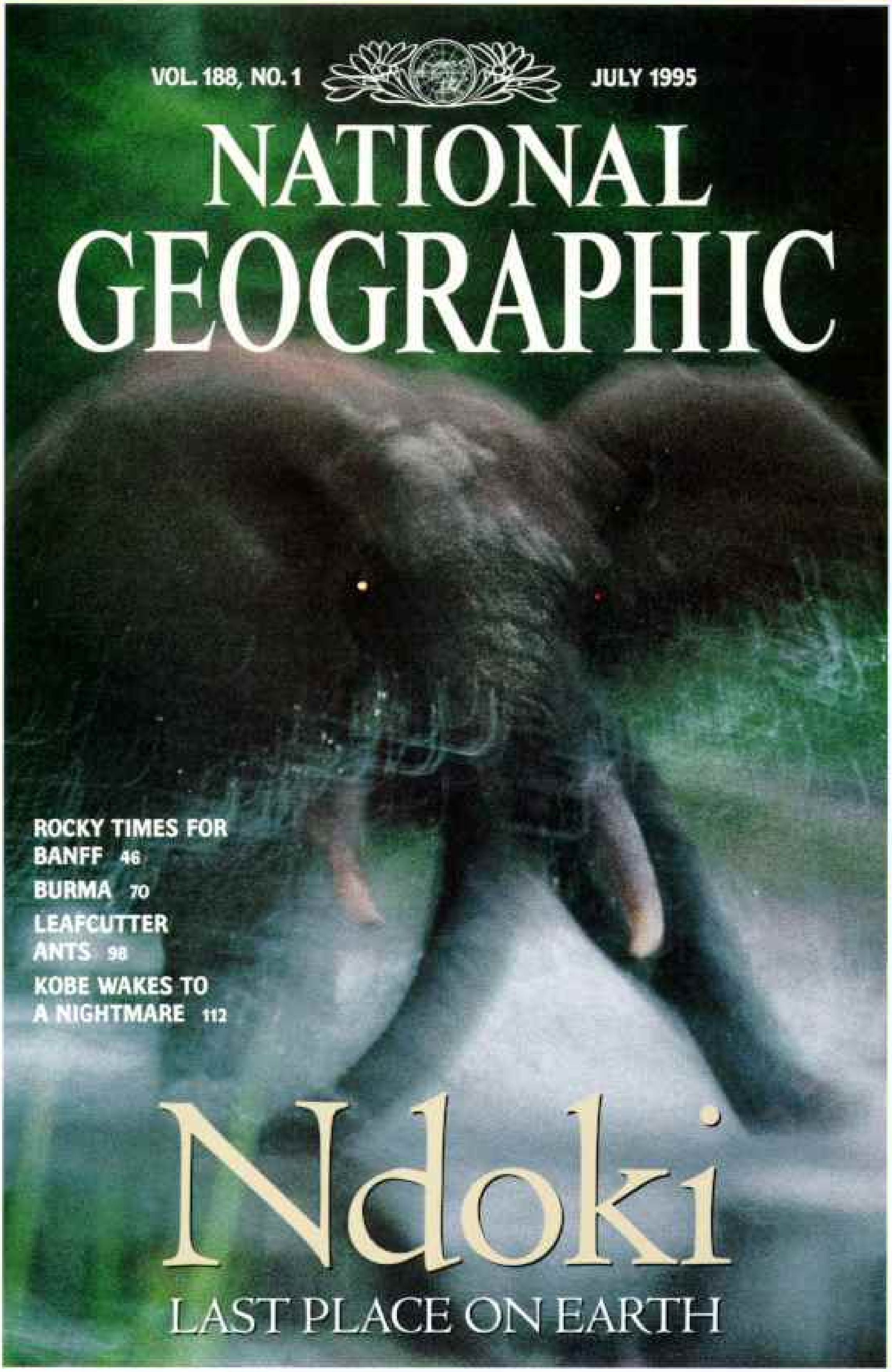
DOUBLE MAP SUPPLEMENT: HEART OF THE ROCKIES

VOL. 188, NO. 1 JULY 1995

NATIONAL GEOGRAPHIC



Ndoki

LAST PLACE ON EARTH

OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

NATIONAL GEOGRAPHIC MAGAZINE

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■ In a remote pocket of central Africa runs a river called Ndoki (which means "sorcerer" in the Lingala language). Its waters flow from a tropical forest that supports groups of Pygmies and a greater abundance of wildlife than exists perhaps anywhere else on the continent. Teeming with leopards and golden cats, gorillas and elephants, this jungle also harbors chimpanzees that may never have encountered a human being. It is one of the world's last undisturbed natural sanctuaries.

Steamy, insect infested, forbidding, the region is not only threatening but threatened too, by loggers and poachers.

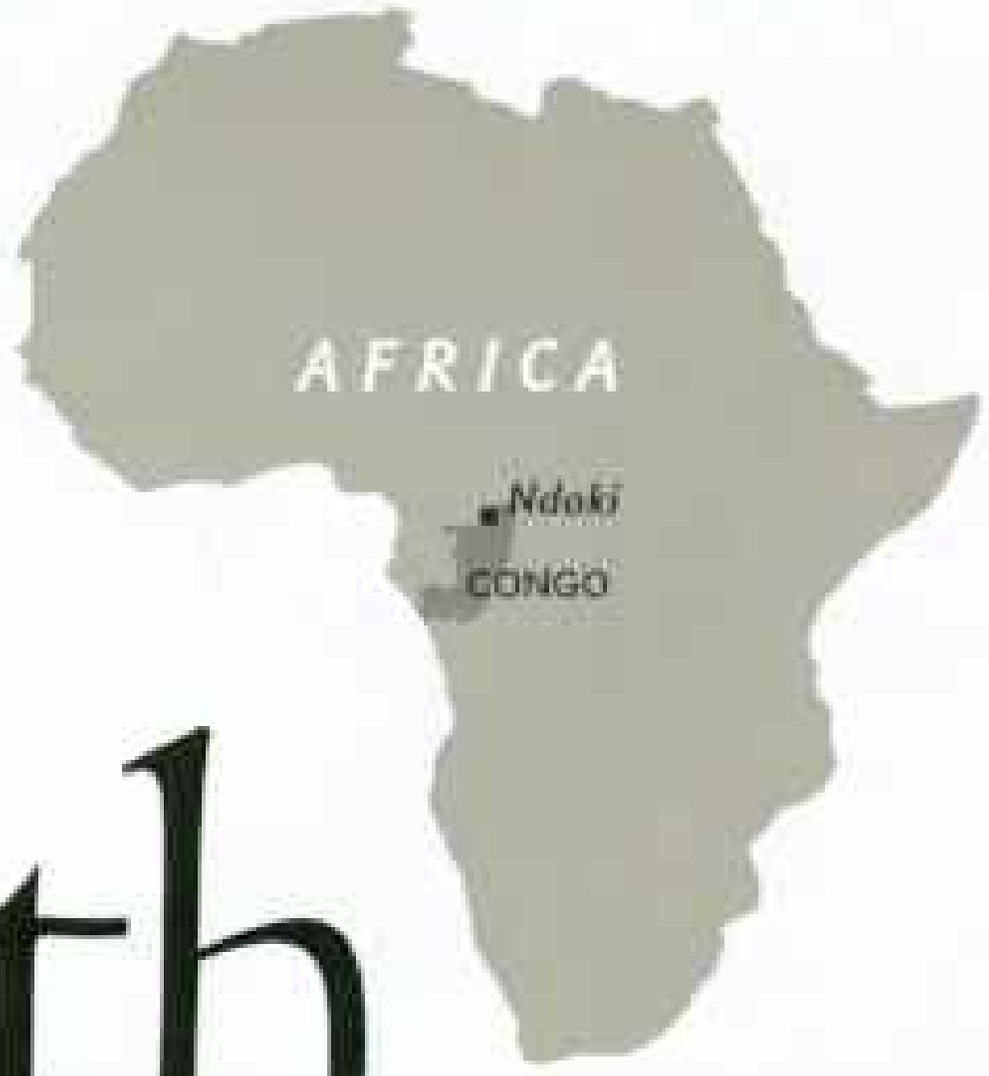
Last Place

By DOUGLAS H. CHADWICK

Photographs by MICHAEL NICHOLS

Okapi

A coalition of organizations led by the Wildlife Conservation Society has been trying to save it. In 1993 a team from National Geographic set off to document this wilderness. Working conditions were miserable, and just getting there was an ordeal. But when our team finally came home, physically and emotionally drained after more than a year of intermittent treks, they had experienced a slice of Africa that feels like another world. This is what they discovered. —THE EDITOR



on Earth

■ The clearest paths are often the wettest ones in the Nouabalé-Ndoki forest, where Alphonse Konga, a Bangombé Pygmy, carries camping supplies at the start of the expedition. Much of this forest remains unknown territory, even to the Pygmies who live on its periphery, so it's best to bring a compass, a machete, and lots of stamina. Hiking through this claustrophobic hothouse, says the author, "is like being passed through the guts of the forest and being slowly digested."

There was no sunset on the forest floor. There never is.

Deep shadows welled up from the swamps and root tangles, and evening wove them together until it was night. The air stayed hot. This was the end of the dry season in the northern Republic of Congo. Thunderstorms were beginning to sweep the region with torrents of rain. But they never brought enough to really cool things down. They only added to the steam. Just eating dinner—lifting a fork, chewing—made me sweat.

To reach this place, our expedition had traveled up one of the Congo River's main tributaries, the Sangha, to the little village of Bomassa, just three miles from the southern tip of the Central African Republic. From there we turned east, crossing overland to the river called Ndoki, and poled dugout canoes up its sunless channels of black water. White lilies lit the way. We began marching through this low-lying part of the Congo Basin after that, sometimes south and sometimes east and too often through hip-deep marshes of muck, leeches, tsetse flies, and dwarf crocodiles. By now we were beyond even the nearest Pygmy hunting territories, probing truly unknown country. I was tired. We were all tired, and it was taking a toll.

■ "If the insects aren't sucking on you or putting some parasite into you, then they're driving you insane," says photographer "Nick" Nichols, whose skin crawls with stingless *Trigona* bees. The bees invade every body crevice, seeking salt in sweat. Leeches go for blood (bottom). Burn the leech and it falls off, reducing the risk of infection. Even in the canopy (opposite) there is no escape from the insect onslaught.

Spread between the Sangha River and the Oubangui, another major tributary of the Congo, the Ndoki watershed encompasses roughly three million acres. In December 1993 nearly a million of those acres became Nouabalé-Ndoki National Park—one of the most significant tropical forest preserves in the world.

Our expedition was to examine a section of the park's southern boundary, then forge on to tributaries of the Oubangui and the swamp known as Likouala aux Herbes, which begins 50 miles southeast of Bomassa. Rumors say this vast marsh is the home of *mokélé-mbembé*, the legendary Congo Basin dinosaur.

J. Michael Fay, a 38-year-old American ecologist with the Wildlife Conservation Society, who had helped organize the effort to protect Nouabalé-Ndoki, wanted to find out where the region's elephant herds go during the dry season. He thought the swamp, with its stands of tasty raffia palms, might be the answer. We would be gone for three weeks.

Bryan Harvey, our video cameraman, had been lying in his tent all afternoon, burning in the grip of some nameless fever. Now moans came from the tent of François "Franco" Nguebo, who tended the camp we had established. His symptoms added up to malaria, and one of the forms here can kill you within hours of the first attack. I knelt by Franco's

■ Hacking away, photographer's assistant Neeld Messler clears a tree from an old logging road that runs from Bomassa to Ndoki camp. Although logging companies abandoned this one, they have built many new roads to take out timber east of Kabo. To prevent further environmental damage, several organizations—including the U. S. Agency for International Development and the World Bank—joined with the Wildlife Conservation Society and the Congolese people to establish Nouabalé-Ndoki National Park in 1993. Roughly the size of Rhode Island, it is both a victory and a compromise. While the park is the first to be created in the Republic of Congo, some of the region's richest wildlife habitats, such as the so-called Inner Sanctum, extend beyond the park's protection.

tent to give him medicine, pausing to knock a scorpion off the door flap so I could pass the pills through.

My arms were crosshatched with infected thorn scratches that refused to heal. The bites of ants and *toona* flies showed red in between. Bee stings had raised lumps on my stomach and neck, and I had larvae wriggling through the surface tissues of my feet. Most of us were plagued as well by painful little ticks that favored parts of the body supposed to be very private. Still, nothing had turned septic. Nothing had invaded my whole system. I told myself I was OK.

I walked away from the camp's fires and stood facing the darkness. It pulsed with animal songs. The calls of tree frogs and insects were ringing as though all the leaves that enclosed us had turned into glass chimes. Fifteen intertwined stories overhead in the canopy, fireflies formed constellations with the occasional star that winked through. Phosphorescent molds shone underfoot like moon drops sprinkled on the dank leaf litter.

A good night for spirits; Raymond Mokango and Alphonse Wawa, two of the Babenzélé Pygmy trackers and porters in our party, said that you can sometimes feel them winding

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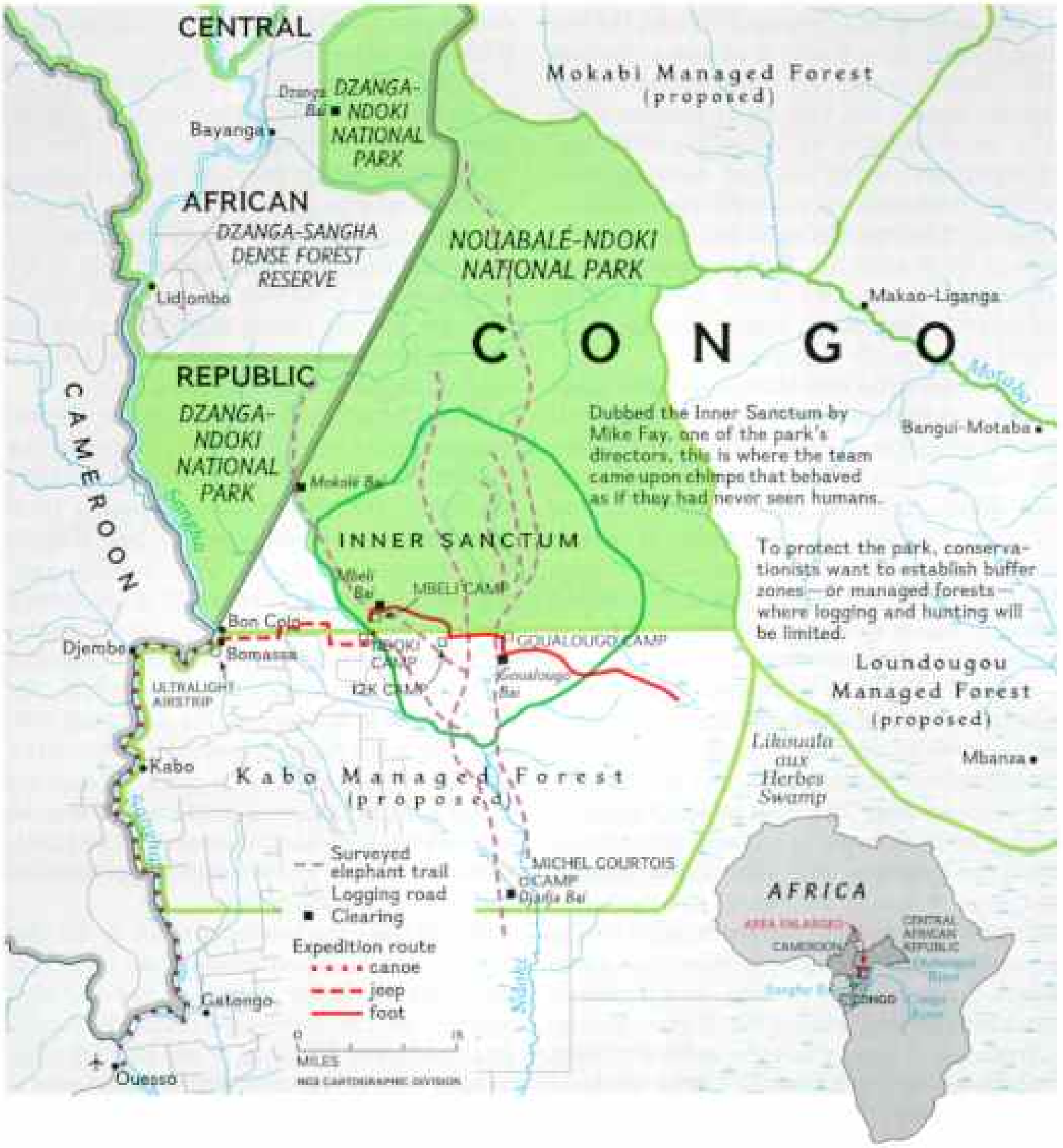
DOUGLAS H. CHADWICK, a wildlife biologist, visited the Congo Basin prior to this assignment for "Elephants: Out of Time, Out of Space" (May 1991) and for his book *The Fate of the Elephant*. MICHAEL NICHOLS has spent more than a decade in Africa and Asia photographing the great apes.



between the trees like great, invisible pythons.

Just then, something reached out of the gloom and grabbed the lower part of my face. I yelped and milled my arms until the thing went away. I have no idea what it was. Maybe it was just an insect; the forest was full of huge moths, six-inch-long mantises, and nine-inch-long walkingsticks. My subconscious was still roiled by images of the leopard that had been in camp the night before, stalking past our nylon and mesh tents and knocking over gear. While this area may be unpeopled, it was, I began to realize, the most inhabited place I had ever visited.

Lowland tropical forests represent the richest assemblage of life-forms known. But as almost everyone is aware by now, these ecosystems are rapidly vanishing. After South America, Africa holds more intact tropical forest than any other continent. The largest share is in Zaire, followed by the Republic of Congo, with some 77,000 square miles.

Mike Fay joined Marcellin Agnagna, a Congolese wildlife biologist with the Ministry of Waters and Forests, to make a series of treks through untamed portions of the republic in 1989. They were looking for forest elephants, a smallish, round-eared subspecies about which relatively little was known. In the face of the ivory-poaching crisis then sweeping Africa, scientists were scrambling to learn more about where the animals lived and how they were faring. Marcellin and Mike hoped to help fill in the picture.

While traversing Nouabalé-Ndoki, the two men uncovered a bonanza of forest elephant sign. Follow-up surveys confirmed that these jungles harbor not only many elephants but also an abundance of lowland gorillas and chimpanzees, which are fast declining elsewhere. Alongside them dwell nine different types of monkeys; the most majestic and elusive of forest antelope, the bongo; and a variety of other species from forest hippos to genets—ring-tailed, night-roaming carnivores related to the mongoose.

Now Marcellin and Mike were once again on reconnaissance in Nouabalé-Ndoki, this time leading the National Geographic team. In addition to Bryan Harvey and me, our group included photographer Michael "Nick" Nichols, an old hand at jungle adventuring who has an extensive knowledge of great apes, and Neeld Messler, a skilled climber whose specialty was rigging ropes so we could reach the treetops.

Mike Fay usually went first on the trail, peering at the world through thick spectacles. He is a scientist of modest height and unexceptional muscle development, but his appearance is deceiving. This man powered ahead in high gear from dawn until dusk, clad only in shorts and sandals, oblivious to pain, fatigue, and fear. What to me was an extraordinary adventure was to Mike merely the latest trek in a succession that has spanned more than a decade, a dozen bouts of malaria, and hundreds upon hundreds of miles rarely, if ever, trod by a Westerner. In many ways he seems a modern version of the 19th-century Congo explorer Henry Stanley, the unstoppable force whom the natives called Bula Matari, "breaker of rocks." I was in sturdy company.

I struck off from the group one afternoon with Marcellin, who had studied wildlife biology in Havana and Paris, and a Babenzélé Pygmy named Gabriel Yoka, who studied the tracks around us. Every few hundred yards Gabriel would halt and imitate the nasal yowls of a duiker. As Pygmy hunters discovered long ago, the sound readily draws in various species of these forest antelope—Peter's, yellow-backed, white-bellied, black-fronted, blue, and bay duikers all dwell in the park. Marcellin used the call as a census technique.

"I think Nouabalé-Ndoki has the highest density of big mammals in our nation and one of the richest faunas left in all of tropical Africa," he said, after we had watched a bay duiker race in and stand quivering before us as if attached to an electric current.

By the 1980s the whole of the northern Congo had been divided up into timber concessions and scheduled for logging. Marcellin and Mike Fay worked to convince the government of the forest's value for wildlife and for protecting water quality. "The streams are very pure, and they are an important part of the Sangha River's sources," Marcellin noted. "We are already seeing more and more silt from deforestation upstream in the Central African Republic and Cameroon."

West Africa has already lost perhaps three-quarters of its woodlands. To conserve the tropical forests of Nouabalé-Ndoki, Mike, Marcellin, and their colleagues tried a fresh approach. In a joint project of the Wildlife Conservation Society and the Congolese government—with support from the U. S. Agency for International Development and other organizations—they designed a reserve integrated with its surroundings. Nouabalé-Ndoki National Park is to serve as the protected core area. For some distance beyond it there will be transition zones in which logging, subsistence hunting, safari shooting, and tourism may be allowed but with careful controls. The idea is to sustain nature and economic opportunities for local people side by side.

Multiplying the project's value is the fact that Nouabalé-Ndoki adjoins two conservation sites of similar design in the southern reaches of the Central African Republic: Dzanga-Ndoki National Park and Dzanga-Sangha reserve. Another conservation area is proposed in Cameroon.

ABOUT HALFWAY IN OUR JOURNEY to the Likouala swamp, we stopped at Goualougo clearing to build a camp and were spreading out mildewed gear in the hope it might dry, when a chorus of screams arose from the north. I cupped my ears and waited. A flock of gray parrots came racketing by. As soon as they passed, the sounds of monkeys emerged: black-and-white colobus, greater white-nosed guenons, and gray-cheeked mangabeys halfway up an *Angylocalyx* tree, competing with wood pigeons and hornbills for its ripe orange fruit.

But there were almost always monkeys shrieking and crashing from branch to branch somewhere nearby. The sound we had heard was different. When it came again, we set off

at a trot. Nearing the source, Mike signaled for us to crouch motionless, then began a duiker call. All at once the forest erupted, and we were among more than a dozen chimpanzees that had almost surely never seen a human being in their lives.

The chimps had come from all sides on the ground, probably intent on catching a duiker to eat. As soon as they made out our still forms through the foliage, they screamed again and leaped into the trees. There, led by a big, grizzled male, they began an even wilder display, yelling, baring their teeth, hurling sticks with fair accuracy—and urinating with equally unsettling aim. Yet within minutes several members of the group were starting to alternate such threats with soft, questioning *hoo*'s.

Everywhere we looked, eyes built by genes practically identical to ours stared back. Behind those eyes, I felt sure, were minds overcome by the same astonishment we felt. "Almost any other chimpanzees left on the continent would have fled as soon as they saw us," Mike said. "These guys are totally naive. They've never been hunted or harmed by people. And we're trying to see to it that they never will be." *(Continued on page 28)*

■ Smart enough to stay out in the rain, ecologist Mike Fay, a prime mover in the park's creation, perches beside a clearing, or *bai*, called Mbeli. Though he hopes to spot lowland gorillas, Fay prefers that gorillas spot him, so they may acclimate to the presence of researchers. Such animal habituation has helped biologist Andrea Turkalo (above), Fay's wife, identify 2,000 forest elephants at Dzanga Bai in the Central African Republic. She estimates that another 1,000 visit here—making Dzanga a hot spot for forest elephant research.

A First Encounter?

■ Lured into camera range with an audible decoy (a man imitating the cry of a duiker), this and other chimpanzees expected to feast on an antelope—but found a photographer instead. Most chimps would have fled in fear, but these animals appeared too curious to run. They shrieked, yelped, threw sticks, and generally raised a ruckus, then settled down to watch. Why? It could well have been their first contact with human beings. "Otherwise they'd never let you get this close to them," insists Nick, who has years of experience photographing primates.

"After a long time," says the author, "they still peered at us, trying to get closer to look into our eyes to see what we were about."

■ Getting a clear shot at a forest elephant is no easy trick—but that's small comfort to these beasts. Killing them for their ivory tusks, poachers have slaughtered more than 50 percent of Africa's elephants—with savanna elephants, which roam the open plains, suffering greater losses than forest elephants, which live under cover. Despite a six-year-old international ban on the ivory trade, the killing continues.

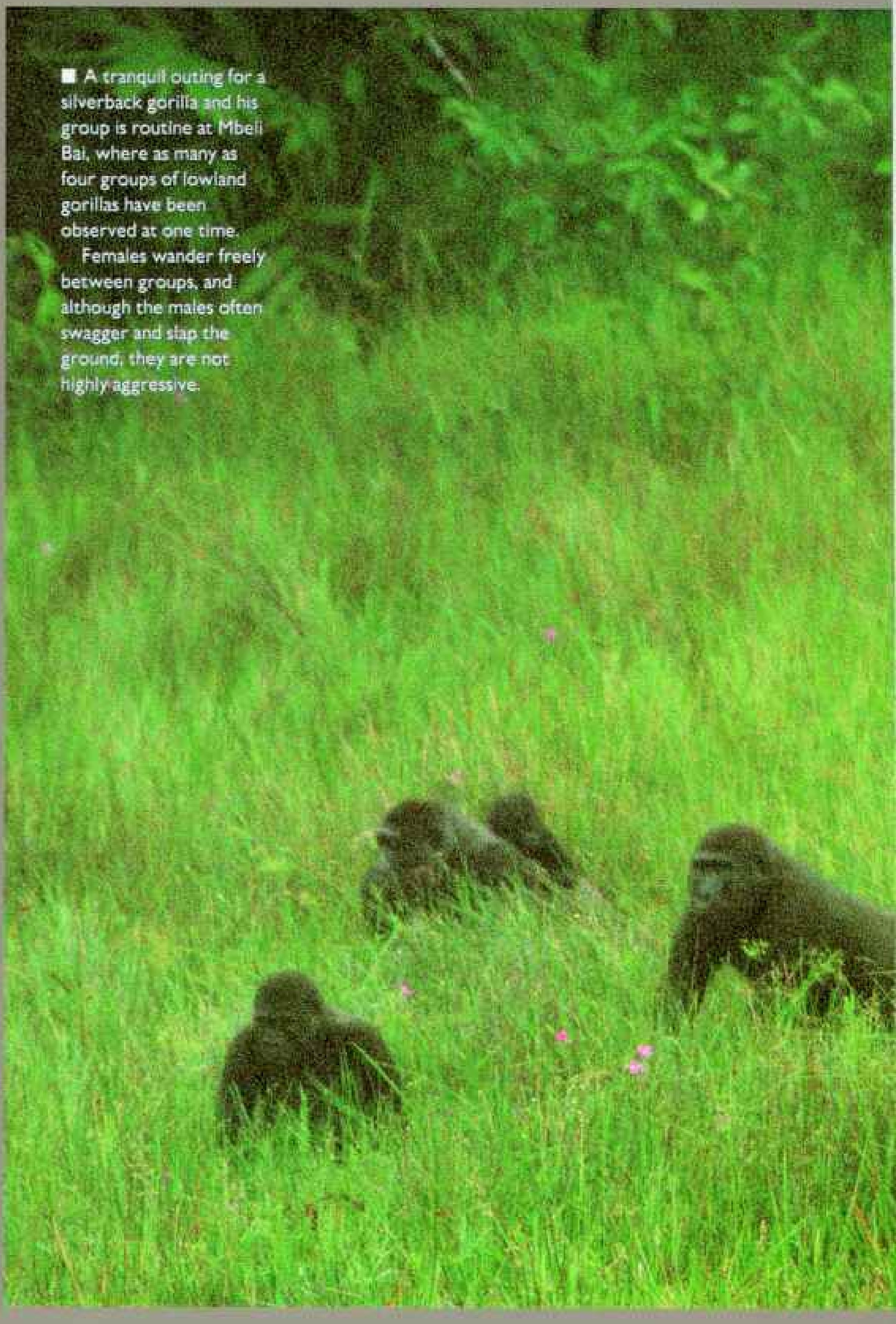
■ Water doesn't deter a hungry lowland gorilla cautiously edging toward a grassy patch in Mbeli Bai. While it's not news that sedges serve as a starchy supplement to a gorilla's diet, biologists have only recently discovered that the apes will go wading to get them. The scientific wisdom had been that gorillas avoid water; in fact, streams were thought to have been barriers constraining gorilla distribution within Africa.

The change in thinking took time—and so did this photograph, the first ever published of a lowland gorilla in water.

Nick spent 21 days on a platform, sitting and waiting (and playing countless games of Nintendo) before this gorilla sloshed along.

Though the photograph may have been a lucky break, the choice of location wasn't. Mbeli Bai (left) is one of many clearings in the Nouabalé-Ndoki forest that attract a wide range of animals, including sitatungas, elephants, bushpigs, otters, and plenty of gorillas. Researchers believe that more than 20 gorilla groups regularly visit. And because Mbeli Bai is wide open, scientists studying gorillas can observe in a few weeks what would take years in the forest.

That's exciting for researchers, who hope that Mbeli Bai may become the site of breakthroughs in the study of lowland gorillas, much the way Tanzania's Gombe National Park served as the locus of Jane Goodall's seminal study of chimpanzees.



■ A tranquil outing for a silverback gorilla and his group is routine at Mbeli Bai, where as many as four groups of lowland gorillas have been observed at one time.

Females wander freely between groups, and although the males often swagger and slap the ground, they are not highly aggressive.

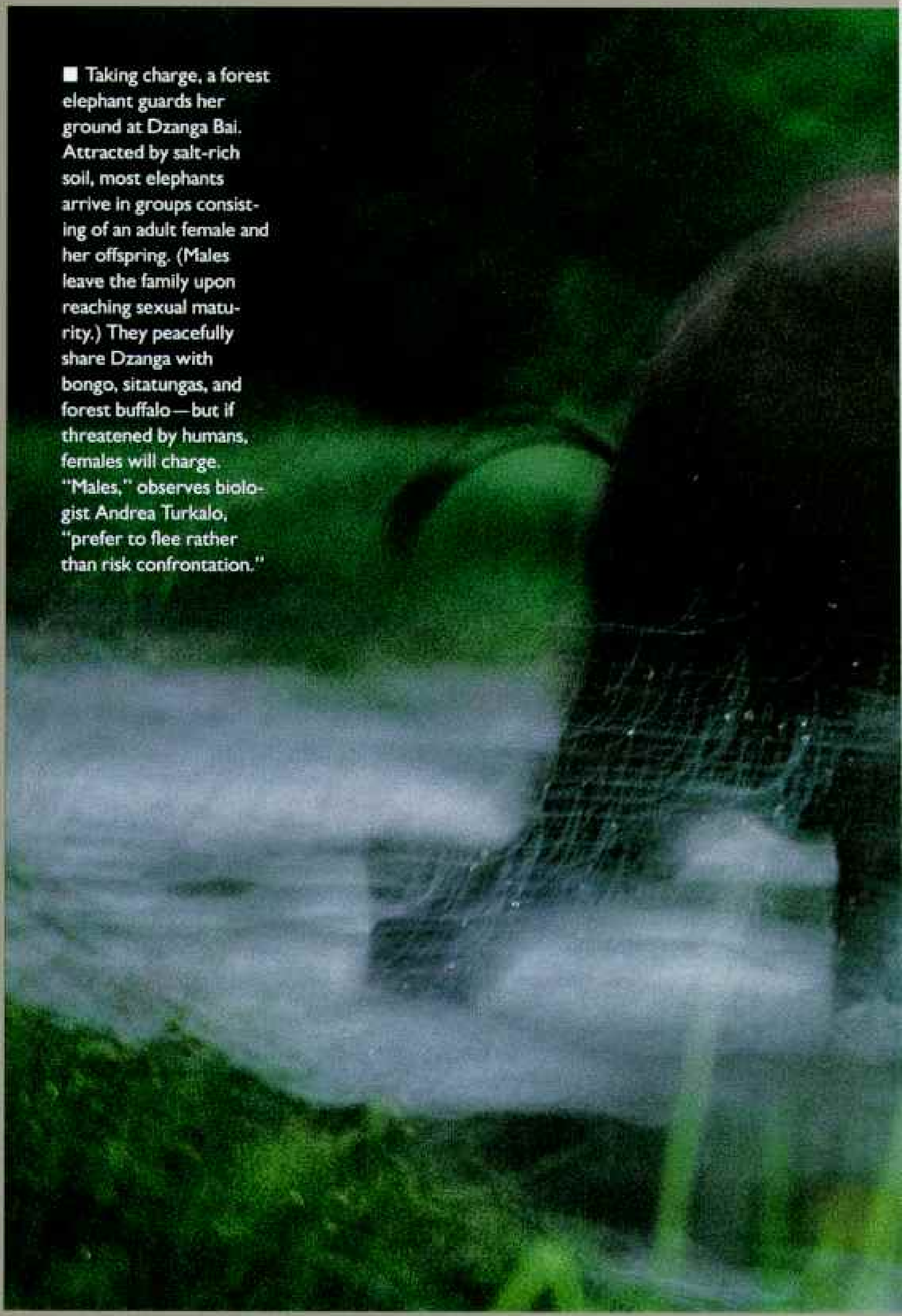
■ Hanging out with style, a potto uses its tenacious grip to swing from a palm tree. A lower primate roughly the size of a rabbit, the nocturnal potto climbs upside down as readily as right side up, slinking along silently to avoid predators.

When facing an enemy, a potto will freeze or go into a defensive crouch, burying its head between its front legs, leaving only the thick, bristly back side of its neck exposed.

At first light the jungle comes alive with the plaintive cry of the great blue turaco (above). Nimble climbers and acrobatic feeders, these birds will often hang upside down to feed on fruit at the tip of a branch. In the air, though, turacos are far less graceful. In preparation for takeoff they sprint down a branch with their wings raised and tail feathers fanned, then throw themselves skyward before settling into an awkward glide. At touchdown great blue turacos sometimes crash into the forest floor, then scamper back to the canopy.

Living slower—and much lower—solitary hinged tortoises (below) eat mushrooms and are themselves fed on by Pygmies.

■ Taking charge, a forest elephant guards her ground at Dzanga Bai. Attracted by salt-rich soil, most elephants arrive in groups consisting of an adult female and her offspring. (Males leave the family upon reaching sexual maturity.) They peacefully share Dzanga with bongo, sitatungas, and forest buffalo—but if threatened by humans, females will charge. "Males," observes biologist Andrea Turkalo, "prefer to flee rather than risk confrontation."



■ In their role as architects of the jungle, elephants create a network of trails and clearings, such as this small one near Dzanga Bai, where they gather to drink, socialize, and joust for dominance.

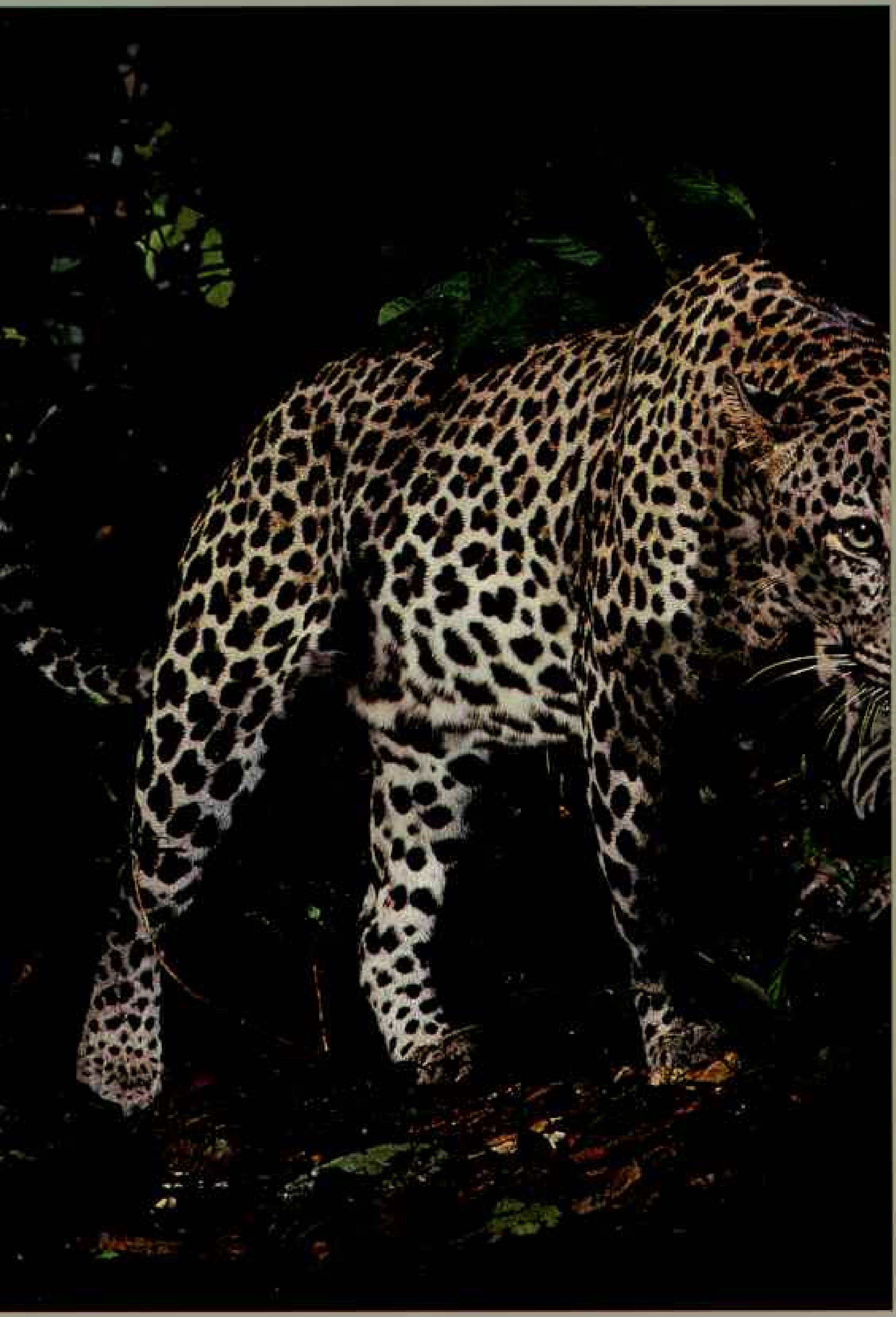
Elephants regularly redesign their surroundings: They'll haul down a tree branch by tugging on a vine, or girdle the trunk of a tree, stripping away its bark until it dies and drops. They savage abandoned termite mounds and rotting logs for minerals.

Elephants browse on grass, urinate and defecate, then trample what remains into nutrient-rich muck. Out of this morass sprout monocots—grasses and other starchy plants that grow quickly and attract more elephants.

Into newly made clearings come creatures like the genet (right), a nocturnal mammal that feeds on small birds, reptiles, eggs, and insects. With its ringed tail and sleek body, the genet looks like a cross between a raccoon and a cat.

Bongo (above) also venture into these clearings, usually at dusk or at night. Unlike most other antelope, female as well as male bongo have horns.

■ On the prowl in deep forest, a leopard pads silently in search of a meal—a duiker, a bush-pig, or maybe a monkey. Hunting and living alone, leopards are so strong and agile they can tackle prey two times their own weight, which helps keep them on top of the forest's food chain. This cat was caught—but just barely—as it crossed an infrared beam, triggering a remote camera.



■ Hoisting their prey, commercial hunters quickly retreat from the jungle on the border of Cameroon, where one of their snare traps has snagged a bushpig. Though snares are illegal, cruel, and indiscriminate—wire nooses snap at a gorilla's leg as readily as a duiker's—hunters still use them. In a region with few jobs and little farming, snares are a cheap, easy way to bag bush meat. For poachers, who eat the meat or sell it, anything's game, including a threatened golden cat (below).

(Continued from page 11) An hour or so after first contact, most of the chimps continued to stare without letup, now and then hugging one another. "For reassurance," Nick whispered. The big male turned away to lie on his back atop a thick liana, where he began to rock slowly as if settled into a hammock, occasionally sneaking a peek over his shoulder. A small male of perhaps six or seven years of age clambered down to perch no more than 20 feet from us, glancing from face to human face. He widened his eyes; we widened ours. He hooed. We hooed back, and he responded with another hoo right away. We carried on the same conversation with several different animals. We even mimicked the chimps unconsciously, scratching our sides and waving our hands past our faces, for the insects had begun to swarm our primate parley.

Worst of all, as usual, were the *Trigona* bees—sweat bees—stingless, gnat-size fliers that covered our bodies in their search for salt and other nutrients. After two hours we grew so distracted that we began to think about breaking off this rarest of encounters. We had stepped beyond the reach of time into a green empire that has endured for thousands of years and been greeted not by strange, exotic beasts but by a familiar consciousness. Preserved within that consciousness were the roots of the boundless curiosity that defines our own kind—the very quality that had brought us here. None of us who had met this day would ever be quite the same again.

The fact that the chimps were still around puzzling over our crew when we finally departed was telling in itself. Whereas other species' waking hours are largely taken up by the demands of foraging and avoiding enemies, *Pan troglodytes*, like *Homo sapiens*, plainly has time to spare. Of the ten chimpanzee groups I encountered close-up over the days to follow, only two left before the people did.

Mike speculates that such leisure time works in a sort of feedback loop with the chimps' complex behaviors. That is, the more efficiently the animals can obtain food through cooperative hunting and their use of tools, the more moments they have free to investigate, experiment, and invent new methods. He and Marcellin would soon show me evidence of chimps using twigs to gather termites from their mounds, pounding open the hardened nests of *Trigona* bees with clubs to get honey, and digging as much as a foot or two underground with pointed sticks in search of buried insect larvae.

A digging stick still lay at the edge of one freshly made hole. Yet the footprints in the loose dirt were those of a gorilla. Since no one has reported tool use among wild gorillas, we guessed this was just a case of a gorilla happening by and pausing to inspect some chimpanzee's handiwork. An inquisitive gorilla—like either of the two adolescent males that came sneaking through the brush one afternoon for a closer look at us, egging each other on until Mike and I could make out individual

hairs above their furrowed brows. When we ignored them, pretending to be busy stuffing leaves in our mouths, they shuffled closer yet.

At first it seemed like a face-to-face meeting with a yeti or Bigfoot. But the longer I looked, the more I felt as if I were looking at my own reflection in a shadowy jungle pool. Who is to say that a gorilla might not catch on to the trick of digging one day—perhaps from watching chimps? Anything appeared possible in an ecosystem so full of near-human forms.

Mike paused to sniff the chewed ends of herb stalks left on a faint gorilla trail and pronounced them a day old. He noticed fresh scrape marks where a duiker had left its scent, and sniffed them. Then this most curious of primates pressed a leaf against his lips and imitated the whistle of a crowned eagle to stir up the monkeys above us so he could get a better look at them.

In addition to chimps and gorillas, portions of Nouabalé-Ndoki may support as many as 50 monkeys per square mile, Mike estimates. Of the hoofed animals, blue duikers alone probably number 100 per square mile. "Now add in elephants, bushpigs, bongo, and the nocturnal animals," said Mike. "I'd like to conceptually strip the leaves off this forest and show that it is a match for the African savanna in terms of concentrations of big animals."

As a rule, large mammals aren't particularly abundant in wet tropical forests. A key reason so many have been able to carve out niches here is the existence of natural clearings. In Nouabalé-Ndoki they are called *bais* and are usually associated with streams, marshes, or springs. The forest's large herbivores ordinarily would have to get much of their forage by browsing woody plants. But the sunny bais offer grasses, sedges, and nutrient-laden herbs. Such habitats also help sustain grazers, such as sitatungas, and mixed feeders, such as forest buffalo, adding extra dimensions to the Congo Basin community.

WE OFTEN HIKED several miles from camp to reach a nearly pure stand of towering *Gilbertiodendron*, or *malapa*, trees. The ground beneath them was unusually open and carpeted with their long, oval leaves. A major thoroughfare stomped out by generations of elephants made the going even easier. Every tree along the way wore a coating of dried mud where the gray giants had rubbed.

■ Prime timber topples east of Kabo, where foreign logging companies fell the forest's biggest African mahogany trees. Although contracts supposedly limit the harvest, enforcement in mid-jungle is nearly impossible. So more trees fall, and bulldozers carve new logging roads, which give hunters easy access to once remote areas.

The bark held squashed ticks and stiff hairs from the hides. Dozens of side trails led off the elephant highway to a chain of bais paralleling the malapa stand. We turned down every one, tiptoeing toward the brightness.

As we emerged from the forest, butterflies sometimes filled the air until I envisioned myself stepping into a pointillist painting, in which the world is formed from countless separate dabs of pure color. We picked out fresh prints of bongo, buffalo, and giant forest hogs in the sunlit mud. Leaping for cover at the edge of one bai was a water chevrotain. A small, deer-like creature whose males carry tusks, the chevrotain qualifies as a browser and a grazer—and a carnivore, for it dines on fish, insects, and carrion at times. More than anything else, we saw gorillas, feasting on the starchy stems and roots of an aquatic plant named *Hydrochoris*.

Wherever lowland gorillas are hunted, which is in most places they are found, the dominant, silverback male in a group is likely to make a roaring attack when people approach, giving the females and young time to flee. Here, the silverback would typically rise up to beat his chest a few times, perhaps give the soggy ground a tremendous whap with his open hand for good measure, then sit down near the bai's edge to wait us out. Before long he would be back to feeding, merely staring at us now and then with a perplexed expression.

Through grazing, digging for roots, and churning the mud with their feet, the users of a bai tend to maintain it in a pasture-like state, free of trees and shrubs. Elephants are particularly good at plowing bais while they feed and mud bathe. In many cases they expand the clearings by tearing down small trees and stripping the bark off larger ones, eventually girdling them.

In this forest, animals not only reflect the richness of their environment but also play an important role in creating it. Fruit bats, for instance, deposit fig seeds in their droppings up near the tops of trees, which turn out to be

exactly where many types of figs are adapted to begin growing—up where plenty of sunlight shines; they then send down aerial roots to make contact with the soil. Meanwhile, a catfish with a taste for fruit helps distribute the seeds of a tree known as *Irvingia smithii* up and down riverbanks. Maybe my impression of the jungle as a single, huge organism isn't so far-fetched after all.

MARCELLIN HAD TO RETURN to the capital, Brazzaville, for a meeting and departed the Goualougo camp with two Babenzélé companions. The time had come for the rest of us to push on to the Likouala swamp and see if we couldn't find the elephants' dry-season range. One evening we pitched our tents on the side of a low rise that we struck just after crossing a marsh. I backtracked toward the water after dinner to wash away the day's sweat, then returned to camp and played cards with the crew while inch-long ants crawled over our legs. I ignored them, saving my concern for the army ants that sometimes stormed through at night. They could make you feel as if you had fallen into a fire.

It had taken a while, but I was coming to terms with this realm, with its eternal sauna heat and closeness, with its thousand small, daily insults to the flesh. I went off to bed. Now and then I was awakened by bites from various things that had gone off with me. Sometime after midnight I turned over onto an African honeybee and got stung. Hard. By three in the morning my body was swollen and my breathing labored. Swallowing was all but impossible. I finally roused myself enough to understand that I might be headed into anaphylactic shock, a potentially fatal allergic reaction.

Although I had never been badly affected by a bee sting before, my life might soon depend on an injection of adrenaline. Then I found that through a miscommunication as we divided up gear for this leg of the journey, our team had only one dose among us. If I used it now, what would I rely on afterward? More stings were inevitable. I stared at the night. But the night had no answers.

So I sat alone through the wee hours talking to myself while I contemplated the syringe in my hand. I stirred the fire's embers and willed my next breath. Hearing me rustle about, Neeld Messler came over to offer words of encouragement, much as he had the day I climbed behind him on a rope he had rigged 140 feet straight up into the canopy. Just before dawn, in that time when each moment seems to pause and stretch before moving on and the only sound is the dripping of dew from leaf tips, I realized that I would be all right.

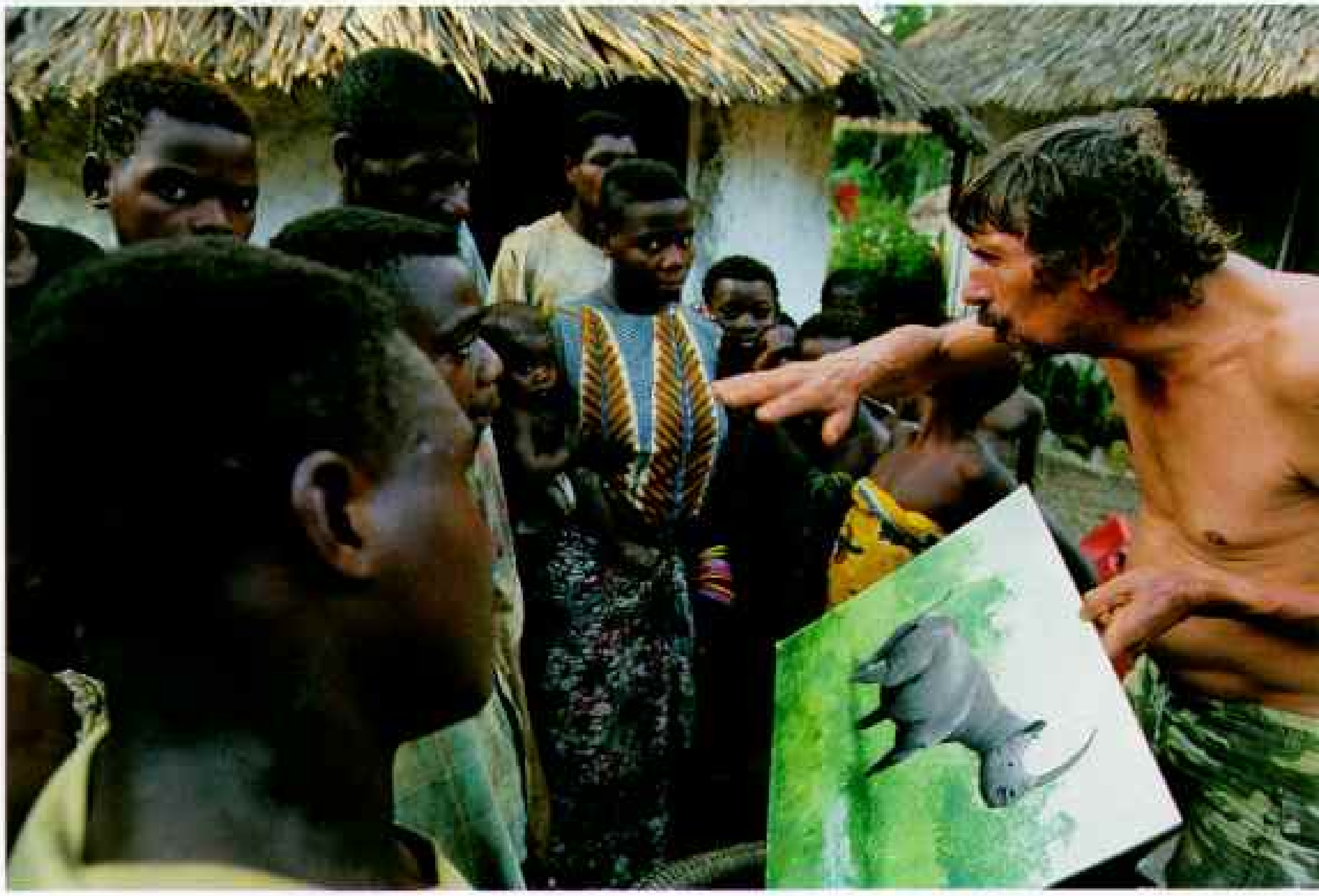
This always was my favorite part of the day. The forest's breath, heavy with oxygen, felt cool and sweet. Light gathered to the growing bird chorus. I recognized the voice of great blue turacos, bulbuls, and a secretive species I would never know except by the slow, beautiful song it whistles. Pale termites emerged from tunnels and began to sculpt the damp, red, sandy soil into coral-like confections. Then gradually, inevitably, the bird chorus was drowned out by the buzzing of insects.

Time to break camp. Starting off, I heard a new bird begin to call, its three sharp notes a perfect imitation of my mother's whistle for me when I was a boy. And as we hacked away at the undergrowth with machetes—as much so we could find our way back as to clear a route forward—I heard a child's voice in my head replying: "Mom? Listen, I can't come right now. I'm off with the wild boys to see the jungle's far side." Pray, an older voice added, that our luck holds.

The next two days brought the worst snarls of ant-coated, organic barbed wire we had yet run up against. Mike once described the Congo forest to me as relentless. No matter how hard you hike, he noted, you never have the payoff of reaching some grand scenic vista—not even a breezy hilltop where you can relax for a while. You only reach more jungle.

Now he was barking, "Come on, you guys. Don't wimp out on me. A couple more miles and we'll take a break." Two miles later, when he finally did call for a rest, I looked up from where I had collapsed on my pack to find him pacing beneath an *Anonidium* tree, a primitive angiosperm pollinated by beetles. He was reflecting out loud on the links between insects and the evolution of flowering plants. That was when I finally understood that Mike is able to accomplish what he does in this environment because he has made himself every bit as relentless.

As it turned out, the most exciting thing about reaching the Likouala was knowing that we were done marching. We never located the elephant herds, much less any brontosaurian mokélé-mbembé. On the other hand,



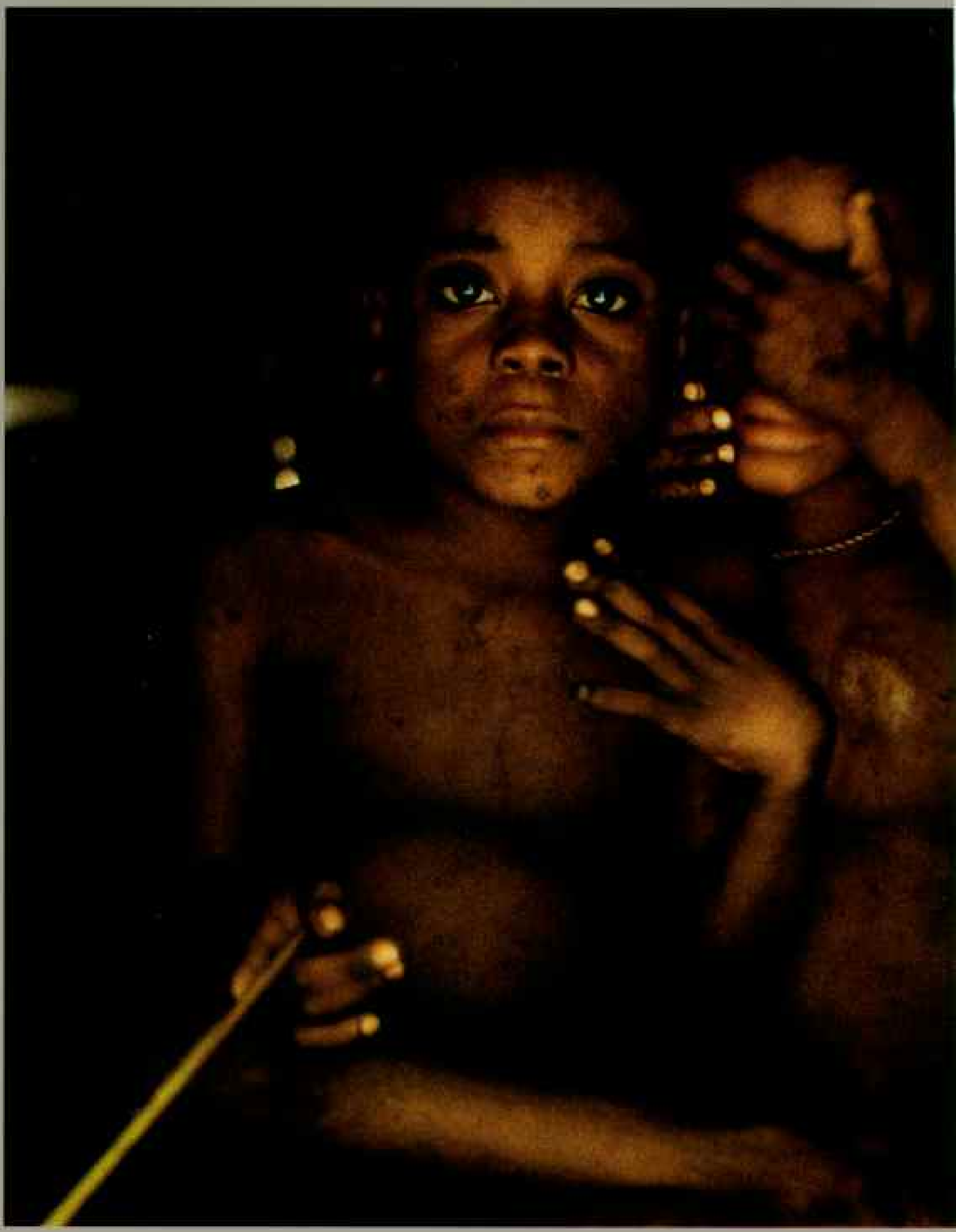
■ Name this creature, asks Michel Courtois, a Frenchman who has lived among Pygmies for 23 years. They reply: *mokélé-mbembé*—the god-beast, the elephant killer. Rarely (if ever) seen, the creature looms large in the minds of local people, whose descriptions of the beast were used to paint this rhinoceros-like portrait. Mokélé-mbembé is rumored to be the last living dinosaur.

although I got stung twice more, I suffered much less severe reactions. And I sighted fabulous beasts that many scientists consider true survivors of the dinosaur line—birds: Hadada ibises, African fish eagles, chocolate-backed kingfishers, olive sunbirds—along with modern reptiles: several turtles and a cobra. And we crossed more and more of the elephants' north-south migration trails. We even passed a few elephants and heard others trumpeting in the distance.

Mike shrugged and said, "This looked like the right route, but there's not much food in the thick stuff we've been going through. The elephant trails continue farther south. I wouldn't have known that if we hadn't hiked here. That's why you have to keep exploring. You just keep putting pieces together until you finally get a picture of how the animals are using the place. There's no other way. We're in one of the last great wild places, and we barely understand how it works."

Six or seven long days later—I forget which—we were back in Bomassa, and I was sitting on the edge of the wide, brown Sangha River staring for hours on end at something I had almost forgotten existed. Clouds unfurled within it, billowing with sunlight. Breezes swirled down from it to caress my cheek. Sky.

IN MY TRAVELS through the developing world, I have seen too many hard-won parks overrun. As part of my explorations of Nouabalé-Ndoki I wanted to know more about the challenge of blending protection with the needs of local communities. So while the rest of the team traveled north to visit elephants in the Dzanga-Sangha park, I boated 20 miles south to the logging town of Kabo. Some 1,500 people, mostly Bantu, dwell in Kabo's clapboard houses, which sprawl along the Sangha's eastern shore. After looking over the lumber-milling facilities *(Continued on page 40)*



The Pygmy Way

■ If land belonged to the people who first staked claim to it, then central Africa's tropical forest would no doubt belong to the Pygmies. Their name, which derives from the Greek word *pygme*, meaning "half an arm's length," is considered pejorative, yet the name has stuck to these, the world's shortest people. Adults average about four feet six inches, because they are unable to process the hormones needed for normal growth.

While several Pygmy groups are acculturated, others live isolated lives, among them a clan of Babenzélé Pygmies for whom the deep forest is still home. This group, including these two boys, lives in a camp located a day's hike from Makao-Liganga (population: 500) and a world apart from the rest of humanity.

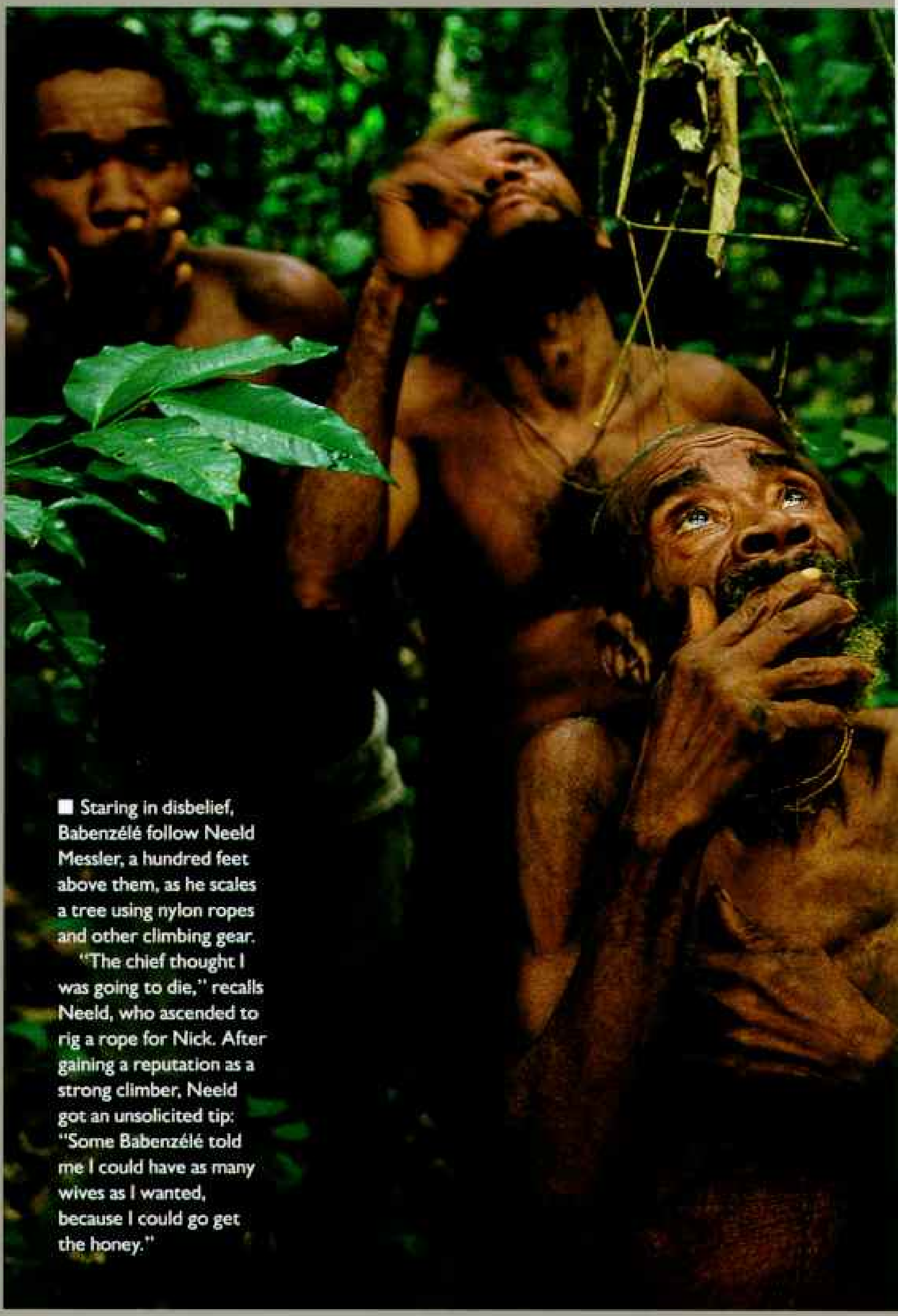
■ The balance of nature swings wildly in the Babenzélé camp. After chigoes burrowed into his feet, a boy (above) lost the use of his legs to a crippling infection. Yet in the jungle the Babenzélé find much of what they need: for building huts, leaves and branches; for food, roots, small birds, fruits, fish, caterpillars, and bush animals.

To kill a monkey, a hunter raises a crossbow while carefully mouthing a poison-tipped arrow (left). To gather honey, villagers fill a basket of leaves with burning coals (right), then hoist it into a tree beside a beehive. When smoke subdues the bees, the hunter grabs the honey.

"These Pygmies have taught me most of what I know about the forest," says Mike Fay.

At a small market in Makao-Liganga, they trade their surplus for manioc and salt or, sometimes, liquor and cigarettes.

Nouabalé-Ndoki National Park protects its forest from loggers but offers no direct protection for these Babenzélé, who live outside its borders. "They're a gracious people, too kind to put up a fight for their rights," says Mike.



■ Staring in disbelief, Babenzélé follow Neeld Messler, a hundred feet above them, as he scales a tree using nylon ropes and other climbing gear.

"The chief thought I was going to die," recalls Neeld, who ascended to rig a rope for Nick. After gaining a reputation as a strong climber, Neeld got an unsolicited tip: "Some Babenzélé told me I could have as many wives as I wanted, because I could go get the honey."

(Continued from page 33) owned by the French and Congolese corporation La Société Nouvelle des Bois de la Sangha (SNBS), I threw fresh supplies in my pack and headed back into the jungle, this time rolling in a huge truck down a webwork of roads. A few hours later, having covered the same distance as I would have in a week of bushwhacking, I reached a handful of huts. They rested on the edge of the Ndoki River, whose formidable swamps may one day be bridged by a long, earthen dike to open new terrain for cutting. This was the camp of Babenzélé workers and hunters, their families, and Michel Courtois, a *mondélé*, or white person, with three Pygmy wives.

The songs and laughter of his youngest wife, Odette, rang through the camp during a dinner of fresh fish and manioc cooked in palm oil. "She is always like this," Michel said, smiling as he fed portions to their son. "Full of true *joie de vivre*."

In a sense, this expatriate Frenchman is Mike Fay's counterpart, for Michel, too, is constantly making long traverses of uncharted jungle. The miles show in the cords of his legs and a scar on one calf from a black mamba bite he barely survived. But he and the Babenzélé scout for marketable trees rather than wildlife.

I remembered pacing off the circumferences of two great trees that rose side by side next to the path on our way back from the Likouala. Each came out to be nearly 50 feet around at the base. The pair had buttresses like rocket fins—thin, tapering flanges of wood that chimps sometimes pound on with open palms, signaling their presence far and wide. The trees shot up into the air draped with ferns and lianas until their tops disappeared in a luminous green haze. You might have thought they were the twin center poles of the entire canopy. They were African mahoganies, the most sought after of all the forest's trees.

Conservationists say cutting in this remote region must be done very selectively. Timber interests tend to agree, because only African mahogany and one or two other types are valuable enough to pay the cost of transportation to distant markets. "Many operations in the northern Congo lose money and exist on subsidies from foreign governments and international development banks," Mike Fay had told me. "The timber companies here have generally supported our project, and SNBS has shown a real interest in making it work."

Laying out a map alongside his round hut of mud and branches, Michel Courtois told me, "On average, we have just one African mahogany of commercial size per hectare [2.5 acres]. Logging them removes only 5 to 10 percent of the total canopy, not enough to change the basic structure of the forest. The problems have to do with the roads one must build to reach those trees. They bring too many people.

"The Pygmy way is to hunt a little bit here, a little bit there, always changing around to let the forest rest," he continued. "But the Bantu villagers come, and they hunt and hunt and supply markets up and down the river. They hunt to make money, and it is that which kills the forest."

Logging crews, truckers, and mill workers often spearhead the plunder of animals. SNBS officially discourages commercial hunting near its camps, but I saw plenty of men on the roads near Kabo with guns and fresh duikers, bushpigs, and other game slung over their shoulders. Later I stopped at Djembe, a clearing on the Cameroon side of the Sangha, where wood from Kabo's mills is unloaded from barges to be trucked along a major new road to the coast. Racks of meat for sale included fresh gorilla and smoked monkey. They usually do at such outposts. My memories of being greeted by primate groups in their homeland and looking into kindred eyes that held more fascination than fear began to seem like a dream. Once the forest is opened, great apes and monkeys are almost always the first to go. Game laws to protect them and other large species exist. They are openly ignored.

TO PUT POACHING in perspective for those of us who forage in supermarket aisles, it is important to know that neither commercial agriculture nor livestock husbandry is common in parts of equatorial Africa. Groceries continue to come straight from the bush, even for urban areas. In an all-too-familiar pattern, market hunters simply keep moving ever farther afield, stripping the countryside of game.

To find out how the park was dealing with the problem, I sought out Richard Ruggiero, who manages operations at the Nouabalé-Ndoki project base camp, a small complex of buildings taking shape between Bomassa and a satellite village called Bon Coin. Together the two settlements contain some 75 Bangombé Pygmies and a roughly equal number of

■ Running a fever of 103°F, Mike Fay huddles under a mosquito net as he sweats and shivers through yet another attack of malaria. Regular preventive doses of antimalarial drugs can have negative long-term effects—like hearing loss and liver and kidney damage—so Mike, who has worked in Africa since 1978, waits until he feels achy and queasy before medicating. It's a risky tactic that has twice nearly killed him.

Bantu. The project intends to establish a second station by Makao-Liganga, a village of some 500 Babenzélé and Bantu on the opposite side of the park.

"Nouabalé-Ndoki has a lot going for it," Richard said, as we swam in the Sangha in lavender twilight. "The crucial thing is that the human population is still very small relative to the size of this region, and hardly anyone even ventures into the park area. That means we can concentrate on getting out ahead of problems with a lot of environmental education."

And just plain education. From base camp I strolled down the path to Bomassa and sat with a class of nearly 30 children reciting letters of the alphabet. A morning class taught the same basic reading and writing skills to adults.

The school, Bomassa's first, was a metal-roofed hut open to the afternoon air—to the river, to women hanging laundry to dry, and to weaverbirds carrying mouthfuls of food to their nests. I wished my old grade school had been half so pleasant.

Mark Daley, a Peace Corps volunteer from Massachusetts overseeing construction work in the base camp, provided the spark in 1993. Using money from his own pocket, he arranged for a Congolese clerk to tutor a village boy in whom Mark saw particular promise. "His father used to be one of the biggest elephant poachers around," Mark told me. "I wanted to make sure this boy grew up with alternatives." So many others showed an interest in the tutor's lessons that the project soon added funds for materials and an additional teacher. Which only seems fair, when you consider that the villagers have been teaching the biologists how to read the forest.

"If my back did not bother me so much when I sit a long time, I would go to school myself," said Georges Tambomo when I stopped to talk to the white-haired chief near the village center between a knot of playing children

■ The Motaba River suffers little from human presence—so far. Park managers hope to satisfy tourists' demand for a wilderness experience in buffer zones just outside the park, so they won't feel cheated by not seeing the untamed interior. "It's not that people haven't been there before," says Nick, "it's that we just don't belong there."

and some women pounding manioc roots into flour. "I see changes for the young and the old since the project arrived, but I do not worry too much, because the changes are good."

Such changes include rules about where hunting is allowed next to the park and how it should be done. Rule number one: no wire snares. They grab paws, hoofs, and elephant trunks indiscriminately, tightening like tourniquets with each tug, and can empty a forest of big life-forms more quickly than any other device. Naturally, the restrictions chafe some hunters. But not too many, because other changes include employment of local men by the project for carpentry, trail building, and transporting equipment. Once the park is up and running, there will be new jobs as guards, interpreters, and research assistants.

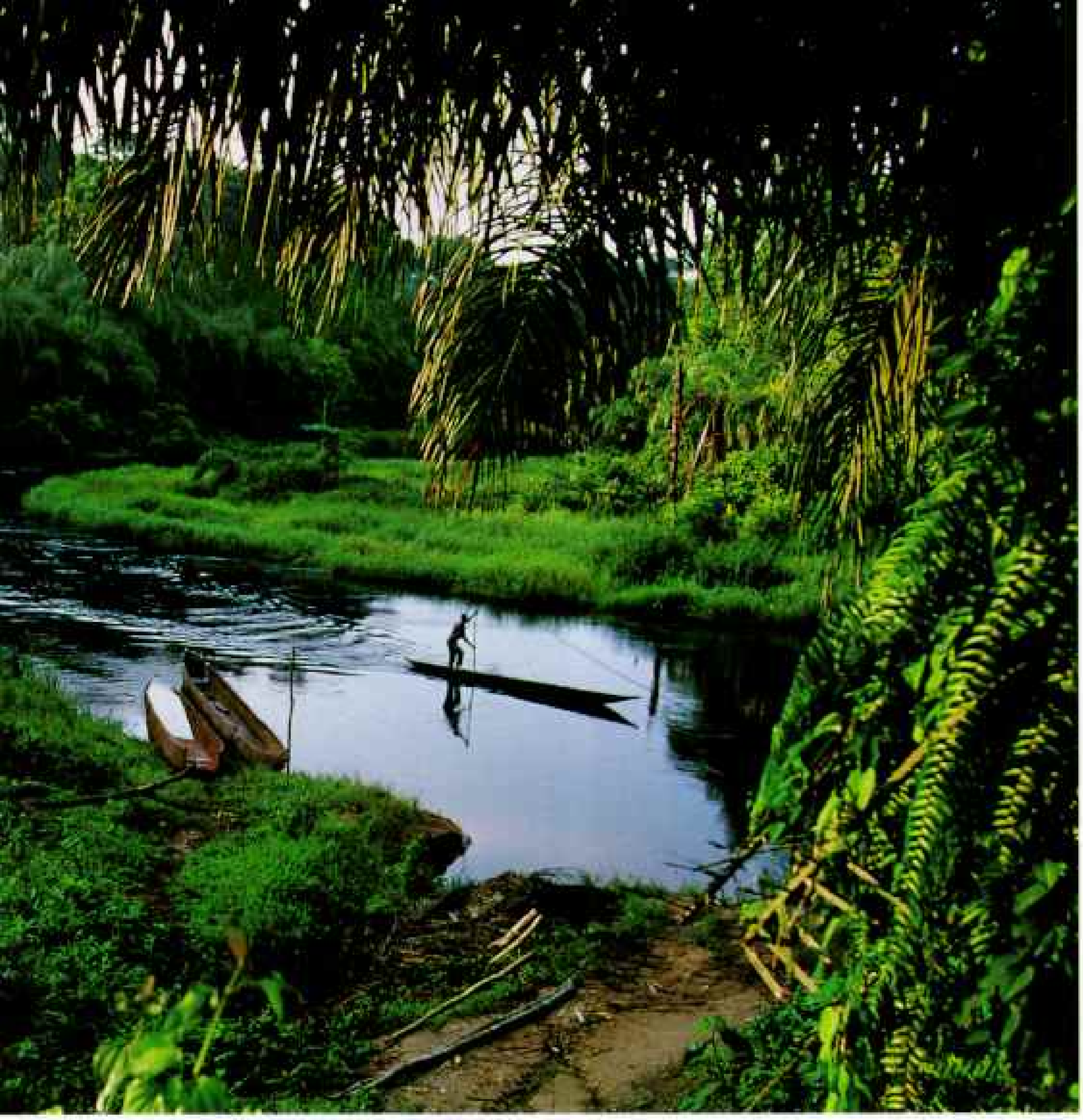
"From the start we have insisted on hiring only local people," Richard declared. "If we lack some skill in our workforce, we train someone here to master it. Otherwise we would become like the logging boomtowns and other big development schemes that draw in workers from all over and place heavy pressures on wildlife and human communities. We hammer home the message at every village meeting: In the end Nouabalé-Ndoki isn't for us or for any other outsiders. It's for you. If you hunt out the animals, I can still buy food. The question is, what will your children eat?"

The next day Richard was in Bomassa confronting a poacher who had set out a snare line. The man was merely warned, and another meeting was held in Bomassa to discuss what people want and what they can gain from managing their wildlife. Such violations were rare, and the fact that the poacher was turned in by other villagers promises to make them rarer yet. The message seems to be getting through: Take no more than the forest can give, and you will have what you need for generations to come. Conservationists also seem to be heeding a simple message: Work with people's self-interest, and you've got the strongest force in the biosphere on your side.

I WENT OFF to do some limited hunting and gathering in the buffer zone myself, collecting beetles just beyond the park along a narrow jeep trail. No matter how the needs of humans, great apes, and monkeys are resolved, the overwhelming majority of animal life in the tropics will always have six legs.

Beetles are the most diverse group; my vials filled with forms resembling everything from polished metal to lichen-splotched bark. Ants and termites are the most abundant; together, their small bodies outweigh all the big mammals combined.

Few animals are able to digest cellulose, the tough structural tissue of plants. Termites can. Aided by specialized microbes that live in



their guts, they turn it into carbohydrates. Upon reaching maturity, many species grow wings and take to the air in a mating flight, a stage during which they are known as alates. Those wings soon detach, leaving pairs of termites scattered throughout the woodland to found new colonies.

A massive flight of alates surrounded me all through the morning. Shrikes and the glossy black birds called drongos fluttered in pursuit. I saw a water mongoose, a golden cat, and then chimpanzees feasting on alates as they drifted down onto the forest floor. Fresh sign said a leopard had been doing the same. The wealth of the forest that had been locked into wood was being distributed to one and all in a mist of gossamer wings.

Nouabalé-Ndoki does not conform to many of the usual romantic notions about nature, I thought as I made my way along another path the next morning. It is simply nature unto itself—real wilderness: ancient, potent, and largely unfathomed.

At any moment some part of it might transform me from a normal human, thinking relatively normal thoughts, into a crazed bundle of mindless reflexes and fear; I knew that now. I would keep pressing ahead into the green embrace anyway, because . . . because, to be honest, I am as much afraid of being a quitter as I am of anything else. But most of all because of the possibility that, in a few more steps, I would once again be transformed by wonder instead.

* * *

Running on Empty

■ A perfect platform for aerial photography, the twin-engine Air Cam was built especially for this article. Flying it in the Congo, designer Phil Lockwood showed Nick its best feature: Sitting in front of the wing, Nick has an unobstructed view of the world below.

When the Air Cam landed on a Bomassa soccer field, locals gave it a spirited welcome (far right). Nick's stomach sank a few days later, when he thought the craft was running on empty (right). "Phil hadn't told me that it's really empty when the gauges are way below E," he says. (The National Geographic Society has since donated Air Cam to Nouabalé-Ndoki National Park for use in research.)

That sinking feeling hit writer Doug Chadwick too. "I tend to romanticize nature," he says, "but over there you're a big fleshy piece of protein, and as soon as you sit down, something crawls or slithers across your feet." Rare, then, were the restful moments (above). "This story beat me up," he admits, "and at times it scared me to death." Hikes were grueling and pain was borne in silence. To communicate with Pygmy men, Nick resorted to hand signals to discuss subjects of universal interest, like women and food. "On this story," Nick says, "I had enough male bonding to last me the rest of my life." □


Air•Cam

By JON KRAKAUER

Photographs by
RAYMOND GEHMAN

Rocky Times for

BANFF

Surrounded by splendid solitude,
a hiker at timberline escapes the crowds
that throng Canada's best loved—
and busiest—national park.

Picture-perfect scenery, such as Peyto Lake, lures more than four million visitors to Banff annually. Such intense use concerns biologists, who say the outlook for the park's wildlife is not a pretty picture.

HIGH IN THE CANADIAN ROCKIES, the August wind already carries the scent of winter, and the streams are edged with a filigree of ice crystals. Clouds rear over the western horizon, threatening snow.

"Look up there!" whispers my companion, an American tourist named Linda Moore, pointing nervously at a slope bearded in heather. "Did you see it move? Oh, please don't be a grizzly!" This is bear country, and neither of us relishes an intimate encounter with Griz, but as we get closer, the "bear" turns out to be a mountain goat, accompanied by three shaggy colleagues. The burly white animals drift up the ridge ahead of us, capering across the boulder-studded incline with an economy of effort that mocks our own halting progress.

Not far above the goats, the ridge narrows into a jagged edge before arcing skyward like a buttress on a Gothic cathedral. At 11,452 feet above sea level the ridge culminates in the summit of Mount Athabasca, crowned with a rakish chapeau of rime, marking the northern boundary of Canada's oldest and most cherished national park: Banff.

Just to the south the tongue of the Saskatchewan Glacier fills a mile-wide valley of its own creation. But the glacier, for all its immensity, is merely Gulliver's toe; the main body of ice, the source from which the Saskatchewan flows, is visible on the skyline as a high white bald. This is the Columbia Icefield, vast and desolate, a frozen carapace twice the size of the District of Columbia, the largest ice cap in the Rocky Mountains.

The breeze howling down from the icefield cuts through every stitch of clothing I have on, so I stop in the lee of a truck-size boulder

to pull on another sweater and chew on the view. It's a primeval landscape, raw and unspoiled and faintly threatening. From where I sit, the hand of man is nowhere apparent.

But that, sadly, is an illusion not easily sustained. On a warmer afternoon we would have company, lots of it. Lower down on Parker Ridge the tundra has been trampled by so many hikers that in places the route resembles a boggy, 20-foot-wide cattle trail.

When the wind penetrates the last of my sweaters, we turn around and descend to the car. At dusk, as we drive south past Mistaya Lake into the heart of Banff National Park, a wolf trots across the highway and pauses nonchalantly to look us over. Only 40 wolves now live in the park. Thrilled to chance upon one, I stop the car and return the creature's

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JON KRAKAUER is the author of *Into the Wild*, the account of a young man who starved to death in the Alaska wilderness, to be published this winter by Villard Books. RAY GEHMAN's photographs appear in the forthcoming Geographic book *Exploring Canada's Spectacular National Parks*.

stare. Then I notice the plastic radio collar around its neck, fitted by biologists to ensure the survival of its kind. As the 20th century draws to a close, I am reminded, much of the continent's remaining "wilderness" is intensively manipulated, regulated, and policed, lest it vanish altogether.

The deeper into the park I drive, the more visible is the human impact. Outside the resort village of Lake Louise the traffic congeals into a bumper-to-bumper crawl, and a few miles farther stops rolling altogether. A young black bear is grazing the berry thickets on the shoulder, creating an instant "bear jam" that turns five miles of Canada's primary highway into an ad hoc parking lot.

Banff, like Yellowstone in the United States, is the nation's flagship national park,

Braving a September snowstorm, guide Barry Ferguson makes a cautious descent from Banff's high country. Ferguson prefers mules over packhorses, he says, "because a mule looks and thinks before he steps."

the most visible symbol of the dominion's natural splendor. Its scenery is known and loved by people around the globe. But some say Banff is loved too much, that the park has grown too popular for its own good. "There are many, many complex issues confronting us," concedes Banff Superintendent Charles Zinkan in a weary voice. "The

Stripped by ancient invasions of ice, Banff's mountains beckon climbers, who walk a thin ledge between adventure and disaster. Missteps kill four climbers here each year, on average.

BANFF

Banff is to Canadians what Yellowstone is to Americans: their country's first and foremost national park. Embracing more than 1.6 million acres on the eastern flank of the Continental Divide, the park belongs to a constellation of preserves that form the Canadian Rocky Mountain Parks World Heritage Site.

park is feeling pressure from all directions."

Hugging the Continental Divide 150 miles north of the Idaho Panhandle in Alberta, Banff is bordered by three other national parks—Jasper, Kootenay, and Yoho. Together with three local provincial parks they form the Canadian Rocky Mountain Parks World Heritage Site, a rugged sprawl of wilderness freckled with hulking glaciers and countless lakes glimmering in shades of blue so electric they defy belief.

More than five million acres in aggregate, these preserves constitute one of the planet's largest protected mountain landscapes. Banff is the best known, the most heavily used—and always seems to spark the biggest ruckus. Whatever happens in Banff has a way of sending ripples through the entire region.

And a lot happens in Banff. More than four million people visit the park annually. Canada's main transcontinental railway and transcontinental highway roll side by side down the length of Banff's main valley. On the busiest weekends the road is clotted with cars, RVs, and tour buses, and a gauzy brown haze of exhaust fumes veils the celebrated vistas. Within the park lie three ski resorts and the town of Banff—home to 7,000 permanent residents. On a typical summer day the townies may see 25,000 tourists streaming through their streets.

Among the people who live and work in Banff, there is considerable disagreement over whether this crush of humanity bodes serious ill for the park's future. Mike McIvor, a resident for 33 years and former grounds foreman at the Banff Centre, an internationally renowned arts institute, believes overdevelopment is fast destroying the place he loves. "The kind of experience that is supposed to be available in a national park has been completely perverted here. This should be a place where people learn to reconnect with the natural world, but that's hard to do

Senses alert to intruders, grizzly bears stand defenseless against development of wildlands.

As few as 50 hang on inside Banff, where half their habitat has been lost to human intrusion.

Negotiating a narrow passage, ice climbers explore the Athabasca Glacier on Banff's frozen northwest border. An early destination for alpinists, the park was described by a visitor in the 1880s as "a great resort for . . . madmen who like climbing mountains at the risk of breaking their necks."

sitting in a traffic jam on Banff Avenue."

Such talk rankles Ossie Treutler, a local businessman and town council member. "Environmentalists like McIvor love to talk doom and gloom," Treutler grouses, "but all you have to do is drive five minutes out of town and you're in the middle of miles and miles of nothing but nature. You get tired of looking at all these big bare mountains; what's wrong with putting a restaurant or a little chalet up there to make it nicer for the people who come here?"

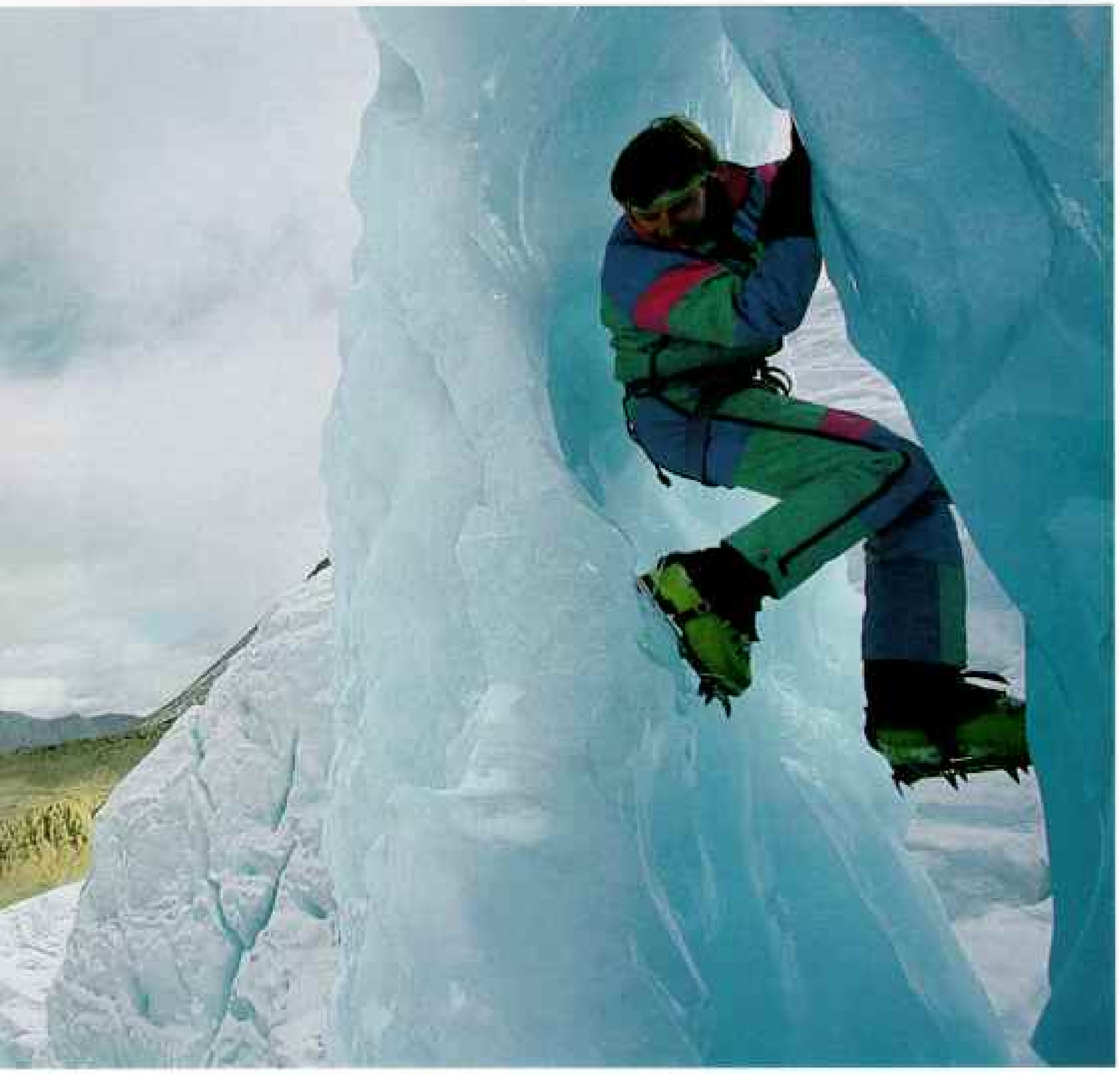
One thing that's wrong with it, according to Paul Paquet, is that the human presence in Banff is wreaking havoc on the area's fragile makeup. "I'd say the park is in very, very poor condition compared with what it was ten years ago, twenty years ago, thirty years ago," declares Paquet, a biologist who has studied wildlife throughout the Rocky Mountains. "There's been a major decline in most of our large predators—black bears, grizzlies, wolverines, lynx, cougars. Such species are one of our best indicators of overall ecological health, and the way things are going, most of these animals will not survive here."

Nonsense, insists Rick Kunelius, a former wildlife warden with the park service. "The large-mammal population is higher than it's ever been," Kunelius says. "Development has actually increased habitat for wild ungulates by creating more forage: the golf course, the recreation grounds, everybody's yard. If you don't believe me, just look at the elk."

LOOKING AT ELK is not hard to do in Banff. And nowhere is it easier than within the boundaries of the town itself, where elk don't have to worry about predators and are presented with a smorgasbord of green lawns. Everywhere I turn, I encounter robust herds of well-fed elk: on the grounds of the hospital, grazing in the downtown park, nibbling petunias in backyard gardens. The park service estimates that 400 of the creatures live in the town's immediate environs.

If the elk have adapted astonishingly well to living with humans, some humans still have much to learn about living with elk. Tourists, assuming the creatures must be tame, often try to pat them or feed them potato chips, only to discover that a thousand-pound beast with a five-foot rack of antlers can do a lot of damage when annoyed.

Nobody has been killed yet by an elk, but there have been several serious injuries. Cow elk become particularly dangerous during the spring calving season; bulls grow mean and mercurial during the autumn rut. On a few occasions bull elk in the throes of lust have even charged vehicles on city streets.



Alarmed at the growing potential for tragic encounters between elk and tourists, park wardens have been singling out problem elk, fitting them with ear tags and radio collars and, for the worst offenders, sawing off their antlers and trucking them far from town. Human foolishness accounts for at least half the problem, though, so wardens have also mounted an intensive campaign to educate tourists about the unpredictability of elk.

Homo sapiens, alas, is a difficult species to train. Wandering along Wolf Street at the height of the fall rut, I come across a bull elk and four cows grazing in a yard three blocks from the center of downtown Banff. In front of me, a young German couple with a toddler decide that a snapshot of their son next to an elk would be cute. The father plunks the child down in front of the bull, then dashes back to shoot a picture as the youngster waddles over to hug the immense, reeking beast.

The elk, not surprisingly, takes exception to this intrusion. His ears flatten, he curls his upper lip. He lowers his antlers and glowers menacingly. Just when bloodshed seems imminent, Dad swoops in and snatches Junior away with a laugh, oblivious to the danger.

THE MULTITUDE OF ELK roaming the streets of Banff gives a false sense of ecological well-being, warns biologist Paul Paquet. "Our best data suggest that there aren't really any more elk now than there were ten or fifteen years ago," he says. "They've just become habituated to the town, so they're much more visible."

Park nightlife takes a citified turn on Banff Avenue, where cocktails and karaoke upstage campfire songfests. "The business community wants Banff to become another Aspen," charges a critic. "We want it to be a national park."

Paquet says the problem is that although there is indeed a vast amount of undeveloped acreage remaining in the park, most of it lies at high altitude, in harsh alpine zones. Many species of wildlife can't live in the rugged, inhospitable landscape of the high country, at least not year-round; the best habitat is the riparian bottomland, which also happens to be the preferred habitat for humans. The bucolic floor of the Bow Valley is where people construct homes, build roads, put up shopping malls. The town of Banff and surrounding development already fill the valley from wall to wall, acting like a noose that chokes off one of the most important wildlife corridors in the northern Rockies.

"Seven years ago," confesses Cliff White, the park's coordinator of ecosystem research, "we made an incredible blunder when we were establishing limits on the size of the town." After determining that elk needed migration corridors at least a hundred meters wide, White and his colleagues laid out town boundaries that permitted development to occur up to a hundred meters of the steep mountain escarpments that crowd the community. "But," he says, gazing ruefully down at the noisy, bustling townsite from the south slopes of Mount Norquay, "we didn't think about the wolves."

Wolves, it turns out, play a crucial role in maintaining the health of the ecosystem and are much more skittish around humans than elk are. "Wolves need corridors at least a kilometer wide," says White. "In our ignorance, we granted permits that allowed construction of a big new hotel right in the middle of a critical wolf corridor at the edge of town."

This newest hotel—with its staff that swells to 300 in summer—worsened an already acute housing shortage. A subdivision on the drawing boards to ease the housing problem would have obliterated the wolf corridor. Revised plans give wolves something of a passageway, 350 meters wide.

The shortage of housing for those employed by the park's half-billion-dollar tourism

industry has become one of the park's knottiest problems. Few sites remain for building; virtually all the flat, open land around Banff is critical wildlife habitat.

Since 1970 the park service has imposed an extraordinary regulation on the town: the notorious "need to reside" clause. The essence of this decree, explains Leslie Taylor, the town's tireless, extremely popular mayor, "is that in order to live in Banff you must have a job here, be a spouse or dependent of a person who has a job here, or be retired after working here for five years."

Still, great pressure is being exerted to increase development in the park. Northwest of town, on a treacherous section of the Trans-Canada Highway, plans are being completed to double the width of the road from two lanes to four. This should make the road safer for human travelers, but Paquet and other environmentalists think the new divided highway and its boundary fence will further disrupt animal movements.

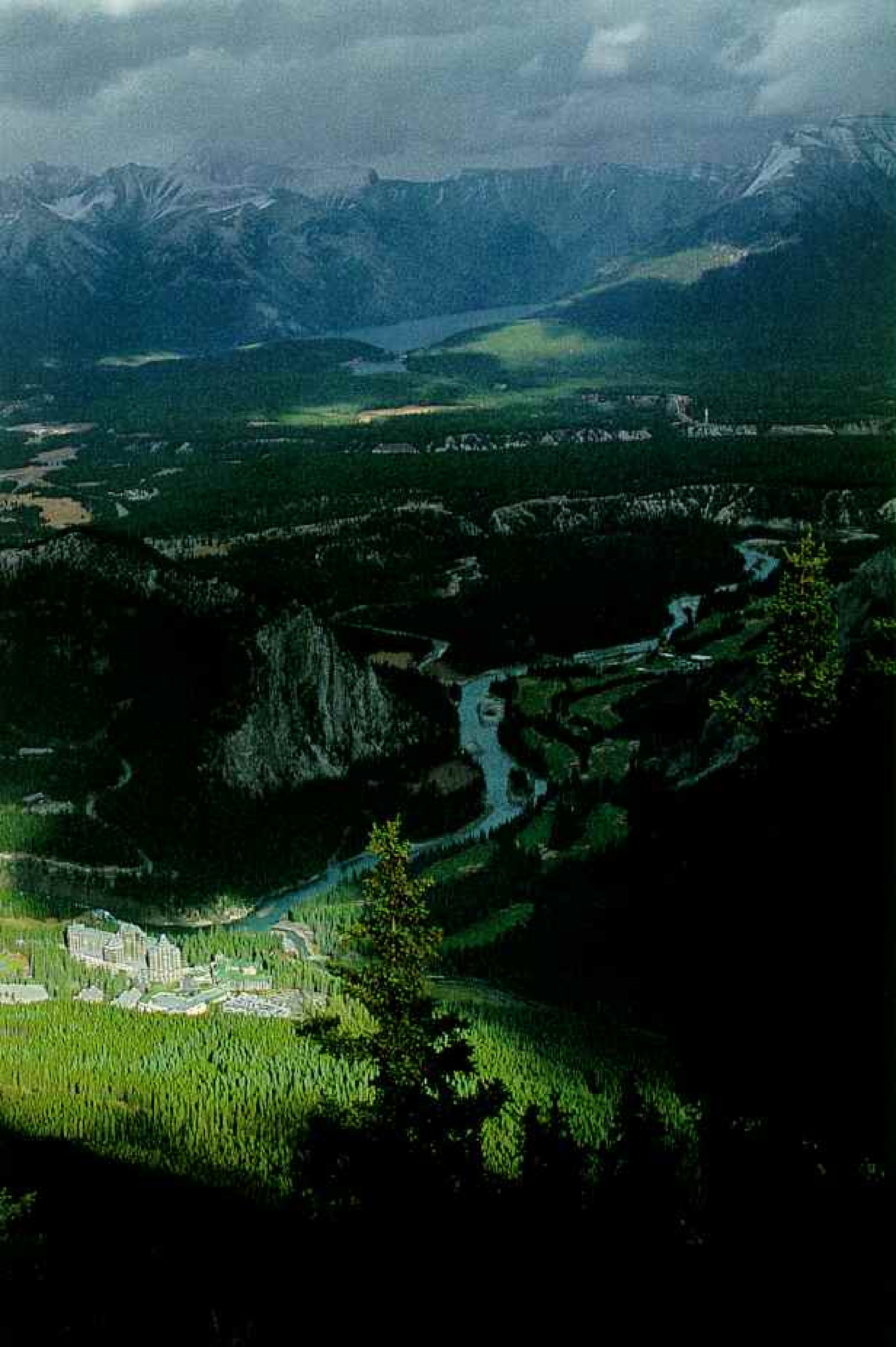
"What a bunch of hogwash!" announces a clerk manning the cash register in a Banff storefront. "There have been ten fatalities in the last ten months alone! And some guys are worried about killing a few elk? The animals are nothing but vermin, overgrown rats with antlers. If those tree huggers manage to prevent the twinning of the highway, the blood of innocent crash victims is going to be on their hands."

Complicating matters further, biologists have lately come to appreciate that development beyond the park's boundaries is having a profoundly adverse effect on Banff's health. At the southern edge of the park, the sides of entire mountains have been carved into rubble by strip mining. And plans have been approved that will transform Canmore—a once sleepy village just outside the park's south entrance—into a sprawling network of golf courses, hotels, and vacation homes.

"The problem," says Chief Warden Bob Haney, "is that the park's boundaries are artificial. Plants and wildlife don't recognize lines drawn on a map. We've been slow to

Grazing in the park's greenest pasture, a bull elk and his harem present a hoofed hazard on the Banff Springs Hotel Golf Course. Forty-three elk attacks were reported parkwide last year. Almost all, say wardens, were provoked by people.

Presiding over a bend in the Bow River since 1888, the baronial Banff Springs Hotel transformed a whistle-stop on a wilderness railroad into a fashionable resort visited by royalty and movie stars.



Framed by picture windows, snow-crowned peaks ring with the sounds of a building boom in Canmore, just outside the park. Blueprinted for eight hotels, four golf courses, and 6,000 new homes, the town is expected to triple in size within 20 years.

understand that setting aside a small postage stamp in the middle of a vast and complex ecosystem just doesn't work."

"Banff is in a period of transition," muses Cliff White, whose family has lived here since 1885; his great-grandfather ran a grocery store on Banff Avenue. "Important questions need to be asked that get at the very heart of what this park is supposed to be."

As it happens, when the national park was conceived 110 years ago, its creators never intended it to be a nature preserve. Quite the contrary. Banff was conceived as an oasis of civilization, an island of gentility amid a sea of wilderness. Protecting biodiversity for the benefit of future generations never occurred to anyone. The founders of the park were inspired by visions of lucre.

A FEW MINUTES from downtown Banff, 30 feet beneath Sulphur Mountain, I stare up at motes of dust suspended in a beam of sunlight. I am standing in a small underground chamber, a limestone cave festooned with weird geologic protuberances. The shaft of light descends with operatic flourish from a small gash in the earth's stony hide. The air I breathe is thick with the smell of rotten eggs. At my feet lies an enchanting blue pool, as warm as bathwater. It was this cave, this soothing water, that gave birth to Banff National Park.

The story begins in 1871, when Prime Minister John A. Macdonald promised the residents of British Columbia that if they would join the dominion, a railway would be built across the whole of Canada, linking the Pacific port of Vancouver to the eastern provinces of the Maritimes. By October 1883 the Canadian Pacific Railway—the CPR—had pushed its tracks west into the Rockies as far as the site of present-day Banff, a desolate wayside then known simply as Siding 29. A month later three railway workers doing spare-time mineral prospecting—Franklin McCabe, William McCardell, and Thomas McCardell—blundered upon a cluster of natural hot springs gurgling from a hillside

above the Bow Valley, the loveliest of which was the blue pool I'd admired in the subterranean cavern.

The appeal of hot springs was immense in that day and age. Steaming mineral pools were thought to cure numerous ailments, from cancer to gunshot wounds to snakebites. It was the public's fascination with thermal waters, in large part, that had led to the creation of the world's first national park, Yellowstone, 11 years earlier. When the three young railway workers inhaled deeply of the hydrogen sulphide fumes wafting from the cave above Siding 29—as historian Sid Marty imagines the moment—"Their nostrils flared to the invigorating scent of dollar bills."

McCabe and the McCardell brothers filed claims with government authorities, but their bumbling efforts to gain title to the springs betrayed a glaring lack of both legal acumen and common sense. Greed too got the better of the would-be spa magnates: Before long the partners were bickering and double-crossing one another, and the government was called in to settle the dispute.

When agents of the crown arrived, however, they saw in the steaming pools a means to replenish the treasury, which had been depleted to the point of bankruptcy funding the wildly overbudget railway. The government resolved the question of ownership on November 28, 1885, by nullifying all pending claims and setting aside land surrounding the thermal waters as a "nation's park," Canada's first, only the third national park to be established on the planet. Christened the Banff Hot Springs Reserve, the park's first incarnation covered all of ten square miles.

As far as the crown was concerned, the springs were of little value in their undeveloped state, so a program of "improvements" was launched. Gambling that tourism would save the railroad from financial ruin, in 1888 the CPR opened an elegant hotel below the hot springs, designed in the image of a grand French château. The largest hotel in the world at the time, it had 250 rooms and cost the staggering sum of $250,000 to build, but

Looking for a free lunch, a mule deer moocher peers inside a hotel room in Banff.

A few dozen "mulies" and some 400 elk inhabit the town, which sits atop their traditional winter range. Fed illegally by tourists, some get hooked on handouts.

Plying the mirror-smooth surface of Lake Louise, paddlers soak up the surreal beauty of Banff's most celebrated mountain tarn. Glacial meltwater laden with silt lends the lake its

the gamble paid off. The Banff Springs Hotel launched a major resort.

Rebuilt in 1928 after a fire, the hotel still stands today, its distinctive turreted roofline visible for miles. Commanding the roundabout in front is a statue of a bald, corpulent man gesturing imperiously toward the horizon. It is a memorial to Sir William Cornelius Van Horne, general manager of the CPR, promoter nonpareil, who more than any other person shaped the character of Banff.

Van Horne had been among the first to pay a visit to the thermal cave. Upon emerging from the steaming cavern he blustered, "These springs are worth a million dollars!" and proceeded to lobby strenuously for Banff to be made into a national park, shrewdly recognizing the revenue such a move would generate for his railroad. It was also Van Horne, by the way, who gave Banff its peculiar name; he did it to butter up the two largest Canadian Pacific Railway shareholders,

incandescent color, which changes with the seasons. "People ask us what we put in the water to make it that color," says a park employee. "They can't believe it's real."

who were born in Banffshire, Scotland.

The park was expanded to 260 square miles in 1887. In 1902 it was expanded again to include the Valkyrian landscape surrounding Lake Louise, 40 miles northwest of the Banff townsite, where Van Horne had built another hotel. The park's expansion did not signal the arrival of a conservation ethic, however. Logging and mining were still permitted. Hunters had all but wiped out the park's elk, bear, and other game.

Despite the heedless exploitation of the park's natural wealth, a subtle shift had commenced in the way it would be run. Commercial development remained a priority, but more and more attention was paid to preservation. In large part, the agents of change were upper-crust American tourists, influenced by the ideas of John Muir and Henry David Thoreau. Many were climbers who'd been drawn to Banff by the unscaled summits that loomed as far as the eye could see.

Unbridled spirits race the wind at the mile-high Ya Ha Tinda Ranch on the eastern border of Banff. "The name is Stoney Indian for 'prairie in the mountains,'" says foreman Ken Pigeon,

LAKE LOUISE IS ABUZZ with tourists, chattering happily in French and English, Italian and Japanese, German and Spanish and Portuguese. Camcorders whirring, they stroll in packs along the shoreline, marveling over the jagged, glaciated heights and sweet-smelling stands of larch and fir. Peals of laughter echo across the morning as novice paddlers navigate rented canoes inexpertly over the turquoise depths.

Four thousand feet above the lake I ascend in solitude. The peaks are silent except for the growl of glacial ice inching toward the valley. At 3 p.m. I arrive atop Abbot Pass, 9,600 feet above sea level, a rocky notch straddling the Continental Divide between the peaks of Mount Victoria and Mount Lefroy. I will spend the night here, in a stone hut maintained by the Alpine Club of Canada, and continue to the top of Lefroy in the morning, when the upper slopes are frozen solid and avalanche hazard is minimal.

When I push open the hut's heavy wooden door, assuming it will be empty, I am startled to be greeted by a smiling, sunburned man with a face like a harvest moon. He is Andrew Smith, a divorced father of two from Saskatoon. "I've been up here three days now," he blurts. "I'm just a flatlander. This is as high as I've ever been."

Later Andrew explains that he's on a two-week vacation from a high-pressure job as a professional mediator. "I've been able to step back and look at things from a different perspective up here," he tells me over a cup of tea. "I have no itinerary. No watch. I know what I'll probably do tomorrow, but I have no idea what I'll be doing the day after that, or the day after that, or the day after that. The biggest decision I've had to make is whether to pee down the Atlantic side of the divide or the Pacific."

In the morning I crawl from my sleeping bag before sunrise, brew some espresso, strap on my crampons, and start to climb. The northwest face of Mount Lefroy looms

who breeds and breaks horses used by Canada's park service. Wardens on horseback patrol 900 miles of motorless trails that braid Banff's backcountry.

directly above the hut, gleaming in the first pale wash of dawn. The route to the summit ascends 2,000 feet of steep, sapphire blue ice.

I climb with a steady, hypnotic rhythm. The steel picks of my ice tools bite into the ice with a reassuring *thunk!* My calves start to burn from the strain of balancing on crampon front points, and my lungs heave in the paper-thin air.

Ninety minutes after starting out, I arrive atop a crest of rime shaped like an immense breaking wave. Peering carefully over the frozen lip, I gaze down at the miniature larch groves of Paradise Valley, a vertical mile below. The sky yawns around me. I'm on the summit of Mount Lefroy.

A cold wind is raking the top of the mountain, so I gulp down a candy bar, snap a few photographs, and then start down without delay. Two hundred feet lower I find myself descending a narrow cleft bordered by walls of crumbly black rock. Something about the place jars me from my summit reverie. This, I realize, must be where Philip Abbot fell to his death in 1896, an event that altered the course of Canadian mountaineering.

Abbot, a lawyer from Boston, was said to be North America's finest mountaineer at the time. Unclimbed Mount Lefroy was the most coveted summit in the Canadian Rockies, and he became obsessed with making the first ascent.

Early on the morning of August 3, 1896, 28-year-old Abbot and three friends set out from Lake Louise to attempt Lefroy and at noon reached the pass that now bears his name. By 6 p.m. they were just below the summit. Abbot, in the lead, told his partners to untie from the rope while he scouted the route above. A moment later there was a rumble of falling rock; then Abbot's body plummeted past his horrified companions and hurtled down the slope they had just ascended. It was the first recorded fatality in North American mountaineering.

Abbot's death created a commotion in the

Apparitions of the Old West appear on an outfitter's camp tent as trail guides while away a chill evening. Meanwhile, heated debate continues on how best to accommodate Banff's swelling stream of visitors without further compromising the park's ecosystem.

press. But instead of squelching interest in Canadian mountaineering, the accident on Lefroy had the opposite effect. After reading breathless newspaper accounts of the challenge posed by Banff's summits, hordes of climbers flocked to the Rockies.

Quick to recognize a cash cow, Van Horne began referring to the Rockies as the Canadian Alps and hyped the region as "a second Switzerland." Then, to ensure that his burgeoning clientele of amateur climbers stayed alive, he imported a corps of Swiss mountain guides.

"We were good at what we did," says Bruno Engler, a guide from Lugano, who arrived in Banff in 1939. "In all the years the Swiss guides were in Banff, there was never a fatality. Then, soon after the CPR closed the guide service in 1954, three women and a man were killed on Mount Victoria, and seven kids died on Mount Temple. It was a mistake for the CPR to get out of the guiding business."

Everybody in Banff seems to have an opinion about the Canadian Pacific Railway. It would be difficult to overstate the impact the CPR has had on the entire dominion, let alone Banff. When the company was formed in 1871, it was granted 25 million dollars in governmental support, 25 million acres of land, a 20-year monopoly on western trade, and—for a time—freedom from taxation on all its holdings.

For most of its history Banff National Park was more or less indistinguishable from a CPR holding. The railway gave birth to the park, owned two grand hotels, ran the tour companies, and until recently shaped important park policy from behind the scenes. "We're not talking about that many years ago," says historian E. J. Hart, "when the Canadian Pacific Railway had senior officials of the Canadian park service in its back pocket."

Hart explains that the CPR was much more than a force of commercial development. "You know," he tells me, "the image the whole world has of the Canadian Rockies as a mountain wonderland is in large measure due to the marketing genius of Canadian Pacific." If there had never been a railway, Hart points out, "for better or worse, Banff as we know it would simply not exist."

TUNNEL MOUNTAIN is a gnarled hump of limestone rising like a grandstand directly over downtown Banff. Late on a blustery afternoon toward the end of September, I hike the short path to the top, recline on the bare rock slabs of the summit shoulder, and

take in the view one last time. In the distance fresh snow dusts the upper reaches of the Sawback Range. Herds of cumulus clouds gallop across the sky, transforming the valley into a shifting matrix of shadow and sunlight.

A thousand feet below, Banff Avenue is clogged with traffic. I can plainly hear the rumble of bus engines and the *whack-whack-whack* of carpenters pounding nails into an embryonic shopping mall. Across the Bow River, past the Banff Springs Hotel, I notice that the bright roofs of a subdivision have taken the place of forest.

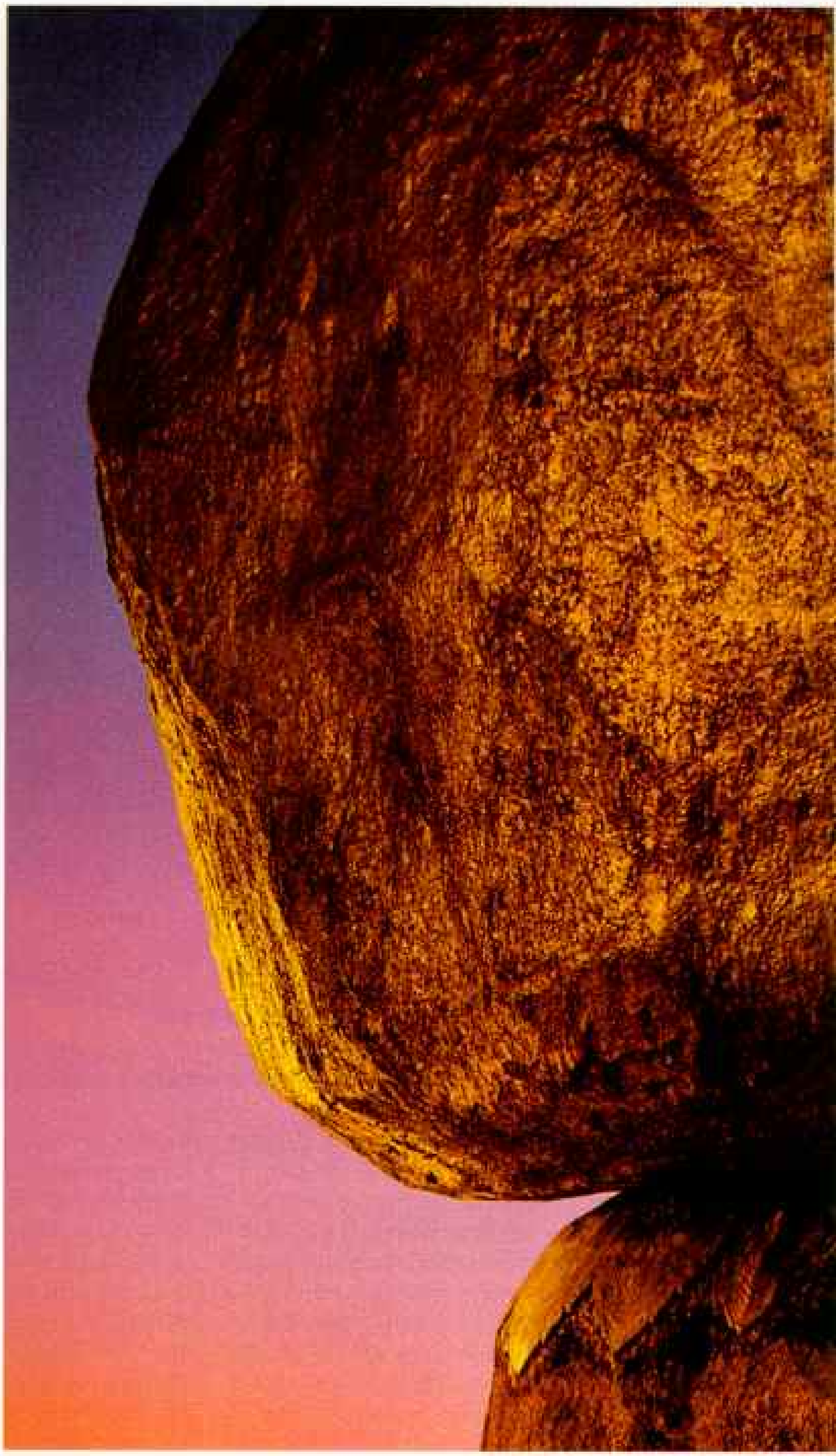
Banff National Park, especially this corner of it, is a long way from being virgin wilderness. Beyond the far edge of town, though, unsullied woods and meadows yet march toward the horizon. There are still some wolves out there, and plenty of elk, and even, if you go far enough, a handful of grizzlies. Given thoughtful stewardship and a little luck, these remnants of the primordial world have a good shot at hanging on.

"I'm optimistic," Mayor Leslie Taylor tells me. "I have faith in the people who live here. I sincerely believe that most of them came to Banff for the same reason I did and want to preserve what initially attracted them."

Taylor arrived as a 16-year-old to study ballet at the Banff Centre. "I can still picture that first day here," she says, tears welling in her eyes. "It was 1968, a perfect July afternoon. I remember looking up at Cascade Mountain for the first time, and right away I knew. I knew I'd found my home." □

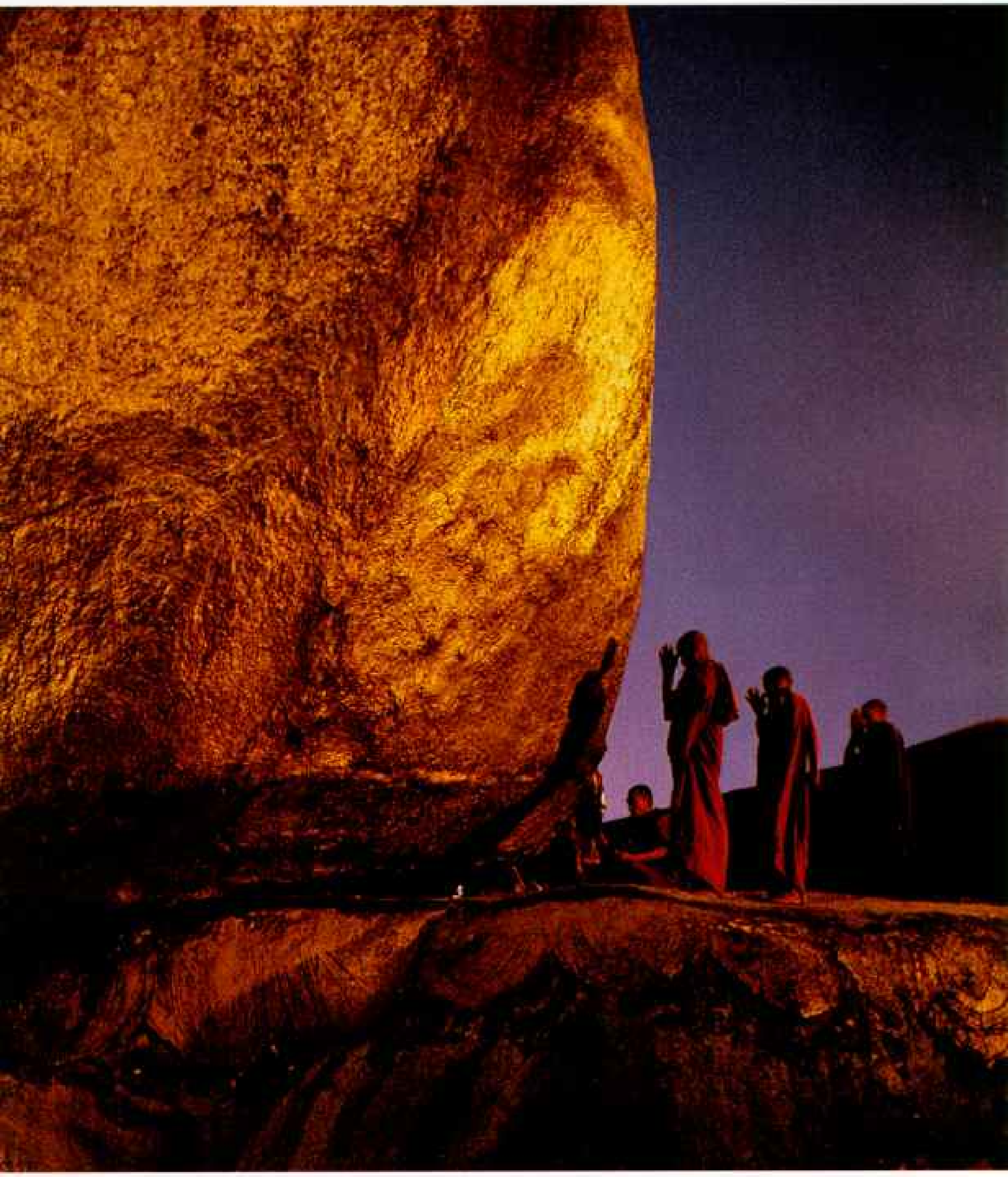
By JOEL L. SWERDLOW
NATIONAL GEOGRAPHIC SENIOR WRITER

Photographs by
STEVE McCURRY



Burnished with prayer, southern Burma's Golden Rock is journey's end for pilgrims who believe it is balanced with a single strand of the Buddha's hair. The country's military leaders, who in 1989 renamed the former British colony Myanmar, engage in a balancing act of their own as they simultaneously preserve their iron grip, acknowledge Buddhist traditions, and exploit the nation's natural wealth.

BURMA



The richest of poor countries

◆ Playing at rebellion, young people imitate Western decadence as best they can during Thingyan, the spring New Year celebration. Students don American fashions, blare Guns N' Roses rock, and generally thumb their noses at authority—marking the only time of year when the military dictators wink at even innocent rebellion.

Among the world's worst human rights abusers, the country's

army gunned down 3,000 demonstrators in 1988 and has forced the relocation of at least a half million people. Hundreds of Burma's citizens are political prisoners.

For 26 years authorities shut Burma off from the world, at times excluding visitors altogether or limiting visas to one day. Eased restrictions in recent years enabled the author and photographer to get rare glimpses of the secretive nation.

◆ June monsoons veil rice planters in southern Burma, along the road to Mandalay from Rangoon, now called Yangon.

But weather is not their worst occupational hazard: Near the paddies lurk cobras and Russell's vipers, making Burma a world leader in deaths by snakebite.

The nation would probably lead in rice production too if it weren't for politics. In 1939 Burma exported more than three million

tons of rice, leading the world. Exports fell during World War II and remained below prewar levels. After socialism was adopted in 1962, foreign shipments all but stopped.

Recent economic reforms and a new high-yield strain have boosted exports. But outdated milling methods leave the kernels broken, unsatisfactory to Western markets. Most Burmese rice that leaves Asia goes to Africa.

"WHERE you from?" strangers ask as I wander around Rangoon.

"America."

"America good," they say.

"Burma good too," I reply.

The strangers say, "No, Burma bad."

Anyone criticizing Burma's military dictators, the State Law and Order Restoration Council (SLORC), faces possible beatings and prison, but many act out a gun pointed at their head or a finger cutting their throat.

Their risktaking makes me uneasy. I also fear feeling out of place, a shadow to memories no one shares. This was my childhood home. I have not been here since the late 1950s, when the military assumed power and deported foreigners like my father, who served as an adviser to the democratically elected government.

But Rangoon is still Rangoon. Men and women wearing tubular skirts called *longyis*. Passengers on the roofs of buses. Monks with freshly shaved heads and flowing orange robes. Monsoon drizzle. Cheroots. Roadside fires warming *mohinga*, rice noodles in fish soup. Trishaw drivers standing as they pedal. People spitting betel juice. So much is the same, so many sounds and smells are deeply familiar, that for days I roam the streets, home again—connected, aroused, barely sleeping.

Change is also clear. I remember well-kept buildings. Now paint and plaster peel. Clothes and umbrellas were bright colored. Now they are drab. Billboards with slogans—"Love Your Motherland, Respect the Law"—now dominate streets. SLORC has required that all signs in English call the city "Yangon, Myanmar," the Burmese language words for "Rangoon, Burma"—a change that pro-democracy leaders oppose.

The Methodist English School, which I attended, is Number One State School. In the main corridor a poster reminds students that washing hands helps prevent cholera. "Cholera is common in Rangoon because of contaminated water and poor sanitary conditions," one teacher explains.

Another reminder of extreme poverty—Burma's $200 annual per capita income is among the world's lowest—comes from tea shops, where Burmese love to sit and talk. "Why don't you put milk on the table?" I ask one tea shop manager. My ignorance makes him sigh. "This is a very poor country," he says. "We cannot afford to let people have all the milk they want."

My boyhood friends and I loved hand-carved slingshots, which we bought from street vendors. We shot clay balls that had been baked in the sun. Where are the slingshots? I ask. "When the army began to slaughter peaceful pro-democracy demonstrators in 1988," someone explains, "some students fought back with *jinglees*, darts shot from slingshots. The points were nails or sharpened bicycle spokes. Now slingshots are banned."

The army has taken other actions to protect itself. Barbed wire surrounds government offices and communications facilities. Army barracks have been built next to pagodas. High walls, with shooting holes, protect military headquarters. Wherever soldiers stand guard, their trigger fingers are extended. Burma feels like an occupied country.

At a café I sit with villagers from areas surrounding Rangoon. Talk turns to relatives seized by the army to serve as porters. "My nephew went to market, and we never saw him again," one man says. With looks over shoulders, the stories come out: relatives and friends forced into service who died from exhaustion, disease, gang rape, and beatings while in army custody.

Such stories are, unfortunately, common. Official documents refer to porters as "government servants." Army officers call them "ghosts." Forced labor and the removal of ethnic groups from certain areas—some groups have fought the central government since Burma became independent in 1948—have created perhaps a million internal refugees hiding in mountains and jungles.

To know who, if anyone, is following me is impossible. Fear of military intelligence is strong in a tea shop frequented by young writers and painters. I ask what they see happening in Burma. The discussion goes nowhere. One writer rises and recites from Dagon Taya, Burma's leading poet: "In search of white among the white / In search of black among the black. / It is very difficult to find the real things / trying to get the truth out of the false things / years have gone / too long to count."

Amnesia has become a way of life here. One example: The records of dead students have disappeared from university files. Many do not have graves—the army often cremated its

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Guns and unrest are familiar themes to STEVE MCCURRY, whose GEOGRAPHIC assignments have included Afghanistan and the Persian Gulf war.

◆ Napping through rush hour at Rangoon's railway station, a bookseller's child sleeps beside her mother's inventory of pulp magazines, popular with commuters. Burma's high literacy rate—now 80 percent—nearly foiled its request for United Nations "least developed country" aid in the 1980s. Buddhism and socialism both encourage reading; hunger for glimpses of the West sells fan magazines by the ton.

victims. Witnesses report that some were still alive. As George Orwell, who served here as a British colonial police officer in the 1920s, observed, the past belongs to those who control the present.

But Burma's past struggles to live. I find the family of a college student who died under machine-gun fire. They describe how troops killed the student and used bayonets to prevent a funeral service. A bag containing hundreds of small copies of his university photograph mystifies me until they explain: They distribute key chains, each with a plastic-encased picture, the date of his killing, and "Human Rights" in Burmese and English. I do not ask what would happen if they got caught.

Such families welcome me with a hospitality that is characteristic of Burma. After two visits to a home, family members call me brother. Most impressive is their family loyalty. "How many in your family?" they ask.

"Four," I say. "How many in yours?"

"Forty-two," says a young mother. She is counting great-uncles and distant cousins—most of whom live in adjoining houses. When I comment that my parents and siblings became scattered among several cities, they keep asking, "Why haven't you lived together?" They cannot imagine life without family.

Burmese have been known for their capacity to laugh. But three decades of dictatorship and deprivation have taken a toll. Many evenings I long to hear someone enjoy a good laugh. It never happens. Always present, however, are the self-discipline and spirituality that define Theravada Buddhism, Burma's chief religion. One evening I bring flowers to my hostess. "I'll take them to the pagoda," she says, careful not to smell them. If the flowers provide enjoyment to anyone, they lose value as an offering.

My new friends are in danger, so I have

BEJEWELED PAUPER

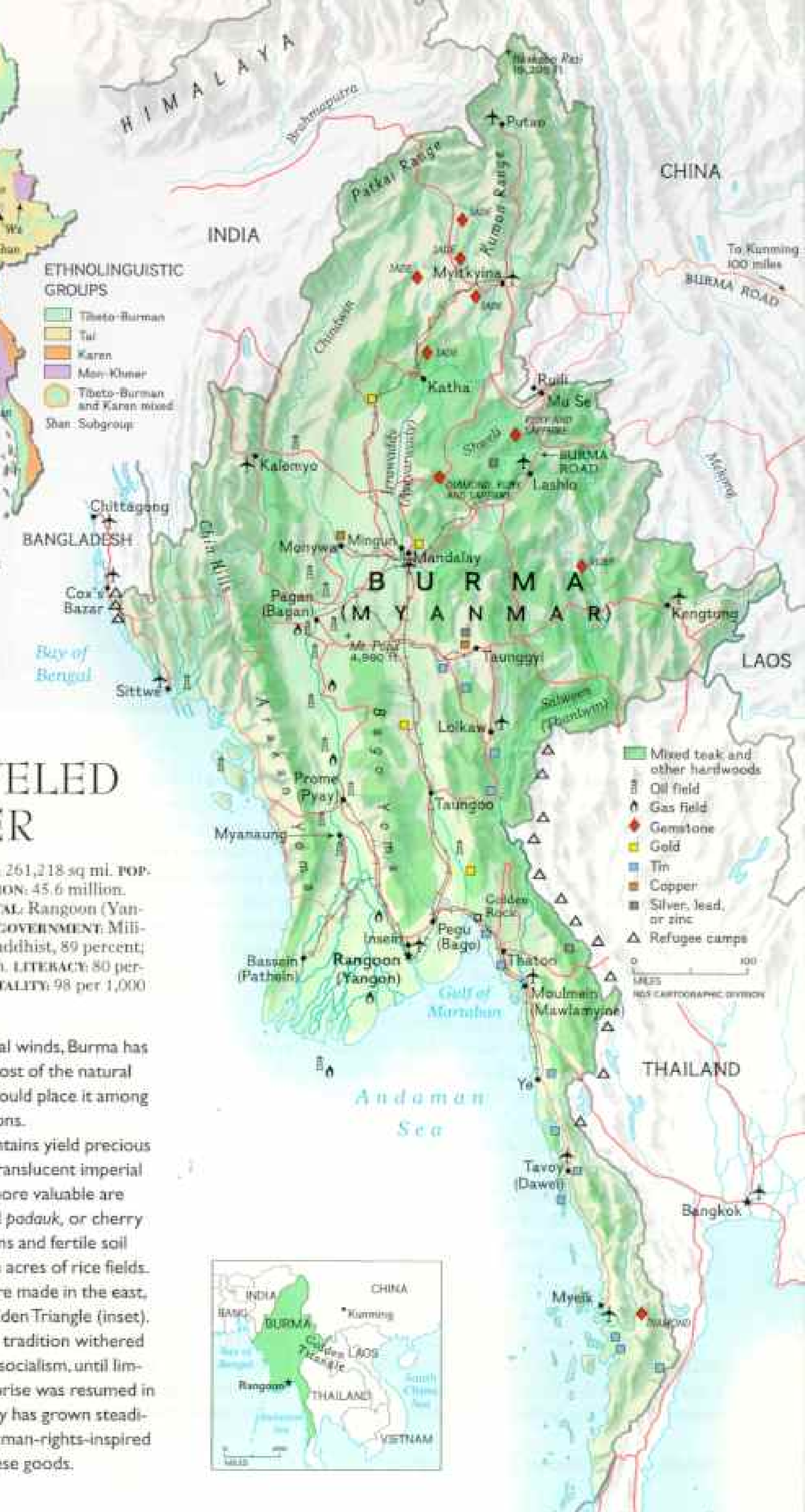
AREA: 261,218 sq mi. **POPULATION:** 45.6 million. **CAPITAL:** Rangoon (Yangon), 3.7 million. **GOVERNMENT:** Military. **RELIGION:** Buddhist, 89 percent; Christian; Muslim. **LITERACY:** 80 percent. **INFANT MORTALITY:** 98 per 1,000 live births.

Buffeted by political winds, Burma has yet to make the most of the natural abundance that should place it among Asia's richest nations.

Northern mountains yield precious stones, including translucent imperial green jade. Even more valuable are forests of teak and *padauk*, or cherry wood. Plentiful rains and fertile soil enrich 14.6 million acres of rice fields. Opium fortunes are made in the east, heart of Asia's Golden Triangle (inset).

Burma's export tradition withered under 26 years of socialism, until limited private enterprise was resumed in 1988. The economy has grown steadily since, despite human-rights-inspired boycotts of Burmese goods.

While Burmese is the primary language, more than a hundred tongues are spoken. Besides indigenous language groups, there are concentrations of Chinese and Indians, the result of Burma's centuries as a trading crossroads.



omitted names. This is most necessary in the case of former political prisoners. One person tells me: "Before you are released, they say to you, 'You will not be arrested again. If you criticize SLORC, we will come and kill you.' "

One evening I arrive unannounced—my usual practice because Rangoon's telephone service is unreliable—at the home of someone I believe to be a successful businessman. A man appears at the door. Several people crowd behind him. He looks relaxed in longyi and sleeveless undershirt, but shouts, "Who are you? Why have you come?" My answer makes servants and family disappear.

The man hesitates, then invites me in. Within minutes I realize he is a key leader of the democracy movement. SLORC recently freed him from prison, he explains, because of family connections and because he promised not to discuss politics.

"I should not be here," I say, standing. "I'm leaving." But he insists, and we keep talking. I dare not ask about the widespread torture—condemned by the United Nations and brought to life by Wendy Law-Yone in her 1993 novel, *Irrawaddy Tango*—and he volunteers only one story. Shortly after his release he met a diplomat who said, "I see no scratches."

"The scratches are all inside," he replied.

My host is magnetic, irresistible, modest, soft-spoken, and believable when he says, "I am not afraid to die." Maybe he already knows sadness that only death can relieve. I leave at 1 a.m., reluctantly. As I step off the back porch, I touch his shoulder. The flesh feels puffy. He remains alone in the moonlight, his eyes fixed on something beyond me.

TORTURE seems out of place in a country so imbued with the Buddha's compassionate teachings. Buddhists believe it is wrong to kill, because it hinders a being from reaching nirvana. When I was a young boy, our gardener once shouted "Stay away!" He pointed to a small bug and said, "That's very poisonous." Then he gently lifted the bug with a leaf and placed it in the neighbor's yard.

Full of such memories, I return to 21 University Avenue, the house where I spent happy years. Still surrounding the house is the drainage ditch where I sailed wooden ships during monsoons. When we lived here, water buffalo wandered among thatch huts, wild dogs chased us kids past piles of trash, and I once encountered a python. All are gone. The area is called Generals' Village. Rents are high, because the homes of generals always get water and electricity while the rest of Rangoon experiences daily cutbacks.

I stroll to 54 University Avenue, home of Aung San Suu Kyi, the pro-democracy leader. Her father, Aung San, founded Burma's army and negotiated the country's independence from Great Britain. He was assassinated only six months before independence and has since been Burma's most venerated figure.

Suu Kyi campaigned for democracy and human rights even after SLORC threatened to shoot her. In 1990 SLORC conducted an election in response to international pressure. The party led by Suu Kyi won 80 percent of the seats, even though she was under house arrest. SLORC effectively nullified the election.

SLORC has held Suu Kyi in custody even though she won the Nobel Peace Prize in 1991. Persistent rumors say she might be released, but she vows she will accept no conditions that compromise the pro-democracy movement.

Outside her house signs say, in Burmese, "No U-turn" and "No Slowing Down." Behind a high fence and trees, Suu Kyi awakens at dawn, meditates, listens to the short-wave radio, exercises, does chores, and reads. No guards are visible. SLORC would not let me see her. Now, standing here, I want to leap over the gate, but behind it are armed guards.

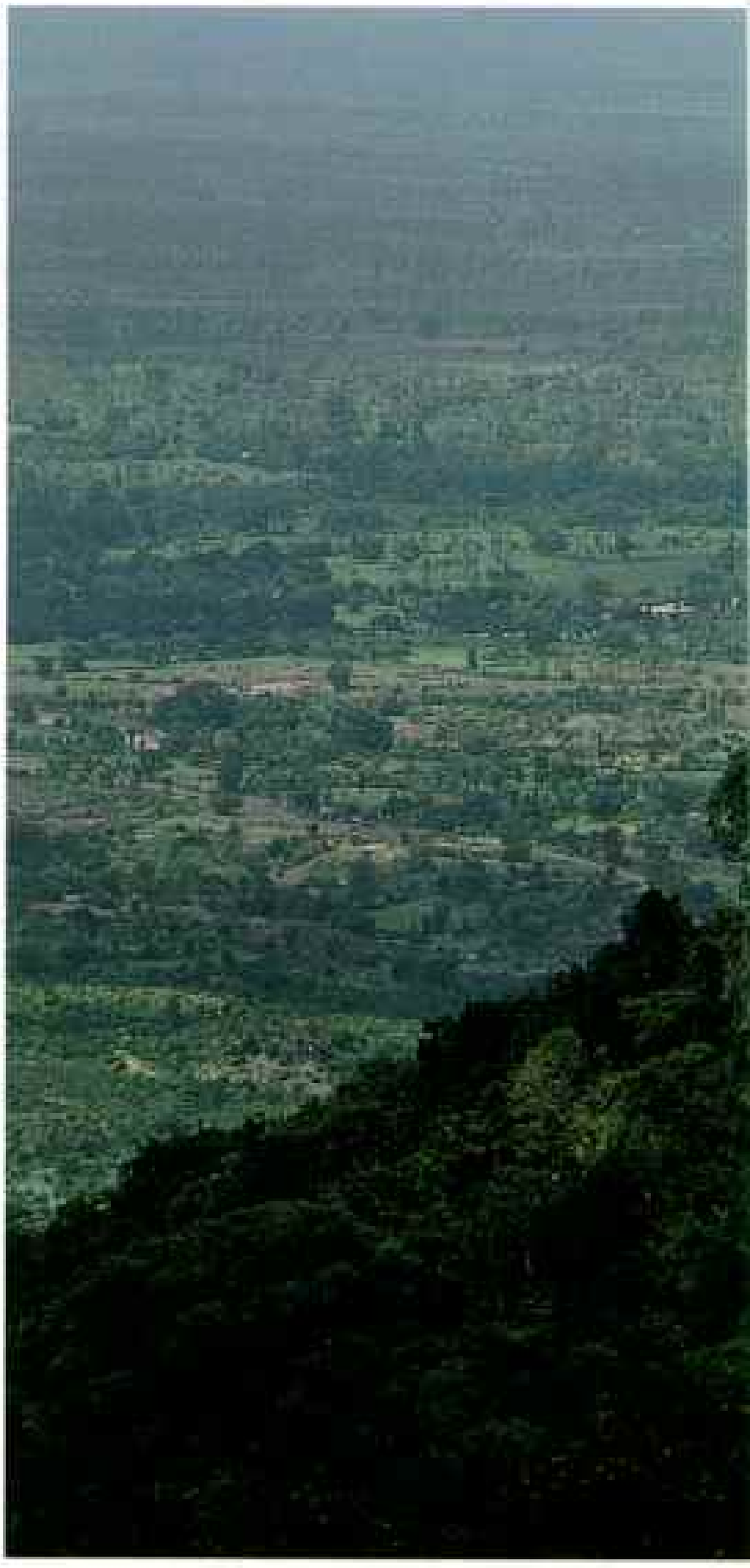
After I cross the street, Suu Kyi's gate opens, and a truckful of soldiers drives out. I ask two shop clerks, "Why so many soldiers?" They look through me as though no words have escaped my lips.

People walk and drive by, pretending one of the world's preeminent political prisoners is not a few feet away. SLORC counts on this. It uses troops to stifle dissent and tries to placate people with economic opportunity and foreign goods. This opportunity represents a major change. Until 1988 the government imposed a harsh "Burmese Way to Socialism," which impoverished what had been Asia's leading rice exporter. Now military leaders say they welcome marketplace economics.

The present SLORC policy, make-money-but-shut-up-about-politics, is also being applied in China and Vietnam. No one knows how it will work. History suggests that long-term prosperity produces a middle class that insists on freedom.

But for now SLORC seems to be successful.

◆ The stairway to heaven is narrow and steep, and it climbs a 300-foot lava plug crowned by Buddhist temples. The plug rises from the slope of Mount Popa, where thousands of pilgrims flock each May to a festival honoring a multitude of terrestrial spirits called *nats*. Burma's Buddhists have a healthy respect for the nats, who bestow favors on those who honor them and inflict punishment on nonbelievers.



In Rangoon one bicyclist tells me he wants to fight SLORC. I point to the growing crowd and warn him to be careful. He leans close, whispers "One day, maybe explode," and pedals away. Others shout for my attention. To discuss repression? No. They urge me to visit their shops.

Later I stroll through a newly opened minimart. Rickety stairs lead to two more floors, all full of such items as frying pans, pens, and canned foods. One man shakes his head as he surveys electric generators. "Until two years ago we had nothing. People prized even paper clips," he says. "In our hearts we beg for democracy, but people enjoy too much what is allowed now." The magnetic pull of consumer goods can be seen in a curious Burmese habit: People leave brand-name stickers on plates, glasses, and utensils.

SOUTHEAST ASIA has some of the world's fastest growing economies, so Burma may take off. About the size of Texas, the country possesses extraordinary natural resources: more teak than any other place in the world; petroleum; minerals; rubies, jade, and other gems; raw rubber; and rice, fish, and other foodstuffs. Burma is not poor. It is a rich country gone wrong.

Burma offers another plentiful resource: cheap labor. The DTK garment factory, about 15 miles north of Rangoon, is typical of those now found throughout the developing world. Twelve hundred women are sewing. The owners are high-ranking military officers and their South Korean partners—such military-foreign partnerships dominate the economy. To get a job at DTK—coveted in a country with high unemployment—one must have a relative with the rank of sergeant or above.

Investors in such ventures argue that their dollars will stimulate the economy and motivate SLORC to loosen its grip. Many Western governments and Burma's pro-democracy leaders disagree, insisting that meaningful movement toward democracy should precede foreign investment.

SLORC counts on compassion fatigue, outsiders becoming saturated with images of suffering in faraway places. SLORC also tells potential investors that its roughness has been necessary. In Rangoon a delegation of Japanese business executives watches a video of a small crowd in 1988: Someone stabs an accused government informer. Chopping. Sawing. His head falls off. A few such horrors did occur. The actions of agents provocateurs? Evidence of public rage? No, says SLORC. This is how the people act without strong leadership.

BURMA'S LEADERS have been unwilling or unable to address systemic economic problems. The black market, which is at least equivalent to the official economy, feeds inflation. The official exchange rate is about six kyats to the American dollar. On the street, you can get 120. A business debt may be paid in a jute bag. No one counts the money. They weigh the bag.

"Align yourself with individual members of SLORC," a British firm advises investors. Outside scholars describe the government as arbitrary and bloated. I expect denials when I ask a Burmese businessman about his successful deals with American investors. Instead, he says, "Go day by day. What is true today could be false tomorrow." Hands go to his eyes like blinders. "Do not look forward or back. Accept the risks. Accept the way things are or go crazy. Then you can make big money." He drives away in a Mercedes-Benz.

Most of Burma's economic muscle strengthens only the military. SLORC has spent a billion dollars on weapons. It has doubled Burma's armed forces, which SLORC claims will soon number 500,000 men and women, one-third the size of the U.S. military. With such spending, can Burma emulate the efforts—population control, capital accumulation, government-supported industry, education,

◆ Having humility for breakfast, Rangoon Buddhist monks, who vow to renounce all possessions, bestow merit on those who provide their meal. By tradition, most Burmese men devote at least a few weeks of their lives to monasticism. Many monks have been imprisoned for participating in demonstrations.

After feeding her children breakfast, the woman at left will convert her outdoor table

into a roadside restaurant. Such spots are among the few places a Rangoon visitor can sample true Burmese cuisine, since most conventional restaurants feature Chinese and Indian food.

At home families eat rice, fish, chicken, and vegetables flavored with *ngapi*, a pungent, fermented seafood paste described by Rudyard Kipling as "fish pickled when it ought to have been buried long ago."

◆ Braving a man-made monsoon in the back of a pickup truck, Rangoon youths greet the New Year with a splash. The entire city erupts in water fights during Thingyan, which began as a solemn medieval ritual marking the advent of the monsoon season. Young people sporting the popular American flag motif prowl the streets armed with hoses and buckets of water, looking for targets—willing or not.

and infrastructure such as roads and harbors—that have enabled other Asian countries to flourish? Infrastructure is probably the most pressing need, because it makes trade possible.

Because mountains rim Burma on three sides, it has few overland links with neighbors. Most trade has been by sea. Just after World War II, Rangoon's harbor had 10 berths. Now it has 13, even though Burma's population, which was 17 million in 1941, now exceeds 45 million. One ship captain tells me he waited for a month before he could unload. Such delays raise prices and exacerbate shortages of crucial items such as medicines. Scarcity of trucks, storage sheds, and cranes, coupled with poor connections to the harbor, also contribute to the costly delays.

Plans call for road improvements, financed in part by China, which wants better transportation between its landlocked western provinces and Rangoon.

SLORC keeps much of upper Burma closed to outsiders, but it grants me permission to visit Mu Se, the major crossing to China.

I TAKE the night train to Mandalay. Nyunt Wai, a 39-year-old Information Ministry official, is assigned to travel with me.

We pull out at 6:30 p.m. The train is crowded. At the end of the train are two "ordinary class" cars with wood benches and people sleeping on the floor. The dining car has charcoal stoves. Windows are open, and wind makes the curtains bounce. Grasshoppers jump in. Because rural Burma has little electricity, the outside is black. Frogs, rain, and the train's metallic clip-clop. A rim of light slowly becomes brighter and rounder. After nearly an hour I recognize a pagoda, floating in the distance.

A typical station: Soldiers. Incense. People asleep on straw mats. Dirt. Monks begging. Boy in a "Hard Rock Cafe" T-shirt. Plastic bags of coconut milk. Burlap bags of rice, onions, and beans. Children sell bananas, mangoes, grapes, pineapples, and quail eggs. When the train stops for bridge construction, voices rise from the darkness: "We are hungry. Have pity." Passengers toss food out to them. "It was never like this when I was young," an older woman mutters.

Sunrise reveals purple soil, sunflowers, and banyan trees. Four bullocks wait to begin work. Arrival in Mandalay is at 9:30 a.m.—the 373-mile trip has taken 15 hours.

In 1890 Rudyard Kipling romanticized this city—"On the road to Mandalay, / Where the flyin'-fishes play"—but apparently he never

came here. The city of about 700,000 was founded in 1857. It is dusty, flat, and treeless. A construction boom, propelled by trade with China and government efforts to attract tourists, has fractured sidewalks and main streets.

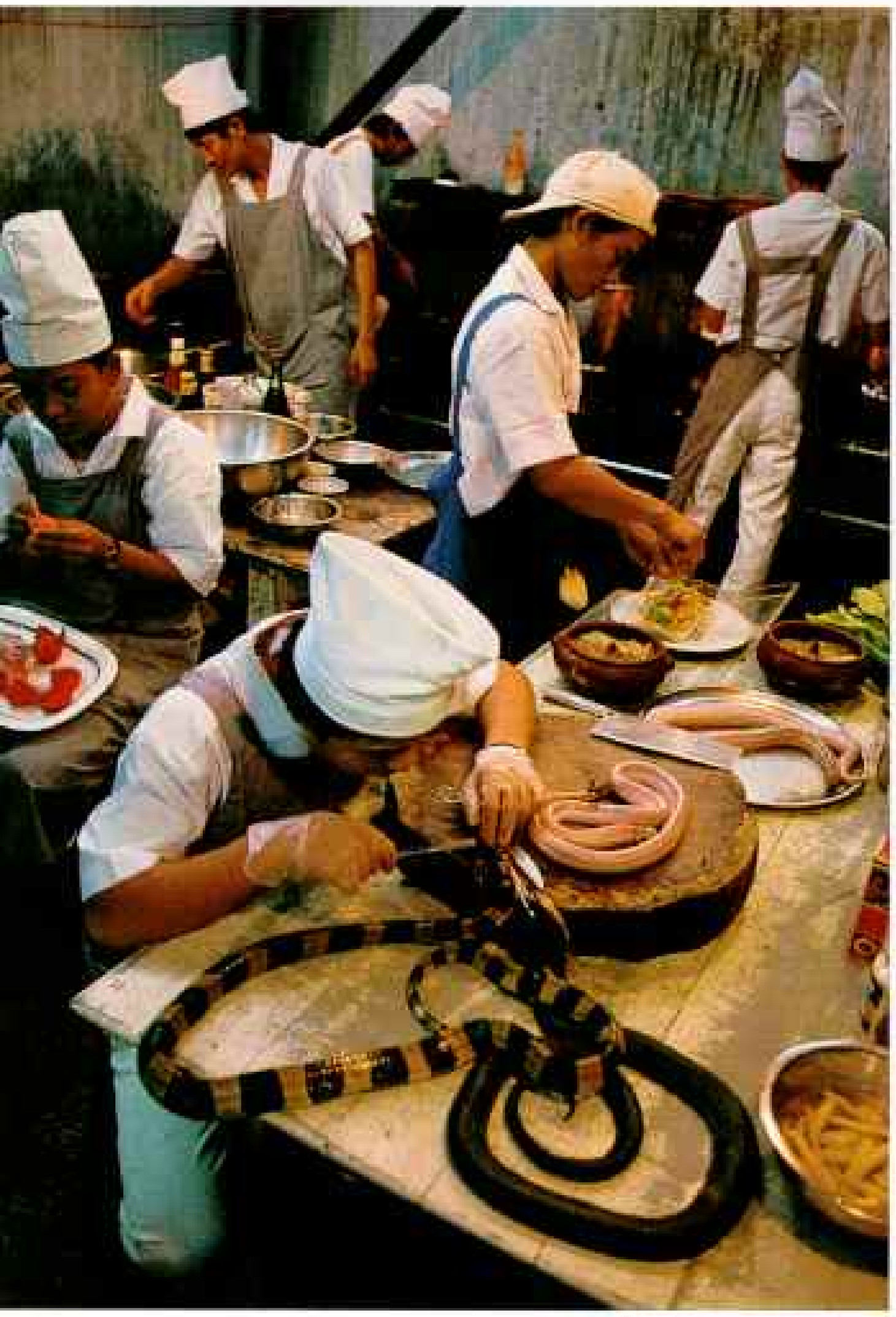
Virtually all commerce between upper Burma and Rangoon passes through here, using the Irrawaddy River. Although most Burmese consider it too cold for swimming—its waters come from the Himalaya—men stand waist-deep, sawing teak logs. Water buffalo pull out the logs, kneel on command, and push them onto a cart. Nearby, women weave straw mats—walls for their homes. Boys stand in a circle playing *chinlon*, keeping the woven bamboo ball in the air without using their hands. Children play with sticks and cans. They use water to draw lines for hopscotch.

The boys seem nine or ten years old. They are 16. I guess the girls' ages at seven or eight. They are 14. I am seeing stunted growth—the United Nations estimates that one-third of Burmese under five are malnourished. Hunger prompts some Burmese families to borrow money and repay it with their daughters' labor in Thailand. Many of these girls are forced into prostitution; some return HIV positive.

Several Mandalay University students invite me to an outdoor teahouse. We sit next to the stone oven and eat fried onions, beans,

and fresh-baked flatbread. On the wall is a wooden house about a foot high, decorated with green cuttings. It is a home for *nats*, terrestrial spirits that influence human affairs.

One student describes the female nat to whom he makes offerings. Another discusses animal magic, insisting that "whenever a snake crosses your path or you dream of a snake, you have good luck." Like most Burmese, the students also believe in astrology. I buy breakfast with a 45-kyat note, which the government introduced because astrologers say nine is lucky, and four plus five—45—equals nine.



◆ Banded krait and other snake dishes feed foreign expense accounts at Thein Gyi Market in Rangoon (above). But snake is not just for tourists; Chinese and several other ethnic groups purchase the meat in local markets.

As Rangoon is opened to world trade, motor traffic (facing page) increases. In the 1980s Rangoon was whitewashed from curb to roof, a cheap face-lift for a city that had seen little construction since the British left in 1948.

I visit Mandalay Fort at 7 a.m. Its 12-foot-deep, 250-foot-wide moat has been drained. Thousands of men and women dig mud and carry rock. These are forced laborers, who must work five to ten days every few months. I wander among them. One man, mindful of soldiers lounging nearby, tells me the lack of pay is fine.

Conditions are rougher in border regions, where hundreds of thousands of "volunteers" do construction for the military. Most notable is a railroad in southern Burma that will intersect with a natural gas pipeline financed by Western companies.

That night, I wander alone through downtown Mandalay. People invite me to their shops and homes. The suffering of the people working on the moat upsets them, but they are more concerned about food prices that have risen 400 percent since 1988. "People are on the verge of starvation," a woman says. She holds her hands over her stomach, mimicking pain. One man looks over his shoulder. "We need the Lady," he whispers, referring to Aung San Suu Kyi.

Many people insist on talking to me only in the presence of Nyunt Wai, my government escort. Nyunt Wai and I have dueling notebooks. When I interview people, I often take notes. Nyunt Wai is usually nearby, writing in his notebook. "Are you writing down everything people say?" I ask.

"No," he replies, "I am just writing where we go." Nyunt Wai's notebook is intended to hold people accountable. In the hands of his superiors, it could cause torture and imprisonment. Because I gather information and talk to people without Nyunt Wai present, my notebooks go under the covers with me at night.

As Nyunt Wai and I head northeast by car

from Mandalay, the beauty of Burma's Shan hills makes me forget his notebook. A sharp drop-off and we enter a valley: fields, irrigation canals, ponds, and trees painted in a range of colors, all green. Above, clear sky and clouds. Women talking, machetes balanced on heads. Red mud glazing water buffalo bathing among lotus flowers. On the far side, hills swirl like frosting on a cake. Atop one hill is a white dot, a small pagoda, accessible only by footpath.

PEOPLE AND LAND are rough. Marco Polo, who visited this part of the world in the 13th century, described "vast jungles teeming with elephants, unicorns, and other wild beasts." The British never fully controlled this part of Burma. Nor did the Japanese during World War II, or Burma's post-independence democratic government. Nor has the present regime.

Lack of government control is clear in Lashio when I see United Wa State Army jeeps and armed Wa soldiers. The Wa, an ethnic group living along the Burma-China border and in the nearby Golden Triangle, have negotiated peace with SLORC—which offers economic development and limited autonomy, a formula that has neutralized breakaway movements in other Asian countries.

Groups like the Wa, however, are mostly opium poppy growers, and such peace treaties formalize relationships between SLORC and those who help supply 60 percent of North America's heroin. Although SLORC mounts occasional campaigns against some drug lords, production has doubled in recent years and is by far the greatest revenue producer within Burma's borders.

Burmese authorities, however, do not want drugs in their own country. A Burmese plainclothes officer, with pistol tucked into his longyi, checks vehicles in Lashio. Officers seize nearly 70 pounds of heroin—street value in the United States would be between 13 and 19 million dollars—from a small truck.

I wander into one of Lashio's few restaurants. Five young Wa women are laughing and flirting. They are from a small town in the Golden Triangle. One of them was married the night before. A man sitting alone is a relative of the groom. That night their family will have a post-wedding celebration. They invite me.

The groom's parents live in a thatch house decorated—like most Burmese homes and shops—with family photographs and movie posters from India, Japan, and the United States. The windows have fire-hardened bamboo bars. Light comes from exposed bulbs. The floor is covered with people, with seats only for older relatives and me.

After songs and formal speeches they serve rice gruel and sugary tea—the only meal they can afford to serve to so many people. The newlyweds bow as they give brightly wrapped presents to their parents and grandparents. The bride's mother receives a towel, a longyi, and a piece of cloth.

I ask about a honeymoon. They do not understand. It is not their tradition. The groom's mother repeatedly apologizes for being so poor. I say she is rich in family. Not sure whether she understands, I add, "America has lots of poor people too." Her mouth

◆ Every day is Armed Forces Day in militaristic Burma, and the official date, March 27, explodes in patriotic murals glorifying the army. For citizens passing by on dilapidated buses, the military, 380,000 strong, is a menacing presence. Living in isolated compounds with superior schools, medical care, and housing, soldiers form a detached elite.

Hundreds of thousands of Burmese citizens have been forced into slavery as army porters, carrying soldiers' supplies and acting as human shields in battles with mountain rebels.

drops in amazement, and she says, "I thought this was the only country with poor people."

EARLY THE NEXT MORNING I head north on the Burma Road, completed in 1938 and famous in World War II lore as the prime land link to besieged China. It has one and a half lanes for traffic in both directions.

Even this far into my trip I am naive. Throughout Lashio, when I saw SLORC soldiers ride with civilian drivers, I thought they were friends. Now, as troops commandeer a truck so they can escort me, I realize that soldiers seize vehicles at will.

Next to the civilian driver is Lt. Sann Oo. His holster is torn. In the rear are five enlisted men in frayed uniforms. They carry automatic weapons and a rocket launcher.

Ten miles north of Lashio the road becomes a moonscape of craters, mud, and jagged rocks. Our swerve-and-bounce is slower than the pace of a sauntering water buffalo. This road was in good condition when SLORC opened border trade. The official weight limit is 13 tons, but most trucks weigh more than 30 tons and crack the blacktop. Rain does the rest. Over a two-mile stretch we pass 104 trucks. Traffic will become even heavier once the monsoons end. Southbound trucks carry manufactured goods from China. Those going north carry Burmese raw materials. During one two-minute period I count 57 huge trucks carrying hardwood logs to China. Despite such exports, Burma is still half-covered with forest, because, as this road demonstrates, it lacks good infrastructure.

Most China-bound trucks carry dried fish,

◆ Fake guns, real war: Rebels of the Karen ethnic minority drill at a mountain outpost near the Thai border.

At a Mandalay temple photographs of monks (facing page) surround pictures of Aung San—the hero assassinated in 1947 while negotiating Burma's independence—and his activist daughter Aung San Suu Kyi. Someone risked imprisonment or worse by honoring the pair. In 1990 Suu Kyi's pro-democracy party won the first free election in 30 years, which was immediately undercut by the military. Under house arrest since before the election, Suu Kyi was awarded the 1991 Nobel Peace Prize.

rice, and other food that does not require refrigeration. I sit with Burmese villagers as the food-bearing trucks drive past their hungry children. Soldiers make it impossible for us to talk. Are the villagers accepting, because of feudal traditions? Do they complain? More than 70 percent of Burma's people live in small villages, so the answer is important. Rural revolts, caused by political repression or challenges to traditional values, have occurred throughout Burma's history.

Trucks teeter and tip. One rolls belly-up, cab flattened. Another slides down a cliff moments after its driver jumps out. An overturned truck blocks the road, stopping more than a hundred trucks in both directions. Drivers do not call this the Burma Road. They call it the "Highway Where You Never Ask What Time You'll Arrive." The 116 miles from Lashio to Mu Se takes one day by car, two days by truck.

Most villages have truck stops. Scavenged engine parts fill glass cases. Shelves offer whiskey, toilet paper, candles, and machetes for carving bypasses when the road is blocked. A well-used comb dangles from a string tied to a mirror. A television sits in a teak cabinet that locks. Whenever we stop, soldiers guard both sides of the road, weapons ready. What they are guarding against never becomes clear. Their watchfulness, however, heightens my feeling of being in an occupied country.

After 14 hours the lights of Mu Se appear. No weary traveler could be happier if he were entering Paris. A huge blue "Love and Cherish the Motherland!" sign welcomes us. Truck repair shops sprawl onto muddy side streets.

I invite Lt. Sann Oo to dinner. He is friendly and concerned about his men. One of them is

14. Another is 15. "They like the army," Sann Oo explains, "but they also enlisted because their families are poor." Poverty is pushing more and more children into the army. They are not exempt from combat operations against drug producers or ethnic groups.

That night, body still aching from the bouncing, I fall asleep quickly. A knock awakens me. "Who is it?" I shout.

"Lt. Sann Oo."

What does the army want? I ask myself as I scramble to get dressed. My notes? I open the door. Lt. Sann Oo wears a longyi and looks much smaller. He hands me a neatly wrapped package. The gift, a small, battery-operated lantern, is larger than he realizes. It is a reminder that even under difficult circumstances, strangers can become friends.

Chinese goods fill Mu Se's markets. Because Burmese prize Western-made items, some shirts sewn in China carry "Made in America" labels. A circle of women squat. Each has bags of Burmese and Chinese money. These black-market money changers work late into the night without fear of robbery. Nearby a group of young men suck on roasted chicken feet and rooster heads. They cross into China daily to work. It is a classic pattern. Burmese go to China for the same reason Turks go to Germany or Mexicans to the U. S.

I visit the Shweli River, which marks the Burma-China border. People and goods cross without documentation. Land on both sides is flat, which explains why this is the busiest crossing. But there the similarity ends. The China side has the city of Ruili, whose smokestacks and tall buildings look like a little Hong Kong. In comparison, Mu Se is primitive.

For many people in Rangoon, however, Mu Se represents the daring future that trade makes possible. "Visit the disco in Mu Se," they told me. To them it shimmers like forbidden fruit—SLORC restricts public dancing, puts the military chorus instead of music videos on television, and calls Rangoon's new karaoke bars a "deteriorating cultural situation." But the disco in Mu Se, I discover, is across the border in China. The admission fee is 50 kyats—about a day's wages for a Burmese laborer.

SLORC may still successfully combat Western influence, but it is fighting a cultural war it

◆ *"Hti like, Maung Gyi!* —Push it over, Big Brother!" A good oozie calls to his elephant as it moves teak logs (above) floated downstream to be hauled by truck. One log can be worth $20,000. Seventy-five percent of the world's teak supply is cut in Burma. Each year 30,000 acres are replanted.

Some loggers use tractors, but elephants are cheaper and do not require forest-damaging roads. Oozies goad their animals with a *choon* (facing page), prodding the elephant's inch-thick skin with the metal hook.

may already have lost. From Rangoon to Mu Se, I see civilians and soldiers transfixed by television programs arriving via satellite. Satellite receivers are expensive and require government permission, but more and more people own hidden, illegal dishes. Young people throughout Burma hold their fingers in a V and say "Make love not war." They are mimicking music-video hostesses on a Hong Kong satellite station.

Such culture creep, coupled with faxes and international computer links, may eventually poison both tyranny and Burma's traditions. But such technologies have not reached most Burmese. On my way south from Mu Se, I stop at Pagan, which from the 11th to 13th centuries was Burma's capital. It is home to more than 2,000 temples and pagodas.

A Buddhist abbot is being cremated. Songs and dances begin shortly after dawn. Hundreds of children squat in the dust, watching. More and more families arrive. Vendors sell flavored ice and plastic toys. The abbot's coffin swings in a hammock as monks perform key scenes from the Buddha's life. The day becomes hot and uncomfortable, yet the children are enraptured well into the evening. Given a choice, would they watch videos?

WHEN I RETURN to Rangoon, police and army presence is heavy. Soldiers are at major intersections. It is July 7, the day before Burma's military blew up the Rangoon University Student Union during protest demonstrations in 1962. The capital will remain tense until July 20, the anniversary of Aung San Suu Kyi's detention in 1989.

By 10 a.m., word on the street is that ten students have been arrested for tossing pro-democracy leaflets out of a bus. Three are

◆ Split by an earthquake in 1838, King Bodawpaya's pagoda in Mingun, near Mandalay, is a monument to earthly ambition and a dream unfulfilled. Begun in 1790 to enshrine a holy relic—a tooth reputed to be the Buddha's—the pagoda was envisioned by Bodawpaya as the world's largest. In brutally familiar Burmese tradition, thousands of slaves did the work.

When Bodawpaya died in 1819, the brick

base with its decorated doorway stood 162 feet high—about one-third the planned height—and 236 feet long on each side. Bodawpaya's children decided that that was big enough. They halted construction on the ornate structure that was to sit atop the brick base, and the shrine fell into disuse.

Despite the pagoda's ruined condition, visitors must still remove their shoes before entering the sacred site.

already at Insein (pronounced "insane"), the country's principal prison.

Insein is a 40-minute drive north of Rangoon. No one knows how many of its prisoners are political. Many people have disappeared into SLORC's jails without full documentation. According to the UN Special Rapporteur, jailed "political leaders" alone total in the hundreds. Crimes include advocating democracy and talking to Western journalists. The top of the yellow outer wall has broken glass embedded in concrete. Guards are visible only at the main gate, which has a low watchtower. The prison looks subtle, almost innocent, yet 200 feet from where I stand are what government officials call "cells of darkness" for political prisoners.

The corner of a large, low building is visible. "Inside that building, your worst enemies are bad sanitary facilities and lack of reading material," says one of my childhood friends. She served nearly four years for assisting pro-democracy candidates in 1990. Her experience includes sleep deprivation, interrogations, beatings, and isolation. Political prisoners cannot talk to one another and cannot mix with other prisoners. They rarely exercise or bathe. Mostly, they rot. "But as long as you obey all the rules, some guards show the kindness that makes Burmese special," she says.

My visit to her Rangoon apartment has surprised her, but she reassures me that "so many kids we knew have been jailed that the government will never know we spoke." She prepares tea and forgets to serve it.

"If democracy ever comes," she says, "it must take into account our Buddhism and our traditional reliance on strong leaders."

I argue that military dictatorships inevitably crumble, because people everywhere want freedom. "The generals have hijacked your history," I say. "You will take it back."

She remembers the tea, and stirs it in silence. Even alone in her apartment, with my promise to omit her name, such talk is scary.

That night a small temple bell arrives at my hotel. There is a note from my childhood friend. "Hang it by your window," she says. "Let it remind you of shared beliefs and shared fantasies."

THE NEXT DAY, I meet with Lt. Col. Khin Maung Thein, chief foreign liaison aide to Lt. Gen. Khin Nyunt, head of military intelligence and Burma's most powerful general. We are in a government guesthouse. Wide lawns. Impeccable garden. Polished teak floors. High ceiling. We sit in easy chairs. Servants bring butter sandwiches on white bread with crusts cut off. Another officer takes notes.

For 45 minutes the colonel paints pretty pictures: An idealistic fight against drug producers. Desire to open the economy. Eventual move to democracy. He does not understand why so many foreigners fail to recognize SLORC's virtues.

My tone matches his. I too am genuinely confused. "Why doesn't SLORC allow the International Red Cross to visit your prisons?" I ask.

The officer taking notes rolls his eyes and shakes his head. "Are you aware that your junior officer is mocking me because I'm asking about the International Red Cross?" I ask Lt. Col. Khin Maung Thein. He just smiles.

By the time I leave the government guesthouse, another story is spreading: Several people unfurled a pro-democracy banner at the Shwe Dagon Pagoda.

I have not yet gone to the Shwe Dagon, because I want it to be the one place in Burma where my childhood memories—slowly rising steps, meditation beads, huge bouquets of flowers, and men carving statues of the Buddha—prevail. Now I decide to go.

Everything is quiet. Changes, however, are obvious. Soldiers guard the steps. One side of the Shwe Dagon has an escalator. Then I begin to climb, and everything is exactly as I remember! I am young again.

Around the Shwe Dagon's dome, people meditate and recite the Buddha's teachings. Incense burns. Bells tinkle. The stone walkway feels soft as I kneel. Eyes closed and head bowed, I pray for the country that still feels like home. □

◆ Links with the past, two Padaung women near Loikaw in eastern Burma wear heavy stacks of brass neck rings, once intended, according to legend, to fend off tiger attacks. Added one at a time from childhood, the rings do not stretch the neck but push down the collarbones and ribs.

Rare in Burma, neck rings appear increasingly across the Thai border, where some Padaung now live. A woman can earn $40 a month modeling the rings for tourists—finding in their exotic past a way to survive a cruel present.

Leafcutters

Gardeners of the Ant World

With powerful saw-toothed mandibles, a leafcutter ant slices through a papaya leaf—first step of an elaborate process in which her colony uses mulched vegetation to raise the fungus on which it feeds. Seen at 50 times life-size, the tiny creature belongs to a remarkable group of ants that evolved a system of agriculture eons before the advent of humans.

Text and photographs by
MARK W. MOFFETT

Living buzz saws

Chief herbivores of the New World tropics, where they originated millions of years ago, leafcutter ants strip away more vegetation than any other animal group. In rain forests their actions remove about 15 percent of leaf production. Members of the attine tribe of ants—the fungus growers—leafcutters enjoy a nutritional relationship with their fungus that enables them to thrive on fresh leaves—matter usually indigestible by ants.

Some leafcutters compete with human farmers. *Acromyrmex octospinosus*, introduced onto Guadeloupe by accident in the early 1950s, is now a major pest to squash and cassava planters. By rapidly oscillating her hind end, this ant (above) cuts out a crescent of leaf with vibrating mandibles in much the same manner as an electric carving knife. The sound serves to attract other workers—all females—to the site to finish off the leaf.

On the mainland the far larger colonies of *Atta cephalotes* normally invade gaps in the rain forest caused by fallen trees or by agriculture. In French Guiana a column of leaf-toting workers

return to their nest along a convenient prostrate trunk (right), following chemical markers deposited by scouting ants. More often they travel along wide pathways they have worn into the jungle floor. Wherever the plants are most attractive, traffic intensifies. Often I watched in amazement as hundreds of dime-size green banners would pass by every minute in caravans 200 yards long. The ants' speed and energy have also impressed my Harvard colleague Edward O. Wilson, who calculated that, scaled to human dimensions, each worker runs the equivalent of a four-minute mile for 30-some miles, with 500 pounds slung over her shoulders.

The voraciousness of large leafcutter ant colonies is legendary. Yet workers rarely kill whole trees, because they constantly shift their activities to new plants. Since the ants use the vegetation to raise fungus, this strategy may assure that their gardens do not overdose on the chemical defenses of any one plant species. Imported human crops are choice targets for the ants, because their leaves usually lack natural fungicides.

Kingdom of leafcutter ants

Leafcutters are most abundant in tropical countries like Brazil, known to Portuguese settlers as the Kingdom of the Ants.

Worlds underground

Huge subterranean ant colonies dot the landscape of central Paraguay with mounds of silt excavated by billions of hours of ant labor. Considered a pest on the savanna, grass-eating leaf-cutters reduce the number of livestock the land can sustain. Occasionally cattle are injured when a mound collapses underfoot. What lies beneath is seen close-up in Brazil, where biologist Virgilio de Silva, at left, examines a partly excavated nest, riddled with exposed fungus gardens. The depth of such nests—which support active colonies for a decade or more—appears to be limited only by the level of the water table beneath.

Native palms sprout from the mounds of dying colonies, at bottom right, illustrating the positive effect of the ants on their environment. Leafcutters turn over and aerate large quantities of soil in forests and grasslands. Imported by humans, cattle are actually the intruders here.

The ant proletariat

A society of females, like all ants, leafcutters are daughters of the same queen. Kept infertile by chemicals from their mother, young females become workers. The size, appearance, and function of newly emerged adults—their caste—is determined by the amount of fungus they were fed as larvae. A soldier—shown below left, above a queen—may be hundreds of times the weight of members of the smallest caste. Hatched from the queen's unfertilized eggs, males contribute nothing except their sperm and are programmed for a speedy death after their nuptial flight.

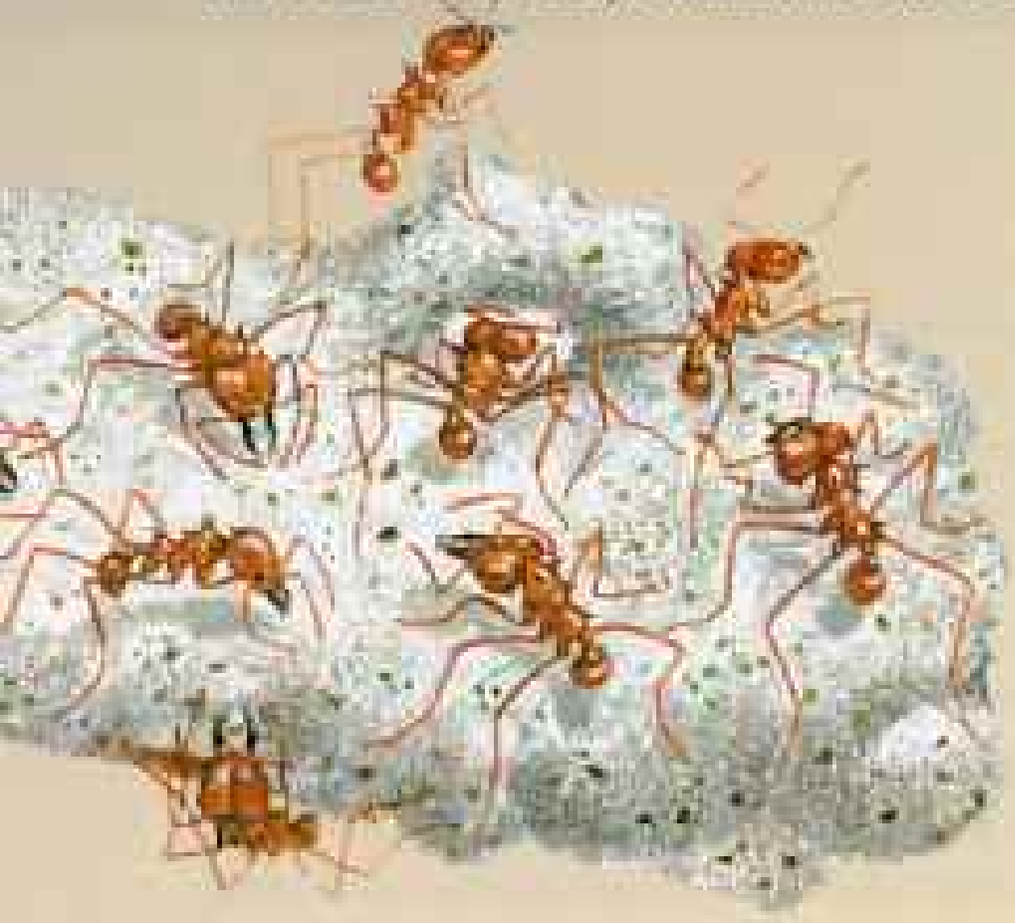
Assembly line

Only the largest nonsoldier workers leave the nest to forage (1). Inside the nest, slightly smaller workers chop leaves into bits (2), which the next caste chews into pulp and fertilizes with deposits of enzyme-rich fecal fluid (3). Other ants apply the fertile leaf paste over a base of dried leaves in new chambers (4). Another caste hauls in bits of fungus from older chambers and plants it in the leaf paste (5), over which it will spread like frost. A teeming caste of dwarfs (6) cleans and weeds the garden, then harvests the fungus for others to eat.

PAINTING BY JOHN E. DAWSON

A growing metropolis

From the first tiny hole, a leafcutter colony expands into a labyrinth of chambers, many containing fungus gardens resembling a human brain. The gardens nearly fill the chambers, which are located near the surface for this species, *Atta sexdens*. Larger, deeper pits hold decomposing plant detritus and waste. A few of these pits, oddly, contain more soil than organic matter, as if a soil cover is needed for especially noxious waste. As hot air rises from these refuse chambers, cool, oxygen-rich air is drawn into the nest. Openings directly above the nest are used only for excavation and ventilation. Cavernous perimeter tunnels form a beltway some 25 feet from the nest.



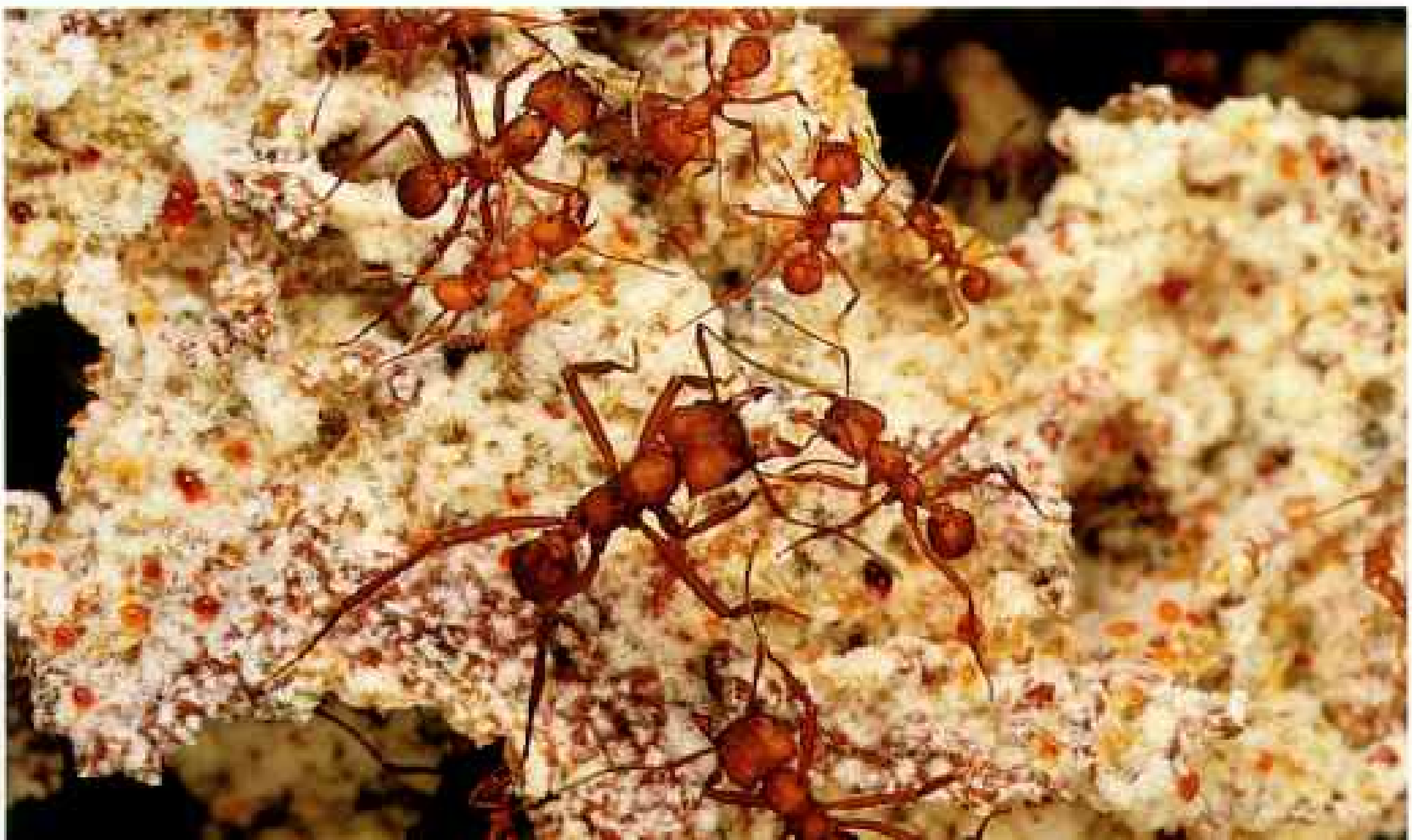
A young queen

An *Acromyrmex octospinosus* queen enlarges a new nest, holding fungus grown from a tiny wad she carried in her cheek from her mother nest. Inseminated with enough sperm to fertilize millions of eggs, she has shed her wings and burrowed underground.

Farms without sun

An ancient symbiosis exists between ant and fungus, in which each is dependent upon the other for its very survival. Among the 200 or so species of fungus-growing ants, most cultivate their fungus with dead organic matter, like insect corpses and plant debris. Workers of this *Trachymyrmex* colony hung their garden from the ceiling of a four-inch-wide chamber (above) and may have used caterpillar feces, much as human farmers use cow manure, for compost.

The 37 leafcutter species are the culmination of social evolution among fungus-growing ants. Only leafcutters exploit living plants for their food production, making them by far the most conspicuous gardeners. Tending their woolly crop, the tiny workers in an *Acromyrmex octospinosus* nest (right) will harvest enough fungus to feed hundreds of thousands of nest mates. Other leafcutter ants have colonies in the millions. Except for drinks of plant sap, leafcutter ants obtain a complete and balanced diet from their fungus alone.



Call to arms

More reliant upon touch and smell than sight, two sister leafcutters on a trail in Guadeloupe check each other out with rapid strokes of their highly sensitive antennae (above). Had they been members of different colonies, each would have released chemical alarms called pheromones to summon help from their nest mates. The first arrivals, driven into a frenzy by the chemical, would tear the enemy apart.

As a colony in Belize emigrated from a site that had been slashed and burned by farmers, workers carried all the ant young (opposite) to a new location. The young included pupae that could not move on their own and a freshly emerged adult, at top, that could walk but perhaps had trouble finding her way.

Certain species have jumbo workers whose primary purpose is to defend against large attackers such as humans. Normally stationed inside the nest, these soldiers go on a rampage when alarm pheromones signal a major nest disturbance. Thousands may boil out of the ground. I watched one soldier poise herself to cut a bloody arc into my skin (above) as effortlessly as a smaller forager would cut leaves. Soldiers, I sorely reasoned, must make life miserable for the armadillos and anteaters that excavate their meals.

Fly bombing in the microworld

Choosing a target on which to lay its egg, a speck-size phorid fly swoops down on a passing leafcutter ant. Sensing its approach, the worker rears up, jaws gaping in defense. A maggot hatching from the egg would feed on the ant's head, eventually decapitating the ant.

With a leaf in her jaws (inset), a worker cannot defend herself, so small ants ride shotgun to keep flies at bay—which doesn't make hefting the burden any easier. □

By T. R. REID
Photographs by KAREN KASMAUSKI

The calamitous January earthquake killed 5,500 people, overwhelmed relief workers, and shook Japan's faith in quake preparedness.

Kobe Wakes to a Nightmare


KYODO NEWS SERVICE

Hellish offspring of urban earthquakes, fire ravages Kobe's Nagata Ward as darkness falls on the disaster's first day. At a memorial service two weeks later, a classmate clutches a picture of Chikako Kitai, one of five Seido Junior High School students killed in their homes. Police officers comb through a demolished apartment house (following pages) as a woman waits to learn the fate of her husband. His body was never found.

AFTER THE SHEER TERROR of watching his house rock and buckle and shake until the walls came crashing down on top of him, after the frantic struggle to dig his way out from under a pile of boards and broken furniture in the predawn cold, after the sorrow of hearing that an old friend had been crushed to death in her hardware store down the street, after the misery of a long day and night in a crowded shelter where the food ration was one small rice ball —after he had been through all that, Kazuo Nakamura looked me in the eye and said, quite calmly, "All in all, I was pretty lucky."

I met Nakamura-san last January 18, the day after a ferocious earthquake ripped through the heart of the historic port town of Kobe, Japan. The tremor lasted less than a minute. The resulting fires raged off and on for two days. The funerals went on for weeks. The multibillion-dollar job of rebuilding will continue for months, even years. And the memories will last a lifetime for Kazuo Nakamura and millions of others in the region known as Hanshin, the busy metropolitan corridor linking Kobe and its larger neighbor, Osaka.

Kobe's earthquake was the worst disaster to hit Japan since World War II. It killed 5,500 people, injured thousands more, and damaged 190,000 buildings. It toppled bridges, twisted highways, snapped ten-ton trucks like toothpicks, and severed the trunk line of Japan's famous bullet train, the technological pride of a high-tech superpower. It shut off water, gas, and electricity to nearly one million households and scrambled the underground pipes so completely that thousands of people were still without gas three months later.

Japan's bureaucrats, with characteristic precision, named the tremor the South Hyogo Prefecture Earthquake of 1995. But the media quickly decided that this mundane label was inadequate for an event of such cataclysmic dimensions. So they came up with a name that will surely last in the history books to describe the disaster that struck at 5:46 a.m. on January 17, 1995: the Great Hanshin Earthquake. It is a phrase rich with meaning for any Japanese, because it evokes the Great Kanto Earthquake of 1923, the awful tremor that killed 143,000 people in Tokyo and the surrounding Kanto Plain.

A BLACKENED WOUND marks the burned-out Nagata Ward, a working-class district where early breakfasts were cooking when the quake hit at 5:46 a.m. Fires erupted when natural gas lines ruptured and falling debris toppled kerosene stoves. The neighborhood's closely bunched wooden houses turned into tinder, while broken water mains left frustrated firefighters with dry hoses.

The January quake devastated the most important heavy cargo port of a nation that lives and dies by foreign trade. Japan's total exports dropped about 5 percent in the month after the disaster. But increased use of other ports and accelerated repair work on Kobe's docks brought the export-import rate back to normal by spring; the nation's huge trade surpluses continued unabated. By moving work to factories elsewhere and finding alternatives to Kobe-made products, industrial Japan weathered the quake with mild impact.

The impact on the national psyche was harder to measure. Initially the disaster was a sharp blow to the confidence of many Japanese, even those far from Kobe. Coming

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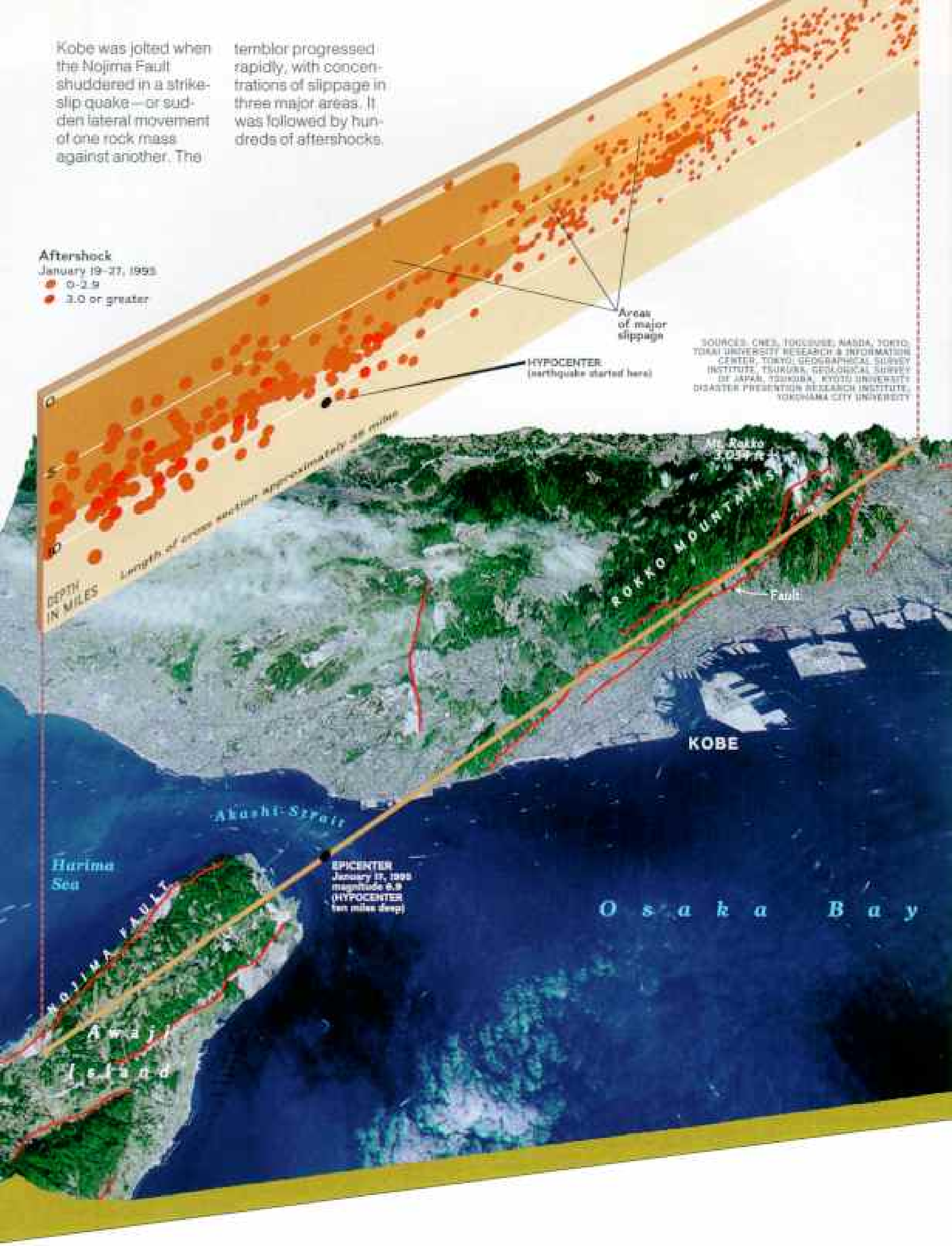
at a time of political turmoil, and after four years of stinging economic recession, the quake almost made it seem as if fate were piling it on. But because repairs in Kobe have proceeded faster than anyone predicted—the reopening of the bullet train line in early April was especially important—the aftermath of the quake could turn into a boost for Japan's national morale.

The earthquake measured 6.9 on the moment magnitude scale—making it twice as powerful as the 6.7 magnitude quake that badly damaged Northridge, California, on the same date one year earlier. On Japan's Shindo intensity scale it was the first quake ever to be rated 7, the top of the scale. By any measure, it offered awesome proof of nature's power to humble even the largest of human creations.

Walking through the shattered, smoky streets in the days afterward, I saw homes and buildings that had crumbled like cookies, pouring bath scales, bookshelves, barbells, radios, rocking chairs, and refrigerators out into the streets. At the Hankyu Kobe Railway's Itami station I saw two maroon passenger cars, weighing about 65,000 pounds apiece, that had been tossed onto the roof of the terminal like a pair of paper clips flipped casually onto a desktop.

A nearly half-mile-long section of an elevated superhighway, the Hanshin Expressway, was plopped over on its side so it rose up like some 50-foot-tall cliff in the center of the city (page 128). Here and there along the base of this black asphalt cliff were the smoldering remains of trucks that had been running down

Kobe was jolted when the Nojima Fault shuddered in a strike-slip quake—or sudden lateral movement of one rock mass against another. The temblor progressed rapidly, with concentrations of slippage in three major areas. It was followed by hundreds of aftershocks.



The hypocenter, where the rupture of the Nojima Fault originated, lay ten miles beneath Akashi Strait. The severity of the quake was a surprise, since the fault had previously been considered minor.

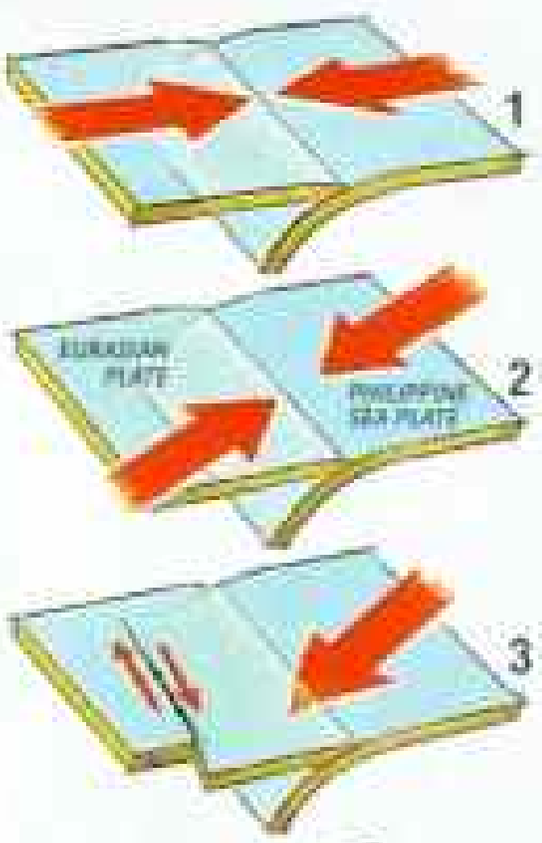
The January 17 temblor was the consequence of strain built by the colliding plates of earth's crust. Japan sits at the intersection of four major plates (right). The Pacific plate moves fastest, subducting four inches a year. Most of the strain is dissipated by strong shallow earthquakes off the east coast.

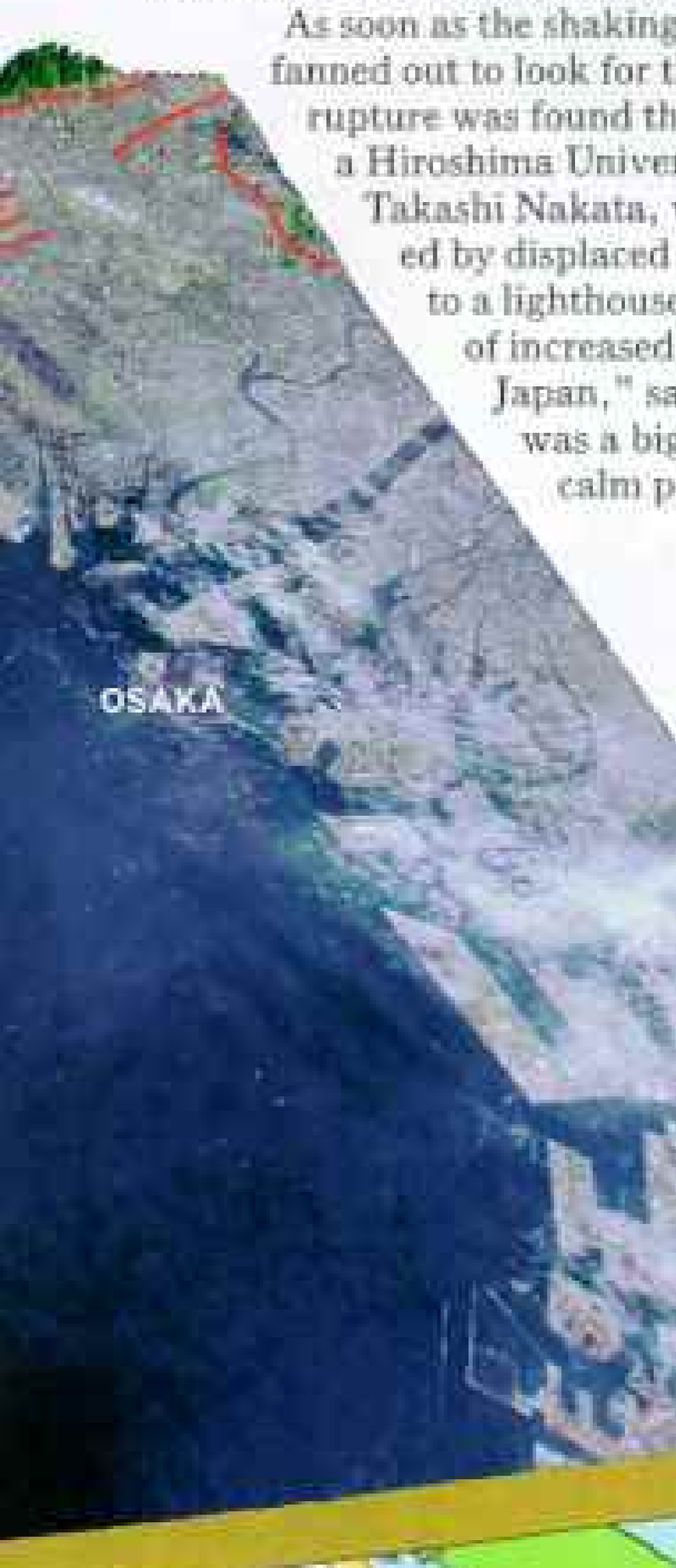
Deadly movement of a minor fault

A ragged gash that tore through terraced rice fields on Awaji Island (right) revealed the disaster's culprit: the Nojima Fault. The earthquake, which registered 6.9 on the moment magnitude scale, took 5,500 lives, displaced 300,000 people, and caused at least 100 billion dollars' worth of damage. It was Japan's worst quake since one measuring 7.9 that hit Tokyo and Yokohama in 1923, killing 143,000.

As soon as the shaking stopped, geologists fanned out to look for the source. The fault rupture was found the next morning by a Hiroshima University team led by Takashi Nakata, who had been alerted by displaced stone steps leading to a lighthouse. "We're in a period of increased seismic activity in Japan," says Nakata. "This was a big one, coming after a calm period of 50 years."

When plates of earth's crust collide, one can be forced beneath the other, creating a subduction zone (1). The Eurasian and Philippine Sea plates meet obliquely (2), which places a lateral strain on the overriding Eurasian plate. When that plate ruptures (3) along the Median Tectonic Line, it puts a strain on the crust behind it, which develops a new fault zone (4) along the Arima-Takatsuki Tectonic Line.





Earthquake
magnitude 6 or greater
1950 to present
- Depth 15 miles or less
- Depth greater than 15 miles

Volcano
- Known eruption in past 10,000 years

Scale varies in this perspective.

SOURCES: JAPAN METEOROLOGICAL AGENCY; SMITHSONIAN INSTITUTION

PRINTING BY WILLIAM H. BOND

NGS CARTOGRAPHIC DIVISION

the road when it suddenly bounced, bolted back and forth, and careened over.

YET AS I TREKKED through the stricken city in those first days after the earthquake, with flames climbing toward the sky and the scream of sirens everywhere, I saw a force even more impressive than the brute strength of nature: the power of the human spirit.

The people of Kobe endured with an almost uncanny calm—a quiet but forceful determination to preserve, even in the face of appalling disaster, Japan's famous virtues of order, peace, and civility.

In a city where art galleries, auto dealerships, CD shops, and convenience stores were shattered and open to all comers, there was almost no looting.

Two days after the quake I watched people waiting in a long line for water from a tank truck that had pulled onto a dusty playground. Holding metal buckets or blue plastic trash cans, the victims had to wait about 90 minutes each on a chilly day. Yet there was no jumping in line, and almost no noise except when a group of people insisted that an elderly woman in a gray kimono should go to the front of the queue (an offer she steadfastly refused).

In Tokyo, opposition politicians raised a hullabaloo about the government's slow and limited response. Some people in Kobe complained too, but most did not. At the seat of the crisis the voices of the victims for the most part echoed the stoicism of Junko Takahashi, a nearly toothless 58-year-old woman I met on a bus one week after the quake. "Our house? It's gone," she shrugged. "I worked in a shoe factory in Nagata [Kobe's most heavily damaged ward], so I suppose my job's gone. We're living in a school gym right now. But I'm not complaining."

The Japanese have a word for this—one of their favorite words, in fact: *gaman*. Japan's version of the stiff upper lip, gaman represents one of the virtues encompassed in the Bushido, the code of the samurai. It means, as the late Emperor Hirohito once put it, "to bear the unbearable," to accept without complaint whatever fate may throw in your path. The concept is closely connected with the Japanese predilection for hard work. When something awful happens, the determination to gaman, to get back to work, can serve as a kind of narcotic. It dulls the pain and gives victims something other than their losses to think about.

One approach that people employ to live up to the rigors of gaman is to try to put the best face on any bad situation. That, I think, is what Kazuo Nakamura was trying to do the morning after the earthquake, in front of the ruined structure in Nishinomiya where he ran a tiny restaurant on the first floor and lived with his wife upstairs.

Nakamura's business is one of many small stores on a long, covered arcade. The place is officially called the Nishinomiya Central Shopping Arcade, but it has been decorated with bright green banners declaring, in English, that the arcade is Smile Shopping Street. It was hard to smile there after the

KYODO NEWS SERVICE (FACING PAGE)

UNITED BY GRIEF, mourners fill a city gymnasium for a funeral commemorating 60 victims. With their houses damaged or destroyed, families could not hold traditional home services. At his family's cemetery, Yoshimasa Kikkawa purifies disturbed graves with salt, an urgent concern in a nation where reverence for ancestors is strong.

CONFETTI OF DISASTER spills from a bank building as if in perverse celebration of a bright spot: Because the quake hit before the workday began, no one was killed within.

Sited on a filled estuary, the drooping structure illustrates the danger of erecting high-rise buildings on soft, unstable soil in a region prone to seismic action.

earthquake, however; central Nishinomiya was one of the areas hit hardest by the tremor. Neighbors said four people were killed in homes lining the street, and virtually all the survivors found themselves, at least temporarily, without a home or a business when they finally dug out of the wreckage. Nakamura and hundreds of others had to move into a refugee center in the Nishinomiya Ebisu Shrine, a lovely 300-year-old Shinto place of worship not far from the arcade.

Nakamura has an irrepressible sense of humor, and he was joking with me almost from the beginning. When I asked him how old he was, he didn't miss a beat. "Until yesterday, I always used to say over 50," he smiled. "Since the quake, it feels more like over 100."

But as the conversation turned more serious, he set out for me all the reasons why he considered himself "pretty lucky."

"The way I see it, the fates were on our side," he explained matter-of-factly. "For one thing, the quake hit on a Tuesday. That's the standard day off for every business on our shopping street. Any other day I would have been up cooking already, with the gas on, and my place would have gone up in flames. I was sleeping late, so I was on the second floor. If I had been downstairs, I probably would have been buried. And if this had hit during the rush hour, it would have killed a lot more people on the highways. If you take it all together, then you say, yeah, the fates were on our side."

A WEARISOME WAIT for housing faced 1,100 homeless people jammed into an unheated municipal gymnasium, where they fought flu, boredom, and irritability. At Hyogo High School the waiting list for a relaxing soak—a Japanese institution—was long. Volunteers bathe an 84-year-old woman in a tub that was refilled daily with water trucked from a hot springs 125 miles away.

WHATEVER SIDE the fates may have been on, fate was decidedly fickle in Kobe on January 17. One of the most striking aspects of the earthquake was the erratic nature of the damage. Although it may not have been obvious to people watching television news, which tends to show the most dramatic images available, the destruction in Kobe was spotty, almost capricious.

On one narrow street in Nishinomiya, the entire first floor of a house—floors, walls, furniture, even a pink toilet with Donald and Daisy Duck on the cover—had tumbled out into the road. But in the garden of the same house stood a skinny persimmon tree, with ripe orange fruit still hanging on the bough.

Walking down the street in Kobe the day after the quake, navigating around toppled vending machines and wide cracks in the pavement, I saw a phone booth that had been knocked over onto its side. I gingerly stepped over the broken glass, reached down through the twisted metal frame of the booth, picked up the phone—and placed a direct-dial call to the United States with no trouble at all.

I was surprised that a quake could be so quirky, but a few days later, purely by chance, I got a lecture on the topic from an expert. I was walking toward downtown Kobe along Route 43, under the Hanshin Expressway.

Amid a horde of pedestrians I happened upon a Westerner with a clipboard in his hand, binoculars around his neck, and a hard hat on his head bearing the inscription CalTrans. This was Professor Nigel Priestley, a structural engineer from the University of California at San Diego and a consultant on earthquakes and post-quake reconstruction to the California Department of Transportation—hence CalTrans. *(Continued on page 131)*

SAME SHOWDOWN (FACING PAGE)

MASSIVE FAILURE of the Hanshin Expressway shoved traffic to the side when single-column supports gave way at their bases. Excavators biting at the highway debris (above) removed the bulk of it within six days (right).

When ambulances were forced to creep along in gridlocked traffic, local officials were criticized for not reserving some passable highways for emergency vehicles. Meanwhile, owners of shops with broken plate-glass windows could take some comfort in a situation that would astound American storekeepers—an almost total lack of looting.

Safeguards get mixed reviews

The quake was an instant test of Kobe's construction. Worst hit were frail homes built right after World War II. Buildings erected after 1981 under a tougher safety code fared better, though failures of some "earthquake proof" structures were conspicuous.

Doubts arose about Japan's earthquake-preparedness program as well as about researchers' attempts at prediction. Some scientists now believe that too much effort has gone into seismic monitoring around Tokyo at the expense of other regions.

Roadway supports

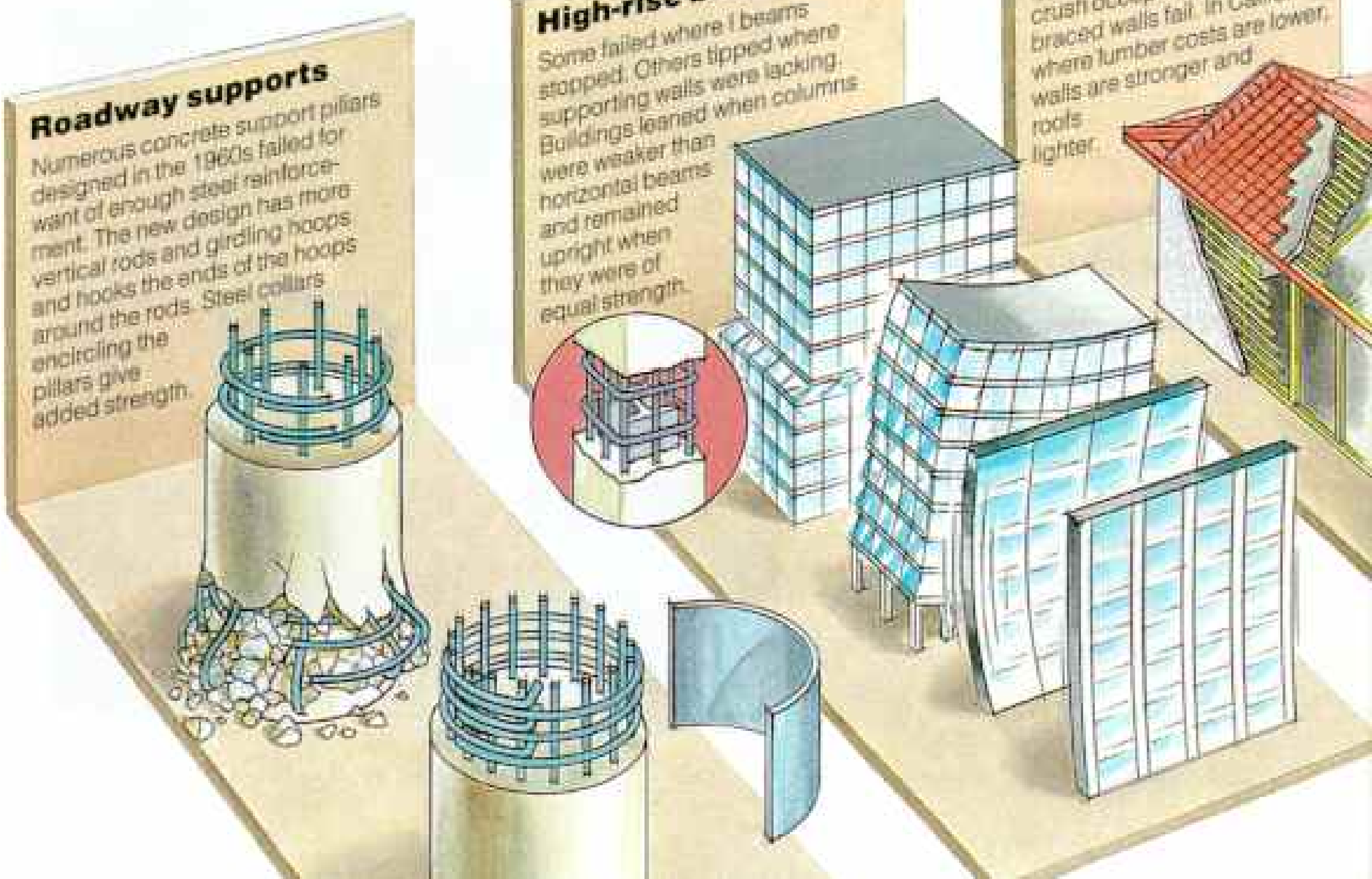
Numerous concrete support pillars designed in the 1960s failed for want of enough steel reinforcement. The new design has more vertical rods and girdling hoops and hooks the ends of the hoops around the rods. Steel collars encircling the pillars give added strength.

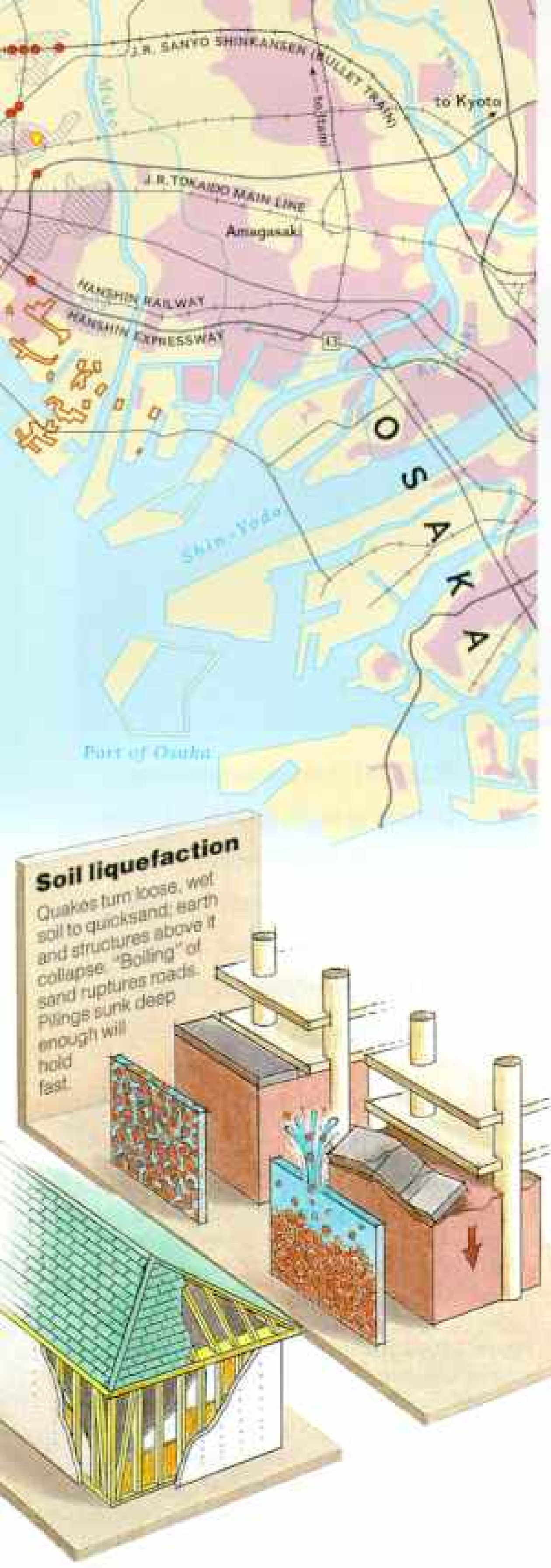
High-rise buildings

Some failed where I beams stopped. Others tipped where supporting walls were lacking. Buildings leaned when columns were weaker than horizontal beams and remained upright when they were of equal strength.

Houses

Designed to withstand typhoons, heavy tile roofs can crush occupants when poorly braced walls fail. In California, where lumber costs are lower, walls are stronger and roofs lighter.





The professor told me that all earthquakes leave a patchwork pattern of destruction. "Some structures will come through undamaged, and others right close will collapse. There are so many variables at work: the characteristics of the structure, the engineering knowledge available when that structure was built, the stability of the ground underneath, the kind of maintenance provided."

AS BEFITS a technically advanced nation that happens to be situated on a geologically unstable archipelago, Japan has made a speciality of earthquake-resistant structures. In fact, some officials had boasted that Japanese architecture was earthquake proof—a claim that turned to dust in the rubble of Kobe. But now, as engineers examine the results, the report card seems to be mixed: Japanese engineering wasn't as good as hoped for, but it wasn't all that bad either.

"Three years ago I proudly declared, 'In Japan, highways will never collapse,' " said a rueful Toshio Mochizuki, head of the Center for Urban Disaster Prevention at Tokyo Metropolitan University and one of Japan's leading authorities on anti-earthquake measures. "I now realize how naive I was."

I called on Professor Mochizuki at a campus office so cluttered with books and papers it looked as if it too had been through a small-scale quake. He was fielding dozens of calls a day from government officials, construction firms, and the news media. But he had found time to do some preliminary studies of which buildings had stood up to the earthquake and which had not.

"As a generalization we can say that the newer buildings came through reasonably well," he said. "That's why you have this interesting phenomenon that the tallest buildings are intact, and smaller ones fell to the ground. You won't see many taller than 15 stories that took major damage."

The data from the Hanshin corridor back this up. The buildings that fared the poorest were the one- and two-story wooden buildings—homes, shops, some small factories—in the oldest residential areas of Kobe, Nagata Ward and Higashi-Nada Ward. These neighborhoods were built in a rush after World War II, when an impoverished Japan was more interested in providing homes than in earthquake-resistant

PAINTING BY WILLIAM N. HYDE

REUTERS JAPAN (RIGHT)

WATER-FILLED DITCH marks the fissure that snarled operations on Kobe's Rokko Island (above), a major containerized-cargo handling facility that serves Japan's premier port city. Cars took nosedives on Port Island, which sank as much as ten feet. Both islands were built from fill, making them particularly vulnerable to quake damage.

architecture. The housing stock consisted largely of weak-walled structures with heavy tile roofs—exactly the wrong kind of home to be in when an earthquake hits.

"The most common cause of death in Kobe was being crushed under a falling building," Mochizuki said. "And that helps explain the statistic that 60 percent of those who died were over 60 years old. Of course, elderly people have a harder time getting to safety. But mainly it's because they tended to live in those old wooden houses."

In buildings ranging from about five to ten stories high, the Great Hanshin Earthquake seemed to confirm a common, if counter-intuitive, lesson taught in Japan's regular earthquake drills: The highest floors of a building tend to be the safest. Many damaged buildings collapsed at the bottom, so the first floor was crushed while upper floors remained largely intact.

"The first floor of a building tends to give way because there's often an open lobby or a big store there, without many supporting walls," Mochizuki explained.

But most of Kobe's glitzy new skyscrapers, designed or built during Japan's "bubble economy era" in the late 1980s, seem to have come through the quake reasonably well—even those with wide-open first-floor lobbies. The city's tallest hotels, the 37-story Shinkobe Oriental and the 35-story Okura, both reopened for business within a few weeks.

But if Japan gets a decent grade for earthquake-resistant engineering, it clearly flunked the test in a related discipline—the science of earthquake prediction.

Both China and Japan have traditionally believed that earthquakes can be forecast. Japan's government has been making regular seismic observations since 1885. Currently it budgets about 110 million dollars a year for earthquake prediction studies.

Just as a doctor uses an electrocardiogram to spot the stresses that indicate an impending heart attack, the Japanese have wired the earth and sea to measure seismic activity. In addition, there are observation wells more

than a mile deep east and west of Tokyo with strainmeters to detect telltale movements in the earth's crust.

Besides these high-tech approaches, there is considerable study under way into the ancient Chinese idea that plants, animals, and even well water can tell us when an earthquake is coming. Indeed, a lot of people in the Hanshin area seem to think that animals were sending warning messages just before January 17. A research team at Osaka City University has gathered some 1,500 reports of unusual natural phenomena. In the waters off Kobe there were reports of large swarms of fish swimming uncharacteristically near the surface in the days before January 17. Crows and pigeons were said to be especially noisy and flying in crazy patterns in the hours before the quake.

Equally suggestive, and perhaps more reliable, are scientific data about changes in groundwater in the Hanshin region before the earthquake. The city of Nishinomiya is known throughout Japan for its sake breweries, which depend on the famous water called Miyamizu, from an aquifer under the city. Scientists began testing the water last October. In the weeks before the quake, they noticed a strange pattern: Levels of radon gas in the water samples rose sharply toward the end of 1994 and then declined sharply after January 8. According to data gathered by Japan's Coordinating Committee for Earthquake Prediction, a similar up-and-down pattern of radon levels has been found in groundwater in the area of three other earthquakes.

POST-QUAKE JITTERS sent one family fleeing to their van, where Yoshi Matsumoto mans the TV remote control during breakfast. His wife, Sumie, and son, Shintaro, were too frightened to stay in their damaged apartment above the family laundry.

A customer leery of airborne germs watches Yoshi pump well water, which he freely shared with neighbors—a generous act in a city with an aching need for charitable spirit.

HOWEVER USEFUL these findings might be in the future, they were completely unnoticed this time. The Great Hanshin Earthquake was a total surprise—not least to the delegates to the annual Japan-U. S. Workshop on Urban Earthquake Hazard Reduction, which was scheduled to open in Osaka on the very morning of January 17. In fact, the meeting was shelved, because all the participants headed down the road to Kobe as soon as the shaking stopped.

The Hanshin quake was like the Northridge quake a year earlier in that it occurred along a so-called minor fault. This fault lies in a complex zone called the Arima-Takatsuki Tectonic Line—an area government officials dismissed as a source of major trouble because it had been fairly quiet for 50 years. The Nojima Fault runs down the western edge of Awaji Island, which is shaped like a dagger, with the point aimed directly at Kobe.

Despite warnings from some seismologists, the Hanshin area was not prepared, materially or mentally, for a massive earthquake. That helps explain why initial relief efforts fell so tragically short. Emergency supplies of food, fuel, water, and blankets were insufficient. There were evacuation and survival plans on paper, but it soon became clear that Hanshin-area governments were nowhere near ready to deal with such a disaster. Among other things, it took days before the police put restrictions on the use of Route 43, the only passable thoroughfare linking Kobe to Osaka after the quake. While neighborhoods were burning down and injured people were dying in central Kobe, fire trucks, ambulances, and other emergency vehicles had to inch their way

down the road through a 20-mile-long traffic jam to reach the scene.

Some 300,000 people had to move to emergency shelters on the day of the quake. About 70,000 were still in shelters two months later. Most went the first two days without adequate food or water, and even after provisions arrived, conditions were close to miserable.

Two weeks after the earthquake I went to Hyogo High School in the Nagata neighborhood, temporary home to 3,085 people. It was cold, noisy, and impossibly crowded. Sleeping cheek by jowl on the gym floor with hundreds of strangers, families built makeshift enclosures of cardboard boxes to get a modicum of privacy. The walls were covered with desperate messages from people looking for friends and relatives. "MIURA YURI-SAN! Where are you?" one sign read. "If you are alive, please contact Kyoko as soon as you can."

Some gave in to the sheer wretchedness of it all. "There are people here who just sit all day looking at the wall," said Fumiko Ikeda, a nurse who was looking after some 50 children from an orphanage that had been destroyed. "When there's an aftershock, we hear screams and crying all over the building."

Yet most of the refugees found the strength to gaman, to impose order and routine despite the unexpected turn their lives had taken. On the high school athletic field, people were cooking miso soup and salt-grilled sea bream over bonfires. A family's laundry was hung out to dry in a soccer goal. Outside a red-and-blue pup tent, I saw a neat line of child-size tennis shoes; Japanese children know better than to wear shoes in the house, even if the "house" is temporarily a tent. "It's amazing, but the kids are actually enjoying this," smiled Atsuko Kubota, mother of the three elementary schoolers in the tent. "We just told them we were going camping for a while."

Japanese politeness also survived the quake, giving rise to one of the stranger aspects of the disaster: People and businesses were constantly apologizing, as if the earthquake had been somebody's fault.

All over the Hanshin corridor, merchants posted signs like the one I saw at the downtown branch of the Seiden appliance chain: "It is a terrible inconvenience and handicap to our respected customers, but because of the earthquake we have been forced to close this humble store." At the several points where rail lines were cut off by damage, uniformed railroad employees wearing gloves said into their bullhorns, "We humbly ask our honorable customers to tolerate the enormous inconvenience of switching to a bus at this point."

IN CONTRAST, there was no apology and no explanation from nature, which caused all this upheaval in the first place. The earth didn't even make it easy to see what had happened, a fact I discovered one Sunday when I took a ferry from Kobe over to Awaji Island. A team from Hiroshima University had found the actual rupture from the quake there—a crack in the earth running along the Nojima Fault. This I had to see.

I had been warned that roads on Awaji were badly damaged, so I made the trek via mountain bike. From the ferry port to the fault line and back was a 30-mile ride, some of it fairly steep. As I rode south on the highway skirting the island's west coast, I saw three colors: the steely gray of the winter sea to my right, the deep green of the wooded mountains to my left, and the bright royal blue of the vinyl fabric that just about everybody in Awaji seemed to be using to shelter their shattered homes.

Finally, I turned up a dirt road leading to a spot where you could see the actual fault. It didn't take long to find; there were a few cars of fellow gawkers on the scene. But when I found it, I was deeply disappointed. It was just a little ditch, smaller than a drainpipe, snaking through a rice field. This was it, the rupture from the Great Hanshin Earthquake?

Glumly, I headed back toward the ferry. But along the way, I turned inland again, to see if I could get another look. I rode through a terraced rice field, where farmers had built heavy concrete retaining walls around the paddies. Those walls were huge—I measured, and found them to be 13 inches thick. And suddenly, I clearly saw the enormous power that had shattered the proud city of Kobe.

The fault line, that unimpressive ditch in the rice field, had smashed its way right through the wall of concrete. Had shattered it like an elephant stepping on a saltine. And then the same mighty force had ripped its way northward, onto the mainland and into the crowded heart of Kobe.

Seeing it, I thought again of Kazuo Nakamura, who had lost a lot to this immense power but had come out with his life and his sense of humor intact. And I knew he was right when he said, "All in all, I was pretty lucky." □

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Burrowing Bettong *(Bettongia lesueur)* **Size:** Length of head and body, 35 cm; tail, 30 cm **Weight:** Males, approx. 1.3 kg; females, 1.0 kg **Habitat:** Semiarid regions with low vegetation on islands off Western Australia **Surviving number:** Estimated at less than 5,000 Photographed by Jiri Lochman

WILDLIFE AS CANON SEES IT

A bettong surveys its surroundings before embarking on its nightly search for food. The boodie, as it was called when still common on the mainland, lives in extensive burrow systems, some with over a hundred individuals. These little kangaroos now occupy less than one percent of their former range, surviving on a few islands where cats and introduced fox cannot reach them and their habitat remains undisturbed. To save endangered species, it is vital to protect their habitats and understand the role of each species within the earth's ecosystems. As a global corporation committed to social and environmental concerns, we hope to foster a greater awareness of our common obligation to ensure that the earth's life-sustaining ecology survives intact for future generations.

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Canon

NATIONAL GEOGRAPHIC

JULY 1995

The Cover

Alarmed by the scent of man, a forest elephant makes a heart-stopping charge in the Central African Republic.

Photograph by Michael Nichols.

Cover printed on recycled-content paper.

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NATIONAL GEOGRAPHIC

Behind the Scenes

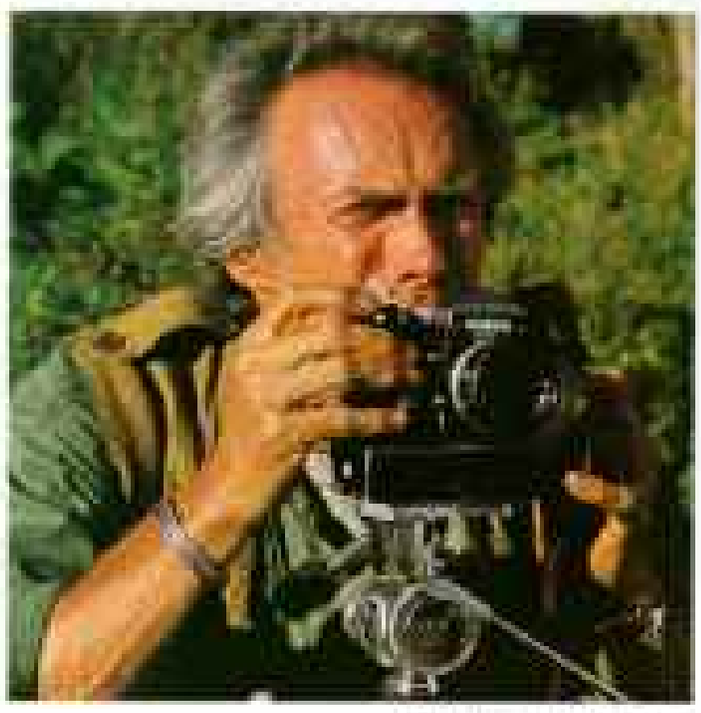
■ FROM THE EDITOR

Every day I hear from staff members, freelancers, and research grant recipients about their experiences in the field and what the Society is accomplishing with your dues. In this new feature we will share these often amusing, sometimes amazing stories.

—BILL ALLEN

The Cover That Never Was

THE LINE between fiction and nonfiction blurred for some of our readers when the novel *The Bridges of Madison County* topped the bestseller lists with its hero, Robert Kincaid, portrayed as a NATIONAL GEOGRAPHIC photographer.

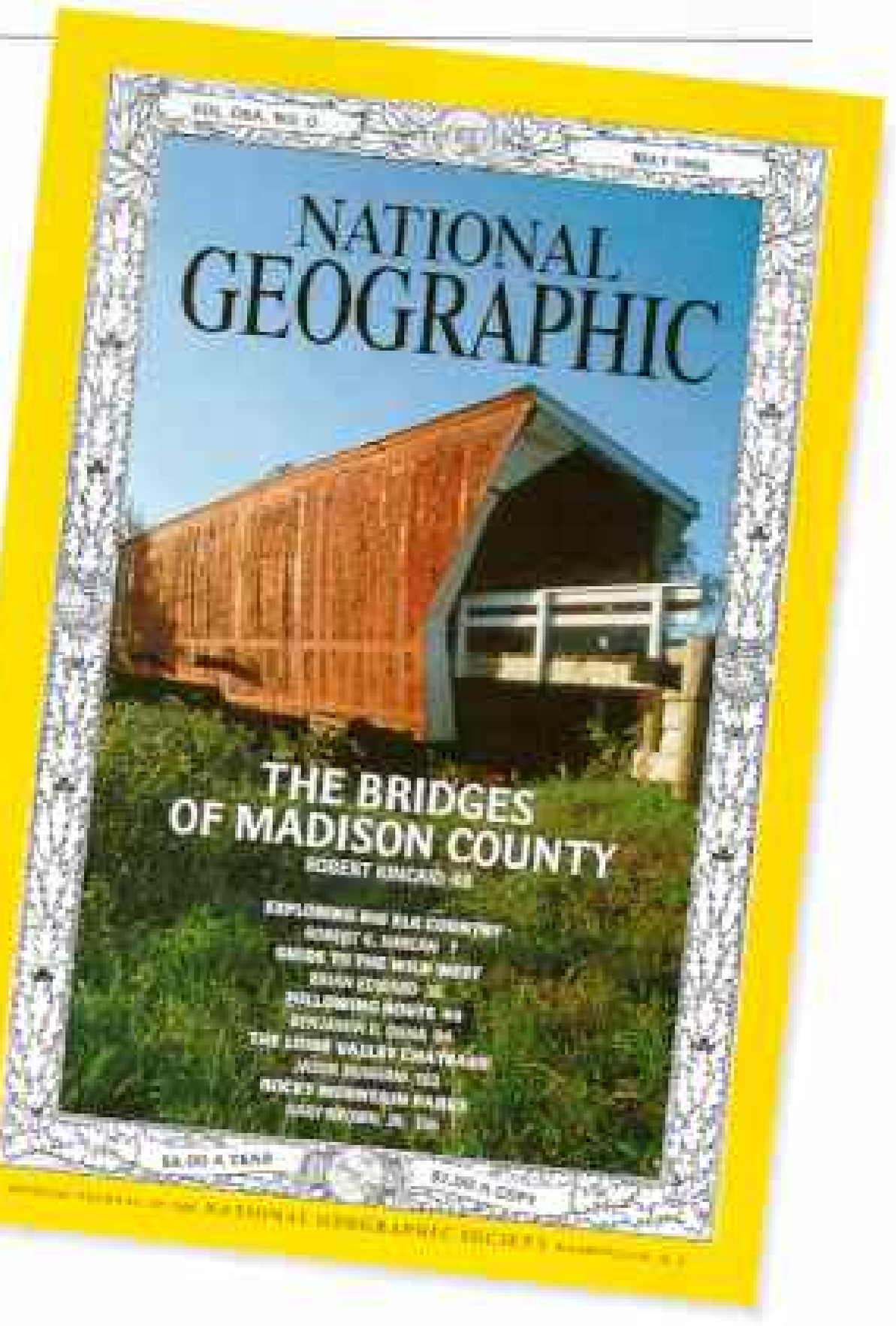


KEN REGAN, CAMERA 5

Convinced that Kincaid is real, members have been writing and calling to ask when his article on covered bridges was published. The answer is: Never. Robert Kincaid is pure fiction. Still unconvinced, one visitor to our library riffled through 1960s GEOGRAPHICS hoping to find his story.

Even so, when actor-director Clint Eastwood announced he would turn the novel into a movie, we decided that if art really hoped to imitate life, it ought to contain some semblance of reality. Thus we sent the production crew two camera bags used in the 1960s by a staff photographer, along with this make-believe May 1966 cover and GEOGRAPHIC photographs that Eastwood—aka Kincaid—shows as his own work.

To learn the truth about what our photographers really do, watch for an article in the August issue on shooting for NATIONAL GEOGRAPHIC.

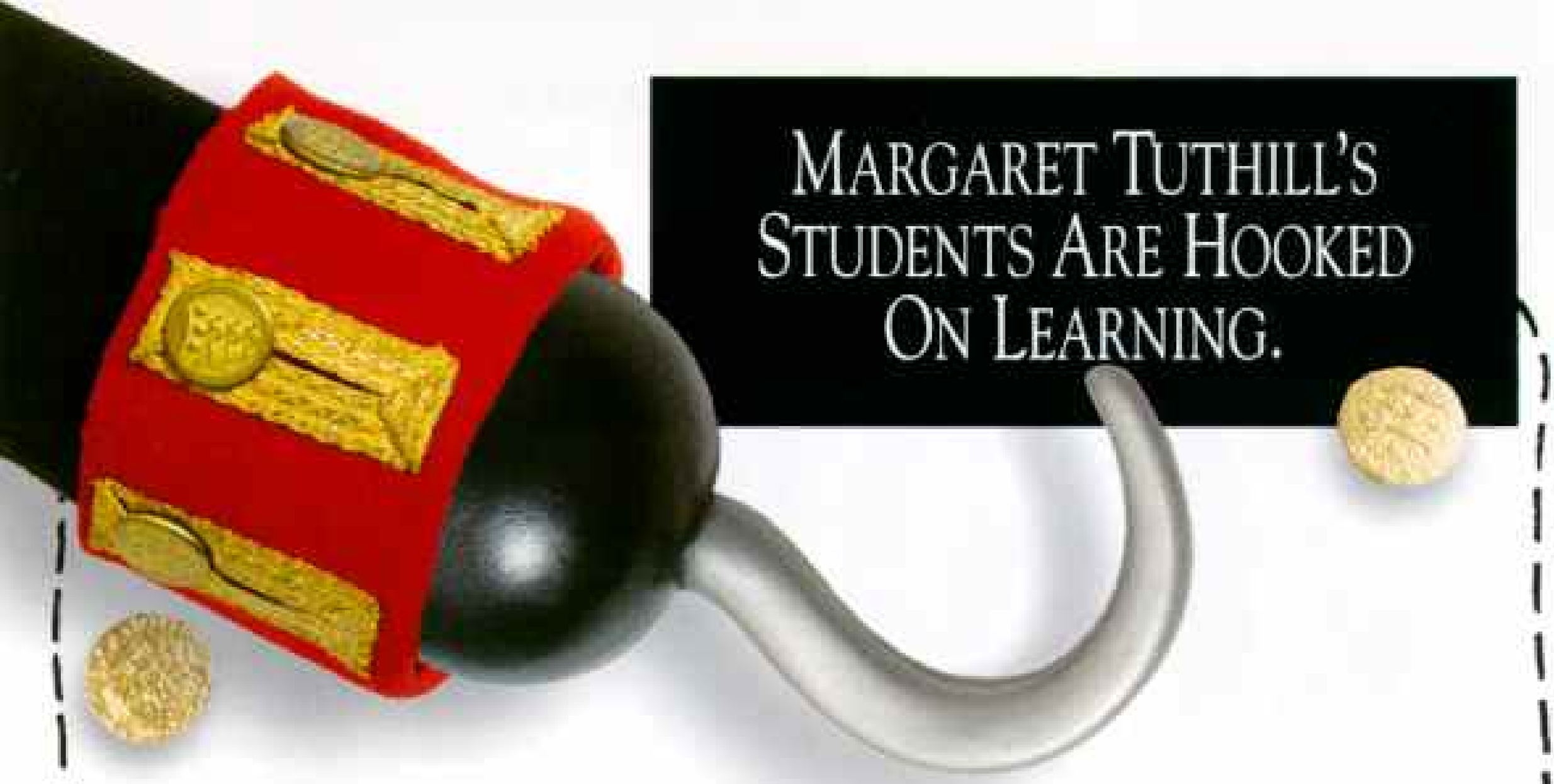


Foreign Language First

ENGLISH OR JAPANESE? Readers in Japan now have a choice. In April we inaugurated our first foreign-language edition of the magazine—in Japanese. When it was advertised in Tokyo, incoming orders overloaded our fax machine there; circulation had reached nearly 140,000 by mid-April.

The new edition, a joint venture with Nikkei Business Publications, is a close copy of the English one. Since Japanese characters require more space, our English text is cut 20 percent before being translated. And translation leads to unexpected variations; Earth Almanac becomes Interesting Little Stories About the Planet.

Annual membership costs 7,800 yen ($95), a bargain in pricey Japan, where a cup of coffee can leave your wallet ten dollars lighter.



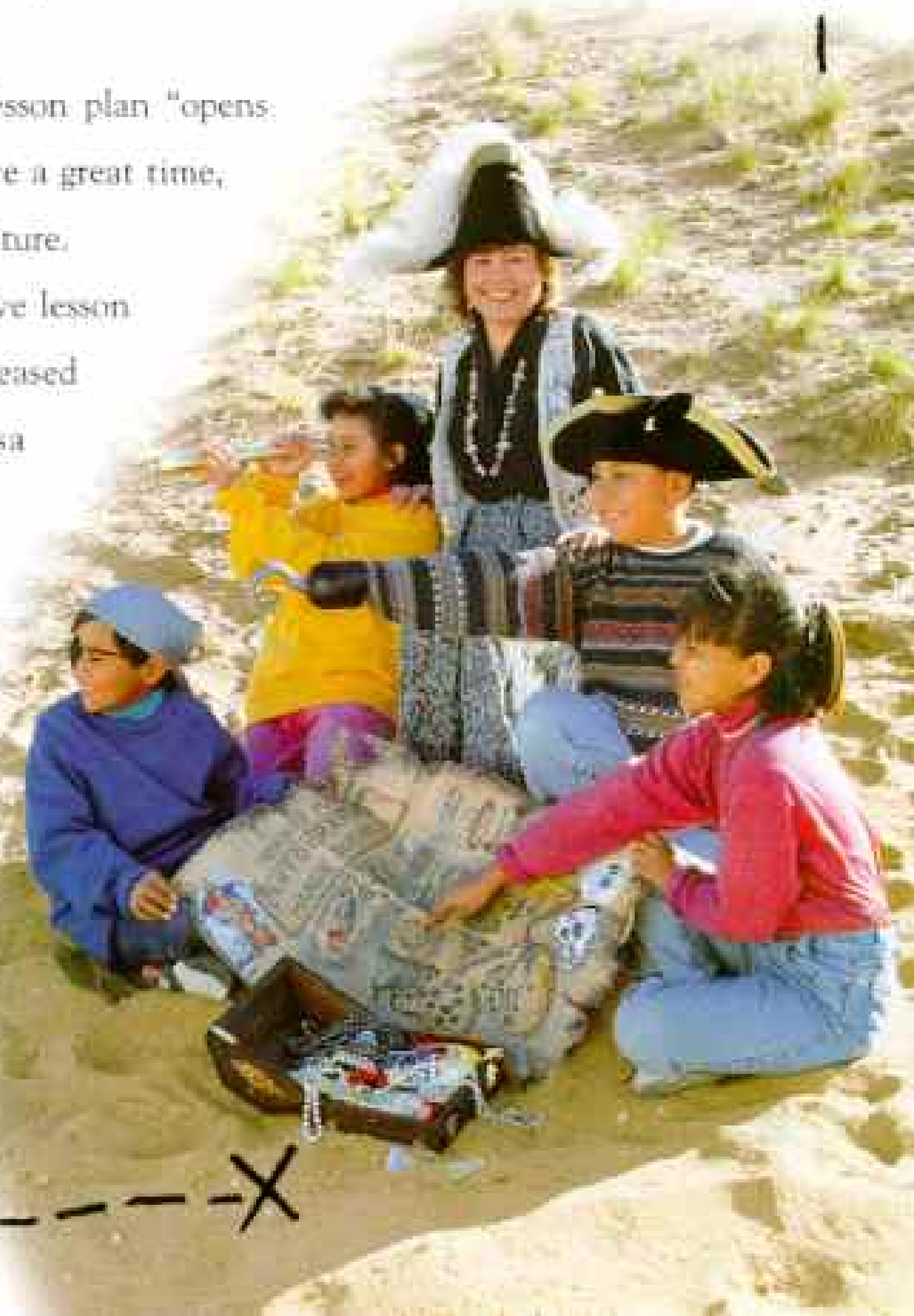
Margaret Tuthill's Students Are Hooked On Learning.

It's yo, ho, ho and a whole lot of fun for fourth graders at Mesa Elementary in Shiprock, New Mexico. Because they're off on a treasure hunt – thanks to the lesson plan created by their teacher Margaret Tuthill.

Margaret starts with excerpts from Robert Louis Stevenson's classic novel, *Treasure Island*, to get them in the pirating mood. Then, they actually create their own buried treasure maps. During the map creation process, Margaret covers the entire curriculum including history, language arts, math, social studies, art and interpersonal communication. And, of course, geography.

She believes that her treasure hunt lesson plan "opens their eyes to the world." Best of all, they have a great time, which makes teaching and learning an adventure.

Thanks Margaret, for putting innovative lesson plans like this on the map. State Farm is pleased to donate $5,000 in your name to Mesa Elementary. (It's buried under the cottonwood tree, behind the rock, ten paces to your left.)



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GREG MARSHALL

Shark Bites Man

IN A CLOSE-UP too close for comfort, EXPLORER TV almost lost Nick Caloyianis on the first deployment of the crittercam. That's the new video camera that rides on a marine animal, films from its viewpoint, disengages, and bobs to the surface.

As divers tried to attach the device to a seven-foot-long bull shark off Cancún, Mexico, it jerked away. Provoked by a fisherman's attempt to recapture it, the shark turned on Nick, biting his hand and leg. A medevac jet flew him to a Miami hospital, where he spent three weeks and underwent five operations.

Mexican fishermen, fearing the shark would attack other humans, killed it and sent its jaws to Nick, a grisly reminder of his brush with death.

Man Bites Spider

BIOLOGIST MARK MOFFETT, here with a smallish tarantula in Peru, shared this morsel after visiting South America for his tarantula assignment: In Venezuela he dined with the Piaroa tribe, who roast dinner-plate-size spiders on special occasions. "Nice white meat. Sort of tastes like crab," he reports.

RICK C. WEST

Beetles: Mini-Splendored Things

WHILE TRACKING elephants and gorillas, the big stars of the Congo tropical forest, writer Doug Chadwick also kept his eye out for smaller game. A coleopterist (that's a beetle expert) at Montana State University had asked him to beat the bushes for beetles to bring home.

Doug used an aspirator to suck beetles from cracks in the ground; he picked insects off his colleagues' evening meals; and he pawed through fresh gorilla droppings for choice dung beetles. His catch: thousands of insects representing hundreds of species, including at least a dozen new to science.

■ READERS' TOP TEN

Of 62 articles published in 1994, U. S. members preferred:

1. **National Parks** (October)
2. **American Bison** (November)
3. **Animals at Play** (December)
4. **English Channel Tunnel** (May)
5. **Mississippi Flood** (January)
6. **The Everglades** (April)
7. **Beluga Whales** (June)
8. **Chornobyl** (August)
9. **Lions of Darkness** (August)
10. **Shanghai** (March)

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said the minivan
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Where can you find the newest thing in a minivan?

Second door on the right. Take a walk around to the driver's side of the all-new Plymouth Grand Voyager, and what you'll find is an industry exclusive: an available second sliding door. Now getting in and out of our minivan is easier than ever. And just wait 'til you see what's behind door number two.

Front cup holders adjust to accommodate everything from a four-ounce baby bottle to a full one-liter jug; they even hold juice boxes and coffee cups with handles. Interior volume is increased, giving it more passenger and cargo space than in any other minivan. ABS is standard. We also reduced the turning circle by over three feet. The question isn't what's new—but what isn't?

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Can you spot the tissue box, the pacifier, the baseball glove, Fido's chew toy and the map of Colorado? One thing you won't have trouble finding in the new Plymouth Grand Voyager is storage space. Underneath the rear armrests, for example, are two huge storage bins. Tucked neatly beneath the front passenger seat is an available drawer with its own lock. A center

console offers a slide-away coin holder, a cubbyhole, and a compartment for storing stuff like CDs and cassettes. Also available is an overhead console with a place for both sunglasses and garage door opener. There are more storage bins, cubbyholes, drawers, pockets and just plain old places to hide things away than ever before. And that doesn't even include the glove box (which, by the way, is where you'll find the pacifier).

For more information about the all-new Plymouth Grand Voyager, call 1-800-PLYMOUTH, or see your local Chrysler and Plymouth dealer. They'll be happy to show you everything you don't see here.

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Forum

Endangered Species Act

Douglas Chadwick's article with the superb photography by Joel Sartore (March 1995) may prove to be one of the most important and effective you have ever published. It cogently reveals the need for maintaining complex ecosystems in good health and the critical importance of biodiversity. In despair I hear politicians and others rant about the cost of protecting insignificant and uncharismatic little organisms. I feel that to correct them would be like trying to explain to medieval doctors how investments in public health and hygiene could prevent the plague.

DAVID HANCOCKS
Executive Director
Arizona-Sonora Desert Museum
Tucson, Arizona

The article repeats the suggestion that the decline of the Steller sea lion was caused by humans fishing its principal food, the pollock. Actually, off Alaska there has been a dramatic increase in pollock biomass. Pollock is fished under conservative quotas that have kept the stocks strong. The annual quota for Alaska is based on a formula that first provides a harvest for sea lions.

A lot of research into the problem is under way. Some scientists have speculated that pollock may not be as good for the sea lions as are fattier species and that sea lions are now getting too much pollock for their own good. The fact is we don't know yet what caused the sea lion's decline.

JOSEPH BLUM
Executive Director
American Factory Trawler Association
Seattle, Washington

As author Chadwick points out, the main reason we are losing species at such a rapid rate is the destruction of habitat. That will continue unless we find a way to persuade landowners to keep portions of their property in natural or semi-natural condition. The Wilderness Society is proposing tax incentives and other inducements to create a national network of "lifelands," made up of ecologically significant private and public lands. This preventive approach is a necessary complement to the emergency-room approach represented by the Endangered Species Act.

G. JON ROUSH
President, Wilderness Society
Washington, D. C.

The "classic boondoggle" of Tellico Dam was the one caused by Dave Etnier, his snail darter, and the Endangered Species Act. The final cost of the dam was 136.9 million dollars, more than three times the original estimate. Contrary to the author's opinion, the main beneficiaries of the dam have been many: property and home owners, construction companies and their workers, new business ventures, and local economies. The Tellico Dam story is a perfect example of environmentalism run amok. Fortunately, saner heads won out on this one.

BOB METZGER
Sharpsville, Indiana

Opposition to the dam began before the snail darter was found, and several other factors contributed to its final cost.

The act, like the species listed, is hovering close to death in our newly elected Congress. In its quest to make the market drive all human interactions and to free society of its current "regulatory burden," other species will be left to fend for themselves. Because kangaroo rats and spotted owls don't pay taxes, build new homes, or drive new cars, their habitat will be converted to a more productive use, and they will cease to exist. While the GNP won't break stride as it tallies our value, I cannot help but think that we will all be the poorer for the loss.

TED HEISEL
Labadie, Missouri

After receiving the March issue with the picture of the netted animal on the cover, I found my four-year-old daughter cutting it with her scissors. I began to scold her when she explained: "But Mama, I was just trying to cut the ropes so the little fox could get away."

SHEILA M. DUNBAR
Montgomery, Alabama

Bombay

Born and raised in Bombay, and being a true-blue Bombayite, I thank John McCarry for portraying the city as it is, its good and bad, and for emphasizing how proud we are to be Bombayites first. This is the most authentic description of my city I have read in the Western world.

SIMMONE SHAH
Mountain View, California

The name Bombay is the anglicized version of the Marathi name Mumbai in honor of the female Hindu deity Mumbadevi, around whose temple Bombay grew. To associate Bombay with the Portuguese Bom Bahia, meaning "good bay" (page 49), slights the Maratha, who still call their city Mumbai with affection and reverence.

VITTAL P. PYATI
Beavercreek, Ohio

Once again the media has highlighted the negative aspects of one of the world's great cities. Why could you not include more pictures of the commercially booming city, instead of the decaying conditions of half the Bombayites?

ABHAY K. DESHPANDE
Atlanta, Georgia

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Chinchorro Mummies

As a member of an Earthwatch expedition, I camped at Camarones Cove while assisting these dedicated archaeologists in their search for early civilizations. These deserts are a fascinating book, of which mummies are but a feature article. Another exciting story is that of the textiles excavated—brightly colored, tightly woven garments in pristine condition. There are also giant petroglyphs of alpacas, birds, and people carved into towering dunes.

OWEN JONES
Cumming, Georgia

After the Chinchorro and before the Inca Empire, many cultures existed in Peru, several of which practiced mummification. The mummies from Paracas, discovered by anthropologist Julio C. Tello, are world renowned. The Nazcas, masters at mummifying heads, kept the heads of loved ones as today we keep pictures. By the way, Arica, Chile, where some of the Chinchorro mummies were found, belonged to Peru before the War of the Pacific (1879-1883).

CARLOS A. JOHNSON
Astoria, New York

Journey to Aldabra

As co-author of a guidebook to Seychelles, I read with fondness your article on the Aldabra Islands. It didn't mention the devastation Assumption Island suffered at the hands of guano miners early in this century. It was rendered barren and nearly lifeless. In contrast, the seas there led Jacques Cousteau to comment that he had never seen any other place on earth with the same clarity of water or such colorful and extensive reef life.

DEANNA SWANEY
Tenby Wells, England

With the photograph of Astove, David Doubilet tells a story about the Veevers-Carters. Unfortunately they were not on Astove, but on Remire Island in the Amirantes, some distance away. The story of their time on Remire is told in *Island Home* (New York, Random House, 1970).

LARRY W. BOWMAN
Storrs, Connecticut

The family also lived for a time on Astove.

North Carolina's Piedmont

Cathy Newman captured the earthy, no-nonsense lifestyle, and Pete Souza's photographs reenforced the laid-back atmosphere. If I didn't know better, I would think they were from here. Martha Ward with her pantry could have been my own mom.

ROGER D. TENCH
Denver, North Carolina

Since North Carolina was the founding state for the technical education system, I am surprised that managers decry a lack of technical training. The state has the second largest technical training program for new industry in the U. S., with 58 community colleges. This is one reason North Carolina consistently ranks among the top corporate locations in the nation.

HARRY C. WHALEN
Executive Director
Economic Development Commission
Salisbury, North Carolina

Apparently former governor Terry Sanford has never had the opportunity to get a true appreciation of all that New Jersey has to offer (page 128). Long Beach Island resembles that part of the Outer Banks where I own property. He should also see the wonders of the Delaware Water Gap and the Pine Barrens. Come up and see us sometime.

JOHN McLEAN
Freehold, New Jersey

If car racing is no longer chicken bones and Bud, why are no caviar producers and champagne makers sponsoring drivers?

RALPH A. BLEVINS, JR.
Whitetop, Virginia

Geographica

Regarding your report on the early domestication of pigs, of course pigs helped ancient people settle down. Any Chinese will tell you that if you put a roof 宀 over a pig 豕 , you will have a home 家 .

PAULINE LEE
Bowie, Maryland

Being from a generation that has grown up on instant, full-color news coverage of any major conflict on the globe, I have often found it difficult to comprehend the images of World War II. Movies or pictures from that era are fuzzy or grainy and in black and white. The photograph of the action on Blue Beach at Iwo Jima in the February issue is the first color print I have ever seen. For the first time, images of World War II seem real. The sky is not gray or black but clear, sunny, blue. The men are no longer shady caricatures but real people. Thank you for bringing a part of history to life.

HEATHER McMILLAN
Edmonton, Alberta

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Geographica

Down to Beirut's Beginning

WORKING AGAINST THE CLOCK—ahead of contractors and officials eager to rebuild Lebanon's war-torn capital—archaeologists are peeling back layers of the port's rich history. Beneath the rubble in downtown Beirut they have discovered the first tangible proof of Canaanite settlement here, including stone city gates 5,000 years old.

Leila Badre (right), curator at the American University of Beirut Archaeological Museum, leans over a sunken funerary jar she found last February. The bones of a three- to four-year-old Canaanite girl buried nearly 4,000 years ago lay within. Her legs and arms were crossed, and she wore a necklace of gold, rock crystal, and carnelian beads. Burial pots, known from other Middle Eastern sites, are "symbols of the mother's womb for a second life after death," says Badre. "The necklace tells us she was from a rich family."

Badre's team also uncovered a city wall built by

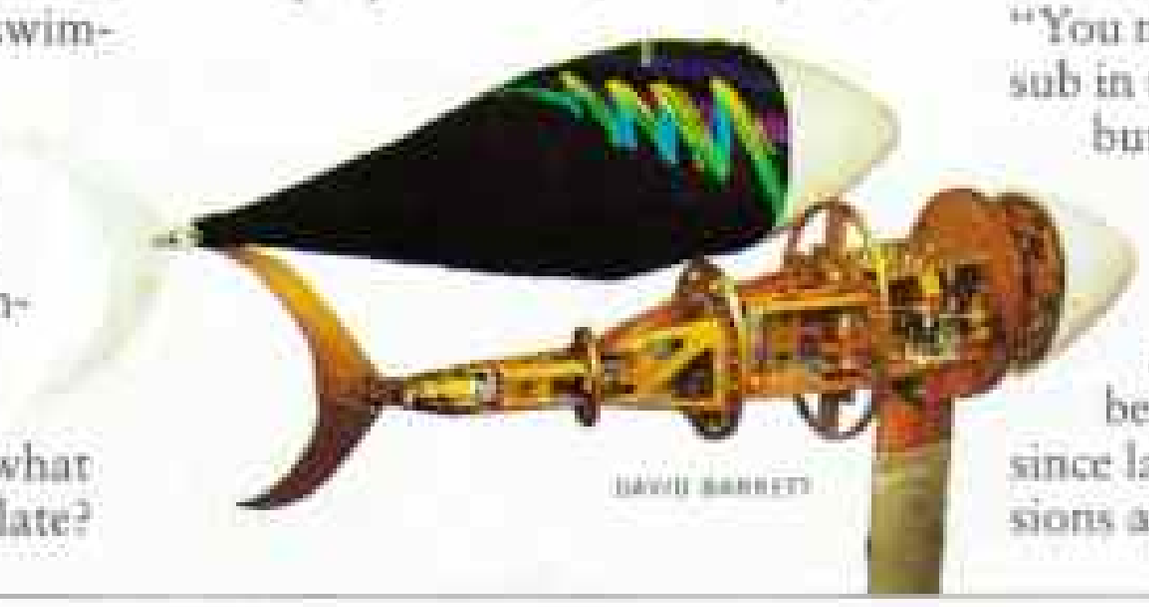
MICHA BAR-AM, MAGNUM (BOTH)

Phoenicians in the seventh or eighth century B.C. —and oil lamps, jugs, bowls, and other pottery that helped date the finds. Remains of more recent occupations include this Greek inscription (above left), honoring the commander of a Roman legion in the third century A.D.

Charlie the Robotuna Follows Nature's Model

A BLUEFIN TUNA is state-of-the-art when it comes to efficient, high-speed, endurance swimming. So when engineers wanted to create a low-cost, long-distance research robot that could measure salinity, track oil spills, or send back images of the Mid-Ocean Ridge, what better "vehicle" to emulate?

Meet Charlie the Robotuna. Modeled on a bluefin, this 52-inch-long tethered prototype has tendons, a segmented backbone, a propulsive tail, and a Lycra,



DAVID BARRETT

foam, and latex skin.

"Exploring underwater is expensive and difficult," says David Barrett, the MIT graduate student who designed Charlie. "You might want to put a robot sub in the water for six months, but you can't store enough energy in its batteries. The alternative is a more efficient propulsion system." Charlie has been tested in an MIT tank since last summer; other versions are in the works.

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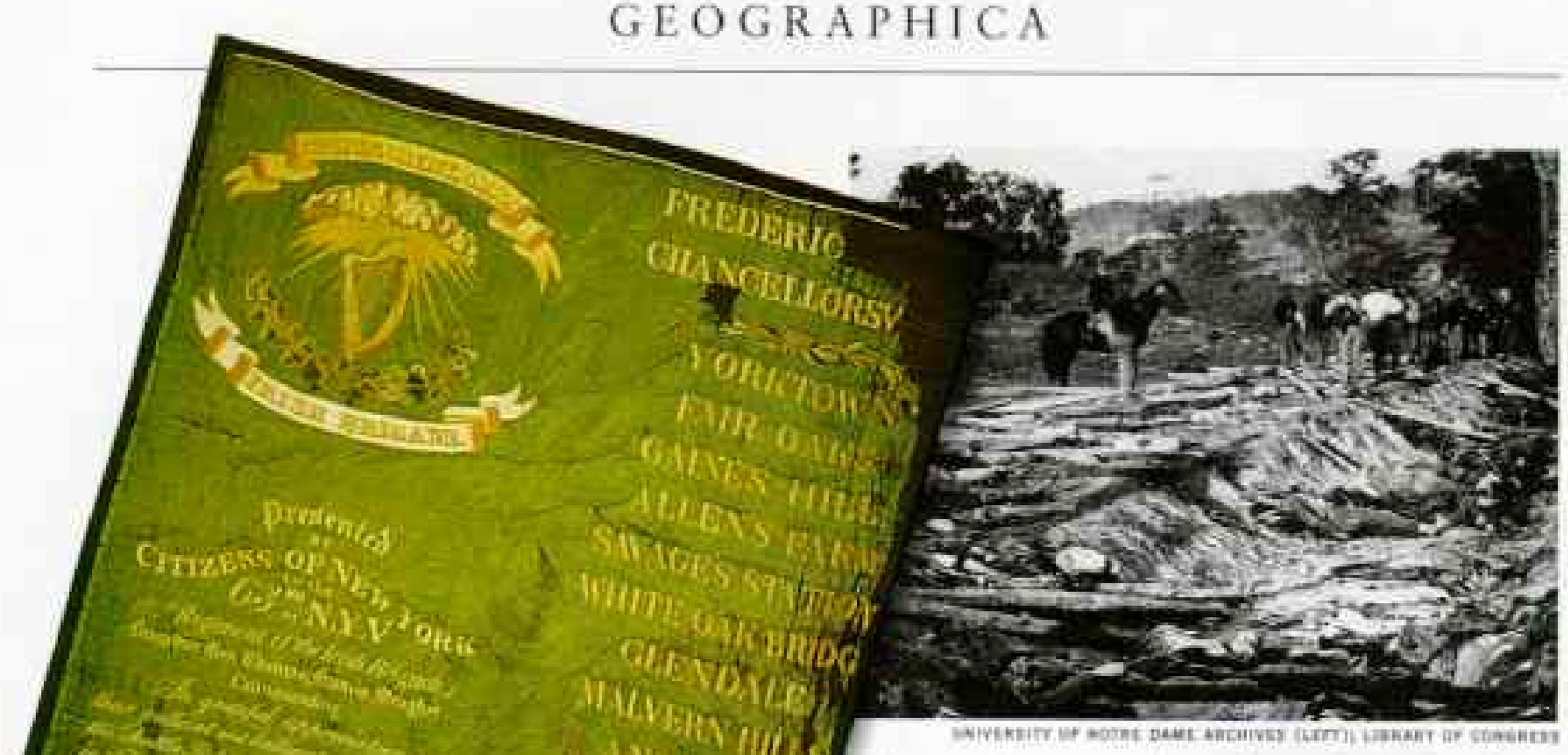

UNIVERSITY OF NOTRE DAME ARCHIVES (LEFT); LIBRARY OF CONGRESS

Identifying Unknowns in Antietam Graves

IN 1988 CIVIL WAR BUFFS prospecting for relics of the Battle of Antietam on a Sharpsburg, Maryland, farm made a grisly discovery: four unmarked graves. After painstaking detective work a National Park Service archaeologist is now close to naming one of the casualties.

"It personalizes this discovery," says archaeologist Stephen Potter.

The shallow graves held the bones of Union soldiers who fell September 17, 1862. Advancing toward a sunken road later known as Bloody Lane (above right), they were cut down by Confederates hunkered in the depression.

Potter's team uncovered cuff buttons from New York State uniforms, pieces of a rosary, and 69-caliber buck-and-ball musket ammunition used by enlisted men of the Irish Brigade, a unit made up of immigrants recruited in New York City.

Examining the bones, Smithsonian anthropologist Douglas Owsley reported that one of the four men was in his 40s. Potter combed the Irish Brigade's records and found that only three enlisted men who had died at Antietam and whose grave sites were unknown were that age—Privates James McGarigan, Martin McMahan, and James Gallagher. All served with the 63rd New York, whose regimental colors (above left) testify to its role in the war.

PHIL SCHOFIELD

I'm a Little Gas Station, Short and Stout . . .

AS POLITICAL SCANDALS GO, the disgrace of the 1920s known as Teapot Dome has real staying power. This Zillah, Washington, gas station still recalls the outrage—and still pumps gas.

President Warren Harding's secretary of the interior, Albert Fall, had secretly leased federal oil reserves in Teapot Dome, Wyoming, and Elk Hills, California, to private firms for personal profit. Fall was later convicted of bribery in 1929 and jailed.

Says Lyn Dasso, who runs the commemorative station, "The spout was the chimney for a wood-burning stove; the handle is a decoration." The teapot was moved a mile in the late 1970s, when I-82 was built. It is listed on the National Register of Historic Places as a landmark example of roadside follies.

—BORIS WEINTRAUB

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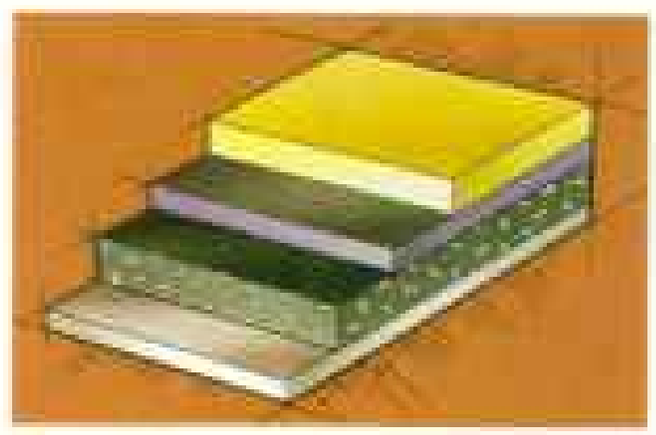

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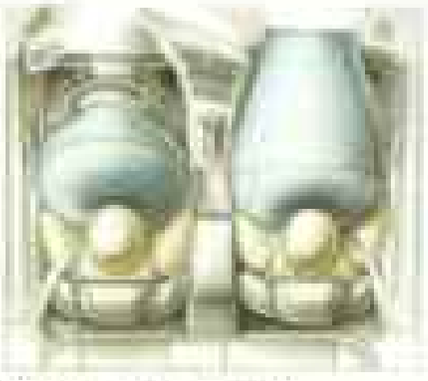

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The Discovery from Land Rover has made it to yet another incredibly hard-to-reach place.

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After *Four Wheeler* magazine tested it both on and off road, along with a number of other top new sport utility vehicles, the Discovery won the illustrious title of Four Wheeler of the Year.

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And it even appeared in *Popular Science* as the Best of What's New.

Of course, such praise isn't too surprising for a 4x4 with all-terrain ABS, permanent four-wheel drive, standard dual airbags, and an astounding ability to handle the farthest-flung corners of the planet.

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As the acclaim it's been getting shows, it's undoubtedly ahead of the competition.

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On Television

■ EXPLORER, JULY 30, 9 P.M. ET

Defying the Odds in Pursuit of a Dream

THREE DAYS SHORT of his 89th birthday Norman D. Vaughan reached his peak—the summit of a 10,302-foot mountain bearing his name in Antarctica's Queen Maud range, 280 miles from the South Pole. He and his wife, Carolyn Muegge-Vaughan (below right), carried a message for all ages: "Dream big, and dare to fail."

EXPLORER's "Height of Courage: The Norman Vaughan Story" chronicles a man's determination to return to the bottom of the world and climb to the top of his mountain. "So far as I know," says Vaughan, "I'm the only person in the world to have a mountain named for him, then to climb it."

As a young Harvard dropout Vaughan volunteered to handle the sled dogs on Adm. Richard E. Byrd's 1928-1930 Antarctic expedition—the first to fly over the South Pole. Byrd called Vaughan (top, at far right) and two fellow dogsled drivers the "three musketeers" and named untrodden peaks near the Ross Ice Shelf after each.

On the ascent of Mount Vaughan the onetime driver carried in his backpack a stuffed toy dog—a tribute to sled dogs past and present. To aid Vaughan, who has a fused ankle and an artificial knee, professional climbers hacked over 7,000 stairsteps in the ice, often on slopes of 30 to 40 degrees.

As they neared the summit, Vaughan forged ahead. "I could see Amundsen and Scott Glaciers and all the way to the polar plateau. In every way the sight lived up to my dreams of the past 65 years."

JOHN G. O'BRIEN (ABOVE); GORDON WILTSIE

■ PROGRAM GUIDE

National Geographic Specials
NBC. See local listings.

National Geographic EXPLORER
TBS. Sunday, 9 p.m. ET

July 2: "Lions of Darkness, Part 1"; "Ndoki Adventure"
July 9: "Lions of Darkness, Part 2"; "Mr. Mummy"
July 16: "Photographer Annie Griffiths Belt"
July 23: "Disaster!"; "Play: The Nature of the Game"
July 30: "Height of Courage: The Norman Vaughan Story"; "The Eagle and the Snake"

National Geographic Videos and Kids Videos Call 1-800-343-6610.

Next Month on EXPLORER "Smoke Jumpers" premieres Aug. 27.

Earth Almanac

CYNTHIA MOSS (LEFT); JOYCE POOLE (CENTER AND ABOVE)

Famed Bulls Dead or Missing

OLD BULLS ARE OLD FRIENDS of the family in Kenya's Amboseli National Park. Its elephants have been studied for 23 years by Cynthia Moss, director of the Amboseli Elephant Research Project. The gentle giants know no fear of mankind. Neither do they know that Kenya's border with Tanzania—where elephant hunting is legal—lies near the park. Eight missing bulls, including Sleepy (above left) and Andrew (center), may have wandered into Tanzania. Two others, RBG (above right), whose name comes from the initials of a project donor, and Sabore (right), were recently discovered across the border, their lives rudely ended by hunters.

Moss was alerted by local Masai, who found the carcasses. Of Sabore she says, "The hunters took a chain saw and decapitated him, then cut down through the top of his head, removed the tusks, cut off both ears, all four feet, and the tail." Moss adds that the bulls may have been shot by hunters who were in or near their vehicles, a violation of Tanzanian hunting regulations. She says, "Killing these bulls was about as difficult and dangerous as shooting your neighbor's poodle."

No other wild elephants had been observed for so long a time. And they were a major tourist attraction. Three ecotourism companies pay a group of Kenya's Masai about $60,000 a year to let them bring visitors to Masai lands to view wildlife, especially elephants. Moss is working to persuade the Tanzanian government to encourage such ecotourism on its side of the border.

AMBOSELI ELEPHANT RESEARCH PROJECT

Legal Crossroads for Endangered Species

AS CONGRESS DEBATES the Endangered Species Act (GEOGRAPHIC, March 1995), one key court case has strengthened the act, while another could severely weaken it.

Last February a judge in San Francisco prevented a firm from logging 137 acres of its land, ruling that lost habitat would threaten the marbled murrelet, an elusive seabird that nests in ancient trees such as coastal redwoods. The birds range from Alaska to California, where they number only about 2,000. "This is the first time a court has used the Endangered Species Act to block logging on private land," said attorney Macon Cowles.

The company, which will appeal, had asked the judge to apply standards from another case known as Sweet Home. In it, a group of Oregon loggers and landowners challenged federal rules for the northern spotted owl. Last year an appeals court, in its decision on Sweet Home, ruled that the act does not prohibit habitat destruction, only direct harm to an endangered species itself. Looming large, a U. S. Supreme Court decision on Sweet Home is expected this summer.

Bears and Alaska Natives Win on Kodiak

AN OLD INJUSTICE that threatened Kodiak's famed bears—among the world's largest—has been remedied. Although two-thirds of Kodiak Island is a federal wildlife refuge, 310,000 acres of the refuge were granted to Kodiak native corporations. Under the Alaska Native Claims Settlement Act of 1971 the natives were forced to select refuge lands—then were not allowed to develop them. Nearly destitute, some natives threatened to defy the law by building cabins and bringing in tourists—certain to increase conflict between people and Kodiak's 2,500 bears (GEOGRAPHIC, November 1993).

Late last year the *Exxon Valdez* Oil Spill Trustee Council, allocating damages for the 1989 disaster, began negotiating to restore 212,000 native-owned acres to the refuge in exchange for payments totaling 89 million dollars. Most of the money will be invested by three native corporations for their 3,500 native shareholders. "This was a big win," said Ralph Eluska, president of Akhiok-Kaguyak, Inc. "It's a good deal for the people coming after us."

DAVE HAMMAN, AGPIX PHOTO LIBRARY (BELOW); DAVID CLARK

Lobstergate: Shellfish Windfall in Power Plant

AN ELECTRIFYING DISCOVERY was made by New Hampshire Fish and Game officers last year. A worker at a Portsmouth power plant allegedly found that his job offered some extraordinary employee benefits—a steady supply of lobsters sucked into the plant through a cooling pipe. An officer caught the employee headed home with 28 lobsters for his freezer, which was stuffed with 508 more.

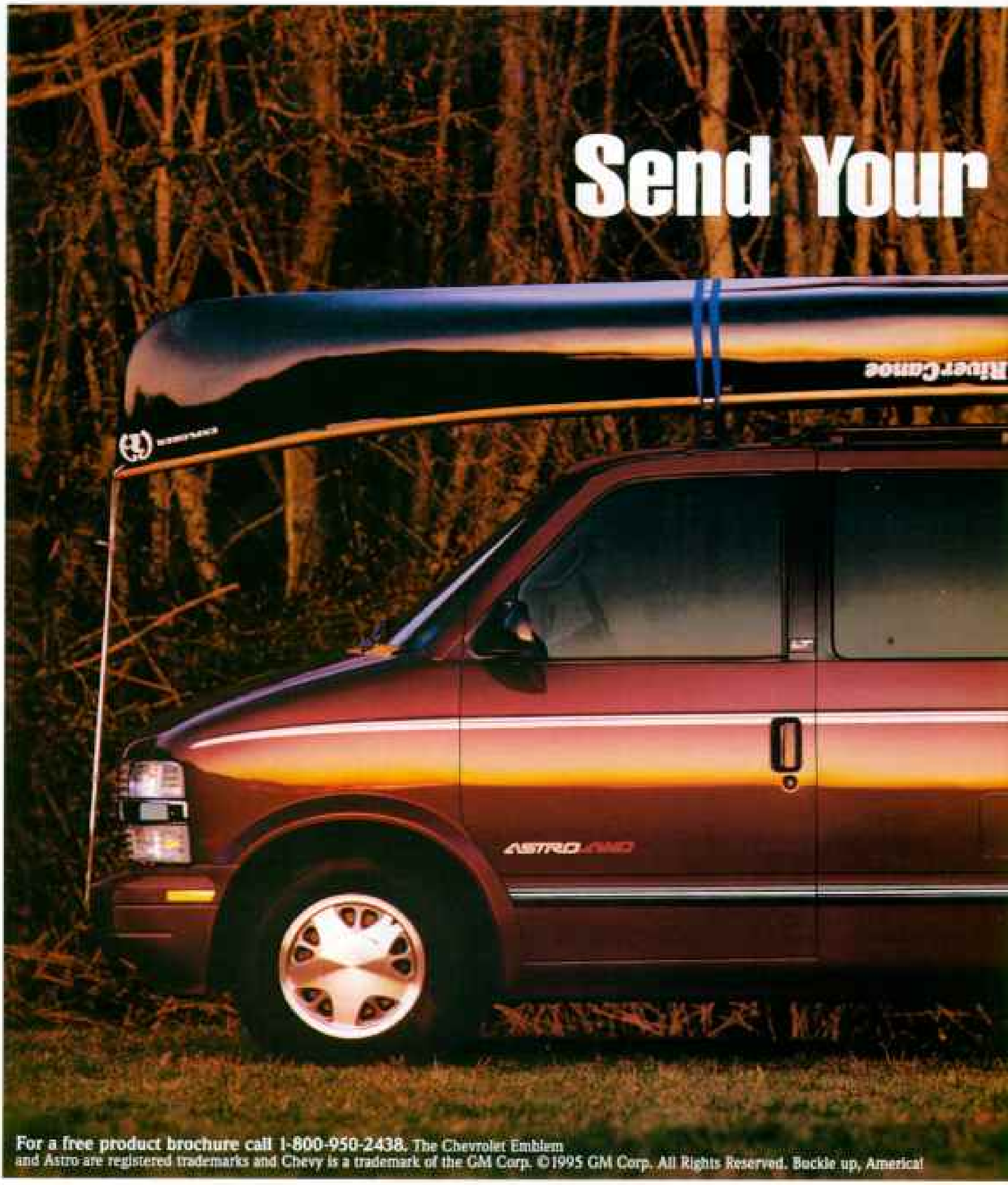
"We were in shock, obviously," said state marine biologist Bruce Smith. "During peak times 50 to 80 lobsters were being taken." The plant lies four miles from the Atlantic Ocean on the Piscataqua River, salty and rich in lobsters. Sand buildup had raised the bottom, allowing lobsters to crawl into an intake pipe. They wound up on an internal screen that is washed every four hours. "That's where the lobsters were intercepted," Smith said. The suspect could be fined $30,000 and spend a year in jail.

Wild Dogs Persecuted as "Wolves of Africa"

"IT WILL BE an excellent day . . . when means can be devised . . . for this unnecessary creature's complete extermination." The 1914 wish of big game hunter R.C.F. Maugham may soon come true. In his day Africa's wild dogs may have totaled 200,000. Perhaps 5,000 remain, facing habitat loss, disease, and human animosity.

The dogs live as an extended family in packs of six to eight adults with about eight puppies. With peerless coordination they bring down and disembowel their prey—with a proficiency that has earned them the enmity of hunters and of farmers, although wild dogs seldom kill livestock. They have nearly vanished from 19 of 34 countries, with strong populations remaining only in southern Africa.

—JOHN L. ELIOT



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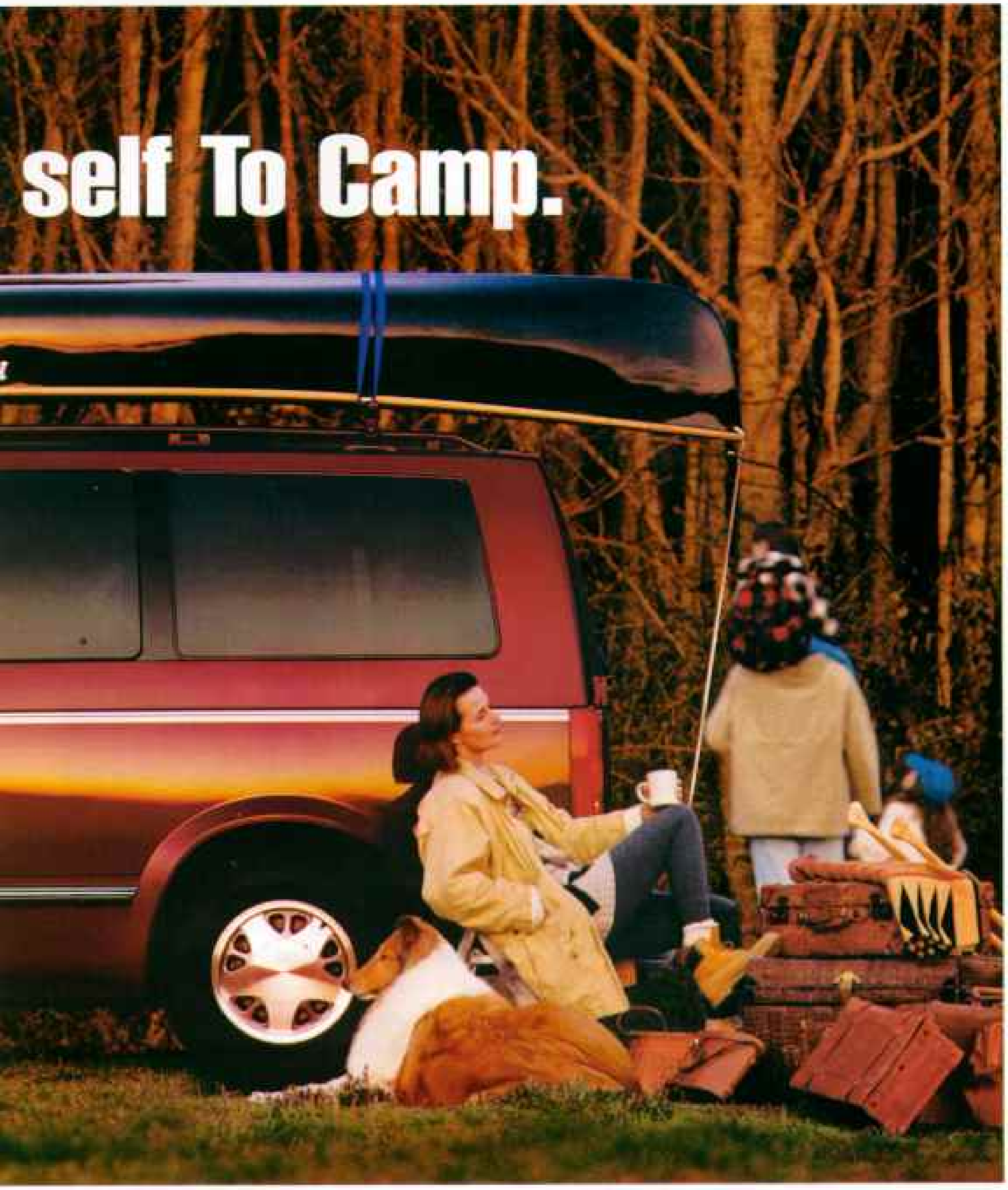

overhead console, armrest coolers and wall to wall carpeting. To be on the safe side, Astro carries a driver's side air bag and standard 4 wheel anti lock brakes. Camp Astro, here we come. And don't forget the marshmallows.

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NATIONAL GEOGRAPHIC

On Assignment

■ BURMA, THE RICHEST OF POOR COUNTRIES

A Writer Returns

STEVE MCCURRY

WHILE MANY AUTHORS agonize over what editors cut from stories, Senior Writer JOEL SWERDLOW—here performing a purification rite at a Rangoon shrine—worried more about what he should leave in. "People risked their lives to talk to me about Burma's military dictatorship," he explains. "I had to make sure they couldn't be identified. I knew the government might retaliate."

Born in Washington, D. C., into a world-roving family, Joel went to Burma—from Paris—at age nine. When the democratic government fell three years later, the Swerdlows moved to Syracuse, New York.

While earning a doctorate at Cornell University, Joel resolved to become a writer. To earn money while working on a novel, he covered the Watergate trial for National Public Radio.

His first GEOGRAPHIC article, "To Heal a Nation" (May 1985), described the creation of the Vietnam Veterans Memorial. His book with that title became a TV movie.

Joel's books, short stories, and articles have been translated into several dozen languages. At the GEOGRAPHIC since 1992, his articles have ranged from the human brain (June 1995) to Walt Whitman (December 1994)—a finalist in the 1994 National Magazine Awards.

BARRY BLANCHARD

■ ROCKY TIMES FOR BANFF

Climbing Above the Crowds

"IT WAS A NICE FALL DAY on the valley floor when we started climbing," recalls contract photographer RAYMOND GEHMAN, shown here part way up a glacier on the north side of Mount Athabasca. "You can hike to a different season in a few hours at Banff." And get away from the crowds in Canada's busiest national park.

Ray first took up photography after the U. S. Army sent him to Germany. He traveled in Europe, where "taking pictures seemed like the natural thing to do." Back in the States, he studied photojournalism at the University of Missouri. He found working as a newspaper photographer in Montana and Virginia "the best training in the world." It has served him well on GEOGRAPHIC assignments that include Hurricane Andrew (April 1993) and eastern wildlife (February 1992).

NATIONAL GEOGRAPHIC (ISSN 0027-9358) IS PUBLISHED MONTHLY BY THE NATIONAL GEOGRAPHIC SOCIETY, 1145 17TH ST. N.W., WASHINGTON, D. C. 20036-4688. $25.00 A YEAR; $3.00 A COPY. SECOND-CLASS POSTAGE PAID AT WASHINGTON, D. C., AND ELSEWHERE. POSTMASTER: SEND ADDRESS CHANGES TO NATIONAL GEOGRAPHIC, P.O. BOX 2174, WASHINGTON, D. C. 20013.

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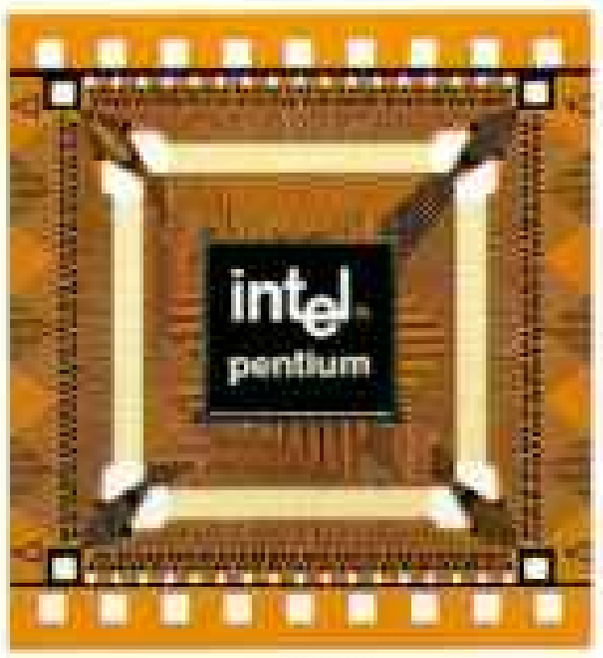

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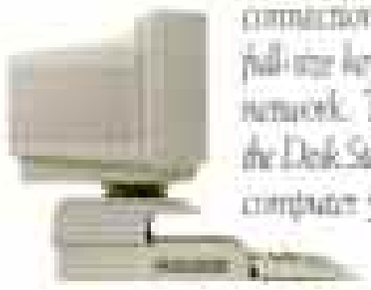

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