down at my feet, straddling the transition. What would have happened, I wonder, if the quilted species had kept control of the planet, if animals had never taken over?

Someday we may find an answer. While exploring a distant planet, we may come across a world where evolution never took the turn leading to fast and fierce animals, a world where life remained placid, a world where the Ediacarans continue to reign. □

The Vanishing Prairie Dog

NATIONAL ARCHIVES

Seen both as vermin and as victims, black-tailed prairie dogs scan for predators in the South Dakota Badlands. Habitat destruction, shooting, and poisoning—the method federal agents in Arizona used to exterminate this pyramid of dogs in the early 1900s—have eliminated the rodents from about 98 percent of their range.

By MICHAEL E. LONG
Photographs by RAYMOND GEHMAN

EARLY MORNING on the eastern plains of Colorado. While a parching sun is doing its duty, the prairie dogs are flying—to the right, to the left, and even straight up—propelled by the impact of high velocity bullets fired from hundreds of yards away. Rifleman Ken Holmes squints through a telescopic sight that magnifies 25 times, squeezes the trigger, and a plastic-tipped slug erupts from the muzzle. An eye blink later the bullet explodes in a prairie dog's hindquarters 400 yards distant, and the animal becomes airborne as smithereens of whirling flesh.

A black-tailed prairie dog finds harmony with bison at the Triple 7 Ranch south of Rapid City, South Dakota—but tries the patience of ranchers like Chauncey Taylor, standing at a burrow. "Between dogs and cattle it's a fight for grass," he says. Scientists, though, point to prairie dogs' contribution as soil enrichers.

"Give him some frequent flier miles," says Holmes, one of 30 members of the Varmint Militia convened near Wray for two days of shooting prairie dogs on local ranches. Holmes chambers another cartridge.

As the morning wears and scores of animals are killed, activity in the dog town in front of us slows. Don Andrews, a rancher, asks, "Can I applaud now?" He mentions that his neighbor Robin Wiley would like the militia to come over and shoot his prairie dogs. Holmes and the three other riflemen pack up. The shooting resumes on the Wiley ranch until, afternoon shadows grown long, the cows come home.

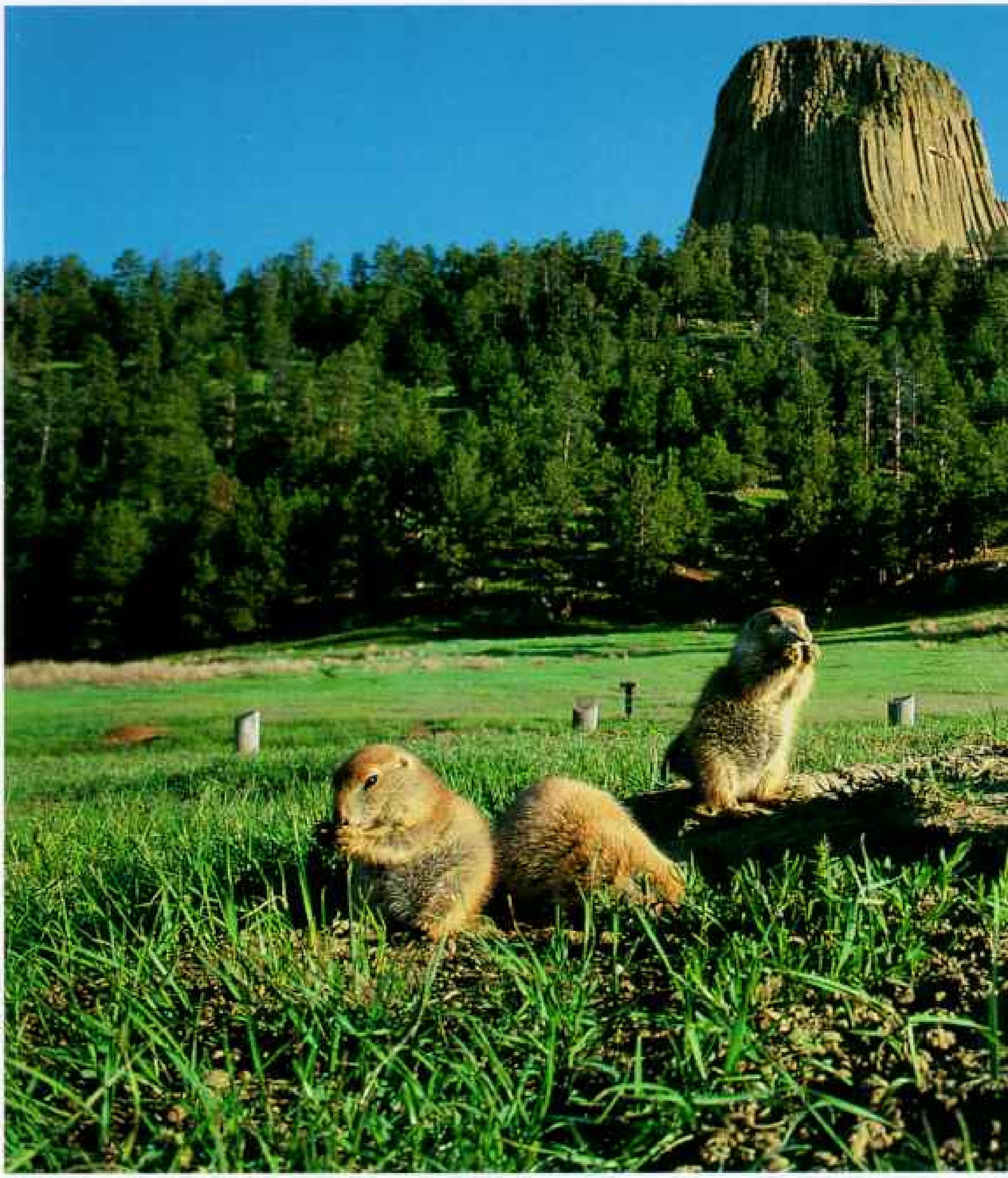
We return to an excited buzz at a gun club in Wray: "Animal rights protesters . . . invading the line of fire from militiamen . . . chained themselves together and chanted . . . refused to move . . . arrested by Kit Carson County sheriffs . . . spending the rest of the weekend in jail." Militiamen exult.

Shoot them or save them, hate them or love them, there's little middle ground where prairie dogs are concerned. The government poisons them, developers bulldoze them, aficionados rescue them, while ranchers, complaining that they take the grass from grazing cows' mouths, brand them "prairie rats."

Scientists counter with a list of ecological good deeds—prairie dogs are virtual fertilizing machines—and point to their linchpin status as supermarket and hotelier: For many creatures prairie dogs are prey and their burrows provide shelter.

Traveling west across the plains in 1804, Meriwether Lewis reported seeing the animals in "infinite numbers." Biologists estimate that at the turn of the century perhaps five billion prairie dogs occupied millions of acres of short- and mixed-grass prairie.

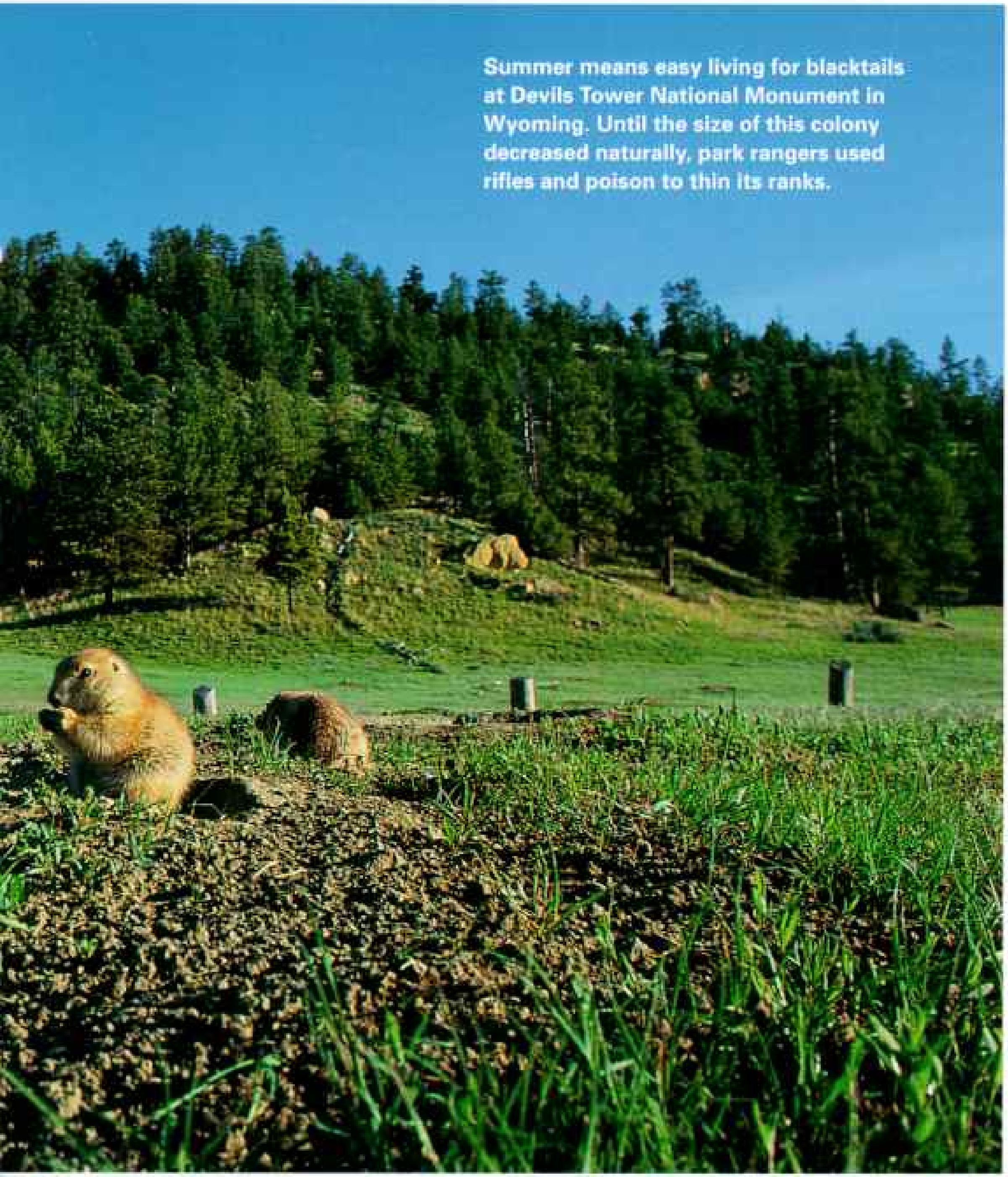
But decades of determined eradication by federal, state, and local governments, wipeouts from flea-borne plague, recreational shooting, and habitat destruction have left prairie dogs a pale presence—they now inhabit perhaps only 2 percent of their range from Mexico to



Canada. Of five species, the Mexican is listed as endangered and the Utah as threatened. The other species are the black-tailed (most numerous), the white-tailed, and the Gunnison's.

Christened dogs by settlers because of their high-pitched alarm calls, these members of the squirrel family live in burrows that can be 15 feet deep and more than a hundred feet long. They have a complex social system anchored by the coterie, usually composed of one male and several close-kin females and their offspring. Inside this core unit things are mostly amicable, but prairie dogs will skirmish with and occasionally kill intruders.

Then why, at this dog town in Bryce Canyon National Park, are these Utah prairie dogs kissing? I ask John Hoogland, a scientist who has been observing their behavior for 25 years.



supported in part by grants from the National Geographic Society. He believes that they're actually touching teeth in a ritual of recognition.

Perched in Hoogland's wooden observation tower, we look out on acres of a dog town pimpled with burrow entrances. "I have 84 animals here and 84 different personalities," he says. "Some are aggressive, some are nice, and some are mean." Hoogland has trapped and marked the animals with distinctive dye patterns, enabling him to tell Blackbottom 7 from Racing Stripes from Executioner, whose dyed head resembles a hangman's hood.

Hoogland also bestows behavioral names: Houdini is hard to trap; Arnold is the colony's toughest male; Cruise Machine is noted for his indefatigable mating behavior, as are resident females. During a four- or five-hour estrus,

a female will copulate with as many as five different males, Hoogland reports. Thus pups from the same litter can have different fathers.

Though prairie dogs are mainly vegetarian, Hoogland has documented infanticide as the major cause of mortality among juveniles. "Nursing females will kill and cannibalize one another's babies one week, and the next week they'll communally nurse others' pups."

Prairie dogs are talented linguists. "They possess the most sophisticated natural animal language so far decoded," says Con Slobodchikoff of Northern Arizona University. Researching alarm calls of Gunnison's, he found that they discriminated among predators—humans, hawks, coyotes, and dogs. Moreover, the prairie dogs distinguished between people of different sizes, and when they gave the same call for a man—wearing the same clothes—after not seeing him for two months, "that blew me away," says Slobodchikoff.

At a cabin in Jackson, Wyoming, I meet with Tim Clark, a Yale University biologist and a veteran of years of observing prairie dogs and black-footed ferrets in the field. "Prairie dogs figure prominently in the ecology of this continent," he says. "They are an umbrella species that offers prey, shelter, and habitat to other creatures, and the list is long: black-footed ferrets, burrowing owls, ferruginous hawks, badgers, mountain plovers, swift foxes, rattlesnakes, and an array of toads, rabbits, spiders, salamanders, ants, and beetles."

Clark points out that the nearly extinct black-footed ferret, which is almost wholly dependent on prairie dogs for prey and habitat, is the object of a 15-million-dollar recovery program coordinated by the U.S. Fish and Wildlife Service. "Does it make sense," he asks, "to try to eliminate prairie dogs and then turn around and declare ferrets endangered and spend a lot of money attempting to restore them?

"We'd never think of burning a museum, yet when it comes to our biological heritage, we don't hesitate to bulldoze it, burn it, or plow it under. What we're doing is creating threatened and endangered species. To avoid that, we should be protecting prairie dog habitat."

As a GEOGRAPHIC staff writer, MICHAEL E. LONG covered such subjects as aviation and medicine. He now reports on Western topics from his home in Denver. RAYMOND GEHMAN often photographs wildlife and environmental stories for the magazine.

Burrowing owl

Image Not Available

Eastern tiger salamander

Image Not Available

Ferruginous hawk

Swift fox

Mountain plover

Black-footed ferret

Innkeepers of the Plains

Providing burrows for shelter—and themselves as prey—prairie dogs anchor a vanishing ecosystem. The endangered black-footed ferret (above), dependent on prairie dogs for food and shelter, is the object of an intensive recovery program. Other predators like ferruginous hawks and swift foxes have declined in number. Mountain plovers like dog towns' open spaces, while burrowing owls, salamanders, spiders, snakes, and many other creatures call dog burrows home. Five species—black-tailed, white-tailed, Utah, Gunnison's, and Mexican—inhabit a shrinking range.

Black widow spider

Rattlesnake

Veteran researcher John Hoogland examines a young Utah male at Bryce Canyon National Park. Hoogland dyes his subjects for identification (above). With 25 years in the field, the biologist was the first to document infanticide and cannibalism among prairie dogs.

No, we shouldn't, retorts Lawrence Kruse, a rancher in South Dakota's Conata Basin. "Prairie dogs take the grass from cattle, horses, and sheep. Let me show you," he says. Kruse drives me past dog towns newly sprung up on his property, pointing to scarred terrain whose patches of bare earth resemble a miniature battlefield. "They're plum thick in there. They come in from the park and the grassland," he says, referring to nearby Badlands National Park and the Buffalo Gap National Grassland. "What are prairie dogs good for?" he muses. "They might make homes for ground owls and rattlesnakes, but I don't see any use for them."

Prairie dogs eat as much as 7 percent of a ranch's forage, but they may offer ranchers compensation. James Detling of Colorado State University in Fort Collins, studying how plants respond to environmental factors, argues that prairie dogs are natural fertilizers whose incessant grass clipping increases the protein content and digestibility of grass. "Given the choice, bison and pronghorn prefer to graze on dog towns," he says. "I am as certain as I'm sitting here that cattle do too, but I don't have data to prove that."

Detling is sympathetic to the ranchers' view. "If I were a rancher and half my ranch was a dog town, I'd be concerned whether my cattle would be getting enough grass."

That concern is clearly manifested in South Dakota, which has declared the animal a noxious pest and mandates its control. Threatened with lawsuits from ranchers, authorities at Badlands National Park poison prairie dogs. Therein lies an anomaly: Badlands is reckoned a prime locale for reintroducing the black-footed ferret, so dependent on prairie dogs.

Surprisingly, reintroduced ferrets aren't fully protected by the Endangered Species Act because of an amendment added several years ago to placate farmers and ranchers. The government declares them "experimental" and "nonessential" animals, in the same category as wolves that were reintroduced into Yellowstone National Park. Thus ranchers sit easy, knowing they won't have to worry about an endangered critter on their lands. And the Park Service doesn't get sued. Meanwhile, prairie dogs are poisoned. And the ferrets?

Of 600 captive-bred ferrets released over the past seven years in South Dakota, Montana, Wyoming, and Arizona, 100 wild descendants survive, a creditable performance given the

reality of predation. But is the government's goal of ten towns of 150 animals each realistic?

"As of right now, the black-footed ferret is functionally extinct," says Pete Gober, ferret recovery coordinator for the U.S. Fish and Wildlife Service in Pierre, South Dakota. "The goal of self-sustaining populations over the long term is doubtful. We simply don't have large enough expanses of plague-free prairie dog habitat."

ONCE PRIME HABITAT for the black-tailed prairie dog, Colorado's Front Range now specializes in accommodations for humans—subdivisions, interstates, and shopping malls. Near the intersection of Wadsworth and Belleview Avenues in southwest Denver, a sliver of wild habitat composed of a dozen acres of dog town, wetland, and towering cottonwood trees is chewed by bulldozers.

"It's always been known as Hawk Alley, for the hawks that preyed on prairie dogs here," Michele Alley-Grubb told me as cottonwoods toppled and a small marsh disappeared. "Now it's going to be a car dealership."

Michele and others in a small group known as the Prairie Ecosystem Conservation Alliance have convened to rescue prairie dogs that have survived the bulldozer blade. After participants hose soapy water into a burrow, they scoop up escaping animals, towel them off, and deposit them in hay-filled cages.

Volunteering for scoop duty, I insert my right hand into a soapy burrow. "When you feel the prairie dog's feet on your palm," says Michele, "grab its front legs and collar the animal with your left hand."

Explosive confrontation: Two marked Utahs duel for territory and females; the defender, at left, won this round. Skirmishes are sometimes bloody but rarely fatal.

After several burrows fail to produce, I feel the tickle of prairie dog feet and grasp a muscular, squirming male who rakes my forearm with his hind claws before I can hand him off. Meanwhile, Michele skillfully retrieves animal after animal without incident. In two days, more than 60 prairie dogs are collected and later transported to the Rocky Mountain Arsenal National Wildlife Refuge northeast of Denver. Michele explains that the alliance's major purpose is not to rescue prairie dogs but to persuade the public that people can coexist with them. "You don't have to kill prairie dogs," she says.

While many communities are getting rid of their prairie dogs, Santa Fe maintains a municipal park with a resident colony of Gunnison's and is considering making another band of Gunnison's part of a proposed park.

Commenting on the idea, the *Santa Fe New Mexican*, a local paper, raised the P-word—plague. It asked, "Can the City of Santa Fe afford to expose people to wild animals associated with the spread of bubonic plague?" A good question for residents of Santa Fe County, which has experienced 40 plague cases since 1949, the second highest record in a state that leads the country.

Prairie dogs acquire plague from fleas infected with plague bacteria. Though most prairie dogs have fleas, few fleas are infected, and most public health officials believe the chance of contracting plague from prairie dog fleas is low. Since 1949 the Fort Collins branch of the U.S. Centers for Disease Control and Prevention (CDC) has recorded 395 cases of plague in humans. Only 23 cases, including three fatalities, were linked to prairie dogs.

People and prairie dogs mix uneventfully at Custer State Park south of Rapid City in South Dakota. I get directions to a popular dog town from Barbara Schmitz, a park attendant: "Three miles down the road, and don't feed them those nasty things that kids eat. They don't drink water. They get moisture from their food. People food isn't good for them."

Schmitz tells me about another attendant who roves on snack patrol, snatching forbidden bags from the hands of tourists before they can feed the animals. Surreptitiously I position my notebook over a bag of salted peanuts I have brought, resolving to eat them myself.

At the dog town I watch playfully compliant prairie dogs thoroughly at home with delighted humans. "Peter," a mother tells her camera-toting son, "wait till he stands up and looks

Prairie dogs touch noses in a possible prelude to a kin recognition ritual that involves a touching of teeth and sometimes a locking of incisors. Recent research shows that the animals' alarm calls consist of a broad vocabulary of descriptions to characterize a predator's identity, size, and speed.

cute." Peter snaps a prairie dog's jump-yip call, a hilarious sort of reverse sneeze in which an animal explosively rears, throws back its head and small forepaws, and yips.

Signs advise against feeding and recommend keeping a distance. Telling children to stay away from friendly prairie dogs is like telling them to stay away from candy and puppies. I observe a blond tot primed for interaction. Her father reasons that it wouldn't hurt to feed the prairie dogs their natural food. Soon there is a long stalk of grass with the child on one end and a prairie dog chomping on the other.

Later I ask Kenneth Gage, plague specialist at the CDC office in Fort Collins, about the risk of plague infection. "You should avoid close contact," he says, "but the risk is fairly low. It's a matter of being reasonable, to allow people to have the experience." Gage points out that prairie dogs themselves are highly susceptible to plague, which can rapidly destroy a colony.

WHAT MIGHT THE FUTURE BRING for prairie dogs? I ask the varmint militiaman Ken Holmes, who estimates he's shot 20,000. Holmes, a professional exterminator of both bugs and dogs who would like to retire and shoot prairie dogs full-time, thinks they are holding their own.

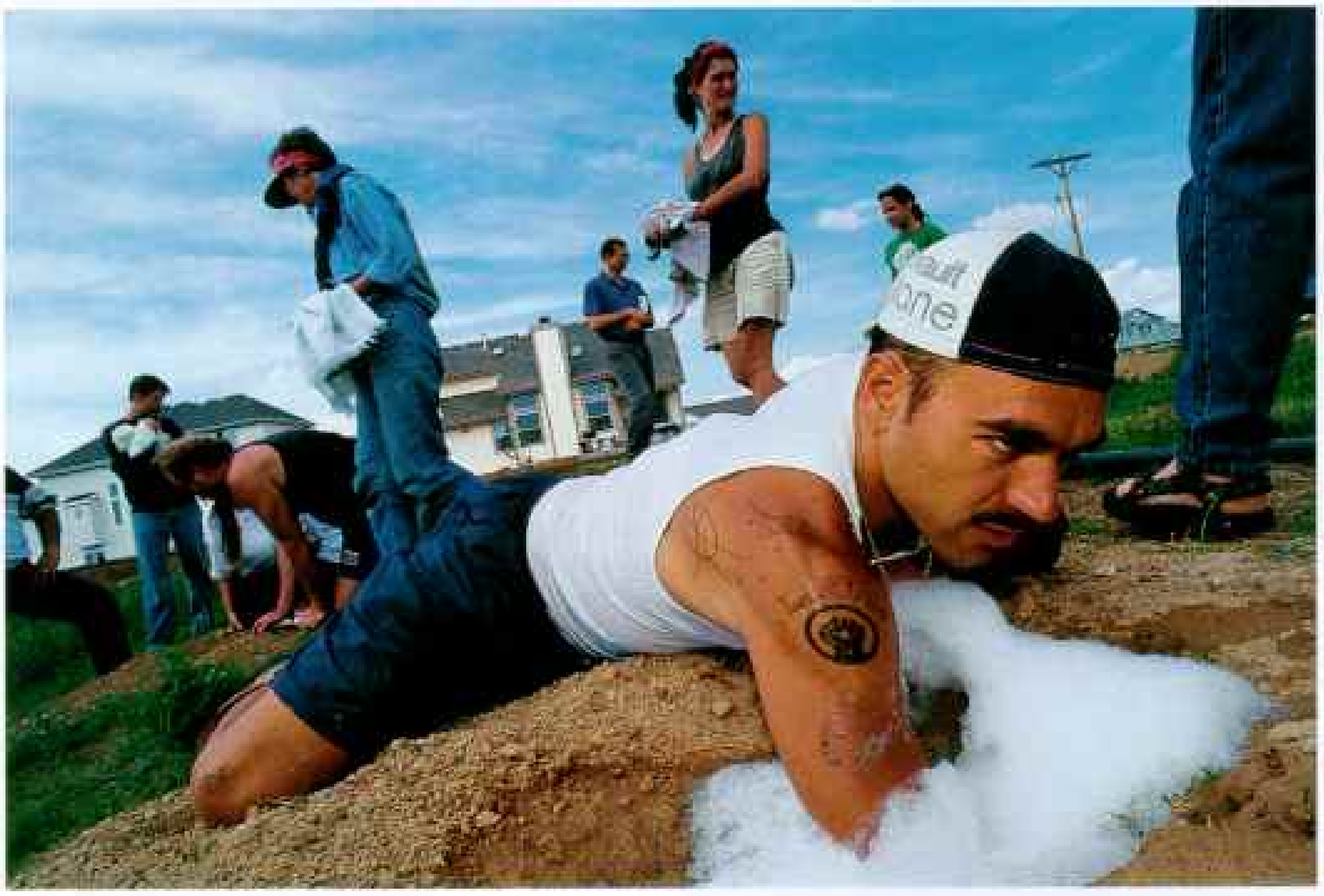
"I don't think dogs will ever plague out," he says. "They definitely cannot be shot out. It's difficult enough to kill them with the poisons I use. You could scorch the earth and the dogs would be underground. They're survivors."

Others argue that because of the triple onslaught of poison, plague, and recreational shooting the prairie dog ecosystem has already collapsed. John Sidle, an endangered species coordinator for the U.S. Forest Service, is in the midst of a yearlong aerial survey of prairie dogs in Montana, the Dakotas, Wyoming, and Nebraska. "The public perception is that there are lots of dog towns," he says, "but I see just scattered fragments. There is still habitat available, but nobody wants prairie dogs around."

At Fort Belknap Indian Reservation in northern Montana, Mike Fox, a Gros Ventre Indian who majored in American history and who manages the reservation's wildlife program, has decided he wants prairie dogs around. Fox grew up poisoning and shooting them, remembering his father's teaching that prairie dogs were "the scourge of the Earth." That's an opinion commonly held by Indian cattle ranchers here.

Later Fox helped expand the reservation's prairie dog shooting program, which attracts riflemen from all over the U.S. Tens of thousands of dollars in license and guide fees were welcomed in a community with 70 percent unemployment. Prairie dogs became a cash crop, "per acre, more productive than our cattle operations," Fox says. Meanwhile, shooters were reducing dog town acreage by nearly half, and Fox was having second thoughts.

Observing the interaction between prairie dogs and the reservation's bison herd, which he started in 1974, Fox changed his mind about prairie dogs. Though there's less grass per acre around dog towns, Fox says, "the grass on dog towns is the best grass



Big wheels flatten prairie dog burrows at a construction site in south Denver (opposite). North of the city in Windsor a rescuer waits to collar an animal fleeing soapy water pumped into its burrow. About 75 dogs were relocated, a small reprieve for a species in free-fall decline.

around. The bison go where the good stuff is."

In Fox's pickup we bounce along a rutted road that ends at a granitic promontory overlooking a sea of prairie. "Watch where you step," Fox recommends. "We don't call this Snake Butte for nothing."

"Rattlers?" I ask.

"Yeah."

Fox points to rings of stones. "They are tepee rings of Indians who camped here long ago, waiting for bison," he says. I look down at a constellation of dark specks, the reservation's 400 bison. Fox takes me for a drive among the herd, pointing to an old bull called Evil Eye, who rolls on his side raising a cloud of dust as we approach. "It's called wallowing," Fox says, "It's a message from Evil Eye, saying he's not afraid of us."

Fox explains how bison and prairie dogs coexisted on the original prairie. "The bison would trample an area and the prairie dogs would move in. Later, prairie dogs returned the favor by providing nutritious graze for bison.

"None of us are losing any sleep over prairie dogs in the bison patch," Fox says. "At first I thought the dogs were costing us money. With what I have seen in the past five years, I've totally changed my mind. The prairie dogs are part of the system too. They need to be here. I'm convinced you can make a living and not destroy nature."

Fox cut the quota of shooters nearly in half and has accepted 23 black-footed ferrets from the recovery program. He laughs. "With bison, prairie dogs, and now ferrets, some Indian ranchers see our program as a threat. I tell them that they were all here before. The ferret is not a new animal. It's just an old one returning."

The prairie is gone in most places. Biologists figure you'd need around a million contiguous acres to reconstruct a prairie ecosystem. Fort Belknap offers just 500,000 acres of prairie, and Mike Fox knows it would be a job to convince his ranchers that a hunk of pristine prairie is a worthwhile goal. Yet he'd like to give it a try. As a student of history, he remembers a time when Indians lived among the creatures of the prairie. □

Visit a virtual prairie dog village at www.nationalgeographic.com.

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Onager (*Equus hemionus onager*) **Size:** Shoulder height, 120 cm **Weight:** Approx. 290 kg **Habitat:** Deserts in Iran **Surviving number:** Estimated at fewer than 800

Photographed by Gertrud and Helmut Denzau

WILDLIFE AS CANON SEES IT

An onager and her foal drink from a spring, revitalized from rains in the mountains bordering Iran's great salt desert, Dasht-e Kavir. During the scorching months of summer when fresh water becomes scarce, onagers drink salty water to survive. These hardy animals exist in a harsh and barren environment where they eat mostly sparse grasses and herbs growing along the desert's edge. Although onagers occur within protected areas, wild populations are low and scattered. Poaching and competition for water and grazing from domestic livestock threaten the onagers' survival. 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.

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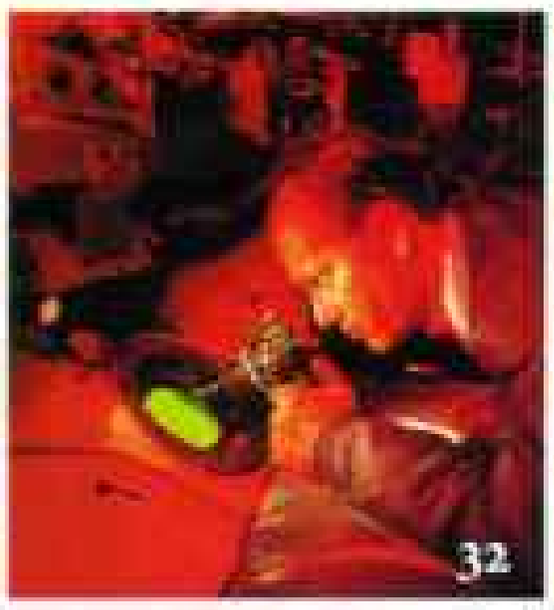
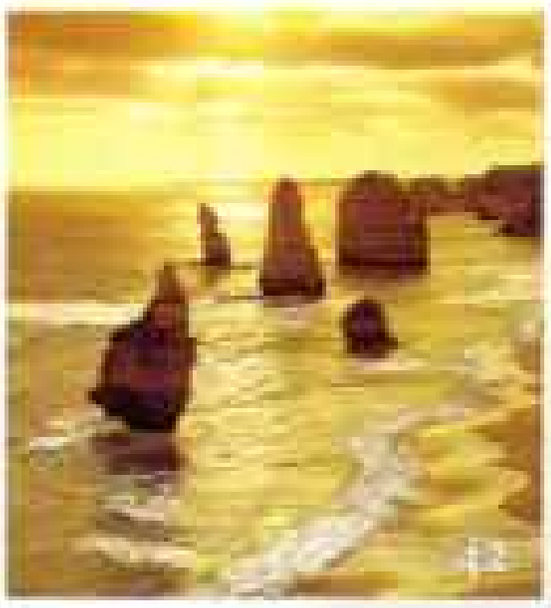
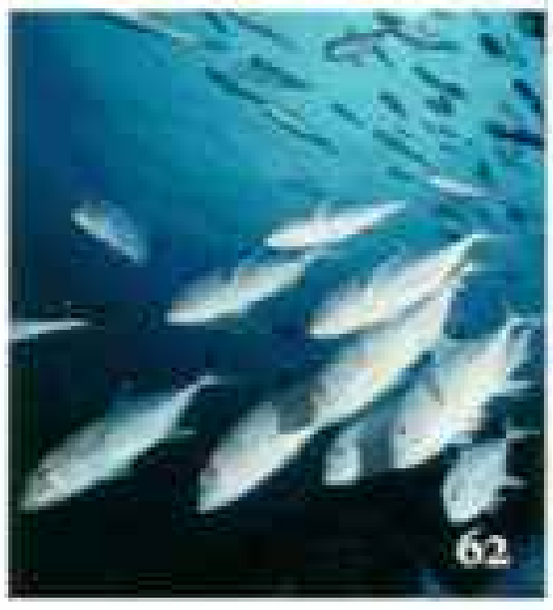
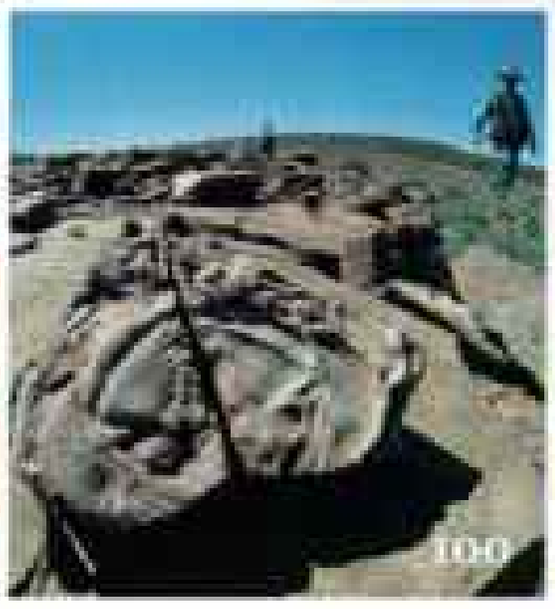
NATIONAL GEOGRAPHIC

APRIL 1998









2 **The Orinoco** *The bewitching song of El Dorado—fabled fountainhead of gold—still echoes along Venezuela's longest river as it flows past rain forest villages, cattle ranches, and natural caches of mineral wealth.*
BY DONOVAN WEBSTER PHOTOGRAPHS BY ROBERT CAPUTO

32 **Roman Shipwrecks** *Probing the depths of the Mediterranean Sea, a nuclear submarine locates the remains of trading vessels that sank west of Sicily 2,000 years ago.*
BY ROBERT D. BALLARD PHOTOGRAPHS BY PRIIT J. VESILIND

42 **Australia by Bike, Part Three** *Surviving a self-imposed ordeal of 10,000 wind-blasted miles, an American journalist completes a circuit of his adopted country and finds himself in a different place.*
BY ROFF MARTIN SMITH PHOTOGRAPHS BY B. IAN LLOYD

62 **Testing the Waters of Rongelap** *This Pacific atoll, heavily contaminated by radioactivity during a 1954 nuclear bomb test, remains off-limits for human habitation, yet in its waters life abounds.*
BY BILL CURTSINGER AND EMORY KRISTOF

76 **Ozarks Harmony** *Rich in natural beauty and native pride, the hills that straddle Arkansas and Missouri now host an influx of newcomers whose ways sometimes strain a staunchly independent culture.*
BY LISA MOORE LAROE PHOTOGRAPHS BY RANDY OLSON

100 **Life Grows Up** *Bizarre organisms filled the seas more than half a billion years ago, foreshadowing the rise of more complex creatures. Their fossils are rewriting the history of life on Earth.*
BY RICHARD MONASTERSKY PHOTOGRAPHS BY O. LOUIS MAZZATENTA

116 **The Vanishing Prairie Dog** *Shoot them or save them? Opinions on prairie dogs divide the American West. What's clear is that these rodents are disappearing, along with their entire ecosystem.*
BY MICHAEL E. LONG PHOTOGRAPHS BY RAYMOND GEHMAN

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Behind the Scenes
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On Television
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On Assignment

The Cover

With a call known as a jump-yip, a prairie dog greets its neighbors or signals "all clear" after a predator has left the foraging area of its prairie dog town. Photograph by Raymond Gehman

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digitaria sanguinalis
(crabgrass)

ambrosia franseria
(ragweed)

taraxacum officinale
(dandelion)

antiquus pila tenisiae
(old tennis ball)

For more information about Honda's commitment to the environment, call 1-888-CC-HONDA ext. 309. ©1997 Honda North America, Inc.

Don't lawnmowers propel enough scary things into the air?

At Honda, we've always been concerned about clean air. And while we can't do anything about the *ambrosia franseria* flying around your backyard, we can do something about your mower's emissions.

Since 1982, we've been building environmentally responsible mowers with our unique overhead valve engine. Long before clean-air regulations existed.

Compared to many lawnmowers with side-valve engines currently in use, Hondas generate lower hydrocarbon and carbon monoxide emissions. And achieve up to thirty percent better fuel economy.

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This kind of thinking is nothing new at Honda. Throughout our 19 years of building products here in America, our goal has always been the same: To balance your desire for fun and performance with society's need for cleaner air.

This philosophy leads to products like our clean mowers, which let you concern yourself with other things when mowing the lawn. After all, who knows when you may encounter a *taraxacum officinale*.

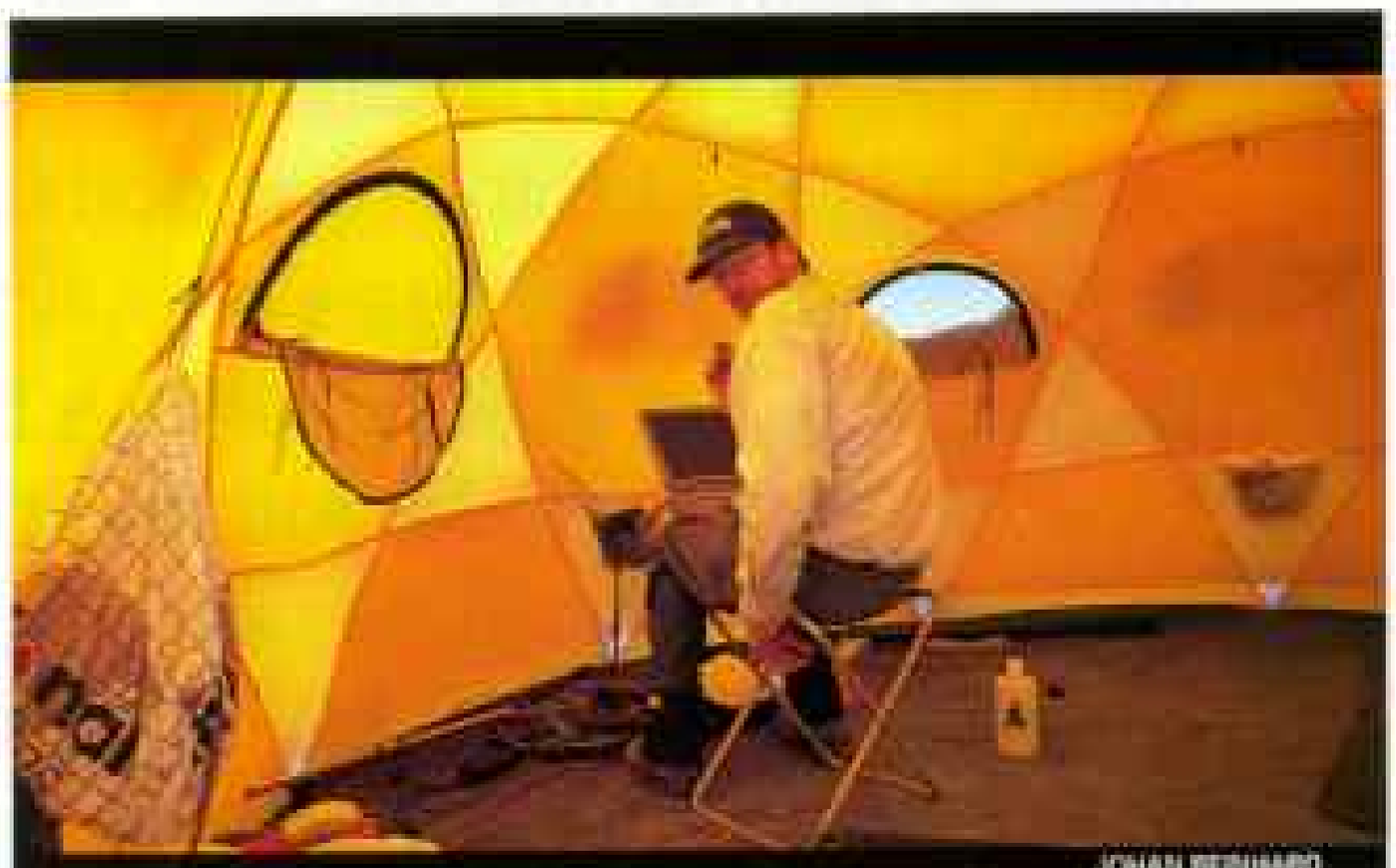
HONDA
Thinking.

NATIONAL GEOGRAPHIC

Behind the Scenes

New Image Database

Our new Global Satellite Mosaic, a joint effort of National Geographic Television and the Jet Propulsion Laboratory, offers one-kilometer resolution with more than 500 satellite images, beating the older four-kilometer standard. First, infrared weather satellite shots, of South America for example (above, at right), were stitched together digitally. Then cloudy areas were replaced with cloud-free data, and colors were balanced, at center. Finally, the colors were converted to natural hues, transforming vegetated areas from red to green. The database, already in use in globe form (inset) for EXPLORER TV animations, will revolutionize Society mapping. Keep watching.



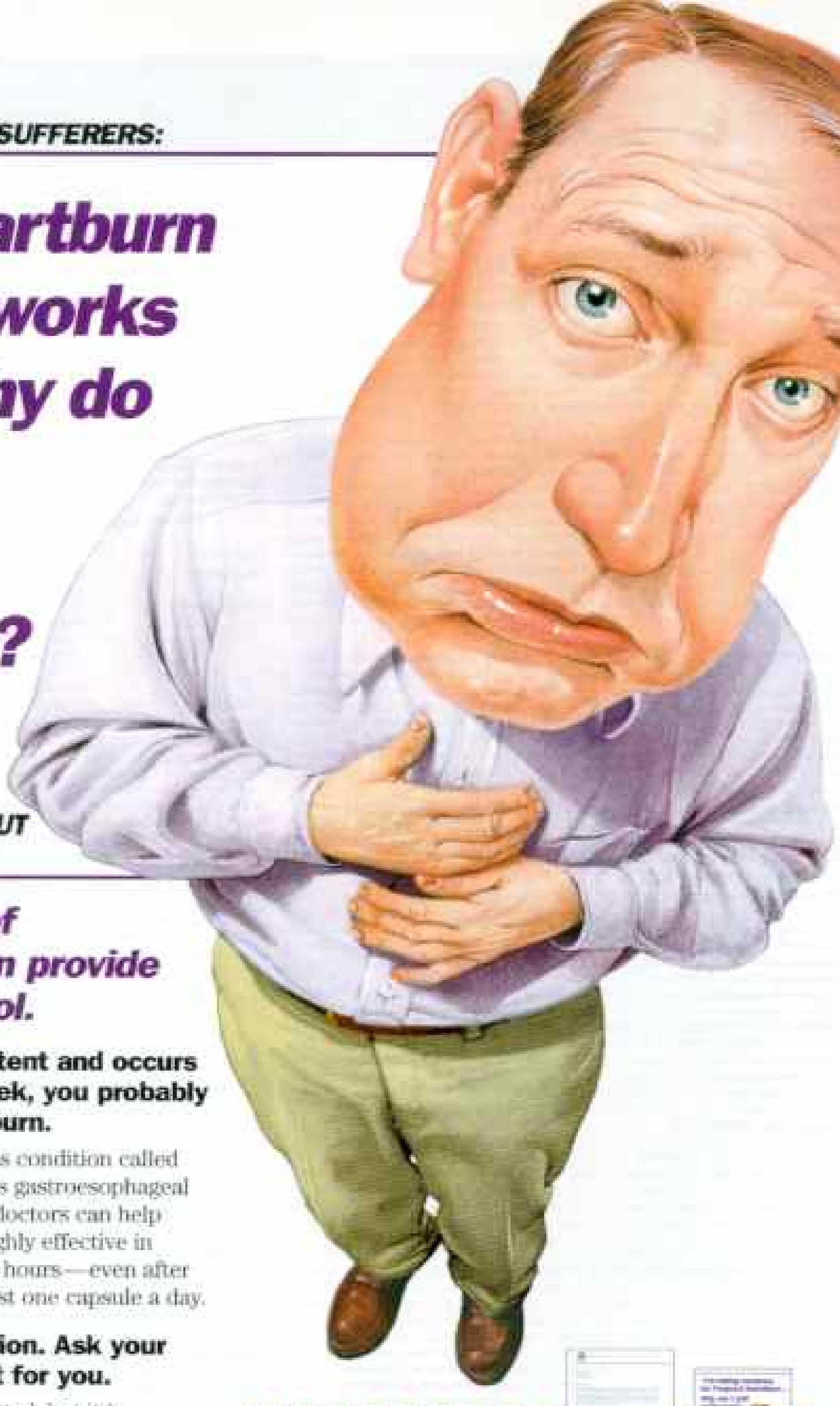
JOHAN REINHARD

Online on Top of the Andes

His tent-office was small, but the view—18,300 feet up—was superb when Yancey Hall, a producer on our website, followed archaeologist Johan Reinhard as he searched for Inca sites on Peru's Pichu Pichu mountain. For 12 days last October Yancey filed reports from his laptop to NG Online; it was, he says, "the adventure of a lifetime."

FREQUENT HEARTBURN SUFFERERS:

If your heartburn medicine works so well, why do you keep getting heartburn?



ASK YOUR DOCTOR ABOUT PRILOSEC

Just one capsule of PRILOSEC daily can provide 24-hour acid control.

If your heartburn is persistent and occurs on two or more days a week, you probably don't have ordinary heartburn.

You may have a potentially serious condition called acid reflux disease (also known as gastroesophageal reflux disease, or GERD). Today doctors can help by prescribing PRILOSEC. It is highly effective in controlling acid production for 24 hours—even after meals, and all night, too—with just one capsule a day.

Available only by prescription. Ask your doctor if PRILOSEC is right for you.

PRILOSEC is generally well tolerated, but it is not for everybody. The most common side effects are headache (6.9%), diarrhea (3.0%), and abdominal pain (2.4%).

Please read important information on the adjacent page and discuss it with your doctor.

www.acidcontrol.com

FREE INFORMATION KIT

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You will receive FREE: a brochure about frequent heartburn, acid reflux disease, and PRILOSEC; plus, a personal heartburn diary, and a symptom questionnaire to help your doctor help you.

JUST ONE CAPSULE DAILY FOR 24-HOUR ACID CONTROL

PRILOSEC® (OMEPRAZOLE) 20 MG ONCE DAILY

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Please read this summary carefully, and then ask your doctor about PRILOSEC. No advertisement can provide all the information needed to prescribe a drug. This advertisement does not take the place of careful discussions with your doctor. *Only your doctor* has the training to weigh the risks and benefits of a prescription drug for you.

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 three-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. Concomitant administration of clarithromycin with cisapride, pimozide, or terfenadine is contraindicated. There have been post-marketing reports of drug interactions when clarithromycin and/or erythromycin are co-administered with cisapride, pimozide, or terfenadine resulting in cardiac arrhythmias (QT prolongation, ventricular tachycardia, ventricular fibrillation, and torsades de pointes) most likely due to inhibition of hepatic metabolism of these drugs by erythromycin and clarithromycin. Fatalities have been reported. [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 14 Prescribing information.] Concomitant administration of clarithromycin with cisapride, pimozide, or terfenadine is contraindicated. There have been reports of an interaction between erythromycin and astemizole resulting in QT prolongation and torsades de pointes. Concomitant administration of erythromycin and astemizole is contraindicated. Because clarithromycin is also metabolized by cytochrome P450, concomitant administration of clarithromycin with astemizole is not recommended. [See also CONTRAINDICATIONS, Clarithromycin, above. Please refer to full prescribing information for clarithromycin before prescribing.] **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 332 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 (84% treated vs. 10% controls). By the second year the difference between treated and control rats was much smaller (46% vs. 29%) but still showed more hyperplasia in the treated group. An unusual 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 (suboptimal) 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 4onal 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® (omeprazole). Numbers in parentheses indicate percentages of the adverse experiences considered by investigators as possibly, probably, or definitely related to the drug.

	Omeprazole (n=4[illegible])	Placebo (n=64)	Ranitidine (n=[illegible])
Headache	6.9 (2.4)	6.2	7.7 (2.5)
Diarrhea	3.0 (1.3)	3.1 (1.6)	3.1 (0.5)
Abdominal Pain	2.4 (0.4)	3.1	3.1
Nausea	2.2 (0.8)	3.1	4.1 (0.5)
URI	1.9	1.6	2.6
Dizziness	1.7 (0.0)	0.0	2.6 (1.0)
Vomiting	1.3 (0.4)	4.7	1.5 (0.5)
Rash	1.5 (1.1)	0.0	0.0
Constipation	1.3 (0.9)	0.0	0.0
Cough	1.1	0.0	1.5
Asthenia	1.1 (0.2)	1.6 (1.6)	1.5 (1.0)
Back Pain	1.1	0.0	0.5

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 2,001 patients and subjects received omeprazole.

Incidence of Adverse Experiences ≥ 1% Causal Relationship not Assessed

		Omeprazole (n=253)	Placebo (n=[illegible])
Body as a Whole			
site unspecified	Abdominal pain	6.3	3.2
	Asthenia	1.2	0.8
Digestive System	Constipation	1.5	0.8
	Diarrhea	3.7	2.5
	Flatulence	2.7	3.8
	Nausea	4.0	6.7
	Vomiting	3.2	10.0
	Acid regurgitation	1.9	3.2
Nervous System/Psychiatric	Headache	9.9	3.5

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 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. Gastric 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, anxiety, 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, leukopenia, 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=340) which differed from those previously described for omeprazole alone were: Taste perversion (11%), 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: There reports have been received of overdosage with omeprazole. Doses ranged from 320 mg (4 x 80 mg) to 2400 mg (120 40 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 WARNINGS, and for information regarding dosing in elderly and renally impaired patients. [PRECAUTIONS, General; PRECAUTIONS, 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 erosions 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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Manufactured by:
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Södertälje, Sweden

February 1997 PRC-44/97 PRE4

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.

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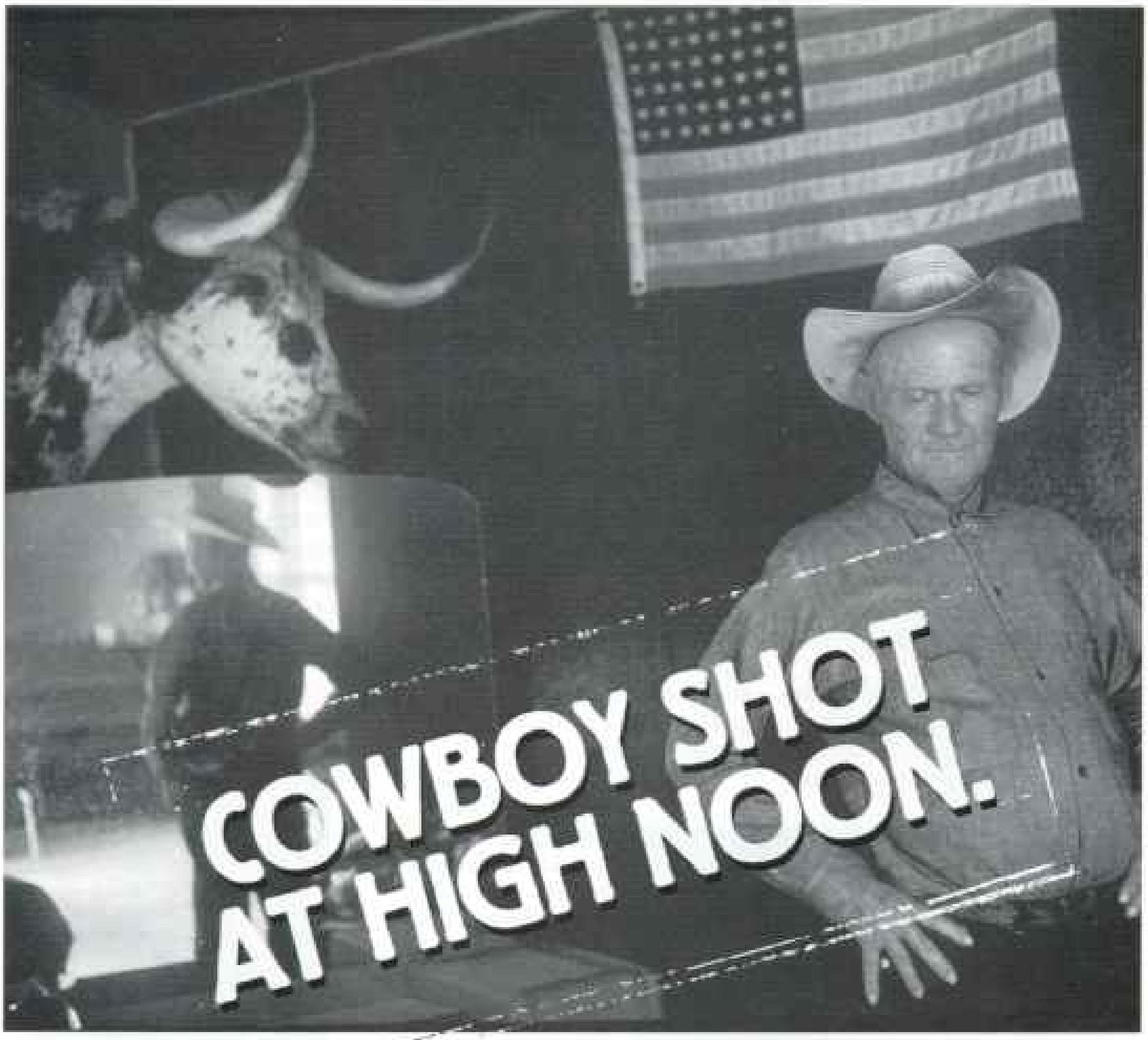

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William Albert Allard. High Noon. Journey with National Geographic on exotic photo shoots to see and hear the world through the eyes of award-winning photographers. Share firsthand findings from explorers in search of dinosaur eggs, pirates' treasure 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.

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WEB GONE WILD.

RAYMOND GEHMAN (ABOVE); WALTER BOGGS (INSET)

Owl in a Day's Work in Prairie Dog Town

"A prairie dog is only easy to photograph if it's yesterday's hawk food; live ones move too fast," says Walter Boggs of our photo-engineering division. In hopes of getting a new look at the little creatures, Walter (above) built a video camera to catch them in one place where they do slow down: their burrows. But tunnels between the burrow chambers proved too much even for his invention, a one-inch-wide camera on a 30-foot cable. "It could reach into one chamber but not follow the winding tunnels to others," he says.

On a test run at Rocky Mountain Arsenal National Wildlife Refuge in Colorado, the camera did surprise one tunnel occupant, an eight-inch-tall burrowing owl (below).

"If the prairie dogs move out, burrowing owls sometimes move in to nest," explains Walter.

No word on how the owls protect themselves from prairie paparazzi like Walter.

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TEXT BY MAGGIE ZACKOWITZ

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World-class Advisers on the Job

Who cares what kids think? WORLD magazine does. In 1993 it instituted its Junior Member Advisory Board. Every year some 150 readers—such as 11-year-old James Anderson of Colorado Springs, Colorado—are chosen from hundreds of applicants who respond to an announcement in the January issue. Candidates describe their interests—James likes frogs—and suggest ideas for a future issue. Board members critique story ideas and magazine content. Says Editor Susan Tejada, "We take kids seriously."

STUART WOHL, COLORADO SPRINGS GAZETTE

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Forum

Our December 1997 cover article on the plight of tigers in the wild was widely publicized in other media and drew heartfelt concern: "Maximum protection of these creatures should be a major priority. Their sheer beauty would make their extinction a great tragedy," a New Jersey reader wrote.

Making Room for Wild Tigers

The article was excellent but very disturbing. Some of us may unwittingly contribute to the problem by buying products made from the killing of tigers. A list of products made from tigers, or a resource for obtaining this information, would be helpful.

LYNETTE WHITESIDES
Irvine, California

A 1998 report from the World Wildlife Fund (1250 24th Street N.W., Washington, D.C. 20037) titled "While Supplies Last: The Sale of Tiger and Other Endangered Species Medicines in North America" lists such products. The shipping cost is five dollars. When buying a Chinese medicinal, check the ingredients for tiger or Os tigris.

After seeing NGS photographer Michael Nichols interviewed on the *Today Show* on December 4, we wanted to let readers know that not all practitioners of traditional Chinese medicine are oblivious to the plight of the world's tigers. Our company, the largest producer of English books on Chinese medicine, has been trying for years to inform fellow practitioners about the issue of endangered species and about substitute medicinals that may be used as effectively.

HONORA LEE WOLFE, CEO
Blue Poppy Press, Inc.
Boulder, Colorado

The article dwelled at length on tiger preservation in the national parks of India but not on the concern that we Bengalis have about the preservation of this beautiful animal in the Sundarbans in Bangladesh and West Bengal, the true home of the Bengal tigers.

SYED NOOR HOSSAIN
Solna, Sweden

You make the statement that tiger poaching in India appears to have fallen off since 1995. While poaching and seizure figures did show a decline in 1996, there was a rising trend once again in 1997. Ten cases were recorded in a two-week period in December alone.

ASHOK KUMAR AND BELINDA WRIGHT
Wildlife Protection Society of India
New Delhi, India

As an American, I am shamed by the fact that parts of these noble beasts are sold in stores in this country. I implore our government to take a visible stance in the fight against this ruthless and needless slaughter. My congressman will receive a letter asking what his stand is on this subject. If it is not what it should be, then he will no longer get my vote.

JEFF ELLIS
Telluride, Colorado

The photo on pages 6-7 shows a poster reading "Stop the Men Eating Tigers in Taiwan" while the text states that the practice "has declined there." One is led to believe it is still a practice. Nothing could be further from the truth. The government of Taiwan has taken great steps to stop the illegal use of endangered species. Laws akin to the Endangered Species Act in the U.S. have been enacted and are strongly enforced. More people in Taiwan have been convicted of violating these laws than in all of England, France, and Germany. The penalties are harsh.

ROBERT N. CLEAVES
Wilderness Conservancy
Los Angeles, California

The collection of photographs showing dead poachers (page 21) is presented as a victory on behalf of tiger conservation efforts. My God! Are tigers, albeit endangered, more important than human beings?

LORI HORN
Sylmar, California

The real quandary is not how to preserve wild cats but how to eliminate the poverty in the areas so that the need for income and food that the tiger might bring is eliminated.

H. M. KUHLMANN
Seattle, Washington

Australia by Bike

I was a student in Adelaide for four years and immersed myself in the Australian way of thinking and way of life. I discovered the mateship, the warped sense of humor, and how beautiful it was to be on the road, surrounded by clear blue sky and an endless carpet of red earth. I agree with you, Roff—Australia is truly magic.

ARRY TANUSONDJAJA
Jakarta, Indonesia

How refreshing in this day and age to hear of a group of people so eager to take in a stranger as one of their own. It is obviously a hard country to live in, filled with strong, friendly people who share a sense of family with all people. I see values that are long lost in today's world. If I had read this article 15 years ago when I was still single and without children, I might be living in the outback at this very moment. Thank you for the chance to escape the drudgery of daily life through one lucky man's adventure.

JIM KUCHARIK
Northampton, Pennsylvania

I had the good fortune to spend three summers bicycle touring around the United States. Describing

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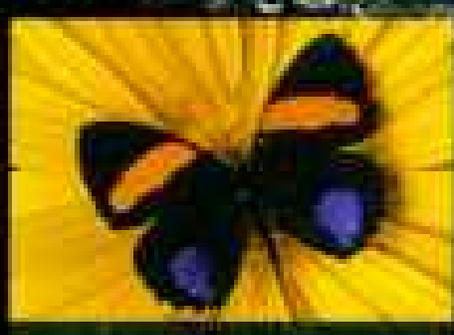

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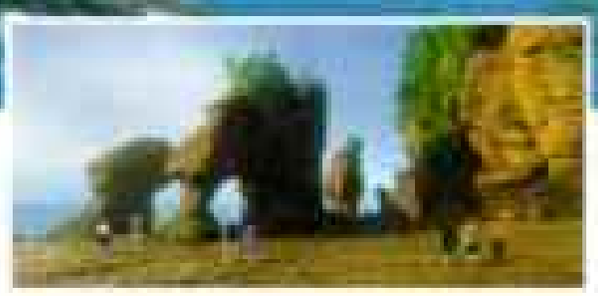
CANADA'S ATLANTIC COAST



Large image: Meet the Homefolks of Nova Scotia, Newfoundland & Labrador's shore. Small inset image: Walk the ocean floor at Nova Scotia's Bay of Fundy. One of the Marine Wonders of the World.

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those experiences to friends has always proved daunting, as bicycle touring combines a sense of adventure, a collage of human contacts, an appreciation for the land, and inward reflection and self-growth. Roff Martin Smith's article aptly combines those elements and provides testimony about why bicycle touring is well suited to learning about the interaction of people and their places. At heart, that is what geography is all about.

MIKE HARRIS
Williston, Vermont

Map: Ancient Mesoamericans

Mesoamerica refers to a great cultural area supposed to embrace many common traits for the human groups within. This concept was coined by Austrian ethnologist Paul Kirchhoff in 1943 and became the background for all Mexican anthropology, especially archaeology, but the concept has been criticized in the past five or six years by a number of researchers, including myself. Our argument is that many of the pre-Hispanic peoples in the area were not ethnically, culturally, or linguistically related, so we should no longer talk about one people called the Mesoamericans.

IGNACIO RODRIGUEZ GARCIA
National Institute of Anthropology and History
Mexico City, Mexico

You depict obsidian as a resource available in the Valley of Oaxaca, yet there is no obsidian source in the region. Also the canal system around Monte Albán was very small, not as large as you note. Nonetheless I appreciate the attention your journal gives to ancient Mesoamerica.

GARY FEINMAN
Professor of Anthropology
University of Wisconsin-Madison

The Age of Comets

I am tired of the "bad press" that comet Kohoutek got in 1973-74. Your caption for "A Comet Gallery" (pages 98-9) didn't treat comet Kohoutek fairly—"hardly visible to amateurs." I don't think so. I followed the object for several months and so did many other amateur astronomers. It was easily visible to the unaided eye during twilight in the first weeks of January 1974 and was a better performer than comet Halley in 1986. I have a nice shot of Kohoutek competing with a nearly full moon on January 7, 1974. Kohoutek was a very respectable comet and deserves better historical treatment.

DAVID KNISELY
Beatrice, Nebraska

The diagram on page 104 showing various comet tracks that pass through the solar system emphasized an inescapable fact: There is a comet or asteroid out there with our name on it. If I think "when?" I wonder about the Maya calendar. As one of the most accurate of the ancient world's calendars, it stops counting in the year 2012. Hmmm.

ARTHUR C. JOHNSON, JR.
Heathsville, Virginia

Your point is well-taken. However, 2012 is the end of only one cycle of the Maya calendar, which is perpetual.

Geographica

The report on bottle trees implies that Pennsylvania Dutch hex signs were placed on barns to ward off evil. This is an interpretation without merit, dating from the 1920s. They are, according to one Pennsylvania Dutchman, "chust for nice."

DAVID W. LUZ
Schuylkill Library
Pennsburg, Pennsylvania

Earth Almanac

The article on *Pfiesteria piscicida* was scarier than anything on the Sci-Fi Channel. Scarier because it is not fiction. We have stupidly polluted our world's waters, killing millions of creatures. Now we're creating millions of killers. Our ignorance is making monsters, and we should smarten up.

BEVERLY SIMONE
West Nyack, New York

The article referred to *Pfiesteria* as single-celled animals. There are no single-celled "animals." They are classified as dinoflagellates, kingdom Protista, not Animalia. As educators we try to fight such misconceptions all the time.

KIM ORSZAK
Charlestown, Massachusetts

Regarding the November piece on the depletion of *Echinacea purpurea* in the wilds, all species of echinacea are threatened along with goldenseal *(Hydrastis canadensis)* and ginseng. I belong to a nonprofit group called United Plant Savers (Box 420, East Barre, Vermont 05472), which was formed to protect our wild medicinal plant communities. The goals include raising public awareness about overharvesting, compiling information on threatened plants in each bioregion, providing resources for obtaining seeds, roots, and plants for restoration, and securing land trusts for the preservation of seed stocks for propagation efforts. If you use endangered herbs as part of your health care, make sure your product is cultivated and not wild crafted.

JULIE MITCHELL
Moretown, Vermont

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.

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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 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, 22%, and 135 mg/kg/day (or approximately 40, 180, 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:** Reduced pup weight gain was found in mice during lactation when dams were given cetirizine at 90 mg/kg/day (approximately 40 times the maximum recommended adult human daily oral dose on a mg/m² basis). Studies in lactating 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, 186 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 374 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 30 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 (2.0% 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% in 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 were no differences 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=2034) vs Placebo (N=1612) respectively:** Somnolence (13.7% vs 6.3%), Fatigue (5.9% vs 7.0%), Dry Mouth (5.0% vs 2.3%), Pharyngitis (2.2% 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 600 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=209):** Headache (11.0% 5 mg, 14.0%, 10 mg, 12.3%, placebo); Pharyngitis (6.2%, 5 mg; 2.8%, 10 mg; 2.9%, placebo); Abdominal pain (4.4% 5 mg; 5.6%, 10 mg, 1.9%, placebo); Coughing (4.4%, 5 mg; 2.8%, 10 mg; 2.9%, placebo); Somnolence (1.9%, 5 mg; 4.2%, 10 mg; 1.3%, placebo); Diarrhea (3.1% 5 mg; 1.9%, 10 mg; 1.3%, placebo); Epistaxis (3.0%, 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; 2.3%, 10 mg; 1.0%, placebo). The following events were observed infrequently (less than 2%) in either 3982 adults and children 12 years and older or in 688 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:** anosmia, urinary retention, flushing, increased salivation, dry mouth. **Cardiovascular:** palpitation, tachycardia, hypertension, cardiac failure. **Central and Peripheral Nervous Systems:** paresthesia, confusion, hyperkinesia, hypertonia, migraine, tremor, vertigo, leg cramps, ataxia, dysphonia, abnormal coordination, hyperesthesia, hypokinesia, 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, eructation. **Genitourinary:** polyuria, urinary tract infection, cystitis, dysuria, hematuria, micturition frequency, urinary incontinence. **Hearing and Vestibular:** earache, tinnitus, deafness, otorrhoea. **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, hypokeratosis, hyperhidrosis, 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 potential 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 100 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. 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NATIONAL GEOGRAPHIC

Geographica

SAM KITNER (ABOVE); MASSACHUSETTS ART COMMISSION

Marching to Glory in the Nation's Capital

With grim determination, the Civil War's most storied black unit strides toward destiny: a valiant but vain effort to seize Fort Wagner, South Carolina. Under Col. Robert Gould Shaw, who died with many of his men, the Massachusetts 54th Regiment—featured in the film *Glory*—inspired sculptor Augustus Saint-Gaudens to create a tribute. Veterans attended the dedication of the bronze original a century ago in Boston (left). Now a restored plaster version has a home in the National Gallery of Art (above), in an area being remodeled and due to reopen this fall. Curator Nicolai Cikovsky, Jr., says the memorial "adds a new national monument to Washington." The plaster sculpture had been at Saint-Gaudens National Historic Site in Cornish, New Hampshire.

■ NGS RESEARCH GRANT

A "New" Jaw Reopens Some Old Questions

This shrew-size mammal (right) lived in what is now Australia 115 million years ago. But to the researchers whose team uncovered its fossilized jaw southeast of Melbourne, the animal was in the "wrong" place at the "wrong" time. That's because its teeth hint that it may have been a placental mammal. And except for bats, placentals are not known to have entered Australia until five million years ago.

Thomas Rich and Patricia Vickers-Rich found this jaw in a long-term Society-funded search for early Cretaceous fossils. Its teeth indicate *Ausktribosphenos nyktos* was neither an egg-laying mammal like a platypus nor a pouched marsupial like a kangaroo. "A good case can be made that it is a placental," Rich says. "If so, it will force us to rethink basic ideas about the origin and evolution of mammals."

STEVEN MORTON; ART BY CRAIG SELT

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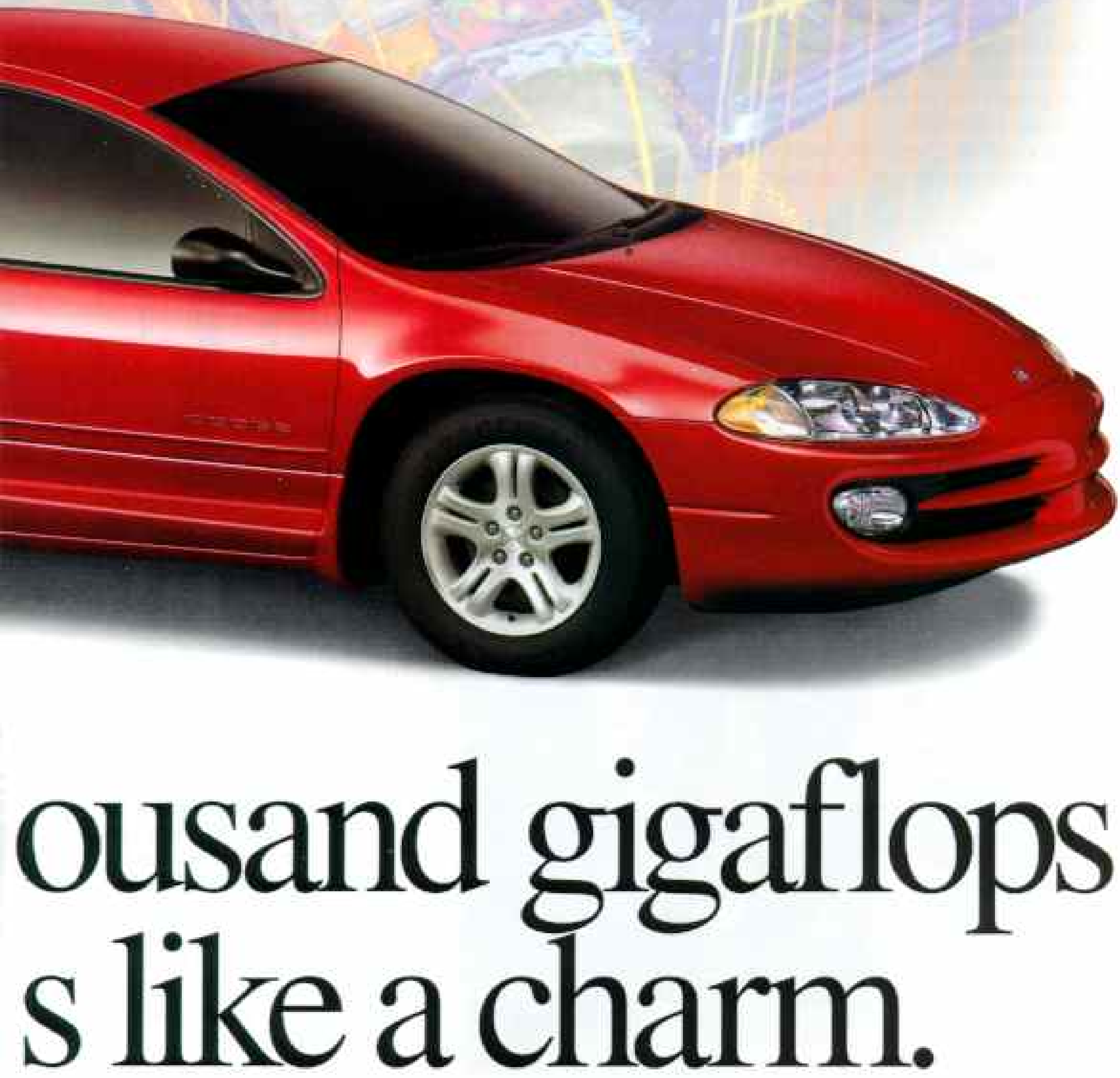

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KEVIN MULLOWEY, GEORGE STEWART (BELOW)

Spear-throwers Hurl Into the Past

Harking back to prehistoric ancestors, Bill Tate flings a spear into the Colorado sky with an atlatl, a hooked stick that holds the missile in place and adds to the force of the throw.

The World Atlatl Association, based in Ocotillo, California, of which Tate was the first president, has stimulated interest in the primitive technology. The group's 400 members take part in distance and accuracy contests in the U.S. and Europe; one man using a carbon-fiber atlatl hurled an aluminum spear nearly 850 feet. Archaeologists have shown that a spear chucked with an atlatl could fell bison and mammoth. Today several U.S. states allow its use in hunting.

The device made its appearance at least 17,000 years ago in Europe and was known on every populated continent but Africa. It was named atlatl by the Aztec, who used the aid to launch darts that pierced Spanish armor. It was called *propulseur* in Europe, *wumera* in Australia, and *norsuq* by the Inuit, among the last traditionalists to use it to hunt.

Homage to Augustus: a Statue in Troy

The ancient Romans considered heroic Aeneas and his fellow Trojans, who settled in Italy after the Trojan War, their early ancestors. So it is not surprising that Augustus, who became the first emperor of Rome in 27 B.C. (GEOGRAPHIC, July 1997), set about revitalizing the city of Troy, in modern-day Turkey.

Now archaeologists have found a tangible link between Troy and Augustus: a marble head of the emperor that probably topped a full-length statue in the city's theater. "We know it's him because of the hairstyle with bangs falling on the forehead and the shape of the nose and the strong chin," says Brian Rose of the University of Cincinnati, at far right. His team has found pottery, coins, and other sculpture, indicating a Trojan renewal during the Augustan era, a burst of vitality that lasted until the fifth century A.D.

MICHELLE SCHNEIDER, UNIVERSITY OF CINCINNATI

Creative Science Foils a Vicious Cereal Killer

Working below the surface, a parasitic plant known as witchweed siphons nutrients from the roots of Africa's vital cereal plants, such as sorghum (above, at left), leaving it bedraggled and dying, at right. Yearly crop losses in West Africa alone range up to seven billion dollars and affect a hundred million lives. "Truly it bewitches the host plant," says Purdue University's Gebisa Ejeta, who has developed a sorghum variety resistant to witchweed. Its seeds are being snapped up across Africa—so eagerly that Ethiopian farmers, for example, smuggled seeds in from Sudan before their own government agreed to distribute them.

TEXT BY BORIS WEINTRAUB

What to do when a whale calls 911.

In January 1997, a baby gray whale was found struggling along the California coast. Separated from her mother at birth, she was weak, dehydrated and barely clinging to life. Her only chance for survival was Sea World. Thanks to an around the clock team of dedicated marine mammal specialists and veterinarians, thousands of gallons of clams, fish and cream, and her very own 1.7-million-gallon pool, this big baby named J.J. is still making history. Now a robust 20,000 pounds, J.J. is ready to face her next challenge. If all goes well, her successful return to the ocean will begin a new chapter in a very special story.

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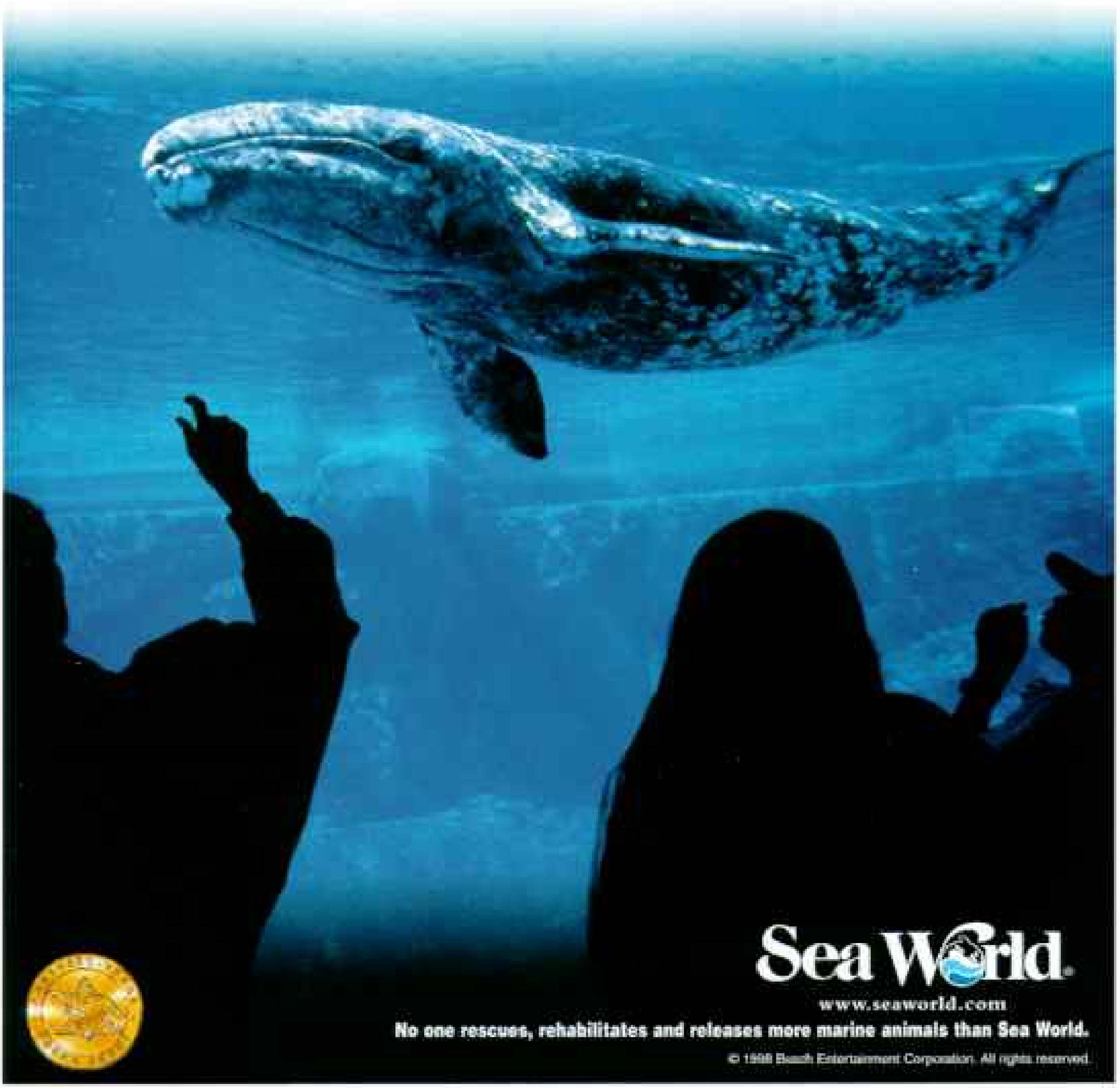

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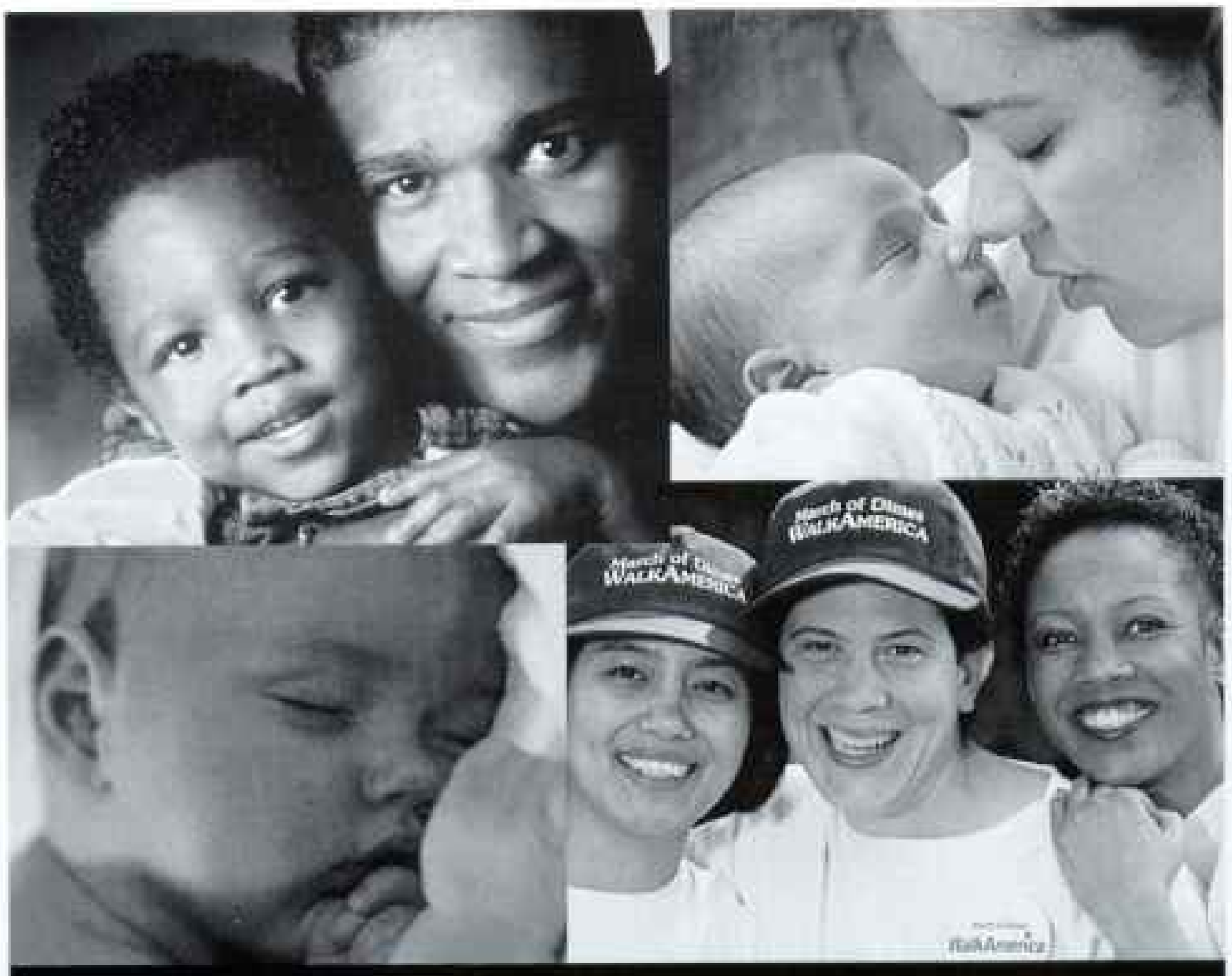

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CONTRAINDICATIONS: Hypersensitivity to any component of this medication. Active liver disease or unexplained, persistent elevations in liver function tests (see **WARNINGS**). *Pregnancy and lactation.* Atherosclerosis is a chronic process and discontinuation of lipid lowering drugs during pregnancy should have little impact on the outcome of long-term therapy of primary hypercholesterolemia. Cholesterol and other products of cholesterol biosynthesis are essential components for fetal development (including synthesis of steroids and cell membranes). Since HMG-CoA reductase inhibitors decrease cholesterol synthesis and possibly the synthesis of other biologically active substances derived from cholesterol, they may cause fetal harm when administered to pregnant women. Therefore, HMG-CoA reductase inhibitors are contraindicated during pregnancy and in nursing mothers. **Pravastatin should be administered to women of childbearing age only when such patients are highly unlikely to conceive and have been informed of the potential hazards.** If the patient becomes pregnant while taking this class of drug, therapy should be discontinued and the patient apprised of the potential hazard to the fetus.

WARNINGS: Liver Enzymes. *HMG-CoA reductase inhibitors, like some other lipid-lowering therapies, have been* associated with biochemical abnormalities of liver function. Increases of serum transaminase (ALT, AST) values to more than 3 times the upper limit of normal occurring on 2 or more (not necessarily sequential) occasions have been reported in 1.3% of patients treated with pravastatin in the US over an average period of 18 months. These abnormalities were not associated with cholestasis and did not appear to be related to treatment duration. In these patients in which these abnormalities were believed to be resistant to pravastatin and who were discontinued from therapy, the transaminase levels usually fell slowly to pretreatment levels. These biochemical findings are usually asymptomatic although worldwide experience indicates that tiredness, weakness, and/or abdominal pain may also be present in rare patients. In the largest long-term placebo-controlled clinical trial with pravastatin (Prevention Primary Prevention Study; See **Clinical Pharmacology**), the overall incidence of AST and/or ALT elevations is greater than three times the upper limit of normal was 1.05% in the pravastatin group as compared to 0.72% in the placebo group. One (0.02%) pravastatin-treated patient and 2 (0.06%) placebo-treated patients were discontinued because of transaminase elevations. Of the patients with normal liver function at week 12, three of 2675 treated with pravastatin (0.11%) and one of the 2919 placebo patients (0.03%) had elevations of AST greater than three times the upper limit of normal on two consecutive measurements and/or discontinued due to elevations in transaminase levels during the 4.8 years (median treatment) of the study. **It is recommended that liver function tests be performed prior to and at 12 weeks following initiation of therapy or the elevation of dose.** Patients who develop increased transaminase levels or signs and symptoms of liver disease should be monitored with a second liver function evaluation to confirm the finding and be followed thereafter with frequent liver function tests until the abnormality(ies) return to normal. Should an increase in AST or ALT of three times the upper limit of normal or greater persist, withdrawal of pravastatin therapy is recommended. Active liver disease or unexplained transaminase elevations are contraindications to the use of pravastatin (see **CONTRAINDICATIONS**). Caution should be exercised when pravastatin is administered to patients with a history of liver disease or heavy alcohol ingestion (see **CLINICAL PHARMACOLOGY: Pharmacokinetics/Metabolism**). Such patients should be closely monitored, started at the lower end of the recommended dosing range, and titrated to the desired therapeutic effect. **Skeletal Muscle. Rare cases of rhabdomyolysis with acute renal failure secondary to myoglobinuria have been reported with pravastatin and other drugs in this class.** Unexplained myalgia has also been reported in pravastatin-treated patients (see **ADVERSE REACTIONS**). Myopathy, defined as muscle aching or muscle weakness in conjunction with increases in creatine phosphokinase (CPK) values to greater than 10 times the upper normal limit, was rare (< 0.1%) in pravastatin clinical trials. Myopathy should be considered in any patient with diffuse myalgias, muscle tenderness or weakness, and/or marked elevation of CPK. Patients should be advised to report promptly unexplained muscle pain, tenderness or weakness, particularly if accompanied by malaise or fever. **Pravastatin therapy should be discontinued if markedly elevated CPK levels occur or myopathy is diagnosed or suspected. Pravastatin therapy should also be temporarily withheld in any patient experiencing an acute or serious condition predisposing to the development of renal failure secondary to rhabdomyolysis, e.g., sepsis; hypotension; major surgery; trauma; severe metabolic, endocrine, or electrolyte disorders; or uncontrolled epilepsy.** The risk of myopathy during treatment with another HMG-CoA reductase inhibitor is increased with concurrent therapy with either erythromycin, nicotinamide, niacin, or fibrates. However, neither myopathy nor significant increases in CPK levels have been observed in three reports involving a total of 100 post-transplant patients (74 renal and 26 cardiac) stabilized for up to two years concurrently with pravastatin (10-40 mg) and cyclosporine. Some of these patients also received other concomitant immunosuppressive therapies. In one single-dose study, pravastatin levels were found to be increased in cardiac transplant patients receiving cyclosporine. Further, in clinical trials involving small numbers of patients who were treated concurrently with pravastatin and niacin, there were no reports of myopathy. Also, myopathy was not reported in a trial of combination pravastatin (40 mg/day) and gemfibrozil (1200 mg/day), although 4 of 75 patients on the combination showed marked CPK elevations versus one of 73 patients receiving placebo. There was a trend toward more frequent CPK elevations and patient withdrawals due to musculoskeletal symptoms in the group receiving combined treatment as compared with the groups receiving placebo, gemfibrozil, or pravastatin monotherapy (see **PRECAUTIONS: Drug Interactions**). **The use of fibrates alone may occasionally be associated with myopathy. The combined use of pravastatin and fibrates should be avoided unless the benefit of further alterations in lipid levels is likely to outweigh the increased risk of this drug combination.**

PRECAUTIONS: General: *Pravastatin may elevate creatinine phosphokinase and transaminase levels (see* **ADVERSE REACTIONS**). *This should be considered in the differential diagnosis of chest pain in a patient on therapy with pravastatin. Heterozygous Familial Hypercholesterolemia.* Pravastatin has not been evaluated in patients with rare homozygous familial hypercholesterolemia. In this group of patients, it has been reported that HMG-CoA reductase inhibitors are less effective because the patients lack functional LDL receptors. *Renal Insufficiency.* A single 20 mg oral dose of pravastatin was administered to 24 patients with varying degrees of renal impairment (as determined by creatinine clearance). No effect was observed on the pharmacokinetics of pravastatin or its 3α-hydroxy isomeric metabolite (SQ 31,906). A small increase was seen in mean AUC values and half-life (t½) for the inactive enzymatic ring hydroxylation metabolite (SQ 31,945). Given this small sample size, the dosage administered, and the degree of individual variability, patients with renal impairment who are receiving pravastatin should be closely monitored. **Information for Patients:** *Patients should be advised to report promptly unexplained muscle pain, tenderness or weakness, particularly if accompanied by malaise or fever.* **Drug Interactions:** *Immunosuppressive Drugs, Gemfibrozil, Niacin (Nicotinic Acid), Erythromycin* (See **WARNINGS: Skeletal Muscle**). *Antacids:* Since concomitant administration of pravastatin had no effect on the clearance of lansoprazole, interactions with other drugs metabolized via the same hepatic cytochrome isozymes are not expected. *Cholestyramine/Colestipol:* Concomitant administration resulted in an approximately 40 to 50% decrease in the mean AUC of pravastatin. However, when pravastatin was administered 1 hour before or 4 hours after cholestyramine or 1 hour before colestipol and a standard meal, there was no clinically significant decrease in bioavailability or therapeutic effect. (See **DOSAGE AND ADMINISTRATION: Concomitant Therapy**.) *Warfarin:* In a study involving 16 healthy male subjects given pravastatin and warfarin concomitantly for 6 days, steady-state parameters of steady state for pravastatin (parent compound) were not altered. Pravastatin did not alter the plasma protein binding of warfarin. Concomitant dosing did increase the AUC and Cmax of warfarin but did not produce any changes in its anticoagulant action (i.e., no increase was seen in mean prothrombin time after 6 days of concomitant therapy). However, bleeding and extreme prolongation of prothrombin time has been reported with another drug in this class. Patients receiving warfarin-type anticoagulants should have their prothrombin times closely monitored when pravastatin is initiated or the dosage of pravastatin is changed. *Cimetidine:* The AUC, t½, for pravastatin when given with cimetidine was not significantly different from the AUC for pravastatin when given alone. A significant difference was observed between the AUC's for pravastatin when given with cimetidine compared to when administered with antacid. *Digoxin:* In a crossover trial involving 18 healthy male subjects given pravastatin and digoxin concurrently for 9 days, the bioavailability parameters of digoxin were not affected. The AUC of pravastatin tended to increase, but the overall bioavailability of pravastatin plus its metabolites (SQ 31,906 and SQ 31,945) was not altered. *Cyclosporine:* Some investigators have measured cyclosporine levels in patients on pravastatin, and to date, these results have not revealed any clinically meaningful alterations in cyclosporine levels. In one single-dose study of pravastatin, levels were found to be increased in cardiac transplant patients receiving cyclosporine. *Sertraline:* In a crossover study in 29 healthy male volunteers given concomitant single doses of pravastatin and sertraline, there was a significant decrease in urinary recoveries and protein binding of pravastatin. In addition, there was a significant increase in AUC, Cmax, and t½ for the pravastatin metabolite SQ 31,945. *Combination therapy with pravastatin and gemfibrozil is generally not recommended.* In interaction studies with aspirin, antacids (1 hour prior to PRAVACHOL), cimetidine, nicotinic acid, or probucol, no statistically significant differences in bioavailability were seen when PRAVACHOL (pravastatin sodium) was administered. *Other Drugs:* During clinical trials, no noticeable drug interactions were reported when PRAVACHOL was added to diuretics, antihypertensives, digitalis, ACE inhibitors, calcium channel blockers, beta-blockers, or nitroglycerin. **Endocrine Function:** HMG-CoA reductase inhibitors interfere with cholesterol synthesis and could conceivably impair steroid and/or gonadal steroid hormone production. Results of clinical trials with pravastatin in males and post-menopausal females were reevaluated with regard to possible effects at the drug on basal hormone levels. In a study of 21 males, the mean testosterone response to human chorionic gonadotropin was significantly reduced ($p = 0.004$) after 16 weeks of treatment with 40 mg of pravastatin. However, the percentage of patients showing a ≥ 50% rise in plasma testosterone after human chorionic gonadotropin stimulation did not change significantly after therapy in these patients. The effects of HMG-CoA reductase inhibitors on spermatogenesis and fertility have not been studied in adequate numbers of patients. The effects, if any, of pravastatin on the pituitary-gonadal axis in pre-menopausal females are unknown. Patients treated with pravastatin who display clinical evidence of endocrine dysfunction should be evaluated appropriately. Caution should also be exercised if an HMG-CoA reductase inhibitor or other agent used to lower cholesterol levels is administered to patients also receiving other drugs (e.g., ketoconazole, spironolactone, cimetidine) that may diminish the levels or activity of steroid hormones. **CNS Toxicity:** CNS vascular lesions, characterized by perivascular hemorrhage and edema and mononuclear cell infiltration of perivascular spaces, were seen in dogs treated with pravastatin at a dose of 25 mg/kg/day, a dose that produced a plasma drug level about 30 times higher than the mean drug level in humans taking 40 mg/day. Similar CNS vascular lesions have been observed with several other drugs in the class. A chemically similar drug in this class produced optic nerve degeneration (Wallerian degeneration of optic nerve fibers) in clinically normal dogs in a dose-dependent fashion starting at 50 mg/kg/day, a dose that produced mean plasma drug levels about 30 times higher than the mean drug level in humans taking the highest recommended dose (as measured by total enzyme inhibitory activity). This same drug also produced vacuolization of peripheral Wallerian-like degeneration and retinal ganglion cell chromatolysis in dogs treated for 14 weeks at 180 mg/kg/day, a dose which resulted in a mean plasma drug level similar to that seen with the 50 mg/kg/day dose.

Carcinogenesis, Mutagenesis, Impairment of Fertility: *In a 2-year study in rats fed pravastatin at doses of 10, 30, or 100 mg/kg body weight, there was an increased incidence of hepatocellular carcinomas in males at the highest dose ($p < 0.01$). Although rats were given up to 125 times the human dose (100 on a mg/kg body weight basis, serum drug levels were only 6 to 10 times higher than those measured in humans given 40 mg pravastatin as measured by AUC. The oral administration of 10, 30, or 100 mg/kg pravastatin produced plasma drug levels approximately 0.5 to 5.0 times the human drug levels at 40 mg/d of pravastatin to mice for 22 months resulted in a statistically significant increased in the incidence of malignant lymphomas in treated females when all treatment groups were pooled and compared to controls ($p < 0.05$). The incidence was not dose-related and male mice were not affected. A chemically similar drug in this class was administered to mice for 72 weeks at 25, 100, and 400 mg/kg body weight, which resulted in mean plasma drug levels approximately 0.1%, and 13 times higher than the mean human serum drug concentration (as total radioactivity activity) after a 40 mg oral dose. Liver carcinomas were significantly increased in high dose females and mid- and high dose males, with a maximum incidence of 90 percent in males. The incidence of adenomas of the liver were significantly increased in mid- and high-dose females. Drug treatment also significantly increased the incidence of lung adenomas in mid- and high-dose males and females. Adenomas of the eye (harderian gland is gland of the eye of rodents) were significantly higher in high dose mice than in controls. No evidence of mutagenicity was observed in vitro (with or without rat liver metabolic activation) in the following studies: microbial mutagen tests using mutant strains of Salmonella typhimurium or Escherichia coli; a forward mutation assay in L5178Y TK +/- mouse lymphoma cells; a chromosomal aberration test in Chinese cells; and a gene conversion assay using Saccharomyces cerevisiae. In addition, there was no evidence of clastogenicity in either a dominant lethal test in mice or a micronucleus test in mice. In a study in rats, with daily doses up to 500 mg/kg, pravastatin did not produce any adverse effects on fertility or general reproductive performance. However, in a study with another HMG-CoA reductase inhibitor, there was decreased fertility in male rats treated for 24 weeks at 5.5 mg/kg body weight, although this effect was not observed in a subsequent fertility study when this same dose was administered for 11 weeks (the entire cycle of spermatogenesis, including epididymal maturation). In rats treated with this same reductase inhibitor at 180 mg/kg/day, seminiferous tubule degeneration (necrosis) and loss of spermatogenic epithelium was observed. Although not seen with pravastatin, two similar drugs in this class caused drug-related testicular atrophy, decreased spermatogenesis, spermatocytic degeneration, and giant cell formation in dogs. The clinical significance of these findings is unclear.* **Pregnancy: Pregnancy Category X.** (see **CONTRAINDICATIONS**). Safety in pregnant women has not been established. Pravastatin was not teratogenic in rats or mice up to 1000 mg/kg daily or in rabbits at doses of up to 30 mg/kg daily. These doses resulted in 20x (rabbit) or 240x (rat) the human exposure based on surface area (mg/meter²). However, in studies with another HMG-CoA reductase inhibitor, skeletal malformations were observed in rats and mice. There has been one report of severe congenital limb deficiency, tracheo-esophageal fistula, and anal atresia (VATER association) in a baby born to a woman who took another HMG-CoA reductase inhibitor with first-trimester exposure. Rubella infection during the first trimester of pregnancy. PRAVACHOL (pravastatin sodium) should be administered to women of child bearing potential only when such patients are highly unlikely to conceive and have been informed of the potential hazards. If the women becomes pregnant while taking PRAVACHOL (pravastatin sodium), it should be discontinued and the patient advised again as to the potential hazards to the fetus. **Nursing Mothers:** A small amount of pravastatin is excreted in human breast milk. Because of the potential for serious adverse reactions in nursing infants, women taking PRAVACHOL should not nurse (see **CONTRAINDICATIONS**). **Pediatric Use:** Safety and effectiveness in children less than 18 years old have not been established. Hence, treatment in patients less than 18 years old is not recommended at this time.

ADVERSE REACTIONS: Pravastatin is generally well tolerated; adverse reactions have usually been mild and transient. In 4-month long placebo-controlled trials, 1.2% of pravastatin treated patients and 1.2% of placebo-treated patients were discontinued from treatment because of adverse experiences attributed to study drug therapy; this difference was not statistically significant. In long-term studies, the most common reasons for discontinuation were asymptomatic serum transaminase increases and mild, non-specific gastrointestinal complaints. During clinical trials the overall incidence of adverse events in the elderly was not different from the incidence observed in younger patients. **Adverse Clinical Events:** All adverse clinical events (regardless of attribution) reported in more than 2% of pravastatin-treated patients in the placebo controlled trials are identified in the table below; also shown are the percentages of patients in whom these medical events were believed to be related or possibly related to the drug:

	All Events		Events Attributed to Study Drug	
Body System/Event	Pravastatin (N = 900) %	Placebo (N = 411) %	Pravastatin (N = 368) %	Placebo (N = 411) %
Cardiovascular				
Cardiac Chest Pain	4.2	3.4	0.7	1.0
Dermatologic: Rash	4.0*	1.1	1.3	0.2
Gastrointestinal				
Nausea/Vomiting	7.3	7.1	2.3	3.4
Diarrhea	6.2	5.8	2.0	1.9
Abdominal Pain	5.4	6.3	2.5	2.9
Constipation	4.6	7.1	2.4	3.1
Flatulence	5.3	3.8	2.7	3.4
Heartburn	2.8	1.8	2.5	0.7
General				
Fatigue	3.8	3.4	1.8	1.3
Chest Pain	3.7	1.8	0.3	0.2
Influenza	2.4*	0.7	0.6	0.2
Musculoskeletal				
Localized Pain	10.0	9.0	1.4	1.5
Myalgia	3.7	1.0	0.8	0.0
Nervous System				
Headache	8.2	3.9	1.7*	0.7
Dizziness	3.3	3.2	1.0	0.5
Renal/Genitourinary				
Urinary Abnormality	2.4	2.9	0.7	1.2
Respiratory				
Common Cold	7.0	6.3	0.6	0.2
Rhinitis	6.5	6.1	0.1	0.2
Cough	2.9	1.7	0.1	0.2

*Statistically significantly different from placebo.

In the Pravastatin Primary Prevention Study (West of Scotland Coronary Prevention Study) (see **CLINICAL PHARMACOLOGY: Clinical Studies**) involving 6595 patients treated with PRAVACHOL (pravastatin sodium) (N = 3302) or placebo (N = 3293) the adverse event profile in the pravastatin group was comparable to that of the placebo group over the median 4.8 years of the study. The following effects have been reported with drugs in this class; not all the effects listed below have necessarily been associated with pravastatin therapy. *Skeletal:* myopathy, rhabdomyolysis, arthralgia. *Neurological:* dysfunction of certain cranial nerves (including alteration of taste, impairment of extra ocular movement, facial paresis), tremor, vertigo, memory loss, paresthesia, peripheral neuropathy, peripheral nerve palsy, anxiety, insomnia, depression. *Hypersensitivity Reactions:* An apparent hypersensitivity syndrome has been reported rarely which has included one or more of the following features: anaphylaxis, angioedema, lupus erythematous-like syndrome, polymyalgia rheumatica, dermatomyositis, vasculitis, purpura, thrombocytopenia, leukopenia, hemolytic anemia, positive ANA, ESR increase, eosinophilia, arthritis, arthralgia, urticaria, asthenia, photosensitivity, fever, chills, flushing, malaise, dyspnea, toxic epidermal necrolysis, erythema multiforme, including Stevens-Johnson syndrome. *Gastrointestinal:* pancreatitis, hepatitis, including chronic active hepatitis, cholestatic jaundice, fatty change in liver, and, rarely, cirrhosis, fulminant hepatic necrosis, and hepatoma, anorexia, vomiting. *Skin:* alopecia, pruritus. A variety of skin changes (e.g., nodules, discoloration, dryness of skin/mucous membranes, changes to hair/nails) have been reported. *Reproductive:* gynecomastia, loss of libido, erectile dysfunction. *Eye:* progression of cataracts (lens opacities), ophthalmoplegia. *Laboratory Abnormalities:* elevated transaminases, alkaline phosphatase, and bilirubin; thyroid function abnormalities. **Laboratory Test Abnormalities:** Increases in serum transaminase (ALT, AST) values and CPK have been observed (see **WARNINGS**). Transient, asymptomatic eosinophilia has been reported. Leukopenia usually returned to normal despite continued therapy. Anemia, thrombocytopenia, and leukopenia have been reported with HMG-CoA reductase inhibitors. **Concomitant Therapy:** Pravastatin has been administered concurrently with cholestyramine, colestipol, nicotinic acid, probucol and gemfibrozil. Preliminary data suggest that the addition of either probucol or gemfibrozil to therapy with lovastatin or pravastatin is **not** associated with greater reduction in LDL-cholesterol than that achieved with lovastatin or pravastatin alone. No adverse reactions unique to the combination or in addition to those previously reported for each drug alone have been reported. Myopathy and rhabdomyolysis (with or without acute renal failure) have been reported when another HMG-CoA reductase inhibitor was used in combination with immunosuppressive drugs, gemfibrozil, erythromycin, or lipid lowering doses of nicotinic acid. Concomitant therapy with HMG-CoA reductase inhibitors and these agents is generally not recommended. (See **WARNINGS: Skeletal Muscle** and **PRECAUTIONS: Drug Interactions**.)

OVERDOSAGE: To date, there are two reported cases of overdosage with pravastatin, both of which were asymptomatic and not associated with clinical laboratory abnormalities. If an overdose occurs, it should be treated symptomatically and supportive measures should be instituted as required.

CAUTION: Federal (USA) law prohibits dispensing without prescription.

Revised April 1997
CO-80001-4-97

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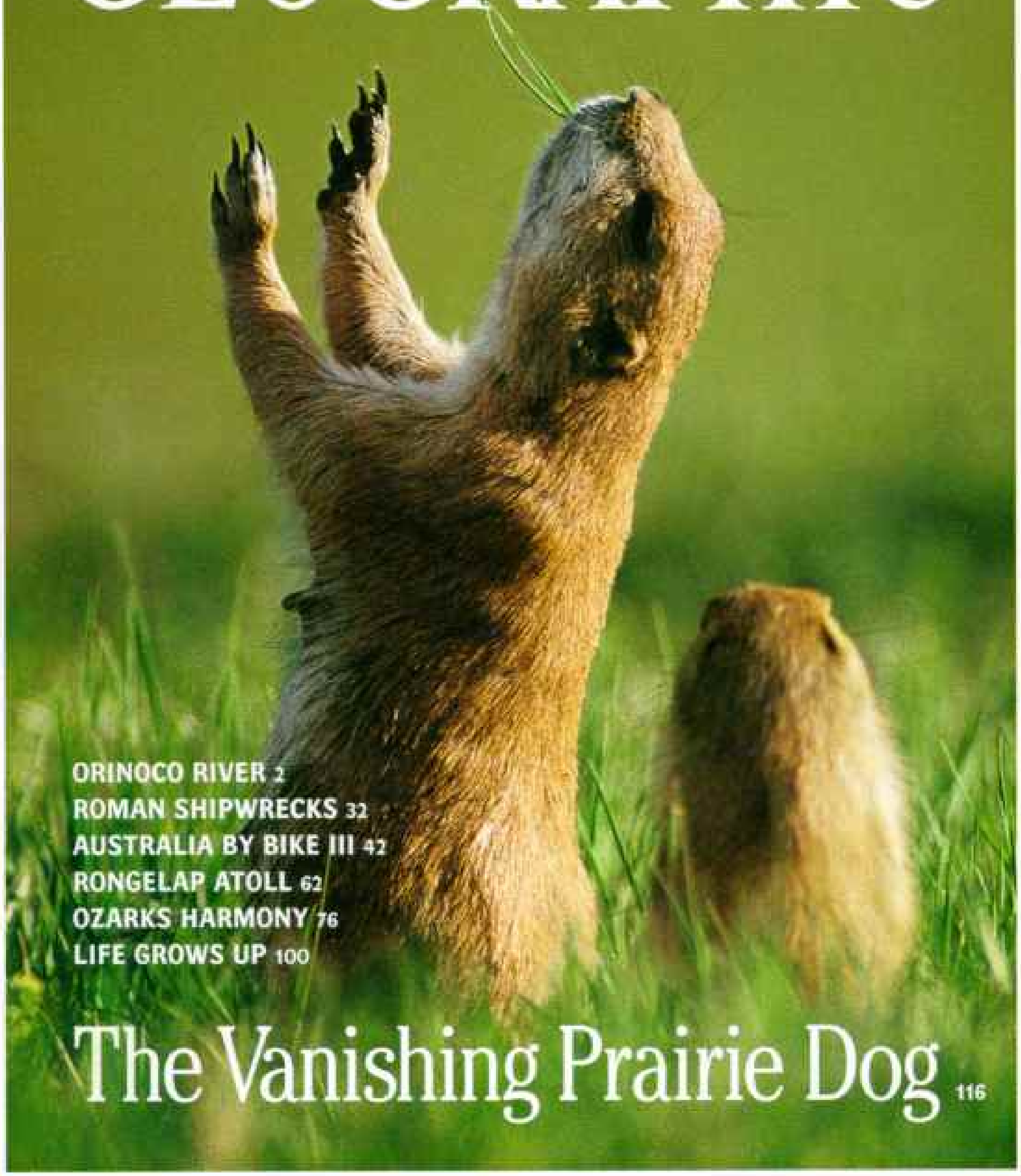

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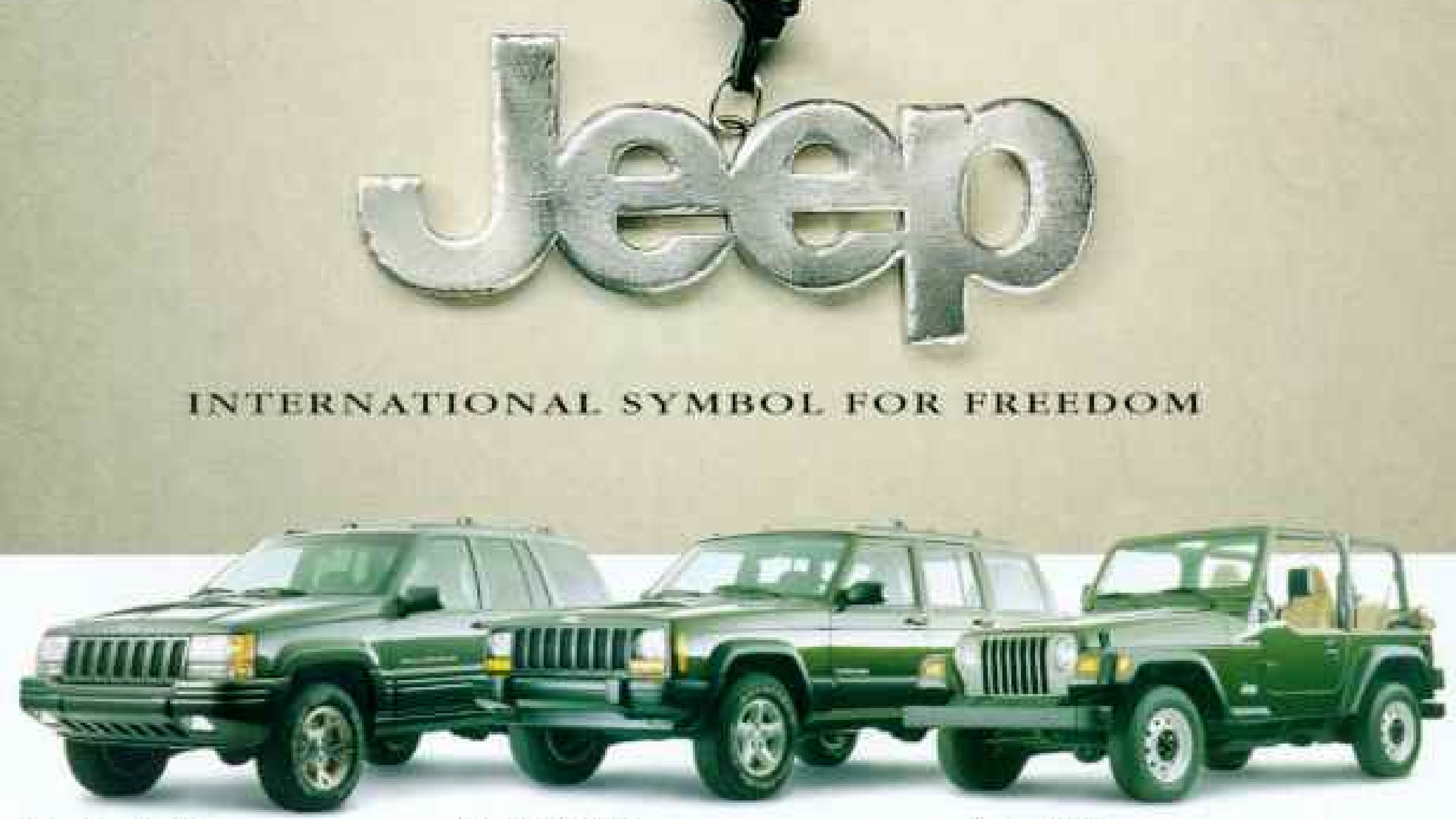

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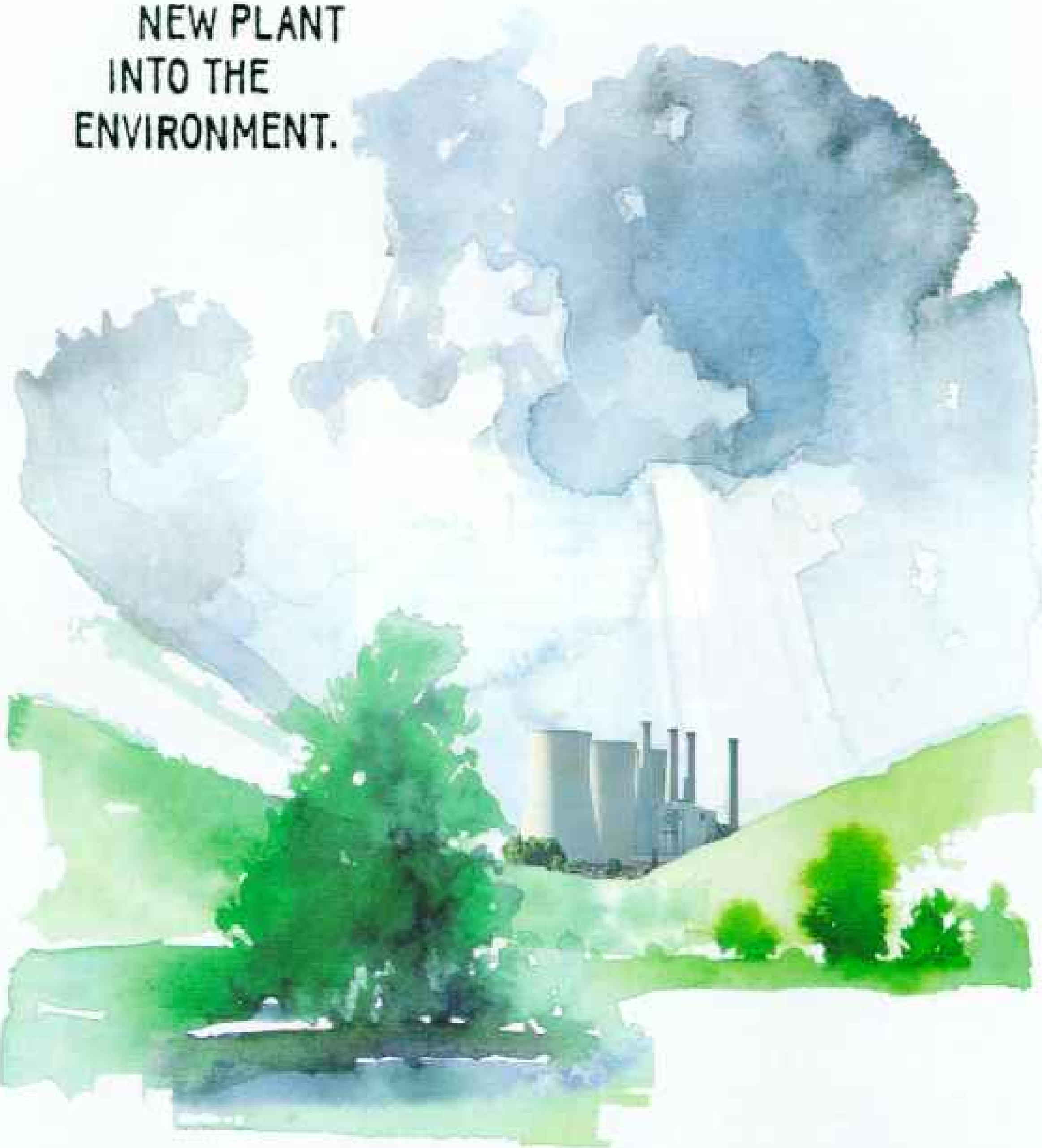

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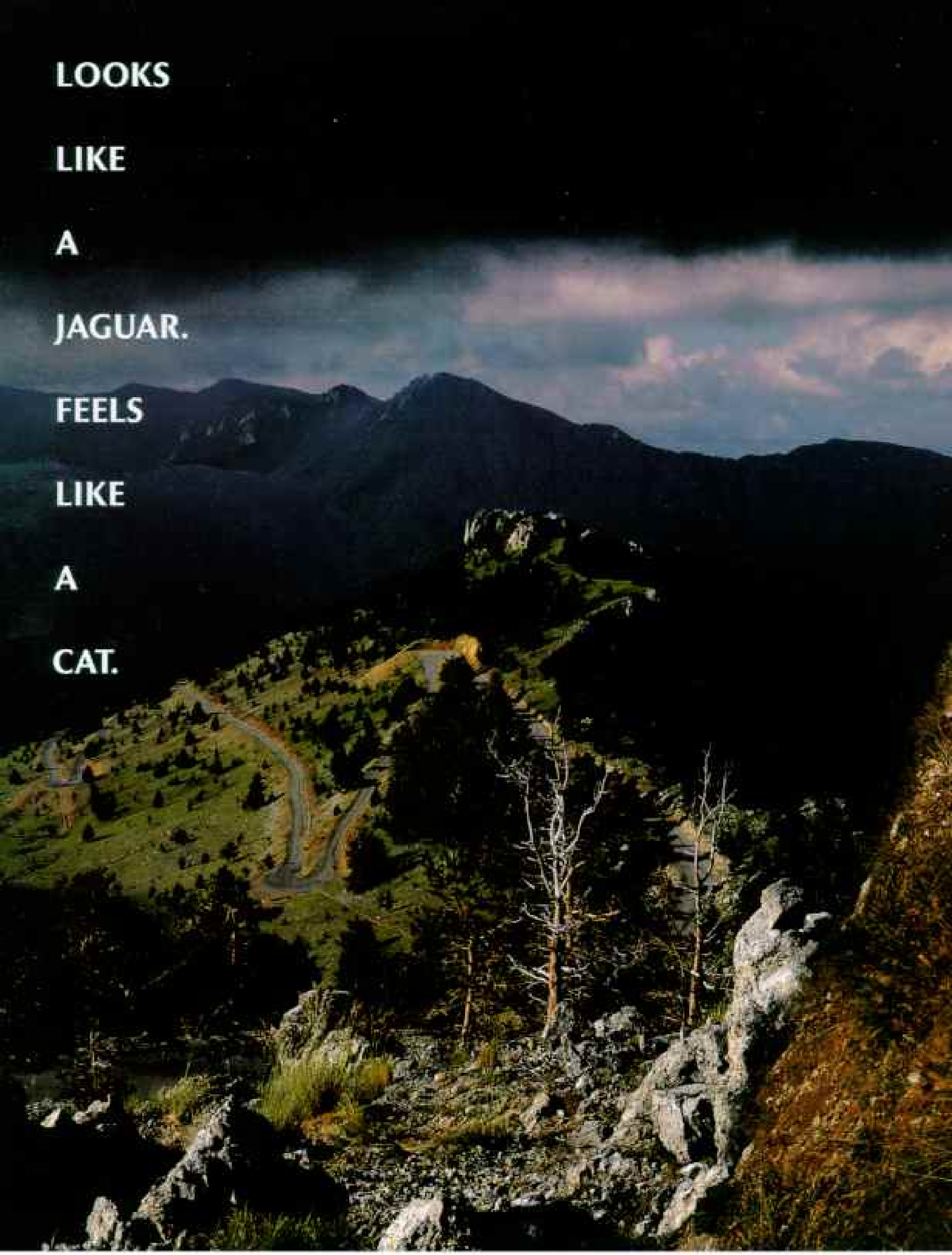

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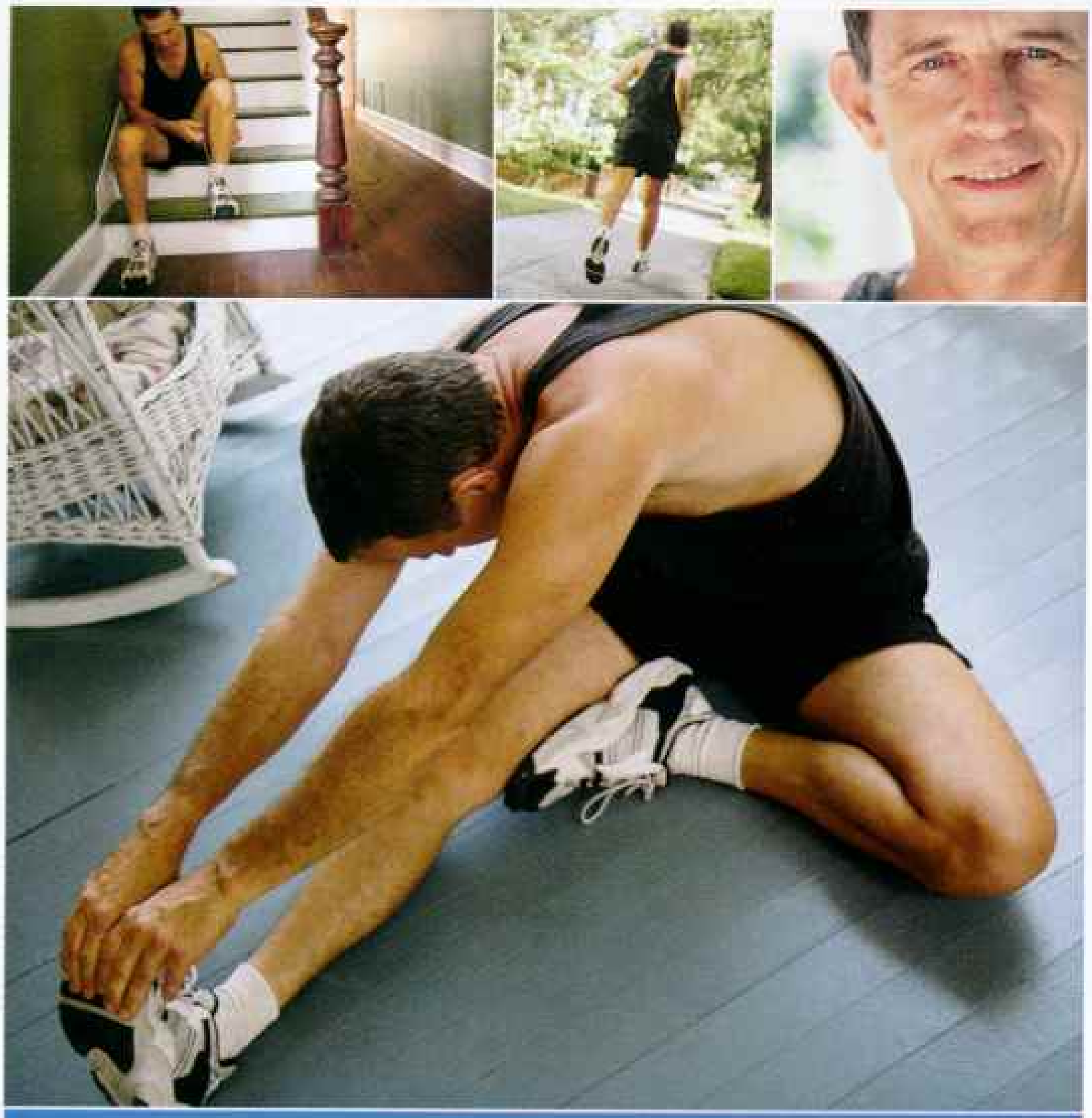

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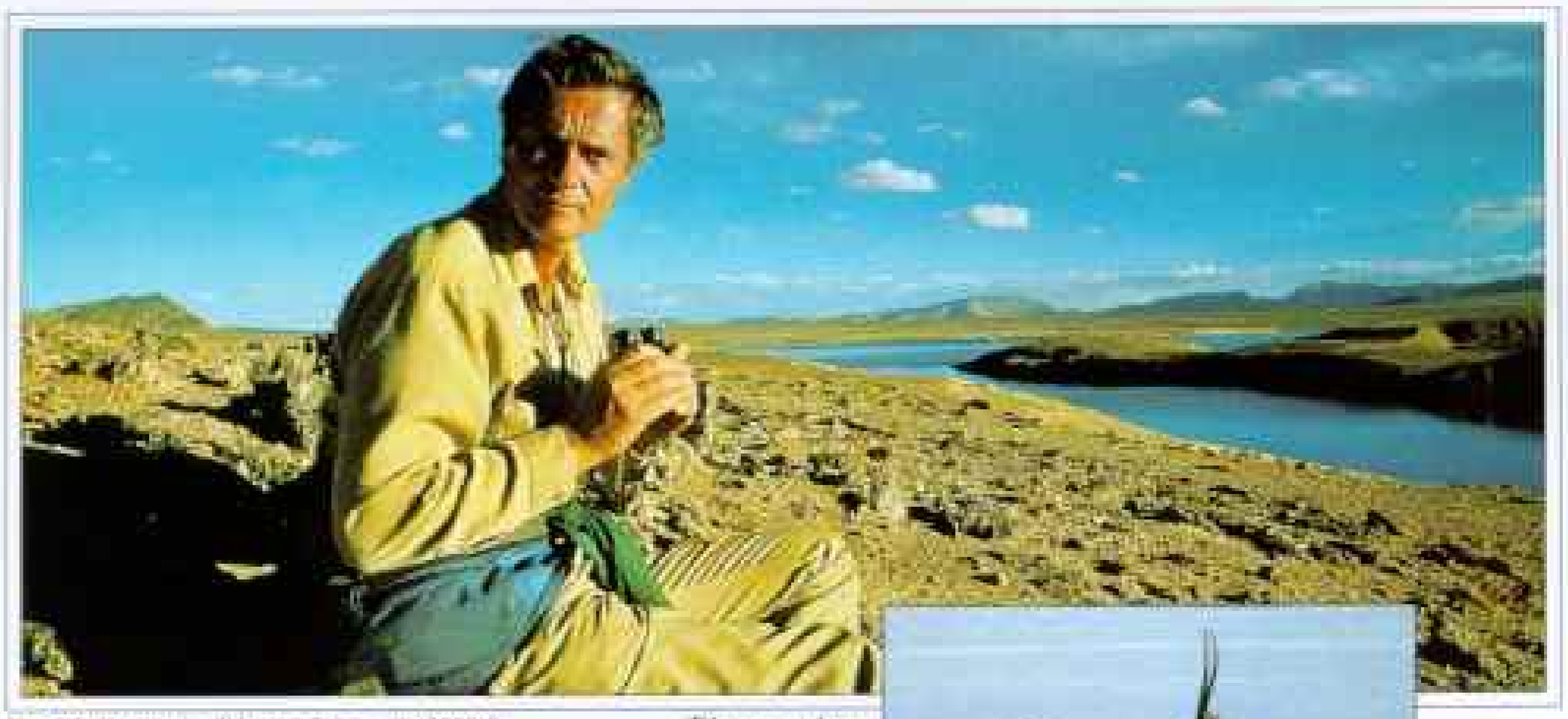

Dr. Schaller on the Tibetan plateau at 17000 ft.

Tibetan antelopes

Chang Tang—the name means northern plain in Tibetan—is high, austere, and largely unexplored. Rolling away to the horizon, its immensity is broken only by snowcapped ranges. Vegetation is scant, with neither shrubs nor trees to break the expanse. Just a few nomadic herdsmen inhabit the fringes.

Wolves still prowl the plains and snow leopards stalk their prey among the crags; wild yaks forage on the hillsides and herds of Tibetan antelopes migrate over unknown paths. This is a landscape untouched by civilization, virtually the same today as it was over a hundred years ago.

Site of the Chang Tang Reserve in the Tibet Autonomous Region.

George Schaller, science director of International Programs for the Wildlife Conservation Society, has spent four decades in wild and rugged places, studying wildlife, and fighting for its survival. And now Schaller and his Chinese and Tibetan colleagues have helped establish a huge reserve the size of Arizona in the Chang Tang. There, Tibet's last great herds can roam free and the nomads can maintain their traditional culture. Schaller explains, "If we don't protect the Chang Tang now, the magnificent species found here could soon vanish forever."

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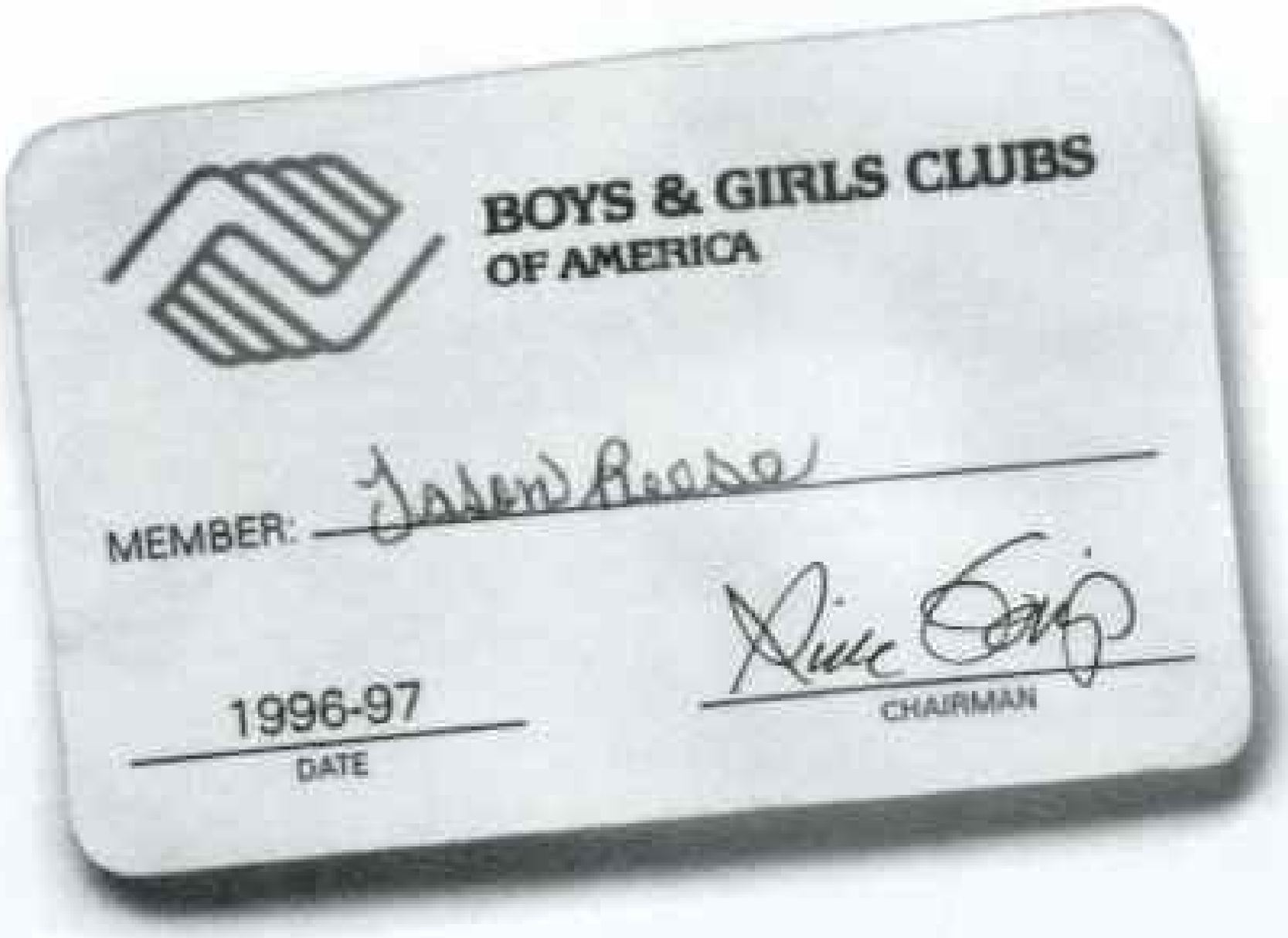

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■ FROM THE GEOGRAPHIC ARCHIVES

At the Door of the Ozarks

A Missouri mother and her sons meet photographer C. P. Cushing at the door of their backwoods cabin in this portrait, received at the Society in June 1929 but never published. Our first story on the Ozarks appeared in May 1943, when staff writer Frederick Simpich recalled his boyhood in "Land of a Million Smiles." "Old ways . . . long since abandoned elsewhere, tend to persist," he wrote. "When a man dies, the family clock must be stopped. To keep milk and butter cool, they set their tin buckets in cold streams. . . . Chickens and turkeys often roost in trees, and people say their tame gobbler sometimes meets his wild cousin in the pea patch."

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■ SPECIAL, FRIDAY, MAY 1, 8 P.M. ET

Strange Lizards Roam the Galápagos Islands

Since marine iguanas can lose up to 45 percent of their body heat on dives that can go as deep as 40 feet and last 30 minutes, they must bask like living solar panels (above) until their body temperature returns to normal. Specially adapted long claws enable the world's only seagoing iguanas to cling to underwater rocks while they feast on algae that flourish in the nutrient-rich waters around the Galápagos Islands. With bellies full, the chilled lizards clamber ashore through often thunderous surf to once again warm themselves.

Ancestors of today's Galápagos iguanas probably arrived several million years ago on vegetation that floated in from mainland South America. One branch of the family took to the sea. The other took to the hills, and the story of land iguanas is even more bizarre.

A new film, "The Dragons of Galápagos," by David Parer and Elizabeth Parer-Cook, examines the lifeways of both these reptiles in a National Geographic Special. "When we first learned of the incredible journey that the female land iguana undertakes to lay her eggs," said Parer, "we knew we had to make this film. Here is this rather unprepossessing lizard, alone and driven by we know not what, journeying 10 to 15 days up to the 5,000-foot rim of one of Earth's most active volcanoes. Then, braving landslides and brawls with other females protecting their nests, she moves on down into the caldera where she lays her eggs in ash-filled pockets warmed by fumaroles in the crater floor."

The Parers recorded other creatures on film, including giant tortoises, hawks, and blue-footed boobies as well as the most northerly of penguins.

Off camera, their three-year-old daughter, Zoe, found the best companions of all: sea lion pups to play hide-and-seek with in tide pools warmed by the equatorial sun.

■ PROGRAM GUIDE

National Geographic Specials
"The Dragons of Galápagos"
NBC. Friday, May 1, 8 p.m. ET.

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

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

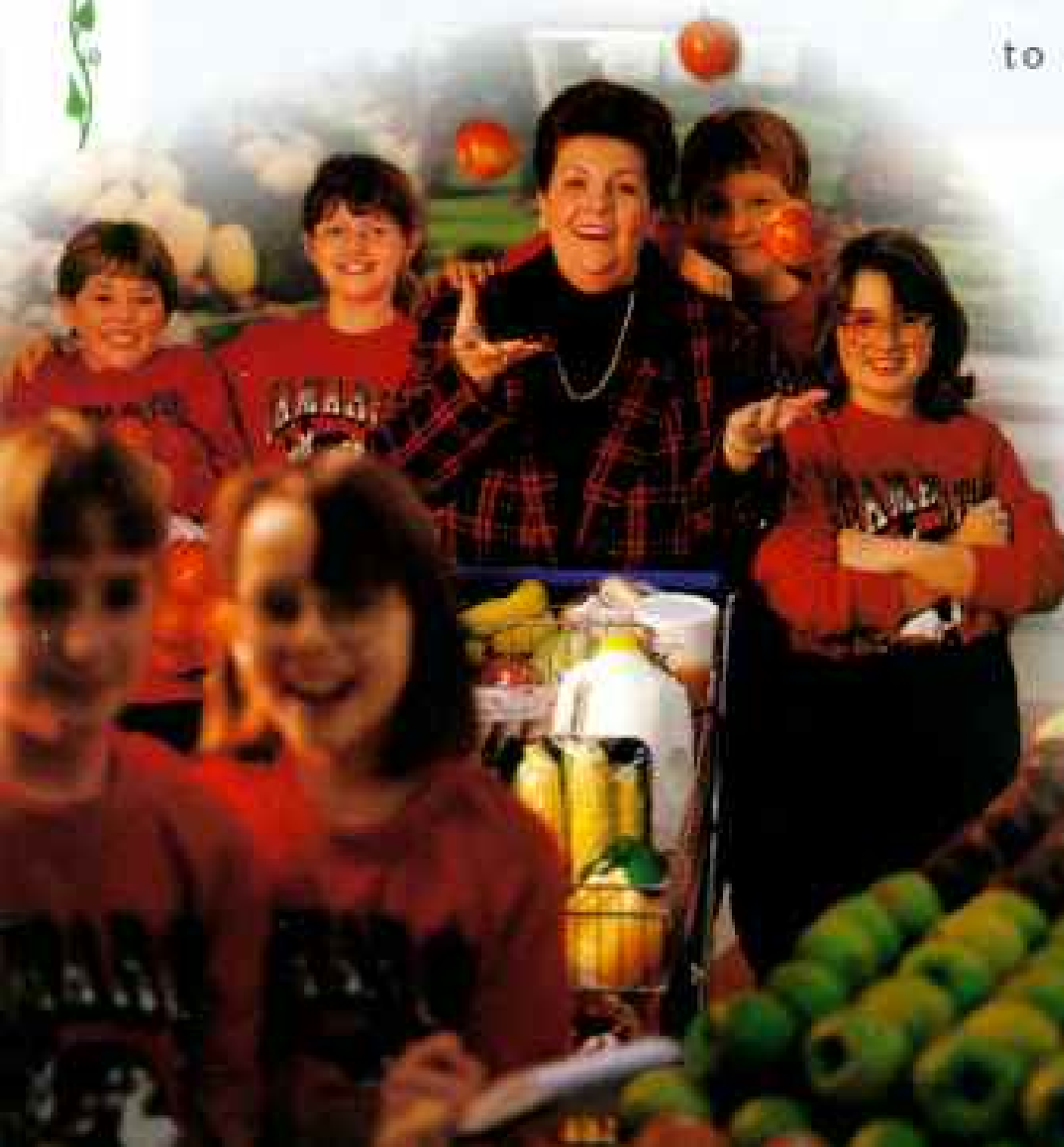
Programming information accurate at press time; consult local listings.

Look for the National Geographic Channel when traveling in the United Kingdom, Ireland, Scandinavia, Finland, and Australia.

These kids sure know a lot more than beans.

Marketta Blackburn Farris is one teacher who really knows how to produce results. In fact, she does it by taking her 4th grade social studies class to places like the produce section of their local supermarket. She believes that her students should learn as much from life as they do from books. At the store, she makes them deal with real life problems like working with budgets, analyzing nutritional information, comparing product benefits and using their math skills to determine the best bargains. For showing her students that life is a learning experience.

State Farm is proud to present Marketta Blackburn Farris with our Good Neighbor Award and to donate $5,000 to the Camargo Elementary School of Mount Sterling, Kentucky.



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Whale Meat Feeds People—and Foxes

As many as 140 gray whales may be killed legally each year off Siberia by native hunters like these Chukchi. The International Whaling Commission (IWC) has set that quota for subsistence whaling, as it does for other stocks of whales hunted by aboriginal peoples. National governments then designate approved hunters, traditionally those who eat whale meat and to whom the hunt is culturally important. But in Siberia there is a controversial twist. While Chukchi and Eskimos eat some whale meat, much of it is fed to foxes raised for their fur on local farms (right).

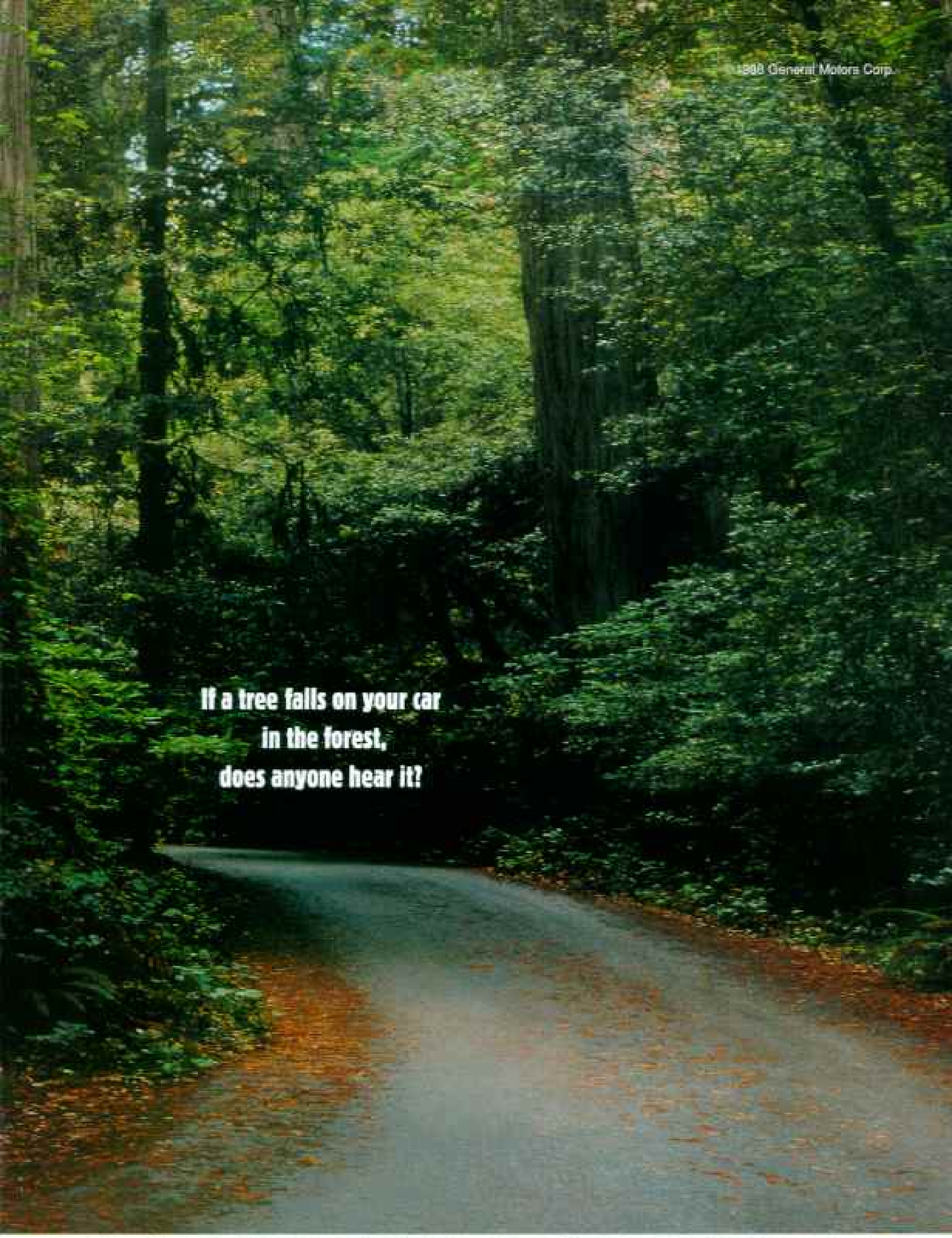
"Last October at our Monaco meeting Russian delegates told us they were no longer going to allow the fox feeding," says the IWC's Ray Gambell. "This was begun by the Soviets 30 years ago. And now there is no market for fox fur, so the farms are losing money." Protected from commercial hunters, gray whales have rebounded to about 23,000.

BOTH BY YURI KOZYREV

Image Not Available

Color Them Safe

If an insect is colored red, hungry predators have learned that it may be poisonous. One of these young insects in Guatemala—members of the order Hemiptera, or true bugs—by itself might not deter a hungry bird. But a cluster conveys an unmistakable red flag.



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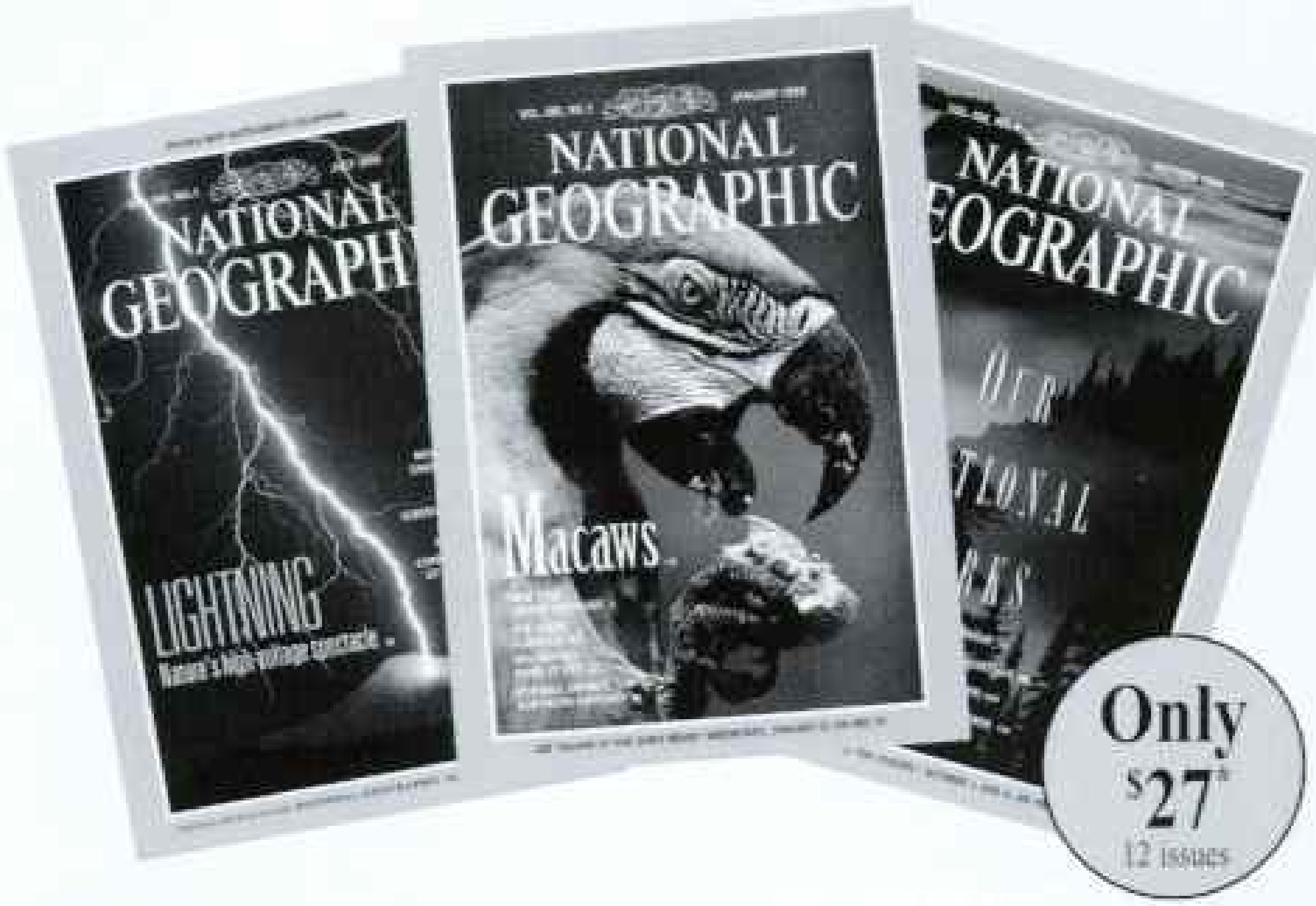

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NGZANB0

ROBERT CAPUTO

Comeback for Orinoco Crocodiles?

For handbags, belts, and shoes, Orinoco crocodiles in South America were hunted ruthlessly for decades. By the mid-1960s they had been nearly wiped out in the Orinoco River Basin of Venezuela and Colombia. In 1976 hunting was banned, but the damage was done: A census found fewer than 300 animals. Conservationists and scientists have worked hard to bring back this beleaguered reptile, which can exceed 20 feet in length. Four captive breeding centers in Venezuela have reared and released more than 1,300 crocodiles into the Orinoco and its tributaries since 1990.

SIDNEY A. GAUTHREAUX, JR.

Great Radar for Birds

Forecasters aren't the only people who think Doppler weather radar is terrific. Sidney Gauthreaux, Jr., of Clemson University is using a 164-station system to track migrating birds. "It's the first radar that can readily determine direction and speed," he says. It also gives the birds' numbers and altitude. Colors in this image indicate the speed of spring flocks as they head north over the Gulf of Mexico.

TEXT BY JOHN L. ELIOT

Fewer Crabs, Eggs—and Birds

Ancient, armored, and seemingly indestructible, horseshoe crabs are in serious decline in Delaware Bay. A one-day census of spawning crabs shows a drop from 1.2 million in 1990 to fewer than 500,000 in 1996, a year when 900,000 crabs were harvested for sale as bait. Last year New Jersey officials banned horseshoe crab fishing by trawlers, permitting only limited hand harvesting.

Also suffering: birds that gorge on billions of the crab eggs. Three species' numbers were down 25 percent last year.

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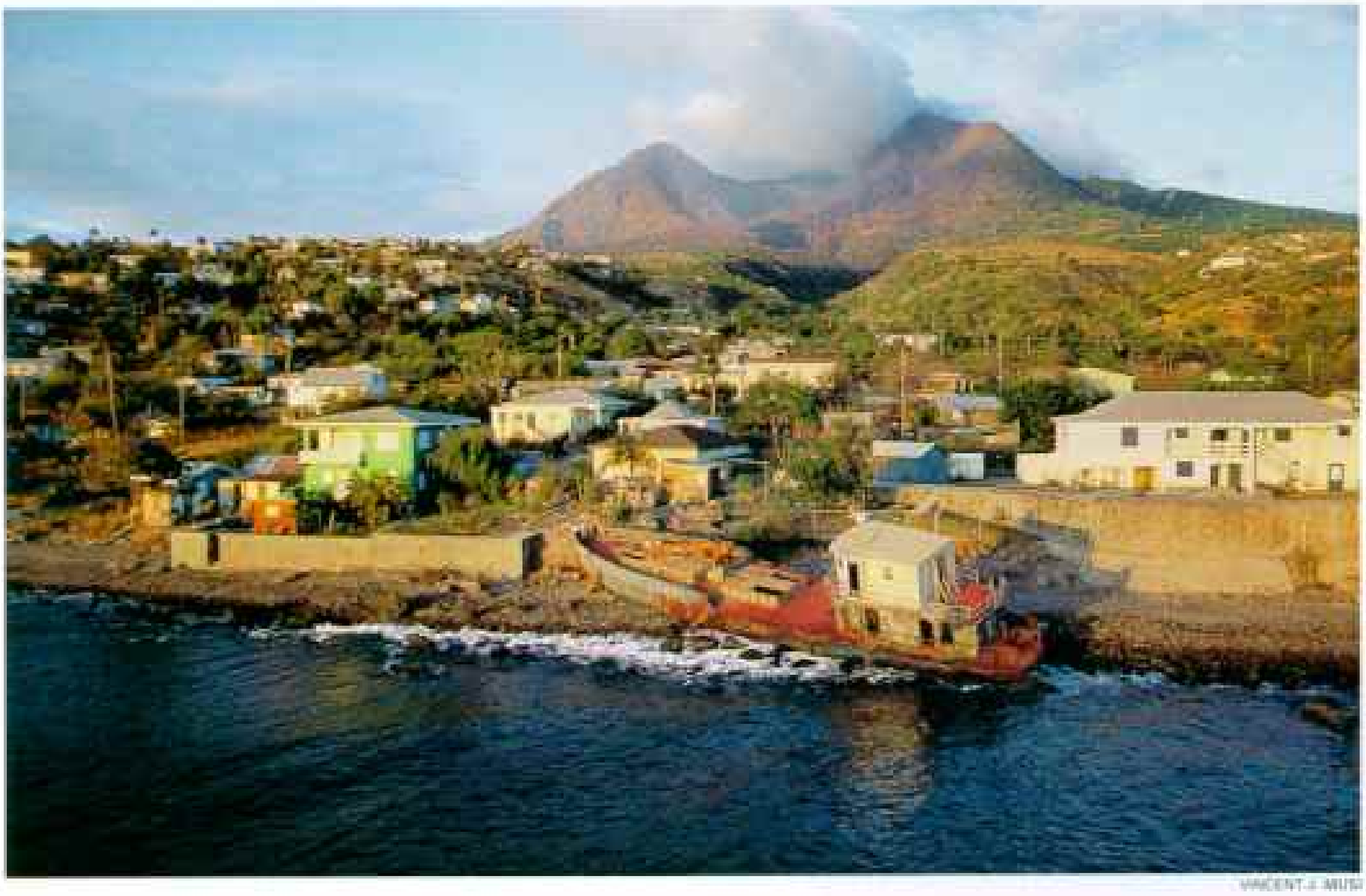

VINCENT J. MUSI

■ ONLINE

Empty Villages, Crowded Towns

First came steam. Then billows of gas, ash, and rock. Since July 1995, volcanic eruptions on the Caribbean island of Montserrat have transformed emerald hills (above) into gray wasteland and uprooted more than 8,000 people, two-thirds of the population. Observe tectonic clashes, eruptions, and pyroclastic flows in the still unfolding drama of Montserrat and in the profiles of some of Earth's most notorious volcanoes. Link to the Montserrat Volcano Observatory for daily updates from the experts. Witness the power of geology at *www.nationalgeographic.com/features/98/volcanoes.*

■ Dive into the article on Roman shipwrecks in this issue and share your thoughts at *. . . /media/ngm/9804/forum.*

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■ One of the most famous residents of the U.S. Plains stands at attention outside his subterranean home. Follow a prairie dog into his burrow in a town that can spread through hundreds of acres and shelter thousands of animals. Ferrets, owls, rabbits, snakes, and other creatures elbow into town. Some prey on one another—or on their hosts. Meet the neighbors at *. . . /features/98/burrow.*

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NATIONAL GEOGRAPHIC

OnAssignment

■ RONGELAP

Roping for the Best

"It looks simple," says photographer Emory Kristof of his "rope cam," a computer-operated digital video camera he tested in Rongelap Atoll. "but it's the product of 20 years of deepwater work." Crafted by Geographic specialists, the dangling, unmanned camera can be deployed from small boats. "The rope cam lets us study deep waters in remote areas," says Emory. Little fishing has been done in Rongelap since nuclear tests rocked the region decades ago, and now "it's an Eden for fish." And for fish photographers.

BILL CURTSINGER

JUDY PROTIVA

■ OZARKS

Pitching In

Harvesting hay on the Peace Valley, Missouri, farm of the Protiva family gave staff writer—and lifelong urbanite—Lisa Moore LaRoe quite a challenge. "The horse-drawn wagon was pretty wobbly. It was hard to keep my balance, and I was swinging a pitchfork while the family's three children were jumping around to flatten the hay. It's a miracle that I didn't skewer somebody—or myself. But I loved the smell of the earth, and I got a real sense of how rural people in the Ozarks lived for centuries."

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