DOUBLE MAP SUPPLEMENT: ANCIENT MESOAMERICA

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NATIONAL GEOGRAPHIC

Wild Tigers

SEE "FORBIDDEN TERRITORY: STANLEY'S SEARCH FOR LIVINGSTONE," DECEMBER 7, ON ABC

NATIONAL GEOGRAPHIC

From the Editor

IN 1890 NATIONAL GEOGRAPHIC SOCIETY grantee Israel C. Russell returned from an expedition to Mount St. Elias, Alaska, with fossil-bearing rocks. They marked the beginning of the Society's long fascination with ancient life-forms.

The Society's Committee for Research and Exploration has funded scores of paleontological studies, from mammoth skeletons in Wyoming to prehistoric pollen in Madagascar. In 1933 explorer Roy Chapman Andrews of the American Museum of Natural History wrote a NATIONAL GEOGRAPHIC article recounting his discovery of dinosaur eggs in the Gobi desert.

As this month's article about dinosaur finds in Patagonia attests, our tradition continues. We commissioned dinosaur embryo sculptures by Brian Cooley for the magazine last year (above), and we support the work of Paul Sereno (below), a paleontologist at the University of Chicago. Sereno has received eight Society grants for his globe-spanning discoveries, which include the fossil remains of a giant 90-million-year-old Sahara carnivore called *Carcharodontosaurus*.

"I don't think there's anyone digging for dinosaurs who has not been touched by National Geographic," says Sereno. "They may be grantees, or have worked with grantees, or simply had that spark of inspiration lit in them by an article in the magazine. And at the other end, there is simply no way to reach the global public that compares to NATIONAL GEOGRAPHIC magazine."

As for you Paul Serenos of the future who are now finding inspiration in these pages: Start digging. We're holding a few pages for you.

Bill Allen

LOUIE PSIHOYOS (ABOVE); MODEL BY BRIAN COOLEY

Making Room

for Wild Tigers

By **GEOFFREY C. WARD**

Photographs by **MICHAEL NICHOLS**
NATIONAL GEOGRAPHIC PHOTOGRAPHER

Resting after a night of hunting, a tigress called Sita remains a sentinel, ready to leap at the throat of any creature that dares approach the den where her cubs lie hidden in India's Bandhavgarh National Park. Alarming drops in world tiger populations present a quandary: how to preserve wild cats in wild lands as farms and cities eat away at habitat and poachers step up their murderous trade.

Jaws that can crush a backbone become a tender conveyance as Sita totes a cub to a new den, a constant chore to safeguard her young from leopards, wild dogs, and other tigers. Hiding cubs well is critical, since she may be away hunting for 24 hours or more. Sita is living proof that this endangered species can flourish if only given enough room and enough prey.

Environmental firebrand Samuel LaBudde exposed tiger killers in his work for Earth Island Institute. In San Francisco's Chinatown he holds a photograph taken in Taiwan just before a tiger was cut up for food and medicine, a practice that has declined there. Selling tiger parts is illegal in the U.S. Yet a recent survey found dozens of products advertised as containing tiger bone for sale in five U.S. cities.

STOP THE MEN
EATING TIGERS
IN TAIWAN.

A wide-eyed Sumatran tiger is still anxious nine years after he was brought in from the wild and placed in the captive-breeding program at Taman Safari Indonesia near Jakarta. The program is part of a concerted worldwide effort to boost the precariously low populations of all five remaining tiger subspecies.

I first saw the tigress called Sita in 1986 in Bandhavgarh National Park in the central Indian state of Madhya Pradesh. She lay asleep on a hillside when the elephant I was sharing with the Indian naturalist Hashim Tyabji found her, full bellied after eating from the spotted deer that lay next to her. She was exhausted by the steady strain of having to feed and care for her first litter of three cubs, whose mewing I could just make out from still higher up the slope amid the expectant cawing of crows that teetered in the branches of the surrounding trees.

We were just 30 feet or so from the tigress, close enough to hear her steady, sonorous breathing. Over the next half hour or so three more elephants bearing tourists came and went. Cameras clicked. One overeager photographer dropped a canister of film, and the mahout loudly ordered his mount to pick it up with its trunk and return it to its owner. The tigress slept on, oblivious. Nothing seemed to faze her—nothing, until a rufous-and-white tree pie smaller than a North American magpie fluttered down onto her kill. She was up and fully awake in a millisecond, swatting at the terrified bird with one enormous forepaw and roaring so loudly the sky seemed to split.

It was the first time I'd been so close to so much tiger anger. I was thrilled but frightened too, and looked to Hashim for an explanation. Why had she become so furious so fast?

Quality time: With her belly full, Sita nuzzles one of her trio of six-month-old cubs. Their home in Bandhavgarh's 268 square miles was once the royal hunting grounds of the maharajas of Rewa. The park now shelters nearly 50 tigers and their prey.

Fast food Spooked by an elephant carrying sightseers, chital, or spotted deer, scamper across the Bandhavgarh grassland. Sita crouches silent, still, and well camouflaged in the brush (right), ready to explode in pursuit of the park's most common tiger prey. A shrinking prey base may be an even greater threat to tigers than loss of habitat and poaching.

He smiled. "Tigers," he told me, "do not like to share."

Last spring I was back at Bandhavgarh starting out again at dawn, riding the same elephant with the same mahout, and looking for the same tigress.

Sita is nearly 16 now, unusually old for a tigress in the wild, and she has given birth to 18 tigers over the 11 intervening years. Just seven made it to adulthood. The rest died or disappeared: One young male was killed by an adult male seeking to displace the cub's father, and his sister drowned in a monsoon flood; a female cub struggled with physical deformities, then seemed to waste away. And all three offspring from Sita's fifth litter—born in March 1996—died two months later. No one knows for sure what happened to them.

Still, less than ten days after the loss of her fifth set of cubs, Sita was seen mating again, with the big, testy resident male. He is nicknamed Charger because of his enthusiasm for doing just that, once clawing his way up the back end of a tourist elephant when it got too close and in the process traumatizing the visitors on board.

The forest was still dark as we set out, and our fleet of five elephants moved along in almost total silence. But around us there were already morning sounds: Peacocks called from their nighttime roosts and were answered by the raucous crowing of jungle fowl, gaudy ancestors of the domestic chicken. Gray langur monkeys gave out with the low self-satisfied hooting with which they greet the day and warn one another to be on alert.

Ahead of us we could just make out a broad stretch of swampy grassland, where I hoped to see Sita again and, if I was very lucky, catch a glimpse of the new litter of cubs said to be somewhere in the area as well.

ONE EVENING not long before I left for India, the former head of one of America's best known zoos appeared on a nationally televised talk show, clad in safari clothes and holding a live cub in his arms. Tigers kill their prey by breaking its neck, he assured his host, then bury it overnight. Only 2,000 tigers remain in the wild and all of them will be gone by the year 2000, he suggested. The only surviving tigers will be in zoos.

His heart may have been in the right place, but everything he said was suspect. In fact, tigers throttle most of their prey—in the field the distinctive throat wounds left by their big canines often provide the best evidence that they have been at work. And while they do conceal their kills as best they can in brush or leaves or tall grass, they do not bury them. Nor has anyone any real idea how many tigers survive in the wild—the dearth of reliable numbers is one of the most frustrating aspects of tiger conservation. There is no question that

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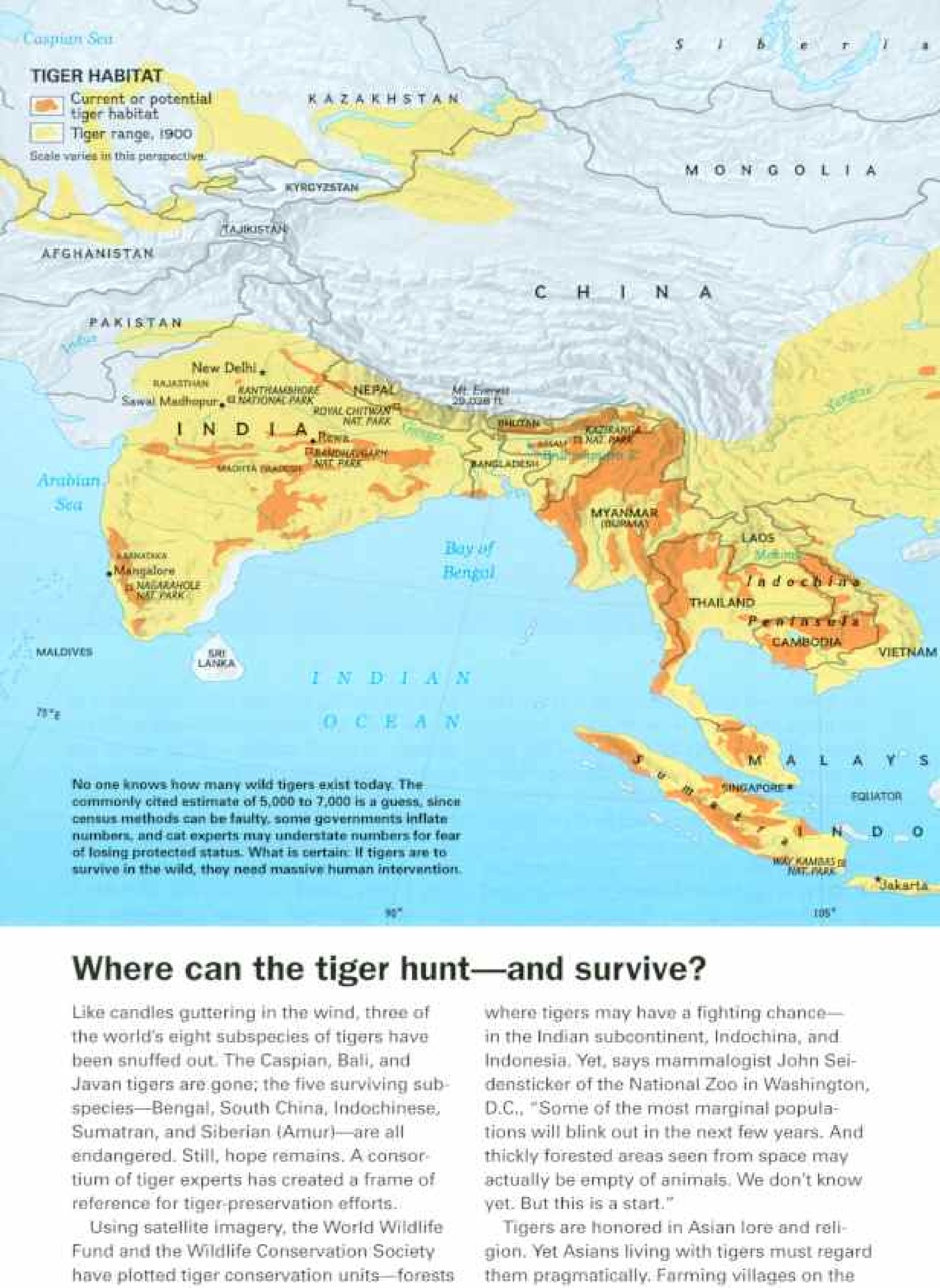
the species is in trouble throughout its remaining range, but there is no reason to suppose tigers will all be gone by the turn of the century—or anytime soon after that—provided governments intensify their efforts to protect them, good science is applied to their conservation, and well-meaning alarmists don't convince the public that their rescue is a lost cause.

Tigers are generally believed to have evolved in southern China more than a million years ago and then to have prowled westward toward the Caspian Sea, north to the snow-filled evergreen and oak forests of Siberia, and south, across Indochina and Indonesia, all the way to the lush tropical forests of Bali. Their modern history is admittedly dispiriting. Into the 1940s eight supposed subspecies persisted in the wild. Since then, however, the tigers of Bali, the Caspian region, and Java have vanished, and the South China tiger, hunted as vermin during the regime of Mao Zedong, seems poised to follow them into extinction; fewer than 30 individuals may now survive outside zoos, scattered among four disconnected patches of mountain forest, probably too few and far between to maintain a viable population ever again.

Just four other subspecies remain, and well over half the tigers in the wild are believed to live in India and neighboring Nepal and Bangladesh. When I started writing about the tigers of India in the early 1980s, their future, at least, seemed assured. Shooting them had been banned since 1970, and there were stiff penalties for anyone caught trying. Project Tiger, undertaken at the instigation of Prime Minister Indira Gandhi in 1973, had set aside 9 national parks for special protection (14 more have been added since). The core areas of these tiger reserves, off-limits to humans, were meant to be "breeding nuclei, from which surplus animals would emigrate to adjacent forests." Broad buffer zones, into which human incursions were limited, were to protect the breeding grounds. It was an extraordinary commitment for a relatively new nation beset by other, more pressing challenges; no Western country has ever mounted so serious an effort to save a magnificent but potentially deadly predator in such proximity to its citizens.

And it seemed to be working. In 1984 forestry officials declared that the number of wild tigers in India had more than doubled, from 1,827 individuals to better than 4,000. Project Tiger seemed so successful, its reserves were



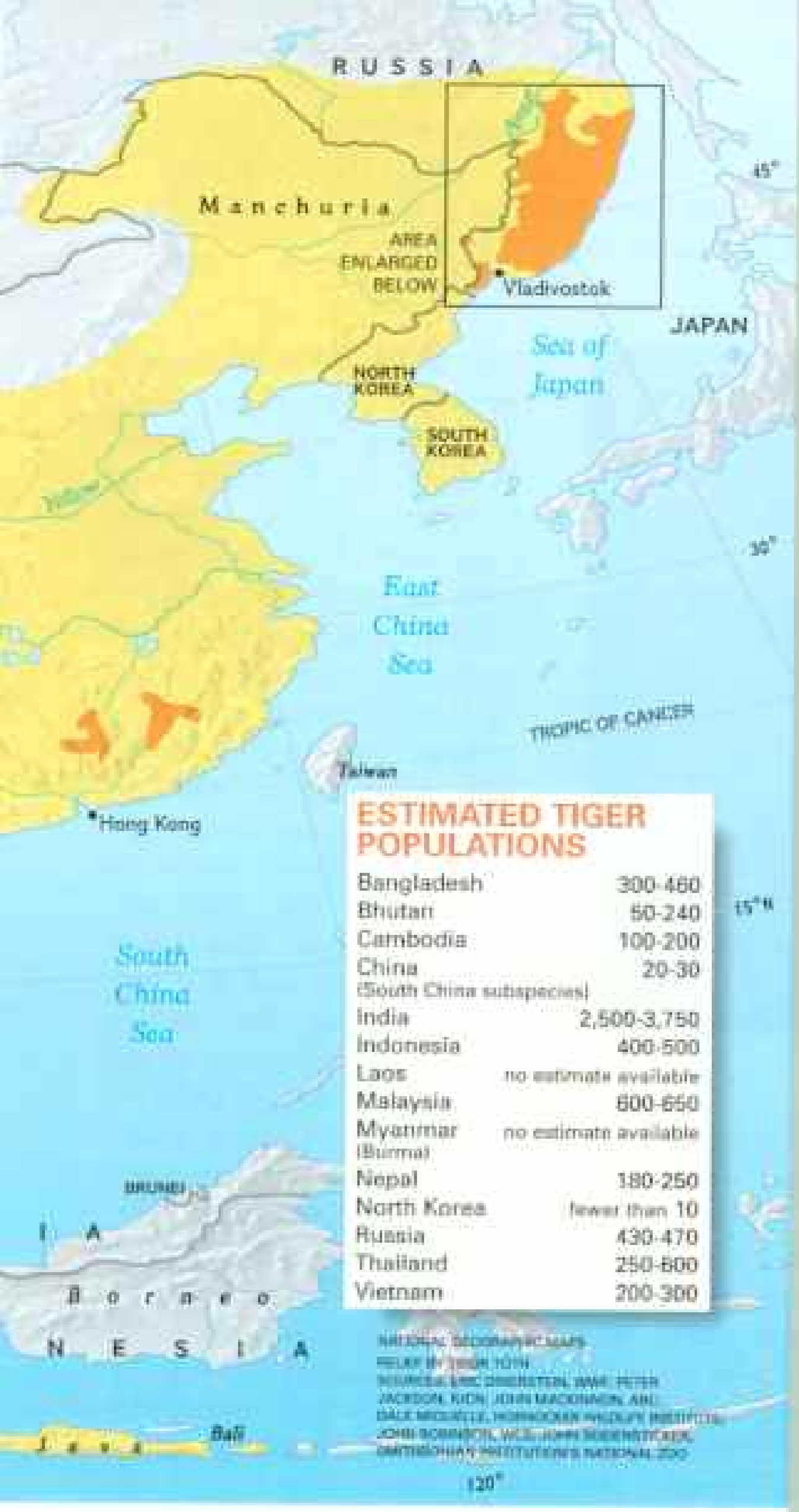
No one knows how many wild tigers exist today. The commonly cited estimate of 5,000 to 7,000 is a guess, since census methods can be faulty, some governments inflate numbers, and cat experts may understate numbers for fear of losing protected status. What is certain: If tigers are to survive in the wild, they need massive human intervention.

Where can the tiger hunt—and survive?

Like candles guttering in the wind, three of the world's eight subspecies of tigers have been snuffed out. The Caspian, Bali, and Javan tigers are gone; the five surviving subspecies—Bengal, South China, Indochinese, Sumatran, and Siberian (Amur)—are all endangered. Still, hope remains. A consortium of tiger experts has created a frame of reference for tiger-preservation efforts.

Using satellite imagery, the World Wildlife Fund and the Wildlife Conservation Society have plotted tiger conservation units—forests where tigers may have a fighting chance—in the Indian subcontinent, Indochina, and Indonesia. Yet, says mammalogist John Seidensticker of the National Zoo in Washington, D.C., "Some of the most marginal populations will blink out in the next few years. And thickly forested areas seen from space may actually be empty of animals. We don't know yet. But this is a start."

Tigers are honored in Asian lore and religion. Yet Asians living with tigers must regard them pragmatically. Farming villages on the



ESTIMATED TIGER POPULATIONS

Bangladesh	300-460
Bhutan	50-240
Cambodia	100-200
China (South China subspecies)	20-30
India	2,500-3,750
Indonesia	400-500
Laos	no estimate available
Malaysia	600-650
Myanmar (Burma)	no estimate available
Nepal	180-250
North Korea	fewer than 10
Russia	430-470
Thailand	250-600
Vietnam	200-300

Keeping track of the Siberian tiger

A welcome sign attracts Dale Miquelle of the Hornocker Wildlife Institute during a Siberian tiger census in Russia's Far East. The count pegged the population at 430 to 470—figures some researchers think too optimistic. Still, the Siberian is back from the brink and now may have the brightest among dim tiger prospects. Miquelle helps coordinate the Siberian Tiger Project, which developed a habitat protection plan (below). It classifies areas according to their ability to sustain tigers in the wild.

fringe of tiger territories lose livestock—and human lives—to tiger attacks, and villagers fight back. A more immediate threat: poachers collecting tiger bones, organs, and other body parts for traditional Chinese medicine and aphrodisiacs. Tiger bone, like all mammal bone, is essentially phosphorus, calcium, and iron, and no scientific proof of its benefits exists. Investigations show that some bone products contain mercury and arsenic, added to convince users of their potency by producing a sensation.

Fatal beauty Working to end trophy killings, Vladimir Shetinin, leader of a Russian anti-poaching squad, displays a confiscated tiger skin. A young Siberian (right) is the son of Olga, a tigress equipped with a radio collar. Her movements cover 225 square miles, important data in determining how much territory is needed for a healthy, stable population.

said to be so full of tigers, that some conservationists worried about what would happen to all the surplus animals.

Then came the bad news. The assassination of Mrs. Gandhi in 1984 swept from the scene Indian wildlife's most powerful defender. Afterward, as effective political power slowly shifted from the central government at New Delhi to local politicians in the individual states, enthusiasm for defending India's jungles slackened under pressure from ever growing numbers of poor voters who saw them primarily as easy sources of fuel and fodder. The authenticity of the gains Project Tiger had claimed came into question as well. No one doubts that the number of tigers really had risen. But in reaching their ever more impressive tallies, forest officials had relied on identifying individual pugmarks, or paw prints—a system since shown to be inexact—and then, concerned for their jobs if the number of animals under their care didn't steadily climb, some had inflated their findings well beyond the numbers the resident prey base could conceivably have sustained.

Meanwhile, the human population rose. Promised corridors were turned into farmers' fields, inundated by dams, and honeycombed with coal mines. Many of the "adjacent forests" to which the corridors were meant to lead simply vanished. There were fewer and fewer places to which young tigers could disperse and more and more conflicts between tigers and human beings.

Then, beginning about 1986, something else began to happen, something mysterious and deadly. Tigers began to disappear. It was eventually discovered that they were being poisoned and shot and snared so that their bones and other body parts could be smuggled out of India to supply the manufacturers of Chinese traditional medicines. After the virtual disappearance of the South China tiger in the late 1980s, stockpiles of tiger bones were depleted, and resupplying them became a big business. No one knows how many tigers in India fell victim to this illicit trade, but the figures compiled by Ashok Kumar and Belinda Wright, whose tiny Wildlife Protection Society of India has spearheaded the fight against poaching on the subcontinent, represent only a small part of a very grim picture—94 tigers killed in 1994, 116 in 1995. Most poaching goes undetected, so the real number of butchered tigers must have been much higher.

RANTHAMBHORE NATIONAL PARK in eastern Rajasthan—with its blue lakes, sprawling hilltop fortress, and ancient ruins scattered through the forest—was the pride of Project Tiger when I first visited it, famous both for the number of its predators and the astonishing ease with which they could be seen and photographed. On one especially memorable day at Ranthambhore in 1986, I was privileged to watch nine different tigers hunting, courting, caring for their young. My

guide was the park's longtime field director, Fateh Singh Rathore. It had taken him 18 years of unremitting work to turn a small and largely lifeless former hunting preserve into perhaps the most celebrated national park in India, and he had almost lost his life in the process: Angry herdsmen beat him into insensibility, determined to graze their buffalo in grasslands he was no less determined to hold in reserve for the deer and wild boar on which his tigers fed.

He has not been in charge of the park for a decade now, but he still lives on its western edge, and it was he who first noticed that the tigers he had observed for years were vanishing. By 1993, he believes, perhaps as many as 20 had been killed—nearly half of those then thought to be living in the park—so catastrophic a loss that even the tiger's extraordinary ability to rebuild its population may never be able to compensate for it.

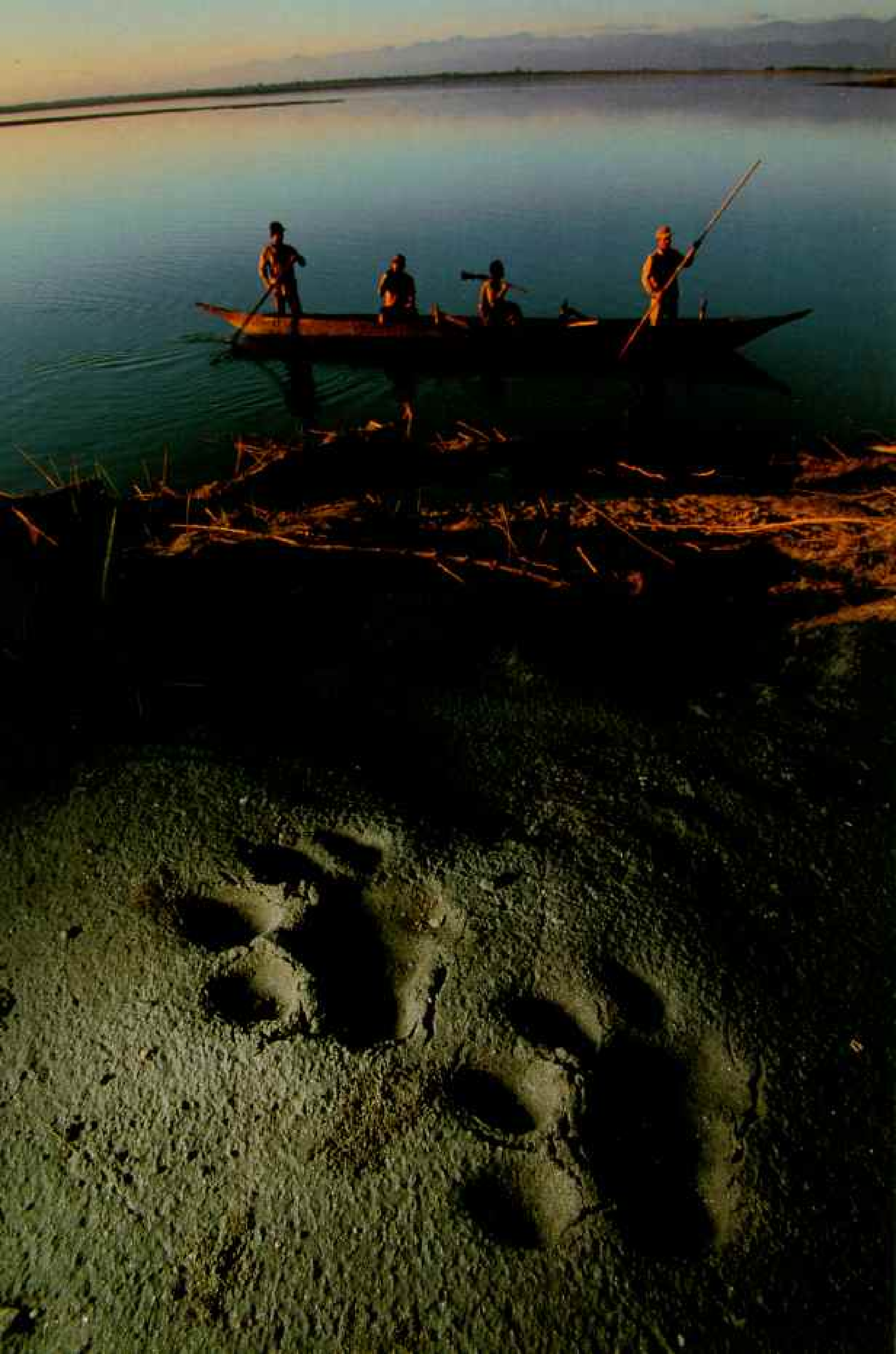
A sign near the railroad station at Sawai Madhopur proudly welcomed me last spring to the "City of Tigers," and the road that leads out of town toward Ranthambhore was lined with hotels that provide accommodations for thousands of eager wildlife viewers who still come here each year from all over the world.

Ranthambhore has always been an embattled island. It is small—just 150 square miles—and surrounded by ever growing numbers of desperately poor people with little time or sympathy for tigers. The area once meant to be a buffer zone had been stripped bare by foraging livestock. And without strong backing from the state government of Rajasthan, forest officials no longer seemed willing to risk their lives resisting encroachment by human beings or their ravenous herds.

Nongovernment organizations, most notably the Ranthambhore Foundation, have labored hard to persuade local people to plant trees in the ravaged countryside around the park. They have improved health in some villages, demonstrated alternative ways to feed cattle and fuel village fires, done all they could to spread the gospel of conservation. But the odds they face are formidable.

A first-time visitor could easily be deceived. Shimmering peacocks still danced in and out of the scattered ruins, trying to impress perpetually inattentive peahens. Monkeys still perched in the tallest trees, on the lookout for predators. And in the evenings the three lakes around which I once watched tigers prowl in

With feline grace abandoned, Bachhi takes her picture by breaking an infrared beam at an unmanned remote-camera site in Bandhavgarh. Sweltering in 120-degree heat, she seeks relief in a pool, despite its fetid brew of rotting leaves and monkey urine. A daughter of Sita, she has outgrown her name; Bachhi means "female child" in Hindi.



Guns for conservation A patrol poles past tiger tracks in India's Kaziranga National Park in search of rhino poachers, who favor automatic rifles. Squad members rely on antiquated arms like this bolt-action rifle (below) but still get results, as photographs of poachers from a park officer's scrapbook attest. The result? Fewer rhino deaths and an unmolested tiger population.

broad daylight still seemed packed with protein—scores of shaggy sambar, hundreds of spotted deer, and big sounders of wild boar. I counted 80 snuffling piglets around one of the lakes, rushing back and forth in furious imitation of their elders. "Lovely sight," said Fateh. "But bad sign. These are easy meals for tigers. Too many piglets are an indicator that predation is nearing zero."

There were other bad signs too. No patrols were seen anywhere. Along upland roads closed to ordinary tourists because of "repairs" nowhere in evidence, the once rich meadows through which I had watched tigers stalk their prey were stubble, chewed over by hundreds of domestic cattle whose droppings lay everywhere. Defiant herdsmen from a nearby village had commandeered a guard post on the western edge of the park originally built to keep them out and had scrawled their names on its walls in Devanagari script nearly a foot high—BHARAT RAM, CHANDRA MINA, DHAN RAJ, B.L. MINA, CHOTA SINGH—just to taunt the forest department.

The Ranthambhore tigers' drive to reproduce remained strong—three tigresses had borne litters in the past 18 months or so—but the big male that is presumed to have sired them all died suddenly last May, after an injury to one of his shoulders turned septic. The forest department now admits there may be as few as nine adult tigers within the park—fewer than are said to have been living there when Fateh arrived some 30 years ago.

Since my visit, there has been one hopeful sign. During the monsoon, when even the sere Rajasthan jungle turns lush and green and graziers traditionally drive their herds into the park to feed, a reinvigorated forest staff, armed only with bamboo staves, managed to fend off the graziers for the first time in years.

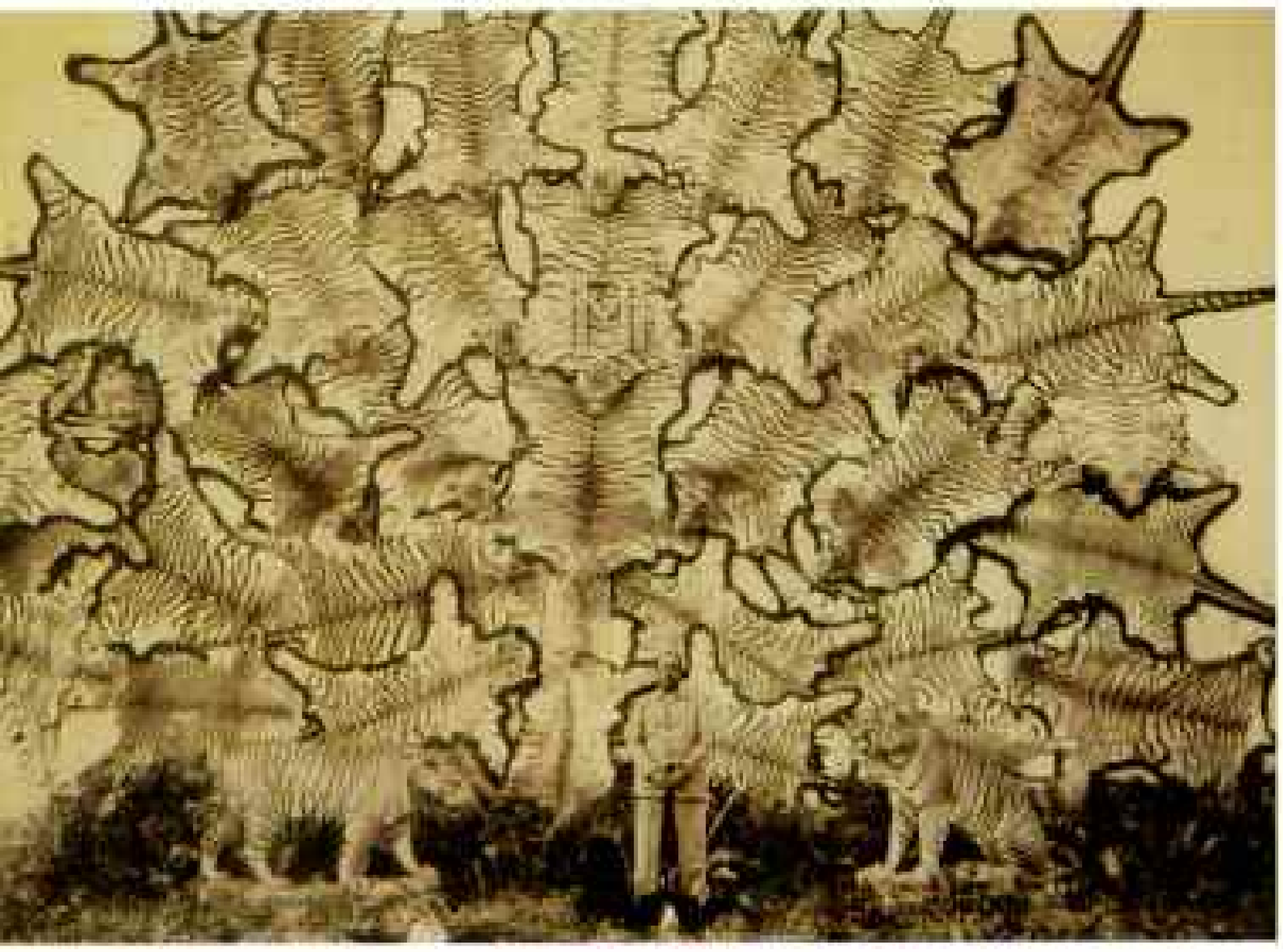
But the line between survival and extinction remains precariously thin. Even if the annual invasion of livestock can be permanently curtailed, if the poaching threat really has eased, and if other vigorous males remain, two or three more fatal accidents could still spell the end for the tigers of Ranthambhore.

I asked Fateh what he thought would happen to the City of Tigers if the tiger vanished from the park altogether. "Maybe," he sighed, "they could call it the City of Peacocks."

THE CONSERVATION COMMUNITY was initially stunned by the poaching emergency in India. And there was soon evidence of poaching for the bone trade from Indochina and the Russian Far East as well. Suddenly every gain seemed in danger of being wiped out. Articles began to appear in the press declaring the tiger doomed.

"Rather than a cozy feeling from tiger land," remembers John Seidensticker, curator of mammals at the Smithsonian's National Zoological Park in Washington, D.C., "we realized the tiger was once again in crisis." A big, plain-spoken man, Seidensticker witnessed the passing of the Javan tiger as a young field researcher

Tiger as symbol An Indian nawab posed in 1940 with trophies he collected on tiger hunts, a pursuit eagerly adopted by British colonials. The creature's grandeur is captured in a different way in Mangalore, where painted dancers prepare to escort an effigy of the goddess Durga from her temple. A fierce slayer of demons, Durga is often depicted riding a tiger.



and has never gotten over it. "It was like mourning a death in the family," he says. "My first reaction was to lash out in anger. Since then I've learned that anger alone is a waste of time. We need to learn from these tragedies so they won't be repeated."

Those lessons took time to learn. The crisis initially produced denials, recriminations, quarrels over funds among conservation organizations, bickering between advocates of captive breeding and those determined, against all odds, to save the species in the wild. And any number of rescue schemes were put forward, including a suggestion from an overzealous Briton, who sought funds with which to tranquilize and radio-collar every single tiger in the Project Tiger reserves so that a satellite could keep track of them all from space.

But real progress was made too. Representatives of most of the 14 tiger-range countries met at New Delhi in 1994 and promised for the first time to cooperate in combating the tiger trade. The next year the Exxon Corporation pledged more than a million dollars annually for a five-year worldwide "Save the Tiger Fund" campaign to be administered by the U.S.-based National Fish and Wildlife Foundation. Pressure from foreign governments, including the U.S., helped persuade China and Taiwan to enforce their bans on the trade in tiger bones, and, perhaps in part as a result, the incidence of tiger poaching in both India and Russia appears to have fallen off since 1995. Belinda Wright and Ashok Kumar are not reassured, pointing out that the market for medicines that at least claim to contain tiger derivatives has not shrunk. They suggest that Indian traders have simply become more crafty in concealing their bloody work; certainly the illegal slaughter of some tigers as well as leopards and other wildlife in India continues. And so does the official lack of commitment that allows it to go on.

Perhaps the most hopeful sign for the tiger is that serious science is at last being enlisted in its conservation across much of its range.

IT WAS EARLY MORNING in Nagarahole National Park in the southern Indian state of Karnataka. Two massive gaur bulls occupied a roadside clearing. Gaur are the largest wild cattle on earth. The elder hadn't yet risen from his night's sleep, but he weighed about a ton and looked, just lying there, like a dark brown mountain. In what seemed to me an unwise effort to intimidate him, his young rival began a slow-motion strut across the clearing on his white-stockinged hoofs, carefully keeping in profile so he'd seem still bigger than he already was. He came to a halt beside a sizable bush and slowly roiled its leaves with his horns. The older bull seemed unimpressed. But he lumbered to his feet and, moving at a yet more stately pace, approached a termite mound, lowered his horns, and, as slowly and deliberately as possible, nudged it over. The younger bull waited until the dust cleared, then started

gliding toward a termite mound of his own.

"This will go on all morning," Ullas Karanth whispered, reaching for the key to start our jeep. He has been coming to Nagarahole for more than 30 years, the last 11 as a field biologist working for the Wildlife Conservation Society headquartered at the Bronx Zoo. "We can come back. They're not going anywhere."

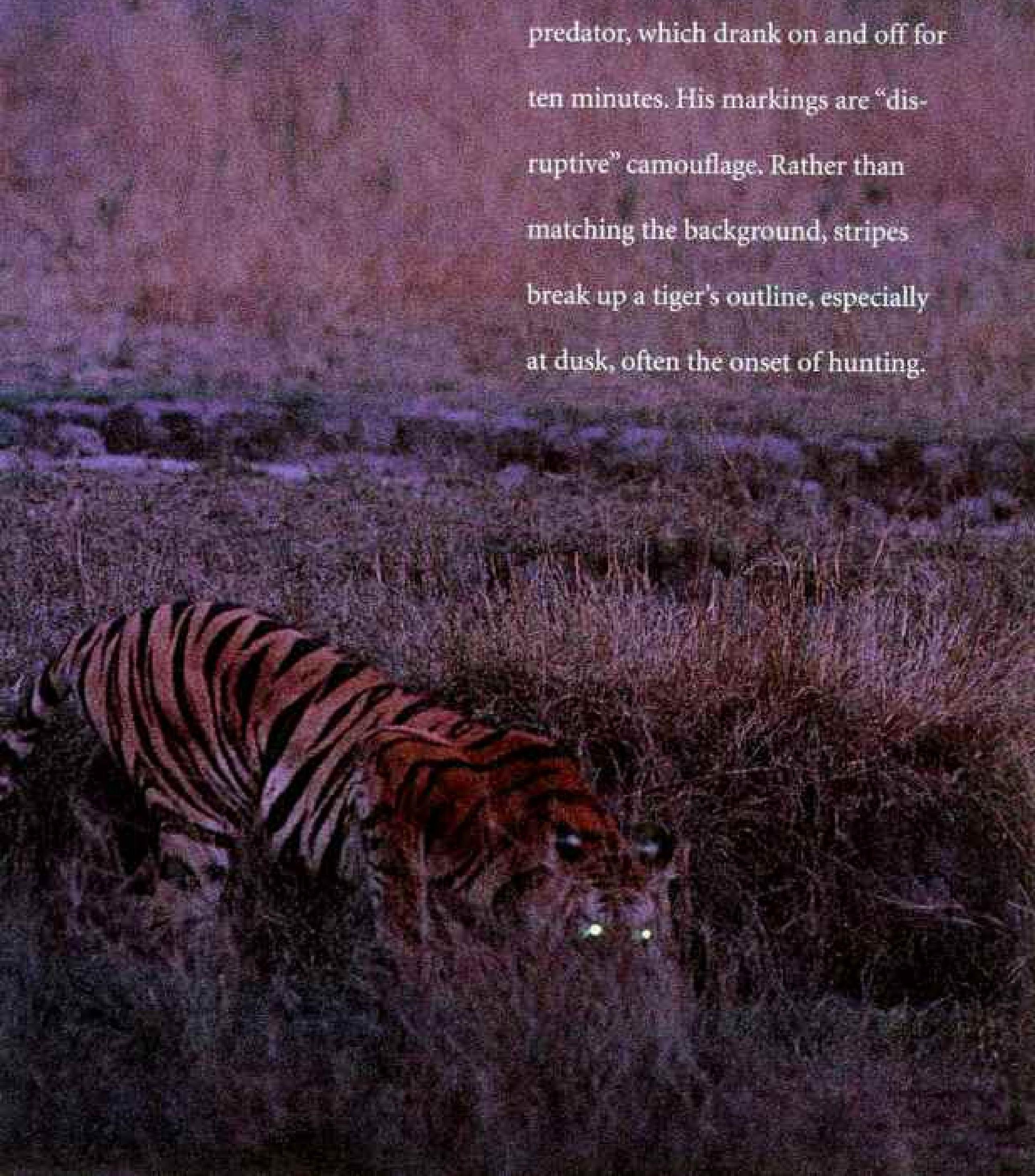
But they were. Just as the motor started, a tiger roared deep inside the jungle. In an instant the bulls forgot their rivalry and vanished into the undergrowth; each of them represented a 2,000-pound breakfast to a tiger.

Tigers are so beautiful, so powerful, so secretive, so shrouded in myth that the daily reality of their lives can seem prosaic. Tigers do not "roam" the forest as romantic writers like to have them do; instead they doggedly work carefully delineated territories, on the lookout for their next meal—and on the alert for any other predator that threatens access to it. They need meat, massive amounts of it, just to stay alive. An adult Bengal tigress on her own eats an average of 13 pounds every day, 4,700 pounds every year; a tigress with two cubs can demand more than 6,800. That's somewhere between 40 and 70 kills annually. It takes enormous energy to do all that killing—observers at Ranthambhore estimated that the average tiger there made ten attempts before it managed to pull anything down—and it is therefore far more efficient for tigers to hunt big animals. The tigers of Nagarahole routinely feast on gaur, favoring them over the much smaller spotted deer that are staples of the tigers' diet in other forests.

Karanth and his colleague Mel Sunquist of the University of Florida have shown that Nagarahole provides 32,385 pounds of meat for every square mile, such a staggering amount of prey in so many different sizes that three of India's large carnivores—tiger, leopard, and wild dog—are able to flourish here side by side. But in parts of Thailand, for example, where large ungulates have been hunted almost to extinction, tigers now struggle to survive on porcupines, monkeys, and 40-pound muntjacs. "Indochina, with its huge forests, ought to provide the greatest potential for tiger preservation," Karanth says. "But the prey is all buggered-up."

Studies by Karanth, Sunquist, Seidensticker, and others suggest that density of suitable prey is the most reliable indicator of how a tiger

Burning bright, tiger eyes are mirrored by the stare of a chital in Bandhavgarh. Anxious to read the tiger's intent, the deer actually drew closer. But thirst, not hunger, drove the predator, which drank on and off for ten minutes. His markings are "disruptive" camouflage. Rather than matching the background, stripes break up a tiger's outline, especially at dusk, often the onset of hunting.



Drastic measures In a failed effort, veterinarian Douglas Armstrong introduces the semen of a Sumatran tiger into a female at Omaha's Henry Doorly Zoo. The operation is seldom successful with tigers, but zoos continue to try, hoping to use artificial insemination and sperm banks to ensure genetic diversity among tigers in captivity and, perhaps someday, in the wild.

population is likely to fare. And history bears them out. Tiger hunting and loss of habitat were once blamed for the loss of the Bali, Caspian, and Javan tigers—and both surely played a part in their decline. But the latest research suggests that it was the loss of their prey that finally made their lives literally insupportable.

Karanth doesn't minimize the seriousness of poaching. "If it continued at the levels it reached in the early nineties, it could provide the *coup de grâce* for the species in India," he says, "and we should be ruthless in dealing with anyone involved in it." But there will probably always be some hunting, he continues, and a healthy tiger population can tolerate a reasonable amount of it: "Suppose a forest holds 24 breeding females and each year 8 of them give birth to a litter of 3 cubs. That's 24 cubs. In the natural course of things, half the cubs will die before their first birthday. If properly protected and fed, each of the surviving 12 will either disperse or kill and replace an already existing tiger. So in a healthy community there's always a doomed surplus."

As long as poachers don't remove more than that number, Karanth argues, the population should remain more or less stable. (If poachers do exceed that number—as they may have done at Ranthambhore—all bets are off.) But if the prey base collapses, if tigresses begin to have trouble feeding themselves let alone their cubs, populations plummet.

"That sort of basic knowledge is essential if tigers are to be managed properly," Karanth says. "The role of good science is to set the standard for what potentially can happen in a park and then offer ways by which managers can accurately assess their own work. Instead of indulging in this crazy numbers game of trying to count every single tiger, we are trying to introduce basic sampling techniques to monitor success or failure. Studying prey—counting deer pellets and picking apart tiger scat to see what they've been eating—is

unglamorous," he admits. "But after providing protection, management's most important role should be to build up the prey base. With enough to eat, enough space, and enough protection, tigers will take care of themselves."

THE THREE SUBSPECIES that survive elsewhere in Asia—Indochinese, Sumatran, and Siberian, or Amur, tigers—face all manner of threats. But the most serious in every case is the potential loss of prey.

Tigers remain in six Indochinese countries—Cambodia, Laos, Malaysia, Myanmar (Burma), Vietnam, and Thailand. But all have suffered war or civil unrest in the past half century, and their interiors have largely been off-limits to scientists. While forest still covers much of the region, no one knows how much wildlife survives beneath its canopy.

George Schaller, the peripatetic director for science at the Wildlife Conservation Society whose pioneering 1967 study, *The Deer and the Tiger*, set the standard for scientific research on the animal, is not optimistic. "I'm afraid there are very few tigers left in Indochina," he says, "and there are very few researchers to study them. Forests look intact from the air, but many are alarmingly empty on the ground. In Laos you can walk for weeks in the rain forest and never see a pugmark—less because of poaching than because local people have snared and eaten all but a few barking deer. The remaining tigers are forced to wander for miles in search of their next meal. When you ask villagers if there are tigers nearby, they answer, 'Yes, one came by here a year ago.' Most populations are too small and scattered to survive much longer."

Schaller's colleague Alan Rabinowitz, one of the few scientists to have worked extensively in the region, agrees. "Deer are disappearing everywhere," he says. Four of the six species that were staples of the tigers' diet in Thailand have been virtually annihilated. Commerce in wild animal parts continues to flourish. All of the six range countries except Laos have signed the CITES agreement barring international trade in endangered species. But tiger parts are still sold openly in the marketplace alongside bits and pieces of the animals they once fed upon; in one Burmese bazaar tiger skin was recently being sold for $5 per square inch; an inch of rib cost $4.50.

"If the tiger is to survive in Indochina, governments will have to act fast," Rabinowitz says. "Local people will not save tigers on their own. Why should they? There's nothing wrong with long-term schemes aimed at involving local communities in conservation. But we haven't time to wait for them to work. We need first to find out where the remaining tigers are. Then we need a triage system like the one used in battlefield hospitals, to separate those populations large and strong enough to have some hope of survival from those probably too weak to make it. Finally, governments will have to designate protected areas for tigers, then commit the resources necessary to guard and manage them without compromise. Otherwise, we'll lose the Indochinese tiger."

The news from Indonesia is more encouraging. It was once home to the Bali, Javan, and Sumatran subspecies. Now only the tigers of Sumatra remain, and until recently many authorities believed they were about to disappear as well. But findings by a mostly Indonesian team, headed by Ron Tilson, director of conservation at the Minnesota Zoo, suggest that reports of the Sumatran tiger's imminent demise may have been premature. The study area, Way Kambas National Park near the island's southern end, seems an unlikely source of hope. More than half a million people live along its border, and much of the forest has been logged in the recent past, some parts of it more than once. It was thought until 1995 that no more than 24 tigers survived within the whole park; and during the Tilson team's initial 15 months of studying one 62-square-mile section, its members glimpsed individual tigers just twice.

But when they used modern methods of counting, including camera traps tripped by passing animals, they discovered that their study area alone—just over one-eighth of the park—was home to 6 tigers and regularly visited by 12 more. They now believe Way Kambas may contain as many as 36 tigers and are training "rapid assessment teams" to survey Sumatra's other parks and unprotected forests to see if tigers are underreported there as well. Indonesian authorities estimate that there could be as many as 500 tigers scattered in reserves all across the island plus another 100 in unprotected areas, and Tilson and his researchers have helped the government draw up

a comprehensive management plan to save as many of them as possible. "There's an old Malay saying that attests to the persistence of the tiger's spirit," Ron Tilson says. "'The tiger dies, but his stripes remain.' In Sumatra our job is to provide the information and the means to help the people of Indonesia ensure that both the stripes *and* the tiger survive."

The Siberian tiger once occupied Manchuria and Korea as well as the Russian Far East. Except for perhaps 20 scattered individuals thought to survive in northeastern China and North Korea, it is now confined to a single 625-mile-long strip of mountainous terrain along Russia's easternmost fringe. When the Hornocker Wildlife Institute launched its Siberian Tiger Project fieldwork in and around the Sikhote-Alin Biosphere Reserve in 1992, the tiger's prospects looked very nearly hopeless.* A series of hard winters in the mid-1980s followed by still harder economic times that accompanied the collapse of the Soviet Union drove local people, hunting for food, to take an ominous toll on the elk and deer and wild boar upon which the remaining tigers depended. Unregulated logging and mining threatened to shrink the tiger's home. Tiger poaching was rampant. Between 1992 and 1994, 40 to 60 tigers were trapped or shot each year and their bones and skins sold in China.

But in the past three years the situation seems to have improved dramatically. In 1995 Russian Prime Minister Viktor Chernomyrdin called for a national conservation strategy. Patrolling was intensified, the Chinese border was better regulated, and poaching was reduced.

During the winter of 1995-96 some 650 men, led by Evgeny Matyushkin of Moscow University, coordinated by American researcher Dale Miquelle, and funded largely by the United States Agency for International Development, undertook a systematic census of the entire region. Nothing so precise had ever been attempted. Tiger tracks were followed, measured, and cataloged over 60,000 square miles of snowy mountain forest. The results surprised nearly everyone—there were signs of somewhere between 430 and 470 adult tigers and cubs, nearly twice as many animals as some had estimated just a few years earlier.

The Siberian tiger seems to be slowly edging its way back from oblivion. To continue this hopeful trend, the Hornocker Institute, working closely with Russian scientists, has drawn up a master habitat protection plan aimed at saving what remains of the tiger's beleaguered home. It calls for an inviolate core, a network of protected areas linked by corridors to allow safe dispersal of young tigers, along with careful management of the surrounding unprotected forests to ensure that logging and mining and road building do the least possible damage to tigers and their prey.

"In the Russian Far East we remain optimistic," says Dale Miquelle. "Yes, there's still poaching. Yes, there's a lot of logging. Yes, there's too much hunting of ungulates. But there's still a big stretch of more or less intact forest. Human pressure is low—and not likely to rise. If the Russians extract timber at a sustainable rate, if hunters can be persuaded to remove prey at a rate that allows tigers as well as themselves to eat, if the need or desire to poach tigers can be eliminated, tigers will survive in Russia for the foreseeable future."

*See "Siberian Tigers," by Maurice Hornocker, NATIONAL GEOGRAPHIC, February 1997.

Tiger as performer "When Rajah weighed two pounds, I held him in my palm and bottle-fed him," recalls Gregg Lee (opposite), a six-foot-four trainer at Marine World Africa USA in Vallejo, California. Now Lee gets held as he feeds the white tiger. Chow time provides a close look for tourists in South Korea, where tigers tear off meat hung from a bus at an amusement park.

SETTING FORESTS ASIDE for tigers is one thing, ensuring that they remain protected is something else again. No one disagrees with John Seidensticker's view: "Tigers won't ultimately be safe until they're worth more alive than dead." But that is a tall order in countries where space is at a premium and millions of people are in need of the food and fuel forests have always provided. To meet that challenge in India, the Global Environment Facility and the World Bank are supporting a 67-million-dollar ecodevelopment scheme aimed at relieving the human pressure on five tiger reserves. And last summer, Tiger Link, a new, all-India network of individuals and organizations, persuaded 320 members of parliament representing more than 250 million people to sign an appeal to the prime minister demanding that the central government reorganize and strengthen tiger protection.

More modest projects are also under way. Villagers were encouraged to reclaim and replant more than six square miles of degraded forest on the edge of Royal Chitwan National Park in Nepal and then allowed to keep half the proceeds from tourists eager to view wildlife. In the first year alone they earned $308,000 from entrance fees. Best of all from the wildlife point of view, one resident male tiger, a female tiger with cubs, and two transient males now use the area, and 12 rhinos have given birth within its precincts. Eric Dinerstein of the World Wildlife Fund, who helped guide the project, is delighted. "It helps ensure the survival of the park," he says, "plus it adds to the area under protection. If we don't add more forest whenever we can, we'll end up like curators in a small museum, endlessly cataloging our old collections rather than building new ones." Benefits like these, derived directly from wildlife, seem to offer real hope for the future, though each park and each range country will require its own distinctive solution.

Meanwhile, at Chitwan and everywhere else

House cats Betty Young plays with Butterball, one of 52 tigers at her ten-acre compound in northwest Arkansas. Young takes in tigers given up by owners unprepared for a 400-pound pet, breeds them—even trains them to use a jumbo-size litter box. After she nursed Major Bill (right) from an illness, he took to sleeping in her bed. "He snores," says Young, "but I'm used to it."

where tigers survive, protection requires strict policing. "It always will," says Ullas Karanth. "There is a criminal element even in the most sophisticated cities. We must deal with it in just the same way."

Nowhere is policing more strict than at Kaziranga National Park in the eastern Indian state of Assam. "Only God can keep people from killing tigers in other parks," said Bhupen Talukdar, one of three range officers in charge of its antipoaching effort. He is a fierce, bearded man with bright silver rings on all his fingers. "Here *we* do it."

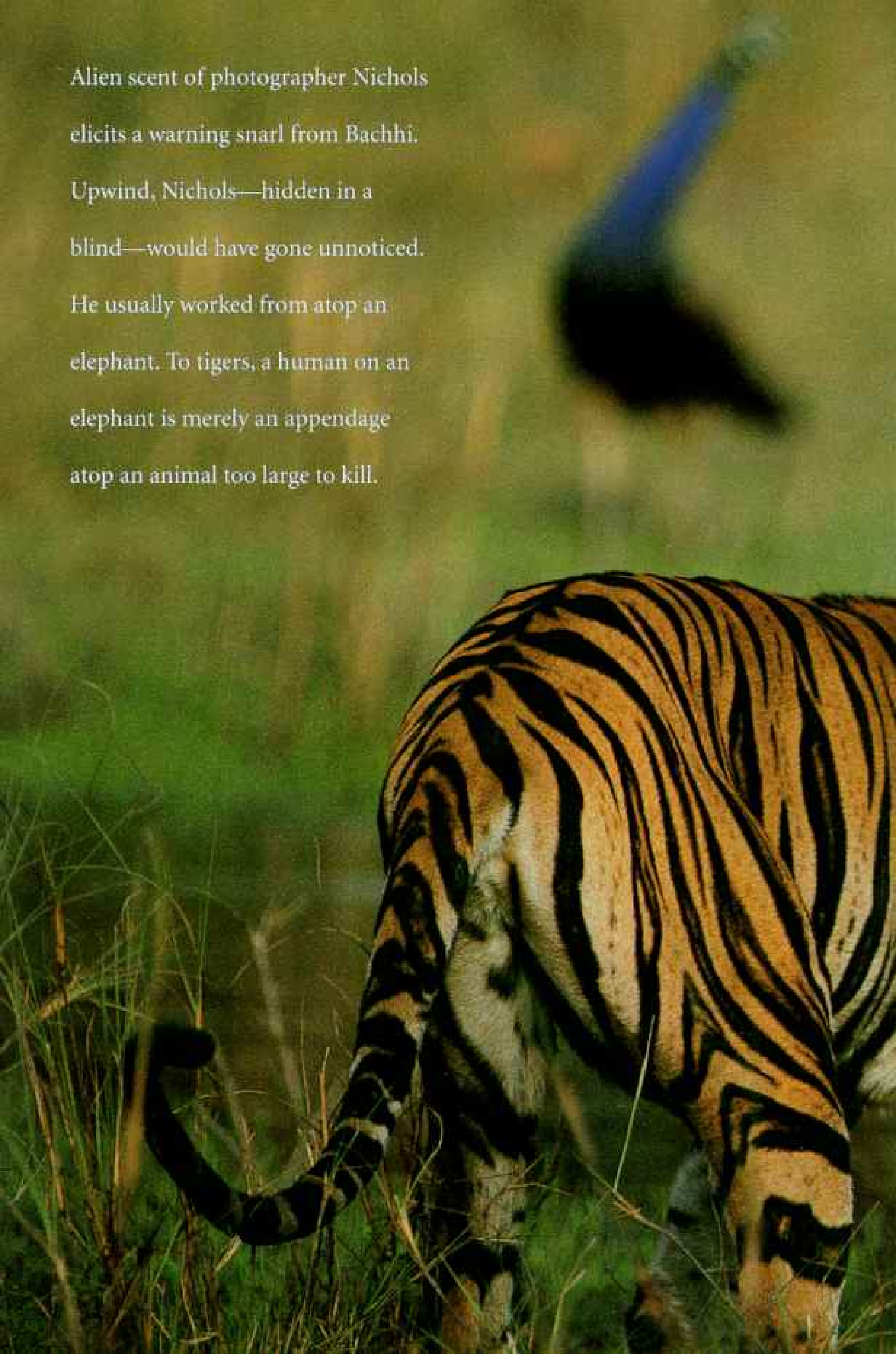
They do, indeed, though tigers are only the unwitting beneficiaries of the officers' primary concern: protecting the Indian one-horned rhinoceros. A long, spongy floodplain of the Brahmaputra River, Kaziranga shelters more than 1,200 of these massive, myopic beasts—more than half of all the wild Indian rhinos left on earth. Like tiger bone, rhino horn is used in traditional Chinese medicine, and a single horn can bring more than $8,000 on the black market—many times the average annual income of the people who live around the park. Between 1989 and 1993, 266 rhinos in India were butchered for their horns. Kaziranga lost 49 animals in 1992 alone.

Nevertheless, Talukdar said, "The rhino is in the Assamese psyche. Lord Krishna is supposed to have brought it to Assam to fight an evil king, using it just like a tank. We are determined to protect it." In 1994 he and his two equally tough-minded colleagues—Pankaj Sharma and Dharanidhar Boro—were given the job of waging the day-to-day struggle required if India is to save the species in the wild.

Kaziranga has many of the same problems that beset other sanctuaries all over Asia, plus a few distinctly its own. It is small. There is no buffer zone: Villages and paddy fields march right up to its boundaries. Just across the Brahmaputra are crowded camps of poor Bangladeshi refugees, some willing for a fee to ferry poachers to and from the park at night. The state's finances are often in arrears; when I visited the park, neither the rangers nor the army of some 400 guards who work for them had been paid for weeks. The battered rifles the guards carry are no match for the automatic weapons wielded by intruders. Finally, the great river overflows its banks every monsoon, drowning hundreds of animals and driving hundreds more—tigers and rhinos and elephants included—into the nearby hills, where they are easy prey for anyone with a gun.

Yet, against all these odds, Kaziranga officials continue to hold the line: Poaching within the park has been sharply curtailed. "We are on a war footing," says Dharanidhar Boro, "and we are fighting wholeheartedly." He does not exaggerate. Guards as well as poachers have been killed in the struggle to save this extraordinary place. There are some 120 permanent outposts within its borders. Within ten minutes of the sound of a shot, armed units can be on the scene. An expert rhino poacher might be able

Alien scent of photographer Nichols
elicits a warning snarl from Bachhi.
Upwind, Nichols—hidden in a
blind—would have gone unnoticed.
He usually worked from atop an
elephant. To tigers, a human on an
elephant is merely an appendage
atop an animal too large to kill.



to saw off the precious horn and race out of the park again in that amount of time—though at least 20 intruders have lost their lives trying to do just that in the past four years. But tiger poaching in Kaziranga is virtually impossible. "No one can skin a tiger in so short a time," Talukdar explains. "And they can't bury it either. The smell lasts for a month. It can't be hidden."

The result is that Kaziranga remains something like a paradise for tigers and their prey. Under Ullas Karanth's direction, a team of young researchers working with camera traps in one small section of the park has recently captured enough individual animals on film for him to guess that Kaziranga as a whole may be home to more than 85 tigers, including cubs. Each cat's stripes are distinctive, Karanth explains, "a sort of bar code by which tigers can be identified." Prey and tiger density here may be even greater than at Nagarahole.

But Kaziranga also offers the most vivid possible reminder that the tiger is only the most charismatic actor on a crowded stage. Above the yellow ten-foot grass, against the Kodachrome blue sky, shrieking flocks of green parakeets fluttered in and out of silk-cotton trees covered with crimson flowers; the fleshy fallen blossoms, the size and shape of six-fingered gloves, patterned the path ahead of us, forming a red carpet as we rolled forward in our jeep. A crested serpent eagle struggled to get off the ground a few yards ahead of us, a big crow-pheasant pinioned in its talons.

Wherever the dense walls of grass part to reveal a clearing, there are animals in overwhelming profusion—hundreds of wild boar and hog deer and swamp deer, scores of sleek black buffalo with horns like scimitars, rhinos that look as large as fire trucks. On the edge of a shallow lake late one afternoon two groups of elephants filed gravely past one another without a sideways glance; I counted 58 cows and calves and one magnificent lone tusker before they all glided into the grass again and disappeared.

The next evening a cow rhino concerned for her calf and agitated by the sound of the jeep in which Pankaj Sharma and I were riding suddenly whirled, kicking up dust, and charged straight for us. Sharma is a big man with a big voice, but when he clapped his hands and shouted to warn her off, she kept coming, amazingly fast, her broad body seeming to float above the ground, head high, ears straining to make out the source of the annoying sound—Mrs. Magoo at full tilt.

We pulled away. She lost track of us, slowed, sniffed the air, and went back to grazing.

As we headed back to headquarters at dusk each evening, we passed antipoaching squads on the move along the winding forest tracks. These are the authentic heroes of conservation, little bands of two and three men wearing tattered overcoats and armed with rifles, moving through the mist. Without them this magical world would long ago have vanished. That it has not already done so despite the odds is dramatic proof that with help from scientists and support and understanding from the rest of the world Asians can save their own forests; the tiger and its world still have a future.

BACK ON THE TRACK of Sita in Bandhavgarh the sun was up, and somewhere high above our heads a hive of bees, awakened by its warming rays, began to hum. The elephant continued to squelch his massive way through the swamp, leaving behind footprints as big around as wastebaskets.

There were signs of tigers everywhere. Pugmarks crisscrossed the inky mud. Deep within the grass lay a clutch of whitened bones, all that remained of a chital kill.

A sleek gray-brown jungle cat, the size of one of its domestic cousins, leaped soundlessly onto a fallen tree, the better to see down into the grass. Something small was moving there. The cat arced high into the air to maximize its pounce, disappeared for a moment, then returned to the log, a mouse wriggling in its mouth, and watched us pass before settling down to eat.

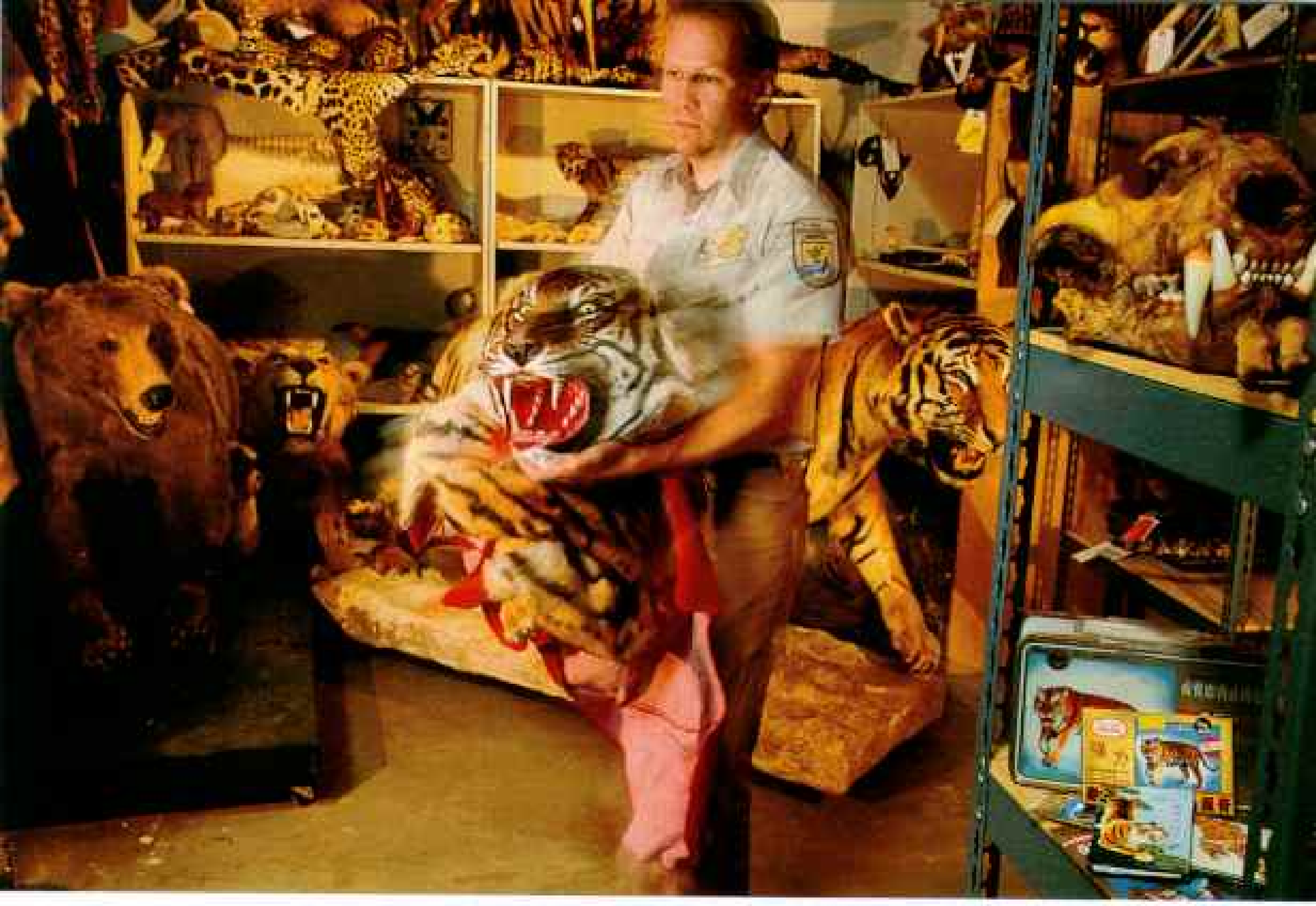
The mahout nudged his elephant to the left, toward a little stream that twists along the base of the hills.

The elephant began to rumble almost imperceptibly.

A tiger was nearby.

The mahout leaned forward, peering through the undergrowth.

Then, there was Sita, sprawled out in a clump of grass overlooking the stream. The crimson rib cage of a half-eaten chital rested just a few feet away. She gazed placidly at me, just as she had 11 years before. The noisy, odd-looking burdens on the backs of elephants



Lifeless menagerie Animal body parts fill a U.S. Fish and Wildlife property room in Los Angeles. A tiger skin cost a California man six months in prison after he sold it—in violation of the Endangered Species Act—to an undercover agent. Many such laws exist throughout the world, but the slaughter will stop only when all governments muster the will to enforce them.

don't seem to register with tigers as human beings—though the sight of a man or woman walking 200 yards away would have sent her rushing off into the forest. She rolled over and was soon fast asleep again, all four paws in the air, full white belly exposed to the sky.

There was no sign of the cubs. No tiny tracks in the mud, no telltale mewing among the distant birdcalls.

Had she lost this litter, just as she had lost her last one?

After some time the mahout urged his elephant back from the tigress. He splashed across the narrow stream, then along the bottom of the hillside.

The sun was high now, the forest silent.

We started climbing, the mahout's eyes fixed on the hillside.

He stopped, smiled, and pointed upward through the leaves. It took me a moment to spot the three cubs the size of cocker spaniels lying on a little rock shelf perhaps a hundred feet above us. The two females dozed, but their brother was up and alert, his big ruffed head and his paws out of all proportion to his body. His bright eyes looked right past us, focused on his mother far below, waiting for her signal to clamber down the hill and eat.

Here at Bandhavgarh—and in every tiger forest where there remains enough to eat and human intruders are kept at bay—the life cycle of the great cats continues. Gazing up at the cubs, I remembered something Dale Miquelle had said to me. "We have to find the magic formula that allows man and tiger to coexist. That's not a dreamy goal. Finding it may be the key to man's survival as well. After all, we share the same ecosystem. If we can't save the most magnificent animal on earth, how can we save ourselves? I don't believe the tiger's cause is hopeless," he continued. "At least it's no more hopeless than our own." □

Learn how the photographs for this article were made at www.nationalgeographic.com in mid-December.

Sita

Life of a Wild Tigress

Photographs by MICHAEL NICHOLS
NATIONAL GEOGRAPHIC PHOTOGRAPHER

A radiant Bengal tigar called Sita gives her cubs an early morning bath. The ritual helps cement the maternal bond so crucial in the first year of life. Sharing the name of a Hindu goddess, Sita is admired by visitors to India's Bandhavgarh National Park for her keen hunting skills and fierce devotion to her young. Conservationists value her prolific breeding; she has bolstered the local population with six litters during her nearly 16 years of life.

As evening falls, Sita marks her territory by gouging a tree, leaving a scent secreted by glands in her paws. After shooing her young back to the den, she begins her exhausting night prowl. An adult Bengal tigress consumes an average of 13 pounds of meat a day, studies in other parks have shown, though some days she will eat far more—and other days nothing at all.

SOURCE: LATIKA NATH, WILDLIFE CONSERVATION RESEARCH UNIT, UNIVERSITY OF OXFORD; NANDA S. J.B. RANA, BARDIA/SUKLAPHA TIGER TRUST
ART BY ROBIN KING

Sita's family tree shows her to be one of the most productive breeders of the wild female tigers documented. The chart also reveals pitfalls confronting tigers young and old. Banka, father of Sita's first two litters, has not been seen since he was injured in a fight over territory with Charger, who sired Sita's next four litters. Of Sita and Charger's first litter, two cubs survive. From their second litter, Bachhi went on to produce cubs herself, but her sibling struggled with paralyzed hind legs and blindness and soon died. Sita's next litter died soon after birth—probably in the jaws of a leopard or a transient male tiger that was observed in the area during that time. A fourth litter survives and is learning mother's hunting skills.

As with most kills, Sita dispatched a chital by attacking from the rear, biting its throat, then dragging it (right) to a hiding place. She consumed it in a day. Felling a larger sambar deer (left) meant food for three to four days.

With its bold trident pattern, Sita's face bears unique asymmetrical markings, as distinctive for identification as fingerprints are among humans.

An in-your-face male, Charger triggered this remote-camera power portrait through a wide-angle lens only three feet away. He earned his name for his unbridled aggression, charging other male tigers as well as vehicles—including an assault attempt on an elephant carrying terrified tourists, uncommon behavior among tigers. Yet he is a male of leisure when it comes to hunting, often seizing prey killed by Sita and the other females he breeds with. He displays affection with his own cubs—or at least tolerates their playfulness with him—and is helping researchers build a profile of male tiger behavior.

Lessons in living await a cub peering from its cover with steady intensity. As morning breaks, Sita takes the cub and its siblings to feed on a sambar deer she killed and hid the night before. At three to four months the cubs begin to eat meat but are still too young to hunt, a skill they will learn at 12 to 16 months. At 18 to 24 months they will leave their mother, eventually competing with her for territory. And so a new generation will prowl through Bandhavgarh.

John Seidensticker, curator of mammals at the National Zoo in Washington, D.C., has studied tigers in the wild. He deems the creature "an irreplaceable link in the process and wholeness of life," and was moved to write in tribute:

Always secretive—never devious
Always a killer—never a murderer
Solitary—never alone.

Self-portraits

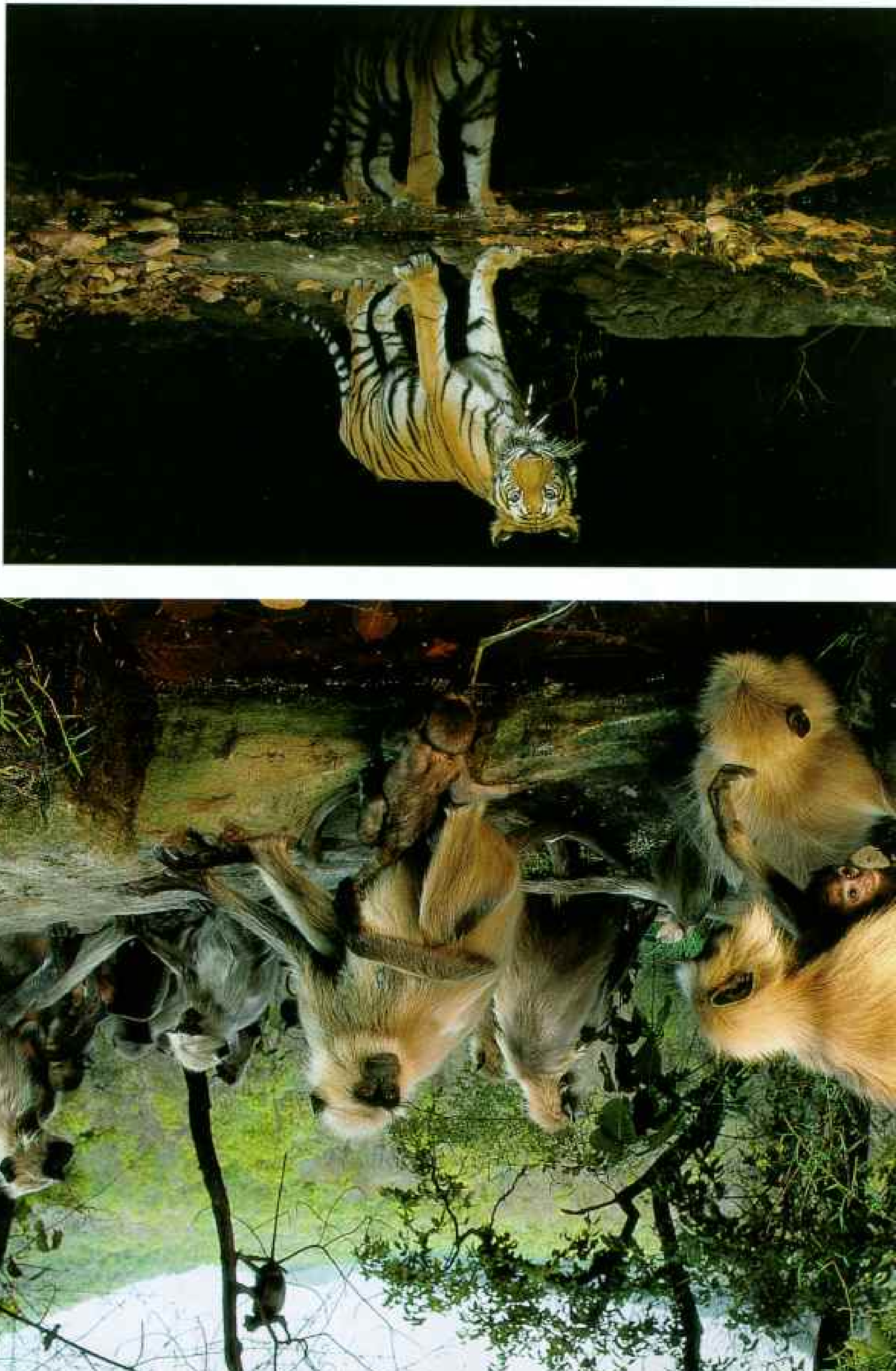
in the wild

Crouching like a big cat, photographer Nichols tests a remotely operated 35-mm camera in Bandhavgarh. His head breaks an infrared beam, tripping the shutter. Behind him, Phulsingh, an elephant mahout, shields his eyes from the flash that illuminates foliage in the background.

The technique produced these startling photographs and those on pages 18-19 and 42-43 in this issue. Nichols and assistant Roy Toft placed cameras in isolated spots, using as many as five strobes to augment natural light. One camera caught a tiger that had fed on a porcupine (right). Quills in its mouth made hunting difficult, and its left front paw had swelled with infection—probably a fatal combination. Langur monkeys broke a beam to reveal sometimes comical views of themselves at a watering hole. In a tree a scout watches for tigers and other predators. "The monkeys jumped around and used up whole rolls of film. Roy and I set the camera out, then Roy went back a week later to check it and found that the film had run out in one day. The counter showed that the monkeys broke the beam more than a thousand times. They arrived anytime between 9 a.m. and 4 p.m. We called it 'monkey time.'"

Success came when Nichols set the timer to activate at "tiger time"—late afternoon, when the cats would come to drink before the nightly hunt. □

TEXT BY CLIFF TARPY



AUSTRALIA BY BIKE

A Bloody Long Way Home

By ROFF MARTIN SMITH

Photographs by R. IAN LLOYD

EDITOR'S NOTE:
Roff Smith embarked on his bicycle trek around Australia with no fixed itinerary. On such a journey it is best to leave ample time for the trip. We will do likewise. This is part one of his adventure; parts two and three will appear in upcoming issues.

June 17, 1997

Oliver Payne
Manuscripts Editor
National Geographic Magazine
Washington, D.C.

Dear Oliver,

All this began last July. I was sitting at Circular Quay in Sydney thinking about the 10,000 miles of pedaling ahead of me: My God! What have I let myself in for? Why slog around Australia on a fully loaded touring bike? I suppose I could have said "because it's there" and that I like cycling and roadside adventure. And that'd all be true.

But there was a sober side to it as well. After 11 years my relationship with my wife had broken down, and I really needed to take some time to come to some decisions. Like whether I wanted to stay in Australia, where I'd spent almost all my adult life and where my kids, Laura and Ethan, would grow up, or whether I should follow my homing instincts and head back to the States. I was going to be 38 in a couple of weeks. Maybe I'd find some answers on the road.

I felt all the emotional attachment to it that I would toward an expense-account hotel room. The fault was certainly mine. The country had been pretty good to me, but I'd made little effort in return. Sure, I'd traveled — all over in fact. Almost always on assignment for some newspaper or magazine, in a hurry to get someplace, in a hurry to get back. Never taking time to smell the wattle. Come to think of it, after 15 years in Australia I wasn't even sure if the Aussies' favorite flower had a scent!

I didn't want 10,000 miles of melancholy. Yes, my marriage was over, but I wasn't going to sound the prim New Englander, riding around the place with a face like a constipated alderman.

As the Scarborough pulled in, I thought that at least by taking the ferry, I wouldn't have to climb a million steps to the Harbour Bridge. All the big talk was over, the good-byes said. How in the hell do travel writers get away with making departure sound as simple as an airy spin of a globe?

Roff

MEGHYNDD TAYLOR

Thursday, August 1
Grafton, New South Wales

Four hundred miles out of Sydney, and I've ridden the last 375 as much on stubbornness as on Kevlar-lined tires. And what's it got me? Throbbing knee ligaments, a bum so sore I can hardly sit, and all the pride I can swallow. I live outside now. Eat on graffiti-ed picnic tables, use dirty gas-station toilets, ask strangers for water. Laura turns four tomorrow, and I'm sitting on a chilly concrete bench far from home. Maybe Emerson was right—traveling really is a fool's paradise. Also thinking that if I'd kept my big mouth shut, I could quit right now, hop a bus to Brisbane, and be on a plane this time tomorrow. Why did I have to tell all my friends I was doing this? Why did I have to say 10,000 miles? What's wrong with 1,000 miles? Or 500 miles?

But something's just happened that makes me believe again. I was hard at work composing one of those dishonest postcards we've all written, crowing about what a glorious time we're having on holiday, when a young guy in a battered top hat and a vest dotted with protest slogans sat down beside me and said: "G'day. Saw you here, and

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ROLF MARTIN SMITH grew up in New Hampshire, studied geology, then switched to journalism shortly after moving to Australia in 1982. He left his position as a senior writer at *Time* (South Pacific) in June 1996 to cycle around Australia. R. IAN LLOYD, who was born in Canada and now lives in Singapore with his Australian wife and ten-year-old son, has photographed 30 books on the Pacific region. This is his first assignment for NATIONAL GEOGRAPHIC.

something told me you needed to talk." I stared at him as though I'd been addressed by a burning bush—then began to babble.

The guy's name was Robert Fantom (sounds like a road handle to me), of no fixed address, and for the next half hour he listened patiently while I unloaded 12 days' worth of fears and frustrations. I didn't have to impress this guy with grand objectives of self-discovery—I was miserable and confused and could say so. And somewhere in the telling I became a spectator instead of a participant and began to see some humor, chuckling about how unfit I'd been when I started this thing; imitating the comical horror on my face the first time I hefted the bike with its 35 pounds of camping gear, clothes, tools, spares, cameras, notebooks and then tried steering this saddlebagged juggernaut through the Sunday crowds on Circular Quay; describing that middle-aged harridan who'd nearly clipped me on Parramatta Road. My tension dismounted and walked away.

A few minutes later so did my listener, saying he had a feeling we'd meet again somewhere down the road. I hope so. I owe him. I may have started pedaling in Sydney, but for me the beginning of this journey will always be the public bench on the high street in Grafton, New South Wales.

Why leave the life I knew in Sydney (opposite) for 10,000 miles of unknowns? I was hungry for a change—which is what drove me to Australia in the first place. When I was 22 and working in Wyoming, I dreamed of living overseas. My foreign language skills were nil, so it had to be an English-speaking country. I wanted to go far away, and Australia was the farthest out there. Yet after 15 years of living there, I realized I didn't really know the place. That too would change.

Monday, August 12
Near Miriam Vale, Queensland

I'm lazing in the grass on the edge of a quiet dirt road, afternoon sunlight slanting through the gum trees. Happy. Since Grafton the road has opened up—and so have I. It's funny how hard it's been to shake that Yankee work ethic. Even with an open road and an empty calendar in front of me—all the freedom in the world—I made those first days a nine-to-five treadmill, marking off distances on the map each night, reckoning 40 miles a "good" day. John Calvin meets Easy Rider.

I'm meeting people now (see what happens when you stop trying to jimmy open the doors of perception?). Mind and knee ligaments have suppled up together. I spent an afternoon with the guys in the back room of the fire station in Casino, New South Wales, watching the Aussies go down to the Dream Team in basketball at the Olympics. At a tie-dye shop in Nimbin I had a cup of coffee with a former drag queen named Truly deVyne, who explained how 17 years in drag had ended his modeling career: "I was growing breasts. It just *killed* me for the men's swimwear market." Yesterday, in the Queensland rum-and-sugar town of Bundaberg, I joined a local family at a charismatic church where a five-piece band belted out Bible rock; parishioners were slain in the spirit, and a jump-and-bawl preacher railed against witchcraft.

I'm nearly in the tropics. Miles of sugarcane a lush counterpoint to the red volcanic soil. The farmers have been harvesting, burning off the cane. I've been cycling through flurries of ash. Black snow, the locals call it. Trucks loaded with charred cane sweeping by and leaving a fragrance of burned molasses in their wake.

I'm almost embarrassed at how little roughing it I've done lately. Queensland hospitality. Last night I rode up to a farmhouse in Yandaran and asked an elderly couple, Phil and Elva Halpin, if I could camp

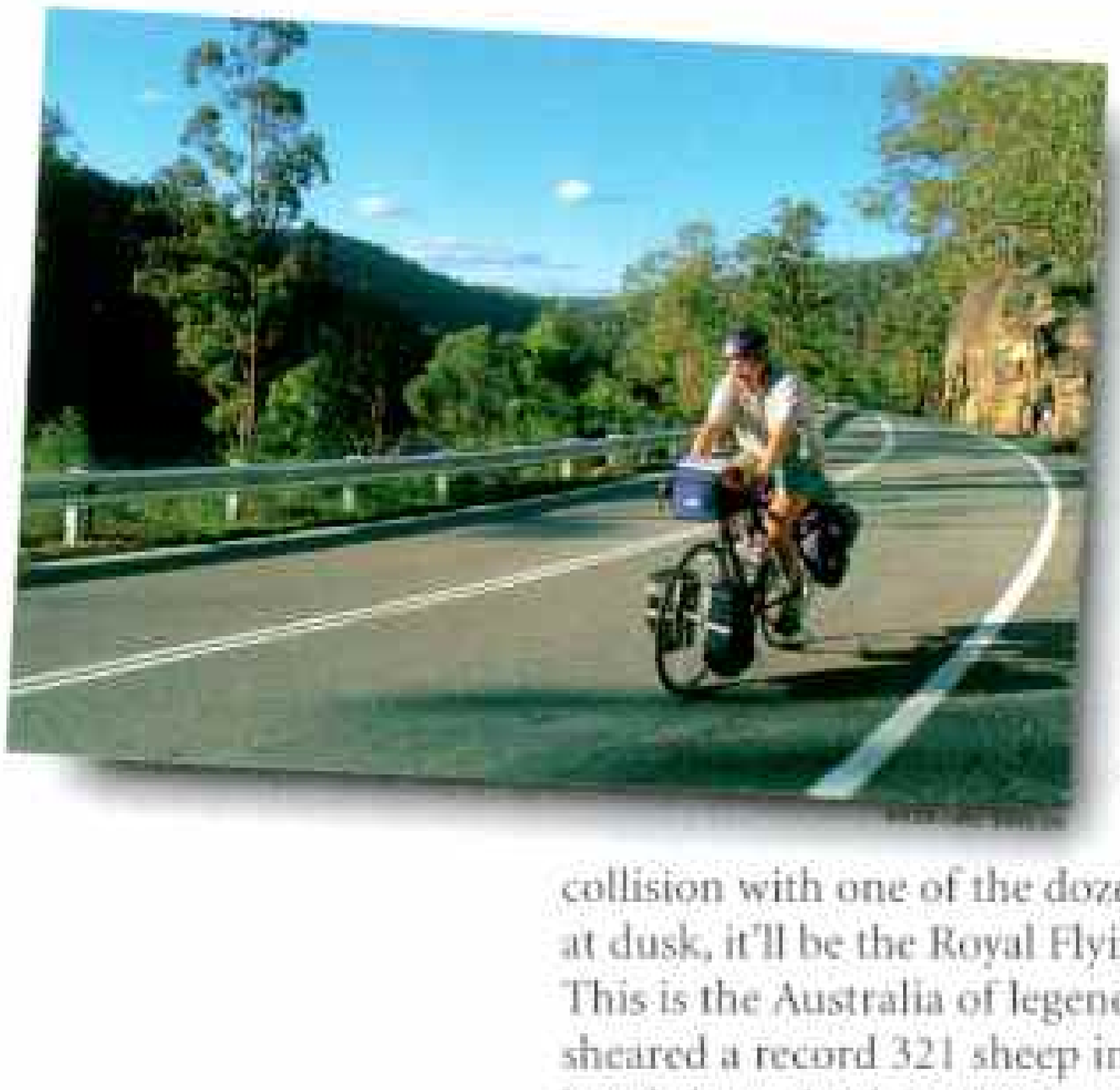
in their paddock. Half an hour later I was sitting on their veranda, shaved and showered, a tumbler of scotch in my hands, with a bed for the night. Over a plate of stew and a glass of Cabsav (Australian for Cabernet Sauvignon), Elva told me a little local history: "There used to be a lot of hobos around here back in the Depression, waiting to get a lift on the steam trains when they slowed down for the grade. My mother never turned one away if he was hungry. They'd put a rock on our gatepost to let others know we were friendly." She laughed and added: "I suppose now you can do the same."

Consider it done. I wonder if she knows how many people read NATIONAL GEOGRAPHIC.

Pudgy and unfit and grinding up Old Putty Road near Singleton, I was carrying just the basic tools and supplies, plus a water purifier. I was bone-tired. Not a good sign: Darwin, the end of the first leg of my journey, was 3,900 miles away, and my knees were already screaming "Mutiny!"

Wednesday, August 14
Rockhampton, Queensland

Australians have never let geography get the better of them. Here at Rockhampton an enterprising town council nudged the Tropic of Capricorn a few miles north to a brightly painted monument just outside the tourism bureau, so you can stand with one foot in the temperate zone and the other in the torrid, then trot inside to buy postcards and tea towels and check on hotel rates. I leaned my bike against the "Torrid Zone," then sat beside the sundial with a map, a bottle of water, and a muesli bar.

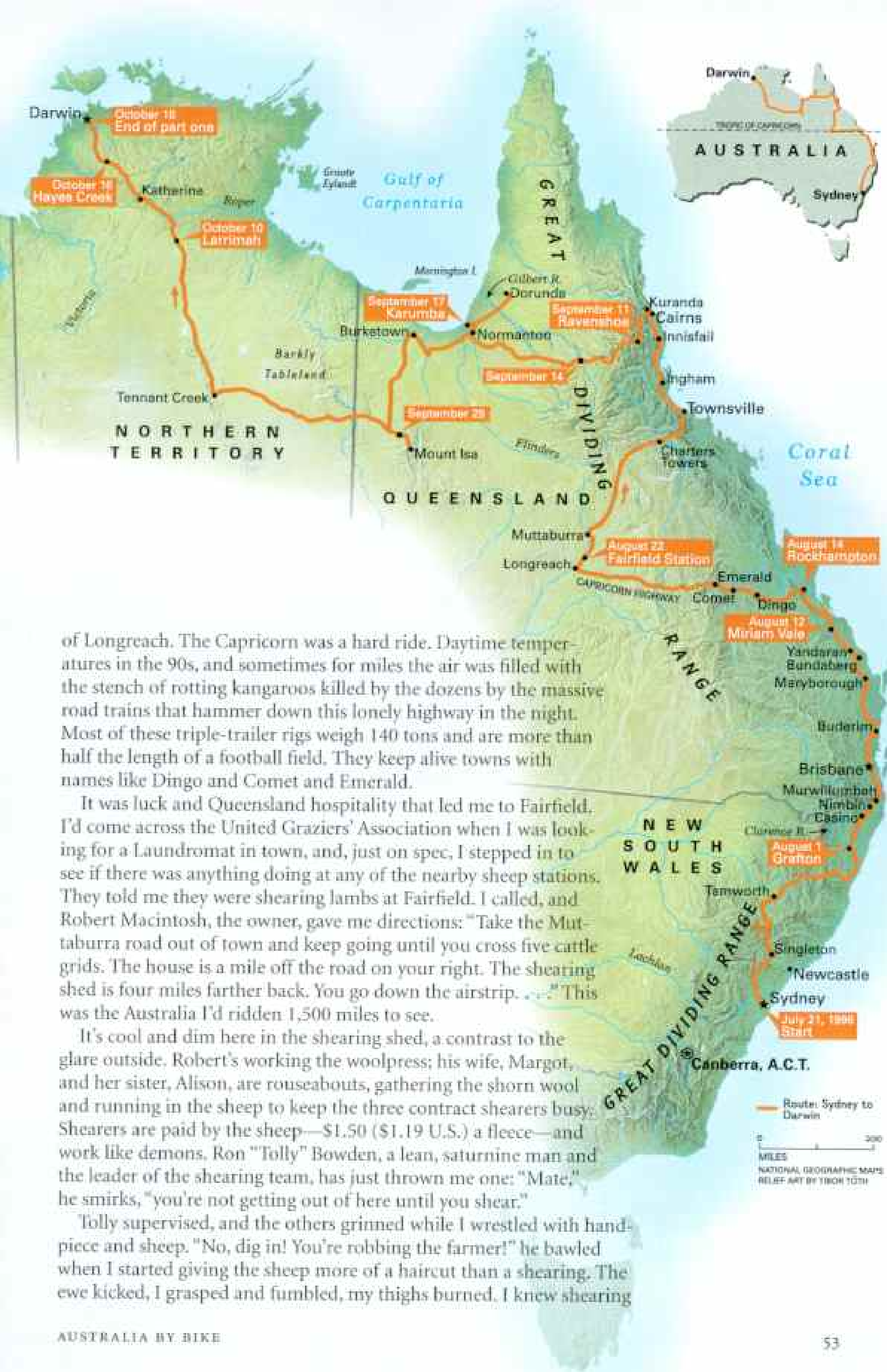


Now a thousand miles north of Sydney. Only one flat tire so far, a thumbtack back in Buderim on the Sunshine Coast. Here at the Tropic of Capricorn it's time to take stock. Until now I've been pretty much hugging the coast, riding in the ruts of thousands of Australian sunseekers and foreign tourists. Time for a change in scenery. I'll be riding the Capricorn Highway (I love the sound of that), which follows the tropic more than 400 miles to the lonely town of Longreach.

If I have a bad accident out there, say, a collision with one of the dozens of roos bounding across the highway at dusk, it'll be the Royal Flying Doctor Service that scrapes me up. This is the Australia of legend. It was out this way that big Jackie Howe sheared a record 321 sheep in seven hours and forty minutes using hand shears back in 1892—a record that stands today; where striking shearers founded the Australian Labor Party in 1891; where Banjo Paterson wandered the empty spaces and wrote "Waltzing Matilda."

Thursday, August 22
Fairfield Station, near Longreach, Queensland

I arrived at Fairfield an hour ago, after a three-hour ride on a rough dirt track out



of Longreach. The Capricorn was a hard ride. Daytime temperatures in the 90s, and sometimes for miles the air was filled with the stench of rotting kangaroos killed by the dozens by the massive road trains that hammer down this lonely highway in the night. Most of these triple-trailer rigs weigh 140 tons and are more than half the length of a football field. They keep alive towns with names like Dingo and Comet and Emerald.

It was luck and Queensland hospitality that led me to Fairfield. I'd come across the United Graziers' Association when I was looking for a Laundromat in town, and, just on spec, I stepped in to see if there was anything doing at any of the nearby sheep stations. They told me they were shearing lambs at Fairfield. I called, and Robert Macintosh, the owner, gave me directions: "Take the Muttaburra road out of town and keep going until you cross five cattle grids. The house is a mile off the road on your right. The shearing shed is four miles farther back. You go down the airstrip. . . ." This was the Australia I'd ridden 1,500 miles to see.

It's cool and dim here in the shearing shed, a contrast to the glare outside. Robert's working the woolpress; his wife, Margot, and her sister, Alison, are rouseabouts, gathering the shorn wool and running in the sheep to keep the three contract shearers busy. Shearers are paid by the sheep—$1.50 ($1.19 U.S.) a fleece—and work like demons. Ron "Tolly" Bowden, a lean, saturnine man and the leader of the shearing team, has just thrown me one: "Mate," he smirks, "you're not getting out of here until you shear."

Tolly supervised, and the others grinned while I wrestled with handpiece and sheep. "No, dig in! You're robbing the farmer!" he bawled when I started giving the sheep more of a haircut than a shearing. The ewe kicked, I grasped and fumbled, my thighs burned. I knew shearing

Near Grafton, morning fog rises from the Clarence River, a 250-mile stream that I crossed on the way to Brisbane. It's a painful reminder of the mental fog I was in the first week out, worrying about failure—and humiliation. Then biking cleared my head. My legs toughened, my confidence grew. And the road ran more like a river, gently tugging me downstream.

MEGHAN TAYLOR

was tough, skilled work, but knowing ain't the same as doing. When I finished and shoved the ewe down the chute—the "moneybox" in shearers' lingo—I asked Tolly how many he'd sheared that day: "Aw, 202." I recalled a bit of advice an old codger had given me in a pub a few days ago: "Don't ever mess with a shearer, mate, you'll always come off second best."

We're riding back to the farmhouse, Mary Macintosh sitting on her daddy's lap steering the Land Cruiser along the track, singing "You Are My Sunshine." She's smiling at me to be sure I'm appreciating her driving skills, which, considering she's all of three years old, are prodigious. "We're coming up to a gate now, Mary," Robert chides. She corrects course, piloting the vehicle between the two posts.

Mary's driving lessons are no mere parental indulgence, Robert explains, noting the pasty smile on my face. "Some day one of us could be hurt, and she might be the only one around to drive for help. You grow up quickly out here."

While Mary practices her steering, Robert tells me the story about the time back in 1870 when Australia's most daring cattle rustler, Henry Redford, stole a thousand head of cattle from the property just north of here and drove the herd across more than a thousand miles of uncharted desert to market in South Australia. "This was over the same country that had killed Burke and Wills only ten years earlier," Robert says, referring to the explorers who attempted to cross the dead heart of Australia and paid for it with their lives. "Redford would have got away with it except there was a distinctive white bull in the herd that gave the game away."

Redford was hauled back to Queensland for trial. But his daring captured the public's imagination, and a jury of his outback peers returned a quixotic verdict: Not guilty, but he's gotta give the cattle back. A furious judge ordered them to reconsider. They did: Not guilty, and he can keep the bloody cattle! "That's the simple secret to success in this country, Roff," Robert says with a wink and a grin. "You've just got to be a good bloke."

I DON'T KNOW if cycling 1,500 miles has made me a good bloke, but it's certainly making me a fitter one. I tipped the scales at a too comfortable 198 when I left Sydney. Today, Sunday, we went to the horse races in town, and I stepped on the jockey's scales. One-eighty-five without my necktie. As for the better bloke part, Robert has taken me in hand. I've been helping put up a new yard. "Know how to use an angle grinder? No? Well, you're going to learn." I've been pounding in fence posts, have learned how to haggle a badly placed one out of the hard Queensland earth with a front loader, and have acquired a fine set of blisters. Robert's a good teacher. He's not trying to impress me with how tough the work is—he doesn't need to do that—he wants me to share his enthusiasm and love of the land. He's succeeding, if not beyond his expectations certainly beyond mine. We mustered 1,200 sheep yesterday. The sun flaring overhead and thousands of cloven feet kicking up choking clouds of dust. Dogs racing around, barking, bringing in the sheep. I loved it.

It's odd. I've been here six days, and in that time nothing extraordinary has happened—kind of an average week on a station, really—but somewhere along the line my whole relationship with this country has changed. There's one image I'll carry with me the rest of my life. It was the morning Robert took me up in his father's Cessna for a look around the property. Rumbling down the dirt strip in front of the homestead, trailing a cloud of dust. Then the ground fell away, and the empty Queensland outback spread out, rust red, horizon to horizon. The kids waved to their daddy, Margot looked up from hanging out the washing, a couple of lambs played in the vegetable garden. At that instant, for the first time in many years, I felt excited to be in Australia.

Rumbling down the back roads of Australia, the road trains whoosh by like locomotives. They deliver all sorts of supplies —livestock, dry goods, petrol, you name it—to small towns in the outback. And while the bigger rigs have 62 wheels and weigh 140 tons, I never had a problem with them. Drivers would always honk their horns as they approached, then give me a generous berth when they passed. Real gentlemen they were.

Wednesday, September 11
Ravenshoe, Queensland

Arrived here mid-morning a couple of days ago, thighs burning after almost a hundred miles of winding switchbacks. I'd had to cross the hard-green, rainforested mountains that form an amphitheater around the tropical port of Cairns. Just below Kuranda I stopped for a last glimpse of the Coral Sea, hazy and still as an old postcard. The next body of water I'll see will be the Gulf of Carpentaria.

Right now I'm sitting on the loading dock at Northland Agencies, a farm-supply store, surrounded by bales of hay and sacks of grain. Going to load a truck in a few minutes. A minor breakdown has sidelined me—the bolt anchoring the derailleur cables to the frame snapped, and I'm waiting for a replacement to be shipped from Brisbane. I'm staying with Grahame West and his family, putting in my days

helping at their store. Grahame is a former art director of an Adelaide advertising firm who fled the button-down corporate scene in 1973 to grow organic produce and sell hay in this corner of the world.

These days he spends a lot of his time making deliveries and, like all truckers, keeping an eye out for local officials—the "scalies"—who fine overloaded truckers. I've gone with him on his rounds. I met an eccentric Luxembourger who came to Ravenshoe two years ago in a Gypsy wagon from Fremantle in Western Australia; an artist named Sherry Vincent, who'd grown up on the Nullarbor Plain in the far south, never attended school, but painted spectacular murals; and the former Lady MacDonald from the Island of Skye, who'd discarded her title in favor of running a shark boat in the waters off Cairns.

One afternoon we took tea with Dr. Harry Bromley, a stout old-school British Army officer in his 80s, who'd been stationed all over the Far East back in empire days, escaped on foot into India ahead of the invading Japanese Army, and won an M.B.E. in '51 for his work with lepers in the Seychelles Islands. Sitting in his neat tropical garden, I had the notion that if Dr. Bromley didn't exist, Agatha Christie would have invented him.

The phone's just rung. The part has arrived in Cairns and will be here tomorrow. But first I've got half a ton of grain sacks to load onto Grahame's truck.

Saturday, September 14
Camped in the far north of Queensland

I've found my niche for the night and settled in. Crispbreads and processed cheese for dinner tonight. Seasoned with Tabasco sauce. A dried fruit course, followed by peanuts and some muesli bars. Maybe a toothpick for dessert. Typical. My radio plays softly, tuned to ABC Radio National, the only station I can pick up this far out. One of the first things everyone seems to ask is how do I sleep at night. The short answer to that is I sleep very well, thank you. Who wouldn't after a hundred miles in the saddle? But that's not what they mean. I camp in the bush a couple of hundred yards off the road. No tent, just a bivvy bag, although I have a tarp I can rig if it looks like rain. Except for a brief, light shower one afternoon on the Capricorn Highway, I've not seen rain in six weeks.

My gear is low slung and dark purple by choice, and when I set up in

They live on their sheep station in the middle of Queensland, yet the Macintosh family never seemed lonely to me. In fact Robert, Margot, and their four kids—including Hugh and Emily (facing page)—relish this remote life. Mornings Emily and her dad troop to the milking sheds (top). Later Margot homeschools her kids, with teachers helping out a bit via two-way radio.

How do you manage 12,000 sheep on a 42,000-acre station? On the Macintosh ranch you fly a 1960 Cessna to spot your flocks and ride motorcycles to round 'em up. This is the idyllic, almost mythic image of Australia cherished by so many folks, Aussies included. But the fact is, the bulk of this continent is so dry that most people live on the coast and work in the city. I did it myself and had no idea what I was missing.

the scrub, I'm invisible from the road. Australia's not a scary place, although it has its share of sordid crimes. Only six weeks ago in Sydney a serial-killer outdoorsman named Ivan Milat was jailed for life for murdering seven backpackers. But I'm okay. Back in Murwillumbah, in northern New South Wales, an elderly gentleman came up to me on the street and put me at ease: "Don't worry. I'll remember you. After you're murdered, I'll remember I saw you here and tell the police."

I'm well and truly in the outback now, a speck in a dusty immensity of savanna grass. The air is still, dry, and very hot. The road is a nine-foot-wide ribbon of bitumen that disappears into a shimmering horizon. Usually have it to myself for hours at a time. I wake before dawn, get my camp rolled away in about ten minutes, and have breakfast down the road—a couple of muesli bars, some dried fruit, and my first and last cool water bottle. By about eleven o'clock—these days self-reliance stretches to guessing the time by the angle of the sun—when the sun is really starting to bite, I scout out a bit of shade in a dry creek bed and settle in for a few hours' kip. Then it's back in the saddle until just before dusk, when I nose my bike through the scrub in search of a bed for the night. The hope is for a flat patch with as few crawling bedmates as possible.

My home is New Hampshire, but I've worked as a journalist in Australia so long I feel as if I've got a foot in both camps. A German guy once told me the only way to live happily overseas is to forget your past. But who am I without my memory?

Tuesday, September 17
Karumba, Queensland

These lines scribbled in haste, in the back room of Ash Colahan's fish-and-chips shop. The guys are lashing the dinghies to the roofs of the Land Cruisers; in a few minutes we're going bush. It began yesterday, in the finest outback tradition, with the offer of a cold beer on a stinking hot afternoon. I was heading toward Normanton when a pair of old, heavily laden Land Cruisers slowed beside me and someone called out in a broad Queensland drawl: "Geez, mate, I'll bet you'd love a cold stubby along about now!" I grinned. "Geez, I'll bet you're right!" We all pulled over. It turned out that Mick Jones, a police constable, was getting married. He, his best-man-to-be, and two of his uncles—"Thommo," Terry, and Paul—were going fishing.

"Tell you what," Mick said, after a couple of get-to-know-you beers on the roadside. "You want to see Australia? Why don't you come with us? We're going into some really wild country along the Gilbert River. You can leave the bike at my in-laws' place." So we spent last night at Ash's place and this morning poking around the town, picking up supplies: sausages, the makings for a hot chili con carne, and a couple of slabs of XXXX Beer.

Karumba is a raw-edged fishing port on the Gulf of Carpentaria, where the old flying boats coming down from Asia used to dock back in the thirties. From its place on the map I'd expected lush rain forests, not a heat-warped dust bowl. It's as tough as it looks. The local watering hole is a concrete arcade called the Animal Bar, where the tables and chairs are bolted to the floor, and bronzed, long-haired, tattooed regulars can outdrink, outswear, and outfight any three city-bred stevedores; the men look even rougher, as I found out when I plucked my Nikon out to play at being

a National Geographic photographer. "You point that bloody thing at me, and I'm gonna shove it down your throat," one guy snarled. He might have done it anyway, except that 240 pounds of hardened ex-con named Andrew happened by and said g'day to me. I said g'day back. The other guy's eyes widened. He remembered he had to be someplace out of 240-pound range. I clicked off a few frames for form's sake—very discreetly—and gave my Nikon the rest of the afternoon off.

Here we go then. The dinghies are lashed. We're leaving this "civilization" and heading for the rough country.

If I spotted this pet tarantula, would it be wearing a tiny collar? Actually crawlies are no joke out here: Australia is home to the world's ten most venomous snakes, including inland taipans, which are more poisonous than cobras. Luckily, they all left me alone.

Ten days of puttering up rivers overhung with prehistoric fronds, a weather eye out for crocs. Casting for barramundi in the mangroves. Eating the catch hot off the skillet. Billy tea. Card games around the campfire. A garbage bag full of crumpled beer cans.

"It's hell in the tropics," Terry liked to say at the end of the day, too laid-back to get out of the dinghy. "If I was going any slower, I'd be going backwards." Thommo'd be rigging up his solar shower. Mick'd be tuning his guitar or filleting some barramundi. Paul in the middle of another ludicrous tale—hustling pool in the Animal Bar, gags he pulled on a work crew out on Mornington Island, stealing watermelons as a kid. "Nobody cares about poor little Paulie Gauci!" he'd wail at the end of these stories, and everyone would crack up.

We swung back through Karumba yesterday to pick up more supplies, and now I'm writing on the countertop at the Burketown pub, where we pulled in for lunch and a couple of beers with Mick's police mates. This is probably the most isolated town in Australia once the rains hit. All the roads wash out, and poor old Burketown can

"Thommo," Mick, Paul, and Terry stopped to offer me a beer, and I ended up spending ten days with them. We fished and laughed and at Dorunda Station enjoyed Mick's bachelor party. We were mates. Days later, looking as if he was on a divine mission, Mick got ready to tie the knot.

BOTH BY ROB MARTIN SMITH

be on its own for weeks. Months, in the bad old spit-and-chaw days.

I'm feeling at home out here in a way I never would have when I left Sydney. These guys have done more for me than shout me a beer and show me some frontier. They've opened the door to old-fashioned Aussie mateship, that uniquely Australian brand of camaraderie that defies easy translation. Even Australians can't quite put a finger on it. Traditionally expressed in challenging outback settings (or the trenches of World War I), it's a blokey, watch-each-other's-back loyalty, leavened with laconic wit and gentle digs at each other's foibles. (Such as my unblokey preference for sarsaparilla over beer.)

SATURDAY—THE BIG DAY. Mick and Kerriann were married this afternoon in the Catholic church in Mount Isa. We hit this wide-open zinc-mining town a couple of days ago, rented cheap cabins in a caravan park, and got haircuts. The wedding coincided with Grand Final Day for Aussie Rules Football. North Melbourne playing Sydney. Typical Aussie blokes, we alternated between watching the game and sprucing ourselves up, while Kerriann and her entourage were off at the beauty parlor. North Melbourne was well ahead when we turned off the TV, straightened our ties one last time, and walked down to the church. It was a nice wedding. The reception was at the golf club.

Sunday, September 29
A stony hillside 30 miles west of Mount Isa

The moon's so bright I can't sleep, so I'm sitting up listening to the radio and writing, lonely as a pin on a map. I left my mates today after a recovery party at Mick's aunty's house. They all gathered to see me off, Mick's mother telling me not to forget I had a family in Queensland now. As I was getting on my bike, Mick hauled me back and gave me a big hug. Those moments etch this place in pretty sharp relief. I've got a thousand empty miles to travel between here and Darwin, and the radio's a poor substitute for Paul's hilarious tales about growing up on the wrong side of the tracks in fifties Queensland, or Thommo's acid wit, or Terry's drawled observations, lazy as tropical sin. I thought about Mick and Kerriann taking their honeymoon in Tasmania; an idle afternoon dealing card games in the laundry room behind Ash Colahan's motel in Karumba; the day we pooled our money—and trebled it—betting on the horses at the Irish Club in Mount Isa.

Now I sit in a nest of spinifex, spiny grass that grows everywhere out here—nature's barbed wire. I miss my new mates. I miss Laura and Ethan, especially after speaking to them on the phone today. Laura's riding her tricycle around the house being daddy. Ethan's talking a little bit now. He said hello.

Thursday, October 10
Camped near Larrimah, Northern Territory

Fifty-four years ago, when Australia was under threat of Japanese invasion, a team of

A steaming asphalt treadmill—that's the road a few hundred miles south of Darwin, where you buck head winds and sweat for hours but the scenery never seems to change.

I once heard that the cyclists who enjoy the greatest success riding this circuit approach the journey as a test of stamina and logistics. My test feels more like an essay question: "On the road less traveled, what really matters most?"

American GIs and Aussie soldiers paved a stretch of the road from Mount Isa to the port city of Darwin in a frantic hundred days. Nobody seems to have done much with it since, at least not on the Queensland side of the border. Cycling it was like riding a rodeo bull. Thirsty work in that heat. I was packing 12 liters of water and rationing it pretty carefully.

Once some Aborigines pulled over with a welcome offer to refill my now nearly empty water bottles. When I remarked on how little water there was out here, their leader, a man named Maurice, laughed and listed half a dozen reliable pools, not too far off the highway, over the next 50 miles.

"How far are you going?" he asked. "Darwin, at the moment," I replied. He shook his head, then said slowly and without a trace of irony, "I'm sorry. I'm afraid I don't know all the water holes between here and Darwin. You'd better ask other Aboriginal people along the way."

Wednesday, October 16
Near Hayes Creek, Northern Territory

One night on this long road to Darwin I woke to the sound of thunder and the earthy tang of approaching desert rain. I scrambled out of my bedroll and wrestled with my tarpaulin in the rising gale to rig a shelter before the storm hit.

JEFF MARTIN SMITH

The Barkly Tableland was a dreamscape. A sooty blackness blocked out the stars in the west; an eerie, fat moon, blood orange from the blowing dust, glowed in the east and cast spooky shadows in the scrub. I drifted back to sleep listening to the patter of raindrops and the tarp snapping like a broken spinnaker. Lightning hissed. I recalled how lonely I'd felt coming out of Mount Isa. But there I was, 60 miles from the nearest dwelling, in a violent storm, relishing my isolation. Being back on the road has a way of curing loneliness.

Tonight's camp is only a hundred miles south of Darwin—a few beers in the local measure of distance. At this rate I'll reach town maybe the day after tomorrow. The nights are breathlessly hot, well into the 80s. Every evening, after the bush flies have quit for the day, I sprawl beneath my mosquito net wondering if the tickling I feel is sweat running off me or ants crawling up. It's generally both.

Some nights I've given up on the idea of sleep altogether and sat amid the spinifex sipping a water bottle and looking at the stars. Every now and then a road train comes booming down the highway, lit up like a county fair, orange running lights festooned along its flanks, high beams scouting for roos on the road ahead. Sitting on the sidelines, watching these big rigs recede in the night, I feel a bit like Huck Finn watching steamboats through the rushes on the Mississippi. □

On the next leg, along the west coast, the weather was scorching, the hills were brutal, and I lost 25 pounds. Other than that, it was a picnic.

THE ROYAL CRYPTS OF COPÁN

By GEORGE E. STUART
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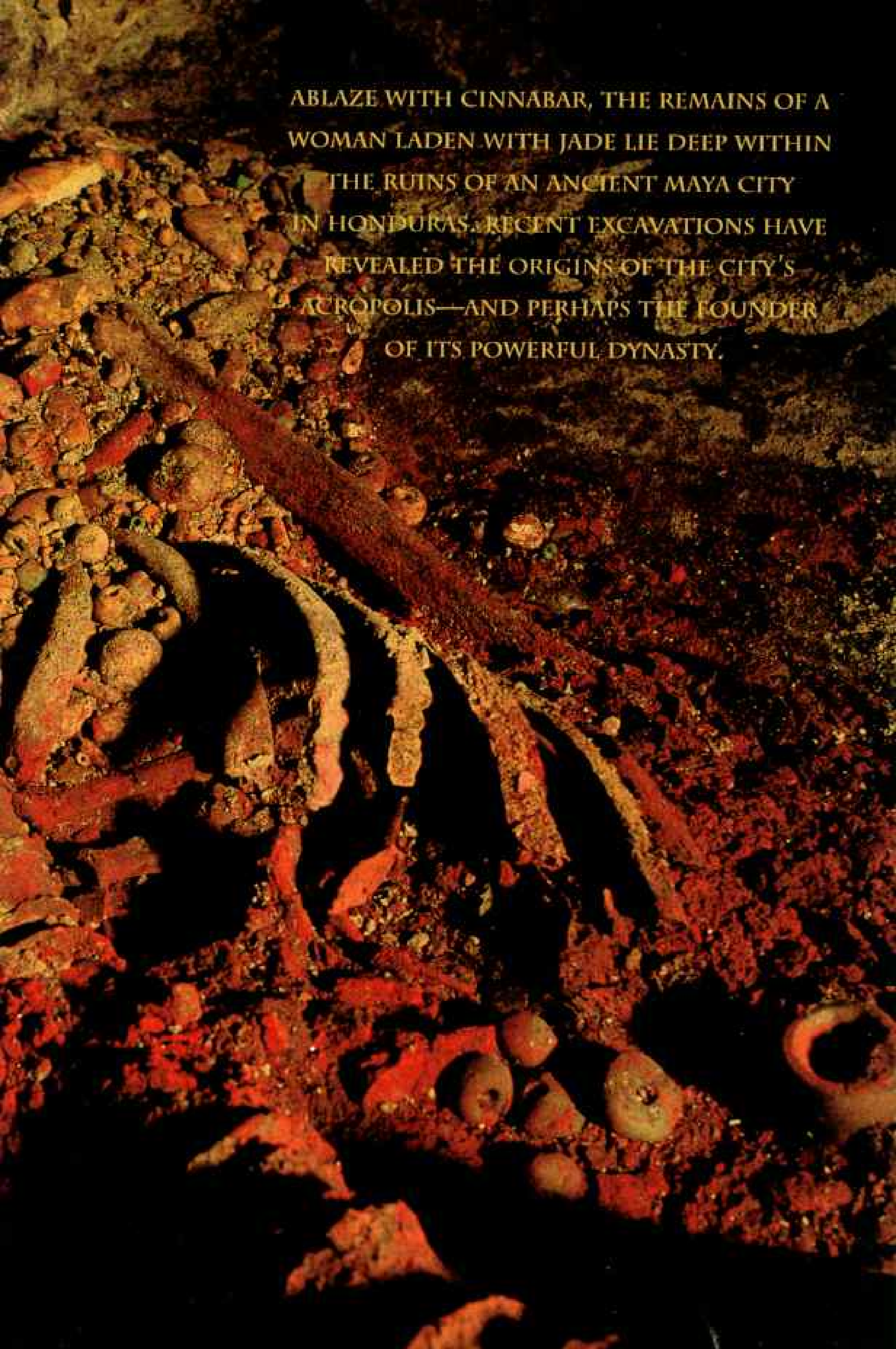
Photographs by KENNETH GARRETT
Art by CHRISTOPHER A. KLEIN
NATIONAL GEOGRAPHIC ARTIST


ABLAZE WITH CINNABAR, THE REMAINS OF A
WOMAN LADEN WITH JADE LIE DEEP WITHIN
THE RUINS OF AN ANCIENT MAYA CITY
IN HONDURAS. RECENT EXCAVATIONS HAVE
REVEALED THE ORIGINS OF THE CITY'S
ACROPOLIS—AND PERHAPS THE FOUNDER
OF ITS POWERFUL DYNASTY.

LIGHTBULBS strung along the ceiling of the narrow tunnel revealed damp walls of reddish clay and gray rubble. The sticky air fogged my glasses. I crouched close behind David Sedat, the University of Pennsylvania Museum archaeologist who is field director of the Early Copán Acropolis Program here in the tropical forests of western Honduras. We were 50 feet below the grassy plazas atop the Acropolis, probing for the buried secrets of Maya history.

RESEARCH PROJECT

Supported in part by your Society

The Maya, whose lands reached from the highlands of Guatemala and neighboring Mexico, El Salvador, and Honduras through Belize and the broad plain of Mexico's Yucatán Peninsula, boasted one of the greatest civilizations of antiquity between about A.D. 250 and 900. In that time at regional capitals such as Palenque, Tikal, Calakmul, Cobá, and Copán, Maya kings held court amid the pomp and circumstance of aristocratic lineages, overseeing dynamic societies of farmers, artisans, astronomers, and scribes. Of all Maya sites, none exceed Copán in the magnificence of the works that have survived through the centuries.

Now, in the tunnel, Sedat moved with the enviable ease of long experience in this hot, stuffy, claustrophobic, earthquake-prone place. He said he had a surprise for me.

Eventually the main passage turned left, briefly revealing a polychrome wall sculptured and painted with Maya imagery and icons as bright as the day they were created more than 1,500 years ago. Sedat led me up a ramp of boards that sagged over a black void. Finally he stopped, just short of a vertical shaft that broke the worn smoothness of the dirt floor.

"This is our surprise," he said, "but there's only room for one at a time. You go first."

With a small flashlight clenched in my teeth, I eased over the brink and cautiously climbed down into the hole, then crunched as low as I could to peer through the opening at the base of a dirt-and-stone wall. I could see

the edge of a large stone slab revealed by new excavation. Now the slightest move became a major problem in physics. Removing my hat to minimize contact with my fragile surroundings, I squeezed my shoulders through the opening and raised my head slightly above the level of the slab. Barely, but enough, for what I saw remains one of the most exhilarating experiences in many years of trying to know the ancient Maya.

On the slab lay the remains and grave goods of a royal personage. Virtually all evidence available to the archaeologists who found it indicates that the individual interred here was none other than K'inich Yax K'uk' Mo', Sun-eyed Green *(Continued on page 78)*

KENNETH GARRETT has photographed numerous archaeological and paleontological subjects for NATIONAL GEOGRAPHIC over the years. His most recent assignment: "Tracking the First of Our Kind," a September 1997 article in the Dawn of Humans series.

A WORLD ORDER CARVED IN STONE

The Jaguar God of the Underworld (above, at left) relinquishes his nocturnal control of the sun at first light. Rulers placed such sculpture on the Acropolis to express their view of the cosmos.

Copán's final ruler—Yax Pasah, or First Dawn—erected a monument known as Altar Q, which records the entire line of 16 hereditary kings. In the crucial scene Yax Pasah (left, at right) symbolically receives a baton from the dynasty's founder, K'inich Yax K'uk' Mo'—Sun-eyed Green Quetzal Macaw. Depicted with foreign trappings, K'inich Yax K'uk' Mo' carries his shield on his right arm rather than his left, likely an identifying personal detail.

The towering Acropolis, civic and ceremonial heart of a city-state of 20,000 people, took shape during four centuries of construction that began about A.D. 400. Each ruler tore down parts of earlier buildings, some reconstructed here in cutaways, and put his own on top.

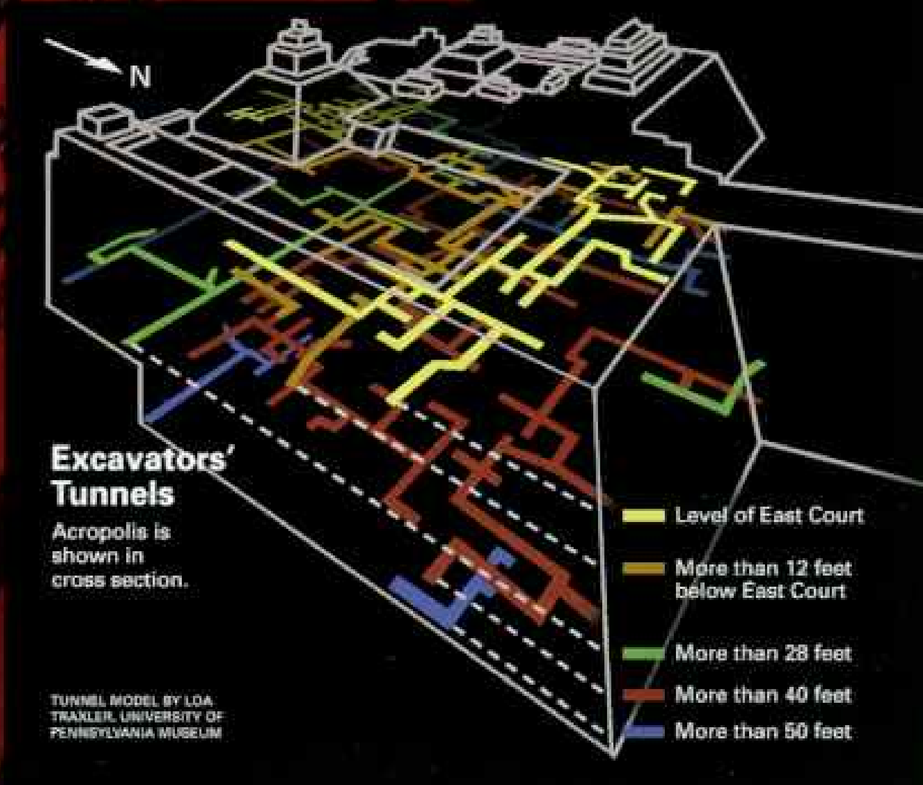
"They created a sacred geography," says project director Bill Fash of Harvard. "You could walk through all the myths of Maya civilization: the Bat House, the House of Knives, the Mountain Where Maize Was Born."

1. Structure 16
2. Rosalila
3-9. Features underlying Rosalila (see pages 86-7)
10. Altar Q
11. Corte (river cut)
12. Bat House
13. East Court
14. House of Knives
15. Sub-Jaguar tomb
16. Jaguar God of the Underworld sculpture
17. Mountain Where Maize Was Born
18. Mat House

VISUAL CONSULTANT: BARBARA FASH, PEABODY MUSEUM, HARVARD UNIVERSITY

LOOKING AT THE PUZZLE IN DEPTH

Through a maze of tunnels archaeologists have explored the buried ruins of buildings without harming the structures on top. "It's like arthroscopic surgery—maximum gain with minimum pain," says Honduran co-director Ricardo Agurcia Fasquelle. Starting in the east, where the Copán River had eroded part of the Acropolis, excavators followed floors on five levels in more than a mile and a half of tunnels (diagram, below). Architecture was their guide. "In one area we went out a door, discovered a patio, turned left, found a building, and followed its rooms to another patio," says field director David Sedat.

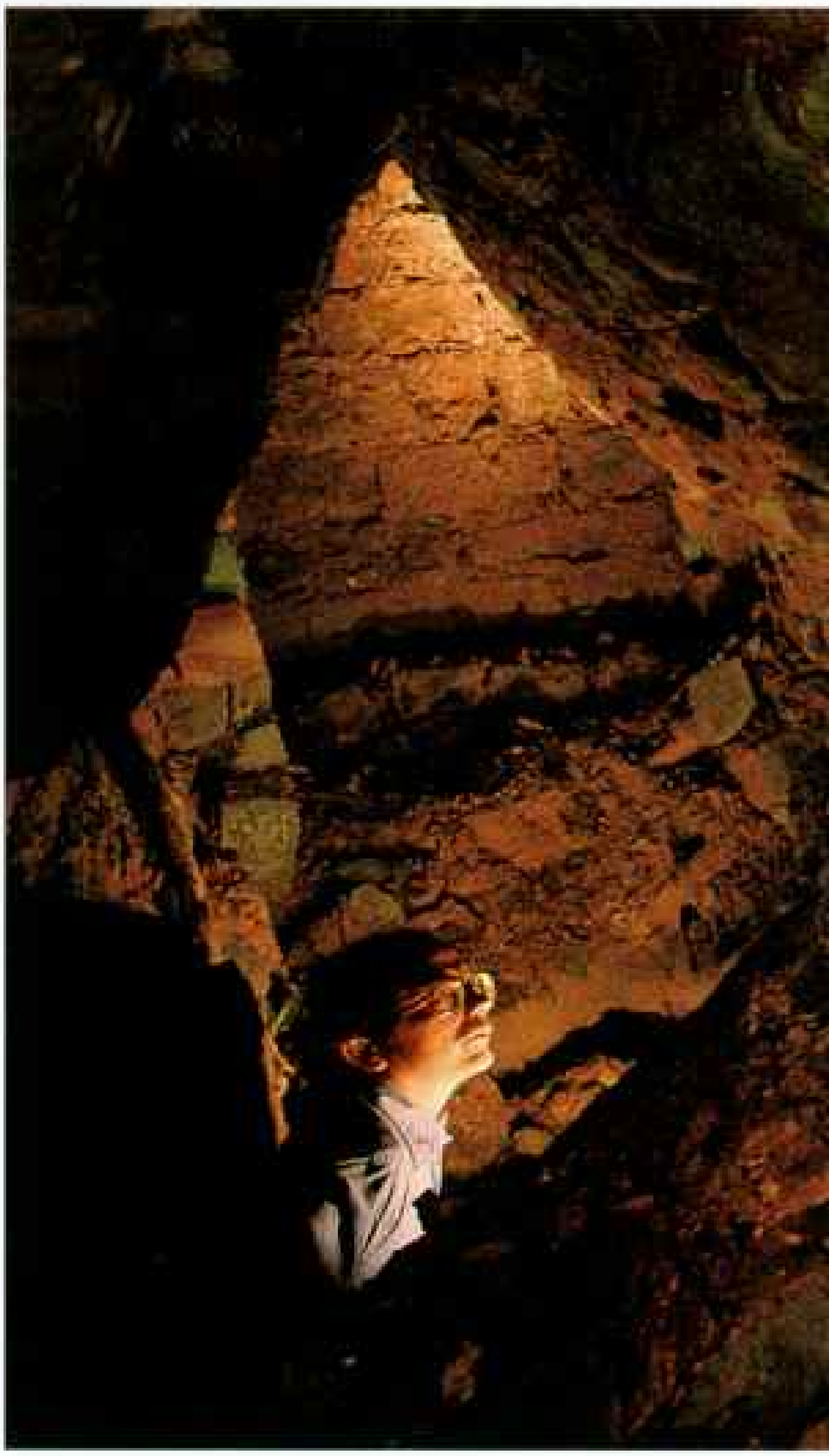


ALL CLUES LEAD TO THE DYNASTY'S FOUNDER

Untouched since their interment, the mortal remains of an important man get a gentle cleaning from Robert Sharer of the University of Pennsylvania Museum. "The evidence points to his identity as K'inich Yax K'uk' Mo'," Sharer says. For instance, the tomb lies at the bottom of the very center of the Acropolis. The jade pectoral next to Sharer's brush seems identical to that worn by the founder on Altar Q. Also, the skeleton's right arm has been horribly crippled—possibly a war wound that the ruler hid behind a shield, as on Altar Q.

Grave goods include a deer effigy pot (top) as well as a variety of other vessels (above) meant to hold food and drink, perhaps for the next life. The jade inlays in two of the man's teeth emphasized that he was a highly esteemed person.

An outpost of Maya culture, Copán sent goods, people, and ideas from the frontier to the heartland and beyond. Experts debate the nature of its foreign contacts, but Copán, flaunting styles from distant places such as Teotihuacan, does not seem like a subjugated city. "Teotihuacan was the New York of that time," believes Ricardo Agurcia. "Everyone wanted to show he had connections there."



(Continued from page 70) Quetzal Macaw, the revered god-king, the fabled "founder" mentioned in Copán's hieroglyphic texts. Some scholars believe the founder was a local lord; others now think that he came to Copán from some Maya city to the north, possibly from one that had fallen under the cultural influence of Teotihuacan, a metropolis in central Mexico, or even from Teotihuacan itself. Once installed in Copán, the founder established a dynasty that would maintain the power of this Maya valley kingdom for some 400 years.

MY COLLEAGUES in Maya archaeology have long recognized the enormous significance of Copán. From more than a century of archaeological research we know that these ruined buildings beside the Copán River served as the political and religious capital of an important kingdom for many centuries before its collapse more than a thousand years ago. Early on, investigators working in the Copán Valley came to realize that the lofty Acropolis served not only as the locus of some of the city's most spectacular architecture and sculpture but also as the seat of governing power of the Copán kingdom during the height of the Maya Classic period, between about 400 and 850.

The Classic period rulers of Copán claimed descent from the sun and ruled by that right. They waged war, traded, commissioned monuments to themselves and their lineages, and presided over a kingdom of some 20,000 subjects. These ranged from farmers who lived in pole-and-thatch houses to the elite occupying the monumental palaces near the

A LAVISH SEND-OFF

Amid debris shaken by earthquakes, David Sedat surveys the contents of an unusual vaulted chamber above a tomb in the building excavators call Margarita. Rich offerings such as baskets, pelts, and feathers once surrounded a Teotihuacan-style vessel nicknamed the "dazzler." Rolled out (below), its painting depicts the goggle-eyed god Tlaloc of central Mexico in a Maya-style temple. "You can't get a more Teotihuacan-in-your-face statement than this pot," says Agurcia. Though perhaps made locally, it shows that foreign influences were important to the deceased.

Acropolis. Some valley households evidently prospered by means of cottage industries that produced special corn grinders, obsidian cutting blades, and shell ornaments. Rituals such as the ceremonial ball game, a soccer-like contest that held cosmic significance, took place in the ball court, while more private royal ceremonies of vision quest and ancestor worship—accompanied by blood-letting or hallucinogens—went on in the security of secret courtyards and rooms atop the Acropolis. Depending upon the times, neighboring kingdoms might be raided for captives for public humiliation rites or sought as partners in diplomacy or royal marriages of advantage.

The Copán Acropolis rises to a height of about a hundred feet above the adjacent river bottomlands. Roughly rectangular and oriented approximately north-south, the construction mass contains roughly 80 million cubic feet of fill. It was once even larger. After the Maya abandoned this site to the forest and the river, probably by A.D. 900, its stone buildings gradually fell into ruin. Lintels collapsed and vaults crashed, bringing down walls and entire buildings, many of which slid into oblivion as the path of the river gradually undercut the eastern edge of the Acropolis.

When John Lloyd Stephens, pioneer explorer of the land of the Maya, and his artist companion Frederick Catherwood approached Copán in the autumn of 1839, the first thing they saw was the great heap of the Acropolis. "We came to the bank of a river," Stephens later wrote, "and saw directly opposite a stone wall, perhaps a hundred feet high, with furze growing out of the top, running north and south along the river."

What Stephens and Catherwood had glimpsed that morning was not a wall—they would figure this out later—but what we now know as the great *corte*, or cut, a sheer cliff sliced by river action. The corte made it clear that the Acropolis was not a natural hill but the accumulated mass of centuries of construction. As William L. Fash, Jr., the Harvard University archaeologist who directs the Copán Acropolis Archaeological Project, puts it, "Each king literally built upon the works of his predecessors."

I first saw the Acropolis some 25 years ago. There were no archaeological probes under way at the time. The place rested in silence under a lofty canopy of aged trees. I remember most vividly the color green. It was everywhere—in the filtered sunlight on the stones, in the bright moss that covered much of the rubble and sculpture alike.

In my roamings that first time, I recall one mound, about 20 feet high, near the northwest base of the Acropolis. It rose like a glowing green heap in the shade of some of the largest trees on the site. Searching its slopes, I came upon a number of life-size carved stone skulls, evidently parts of some wall or stairway decoration. I'm not sure why, but that mound had a profound effect on me. I decided then that I would return to Copán someday, if not to explore its haunting ruins then to have my ashes scattered there after I begin my own journey to whatever green afterlife awaits.

BILL FASH HAS SPENT most of his career at Copán, beginning in 1977 as a graduate student helping to map the thousands of mounds that fill the valley. From 1975 on, with the assistance of the Honduran Institute of Anthropology and History, a series of projects under different scholars has focused on various aspects of ancient life at Copán, ranging from the excavation of a sampling of the humblest valley households to the uncovering of the magnificent Rosalila building within the Acropolis. For ease of discussion the excavators have given nicknames to the various structures. Rosalila was excavated and named by Ricardo Agurcia Fasquelle, the Honduran co-director of the Copán project.*

The discovery of Rosalila, probably the best-preserved building ever found in the Maya area, confirmed Fash's and Agurcia's belief in the special nature of that area of the Acropolis. They had been drawn there by the presence of Altar Q, arguably the most important monument at Copán, which lay nearby at the base of Structure 16, where Stephens and Catherwood had seen it in 1839. Stephens had immediately guessed the true nature of its imagery as depictions of 16 noble personages. We now know these men as the 16 kings of the Copán dynasty founded by K'inich Yax K'uk' Mo' in 426. Altar Q was dedicated in the late

*See "Maya Artistry Unearthed," by Ricardo Agurcia Fasquelle and William L. Fash, Jr., NATIONAL GEOGRAPHIC, September 1991.

DECODING HARD EVIDENCE

History only half understood lies at the feet of Sharer and Sedat in the Margarita offering chamber. Glyphs on a huge stone record a date interpreted as November 30, 437. They also mention the second ruler as well as the first, but the meaning of other parts of the inscription is not yet clear. Was this a monument that the son commissioned upon the death of his father? Was it first used as an offering to K'inich Yax K'uk' Mo' and then reused for the Margarita burial? And if so, who was the revered person laid to rest here?

700s by Copán's last dynastic ruler, Yax Pasah, in a ceremony of animal sacrifice that included 15 jaguars, perhaps in honor of Yax Pasah's predecessors.

Of all Copán's known rulers, none ever really overshadowed the revered memory of the founder. On Altar Q he is shown handing the baton of office to Yax Pasah in 763—a metaphoric transfer of power, since more than 300 years separated their two lives and reigns. In the scene the founder is depicted with a jade bar pectoral—the chest ornament fancied by royalty—hanging around his neck. He wears the symbolic goggles that make him one with Tlaloc, the central Mexican god of lightning and war, and he carries a shield, not of Classic Maya style but of a rectangular shape associated with Teotihuacan, some 700 miles from Copán.

Just how the influence of Teotihuacan came to such a distant area remains a mystery. We do know that Teotihuacan must have appeared to resident or visitor as a place of supernatural power. Its population of 125,000 to 200,000 would have placed it among the largest cities of the ancient world. Its cultural reach was clearly enormous. Some scholars believe that commerce spread the influence of Teotihuacan to the Maya region; others suspect that conquest played the major role.*

Hallmarks of the Teotihuacan presence among the Maya range from objects of a distinctive green obsidian not found in Maya territory to the unmistakable styles of lidded

*See "The Timeless Vision of Teotihuacan," by the author, in the December 1995 issue.

pottery vessels and certain architectural features. These all appeared to varying degrees at virtually every Maya capital, including Tikal, Calakmul, and Palenque, between about 300 and 600. Copán is no exception.

Robert J. Sharer of the University of Pennsylvania Museum directs the team assigned the daunting task of sampling the interior of the Acropolis. In 1989 he and Sedat began tunneling just beneath the surface of the East Court, not far from Rosalila. But the East Court probe was only the beginning. The need to go deeper into the structure in a systematic manner led Sharer and Sedat directly to the confrontation with the lowest levels of the cliff face of the corte. Fortunately for them, the Copán River had been rechanneled in the late 1930s to protect archaeological treasures, thereby leaving the corte high and dry. In 1991, after masons had fortified the cliff face, the archaeologists began their investigation of the earliest chapter in the story of the Copán Acropolis and how it grew.

ONE OF THE FIRST major discoveries came in the form of a great stone, carved with hieroglyphs and in pristine condition, that was uncovered at the base of a masonry wall. Linda Schele, an epigraphist from the University of Texas at Austin, quickly read part of the message on the stone, which proclaimed the dedication of "the death house of the lord of Copán." It also named the founder and his son.

"Apparently," says Bob Sharer, "it had been removed from a razed building near where we found it. And its message seemed clear: The remains of the founder and his buildings lay beneath the very center of the Acropolis. It reinforced what we suspected all along."

The inscribed stone had been reset by the Maya in the wall of a vaulted chamber in the building the excavators call Margarita. Inside the chamber lay what soon became known as the "dazzler" pot, a brilliantly painted tripod vessel on slab feet, left as an offering. Both it and its lid bore images of an intricately detailed structure—a platform in the unmistakable architectural style of Teotihuacan surmounted by a Maya-style temple. Each structure was rendered in part as a living being, with extended arms and the goggle-eyed countenance of Tlaloc staring back at the viewer from a miniature doorway.

Below the offering chamber, the Margarita tomb proved to be a puzzle. At first it was assumed that this tomb must surely have held one of the early rulers depicted on Altar Q. After all, it was the most elaborately constructed and furnished Copán tomb yet uncovered. But Jane Buikstra, a University of New Mexico physical anthropologist who had been called in by Sharer to analyze bones, found that assumption to be wrong.

"Bob Sharer was filming me as I crawled onto the slab to examine the bones," Buikstra remembers, "and for the benefit of the record, I was describing out loud what I was seeing. I had just finished my estimate of the buried person's age. I reported on that—at least 50 years old. Then Bob routinely asked me about the individual's sex. We both had assumed it was a male. Then I looked at the shape of the pelvis. It was that of a female."

The remains of the noble lady had been placed upon a thick rectangle of stone. She had been richly attired and was wearing one of the most extraordinary arrays of jade ever found in a Maya tomb. Her bones, particularly the skull, appeared uncannily bright and red, for after death she had been coated with cinnabar, or mercuric sulfide, a substance sacred to the Maya. The red decoration may have signified the direction east, associated with the sunrise and, by extension, resurrection. So who was this revered lady?

"Our best guess at the moment," Bob Sharer told me, "is that she was the wife of the founder. This makes her the queen mother of the next 15 rulers of the Copán dynasty."

WITH THE DISCOVERY of the woman's tomb, and with the huge entwined bird emblem signifying the name of the founder on the facade of the same structure, it soon became evident that this particular part of the Acropolis constituted a sort of *axis mundi*, in effect a sacred stack of burials and buildings hallowed by the presence of one of almost unimaginable power in the eyes of the inhabitants of Copán. With all these clues pointing to K'inich Yax K'uk' Mo', Sharer and Sedat probed deeper under the Margarita complex. First *(Continued on page 90)*

BURIAL FIT FOR A QUEEN

A woman adorned in splendor astonishes archaeologists as they open the tomb under the offering chamber. More than 10,000 jade beads are scattered near her legs alone. Specular hematite mixed with cinnabar gives one of the engraved jade beads from around her neck its sparkle (bottom). After cleaning the burial (top), Chris Powell prepares bones for detailed analysis. Scars on the pelvis (middle) indicate that the woman had carried at least one child. Her tomb was left open and revisited by several generations of admirers. Could she be the widow of the founder?

EPITAPH FOR A RULER LARGER THAN LIFE

The grand design of the cosmos decorates the entrance to the Margarita building, erected by Copán's second ruler. The entwined quetzal and macaw, center right, stands for the dynastic founder almost certainly buried below, the intermediary between heaven and earth, flanked by gods of nature. "Only the elite could read hieroglyphs, but this would have sung with meaning for anybody," says Bill Fash. Rulers continued to honor K'inich Yax K'uk' Mo' at this spot. "He was an inspiration—all later rulers drew upon his legacy to bolster their own fortunes and image."

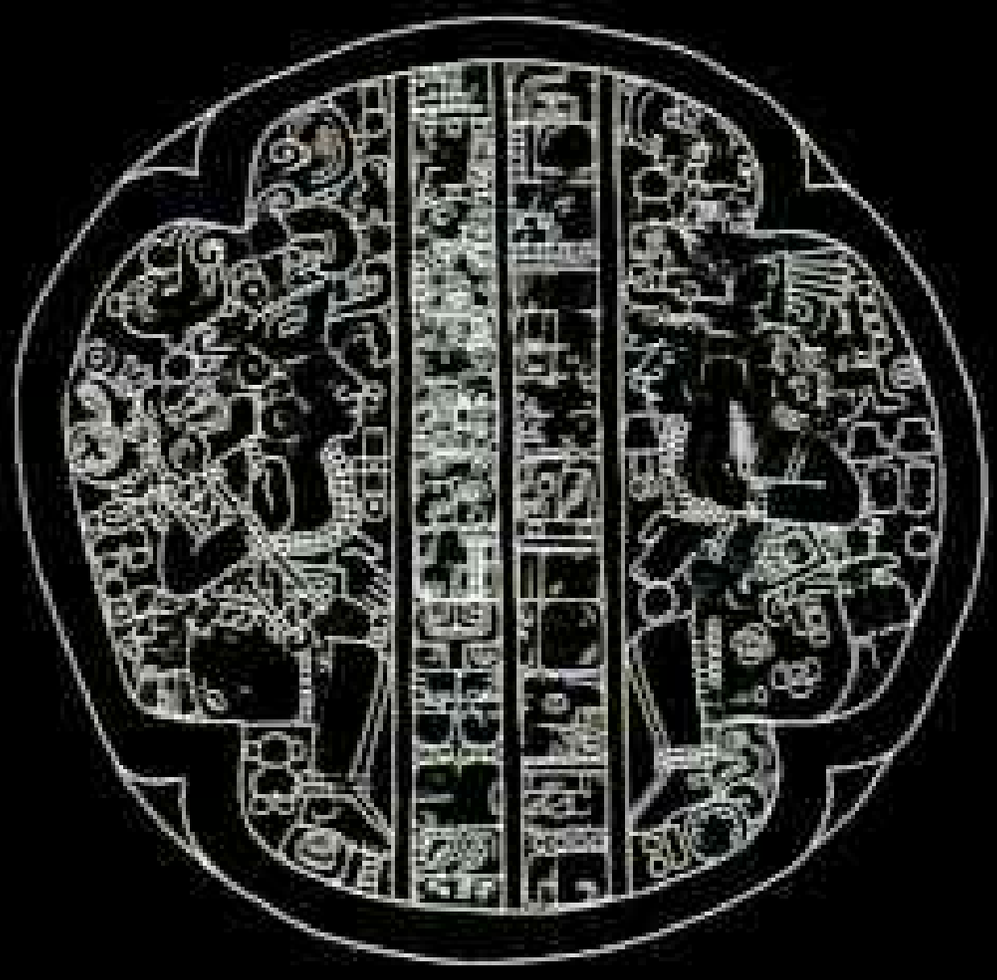
ENRICO FEBORELLI

1. Structure 16
2. Rosalila
3. Margarita
4. Royal female burial
5. Royal male burial
6. Hunal
7. Yehnal
8. Sun god panel
9. Quetzal-macaw panel

CULT OF THE ANCESTOR

One after another, structures erected through the centuries form a mountain in memory of the founder. At the top stands Structure 16, the tallest on the Acropolis. Just underneath is the only completely preserved building at Copán, nicknamed Rosalila. "Before we found this, putting together the thousands of fragments of sculpture from the site was like doing a puzzle without the box top," says Ricardo Agurcia. "This is the box top." At bottom lies Hunal, one of the buildings with which K'inich Yax K'uk' Mo' marked out this sacred area. The Teotihuacan-style architecture ties him to central Mexico.

CONJURING THE SPIRITS



A second mysterious woman of great stature at the dawn of the dynasty was buried with the heads of three men in a circular crypt (far right) on the northern side of the Acropolis. Sacrificed animals include an antlered deer and a puma, whose bones Karla Davis-Salazar has reassembled (below). Offerings such as mercury and quartz, used today by descendants of the ancient Maya in divining rituals, lead Bill Fash to believe the woman was a shaman. "A lot of the power of the rulers was based on their ability to summon supernatural forces," he says. The tomb's engraved capstone (drawn for clarity, top left) mentions rituals performed by the first two rulers to celebrate the anonymous shaman and the founding of the state. Later rulers refer to the rituals, also without naming the woman. "The Copán hieroglyphs tell us only what the men wanted us to know," says Fash. "Women may have played vital roles, but they're invisible."

(Continued from page 82) they uncovered the facade of red sun-god masks on a platform they dubbed Yehnal. Behind that they discovered a skeleton they believe is that of the founder himself.

The crypt lay within another structure—the archaeologists called it Hunal—built beside the river in a time when there had been no Acropolis. Assuming that it is the founder who is interred there, the burial site reinforces the validity of our notion of the world axis that so pervaded ancient Maya belief.

Hieroglyphic texts at Copán suggest that other rulers, perhaps heads of local families, preceded the founder. But evidently when K'inich Yax K'uk' Mo' appeared on the scene sometime in the early 400s, introducing the trappings and the aura of storied Teotihuacan, power and politics changed forever.

The founder's royal marriage brought forth one of the most enduring dynasties among the Maya city-states. As the dynasty grew in power, so did the Acropolis. In the early 400s only a scattering of structures occupied the flat land by the west bank of the Copán River. Most of these, according to the sample yielded by the tunnels, were adobe, but they were dominated by at least two masonry structures, Yax and Hunal. Yax lay due north of Hunal and formed a core of construction that culminated in the temple of the great Hieroglyphic Stairway. Hunal formed the heart of the future Acropolis.

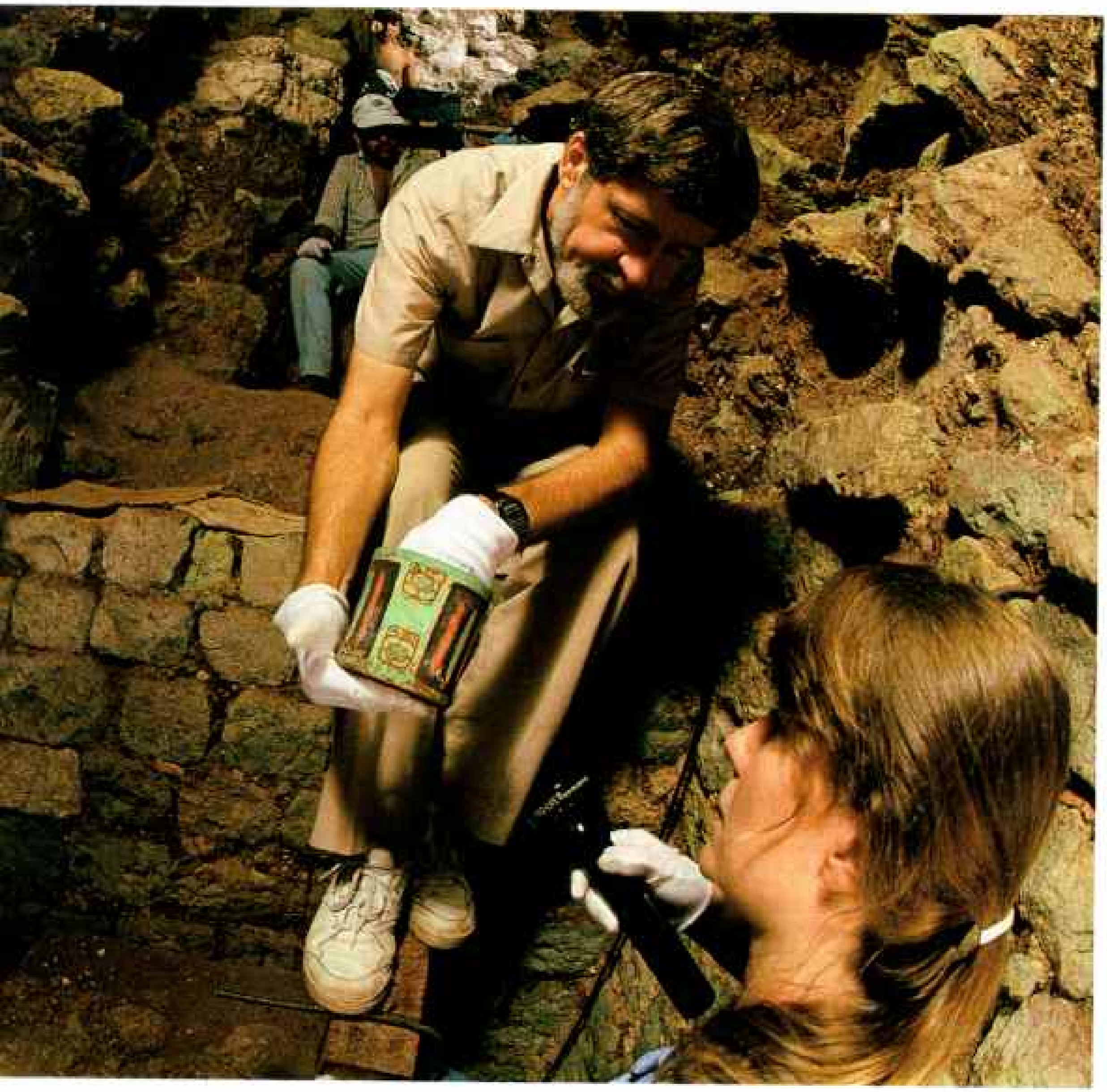
By 437 K'inich Yax K'uk' Mo' was dead. If the Hunal bones are his, he was at least 50 years old, and he passed into the Maya afterlife with a broken, unhealed, and disfigured lower right arm. On Altar Q he is depicted with this part of his anatomy hidden, perhaps intentionally, by his Mexican-style war shield. The Hunal skeleton wears a jade bar pectoral like the one shown on Altar Q. There are signs of other wounds, reflecting injuries or blows suffered in battle or perhaps from the rigors of a ritual ball game.

"His left shoulder appears to be dislocated," Jane Buikstra reported soon after she had examined the bones in detail. "His front teeth are missing—they may have been knocked out—and he suffered from severe arthritis."

Soon after the interment, Hunal was covered with another building, Yehnal, which bore on its facade giant visages of the sun god. By 440 at least a dozen buildings crowded

LEGACY OF AN UNKNOWN LORD

"This is literally the first material to come out of this burial chamber," says Loa Traxler, who trains a light on the stuccoed vessel held by Robert Sharer. A sampling of the pottery (bottom) recovered from the so-called Sub-Jaguar tomb shows both Maya and Teotihuacan influences. A typical Maya offering of jade and a spiny oyster shell (left) lay atop a capstone of the sixth-century tomb. Of all the Acropolis burials, this was the least disturbed by earthquakes and reentries. "It gives a clear picture of the burial process—the sequence in which grave goods were placed and how people came and went," says Traxler. But the identity of the ruler buried there remains uncertain.



the future Acropolis area. A decade later Margarita was built to hold an important woman, perhaps the founder's widow.

On my tunnel trek to the Hunal crypt, I had paused only briefly at the astonishing stucco facade of Margarita but later had the privilege of examining it in some detail. The skillfully carved and painted stucco depicts what, for all practical purposes, forms the heraldic device of K'inich Yax K'uk' Mo': intertwined birds with sun gods emerging from their mouths—the K'in (sun), the K'uk' (quetzal), and the Mo' (macaw) of the name, topped by the prefix Yax, meaning "green" or "first" or "precious." The whole device lies surrounded by motifs of sky and earth. According to David Sedat, the Margarita platform was painstakingly buried, as if it were a living being.

"There was almost no stone in the earthen fill that covered these paintings," he explains. "So we know that those who buried it were taking special care. That's why it's so well preserved."

With the Margarita burial, the axis of the sacred place began to rise vertically off the river-bottom site of the Hunal tomb, and the Acropolis grew upward. Eight rulers and more than a century later, in 573, a period of intensive construction culminated in the magnificent Rosalila structure that Ricardo Agurcia began to uncover in 1989. It too pays homage to the founder.

The original Rosalila building still lies on the sacred axis, covered by Structure 16. An exact replica of it now dominates the Museum of Sculpture at Copán. Meticulously cast and painted down to the last detail, the replica glows as richly as did the original building during the century or so that it gleamed like a jewel atop the Acropolis under the tropical sun.

Anyone contemplating Rosalila as it stood alone, dominating the Acropolis, could not have failed to get its message—that it embodied the founder himself, his divine ancestry, his secular power. The building served as both a polychrome political poster and a sacrosanct icon of the Maya cosmos, but from a distance it looked more like a red-and-white mountain reaching for the sky.

Yax Pasah, apparently the final ruler of the dynasty, erected his own great pyramid,

COLORS SHINE THROUGH TIME

Center of the Maya universe, a sun god of fragile painted stucco is sketched by Nelson Paredes. Sculpted on the building covering what could be the founder's death house, this image may have symbolized K'inich Yax K'uk' Mo' himself, the embodiment of the deity. Through the development of such art and architecture, which parallels the course of the dynasty, researchers have discovered intriguing details about Copán society. "We see what the major players were up to, what they built, what they felt, and what they thought," says Bill Fash.

Structure 16, the tallest on the Acropolis, shortly before 800. This essentially brought the Acropolis to completion.

AFTER MY BRIEF but moving visit to the Hunal tomb, I climbed to the heights of the Acropolis and in the cool, clear air mused over the final days of the old dynasty.

The Popol Na, or Mat House, rises proudly near one corner of the East Court. Recent investigations there led by Barbara Fash, an artist and archaeologist, suggest that the power derived from the founder began to falter after the capture and sacrifice of Copán's 13th ruler by the king of a rival city-state in 738. By Yax Pasah's time, a quarter of a century later, the power of Copán rulership had

failed to rebound. Glyphic emblems on the Mat House, interspersed with the mat motifs that give the building its name, may stand for lineages outside the Acropolis area, suggesting that this building served as a council house of noble valley representatives who helped the three last rulers in their task of governing.

There is still much to do at Copán. This is no surprise, for new questions come with every answer the Acropolis archaeological project has produced. But the main objectives of the endeavor have been achieved.

"Up to now," says Sharer, "most of what we knew about Maya civilization came from the Late Classic period, after about 600. Now we know more about the Early Classic from Copán than from any other Maya site."

Archaeologists continue the quest for more knowledge of Copán, its valley, and its neighbors. Detailed analysis of DNA and other aspects of bone chemistry in the burials of the Copán elite are under way, and Jane Buikstra may soon be able to tell us much more about the individuals in the tombs. Gradually the Acropolis will return, at least for a time, to the solitude it knew before the latest flurry of archaeological activity.

Even so, because of the achievement of Bob Sharer, David Sedat, and their colleagues, neither they nor I, nor any scholar of the American past, will ever again be able to view the great mass of the Copán Acropolis without thinking of the royal secrets that lay concealed so long within its layers. □

To learn more about recent discoveries at Copán, join us online at www.nationalgeographic.com.

The Age of

IN EARLY APRIL COMET HALE-BOPP BEGINS ITS JOURNEY AWAY FROM THE SUN.

JERRY LODRIGUSS

By WILLIAM R. NEWCOTT
NATIONAL GEOGRAPHIC SENIOR STAFF

COMETS

Visitors from beyond Neptune, a parade of cosmic snowballs splay their greetings across the heavens—and bring intriguing hints about the early solar system.

"Deified Julius" reads the inscription on a comet-emblazoned Roman coin minted by Julius Caesar's adopted son, Augustus. A comet seen shortly after the 44 B.C. murder of Caesar was deemed proof of his deity.

Whistling and moaning, a 50-mile-an-hour wind whipped among the telescope domes atop Kitt Peak. Just a few feet below, turning gray in the dusk, slid a river of clouds that had been rising and dropping all day. And high above, comet Hale-Bopp hung suspended like a feathery fishing lure, its tail curving off a bit, as if blown to the side by the punishing wind.

One by one, stars winked on in a darkening sky. In each of the telescope domes, teams of astronomers prayed that the wind would drop below 40 miles an hour, the point at which they'd be able to open the sliding doors and get to work.

The sky turned indigo. Then black. Viewed from the summit, 6,873 feet above Arizona's Sonoran Desert, Hale-Bopp's bright dust tail, along with a dimmer, all but transparent blue one, seemed to grow by degrees. Among the brightest comets ever seen, Hale-Bopp had been visible for months from midtown Manhattan, of all places. But here, on a moonless night in the mountains in the desert, the length of Hale-Bopp's tail became visible—a wispy, delicate veil.

Along with eclipses, comets have been the most feared and admired sky spectacles of all. But while astronomers have been able to predict eclipses for thousands of years, only in the early 1700s was a comet's return correctly predicted, by Edmond Halley.

Some comets swing around the sun every few years. Others, like Hale-Bopp, may take thousands of years. Most can be seen only with a telescope. But every once in a while—a few times a century, perhaps—an impressive one is visible to the naked eye. And in the past two years the world has witnessed not one but two of them.

Hyakutake in 1996 had one of the longest tails on record, stretching more than halfway across the sky; Hale-Bopp in 1997 had one of the most brilliant heads, nearly as bright as the star Sirius. Add the Jupiter crash of comet Shoemaker-Levy 9 in 1994, Halley's most recent visit in

A Babylonian tablet from 87 B.C. reports the arrival of the comet now known as Halley. Comet records date back some 2,000 years—not nearly long enough to report the first pass of comet Hyakutake (above) about 8,000 years ago.

AMERICAN NUMISMATIC SOCIETY, NEW YORK CITY (TOP); JERRY LODRIGUSS (MIDDLE); BRITISH MUSEUM, LONDON

1986, vivid comet West in 1976, and the scientifically significant—if visually disappointing—Kohoutek in 1973-74, and you could say that we are indeed living in the age of comets.

BIBLIOTECA NACIONAL, MADRID

Like a "flaming ear of corn," wrote an Aztec chronicler of the 1517 comet that terrified Moctezuma II, pictured in a 16th-century painting. He saw it as an omen of his downfall and soon surrendered his empire to Spanish conquistadores.

HOVERING in the most fragile of gravitational balances, a fleet of dirty, lumpy snowballs numbering in the trillions is barely held in orbit by the pull of the sun. They are stored in the Oort cloud, a huge, diffuse sphere of cometary nuclei in the far reaches of the solar system. Closer to the sun, yet still beyond Neptune, circle what may well be their brethren, in a great disk called the Kuiper belt.

Comets are leftovers, scraps of material that didn't make it to planethood in the events creating our solar system. Once, many astronomers believe, the solar system was full of comet nuclei, chunks of ice and dust left over from the formation of the sun. Most clumped together to form planets, leaving a relative handful—averaging perhaps a few miles wide, with temperatures as low as minus 400°F—as time capsules of the early solar system.

They orbit in a perpetual deep freeze until some subtle gravitational nudge upsets the delicate balance. Then the great fall begins. Imperceptibly at first, a snowball drifts toward the sun and steadily accelerates. As solar radiation heats the comet, the ice within sublimates, escaping as gas from vents at the surface. Sometimes jets of sublimating ice whirl off the rotating comet nucleus like a fireworks pinwheel. Dust trapped in the ice breaks free. Pushed back by the pressure of the sun's radiation, the dust streams out behind the comet in what appears as a fiery tail.

Now the comet is among the fastest things in the solar system. It whizzes past the inner planets at around 100,000 miles an hour. The tail can stretch a hundred million miles.

A quick whip around the sun, a long journey back into night, and the show's over. Until gravity calls it back.

With each visit to the sun the comet loses more of its ice. Eventually it may become a rocky ghost, its glory days gone for good.

KITT PEAK'S solar telescope is bored right into the mountain, with mirrors on top that can be oriented to follow the sun's path across the sky. Solar studies are one of astronomy's few day jobs, and in 1973 Frank Scherb and Fred Roesler, physicists at the University of Wisconsin, got the bright idea of using the telescope at night to track comet Kohoutek. Scherb has been back for every major comet since then, except for Hyakutake in 1996.

"That one just came up too fast," he said, showing me through the cramped corner of the telescope facility that has been made available to him. A few computers whirred in a row, their terminals displaying Hale-Bopp images taken the night before. He punched up a series taken a few minutes apart through filters that brought out various parts of the light spectrum. With each image, the tail changed shape a bit, indicating the presence of different molecules.

"The most important new result we've got here is that we're detecting an unusual kind of atomic carbon," Scherb told me. "It's being

A Comet Gallery

Comets are similar in content, but their appearance can vary widely due to distance from Earth or sun, angle of approach, and the number of times they have visited the inner solar system. Even when too faint for naked-eye viewing, comets reveal dramatic tails in time exposures.

1. COMET HALLEY
The periodic return of comets was proved by Halley's 1759 appearance.
[illegible]

2. COMET BENNETT
A bright tail made Bennett a spectacular pre-dawn view in 1970.
[illegible]

3. COMET WEST
The brilliant head could be seen even during daylight hours in 1976.
[illegible]

4. COMET KOHOUTEK
Hardly visible to amateurs in 1973-74, it had a long, blue ion tail.
[illegible]

5. COMET IKEYA-SEKI
Nearly grazing the sun, Ikeya-Seki barely survived a 1965 visit.
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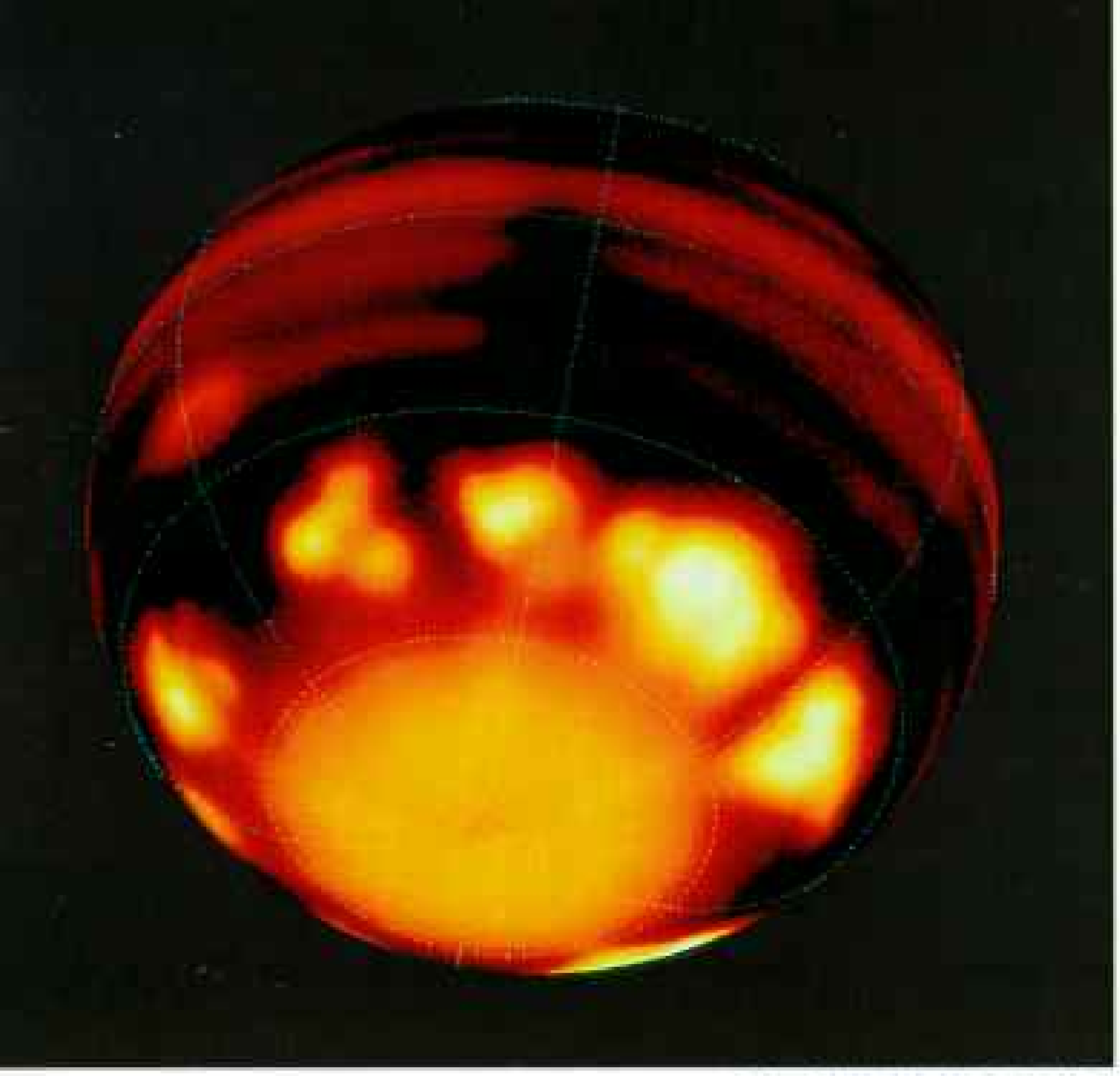


PALOMAR OBSERVATORY/CORNELL UNIVERSITY

Scientists had long suspected that comets can go into orbit around Jupiter, but the first comet seen to do so was Shoemaker-Levy 9. Shattered by Jupiter's gravity, the comet slammed into the planet in July 1994 in more than 20 fragments. Impacts show as bright spots in the composite infrared image above.

A true-color image by the Hubble Space Telescope (opposite, top) shows two impact sites—the larger one the size of Earth—in Jupiter's southern hemisphere. The Hubble sequence at bottom chronicles the steady deterioration of the impact markings, erased by Jupiter's relentless east-west winds.

I asked Scherb about Hale-Bopp's transparent blue tail, which gave the comet the appearance of a celestial bird-of-paradise flower.

"That's the ion tail," he explained. "As water sublimates off the comet, the sun's radiation strips an electron from the water molecules, creating charged particles. Those ions get picked up by the solar wind, and they drift back to form the ion tail."

Ron Oliversen, a NASA scientist working with Scherb, hopes to use the ion tails of comets to get "weather reports" from the distant solar system.

"Ion tails are a kind of wind sock for the solar wind," he said. "If we can follow comets far enough, we can get some idea of what the solar wind is doing out there."

ALAN HALE was on the phone. Again. Giving driving directions so that a TV crew could find his house. Again. The co-discoverer of comet Hale-Bopp was riding the wave of media frenzy on this, the day his comet would make its closest approach to the sun. His four-year-old son, Tyler, had greeted me at the door of their home and ushered me into the cluttered living room. As dad intoned some well-worn answers to an interviewer, Tyler proudly showed me his Thomas the Tank Engine toy.

"My daddy," he confided, "is a star guy."

Much has been made of the fact that Hale found the comet while looking through a telescope in his driveway.

thrown off by the many types of carbon compounds in the comet."

Besides the bountiful hydrogen and oxygen found in cometary ice, astronomers knew that comets contained a lot of carbon monoxide. But radio, infrared, and ultraviolet measurements have revealed a whole zoo of carbon compounds in comets, some of which are essential building blocks in all known life-forms. Two dozen carbon molecules have turned up in Hale-Bopp, along with trace amounts of nitrogen, sodium, and sulfur.

The growing list of compounds found in Hale-Bopp supports the theory that the ingredients for life were delivered to Earth by comets. Scherb's carbon atom measurements will help determine how much of each compound is present in the average comet and whether or not there is enough to keep the theory alive.

Few accounts note that to reach his driveway, you must follow nine miles of unpaved road in the Sacramento Mountains of southern New Mexico. Far from city lights, it's the perfect place for comet hunting.

The sky was absolutely clear the night Hale made history. It was just after midnight on July 23, 1995.

"Sagittarius was high in the south. I was looking at a star cluster there, and I noticed a fuzzy object. I checked a star atlas, and it showed nothing there. So I knew it was a possible comet."

As a trained astronomer who has seen some 200 comets, Hale knew exactly what to do. He headed inside and sent an e-mail to the Central Bureau for Astronomical Telegrams in Cambridge, Massachusetts, to register his findings. A few hours later he got a response: His new comet was officially designated C/1995 O1. His name would also be attached. But he was not alone.

That same night, about 400 miles away, Tom Bopp was out with some pals looking through telescopes in the desert outside Phoenix, Arizona. He, too, noticed something fuzzy in Sagittarius and pointed it out to the friend who owned the telescope he was using.

"You might have something there, Tom," the friend said. He was right.

Bopp, a manager at a construction materials factory, had never seen a comet. He missed Kohoutek. He even managed not to see Halley.

"I knew I had to contact the Central Bureau, but I didn't have the address with me," Bopp told me. "I had to drive all the way back home and get it."

In the wee hours he roused Western Union and fired off a telegram to Cambridge—where its arrival was greeted with the same bemusement that might accompany a horse and buggy at a Porsche service garage.

"*Nobody* sends telegrams anymore," laughed Brian Marsden, who has run the bureau since 1968. "I mean, by the time that telegram got here, Alan Hale had already e-mailed us three times with updated coordinates."

A jovial Brit with a shock of gray hair, Marsden is the Man Who Names the Comets, the leading voice on a committee that has the final say.

"These things can get quite contentious," he added. "Some people try to cheat. They'll see a comet and call a friend, who will then also report it. Usually we can weed them out."

Marsden's brow furrowed—the first time in a half hour the smile left his face. "But I'll tell you, there's at least one comet where I'm sure one of the names was faked." Marsden was seething.

TOM BOPP AND I were sitting in a restaurant near his home in Glendale, a Phoenix suburb. Neither of us thought of it at the time, but the restaurant was part of the same chain where, one week before, 39 members of a California cult had reportedly eaten their last meal before committing mass suicide. They claimed they were departing on a

HEIDI HAMMEL, MASSACHUSETTS INSTITUTE OF TECHNOLOGY/NASA (ALL)

Dust tail

PATH OF COMET HALE-BOPP

February 24, 1996
5.21 AU

Jupiter orbit

April 1, 1997
Perihelion (closest approach to the sun)
.91 AU

Mars

Earth

Sun

A comet's tail always points away from the sun, even when the comet is leaving the inner solar system. Dust from the comet forms a bright, curving tail; gas composes the blue ion tail.

One astronomical unit (AU) is the average distance between Earth and the sun, about 93,000,000 miles.

DWARFING EARTH, the head of a comet may measure a million miles in diameter, and its tail can stretch a hundred million miles. All this astronomical flamboyance comes from a solid nucleus of frozen gas and dust.

A comet's dust tail gives off no light of its own; its fiery brilliance is caused by sunlight reflecting off flecks of material released by the nucleus as it is heated by the sun. A blue ion tail appears when escaping gas molecules lose an electron to solar radiation and are carried off by the solar wind.

As the nucleus rotates, jets of ejecta can swirl off, like sparklers from a spinning pinwheel. The curved jets create what appear to be shells, or arcs, in the head.

EUROPEAN SPACE AGENCY/MAX PLANCK INSTITUTE

HEART OF A COMET The nucleus of comet Halley is a nine-mile-long, potato-shaped lump with a surface darker than coal, as revealed in a historic 1986 image from the Giotto spacecraft. Just one-tenth of its surface was then actively erupting dust and water vapor.

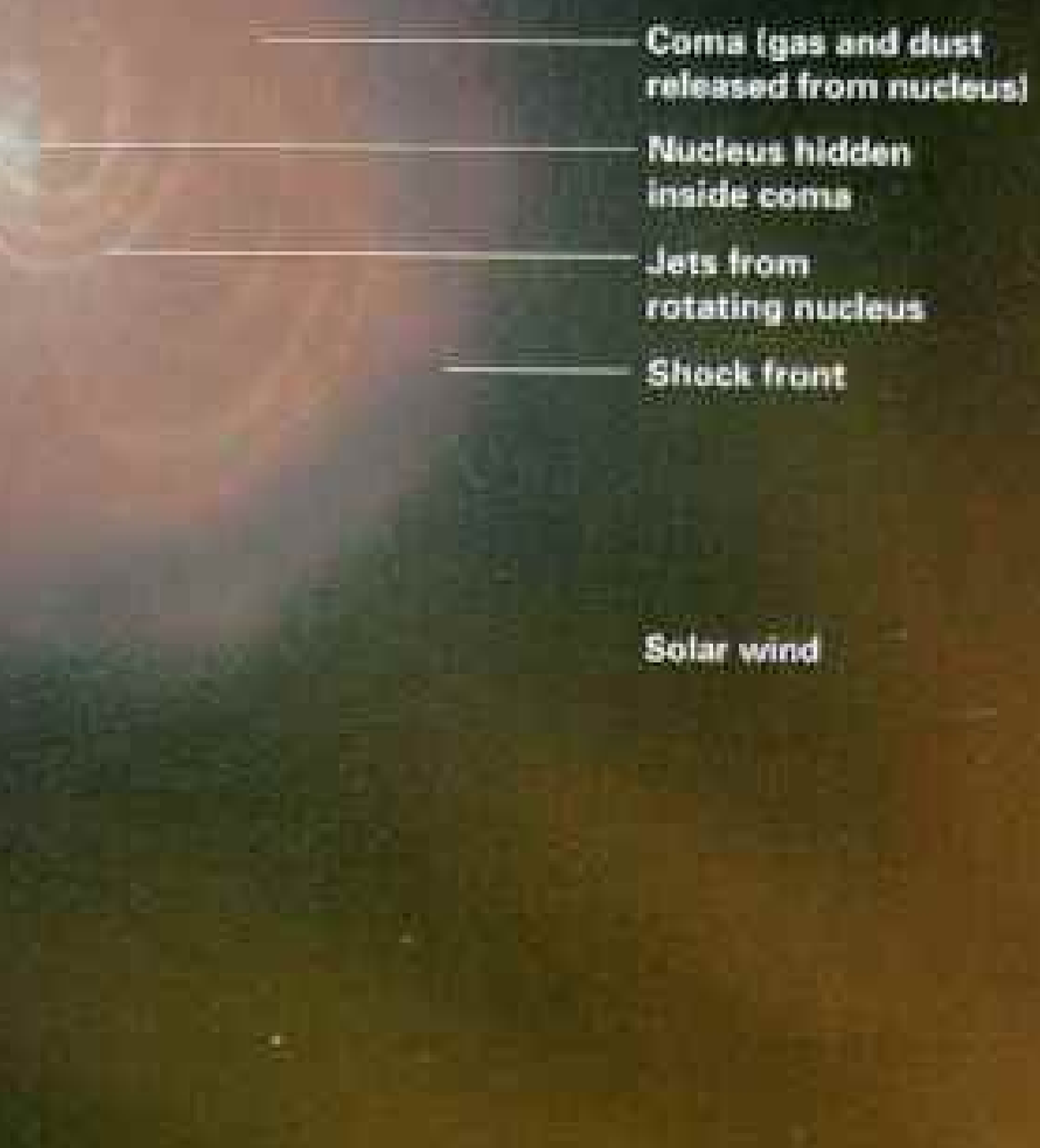


DIAGRAM BY WM PITZER; ORBIT PLOT BY YANGA FERNÁNDEZ (LEFT); PAINTING BY WILLIAM K. HARTMANN

COMETS ARE LEFTOVERS from the formation of the sun and planets. In a gravitational game of kick the can, astronomers theorize, Jupiter, Saturn, Uranus, and Neptune propelled many of them outward to form the Oort cloud; others remain in a disk called the Kuiper belt.

THE OORT CLOUD, starting perhaps 250 billion miles beyond Neptune, may hold a trillion comets awaiting gravity's nudge. Comets from the cloud take millions of years to reach the sun.

ART BY WM PITZER; ORBIT PLOTS BY LAURA WOODNEY

COMET ORBITS

- Encke (1997/2000)
- Hale-Bopp (1997/about 4400)
- Tempel-Tuttle (1965/1998)
- Hyakutake (1996/about 20,000)
- Halley (1986/2061)
- Levy (1990/ejected from the solar system)
- Swift-Tuttle (1992/2126)

Dates indicate when comet last reached perihelion and when it will next reach perihelion.

One AU

COMET PARKING LOT The Kuiper belt is thought to contain countless comets orbiting roughly on a plane with the planets. First predicted in the 1940s, Kuiper belt objects were not confirmed until this decade.

spaceship that was trailing comet Hale-Bopp.

Weird stuff seems to go with major comets. When a comet appeared in A.D. 60, the people of Rome assumed it meant the impending death of their still new emperor, Nero. He responded by exiling a potential rival. When another comet turned up just four years later, ancient historians say he ordered the execution of dozens of nobles. It is said that Moctezuma II saw a comet in 1517 that foreshadowed the downfall of the Aztec empire. In 1910 a wave of hysteria swept over the United States amid reports that Earth was about to pass through Halley's tail.

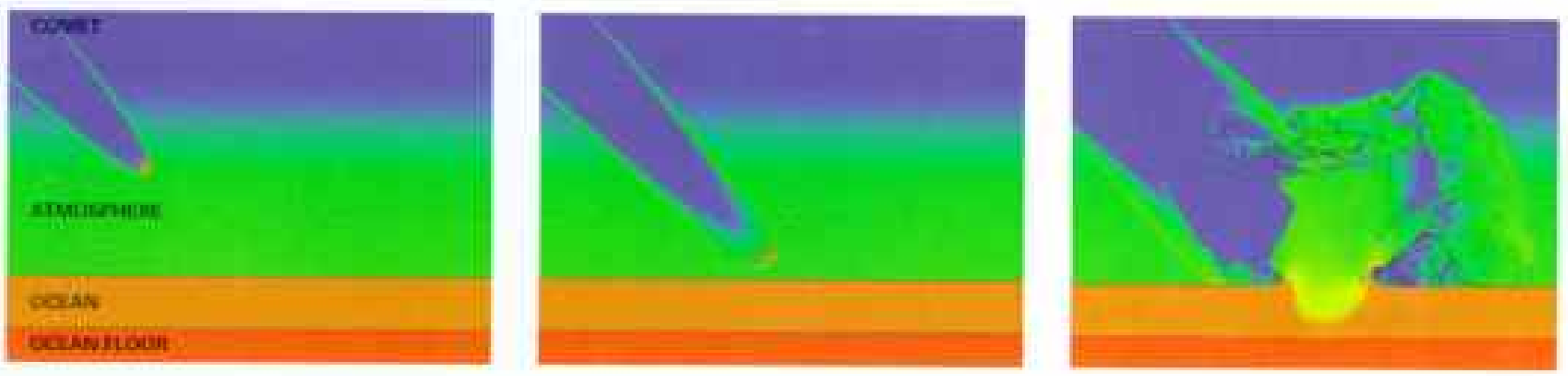
For Tom Bopp, the comet did indeed portend heartbreak. Three days before we met, as his comet reached its most spectacular point, his brother and sister-in-law were killed in a late night car wreck. They had been out photographing the comet.

"This," he told me quietly, "has been the best week of my life. And the worst."

DAVID LEVY'S ALARM goes off at 3 a.m. Trying not to disturb his wife, he leaves the house and trudges to a homemade observatory behind his home in Vail, Arizona, near Tucson. Levy and his friends Gene and Carolyn Shoemaker composed a remarkably prolific comet-hunting group before Gene was killed in a car accident in Australia last July. Working individually and together, they discovered 40 comets.

"On average a dozen comets are found each year," said Levy. "It is unpredictable. Even a comet's periodic return can vary. Hale-Bopp had a 4,200-year period, but thanks to a gravity assist from Jupiter it will be back in 2,400 years. Sometimes a comet such as Shoemaker-Levy 9 will go into orbit around Jupiter and act as a moon. Others leave Jupiter's orbit and go back around the sun. Comets are like cats: They both have tails, and they both do precisely what they want to do."

One thing comets do is crash into things. Imagine yourself atop the Empire State Building with the world's most powerful bowling-ball cannon, capable of reaching the general vicinity of Washington, D.C. You are randomly firing bowling balls as a lone Volkswagen bug circles the Washington Beltway.



Impacts: When Worlds Collide

A comet crashes into an ocean on Earth in one scenario envisioned by scientists using a supercomputer. Streaking in at nearly 40 miles a second (top left), the half-mile-wide comet deforms in the atmosphere (center) before hitting the ocean (top right) and exploding with the energy of 300 billion tons of TNT. The plume of water vapor (right) would spread around the globe, possibly disrupting weather and agriculture worldwide. Scientists have seen 120 rocky asteroids a half mile or larger and some 500 comets that cross Earth's orbit. None are known to be on a collision course with our planet, but experts predict an asteroid impact of global consequences every 100,000 years. Deflecting such objects may someday be possible. Given the expense, policymakers have so far decided to play the odds.

DAVID CRAWFORD, SANDIA NATIONAL LABORATORIES

It's not likely you will hit that Beetle anytime soon, but one of these days, one of these millennia, you will inevitably crush one vintage compact car.

The last bowling ball to devastate Earth—either a comet or an asteroid—hit about 65 million years ago. It blasted a crater more than a hundred miles wide under today's Yucatán Peninsula and threw up a global cloud of dust and gas. The sun was all but blocked for years, dropping average temperatures to near freezing and killing off more than half of the plant and animal species on Earth. The dinosaurs died. On the other hand, many mammal species survived.

"If you want some idea of the devastation that's possible from a comet," said David Levy, "take a look at what just one of the fragments of Shoemaker-Levy 9 did to Jupiter. Here's something as long as two or three football fields, and it left a mark bigger than Earth."

In May of 1983 the comet IRAS-Araki-Alcock got within three million miles of Earth. At its closest Hale-Bopp was 122 million miles away. Had Hale-Bopp arrived just four months earlier, it would have come within 11 million miles of Earth, shone 50 times brighter—and been visible in daytime for about a week.

Comets can bring more than destruction when they slam into a planet. There's evidence that a good storm of comets in a planet's formative stages could provide an ocean or two. We may well be swimming in comet meltoff. "It could take as few as five Hale-Bopps to fill the Great Lakes," says astronomer Michael J. Mumma of NASA's Goddard Space Flight Center.

One of the most popular theories for the origin of Earth's oceans has been that the water was delivered via comets. The theory has problems though. Studies of Hale-Bopp—and of Hyakutake and Halley before it—show that cometary water contains twice as much deuterium as seawater. If the oceans came primarily from comets, the proportion ought to be closer.

DON BARTLETT

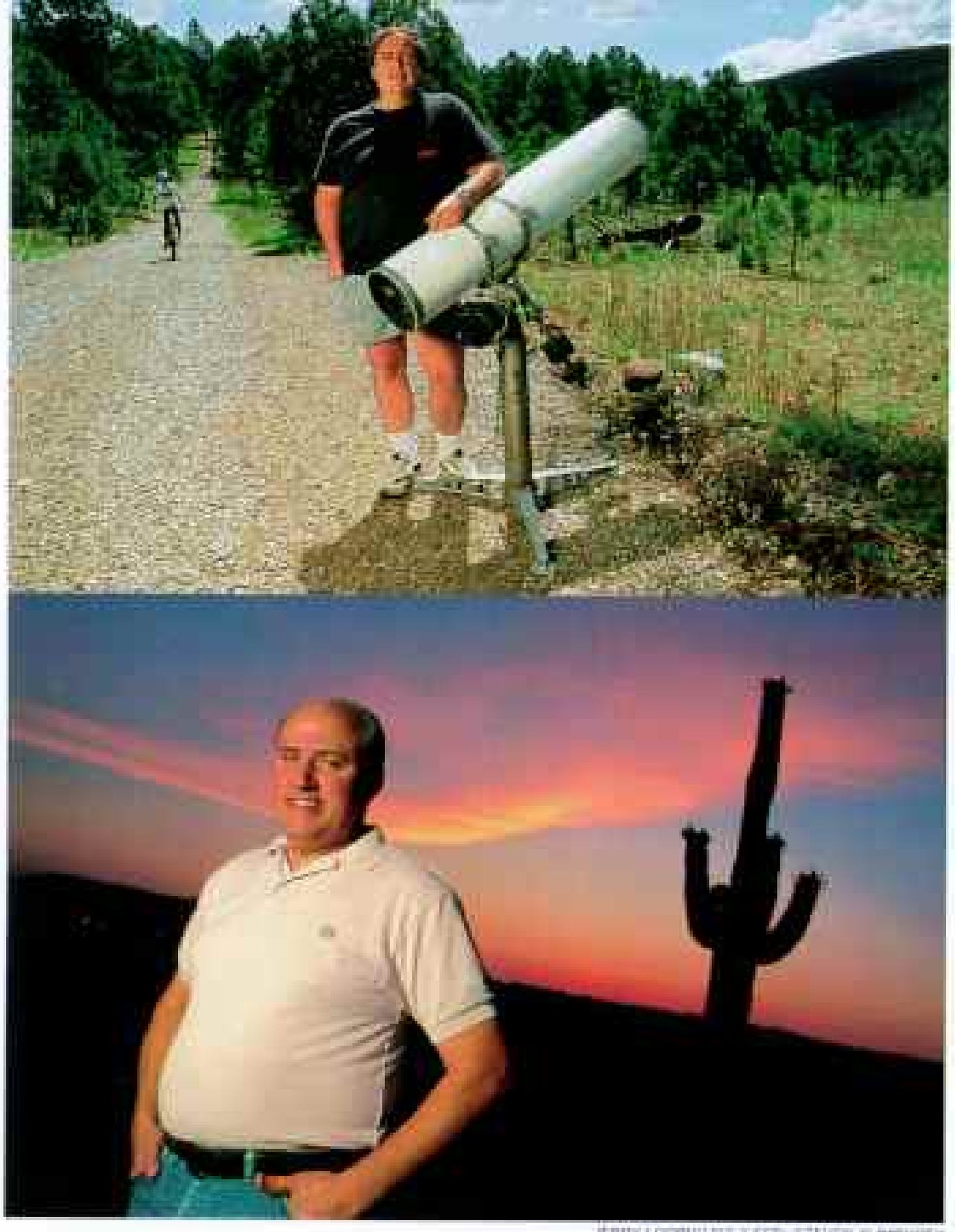
While most scientists were envisioning such big splash models, one man was thinking about a cosmic drizzle.

In 1986 Louis Frank, a physicist from the University of Iowa, suggested that each year Earth is bombarded by ten million house-size mini-comets weighing up to 40 tons each.

Vaporizing high above Earth's atmosphere, these cometlike objects would deliver, in 20,000 years or so, enough moisture to cover the planet with an inch of water.

Frank's credentials are

No telescope was needed to see comet Hyakutake above the Palomar Observatory (above) as it came within 9.3 million miles of Earth in 1996. Hale-Bopp, 13 times as far away at its closest, was twice as bright.



JERRY LODRIGUSS (LEFT); STEVEN PUMPHREY

"I'm using my moment of fame to call for more science jobs for young people," says astronomer Alan Hale (top), co-discoverer of comet Hale-Bopp, shown passing the red North America nebula (left). Amateur stargazer Tom Bopp (above) won't limit himself to comet hunting. "I love the night sky too much."

impeccable: Since 1958 he has worked on scientific payloads for 40 U.S. spacecraft. But his theory was soundly rejected by astronomers. Then in September 1996 NASA's Polar satellite, using cameras and filters designed by Frank, took images of what he says are cosmic snowballs evaporating in long, cloudlike streaks.

"These snowballs are cometlike, but they are just about all water. No dirt," said Frank. "They're very, very fragile. And between Earth and Jupiter there are probably enough of them to fill all of our oceans with water."

After a brief period of uncertainty Frank's critics still don't buy it. "Right now there are a half-dozen papers either published or in preparation that disagree with Lou's interpretation," said NASA's Mumma. "For one thing, we don't know how far those streaks are from the camera. Some suggest they might be ice flakes coming from the craft itself. This has been a raging controversy for ten years, and Lou's images have not made it go away."

As Hale-Bopp passed the sun and headed back toward the deep-space icebox, the biggest news seemed to be the discovery, with the Isaac Newton Group of telescopes in the Canary Islands, of a third tail. Visible only with a sodium light filter, the tail was 400,000 miles wide, 30 million miles long, and made of sodium atoms.

David Levy remains more enamored of a 1986 comet Halley finding that bore both scientific and philosophical significance.

"Halley showed carbon, hydrogen, oxygen, and nitrogen in similar proportions as found in the human body," he said. "I think it just goes to show that we are, as Gene Shoemaker used to say, the progeny of comets."

THE WINDS had died down when I left Kitt Peak an hour after sunset, and Hale-Bopp was already low in the sky. I drove down the winding road and pulled over at the mountain's base. The stars shone like, well, like only stars can shine.

To the west, above where the sun had set, a dim, misty light climbed into the darkness. It was the zodiacal light, the reflection of sunlight off the disk of dust that floats between the planets—the scattered remains of comet tails, slowly drifting toward incineration by the sun.

The sound of crunching rocks startled me. A few feet away three wild horses, black on black against the nightscape, wandered past. They never glanced skyward at the gossamer swath of Hale-Bopp nor at the wondrous spectacle that is the night sky on a clear night, comet or no.

It felt good to be human. □

Exploring Vietnam's Hidden Depths

Scaling the Dragon's Lung of Halong Bay

Exploring a maze of rock and water in a seldom visited corner of Vietnam, Lynn Hill secures a safety rope while scaling a 160-foot limestone tower known locally as Respected Lady.

Anchored by a single finger of his left hand, Todd Skinner reaches for the next hold, as Paul Piana feeds rope from below. Skinner, whose ascent of Pakistan's Trango Tower was featured in the April 1996 GEOGRAPHIC, likens Ha Long to a "crazy stone forest."

By LYNN HILL Photographs by BETH WALD

"WHAT are you looking for up there?" asked Nguyen Mien, a fisherman who'd seen me scaling a cliff on one of the 3,000 tiny islands scattered throughout Ha Long Bay. My friends and I were climbing the most technically difficult towers during a four-week trip to Vietnam.

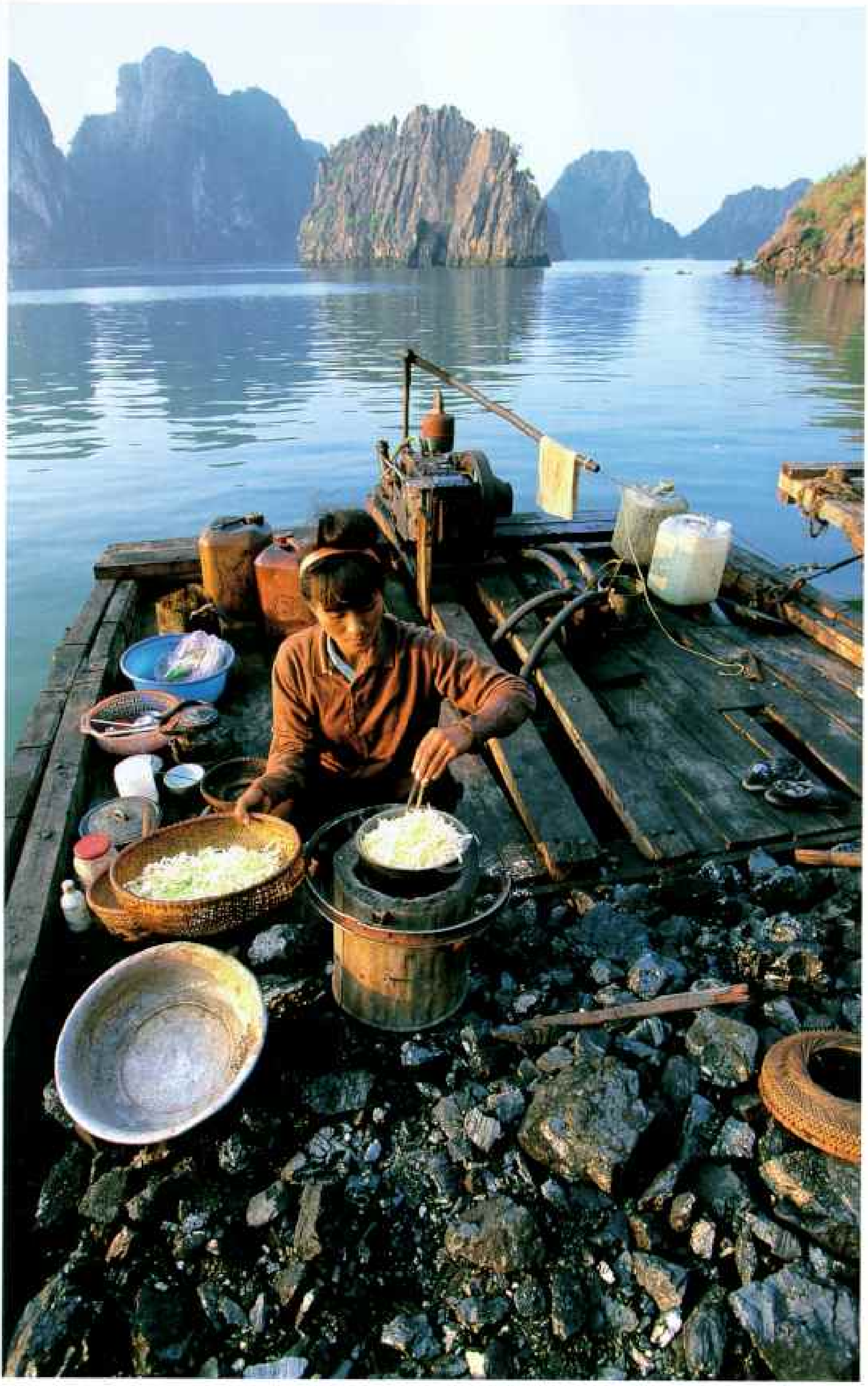
"Nothing. I climb for fun," I explained, saying that for me the sport is like dancing or martial arts. I struck a tai chi pose (below).

"Oh, like this!" he said, pretending to challenge me.

Nguyen and his family live like nomads on the bay, mooring their boat with others in a "floating village" in the Gulf of Tonkin, 40 miles east of Haiphong. When we visited his flotilla of 30 or so vessels, we found women cooking, older men repairing nets, and children hopping from deck to deck like the pirates who are said still to roam these waters.

There are many communities in Ha Long like this one, which is five hours by boat from the mainland. Setting out at dusk with oil lamps hanging from their bows, fishermen return at dawn to trade squid, crabs, prawns, and other catches with middlemen for necessities such as vegetables, fresh water, clothing, and fuel. We met a woman cooking on a barge (right) who travels from village to village with her husband selling coal.

Six years ago, when my friend Todd Skinner first visited Quang Ninh Province, he was astonished by all the karst towers strewn across Ha Long Bay (whose name means "descending dragon"). Remnants of an ancient seabed carved by wind and water, they offer arches of overhanging rock, sheer walls, and caves dripping with stalactites. Todd invited Beth Wald and me to return with him and climbers Paul Piana and Scott Milton. In December 1996 we rented a fishing boat to explore the bay. And by the end of our stay, the fishermen were calling me *nguoi nho nhan nhu nguoi minh leo treo thoan thoat*, "the woman who is as small as we are and can climb any cliff."



WE DROPPED ANCHOR beside a tiny, unnamed island we called Laughing Dog Wall. Most of the towers in Ha Long Bay already have names, such as Teapot Island, Head of Buffalo Island, and Buddha Praying Island. Todd found a cave with giant limestone icicles. The route traversed the ceiling and had plenty of handholds, making it too easy for Todd (above), who's never satisfied unless he's on the

verge of falling. The fact that he can't swim made it suspenseful at least: "I'd rather hit the rocks than go into the water."

I chose a climb around the corner on an overhanging face. Captain Chien rowed me in our little "basket" boat to the base of the wall, where I tossed my bag of climbing gear onto a ledge of sharp barnacles. An hour later I was 50 feet up, out of sight of the others. Without warning, the temporary device holding my rope to the rock gave way, and I flew backward into thin air, zipping headfirst past a pair of stalactites that stuck out from the overhang like fangs. My rope snapped tight, jerking me away from the wall. Disoriented but grateful to be unhurt, I decided to name the route Good Morning, Vietnam!

We established 22 new routes during our time on the bay, though we rarely climbed to the top of any island. Our goal as sport climbers was to attempt the most difficult routes we could find, wherever they might be. Todd's favorite, a natural arch, was only 20 feet off the water. But he never figured out a way to finish it.

"We had to pull him off the rock when it was time to leave," Paul recalls.

We were all touched by the magic of Ha Long Bay and its people. We will climb the dragon's spires in our dreams for years to come. □

LYNN HILL, the only person ever to have free climbed the Nose of Yosemite's El Capitan, is a former world climbing champion. BETH WALD has covered mountain cultures and adventures from the Himalaya to the Patagonian ice cap.

Rolling across the vast, dry plains of southern Argentina, paleontologist Rodolfo Coria hunts a long-dead quarry—fantastic dinosaurs buried in South America a hundred million years ago that are now coming to light in an explosion of discoveries.

Uncovering Patagonia's

By JAMES SHREEVE

Photographs by ROBERT CLARK

Lost World

Art by JAMES GURNEY

RINCÓN DE LOS SAUCES, Argentina, has lost its dinosaur, and the deserted streets seem sorry and bereft. The gritty little oil town squats on the northern frontier of Patagonia, punished by an incessant wind hauling dust in from the badlands. It is midafternoon when I arrive, *la siesta*. The sun is so piercingly bright it seems almost audible. The only inhabitants I see outside are dogs—loitering in the shade of a parked car or crossing a silent street with no great haste and crossing back again with even less. It doesn't look like the sort of place where exciting things happen.

Nor does it seem like a good spot to locate a Holiday Inn. Yet there it sits on the very edge of town, brand new, looking like a giant plastic toy that someone has dropped onto the desert from a passing airplane. I get an even bigger surprise when I check in at the front desk.

"Ah," says Charlie, the young concierge. "You have come for *el dinosaurio*. But they have already taken it away."

Dinosaur? What dinosaur? I have traveled to this part of the world to find out more about its dinosaurs, but Rincón is just a stop on my way to somewhere else. I press Charlie for more details, but all she knows is that a local man found a dinosaur skeleton while riding in the badlands on his dirt bike. Two weeks ago some scientists came and took it away.

It is fitting that my first foray into Patagonian paleontology should begin with a mystery. Patagonia—the remote, astringently beautiful expanse of steppe and stone that covers the southern part of Argentina—is the true lost world of the dinosaurs. Our conventional sense of the great creatures is based almost entirely on bones found in North America and Asia—well-known characters such as *Triceratops*, *Velociraptor*, and, of course, *Tyrannosaurus rex*. Dinosaurs flourished in the Southern Hemisphere too, but during much of their reign oceans separated the supercontinents of Laurasia in the north and Gondwana in the south. Isolated from their northern counterparts, dinosaurs down here followed their own evolutionary course beginning in the Jurassic, 180 million years ago. Patagonia contains the richest potential source of dinosaur information in the entire southern half of the planet. Even so, many researchers considered its dinosaurs mere aberrations: curious creatures, perhaps, but of little use in understanding the evolution of the dinosaurian mainstream. Now that view is changing.

"What we know of the dinosaur world is a very small portion of the complete story," says José Bonaparte, chief of vertebrate paleontology at the Argentine Museum of Natural Sciences in Buenos Aires. Until recently a lot of what we did know of the Patagonian part of the story was due to Bonaparte and his students. Now those students have come of age, and they are finding new species faster than they can get them out of the ground. Already they have what may be the largest predator ever to prowl the earth—and the most birdlike dinosaur too. And the fun is just beginning.

"This is my baby," says Coria, cradling a juvenile *Gasparinisaura* skull. It suggests that 70 million years ago such two-legged, plant-eating dinosaurs survived in South America after close relatives elsewhere had died out. Similar finds let the El Chocón area bill itself as the Valley of the Dinosaurs.

Sharp-Toothed Terror

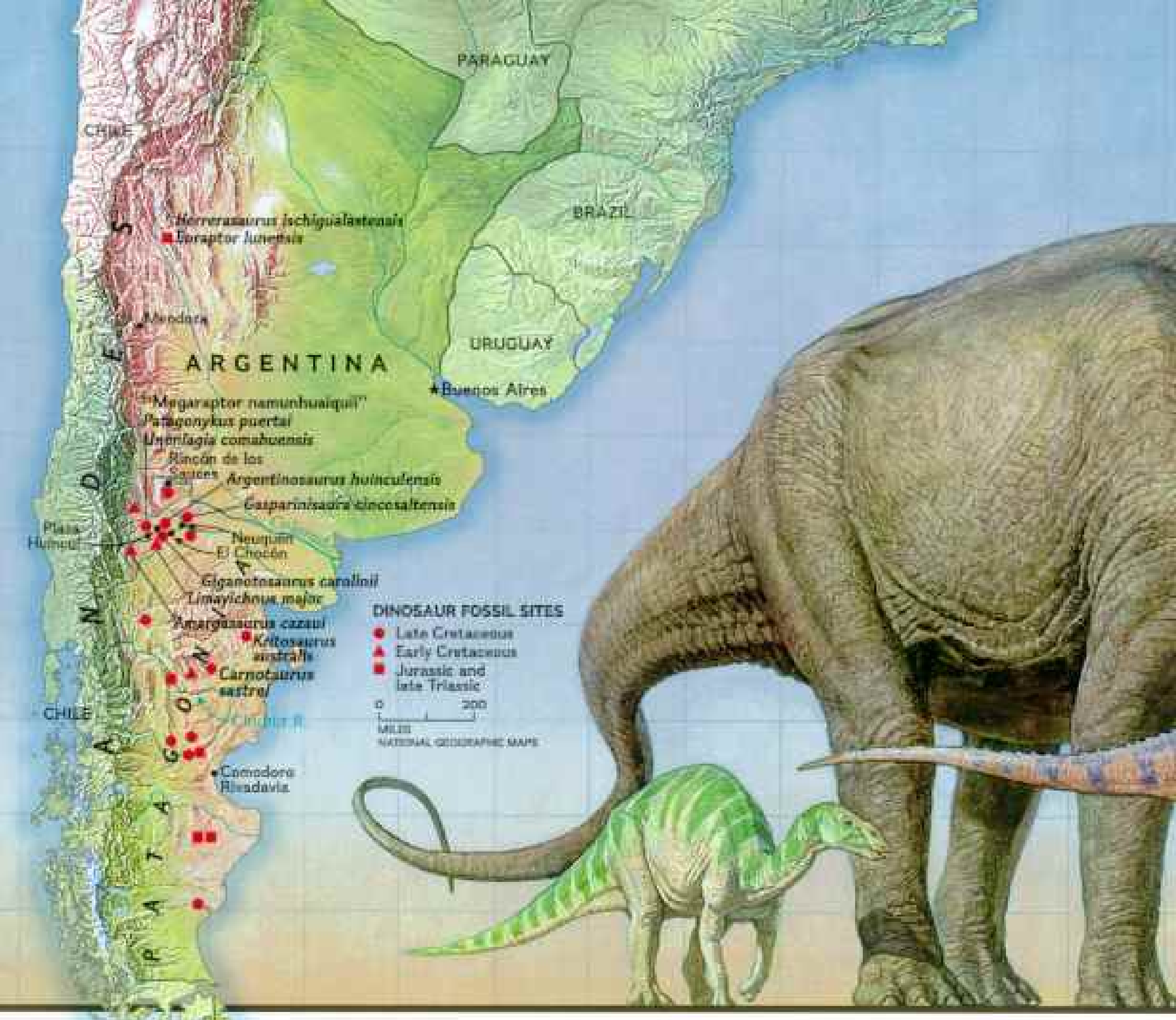
Charging through the Cretaceous landscape, eight-ton, 42-foot-long *Giganotosaurus,* one of the largest of all carnivores, dwarfs a herd of human-size herbivores, larger cousins of *Gasparinisaura.* Based partly on *Giganotosaurus's* remains, found near El Chocón, paleontologists propose a later-than-supposed link between the continents of South America and Africa, where a related beast lived 25 million years before North America's *Tyrannosaurus rex. Giganotosaurus's* dagger-like teeth (right) suggest that the creature preyed on plant-eaters many times its weight. Unlike the longer, wider, bone-crushing teeth of *T. rex* (bottom), the teeth of *Giganotosaurus* were best suited to cutting flesh. "This was an animal that would run in, take a very large bite, then back off and watch," says Canadian dinosaur expert Philip Currie. "Basically, the prey would bleed to death."

Giganotosaurus carolinii

One foot

Tyrannosaurus rex

ACTUAL SIZE



Kritosaurus australis
Relatives found in North America

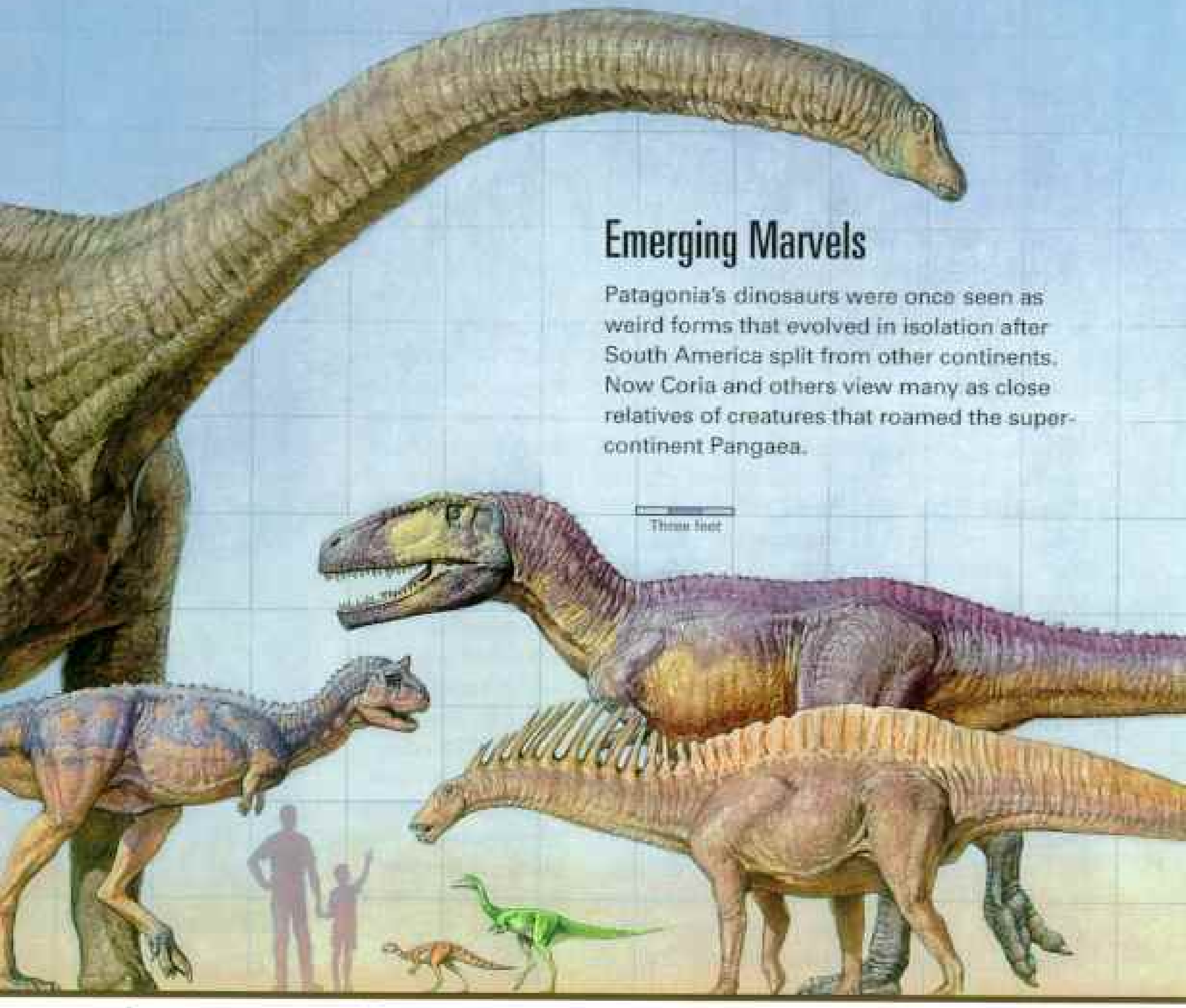
Argentinosaurus huinculensis
Relatives in Africa, Asia, and North America

"It is estimated that about ten new dinosaur species are found each year all over the world," says Rodolfo Coria, a leading figure in the renaissance of South American paleontology. "We find at least one a year within a couple of hours' drive from where we are sitting. That's 10 percent of the world's total. Not bad, eh?"

Coria, an easygoing native Patagonian with deep-set eyes, hoists his long legs up onto his desk in the Carmen Funes Museum in Plaza Huincul, four hours of hard road south of Rincón de los Sauces. A hazy light falls through a thick-paned window and settles on the desk. His office is spare and would be cramped even if he didn't share it with assorted pieces of a colossal Cretaceous predator. But Coria wouldn't trade places with any other paleontologist in the world. The exposed sediments all around Plaza Huincul record the coming and going of dinosaur species for the last 35 million years of their time on earth. Cretaceous calendars, jotted with bones.

An assistant arrives with a steaming kettle and an herb-filled gourd to make maté, a tea-like concoction enjoyed by Argentines at any time of day. She soaks the herb with hot water and passes me the preparation first, since I am the guest. I drain the beverage through a metal straw and hand the gourd back to be refilled with hot water and passed on.

The phone rings. It's a local oil-production manager who has found an interesting bone near a drilling site. Coria promises to check it



out. Fielding such tips from amateurs is a big part of his job. The calls come from farmers, Mapuche Indians, and oil workers manning lonely outposts. What do you expect when you are the resident paleontologist in a region littered with old bones?

Perhaps the most profitable tip so far led to the discovery of Coria's Cretaceous office mate: the great killer *Giganotosaurus*. In 1993 Coria got word that a local mechanic and fossil buff had found something interesting near the town of El Chocón, 30 miles southeast of Plaza Huincul.

"This fellow had called many times," says Coria. "But this time was different." He and his colleague Leonardo Salgado, a paleontologist at the University of Comahue in Neuquén, drove to the site. They brushed some sand from a bone and knew immediately that it was the shinbone of the largest predatory dinosaur ever found in South America. It took a few more days of digging to realize that it might be the largest predatory dinosaur ever found *anywhere*. Coria and Salgado estimated the beast's weight at between six and eight tons, its length at about 42 feet.

Back in Plaza Huincul the phone started ringing for a different reason. Reporters from all over the world had the same initial question. I can't help asking it too.

"So who wins the grand prize? If you saw

JAMES SHREEVE is writing a book about the origin and nature of life. ROBERT CLARK is making portraits of victims of handgun violence for an upcoming work. JAMES GURNEY is the creator of a popular book series on Dinotopia, a land where *Giganotosaurus* reigns.

Giganotosaurus and *Tyrannosaurus* next to each other, which would be bigger?"

"If you saw them next to each other," says Coria, "you would not notice because you would be running away. But I think the answer is *Giganotosaurus* by a couple of feet."

Coria reaches over the desk and places a trophy in my hand: an eight-inch tooth from his beast's upper jaw, polished and bronzed by time. I run a finger down the cutting edge of the crown, serrated like a steak knife and, after a hundred million years, still almost as sharp.

Compared with those of *T. rex*, the teeth of *Giganotosaurus* are much thinner and shorter. Coria sees *T. rex* as more of a scavenger than a hunter, using its thick choppers to maul the bones of an animal already dead. The fragile teeth of *Giganotosaurus*, he says, would have snapped like pocketknife blades if they bore down on bone. Their specialty was flesh ripping and bloodletting.

Lately *Giganotosaurus* has gained a competitor in its quest to unseat *T. rex* as Cretaceous top gun. A new specimen of the African superpredator *Carcharodontosaurus* ("shark-toothed reptile"), found in Morocco in 1995 by Paul Sereno of the University of Chicago, is about the same size as the South American giant.* But the resemblance goes deeper than that. For millions of years after the drift of continents separated the northern and southern landmasses, South America and Africa remained attached as part of the supercontinent Gondwana. Theoretically Gondwana dinosaurs should appear more similar to one another than to northern species. The skull and backbone of the two new giants share many anatomical characteristics, suggesting they are indeed very closely related.

"They are like brothers," says Coria.

He introduces me next to the other megastar of his museum, first recognized by José Bonaparte. Its partial backbone fills the main display room, looking more like a recovered shipwreck than a once living animal. Estimated to weigh as much as a hundred tons when alive, the sauropod *Argentinosaurus* is probably the heaviest land creature ever, truly a giant among giants. It took seven *years* to excavate this plant-eater, and it's only a partial skeleton.

"God forbid we should find a complete *Argentinosaurus*," he jokes. "I would be digging it out for the rest of my life."

Teasing fossilized bone from weathered rock near Plaza Huincul, Coria unearths a *Giganotosaurus*-like meat-eater, one of the finds that have nearly doubled the number of Patagonian dinosaur genera since 1990. A new generation of Argentine scientists is rapidly filling gaps in the evolutionary record of the southern continents. "The dinosaurs most people know about are from North America," says Coria's colleague Jorge Calvo. "We are changing that."

Which raises the question: Why grow so big in the first place? There's probably no single answer. A large animal is better able to store food energy over long periods of time, which helps in periods when there isn't much to eat. Enormous size is also a useful defense against predators; even a killer like *Giganotosaurus* would have thought twice about attacking a goliath ten times its weight. But those heavy bodies generated tremendous quantities of heat. One way evolution copes with excess body warmth is by increasing the surface area of skin relative to bulk. Here's where the sauropods' trademark elongated necks and tails might have been an advantage, functioning like natural radiators to slough off excess heat.

Whatever the advantages and disadvantages bestowed by sheer poundage, the great sauropods had dwindled by the end of the Jurassic period 146 million years ago—at least in North

*See "Africa's Dinosaur Castaways," by Paul C. Sereno, in the June 1996 issue.

America. There they were supplanted as the dominant herbivore by far smaller ornithischian ("bird-hipped") dinosaurs, such as the duck-billed hadrosaurs and horned ceratopsians. The dogma has long been that the sauropods lost out to the ornithischians' superior chewing power. Some duckbills had as many as 1,200 teeth. Rodolfo Coria, however, regards this as just so much "propaganda" born of a mind-set too narrowly focused on dinosaur evolution in North America and Asia.

"Down here in South America sauropods continued to thrive to the end of the Cretaceous," he tells me. The most dominant were an enigmatic group called titanosaurs, which includes *Argentinosaurus*. They held their grip on the title of top herbivore even after North and South America were joined back together, which allowed the supposedly superior ornithischians to filter down from the north. What was the secret of the titanosaurs' success?

Unfortunately a crippling obstacle kept anyone from finding out. Dinosaurs, like other species known only from their fossils, carry their distinguishing characteristics chiefly in the bones of the skull. The fossil record is loaded with titanosaur skeletons, but not one had ever been found with its skull.

Then one day, a few months before my journey to Patagonia, the telephone rang for Rodolfo Coria. Somebody else had found a bone for him to come and examine. The call came from a town called Rincón de los Sauces.

THE DINING ROOM at the Holiday Inn in Rincón is empty when I come in for lunch, which isn't too surprising since I seem to be the only guest. The concierge Charlie explains that the hotel is too new to be known by oilmen, its target clientele, and it is off-season for them in any case. Even so, the empty dining room echoes with the vulnerability of a one-trade town. Sooner than expected, crude oil is getting harder to find

Millennia of erosion of a sandstone outcropping in Chubut Province (above) revealed this exceptionally well preserved titanosaur skull. Found last March by paleontologist Rubén Martínez, it is, says Coria, "the missing piece of the puzzle" —a critical source of information on a primitive form of the plant-eaters that dominated southern continents during the late Cretaceous.

here. No wonder some people are angry that the dinosaur bones have been whisked away. A dinosaur museum might have brought fresh hope, a solid place on the map.

Charlie takes me out to meet the fellow who found the fossil. Daniel Eseisa, quiet and pleasant faced, is one of four local men who call themselves *los perros del desierto*—the dogs of the desert. They ride out into the badlands on their brightly colored dirt bikes on weekends and during the cool evenings.

"We are always looking for strange things," says Eseisa. We sit in the courtyard of the house of his brother-in-law, Carlos Parada, a local businessman and the family patriarch. Señora Eseisa comes out of the house with a maté gourd and a kettle of hot water, and while the gourd makes the rounds, Eseisa tells his story.

One morning in August he was riding alone in the hills east of town when he saw a large bone sticking out of the ground. Then he found another. And another. He raced back to share his discovery with his family. Wisely they called Rodolfo Coria. He came straight to Rincón and saw immediately that it was a titanosaur. It wasn't until November, however, that he could return to excavate. Meanwhile, the Paradas kept the location a family secret.

Local Heroes

Showing off a small-town celebrity, 18 students can barely encircle the massive femur and vertebrae of *Argentinosaurus huinculensis,* herbivorous giant and star of Plaza Huincul's museum. Retired oil worker Guillermo Heredia (bottom right) chanced upon the first bone while tending goats. Some years later scientist José Bonaparte realized it belonged to one of the largest dinosaurs known. Rather than send the bones to Buenos Aires for study, Bonaparte and the townspeople agreed a paleontologist should come to them. Coria came. Now amateurs flood him with finds: Farmer Sofía

Painemil (middle) discovered a titanosaur skeleton; mechanic Rubén Carolini (top) found the tibia of his namesake: *Giganotosaurus carolinii*.

Velociraptor

Fossils recovered shown in tan. Claw circled in red shown at right, actual size.

Killer Claw

"Megaraptor" (silhouetted behind *Velociraptor*) probably used this foot claw, the largest yet discovered, like a huge knife, to slash prey. "Nobody suspected the existence of such an animal. I can't reject the possibility it is a new lineage," says paleontologist Fernando Novas, who in January 1996 collected pieces of the only known specimen from 90-million-year-old mudstone near Plaza Huincul.

I get the rest of the story from Coria.

"On the first day the whole Parada clan came out with us to the site. Just a few bones were exposed. I brushed some sand off the pelvis, moved up three feet and brushed off some more, then moved up again. By the time I got to the middle of the neck, I could not help thinking about the skull. When I got to the tip of the neck, I could not believe my eyes. I could see the eye orbit, the snout, the lower jaw, some teeth. . . ." He shrugs, wordless. "It was too much good luck for just one man."

Coria had budgeted three days to excavate the Rincón specimen. It took three weeks, even working quicker than care would normally demand. Without a trained crew at first, he used the only labor available.

"I positioned myself at the skull, and the Paradas lined up along the neck, bone to bone, cousin to nephew to sister-in-law," Coria remembers. "It was so easy to manage them because they were already linked in spirit. I felt like one person with many hands."

By the end of the first day the location of the dig was no longer a secret. Many people from town came to watch. *¡El dinosaurio!* Civic leaders began to make plans to build a museum, with the titanosaur as its centerpiece. But Coria

had already persuaded Carlos Parada to let it go to Plaza Huincul. The reasons were unassailable. There were no research facilities in Rincón, no paleontologist, no support for the opportunities created by such a valuable specimen. None of this satisfied the loyalists in Rincón, of course. Tempers flared. A local politician campaigned ardently to keep the dinosaur.

Today the skeleton rests in Plaza Huincul, waiting for Coria to find time to study it in detail. Not an easy job, considering that it's the most complete titanosaur skeleton ever found. But it's already clear that the Rincón specimen will provide some surprises. During the excavation Coria noticed what he believes to be long, bony tendons attached to its cervical ribs and extending all the way back to the shoulder. Those tendons would have made it impossible for the animal to bend its neck or even raise it much above the level of its shoulder. Rather than hold its head high on a curved neck, the way we have traditionally pictured sauropods, this one must have kept its neck straight out, head downward. That anatomical revelation could shed light on an old mystery.

"People have always wondered how those big guys brought enough blood up from their hearts to their little brains," says Coria. "The pressure needed to pump blood three or four meters over the height of the heart would have exploded the blood vessels. But if the head was at the same level as the heart, then the heart would not have to pump against gravity."

If Coria is right, the specimen could also bolster an emerging view that most sauropods fed like monstrous vacuum cleaners, swinging their heads low on those hoselike necks. Large amounts of vegetation would thus lie within reach of the animal's mouth without its needing to move a step. Perhaps this isn't as noble an image of sauropods as the swan-necked tropical beauties we are used to seeing in books and museum murals, but it might help explain how these gentle vegetarians found enough nutrition to keep their massive bodies alive.

A FEW DAYS LATER I am awakened by a flock of dinosaurs shouting at one another in a dead tree. I am lying on a cot outside my tent on the north bank of the Río Colorado. The dinosaurs are brightly colored burrowing parrots, which, like all other birds, are now thought by most experts to be living members of the dinosaur clan. The parrots holler and flit from one branch to another, so the whole tree looks like an insomniac shifting around trying to find a comfortable position. An ibis skims close to the water, hooting softly, followed by two coscoroba swans gliding by with the gracefulness of spirits. A trio of free-ranging horses dip their ankles in the river and bend their necks for a morning drink.

Strictly speaking, Patagonia begins on the opposite bank. But the dawn-burnished hills here in southern Mendoza Province are part of the same geologic formation as those around Rincón and Plaza Huincul, with the same potential for yielding Cretaceous dinosaurs. Paul Sereno and his colleagues have been prospecting the nearby terrain for three weeks. I've been here four days helping excavate a megaton—though unfortunately headless—titanosaur.

It's barely 6 a.m., but I find Sereno already sitting at the worktable in the center of camp, editing a manuscript. His self-confident, driven approach to fieldwork has yielded an impressive string of successes. In 1988 he found the most complete skeleton of *Herrerasaurus*, one of the earliest dinosaurs known. Three years later an even more primitive one was found, which he called *Eoraptor*. He has also unearthed extraordinary new dinosaurs in Africa and brought back bones from other continents as well. His approach is global, because dinosaurs were too.

"The age of dinosaurs is really the age of

fragmentation," he tells me. "At the beginning of the Jurassic period, dinosaurs were pretty much the same all over the earth. Then the world started pulling apart. Dinosaurs ended up looking very different from one continent to the other. How did that happen? I think that's the neatest story going."

But it's not one with an easy plot. Sereno takes a stick and sketches a map of the Cretaceous world in the dust between our feet. Next to it he draws a branching tree showing how dinosaur groups are related to each other. If the gradual fragmentation of the world's landmasses was driving evolution, that process should be reflected in the tree. Large African predators, for instance, should resemble South American ones more than either group resembles its North American counterparts. Sometimes the scenario seems to play out perfectly. Witness the "brotherly" match between *Carcharodontosaurus* from Africa and *Giganotosaurus* from here in Patagonia.

Unfortunately the anatomy of the bones seldom reflects the movement of continents so clearly. Seven years ago Fernando Novas of the Museum of Natural Sciences in Buenos Aires—one of the brightest stars in the constellation of Argentine paleontologists trained by José Bonaparte—and his colleagues were exploring a range of hills just west of Plaza Huincul when they found the bones of a dinosaur unlike anything they had ever seen. Built like an ostrich, it had tail vertebrae like a crocodile and an odd sort of stubby claw as the only

Three-toed fossil tracks near El Chocón mark the path of *Limayichnus major,* which lived when shifting continents transformed global environments. Pursuing traces of Patagonia's past, paleontologists leave deep imprints on our knowledge of dinosaurs and evolution.

digit on its forelimb. Novas hadn't a clue what to call the thing—until he learned that a similar creature named *Mononykus* had just been found in Mongolia. The resemblance was so close that he decided to name his specimen *Patagonykus.* Both creatures were from the late Cretaceous, long after Laurasia and Gondwana had drifted apart. How did continents separated by thousands of miles of ocean end up harboring the same kind of dinosaurs? Did they both just happen to evolve the same weird anatomy? Or did land bridges or island chains occasionally link the continents even as they were spreading apart?

"It's a complicated mess," says Sereno. As if to underscore his point, a gust of wind blows in off the river and erases his pictures in the dust.

STILL, A MESSY, UNSOLVED MYSTERY holds far more promise than an unexamined assumption. No one knows yet where the splendid giants of Patagonia fit into the big picture of dinosaur evolution, but they can no longer be dismissed as bizarre no-counts that inhabited a dinosaurian backwater. Rodolfo Coria, in fact, suspects the very opposite may be true.

"I think the South American forms are the *normal* dinosaurs," he tells me, back in Plaza Huincul. "The oldest, most primitive predators come from Argentina. The same is true of the ornithischian dinosaurs and maybe even the sauropods. If you want to see bizarre dinosaurs, go to North America and look at *Tyrannosaurus* or all those different ceratopsians."

Coria admits there are still too few specimens to make a firm case for his theory, but that may not last for long. Just a few months after my visit he unearthed three new giant-predator specimens, at 90 million years old likely tormentors of the megasauropod *Argentinosaurus.* A month later Rubén Martínez, a paleontologist at the National University of Patagonia in Comodoro Rivadavia, found a second, even more spectacular titanosaur skull farther south. Fernando Novas's team has returned to the hills that produced *Patagonykus* and pulled out a frightening claw of a predator similar to *Jurassic Park's Velociraptor* but eight times its bulk. Even more fascinating is *Unenlagia,* a primitive, transitional birdlike creature from the same site—unable to fly but with flight foreshadowed in its forelimb. Those fossils are destined to transform our understanding of dinosaurs not only in Patagonia but all over the world as well.

"That is the fun part of our work," says Coria, as he takes a sip of maté. "There is no last word. Maybe tomorrow a new hypothesis will open up, and another one will close." □

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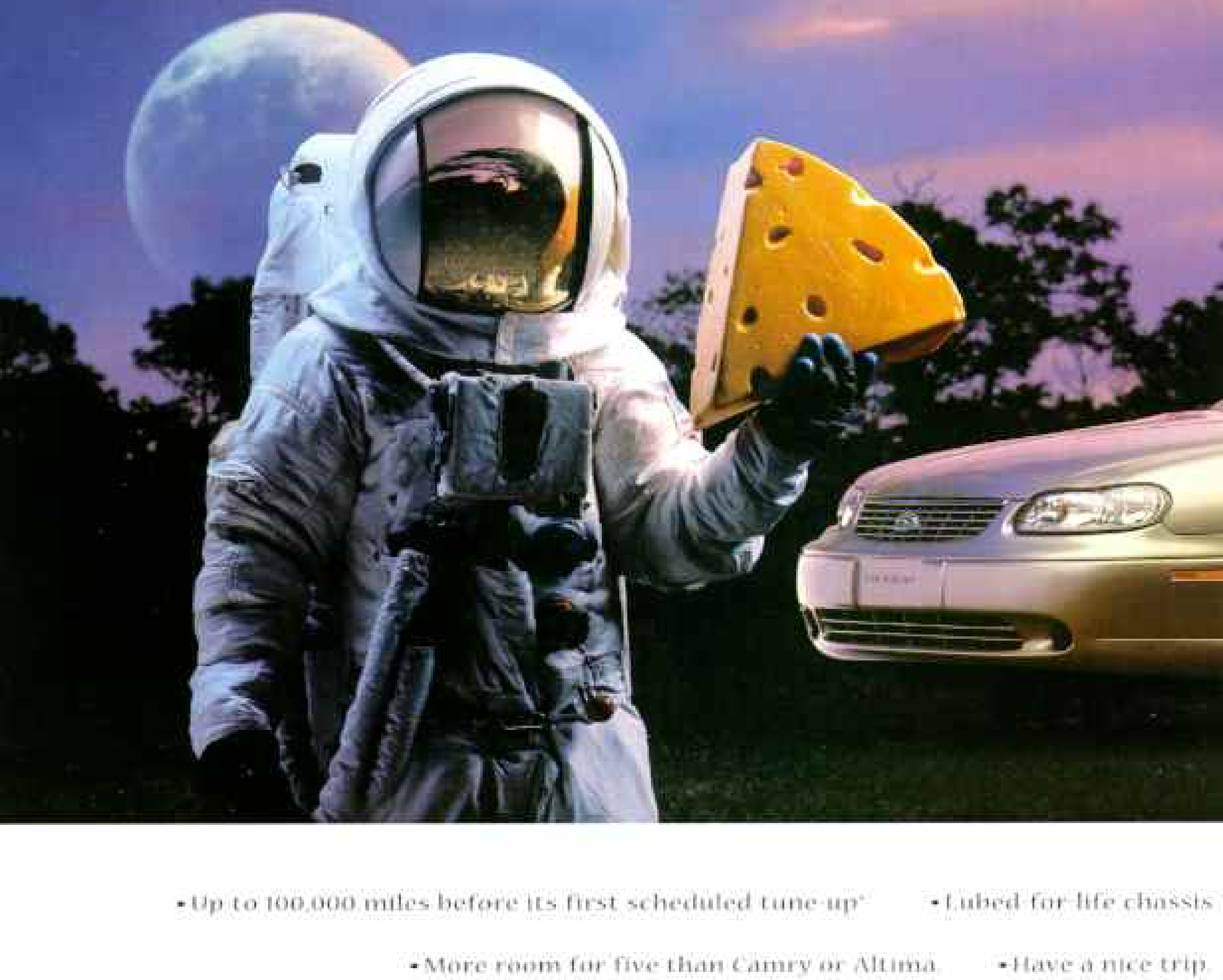

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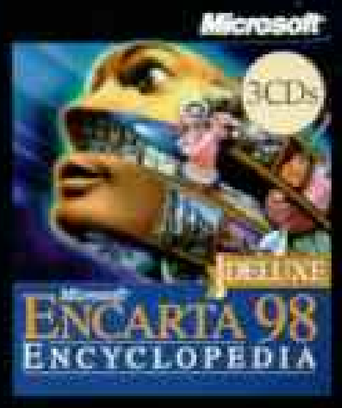

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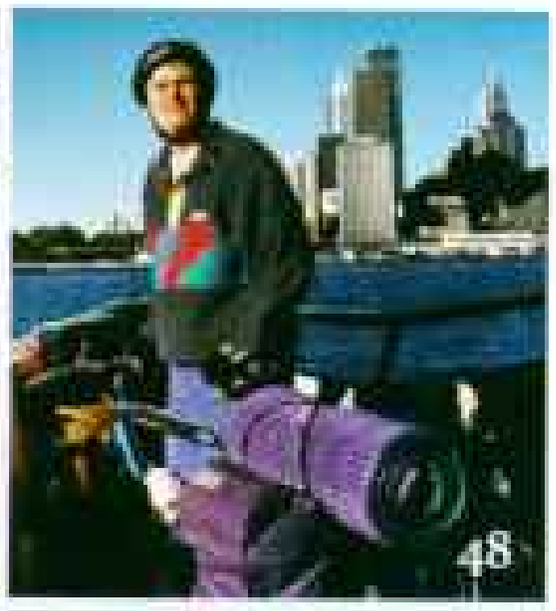

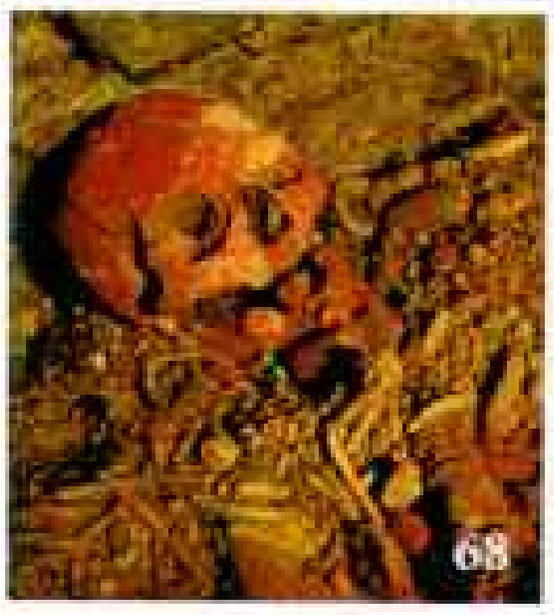

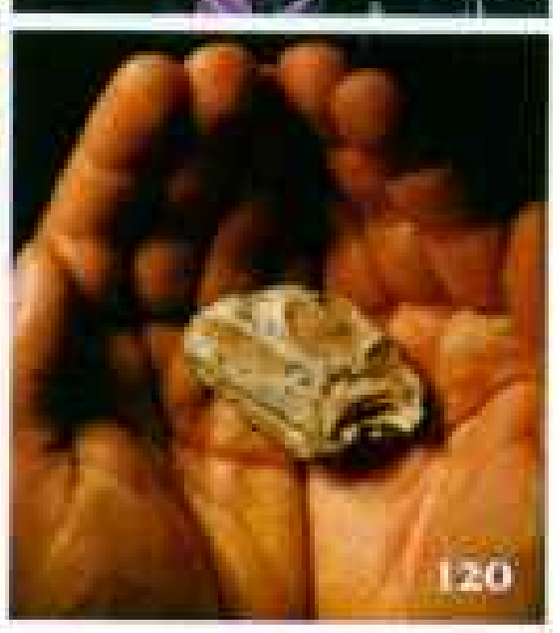

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The Cover

Bengal tigress Sita moves her cubs repeatedly to protect them from predators while she stalks her own prey in an Indian park. Photograph by National Geographic photographer Michael Nichols

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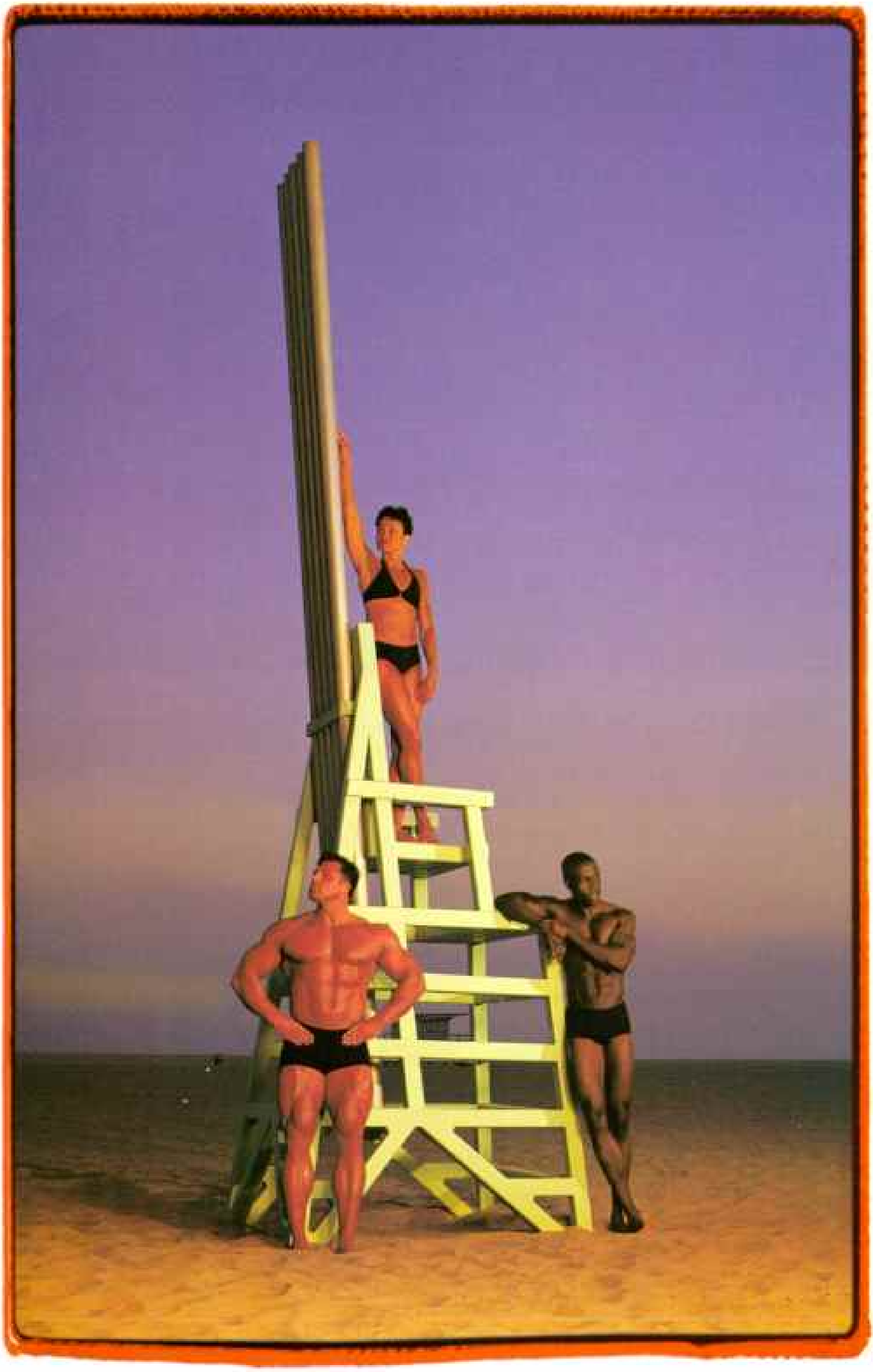

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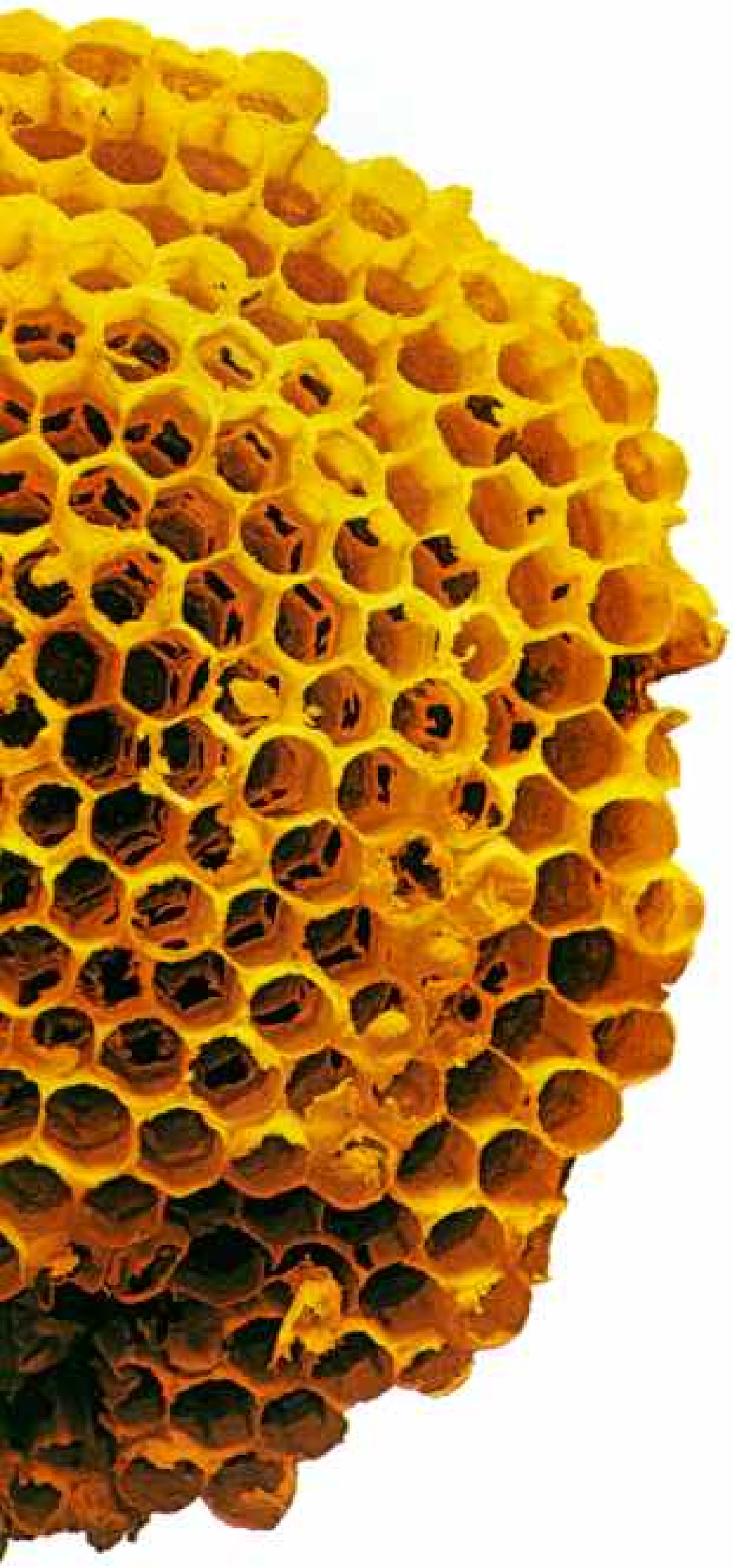

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Behind the Scenes

TECHNART MALLET

Maya Treasures Repatriated

Amid the usual bustle of the Society's loading dock one morning last April, George Stuart, Chairman of our Committee for Research and Exploration, knelt among cartons filled with long-missing Maya sculptures and grinned like a kid at Christmas. The 1,200-year-old stone carvings had arrived from anonymous art collectors responding to George's negotiations for the return of looted treasures to their homelands. With archaeologist Ricardo Agurcia Fasquelle (below, at left) George unwrapped parts of a bust and a monkey sculpture from Copán in Honduras. Also returned: two pieces of a stela (above) taken from the La Mar site in Mexico; an unknown number of fragments are still missing from the monument photographed in 1897 (above right). All items are being repatriated. George hopes other collectors will be inspired to relinquish ancient art of questionable provenance. "Not only does this save the sculpture," says George, "it also allows us to learn more about the Maya and other early cultures."

KENNETH GARRETT (ABOVE AND TOP)

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Art for Our Sake

What do people do with their old NATIONAL GEOGRAPHICS? The magazine often inspires exploration—sometimes of the artistic sort.

After member Leigh Lambert of Washington, D.C., reads her GEOGRAPHICS, she rips them up. "Then I sort the pages according to color," she explains. Leigh cuts the sorted pages into 1/4-inch-wide strips and weaves them into square "color studies" (above).

Esta Lastoria of Plymouth, Massachusetts, combines fragments of photographs to make new images. Her "Infinite Cat" collage (top right) was largely based on an owl photo (May 1970, pages 668-9). The rug under the cat is an aerial photo of a marigold field (August 1968, page 164). "I've been doing this since I was a kid," says Esta.

Savannah, Georgia, artist Elizabeth Cain also rips up her magazines. She never knows what she'll make when starting her freehand cuttings (right) on folded GEOGRAPHIC pages. "I just got back from Germany with some great new sharp scissors," she says—so her studio should be hopping soon.

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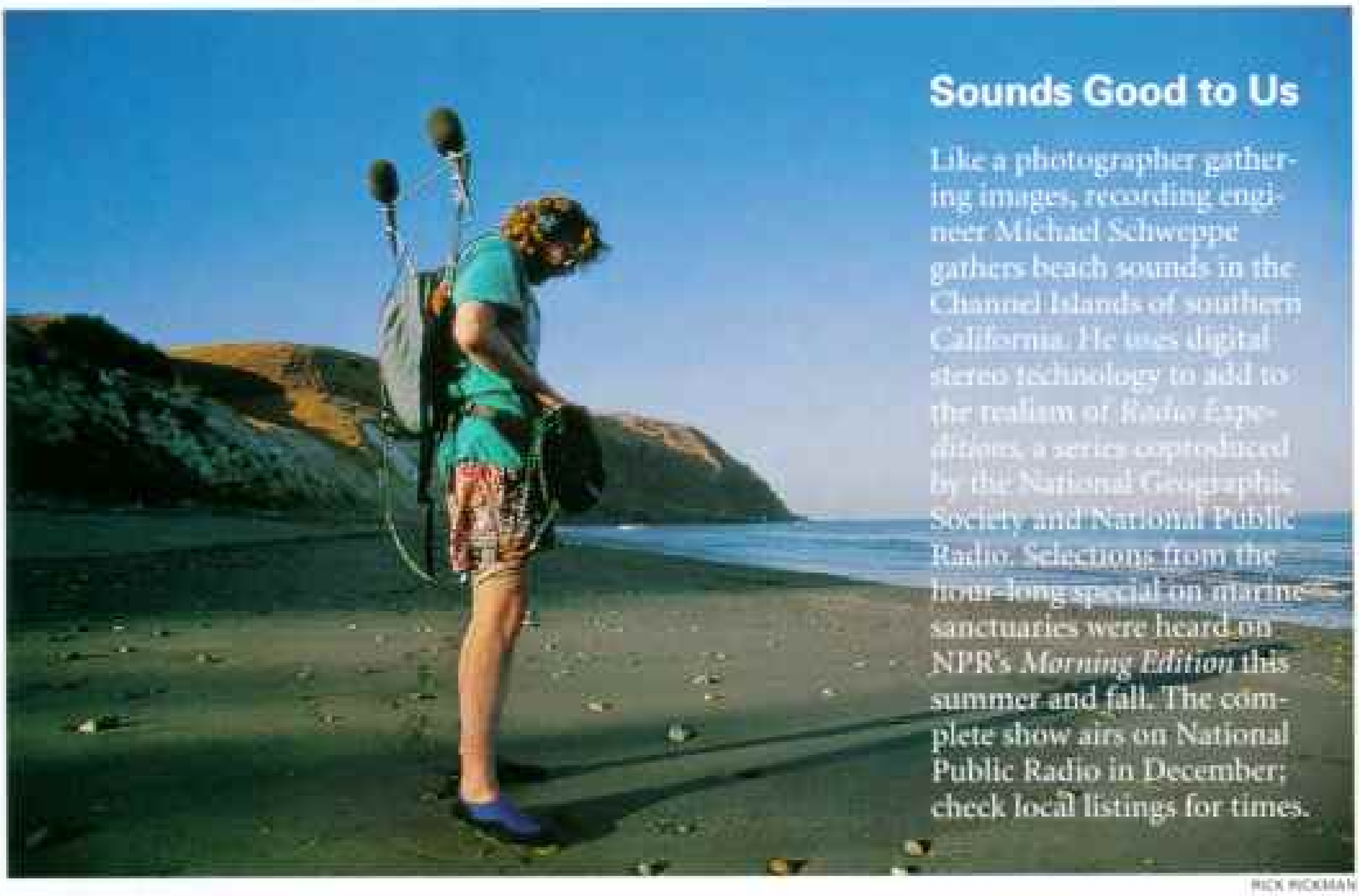

Sounds Good to Us

Like a photographer gathering images, recording engineer Michael Schweppe gathers beach sounds in the Channel Islands of southern California. He uses digital stereo technology to add to the realism of *Radio Expeditions*, a series coproduced by the National Geographic Society and National Public Radio. Selections from the hour-long special on marine sanctuaries were heard on NPR's *Morning Edition* this summer and fall. The complete show airs on National Public Radio in December; check local listings for times.

RICK RICKMAN

Drawing on the Past With Dinosaurs

If the style of the dinosaur paintings in this issue looks familiar, there's good reason: New York artist James Gurney, a longtime GEOGRAPHIC contributor, is also author and illustrator of the popular children's books *Dinotopia* and *Dinotopia: The World Beneath*. "I like to think of dinosaur paintings as wildlife art for the time traveler," says James, whose credits include the U.S. Postal Service's 1997 dinosaur stamps. "Every morning I put on my safari hat, head upstairs to the studio, and take a little adventure."

JIM BLOCK

Answer in the Form of a Question, Please!

What yellow-bordered magazine appears as a category on a popular television game show? Harry Friedman, producer of *Jeopardy!*, knows the answer. "We're trying to make the show more visual, and the GEOGRAPHIC was an obvious source for great pictures." The program's writers combed back issues for striking images to test contestants' knowledge. The category made its debut during this fall's Teen Tournament, broadcast in November.

TEXT BY MAGGIE ZACKOWITZ

LAUREN GREENFIELD

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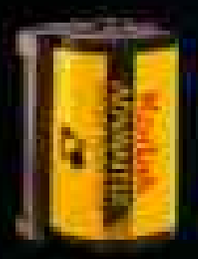

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Forum

Readers found much to admire and some things to criticize in our August article on the Roman Empire, the second in a two-part series. One college student who lamented receiving no education on the Roman Empire in high school believed the articles filled "a major gap." Another writer thought we over-idealized Roman law, saying that today we would be protesting "their human rights record."

Barrier Islands

"Islands at the Edge" was very informative and insightful. I was, however, infuriated to find out that my tax dollars subsidize the whims of the wealthy. In the midst of the turmoil about welfare reform, I am offended that instead of feeding and educating young children, the government finds it acceptable to spend money on restoring coastline that is by its nature not meant to be permanent. Thank you for bringing this misuse of tax dollars to light.

JEANETTE L. GIBSON
Oshkosh, Wisconsin

I was unaware of the level of federal subsidy via flood insurance on private beachfront property. Logical economics would point to a buyout of hurricane-destroyed property after each major storm, with the property then placed off-limits to future construction. Let the taxpayer benefit through environmentally friendly public ownership and use of the land.

SHERRILL L. VINES
Mobile, Alabama

The public's money is used by the federal government to subsidize many national programs. In the case of the beach at Ocean City, Maryland, the city, county, state, and feds all thought it was a good investment [to replenish the beach] and agreed to contribute together. When four layers of government agree on something, it must be of value. Ask some of the millions of middle-class American families who come to the seashore together each year for that magical moment on vacation.

GEORGE M. HURLEY
Ocean City, Maryland

Your list of U.S. barrier islands starts in New York and moves south. If those few small but beautiful islands off southern Rhode Island that shelter salt-water ponds and marshes from the waters of Block Island Sound and the Atlantic aren't barrier islands, what are they?

PATRICK J. O'CONNOR
Danbury, Connecticut

Roman Legacy

If your intent was to provide appetizers for more details on many aspects of the Roman Empire, you scored a victory. I hated history while in college because there was scarcely enough time to think about the people using the aqueducts and traveling the Roman "superhighways" or even the families who patronized the Colosseum. You did a great job in making me aware of our own cultural heritage and in humbling members of this present generation who may have the ill-conceived idea that we alone "came and conquered" the 20th century.

EARL FASHBAUGH
Duluth, Minnesota

You state that, like its counterpart in Rome, the U.S. Senate was "designed as a chamber for the elite." Originally, while the House of Representatives was composed of members elected by the people, the Senate was composed of two members from each state, "chosen by the legislature thereof." The House was considered more prestigious since members had to be elected by the people; after his Presidency John Quincy Adams sought election to the House, not the Senate. The Senate was designed to represent state governments at the federal level. If that function had been retained, a stronger check on abuses of the federal government would exist.

JAMES T. NOONAN
Ellicott City, Maryland

There is another tradition regarding the death of the Apostle Paul. Just before he was martyred by the Emperor Nero, Paul invoked his right as a Roman citizen to be beheaded. The church father Tertullian recorded that he was beheaded, and much Christian art depicts that event, as in Giotto's "Decapitation of St. Paul" at the Vatican Museums.

KATHRYN S. LAFLEUR
Eunice, Louisiana

As a Ph.D. student in linguistics at Ohio State University, I teach introductory linguistics to undergraduates. Author T. R. Reid implies that Latin is somehow more advanced or logical than any other language. My students could tell you otherwise. All natural human languages exist and change regardless of human intervention; only an artificial language such as Esperanto can be described as a "product of careful engineering." All languages, from that spoken by citizens of a powerful empire to that spoken by a small fishing community on a remote island, are equally complex.

JENNIFER MULLER
Dublin, Ohio

I'm happy to report that the study of Latin is alive and well in Boise, Idaho, for all the reasons the author stated. Our six public high schools teach Latin with steady enrollments. Even my former students who study computer programming in college report on the usefulness of their Latin training!

JODY MABE
Boise, Idaho

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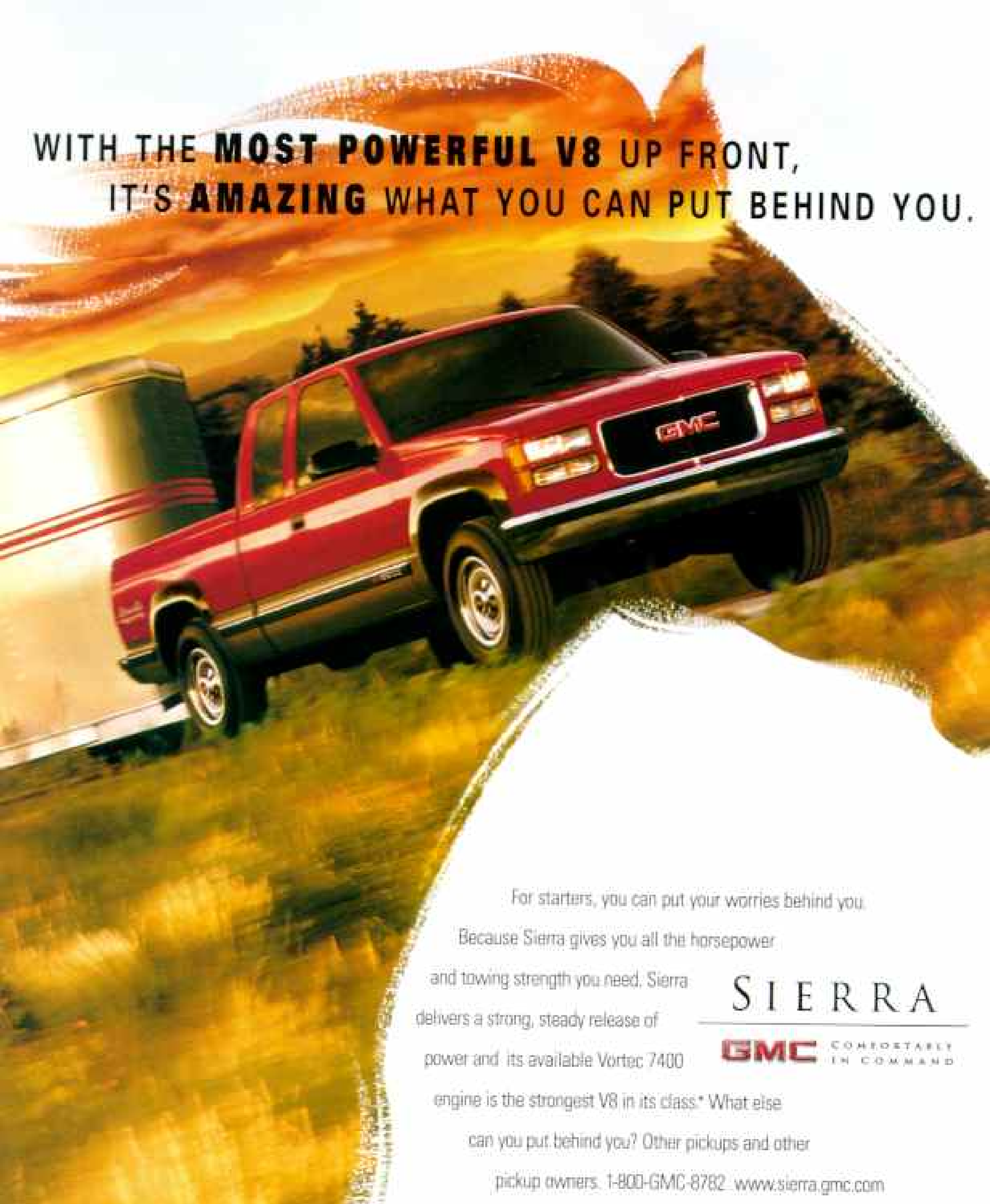

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As a lawyer I have often reviewed contracts prepared in English by lawyers abroad. Once I was struck by my Japanese counterpart's admirable use of the phrase *mutatis mutandis*, an economical way of saying that stated provisions applicable to one party would also apply to the other. Thus the Latin language provided a shorthand term readily understood by lawyers and executives in Japan and America today. Latin is far from dead, but our society's understanding and appreciation of its place in our lives is far from healthy. We are the poorer for it.

JOSEPH L. HERN
Boston, Massachusetts

While Hadrian's Wall is pictured (page 77), no mention is made of the Antonine Wall built about A.D. 140 by Emperor Antoninus Pius, who ordered Hadrian's Wall abandoned and a more northern defense established against the barbarians. Remnants can be seen in present-day Scotland, especially around Falkirk.

CAROLE BAKER
Nashville, Tennessee

Oregon's Outback

As a kid growing up in Adel, Oregon, I was aware that mapmakers, newswriters, and Salem legislators generally ignored the two-thirds of the state that lay east of the Cascades. We called it the Sagebrush Curtain. However, it still stings when your map omits Adel and Plush, the twin meccas of culture and sophistication in Warner Valley. You can probably expect letters from irate citizens of Wagontire and Alkali Lake too, if the mail stage makes it through.

BOB CRAWFORD
Halfway, Oregon

I visited the fringe of Oregon's outback in 1933 and returned with my wife and young daughter during the '60s to explore it in greater depth. Although I found it fascinating, my companions found it desolate and gloomy. It took decades, but I feel in author William Least Heat-Moon another human who can find beauty in such places.

SCOTT WALLS
Oakland, California

The photographs of Steens Mountain give the impression that it is a bleak and foreboding place. Having just returned from a week camping there, we can testify that this time of year [July] the mountain is bright, sunny, and resplendent with wildflowers toward its summit. Big Indian Gorge (pages 88-9) is alive with color. Your team apparently visited during the wrong season. Nevertheless, if your article discourages tourist incursions at one of our favorite places—okay.

BOB AND JUDY OLIVER
Salem, Oregon

Malaysia

T. R. Reid's article was superb with a real feel for the actual situation. Being a Chinese raised in Malaysia, I can feel the changes in the social structure. Where my father would once have shied away from Malays, some of my best friends are Malays. While most Westerners believe that it is impossible for three major races plus indigenous ones to live together, we have accomplished that feat and are pleased with the results. However, the deterioration of individual cultures can be seen, as Mr. Reid pointed out. Perhaps it's time we left our traditions to the museums and came out with a new culture, not Chinese, not Malay, not Indian, but Malaysian.

FONG MIN HUN
Hamilton, Ontario

I wish more had been written about the consequences of the spectacular growth. On a trip last year from Kuching to Sibu by express boat, I saw dozens of ships carrying logs and lumber products destined for markets in Japan and China. On a six-hour bus trip from Sibu to Batu Niah to visit caves where bird nests are collected for soup, I could see the results of the devastation caused by logging. I was required to get a permit to travel into the area because of government concern that this problem would be publicized. My advice to anyone who wants to see this exotic part of the world is to go now before it is lost forever.

MIKE VAN CANTFORT
Seabrook, New Hampshire

Forum

In the August issue a letter writer questioned the necessity of collecting (killing) specimens of newly discovered species. There are cases where scientists do refrain from collecting the type specimen. Indeed, tissue samples from live individuals, supplemented by photographs and sound recordings, can be used to define taxa. For instance, describing a new species of shrike from Somalia (*Lanarius liberatus*), scientists studied the bird in captivity and released it. They contributed material—molted feathers, blood samples, and DNA extracted from feather quills—to the Zoological Museum of the University of Copenhagen.

ANDERS HEDENSTRÖM
Department of Animal Ecology
University of Lund
Lund, Sweden

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 ngforum@nationalgeographic.com. Include name, address, and daytime telephone. Letters may be edited for clarity and space.*

Aerodynamically speaking, a Dodge Stratus is one slippery car. Is it possible to see the future, then, in the rear-view mirror?

Dodge pioneered the cab-forward design concept – moving the wheels out to the corners and sliding the passenger compartment forward. Can cab-forward roominess create more room even in the trunk?

You'd expect a race car to be graded on a curve. Well, if race cars inspired us to modify a double-wishbone suspension, can you handle it?

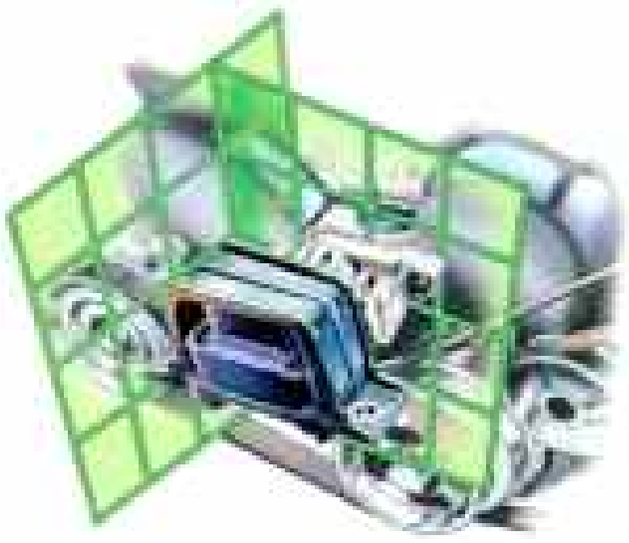
Powder-coat paint technology will give you a paint finish tough enough to help protect a car's shiny overcoat from flying gravel. When it comes to what you'll expect down the road, do we have things pretty well covered?

It's a simple engineering principle: lose weight, gain performance. But can a whole battery of ideas that enhance performance include simply moving the battery?

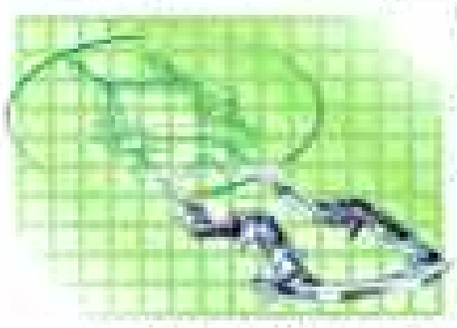
These are the questions.

Do you have to choose between the convenience of an automatic transmission and the performance of manual shifting? Or can an available AutoStick® transaxle shift an automatic a little more toward fun?

Take something as simple as an engine mount – a combination of steel and rubber that holds the engine to the frame rail. Can we mount a good argument that a device filled with liquid could minimize engine vibration and help make things quieter?



Car chassis have traditionally been built on a "floor pan" design. Can a platform that incorporates a continuous rigid, ladder-type frame improve ride and handling characteristics? Can this help us reach a high level of performance?



Let's see, there's more room up front. There's more room in back. Is everyone comfortable with cab-forward?

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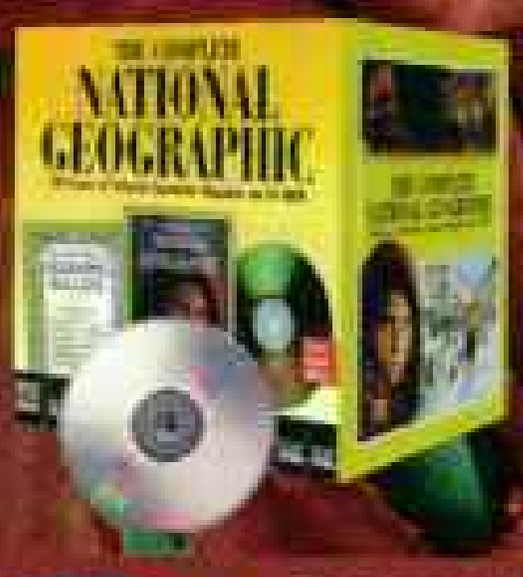

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JONATHAN PLAYER, NEW YORK TIMES

Internet Helps Scottish Islanders Win Back Their Land

Since 1828 the windswept Scottish island of Eigg has been owned by private landlords, most of them absentees who cared little about anything other than collecting rent. Now, thanks to an effort launched by the island's 68 residents and the aid of a site on the Internet, the Hebridean isle is owned by those who live there.

Eigg's last landlord—"a German who called himself an artist," says Maggie Fyffe, an island leader (above)—put the island up for sale in 1996. The residents formed a partnership with the Scottish Wildlife Trust and the local governing council, creating a fund-raising Web page that "sent the message farther than it would have gone otherwise," says Fyffe. A "mystery person" who read about the effort donated more than half the successful bid of 2.4 million dollars. On June 12 the islanders took ownership.

The 7,400-acre island, reachable by ferry from Scotland's west coast, has been neglected. The partnership hopes to stock farms, fix up homes and barns, establish a forest-management project, and create other programs to lure tourists to Eigg and keep the community alive.

FELDER RUSHING

Bottling Up Evil, Inspiring an Art Form

Rooted in an African tradition of capturing evil spirits in glass bottles, bottle trees like this one near Vicksburg, Mississippi, once were common in the rural South. Tradition held that the night wind blowing past the glass caused trapped spirits to moan until the morning sun destroyed them. Folklorists believe the practice came to the U.S. with slaves from western and central Africa. Today whites as well as blacks erect bottle trees in their yards, often on red cedars, for decorative purposes. "In the same way, Pennsylvania Dutch hex signs began as barn totems and now are decorations," says Jim Martin, who wrote about the trees in the *Encyclopedia of Southern Culture*. "Bottle trees are poor man's stained glass."

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September 14, 1997:
Automotive journalists gather in Austin, Texas, to drive the all-new 1998 Chrysler Concorde and Dodge Intrepid. Local armadillo population goes on alert.

May 7, 1997:
A jaw-dropping formation of purple Plymouth Prowlers cruises the Sunset Strip to mark the Prowler's official introduction. The automotive gods are smiling.

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May 27, 1930:
Chrysler Building is completed in New York. A writer comments it "gleams like a giant hubcap."

January 11, 1932:
One of the most distinctive open cars ever created (or so judges at vintage car shows tell us), the Chrysler Imperial grabs a dozen speed records in its class.

January 22, 1934:
Chrysler introduces the radical Airflow. Based on aircraft design principles, it ushers in a new age of automotive design.

September 14, 1969:
What's cooler than watching this Dodge Charger Daytona blow past the competition at Talladega? Going to the dealer and taking one home.

June 17, 1996:
After astounding car show crowds for over a year, the Dodge Viper GTS Coupe slithers into showrooms.

January 15, 1994:
Automobile Magazine bypasses new models by Mercedes-Benz, BMW, and Volvo in naming the all-new Neon its "Automobile of the Year." (Must be the cool round—okay, oval—headlights.)

Besides, as a car company, we like being out in front. The view is better, and the ride, a lot more exciting. Whether you're looking backward or forward, that's what building great cars and great trucks is all about.

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SANFORD

Signs of the Times on a Road to Nowhere

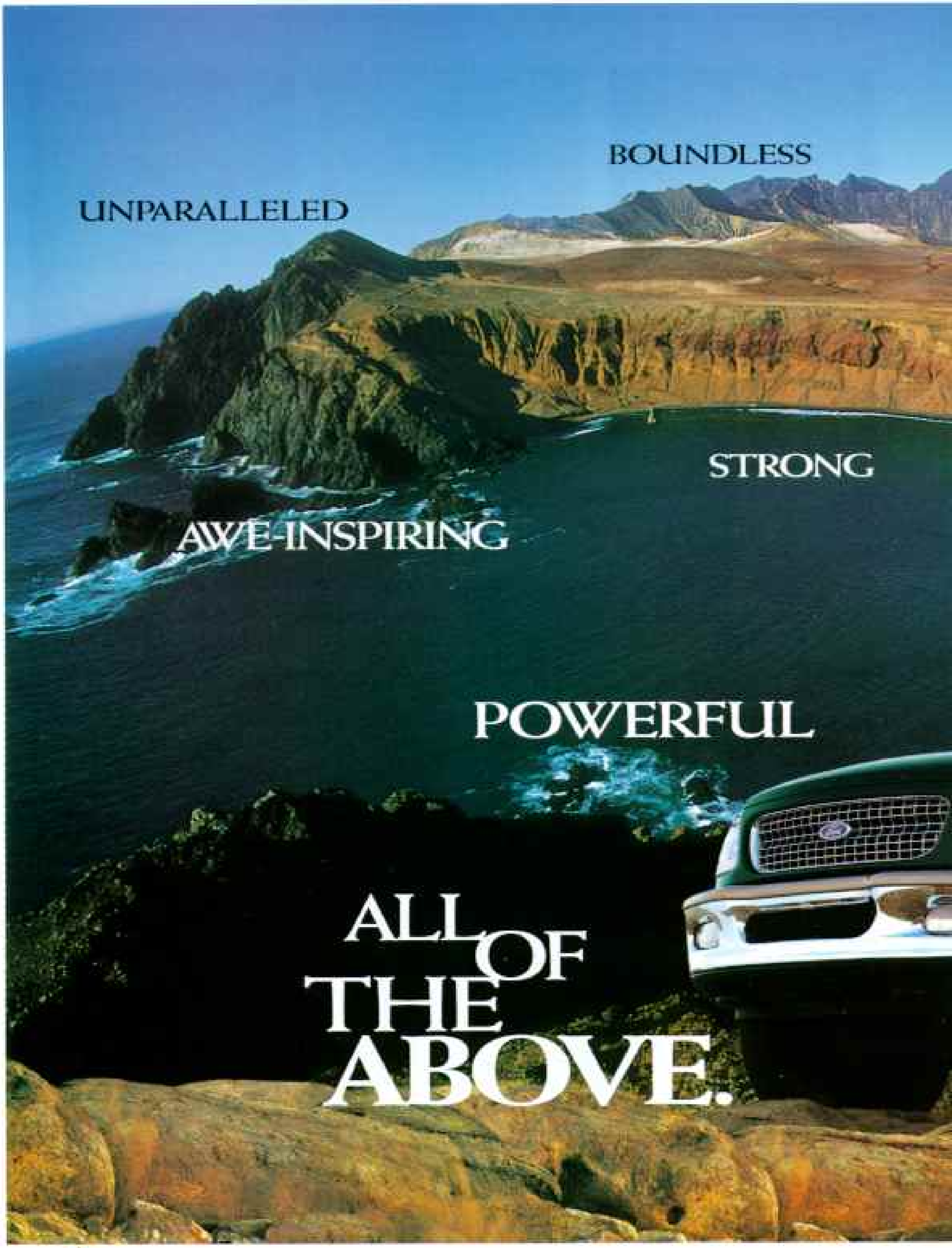
Southern New Mexico's Hidalgo County, with just 6,200 residents in 3,445 square miles, is a place for the solo cowboy, the loner.

But this isolated, arid chunk of land, known as the Bootheel for the way it digs into a corner of Mexico, also harbors a quirky sense of humor, as Michelle Behr, a Western New Mexico University geographer, and Neal Ackerly, her anthropologist husband, discovered last year. On a 14-mile stretch of a "road to nowhere"—it dead-ends at the Mexican border—they found the hand-painted additions to highway signs seen here. The original creator was a cowboy—note the reference to chewing tobacco (top left)—who has lived in the area all his life. But because the signs have different handwriting, Behr and Ackerly believe other denizens of the area added their own comments.

"These humorous alterations reflect local culture and conditions and, given the paucity of traffic, are almost certainly intended for the amusement of local residents," Behr and Ackerly told the Association of American Geographers. In their best social-scientist manner, they categorized the added signs as regional in-jokes, commentaries on water, or observations about modern society. "But we also thought they were cool," Behr admits.

Isn't such tinkering with official signs a bit, er, illegal? "Of course," says Behr. "But face it, this is a road that turns to dirt by the time it hits the border. Nobody here bothers with it."

NEAL W. ACKERLY (ALL)



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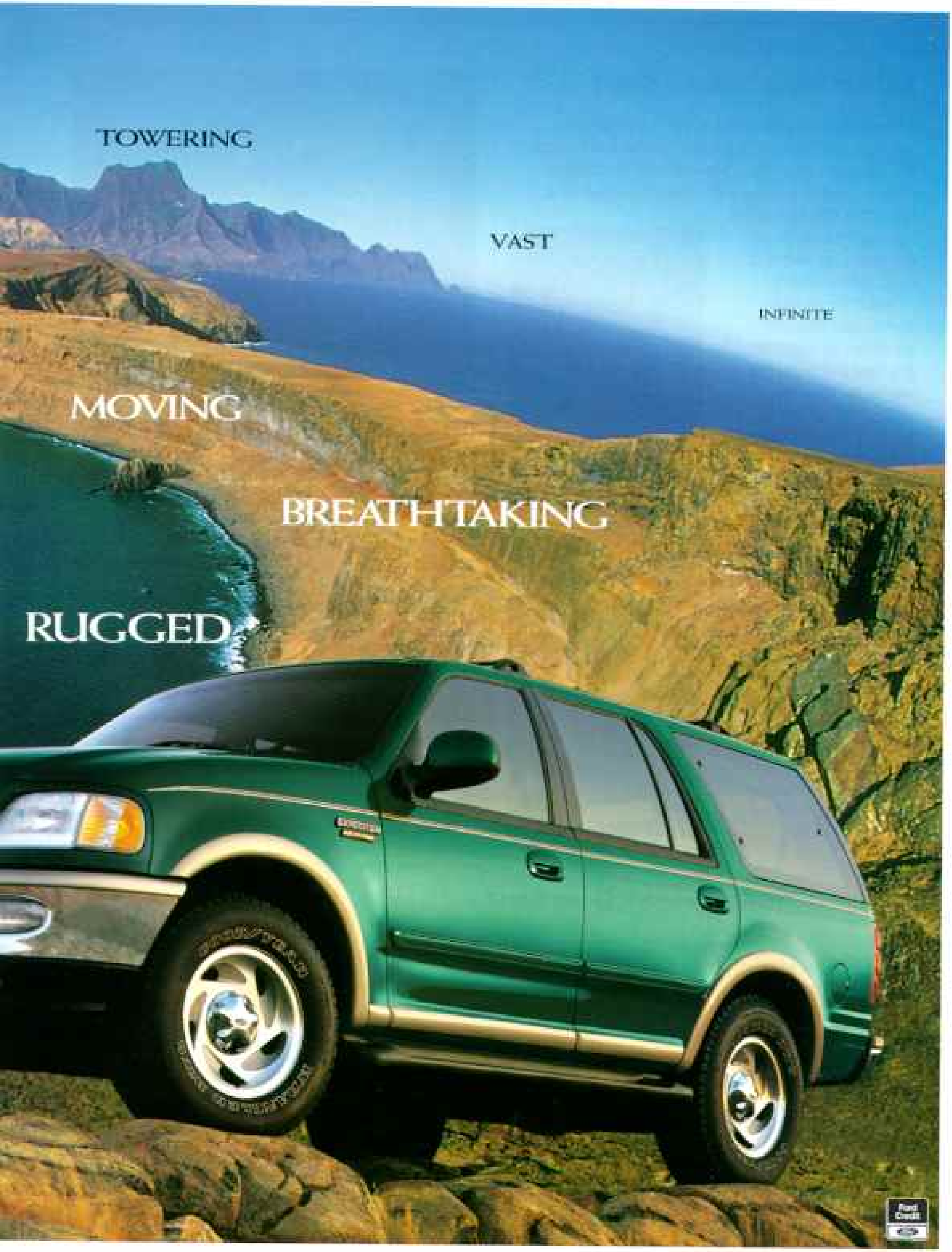

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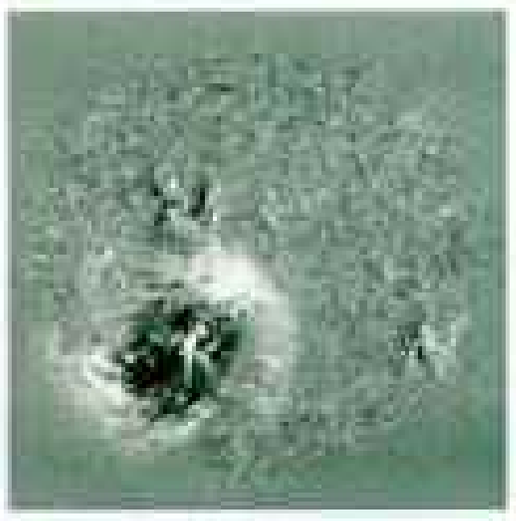
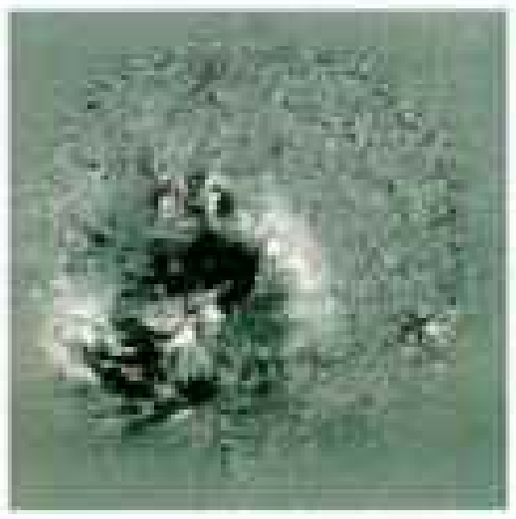
A Solar Wave: What a Blast!

Following a solar flare on April 7, a huge blast wave covered the sun's surface in a violently explosive release of energy. These ultraviolet images (below), made during a 90-minute period by a telescope 900,000 miles sunward of earth, are the first ever views of such solar activity.

Solar flares, blast waves, and massive ejections of superhot gas that strike earth's magnetic field are common. "The sun has been doing its thing for four or five billion years," says physicist Donald Michels. "What's new is our ability to observe such events." The images came from the Solar and Heliospheric Observatory spacecraft fielded by NASA and the European Space Agency. This blast emitted a billion tons of gas, causing brilliant auroral displays as far south as the northern U.S., but it posed no danger to earth.





NASA/EUROPEAN SPACE AGENCY

GUO DASHUN

The Smile of a Chinese Goddess

With jade eyes set in a sculpture of unbaked clay, this face of an ancient Chinese goddess was found in a 5,500-year-old temple. The temple was part of a ceremonial center with 13 groups of burial mounds holding nobles of varying rank—perhaps the oldest site in China with an elite class.

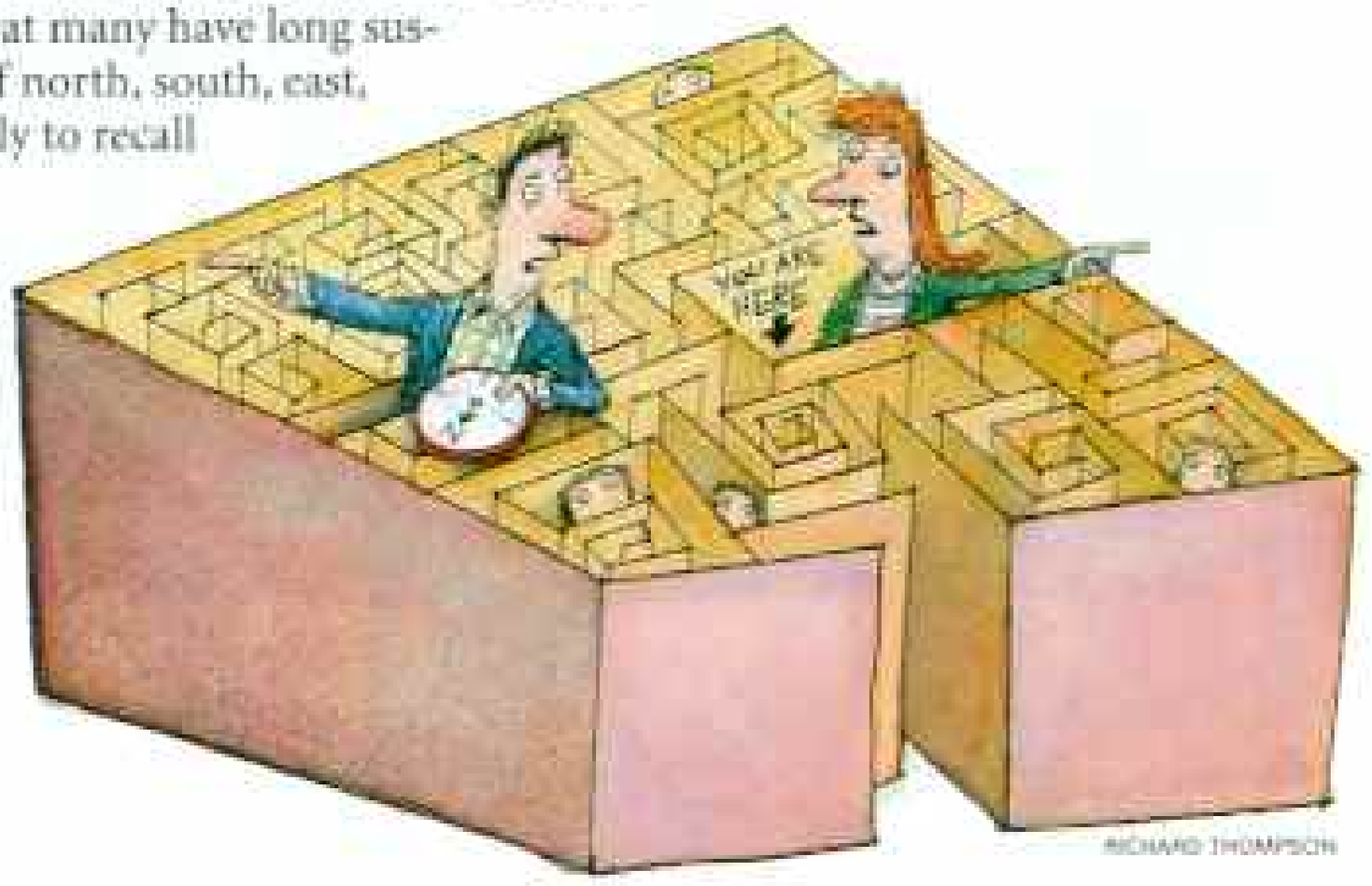
The temple and mounds were created by the Hongshan culture at Niuheliang, 263 miles north of Beijing. "A person of great importance was buried in the middle of each excavated mound, surrounded by others," says Sarah Nelson of the University of Denver. Some of lower rank had been stored elsewhere until their superiors died, then buried with them. The vast ritual center holds no signs of everyday life. The find shows that a complex society developed here far earlier than at better-known sites along the Yellow River.

Dealing With Geography: Does Gender Count?

In a strange place and eager to find your way around? How you do so may depend upon whether you're male or female.

Studies by psychologist Carol Lawton of Indiana University-Purdue University at Fort Wayne confirm what many have long suspected: Men tend to think in terms of north, south, east, and west, while women are more likely to recall landmarks and verbal directions. "Women focus on the details around them, men on the more global framework," she says.

Lawton led students through buildings and on computers through three-dimensional mazes, then asked them to point to the place where they began. Men scored higher on pointing in the correct direction, but the two sexes were equally efficient in finding their way "home."



RICHARD THOMPSON

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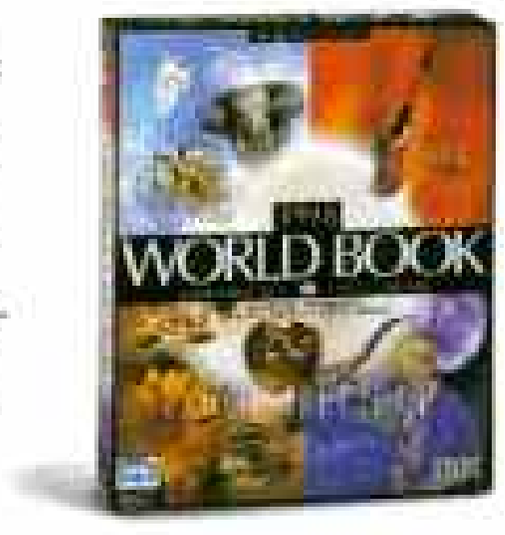

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Limbs on a Snake Family Tree

You have to look closely to see them in this artist's rendering of a 95-million-year-old, three-foot water snake and in the fossil itself, but this snake has two very unsnake-like features: inch-long rear legs.

Michael Caldwell of the University of Alberta and Australian colleague Michael Lee recently spotted the legs in two specimens found 20 years ago in marine rocks on the Jordan River's west bank. "They're full limbs, from the hip down to two toes, but functionally useless," says Caldwell. An earlier study identified the fossils as lizards, but "my first glance told me they were snakes," Caldwell says. Most experts think snakes evolved from a group of small burrowing terrestrial lizards. But these marine fossils have led Caldwell and Lee to offer another closest relative: mosasaurs, giant swimming lizards.

ART BY TOM SAUNDERS; MICHAEL CALDWELL

Vandal Fells a Haida Cultural Icon

It took more than 300 years for this rare golden Sitka spruce (right) to reach a height of 160 feet, a diameter of more than six feet, and a place in the hearts of the Haida people of British Columbia's Queen Charlotte Islands. It took just one night last January for an outsider to bring it down (below).

PHIL WESTERMAN (RIGHT); PHIL SCHOFIELD

A drifter carrying a chain saw swam 40 feet across a river to the site to fell the tree. He then sent a newspaper a note railing against "freaks" in classrooms and corporate boardrooms. He was arrested but later skipped bail.

To the Haida the spruce represented a boy who fled a snowstorm, disobeyed a warning not to look back, and became rooted in the forest floor. "It's like losing a member of the family," says Ernie Collison, administrator for the Council of the Haida Nation. Fortunately, six-foot-high trees from the original spruce were growing at the University of British Columbia Botanical Garden and, with Haida approval, will be planted on the island.

TEXT BY BORIS WEINTRAUB

Mountain Pygmy-possum *(Burramys parvus)* **Size:** Head and body length, 10–12 cm; tail, 13–16 cm. **Weight:** Average 35–40 g. **Habitat:** Alpine and subalpine regions in Victoria and New South Wales, Australia. **Surviving number:** Estimated at 2,600.
Photographed by Jean-Paul Ferrero

WILDLIFE AS CANON SEES IT

The inquisitive mountain pygmy-possum inhabits high elevation boulder fields of the Australian Alps. Heathland shrubs growing among the rocks provide seeds and berries, adding to the possum's main diet of arthropods. The Bogong moth is favored, and even females with pouch-young cross over to the highest peaks where the vitamin-rich moth is most plentiful. In winter, the tiny possum curls into a ball and hibernates up to seven months—it is the only true marsupial hibernator. Low numbers and a limited range make the mountain pygmy-possum particularly vulnerable to habitat disturbances. 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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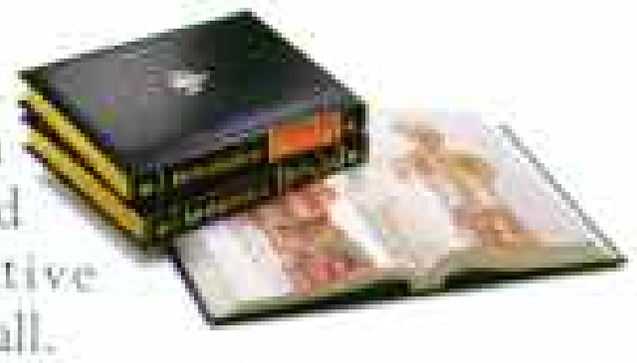

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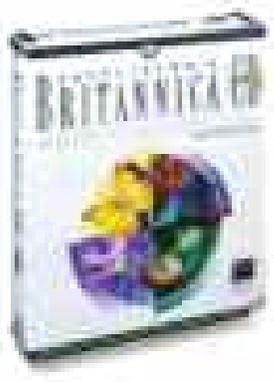

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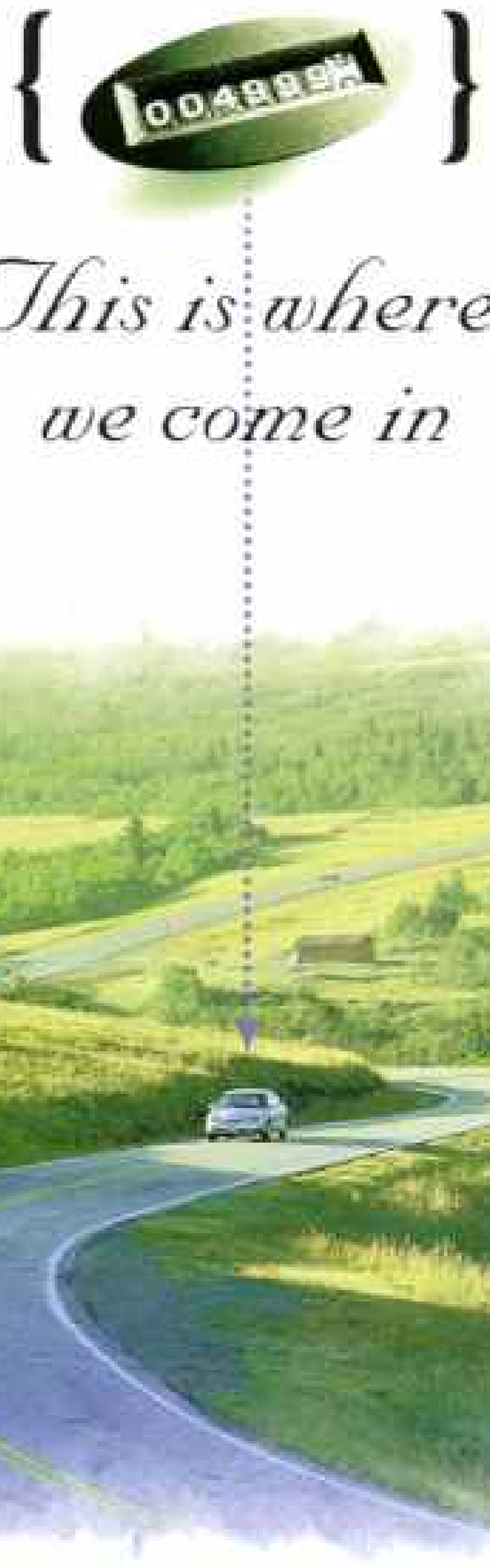

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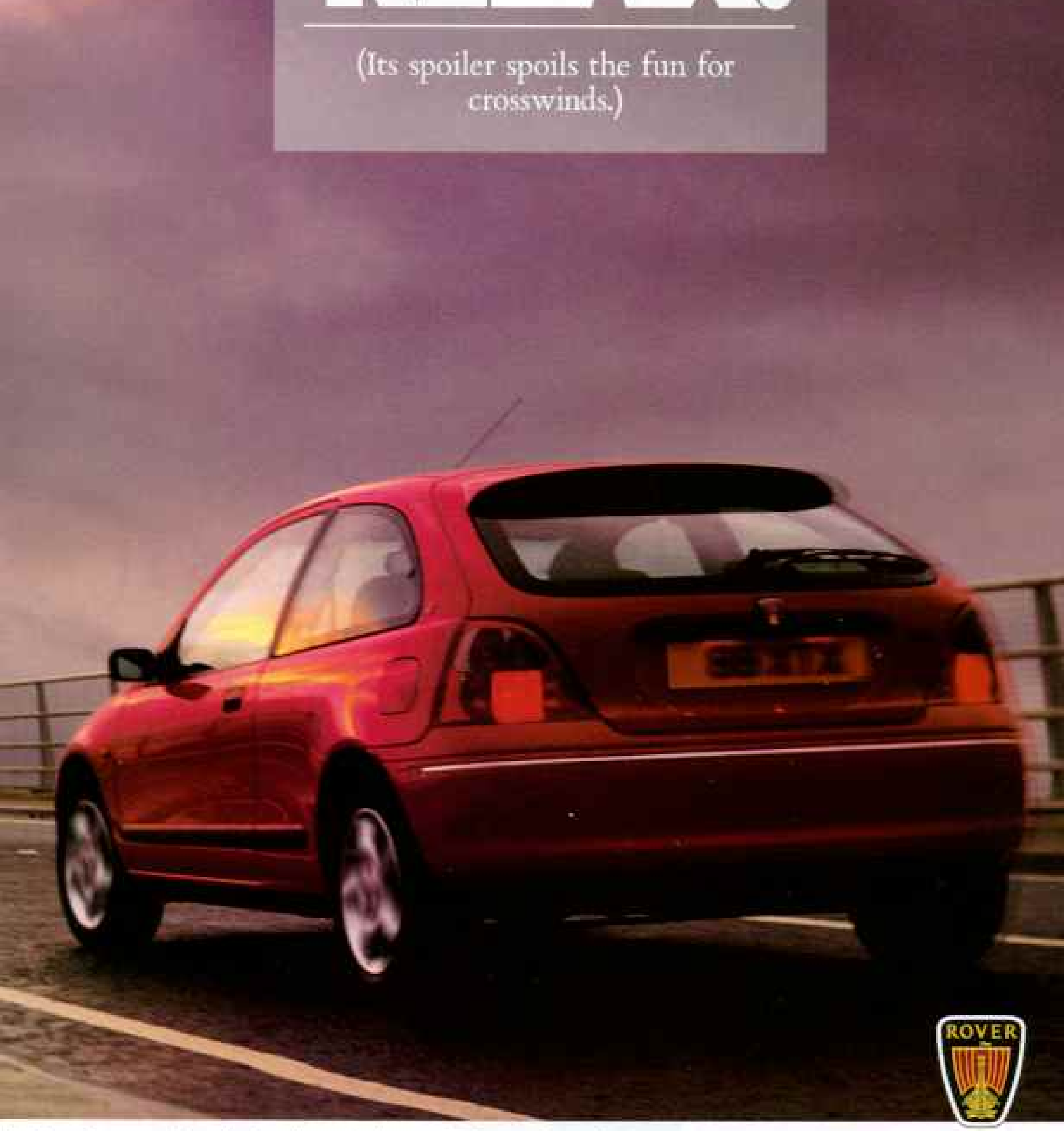
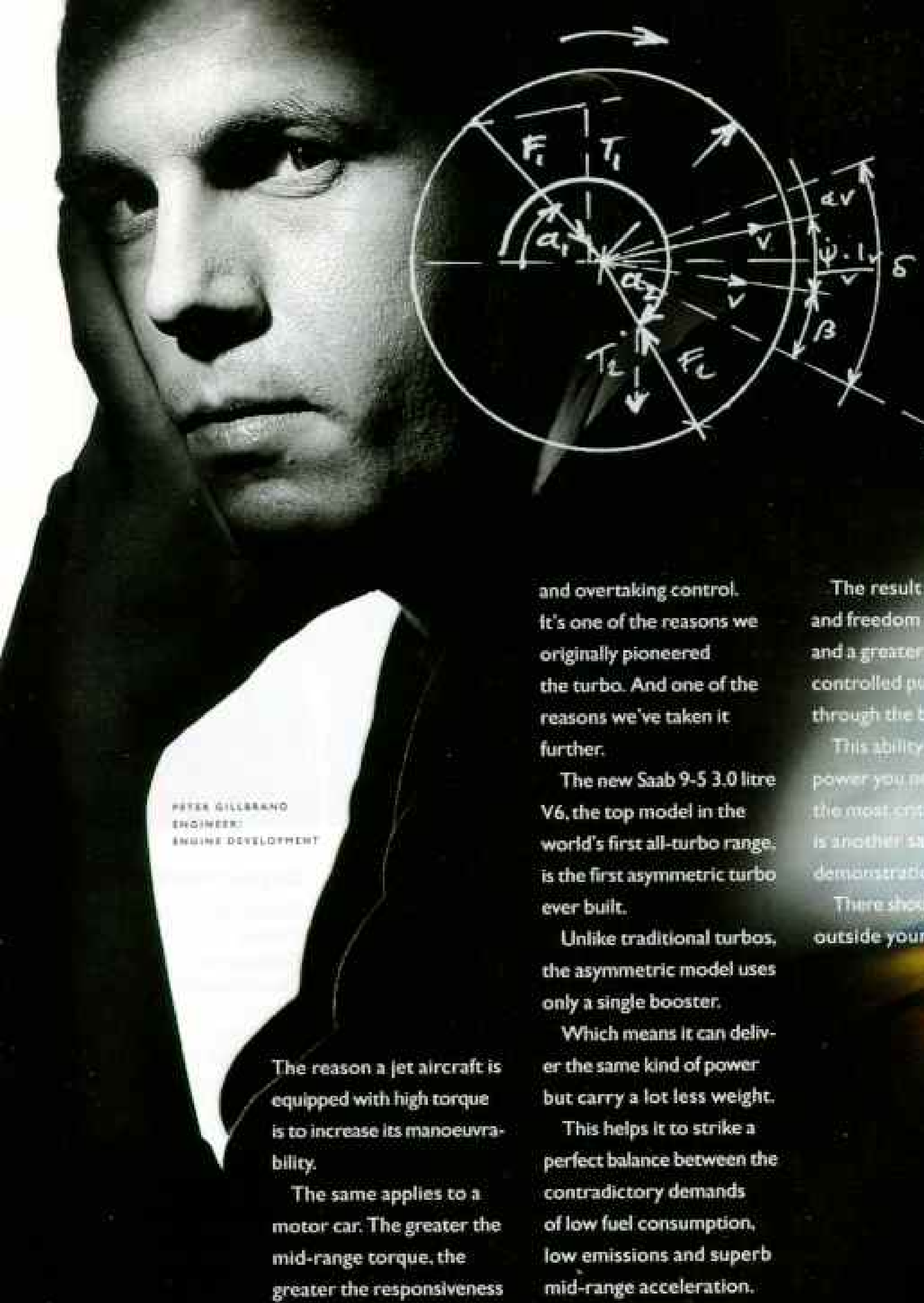


his Rover's roomy shape looks slim and slippery. Who needs aerobics?

RELAX.



PETER GILLBRAND
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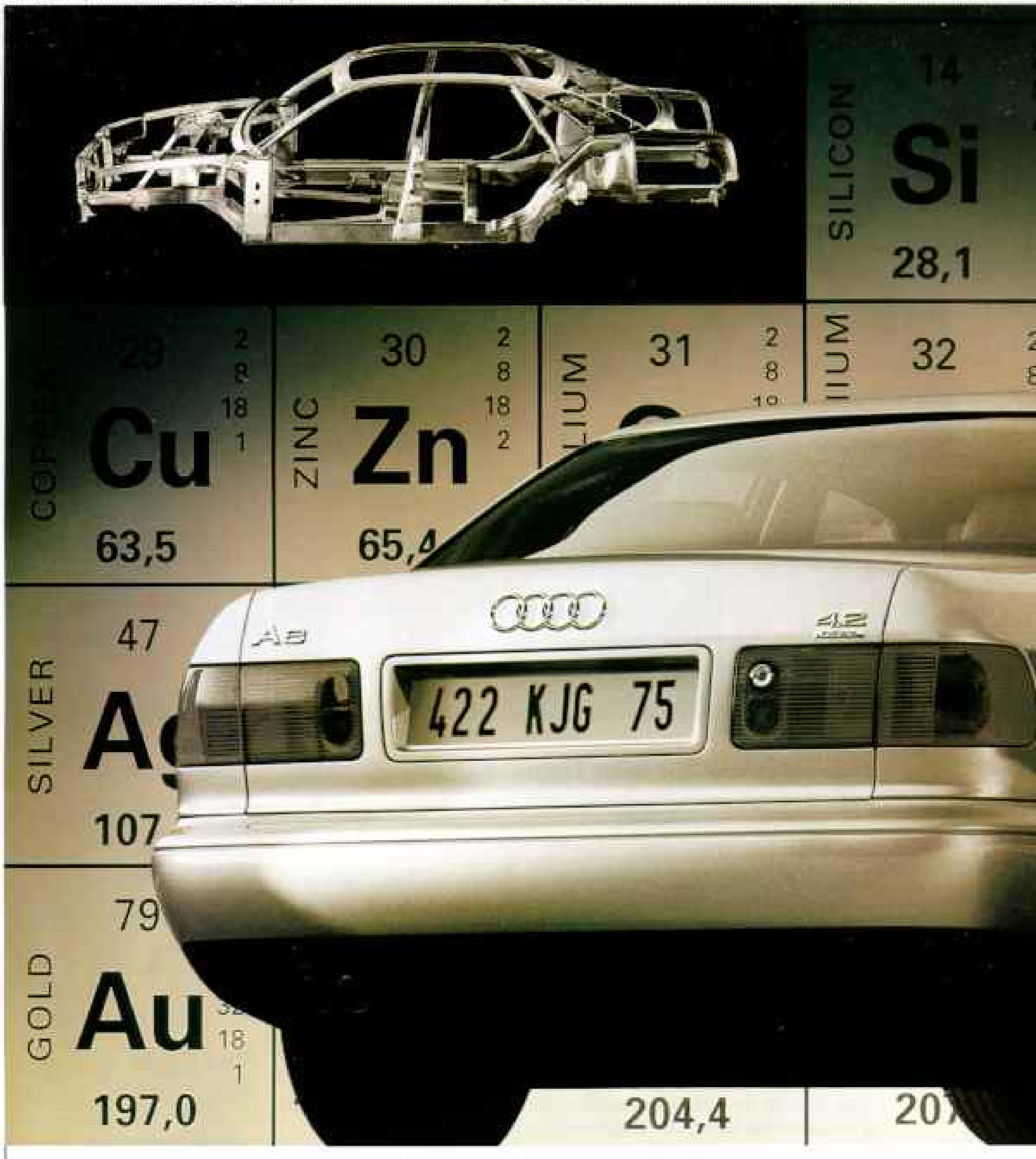

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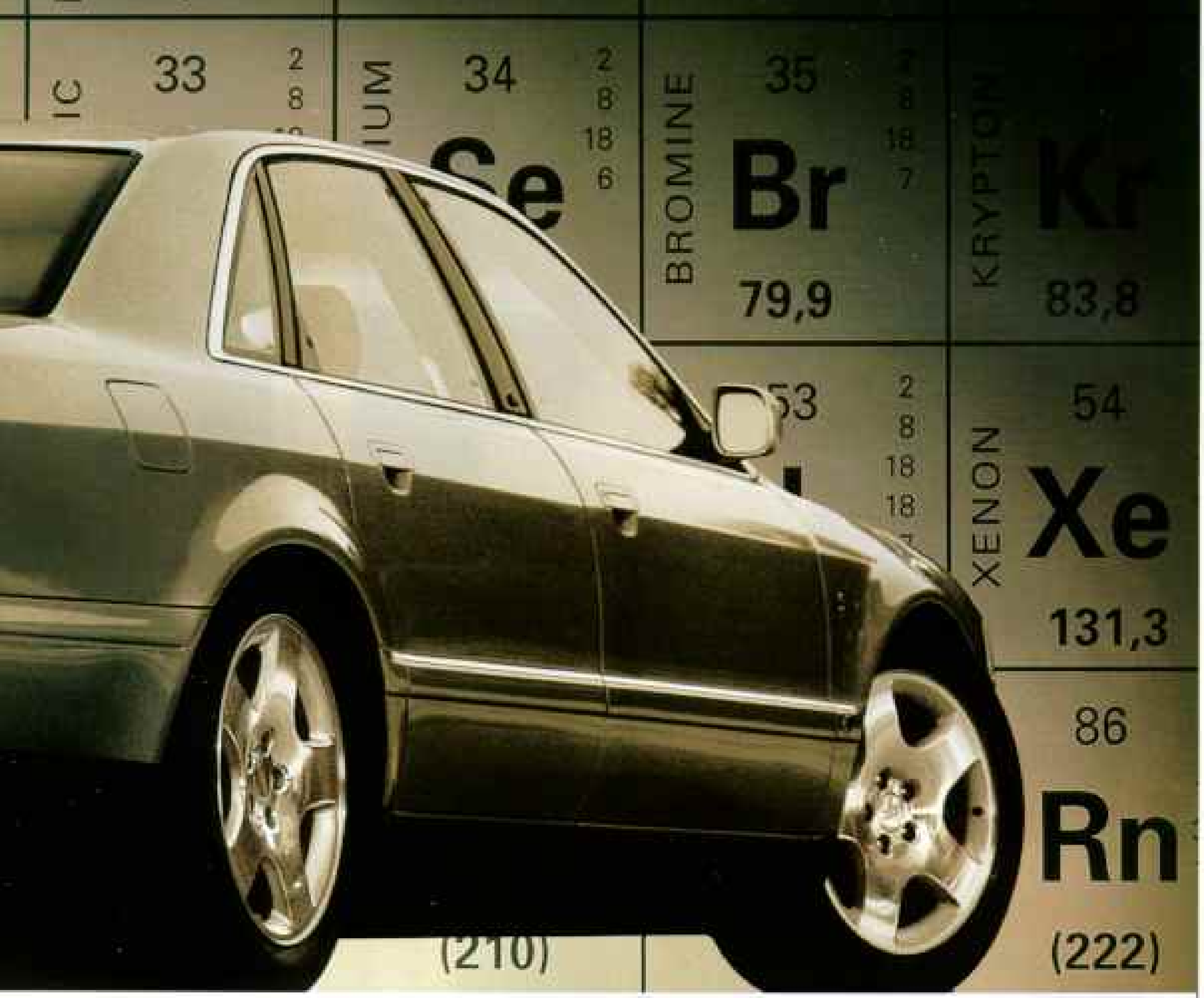

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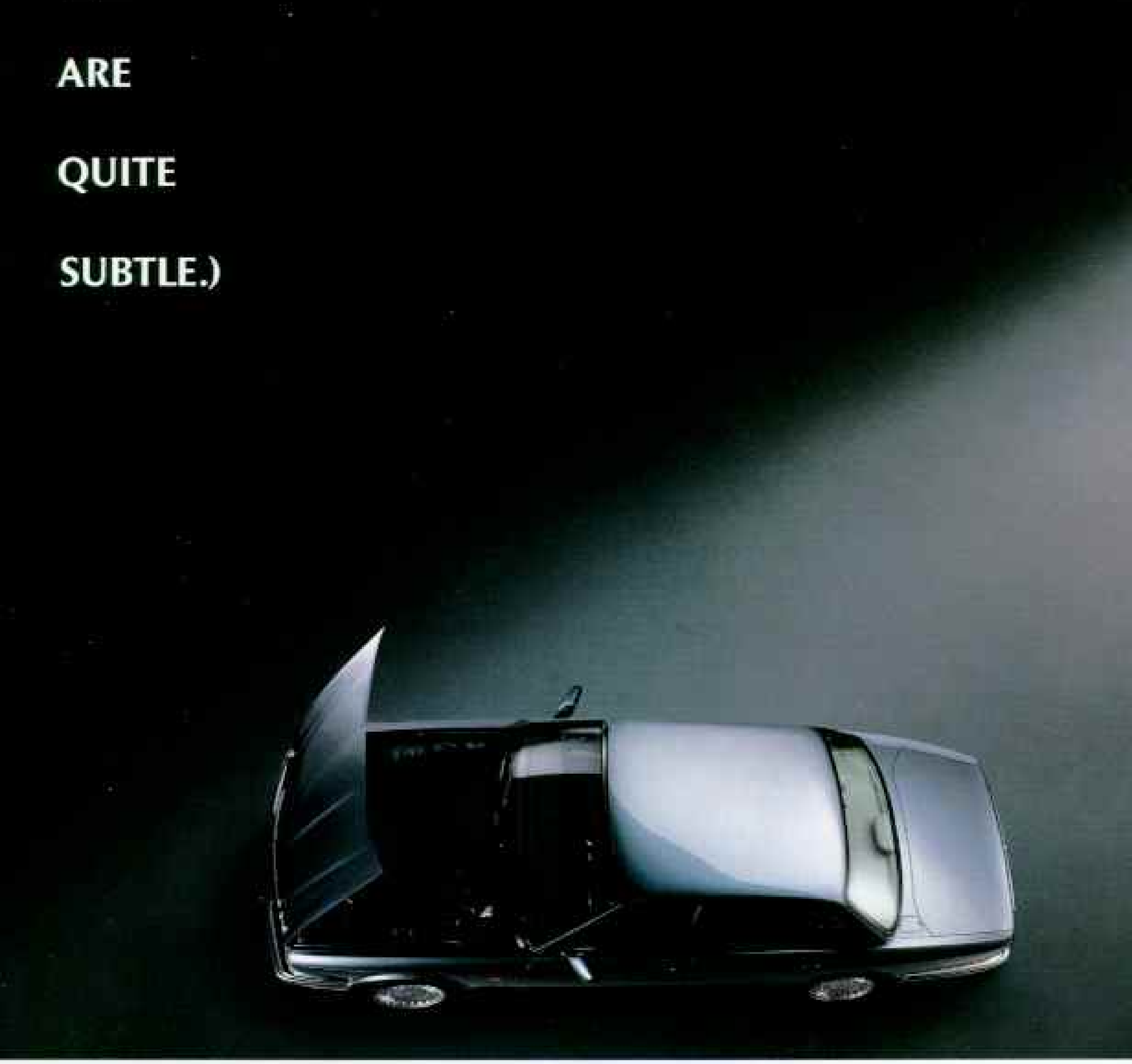

Just take a look at the outside of Jaguar's new V8 XJ Series and, although it may look classically familiar, it isn't quite.

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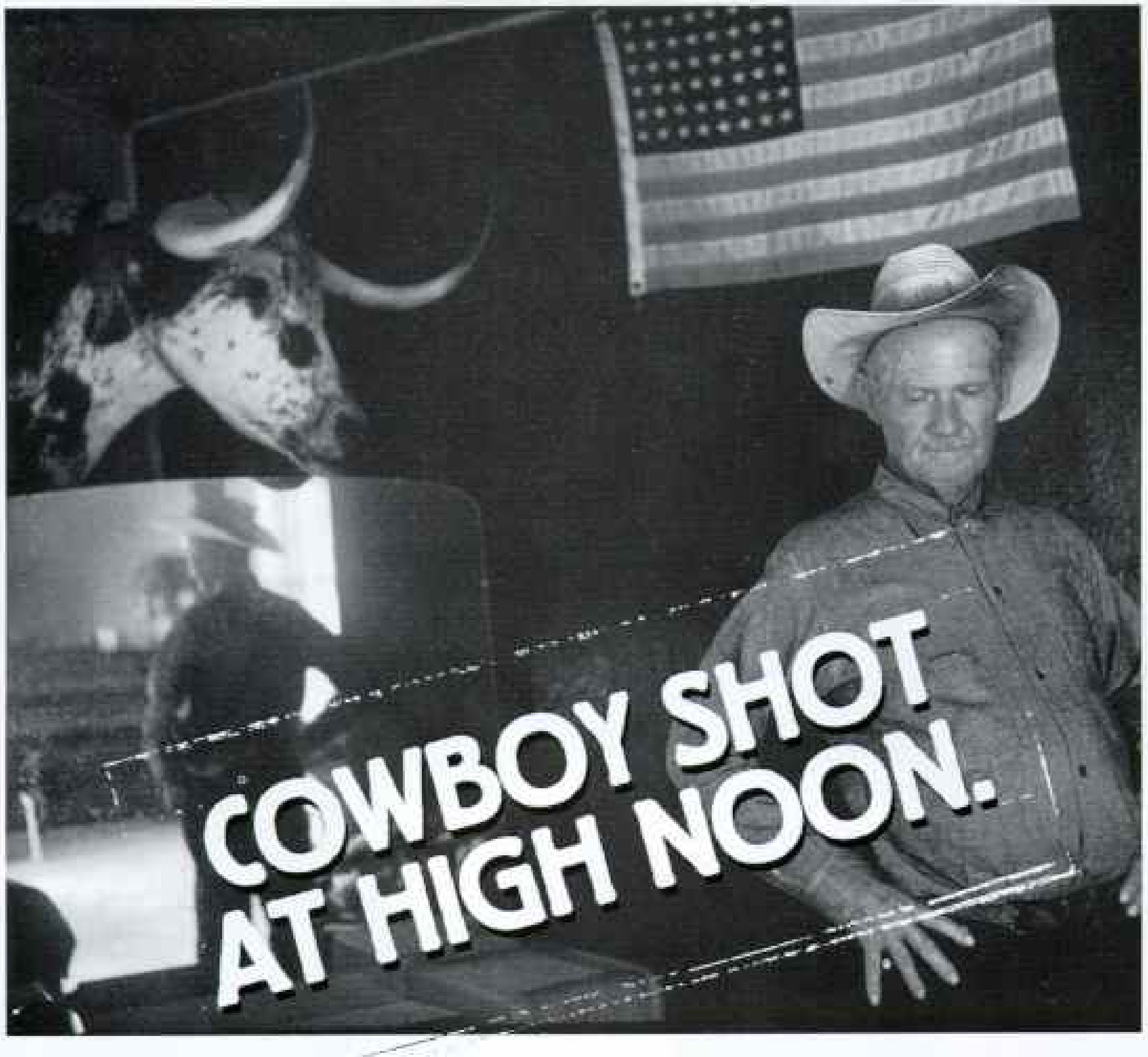

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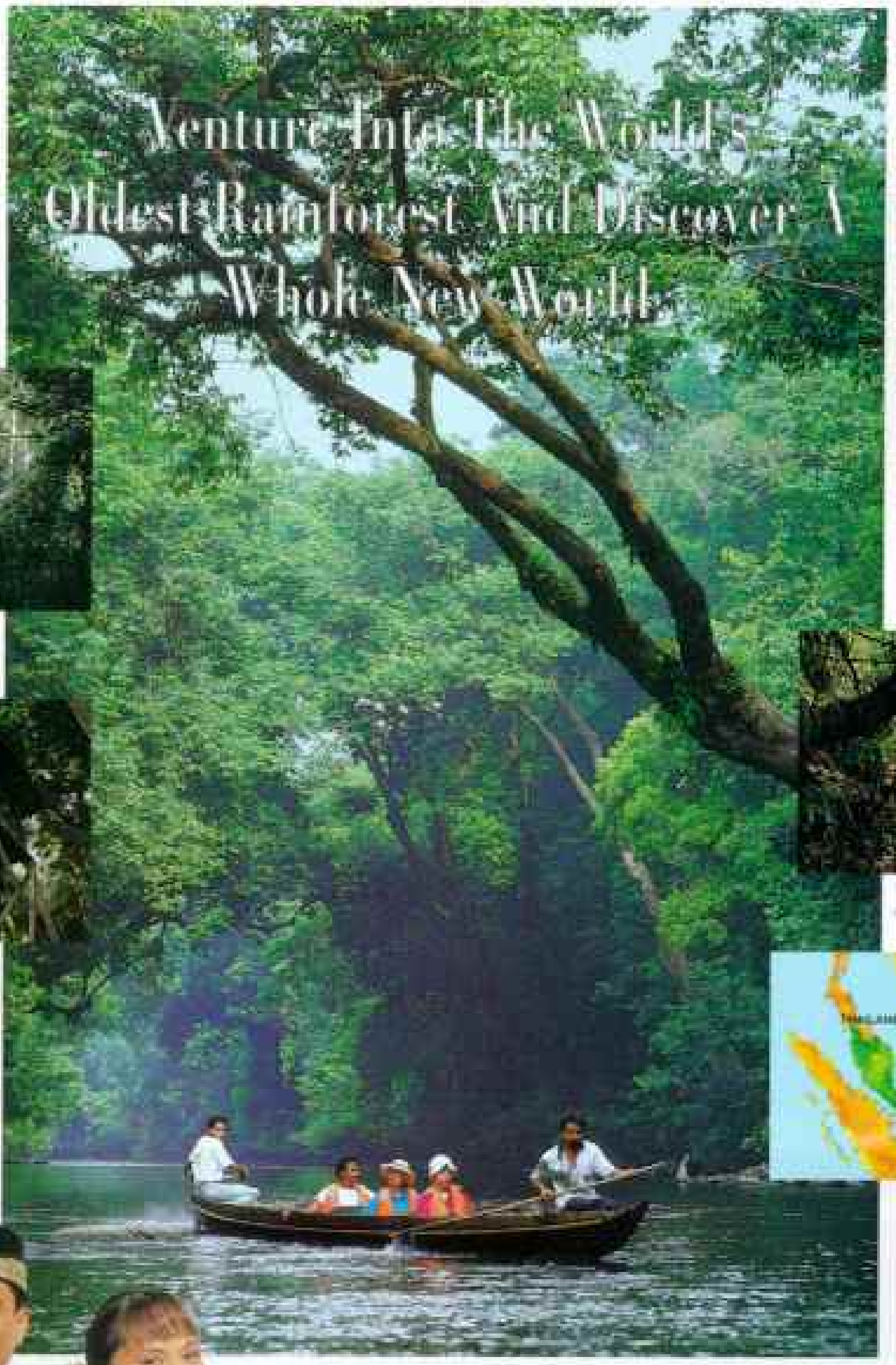

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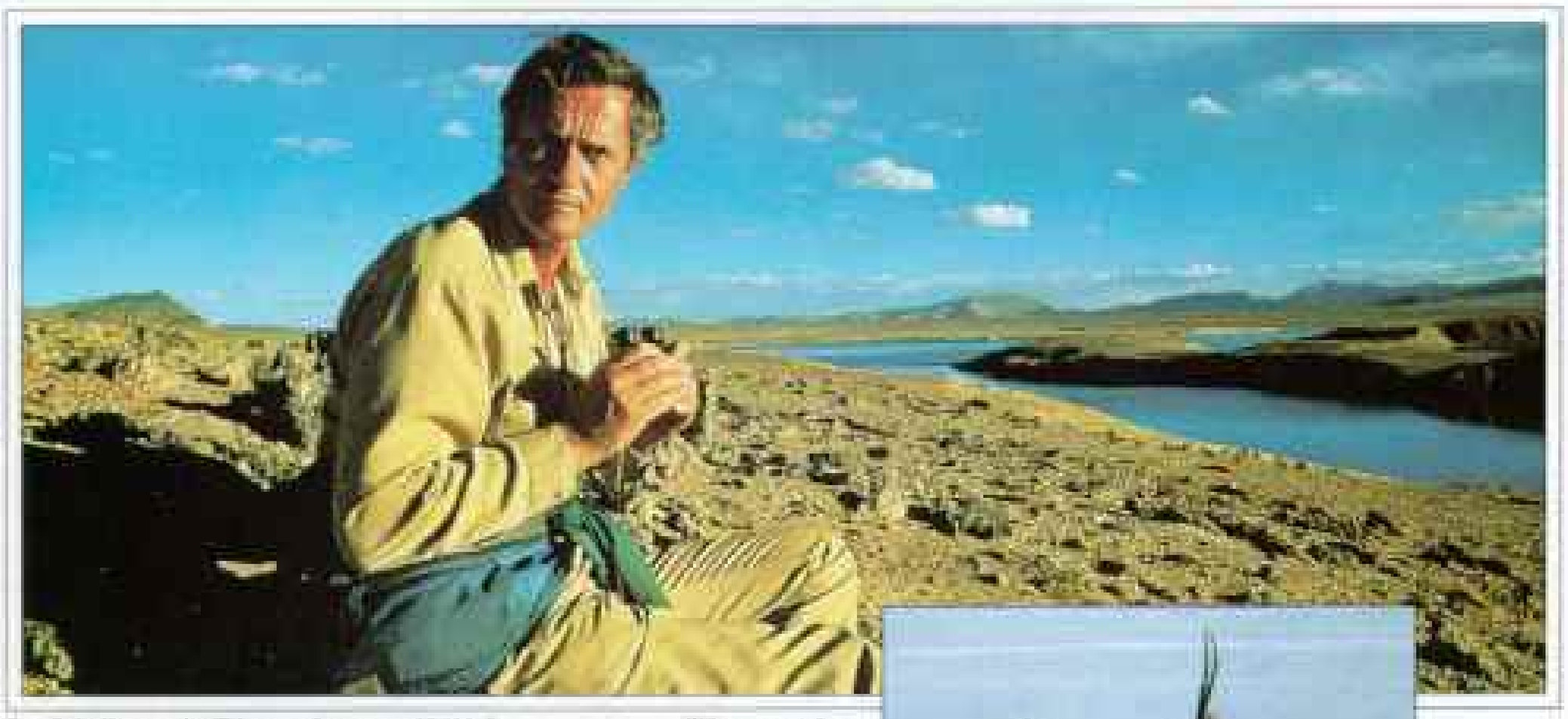

Dr. Schaller on the Tibetan plateau at 12000 ft. *Tibetan antelopes*

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

"We have the chance to save one of the last unspoiled ecosystems on our planet."

George Schaller

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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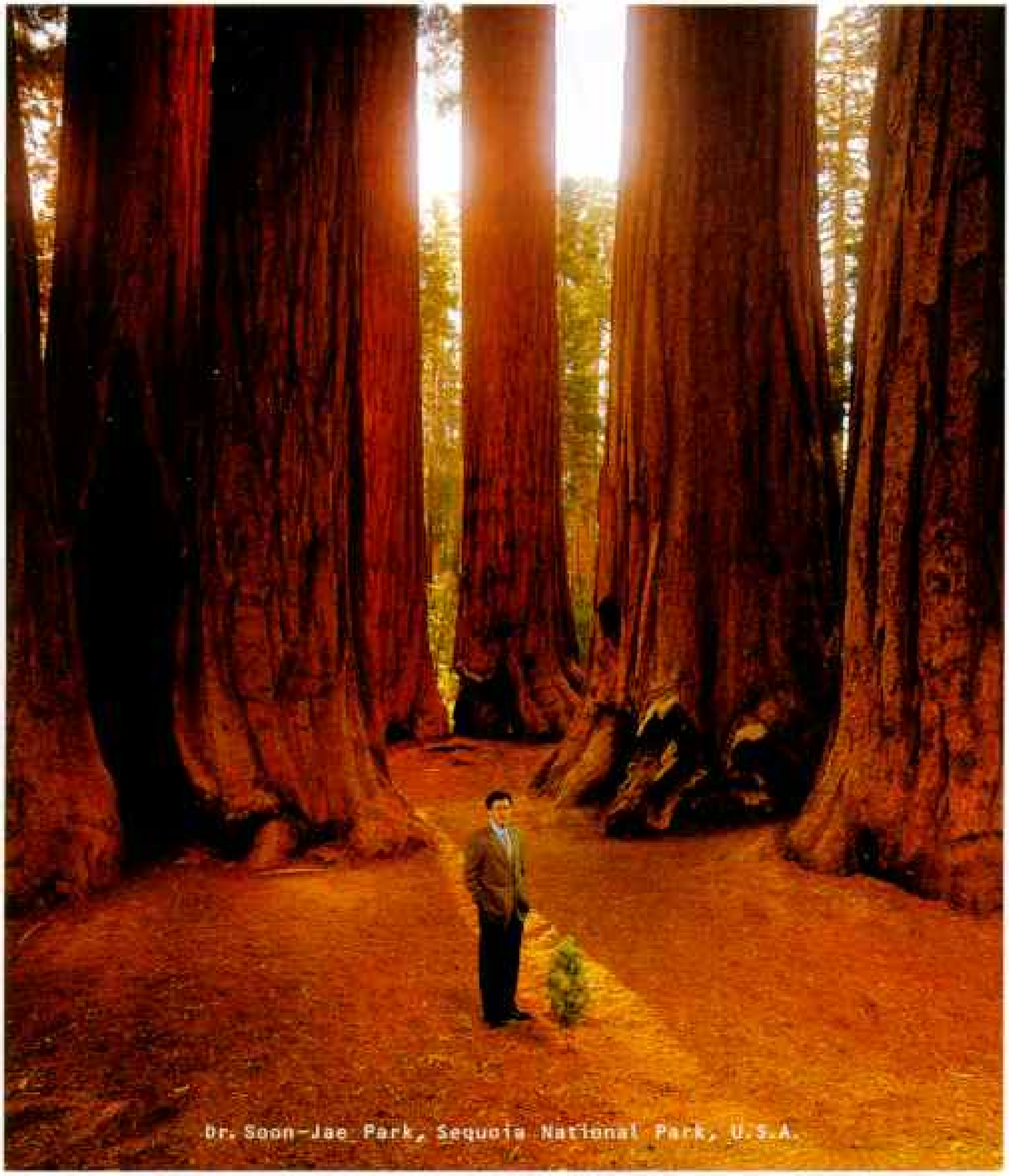

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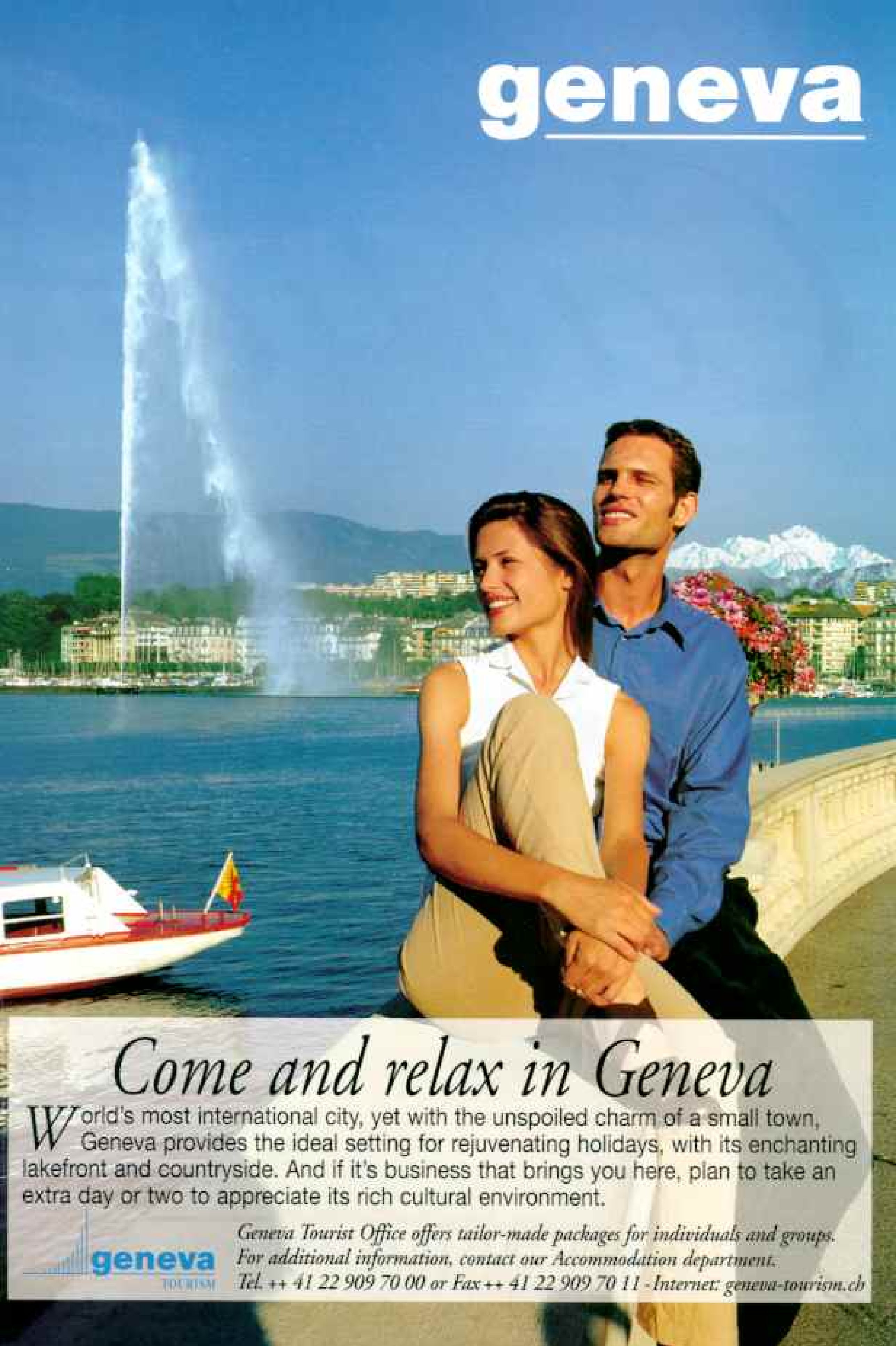

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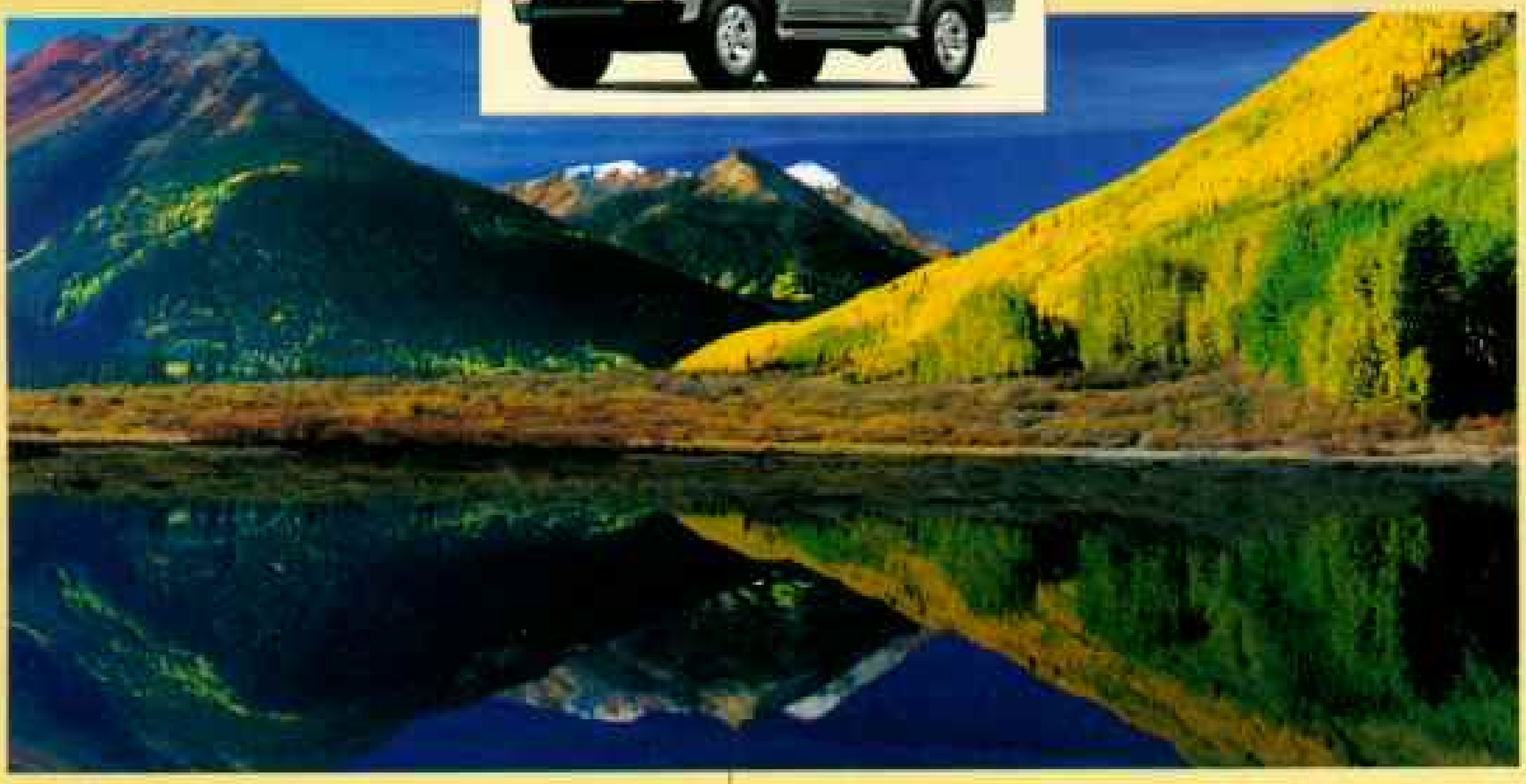

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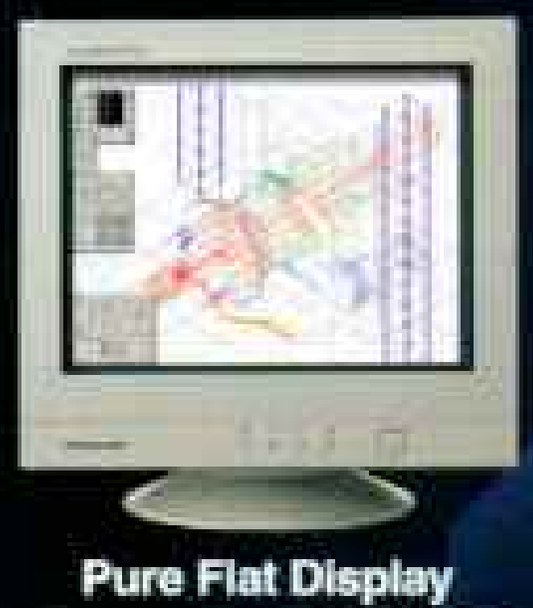

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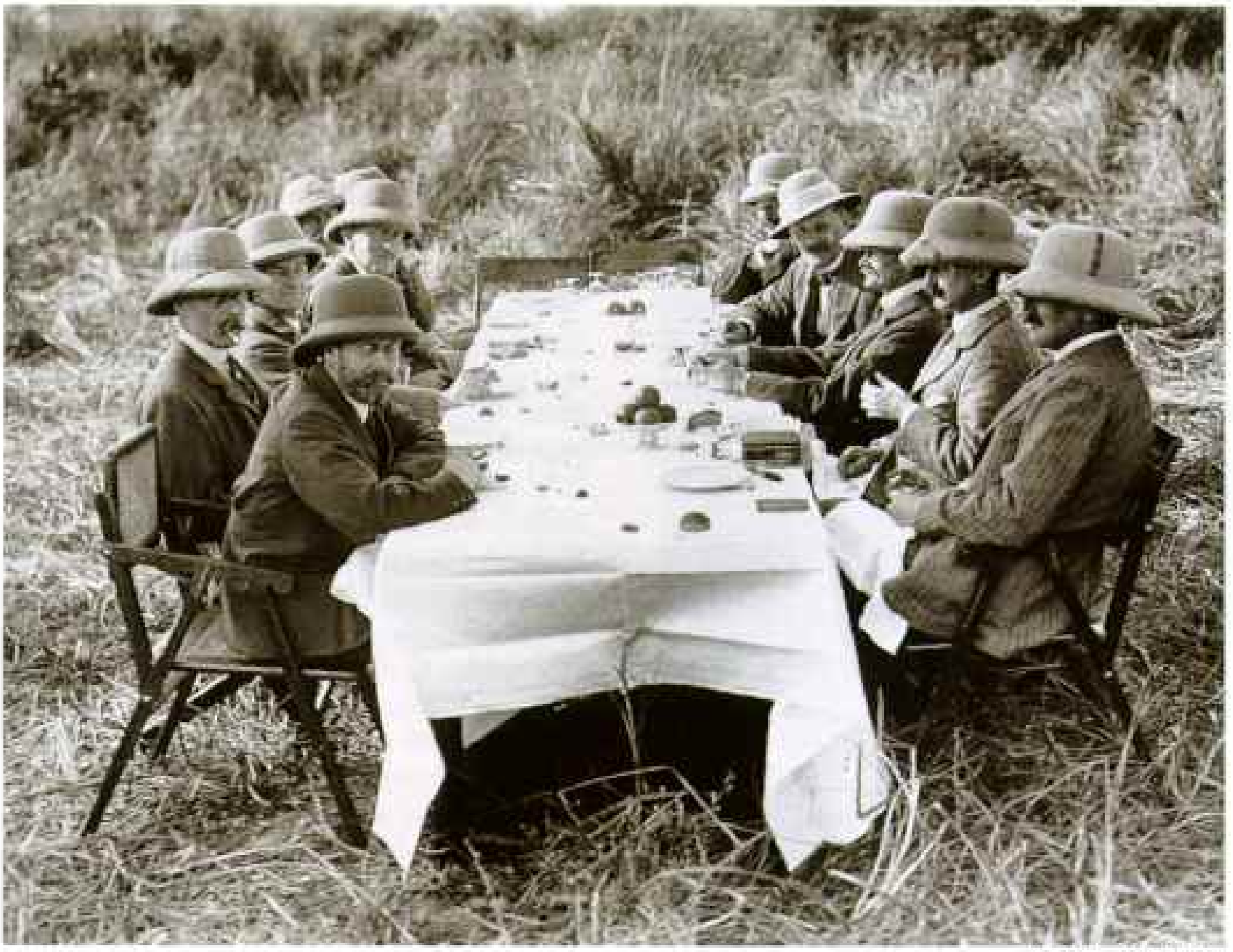

V. C. SCOTT O'CONNOR (BOTH)

■ FROM THE GEOGRAPHIC ARCHIVES

Fete for a King Stalking Tigers

Even a crowned head—wearing a pith helmet—has got to eat. In 1911 Britain's King George V (above, in foreground at left) visited India, his empire's prize possession, in celebration of his recent coronation. His mother, Queen Alexandra, called the journey "inconceivable," and his advisers feared attack by Indian nationalists, but the king's tour was without incident. In the wilds of neighboring Nepal, His Majesty dined off fine china and linen during a two-week hunting expedition. The king, a crack shot, wrote in his journal: "As probably this will be the last and only time in my life when I shall get big game shooting of this kind, I naturally wish to have as many days in Nepal as possible." Local wildlife might have wished his trip were shorter; the monarch, sometimes aiming from the back of an elephant (right), bagged 21 tigers, 8 rhinos, and a bear. These photographs were never published in the GEOGRAPHIC.

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KEY TO 1997

IN 1997 GEOGRAPHIC readers ventured onto ice floes in search of seals and traveled billions of light-years into space via the Hubble telescope; they journeyed across India 50 years after independence and onto Pacific islands still ruled by the French. A 1997 index for NATIONAL GEOGRAPHIC, TRAVELER, and WORLD magazines and books published by the Society will be available in February for $6.

CD-ROMs that contain the first 108 years of the magazine are available to members for $179.95 and to nonmembers for $199.95, plus postage and handling. To order, call 1-888-225-5647 or write to National Geographic Society, P.O. Box 11650, Des Moines, IA 50340-1650. An online index can be searched by going to www.nationalgeographic.com/main.html and clicking on the "Resources" bar, then "NGS Publications Index."

JANUARY

FEBRUARY

MARCH

APRIL

MAY

JUNE

JULY

AUGUST

SEPTEMBER

OCTOBER

NOVEMBER

DECEMBER

IF YOU OWN OR OWNED PROPERTY WITH
MASONITE HARDBOARD SIDING
INSTALLED BETWEEN JANUARY 1, 1980 AND THE PRESENT
PLEASE READ THIS LEGAL NOTICE

Notice Is Hereby Given, that a proposed Settlement has been reached in *Naef, et al. v. Masonite et al.* The Plaintiffs in this lawsuit allege that exterior hardboard siding made by Masonite Corporation is defective, causing Class Members to suffer damages. Defendants vigorously deny these allegations and any and all liability.

SETTLEMENT HEARING

A hearing will be held before the Hon. Robert G. Kendall, located at Government Plaza, 205 Government Street, Mobile, Alabama, 36644 at 9:00 a.m. on January 14, 1998 to determine whether the proposed Settlement Agreement on file with the Court is fair, reasonable, adequate, and in the best interests of the Settlement Class and whether a Final Judgment should be entered approving the Settlement Agreement.

SETTLEMENT TERMS

Each Eligible Claimant, upon proper verification and independent review of damaged Masonite Hardboard Siding, will be awarded damages according to a Compensation Formula established by the Settlement Agreement, unless the damage is subject to one of the specifically agreed upon causation exceptions. **In order to receive monetary benefits**, all Eligible Claimants shall be required, prior to an assessment of damages, to verify ownership of Masonite Hardboard Siding. The proposed Claims Period will run from 7 to 10 years, depending upon the product's manufacture date.

YOUR RIGHTS

If you believe you are a member of the Settlement Class, you have the following options: (a.) If you agree with the Settlement, you need do nothing at this time to preserve your ability to make a claim under this Settlement Agreement; (b.) You may object to or comment on the terms of the Settlement Agreement if and only if you comply with the procedures set forth below.

COMMENTS & OBJECTIONS

You may send written comments in support of or objecting to the Settlement. If you have a valid objection, or wish to be heard in support of the Settlement, you may be permitted to appear at the Hearing to Show Cause why the Settlement should or should not be approved by the Court, if you timely take the following steps:

- **You must notify the Court and both parties' Counsel by December 31, 1997**, with a written notice of your intention to appear, a summary of your reasons for supporting or objecting to the Settlement and a statement under penalty of perjury verifying your ownership of Masonite Hardboard Siding;
- **You must serve your papers** upon the Counsel at the following addresses: (1.) Robert H. Shulman, Esq. - Howrey & Simon, 1299 Pennsylvania Ave., NW, Washington, DC 20004- OR - Stephen M. Bickford, Esq. - Tobin & Tobin, One Montgomery St., 15th Floor, San Francisco, CA 94104 (COUNSEL FOR DEFENDANTS); - AND - (2.) Elizabeth J. Cabraser, Esq. - Lieff, Cabraser, Heimann & Bernstein, 275 Battery Street, 30th Floor, San Francisco, CA 94111(COUNSEL FOR PLAINTIFFS).

EXCLUSION FROM SETTLEMENT

If you **do not** wish to remain a Class Member and participate in the proposed Settlement, and wish to exclude yourself, or "opt out" of this lawsuit, you must submit a signed and notarized letter postmarked **no later than December 31, 1997**.

(a.) Your letter **MUST** include: the name of the case (*Naef v. Masonite Corp.*, Civil Action No. CV-94-4033), your name, address and telephone number, and number of units of property containing the Siding;
(b.) Your request **MUST** be mailed to the Counsel identified above.

If you properly request exclusion from the Settlement Class: you will be excluded from the Settlement Class; will not be permitted to object to the Settlement; and you will not be bound by the final judgment entered under this Settlement.

THIS IS A SUMMARY ONLY; FOR FURTHER INFORMATION, PLEASE CALL:

1-800-330-2722

or write:

Masonite Settlement, P.O. Box 925, Minneapolis, MN 55440-0925

This information is also available on the Internet at:

http://www.kinsella.com/masonite/

PLEASE DO NOT CONTACT THE COURT OR THE CLERK'S OFFICE FOR INFORMATION.

By Order of the Mobile County Circuit Court. DATED: September 29, 1997;

THE HONORABLE ROBERT G. KENDALL, JUDGE OF THE CIRCUIT COURT

NATIONAL GEOGRAPHIC

On Television

ART BY KEN MARSCHALL

■ EXPLORER, DEC. 14, 7 P.M. ET

Titanic Remembered

She was the largest moving object yet built, and on the night of April 14, 1912—five days into her maiden voyage—she struck an iceberg and sank, with horrendous loss of life. EXPLORER recalls that awful night and the expedition of 1985 to locate her resting-place. Robert D. Ballard and a French team found *Titanic* 13,000 feet deep in the North Atlantic. The next year Ballard explored her with submersibles

WOODS HOLE OCEANOGRAPHIC INSTITUTION

such as *Jason Jr.* (above). "With *Titanic*'s discovery we proved we could penetrate deep-sea history," says Ballard. His recent Mediterranean finds will be featured on a future EXPLORER.

■ PROGRAM GUIDE

National Geographic Presents
Forbidden Territory: Stanley's Search for Livingstone
ABC. Sunday, Dec. 7, 9 p.m. ET

National Geographic Specials
NBC. See local listings.

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

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

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Call 1-800-627-5162.

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

FRANS LANTING, MINDEN PICTURES

■ "ANIMAL HOLIDAY" KIDS VIDEO

Wildlife Celebrates the Season

National Geographic's new video features Santa and Mrs. Claus answering children's questions about what animals do in winter. As the animals appear, viewers see wildlife footage set to holiday music. Among the scenes: Penguins shake, waddle, and roll to "Jingle Bells," and whales swim to *The Nutcracker* ballet.

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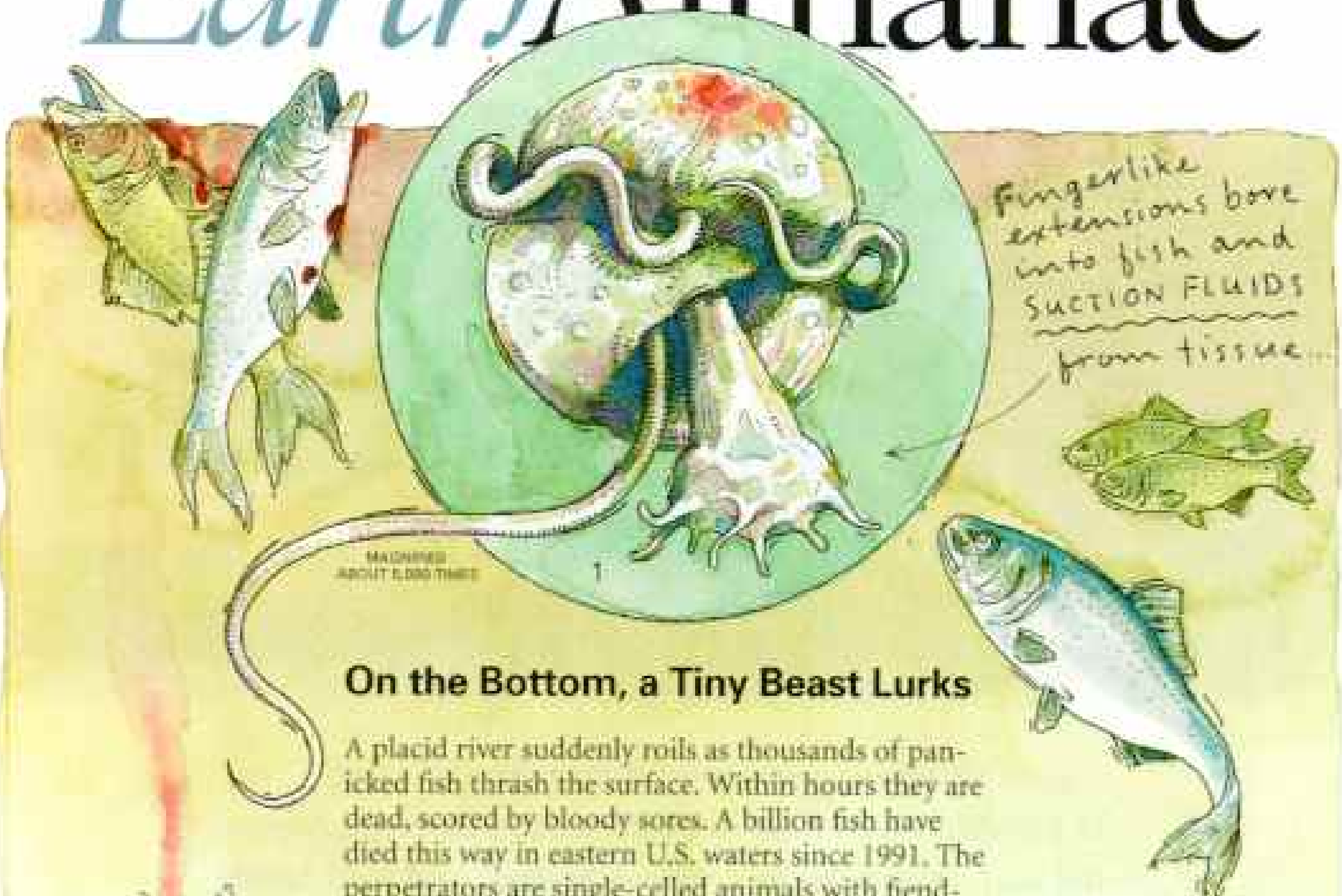
NATIONAL GEOGRAPHIC

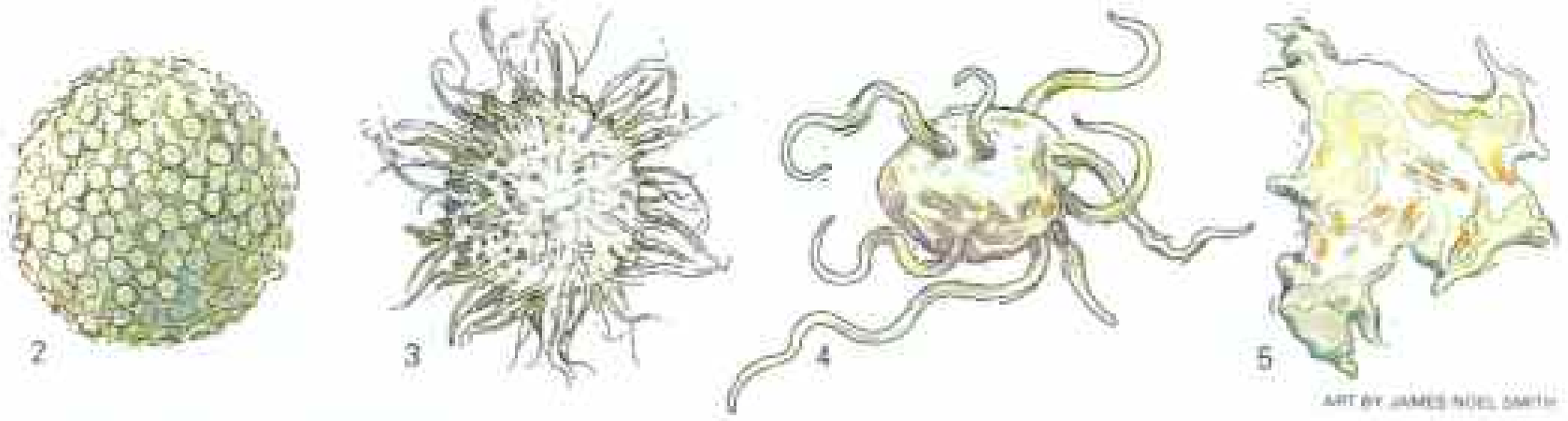
Earth Almanac



On the Bottom, a Tiny Beast Lurks

A placid river suddenly roils as thousands of panicked fish thrash the surface. Within hours they are dead, scored by bloody sores. A billion fish have died this way in eastern U.S. waters since 1991. The perpetrators are single-celled animals with fiendishly complex life cycles. One of their discoverers, JoAnn Burkholder of North Carolina State University, helped christen the best known of them *Pfiesteria piscicida*. The species name means "fish killer."

Burkholder thinks *Pfiesteria* originally fed on bacteria and algae. Recent farm and development runoff has poured tons of nutrients into some rivers, which may have caused the organism to shift its feeding habits to larger prey. Some people who have been exposed to *Pfiesteria* have developed sores, severe memory loss, and other cognitive problems.



Pfiesteria piscicida has 24 known forms. As a dormant cyst (2) it may remain in the river bottom for years. If a school of fish lingers overhead, their waste triggers the cysts to change into a toxic form (1). They swim up with whiplike tails, spew poisons that stun the fish, and feed on the fish's fluids. As the fish die, *Pfiesteria* reproduce. Fresh cysts (3) return to the bottom to await new victims.

Amoeba-like forms of *Pfiesteria* (4 and 5) are armored by a shell against microbial predators. In these forms they can scavenge scraps of dead fish, then change feeding tactics to prey on bacteria and algae. Sometimes *Pfiesteria* extract chloroplasts from algae and use photosynthesis to supplement their food supply—thus *Pfiesteria piscicida*, an animal, masquerades as a plant.

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Giving a Lift to Mountain Caribou

Leaping from their crates, mountain caribou transplanted from Canada hightailed it to freedom last March in the Selkirk Mountains of northeast Washington State. But the risk is high—predators abound. Of 19 mountain caribou transplanted the previous spring—one of them shown traveling in a helicopter's net—12 have died, some killed by bears and cougars. One was shot by a poacher. Radio collars signaled researchers when the caribou stopped moving. Among this year's group of 13, signals from several transmitters have ceased.

"We expect high mortality. We have to plan for it," says Madonna Luers of the Washington Department of Fish and Wildlife.

The program aims to establish a third mountain caribou herd in the Selkirks. One already exists in Idaho, and the other roams southern British Columbia. For the Washington State transplant project, caribou were captured from elsewhere in British Columbia. The three Selkirk herds total only about 70 animals.

MADONNA LUERS, WASHINGTON DEPARTMENT OF FISH & WILDLIFE (BOTH)

Logging May Aid One Bird of Prey

Cutting down trees means disaster to most birds. But on the 4,700-square-mile island of Chiloé off Chile, the chimango caracara, a member of the falcon family, may actually be thriving because of logging.

"Chiloé's temperate rain forest is steadily being logged by the islanders for subsistence agriculture," says ornithologist Joan Morrison of the University of Florida, here measuring a caracara.

STEVEN MORELLO

"As the forest becomes fragmented, caracaras move into open areas to find food. With less cover, smaller forest birds and their nestlings may be more vulnerable to predation by caracaras."

When Morrison substituted clay eggs for real ones in songbird nests, caracaras tried to break them, leaving their beak marks in the clay. She also banded several chicks and a pair of adults.

Small populations of a related species, the crested caracara, live in Florida, Texas, and Arizona.

THE SEATS ARE LEATHER.
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DAVID DOUBILET

sanctuary

National Geographic and National Public Radio present *Frontiers in the Sea*, a special digital stereo production in December of **RADIO EXPEDITIONS**, the acclaimed series hosted by Alex Chadwick. Overuse and pollution threaten our once pristine underwater frontiers, including the crown jewels of our coastlines, the living coral reefs. As we mark the 25th anniversary of the National Marine Sanctuaries system, will we show as much determination to save these submerged kingdoms as we have our national parks? Call your local NPR station for times.

NATIONAL GEOGRAPHIC SOCIETY

NPR

National Public Radio and National Geographic thank the David and Lucile Packard Foundation and the Curtis and Edith Munson Foundation for their generous support of Frontiers in the Sea

JAMES A. SUGAR

Waste Not—"Use Less Stuff"

Ten million computers a year are discarded by U.S. businesses, says a group called Use Less Stuff (ULS). It has more than a hundred affiliates, waste watchdogs such as the EPA and grassroots organizations. Many of these PCs recycled by High-Tech Metal Recyclers (USA) Inc. in San Francisco will be sold to the Philippines. ULS says that recycling is important but that the nation should first reduce waste.

Aiming to cut down holiday waste, ULS declared November 20 Use Less Stuff Day. Between Thanksgiving and New Year's, wrapping paper, packaging, and discarded food add an extra five million tons of trash to the nation's landfills. In the U.S., 2.7 billion holiday greeting cards are sold each year. If everyone sent one card fewer, it would save over 50,000 cubic yards of paper. And if all households canceled 10 of about 150 catalogs they receive, it would save 175,000 tons of trash.

In France's Bay of Biscay, a Grim Tide

More than 700 dolphins and whales piled up on France's Atlantic coast last February and March. Most were common dolphins, but the toll also included striped and bottlenose dolphins—even a few harbor porpoises and fin, beaked, pilot, and minke whales. Many victims had ropes around their tails or had heads or tails cut off; some had been partly butchered for food. To scientists the cause was obvious: These marine mammals were seen as waste, "bycatch," to the fishermen who snared them in their nets while seeking commercial fish.

"Mid-water trawlers are responsible for this, not drift nets," says Anne Collet, a French biologist who examined the carcasses. The European Union has banned large drift nets. Two other European treaties call for bycatch reduction by vessels using huge trawls for hake and other species. But the Bay of Biscay falls beyond the treaties, a painfully obvious loophole.

TEXT BY JOHN L. ELIOT

ANNE COLLET, CENTRE DE RECHERCHE SUR LES MAMMIFERES MARINS

IT'S A BELLS AND WHISTLES

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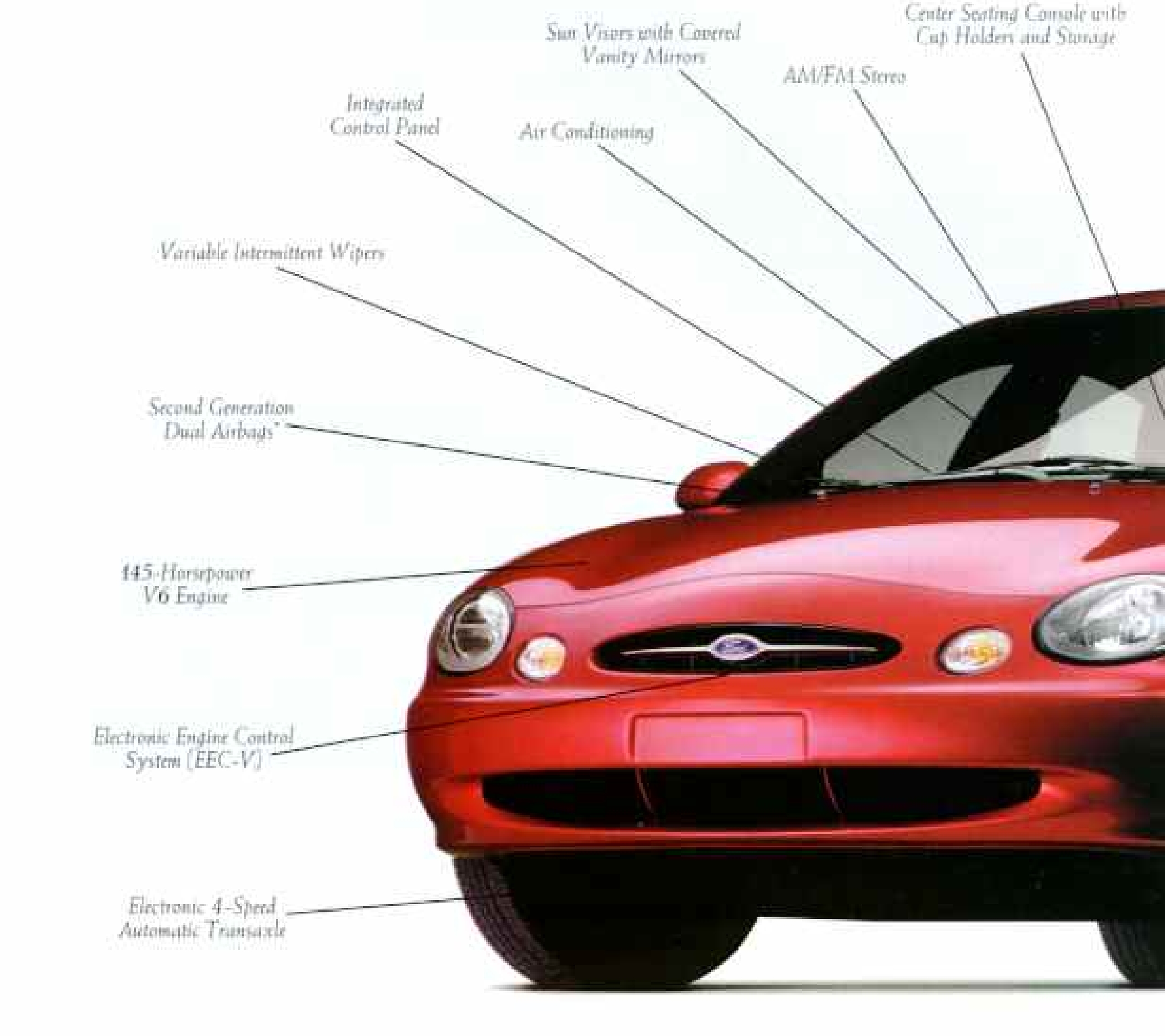

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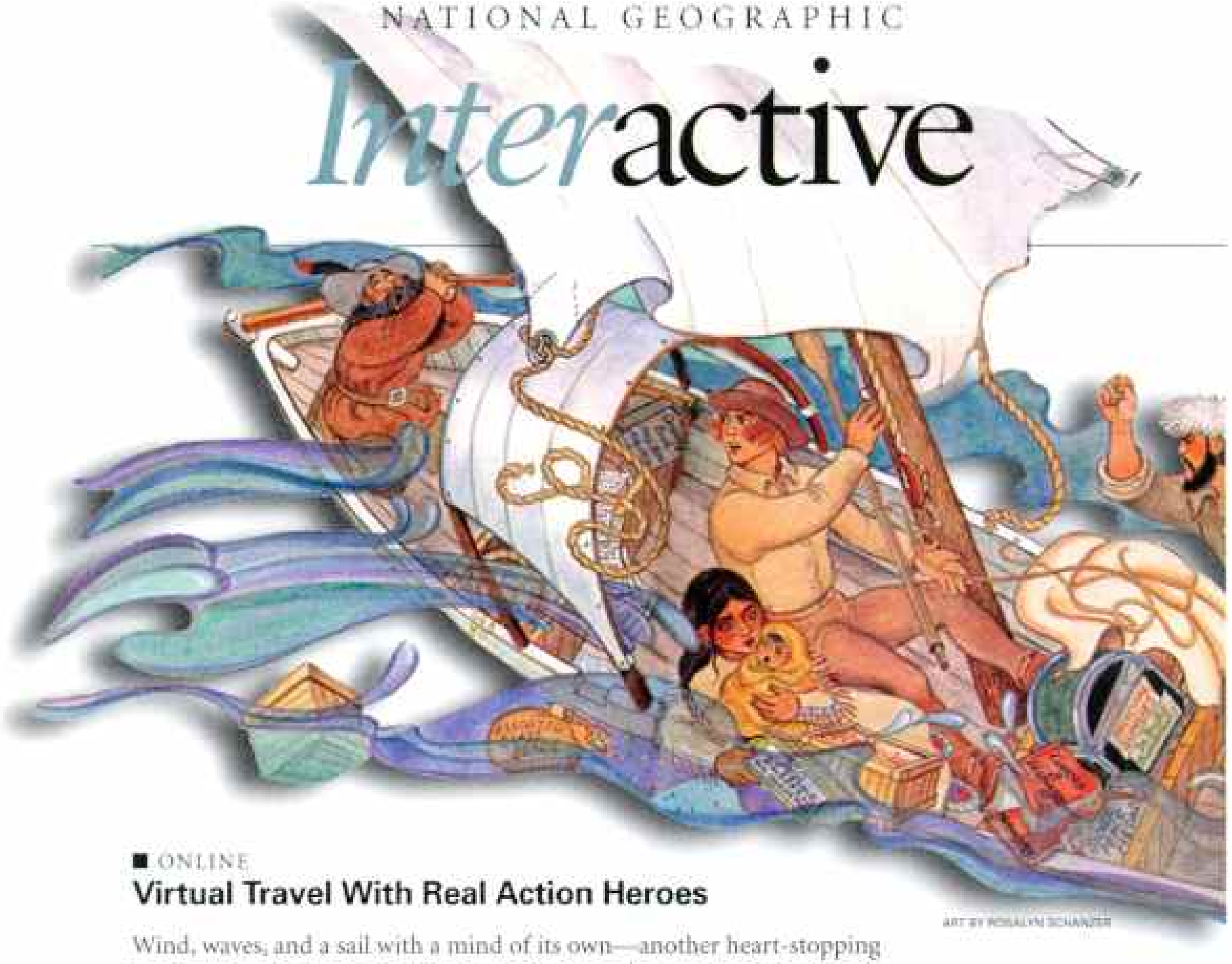

ART BY ROSALYN SCHANZER

■ ONLINE

Virtual Travel With Real Action Heroes

Wind, waves, and a sail with a mind of its own—another heart-stopping moment for the Lewis and Clark expedition as they explored the American West from 1804 to 1806. That trek took nerve, skill, and muscle. All *you* need is a modem. Our website unveils a kids feature, based on our book *How We Crossed the West*, by Rosalyn Schanzer, that celebrates Geography Awareness Week. Electronic explorers face the same dangers, choose a course of action, then find out what Lewis and Clark did. Join the crew at *www.nationalgeographic.com/features/97/west*.

■ Victorians thrilled to the story of missionary-explorer David Livingstone (below) with help from a magic lantern; glass slides shine again in a feature enlivened by behind-the-camera vignettes from the production of our TV film on Stanley and Livingstone. Take your seat at *. . . /features/97/lantern*.

■ Share your thoughts about "Uncovering Patagonia's Lost World" at *. . . /media/ngm/9712/forum*.

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NATIONAL GEOGRAPHIC

On Assignment

MICHAEL NICHOLS, NGS

■ TIGERS

Hanging In There for a Job

"I'm strong, I eat anything, and I work cheap," wrote Roy Toft to photographer Michael "Nick" Nichols. "Need an assistant?" Nick did, so Roy, an aspiring photographer who had impressed Nick while working at the San Diego Wild Animal Park, found himself dangling off a cliff in India. Roy (above, with camera) tests the setup for a leaping tiger shot, as a local man—standing in for the big cat—jumps to trip an infrared beam, triggering Nick's "camera trap."

ROFF MARTIN-SMITH

■ AUSTRALIA BY BIKE

The Outback in Focus

Roped into herding sheep after his day's shooting was done, Ontario-born photographer R. Ian Lloyd (holding lamb) soon felt right at home with the Macintosh family of Queensland. "They were such welcoming people," he says of the ranchers, but laments that "their sheep didn't respond so well to my Canadian accent." Ian followed in the footsteps—and tire tracks—of writer Roff Martin Smith. "At one point I was flat on my back on a trolley cart pulled by another bike, so I could look up at Roff and shoot while he rode. I mean, how many ways can you photograph a man on a bicycle?" asks Ian. "My job was to find out."

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NATIONAL GEOGRAPHIC

Geoguide

Like an angry house cat, a Bengal tiger (below) flashes a mouthful. Lethal for hunting, the teeth don't protect against guns or loss of prey and habitat. The cat's hope for long-term survival is its allure to tourists, who can safely watch tigers from atop elephants in Bandhavgarh National Park.

MICHAEL NICHOLS, NGS (TOP); ROY TOFT

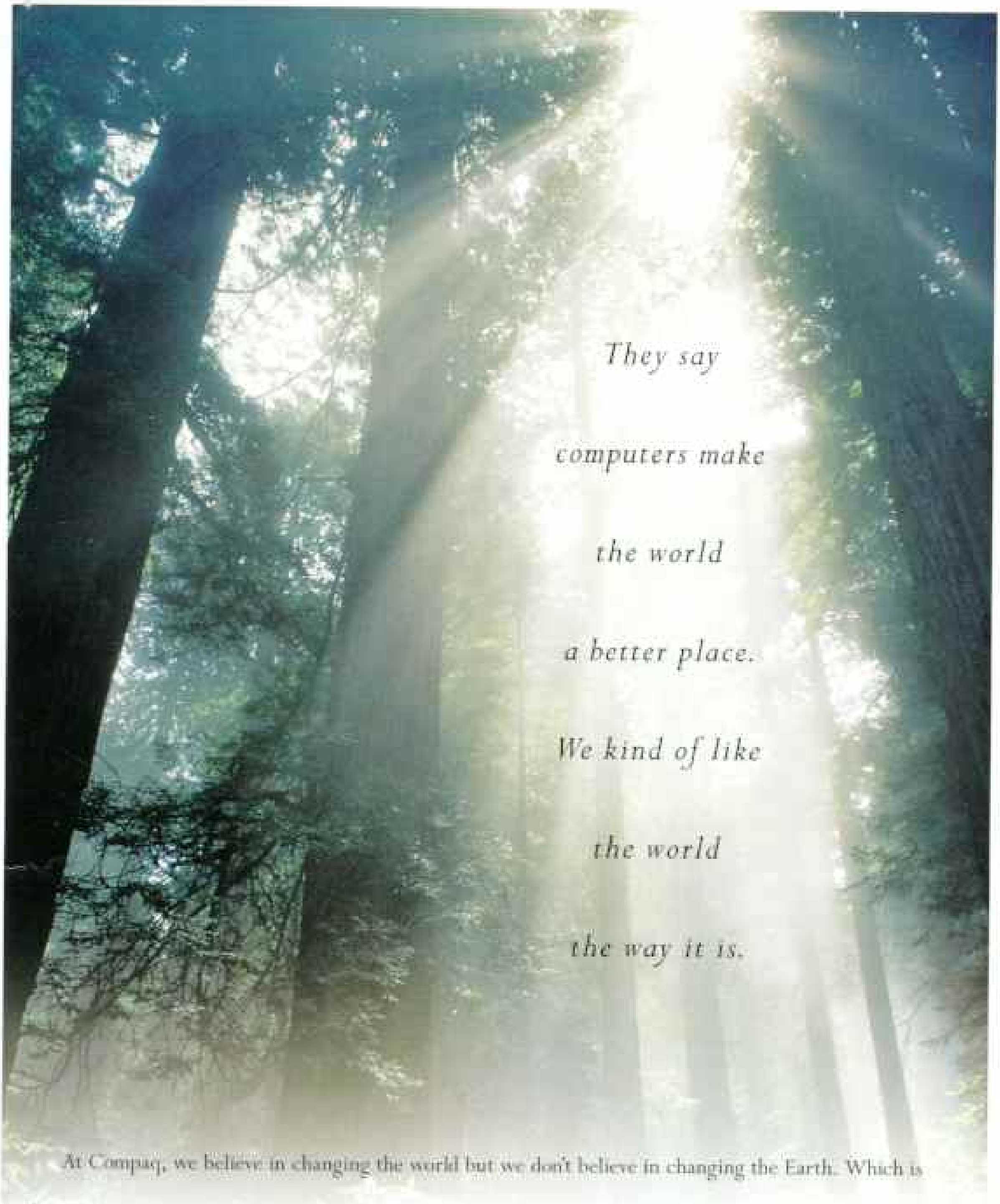
Tigers in Trouble

■ Examine the map on pages 14 and 15 and you'll see how much the tiger's range has shrunk. In North America grizzly bears, mountain lions, and wolves have also lost much of their original habitat to human settlement. How are these animals similar to the tiger in the way they affect people or livestock? How is the tiger's plight different from that of the North American animals?

■ The tiger faces many obstacles to its ultimate survival in the wild. People compete for its territory as well as for its prey, and its body parts bring high prices. If you were pleading with a farmer, a miner, a logger, a deer hunter, or a tiger poacher to save the tiger, what are the chief reasons you would give for protecting these cats in the wild?

■ Perhaps the worst threat to tiger survival is less of prey. To get an idea of what a tiger needs, consider that an adult Bengal tigress eats an average of 13 pounds of meat a day. For a 250-pound cat that's more than 5 percent of her weight. If a 100-pound girl ate 5 percent of her weight each day, what would her daily intake be?

■ Scientists studying tigers can distinguish them by their stripes. Can you spot the differences between tigers in the story—and recognize some from picture to picture by their patterns?



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